Pitch–The psychological correlate of frequency.

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

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

Screening Audiometry–Hearing test procedures used to identify individuals in need of further hearing evaluation. Also called Sweep Screening.

Sensorineural Hearing Loss–A type of hearing loss due to pathology of the inner ear (cochlea) or the nerve pathway from the inner ear (cochlea) and/or nerve of hearing to the brain stem. Sensorineural damage is usually irreversible.

Stapes (stirrup)–The third and smallest bone of the ossicular chain.

Threshold–The softest (minimum) hearing level at which an individual is able to respond to a tone at least 50 percent of the time.

Tubes–See Ventilation Tubes.

Tympanic Membrane–A thin membrane between the external auditory canal and the middle ear cavity, it moves in response to sound waves and sets the ossicular chain into motion.

Tinnitus–Inner ear sounds (ringing, buzzing, or roaring) perceived from possible damage to nerve cells.

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.

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.

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Appendix A

Ear Anatomy

The ear receives sound waves that are processed and transmitted to the hearing center in the brain for interpretation. The ear is divided into three parts: 1) outer, 2) middle, and 3) inner.

The outside ear consists of the auricle, or pinna, and external auditory canal. The auricle, or visible part of the ear, directs and concentrates the sound waves along the external ear canal to the tympanic membrane. The ear canal contains hairs and wax producing glands that serve to protect the eardrum from dirt, inserts, or foreign matter. The tympanic membrane is a thin diaphragm that completely closes the end of the ear canal and separates the outer ear from the middle ear.

The middle ear is a tiny, air-filled cavity between the eardrum and the bony wall of the inner ear, and contains the three smallest bones, called ossicles. The first bone in the ossicular chain is the hammer (malleolus) which is attached to the eardrum. The anvil (incus) fits between the hammer and the third bone, known as the stirrup (stapes). The footplate of the stapes is set in the window of the inner ear. A passage between the middle ear and the back of the nose (eustachian tube) serves as a means for equalizing air pressure and ventilating the middle ear cavity.

The inner ear contains the sensory organ for balance (including the semi-circular canals), as well as, the organ for hearing known as the cochlea. The cochlea resembles a snail shell in appearance and is filled with fluid. Sound vibrations from the eardrum are transmitted through the ossicular chain to the oval window to the fluid in the cochlea. The sound sets in motion thousands of hair-like sensory cells in the cochlea called the organ of corti. These sensory cells transform fluid movements into electrical impulses and, by a series of complicated processes, transmit them to the auditory nerve to the brain, where they are perceived as sound.

The school nurse must know and understand the anatomy and physiology of the ear if she/he is to understand the results of hearing tests. Interpretation of the findings of the hearing test is often based on the structure and functioning of the ear and its many parts.

Normal Hearing and Hearing Loss–Defined

- **Normal Hearing**–Normal hearing occurs between -10 decibels and 20 decibels (loudness of sound). The ability to hear is more developed at birth than the ability to see. There is a normal developmental progression in the ability of an infant to respond to sound.
- **Description and Types of Hearing Loss**
  1) **Conductive Impairments**-Any dysfunction of the outer or middle ear is termed a conductive impairment of hearing. In other words, the difficulty is not with the

perception of sound, but with the conduction of sound to the analyzing system. Conductive hearing loss results from injury to the outer ear, the eardrum, the hearing bones, or the middle ear space. This type of hearing loss can usually be corrected by medicine or surgery. Hearing aids are often helpful with this type of loss if not otherwise corrected.

Causes of conductive hearing impairments:

- Wax buildup;
- Objects lodged in the ear drum (plastic toys, seeds, insects, etc.);
- Damage to the ossicles behind the ear drum;
- Infections of outer or middle ear; and
- Fluid buildup in the middle ear.

2) **Sensorineural Hearing Impairment**-When the loss of hearing function is due to pathology in the inner ear, or along the nerve pathway from the inner ear to the brain stem, the loss is referred to as a sensorineural impairment. In other words, sound is conducted properly to the fluid of the inner ear, but it cannot be analyzed or perceived normally. This loss can be discovered at any age. This type of hearing loss may be a sign of a serious illness and should not be neglected. Hearing aids are usually helpful with this type of hearing loss. Medication and/or surgery are usually effective treatment options for sensorineural hearing impairment. High frequency sounds tend to be more affected, although some congenital losses affect all tones equally. Cochlear implants have been helpful for some individuals, especially if implanted early in childhood.

Causes of Sensorineural Hearing Impairment:

- Damage during fetal development or at birth;
- Familial-hereditary factors;
- Infections;
- Certain medications;
- Certain diseases;
- Prolonged exposure to excessive noise;
- Head injuries; and
- Aging.

3) **Mixed Hearing Impairment-**In some instances, an individual may exhibit symptoms of both conductive and sensorineural hearing loss. For example, a child with a congenital sensorineural hearing loss may also have some degree of conductive hearing loss due to otitis media. A patient with a mixed impairment shows some loss by bone conduction, but a greater loss by air conduction.

4) **Unilateral Hearing Impairment-**An individual may have normal hearing in one ear and a hearing loss in the other ear that could impact learning. These children may benefit from hearing aids or a sound field system.

Educational Implications

There are many factors that affect the speech/language abilities and academic success of each child. Some children have severe loss, very intelligible speech and make good grades. Other children with very mild loss and little family support exhibit considerable academic failure. Labels such as mild, moderate, severe, or profound, based on the pure tone thresholds, do not predict handicap or academic success. The possibility of hearing loss, however mild, needs to be evaluated to assure attention to a learning barrier. Being able to hear all sounds is important when learning to read. Any loss, no matter how mild, needs to be evaluated in order to assure attention to any barrier of learning.

Federal programs exist in all states to assist families and children with early-identified hearing concerns. In Missouri, the First Steps program is designed for children, birth to age 3, who have delayed development or diagnosed conditions that are associated with developmental disabilities. Deafness and hearing impairments are one of the eligibility criteria that qualify young children to receive free services through this program.

Appendix B

Assessment Schedule

Hearing screening begins at birth and continues throughout life. The majority of states (including Missouri) currently conduct newborn hearing screenings. The following schedule lists the methods of screening appropriate for individuals at different ages. As the age of the person being screened changes, so should the screening protocol. Specific program guidelines may differ from the following recommendations:

Age	Appropriate Screening
At Birth	High Risk Register Criteria Observational Screening (Startle Response) Parental screening Questions A-C Otoacoustic Emissions Screening Auditory Brainstem Response
Birth to 6 Months	High Risk Register Criteria Observational Screening (Startle Response) Parental Screening Questions A-C Otoacoustic Emissions Screening Auditory Brainstem Response
7-12 Months	High Risk Register Criteria + Supplemental Questions Parental Screening Questions A-C Observational Screening Tympanometry Otoacoustic Emissions Screening
13-18 Months	High Risk Register Criteria + Supplemental Questions Parental screening Questions A-E Observational Screening Tympanometry Otoacoustic Emissions Screening
19-24 Months	High Risk Register Criteria + Supplemental Questions Parental Screening Questions A, F and G Observational Screening Tympanometry Otoacoustic Emissions Screening
25-36 Months	High Risk Register Criteria + Supplemental Questions Parental Screening Questions A, F and G Otoacoustic Emissions Screening Pure Tone audiometric Screening Conditioned Play Audiometry Tympanometry
3-6 Years	High Risk Register Criteria + Supplemental Questions Pure Tone Audiometric screening Conditioned Play Audiometry Tympanometry
6 Years and Older	Health History Pure tone audiometric screening Tympanometry

Appendix C

History Related to Hearing

A variety of conditions may put a child "at risk" for developing hearing problems after birth. Some children with significant hearing loss are identified after 1 year of age when behaviors may indicate inability to hear. Children with a health history that includes the following conditions should be observed for the development of a hearing loss.

1) High Risk Register (for early childhood screening)

Some babies may be identified at birth as being "at risk" for hearing impairments. The following is a list of criteria to indicate infants who might be considered at risk:

a) Family history of any blood relative with childhood hearing impairment;
b) Rubella or other nonbacterial transplacental infection (e.g., cytomegalovirus infection, herpes infection, syphilis);
c) Defects of the ear, nose, or throat. Malformed, low-set or absent pinnae, cleft lip or palate (including sub mucous cleft), any residual abnormality of the otorhinolaryngeal system;
d) Birthweight less than 1500 grams;
e) Bilirubin level greater than 15 mg/100 ml serum or exchange transfusions;
f) Significant asphyxia associated with acidosis, as determined by attending physician, and proven meningitis;
g) Low Apgar Scores (zero to three at five minutes, zero to six at ten minutes);
h) Respiratory distress;
i) Physical features associated with syndromes that include progressive hearing loss; and
j) NICU stay greater than five days.

If one or more of the criterion are present, refer the infant to the appropriate health care professional.

2) Supplemental Questions

a) Did the child receive a Newborn Hearing Screening?
b) Does the child presently have a continuous or recurrent ear infection?
c) Has the child suffered from any of the following: meningitis, encephalitis, cerebral palsy, mumps, head injury, chemotherapy, or birth defects?
d) Was the child in an intensive care nursery after birth?

3) Parental Screening Questions

a) Have you had any worry about your child's hearing?
b) When he is sleeping in a quiet room, does he move and begin to wake up when there is a loud noise?
c) Does he turn his head directly toward an interesting sound or when his name is called?
d) Is he beginning to repeat some of the sounds that you make?
e) By 15 months, can he use three or four words correctly, other than "mama and dada?"
f) Can he identify familiar pictures when you name them?
g) Does he name things when he wants them, like candy or juice?

Appendix D

Observational Screening for Hearing Problems

Techniques for screening are indicated below and are intended for use in a well-baby clinic, physician's office, parent's home, or for children who can't be conditioned to an audiometer. The screener should be trained to do the observational screening, and have the appropriate materials.

- Select a quiet room for screening with little distraction from the outside.
- Have several noisemakers available–squeeze toys, bells, rattles, etc. Select these carefully to provide a variety of pitch and intensity levels.
- Seat the mother on a chair with the child on her lap. A colorful toy should be available as a distraction, but it should not be too attractive or it will engage the entire attention of the child.
- The screener kneels at a 45-degree angle to the side of the child, with the distracting toy in one hand and the noisemaker well hidden in the other. When the toy held in front of him engages the baby's attention, the screener makes a sound with the noisemaker in the hand, held close to the floor, out of the peripheral vision of the child. If an orientation response is seen after one or two presentations of the sound, the screener moves to the other side. The screener will learn by experience that for the 0 to 4 month age level, the noisemaker must be presented loudly; by 6 to 9 months, it can be presented more softly; and by 10 to12 months, it should be made as soft as possible.

The expected response is some sort of head turn toward the sound. An exact description of the head turn and accompanying eye movement should be noted. A normal-hearing child's orientation to sound will progress as follows:

- Newborn-arousal from sleep, or eye widening, eye blinking;
- 3 to 4 months-rudimentary head turn, a wobble of the head even slightly toward the sound;
- 4 to 7 months-localization to side only;
- 7 to 9 months-localization to side and indirectly below;
- 9 to 13 months-localized to side and below;
- 13 to 16 months-localized directly to all signals to side, below, and above; and
- 21 to 24 months-locates directly to a sound at any angle.

Interpretation of Observational Screening

When there appears to be no response, the screener should repeat the use of a particular stimulus at his discretion until the observer is satisfied that the failure to respond is genuine. Two repetitions should be adequate to establish this fact.

It must be kept in mind that the failure of the child to locate the sound does not always indicate that the child did not hear it. The simple fact that the child may not be interested in that particular sound can account for the lack of response. For this reason, more than one stimulus in a particular pitch range should be available for use at the discretion of the screener. In addition, it is important to conduct the screening when the infant or child is otherwise alert and calm.

Referral Criteria for Observational Screening

In making the observations previously described, a hearing loss should be suspected if the child does not respond appropriately on either side, or if he orients to the wrong side. The child who deviates markedly in these behaviors should be referred for further testing.

Tympanometry, or pneumatic otoscopy, and rescreening of failures may significantly reduce false positives and over-referrals. An infant who fails these additional tests should be referred to an appropriate health care professional.

Appendix E

Screening Students for Dual Sensory Loss

Students who are born deaf, or have a profound hearing loss should be screened for the possibility of the genetic disorder, Usher syndrome. This condition is of very low incidence (three to six percent of the deaf population have Usher's) but the condition, if present, will progress to total blindness. The individual develops retinitis pigmentosa (RP), usually in adolescence. It is important to identify these students as early as possible in order to prepare them for the future. Deaf students may function well using sign language or lip reading, but when they lose their vision, they must develop other means of communication. Students identified with Usher syndrome are often referred to special centers where they learn communication skills and mobility before they become totally blind.

If there are students in the population who are congenitally or profoundly deaf, it is helpful to complete the Usher Syndrome Screening Checklist. This checklist can rule out more than 99 percent of the students who might need further screening. The Vision Screening Guidelines contain the checklist and directions to test for balance (vestibular dysfunction), dark adaptation, and loss of peripheral vision that occurs with RP.

There are three types of Usher syndrome:

1) Type I congenitally deaf (up to 90 percent of Usher syndrome)
   - Impaired balance
   - Retinitis Pigmentosa
2) Type II moderate to severe hearing loss (up to 10 percent of Usher syndrome)
   - Normal balance
   - Retinitis Pigmentosa
3) Type III progressive hearing loss, normal at birth
   - Fifty percent have balance problems
   - Retinitis Pigmentosa
   - Possible mental retardation

Not all students with a hearing loss and RP have Usher syndrome. Type II and III will be mainstreamed in schools, so it is important to remember this possibility when reviewing your hearing screening results.

There is no cure for Usher syndrome and no way to prevent it, but you can screen high-risk students. If you find there is reason for concern after doing the additional screening by history and expanded vision and balance testing, the family should be contacted and a referral made for diagnostic testing.

Appendix F

Missouri History Related to Hearing Screening

Each year, nearly 80,000 newborns are added to Missouri's population. Children born in Missouri receive a Newborn Hearing Screening, as required by law (effective January 1, 2002), to detect hearing loss present at birth. All hospitals delivering babies must now assure a screening is performed prior to discharge. Parents who object to the screening based on religious reasons must document their refusal in writing. Informational materials must be provided to the parents prior to the screening describing the procedures and following the screening for those infants who fail. The Department of Health and Senior Services (DHSS) shall establish standards for screening, records maintenance and the development of follow-up procedures for newborns with reported hearing loss. Information maintained in this system shall be kept confidential. A newborn hearing screening advisory committee assists DHSS in developing rules, reporting forms and procedures, educational materials, and program evaluation forms. For a variety of reasons, e.g., equipment failure, home births, etc., newborn screenings may not occur; however, the vast majority (greater than 90 percent) will have been screened.

The purpose of the Missouri Newborn Hearing Screening Program (MNHSP) is to assure all babies born in Missouri receive a hearing screen and appropriate follow-up, including audiologic evaluation, enrollment into early intervention, and medical intervention, when indicated. Statistics show that three newborns per 1,000 have some degree of permanent hearing loss. Congenital hearing loss is more common than cleft lip or Down syndrome. Early identification of hearing loss and enrollment in appropriate intervention services during the first 6 months of life allows children who are deaf or hard of hearing to take advantage of the critical first few years of life, when language (spoken or signed), is acquired and allows children to develop language at a level equal to that of their hearing peers.

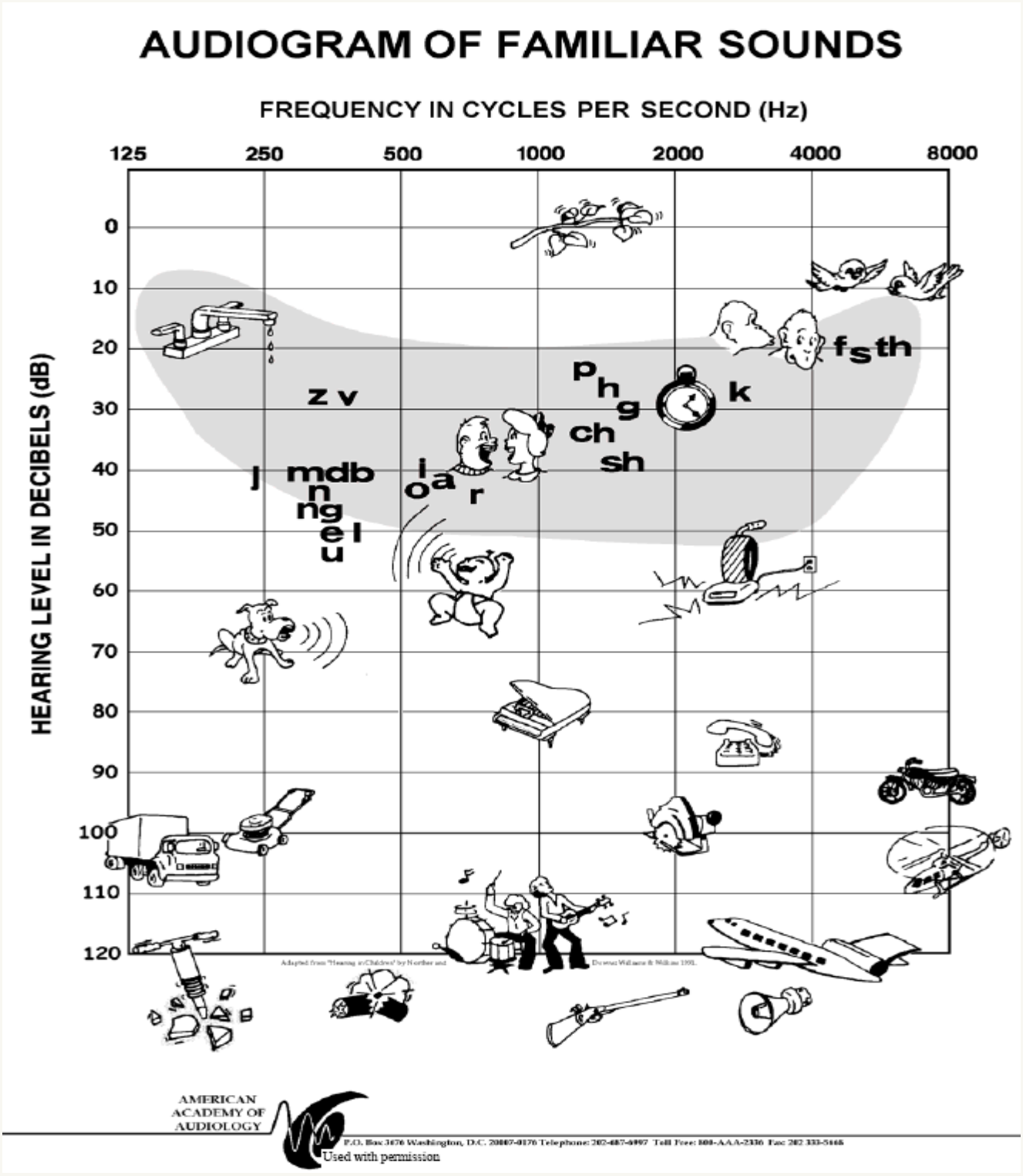
Currently, the MNHSP employs two regional representatives (RRs) who follow-up each newborn who missed or failed the hearing screen. The RRs contact the parents of newborns who need to return for an initial screen, a rescreen, or obtain an audio logic evaluation. Additionally, they contact birth hospitals and primary care physicians to obtain screening results that were not submitted to DHSS. Their goal is to ensure infants are screened no later than one month after birth, diagnosed by 3 months of age, and enrolled into early intervention no later than 6 months of age.

The MNHSP successfully collaborates with numerous entities. The MNHSP works with the Department of Elementary and Secondary Education in order to acquire data about the intervention services children with hearing loss receive through First Steps, Missouri's Part C program. Additionally, Missouri State University provides a contract audiologist consultant who advises the MNHSP in audiological matters and who is available to provide assistance to newborn hearing screening programs throughout the state. All Missouri birth facilities and audiologists report hearing screening and evaluation results to MNHSP, as required by state statute.

APPENDIX G

Diagrams and Forms:

AUDIOGRAM OF FAMILIAR SOUNDS

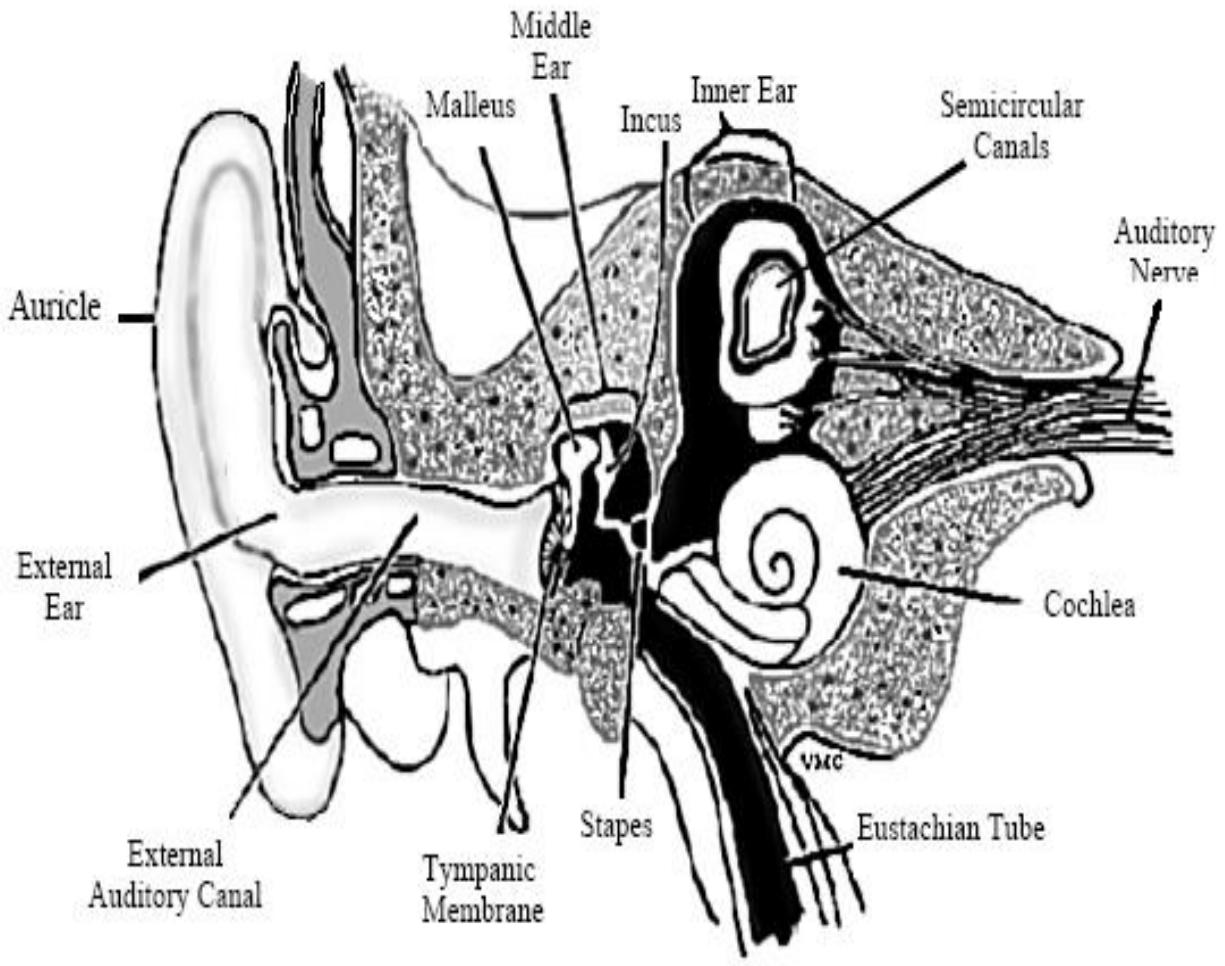


AMERICAN ACADEMY OF AUDIOLOGY

P.O. Box 1676 Washington, D.C. 20007-0176 Telephone: 202-657-0997 Toll Free: 800-AAA-2336 Fax: 202 333-5168

Used with permission

Diagram of the Ear



Individual Screening Form

Name	Grade	
Date	Decibels	
Frequency	Right	Left
1,000		
2,000		
4,000		

Individual Screening Form

Name	Grade	
Date	Decibels	
Frequency	Right	Left
1,000		
2,000		
4,000		

Individual Screening Form

Name	Grade	
Date	Decibels	
Frequency	Right	Left
1,000		
2,000		
4,000		

Individual Screening Form

Name	Grade	
Date	Decibels	
Frequency	Right	Left
1,000		
2,000		
4,000		

HEARING SCREENING PROCEDURES – TRAINING RECORD

School or District Name: _____

Date of Training: _____ Instructor(s): _____

Materials used for training: _____

Topic(s) Covered: _____

_____

_____

I certify that I have attended this training (please sign):

Name	Position (Nurse, volunteer, etc.)
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

HEARING SCREENING PROGRAM
Re-screening Worksheet

Name _____ Age _____ Grade _____ Teacher _____

Parents _____ Address _____

Phone _____ Health Care Provider _____

Conditions Indicative of Possible Hearing Loss: (teacher observations and health history)

_____ Repeated colds
_____ Cold today
_____ Sore throat today
_____ Discharge from ear more than once
_____ Discharge from ear today

Frequent earaches:
R _____L _____ Both_____

_____ Complains of loud, constant ringing in the ears
_____ Hearing problems or deafness in family
_____ Inattentive
_____ Slow responding
_____ Repeating grade
_____ Says "huh?" or "what" often
_____ Speech defect "baby talk"
_____ Omits letters
_____ Substitutes letters
_____ Garbled speech
_____ Distorted speech
_____ Too soft
_____ Too loud
_____ Too high pitched
_____ Too low pitched

Date of Re-screen _____ decibels		
Frequencies	R	L
1,000		
2,000		
4,000		

Tympanometry			
R Ear	P	F	Type Curve _____
L Ear	P	F	Type Curve _____

Referred by nurse to:

_____ Family
_____ Primary Care Provider
_____ ENT Specialist
_____ Speech/Language Pathologist
_____ Audiologist
_____ Other

Parent/Guardian Notification of Screening Completion

Your child, _____, has participated in the Hearing Screening Program in our school on _____, of this year.

At this time, he/she has no apparent hearing problems.

Please contact us if you have questions about your child's hearing.

School Administrator/Nurse

Your child, _____, has participated in the Hearing Screening Program in our school on _____, of this year.

At this time, he/she has no apparent hearing problems. Children may have temporary difficulty hearing due to colds, allergies, or prolonged exposure to loud noise.

Please contact us if you have questions about your child's hearing.

School Administrator/Nurse

(Suggested Content for Referral Letter to Parent)

(Date)
(Address)
(City, State, Zip)

Dear Parent:

The School Health Services program routinely screens students for possible hearing problems in order to identify any barrier to learning that might be corrected. Screening programs to find students with possible problems and to refer them to the appropriate health care provider are important for these reasons:

1. Temporary hearing loss causes students to miss crucial instructions in the classroom;

2. Parents may not be aware of a child's mild hearing loss in every day home situations;

3. Even mild losses may interfere with learning new vocabulary, which is critical for success in reading;

4. Hearing loss is invisible and the child may be blamed for "not paying attention;"

5. Hearing loss may be a sign of ear disease; and

6. Children with very mild losses or loss only in one ear may be experiencing school failure.

Your child failed our screening and rescreening for hearing problems. We feel it is important to your child's school success to have a professional evaluation for this. If a problem is found and corrected, it may help your student do better in his schoolwork. Enclosed is a referral form to take to your doctor if we suspect a medical problem, or an audiologist, if that is more appropriate.

It is important to us to know what is found on the professional examination, so we would appreciate your returning the form to us, with the results of the exam.

Sincerely,

School Nurse

(School or Health Services letterhead)

Screening Tracking Form

SCHOOL	BUILDING	ROOM NUMBER

STUDENT INFORMATION

STUDENT NAME	AGE	GRADE

PARENT NAME	ADDRESS (INCLUDING CITY, STATE & ZIP

Your child has participated in the hearing screening program in our school this year, on _____.

_____ Findings indicate a possible problem.

_____ It is recommended that your child be evaluated by a physician for medical problems that may be interfering with the ability to hear.

_____ It is recommended that your child be evaluated by an audiologist or speech-language pathologist to determine the nature of the problem.

If you have questions, please contact _____ / _____
School Nurse Phone

OBSERVATIONS – Check all that apply.

BEHAVIOR		**SYMPTOMS**		**SPEECH**		**HISTORY**	
Often says "huh?" or "what"		Discharge from ears		Speaks too loud or too soft		Seasonal allergies	
Is slow in responding		Complains of earaches		Distorted speech		Frequent upper respiratory infections	
Inattentive		Complains of ringing in ears		Turns one ear to speaker		History of hearing loss in family	
						History of past concerns re: hearing	

RESULT OF SCREENING (Specify type of screening test)

A. SCREENING	DATE	B. RESCREENING	DATE

Results of hearing screening			Results of hearing rescreening		
FREQUENCY	**RIGHT**	**LEFT**	**FREQUENCY**	**RIGHT**	**LEFT**
1,000			1,000		
2,000			2,000		
4,000			4,000		
6,000 (optional)			6,000 (optional)		
			Tympanometry (See Attached graph)		
OBSERVATIONS			**OBSERVATIONS**		

(Continue on back)

This student was screened in the school setting using a pure tone audiometer/and or tympanometry (impedance unit). Screening was done at _____ decibels. The student failed the screening and rescreening process. In addition, any other concerns are noted above. It is important that your evaluation results be communicated to the school, as they are essential for our completion of follow-up. We will be happy to assure any recommendations are implemented, and give support to the family regarding this problem and any resulting treatment. You may send the report with the parent, or mail to this address:

SCHOOL NURSE: PLEASE COMPLETE THE FOLLOWING:

SCHOOL NURSE'S NAME	SCHOOL NAME
SCHOOL NURSE'S ADDRESS (INCLUDING CITY, STATE AND ZIP)	PHONE NUMBER (INCLUDE AREA CODE)

RELEASE OF INFORMATION FORM

To the physician:

Please provide the school nurse named above with the results of this evaluation so that the school may be informed and make any necessary adaptations and/or do monitoring of condition.

_____ _____

Signature of Parent/Guardian Date

SAMPLE: Tracking Form
HEARING SCREENING

STUDENT	GRADE/ ROOM	RE-SCREEN DATE	RESULTS	TYMP SCREEN/ RESULTS	REFERRAL DATE	COMMENT REGARDING REFERRAL COMPLETION

HEARING SCREENING PROGRAM

SAMPLE: Statistical Report
(Internal Use)

School Year _____

Building Summary Report _____
District Summary Report _____

Building/District _____ Form completed by _____ Date _____

					RESULTS OF PROFESSIONAL EXAMINATION OF REFERRED STUDENTS						
	SCREENED		RE-SCREENED		Diagnosis			Recommended Treatment			
Grade	Total Number of Students	No Problem Found	No Referral At This Time	Referred For Professional Examination	Normal (No Abnormality)	Medical Problem	Audiological Problem	Observation	Med	Surgery	Other
Special Ed.											
TOTAL											

MISSOURI DEPARTMENT OF HEALTH AND SENIOR SERVICES
DIVISION OF COMMUNITY AND PUBLIC HEALTH
Section for Community Health and Chronic Disease Prevention
Community Health & Wellness

PO Box 570
Jefferson City, MO 65102-0570
(573) 522-2822