PRESENTATION GUIDE
FOR

AUDIOMETRIC SCREENING AND PLAY AUDIOMETRY

A training program for hearing screeners.

Prepared by

Children's Medical Services (CMS),
Child Health and Disability Prevention (CHDP) Program,
California Department of Health Care Services

for use in a proctored setting to support program provider education requirements

2007

Syllabus

The purpose of this syllabus is to provide information for the audiometric screening program of the California Department of Health Care Services (DHCS), Child Health and Disability Prevention (CHDP) program. This syllabus is offered in conjunction with a CHDP audiometric training and is not intended as a substitute for the training. The material can only be interpreted properly with reference to the total content of the course. This training is **not** equivalent to the "School Audiometrist" training offered by a college or university to meet the requirements of the California Code of Regulations (CCR) Title 17, Section 2950.

This guide has been prepared to assist physicians and their staff to plan and carry out the screening components of a hearing conservation program for children. This syllabus may be kept with the audiometer for easy reference in the office, clinic or preschool. The CHDP program has specific requirements of hearing assessments for children; these requirements may be found in the CHDP Health Assessment Guidelines and the CHDP Provider Manual. Questions or concerns regarding the information in this syllabus may be addressed during the companion in-person training program conducted by local CHDP programs or referred to the local health department CHDP program.

TABLE OF CONTENTS

HEARING CONSERVATION FOR CHILDREN

Hearing conservation is the term used to include a broad range of activities such as identification of individuals with hearing loss, diagnostic evaluations to determine locus of loss and provisions for rehabilitative services. An ongoing program of public education regarding the cause, nature, and effect of hearing loss is also a vital part of any hearing conservation program.

A hearing loss affects not only the ears of a child, but the whole child. Consequently, hearing conservation programs for children are important for several reasons:

1. A hearing loss seriously affects a child's ability to communicate because it interferes with the development of normal language and learning. Language is the tool for learning that allows children to store information, exchange ideas, and to express feelings.

2. A hearing loss may affect a child's ability to develop normal speech. The speech of some children with severe hearing handicaps is so distorted that the average listener cannot understand him/her.

3. Hearing loss isolates the child from everyday surroundings including parents, other family members, and playmates. Consequently, the child is deprived of the usual opportunity to learn language, speech, social skills, and develop a feeling of self worth.

4. Children with a hearing loss often demonstrate problems in adjustment. Some youngsters compensate for their loss of hearing by becoming overaggressive or disobedient, others withdraw, avoid or shun group activities.

5. Children with a hearing loss are often at a disadvantage because their parents cannot adjust to the child's handicap. The parents' lack of knowledge about the hearing loss, their anxiety about their role as parents, their feelings of guilt about the handicap may cause serious problems for the family.

6. Hearing loss is costly. It necessitates diagnosis, treatment, and special education. This financial burden is borne by both parents and the community. The cost of education programs for deaf and hard-of-hearing children are greater per child than costs per child in a regular classroom.

Hearing conservation, especially identification audiometry, is a preventive measure that can detect many of the aforementioned effects of hearing loss in children. **Early discovery of the hearing problem is the key to successful remediation.** Experience has shown many hearing problems among children respond to medical treatment. With any pathological condition, the earlier the condition is discovered, and medical care is initiated, the better the chance of successful treatment. Early attention to the developmental or educational problems caused by a hearing disability is especially important. It is easier to habilitate a child who is only a few months or a year behind in normal development than it is to help the child who has experienced repeated failure.

The California DHCS, Children's Medical Services has implemented a statewide comprehensive Newborn Hearing Screening Program to help identify hearing loss infants in the first months of life and to link these babies to appropriate services. The American Academy of Pediatrics and other professional organizations recommend screening all newborns and encourage the close monitoring of children's hearing especially through the early years.

ANATOMY OF THE EAR

The primary purpose of the human ear is to receive sound from the environment, process it, and transmit it to the higher brain centers. This function will be discussed as it relates to the four major areas of the auditory system: the external ear, the middle ear, the inner ear, and the auditory nervous system.

A. THE EXTERNAL EAR

The external ear consists of the auricle and the external auditory canal (Figure 1). The auricle (pinna), the visible portion of the external ear, serves in a limited way to collect and funnel sound from the environment into the external auditory canal.

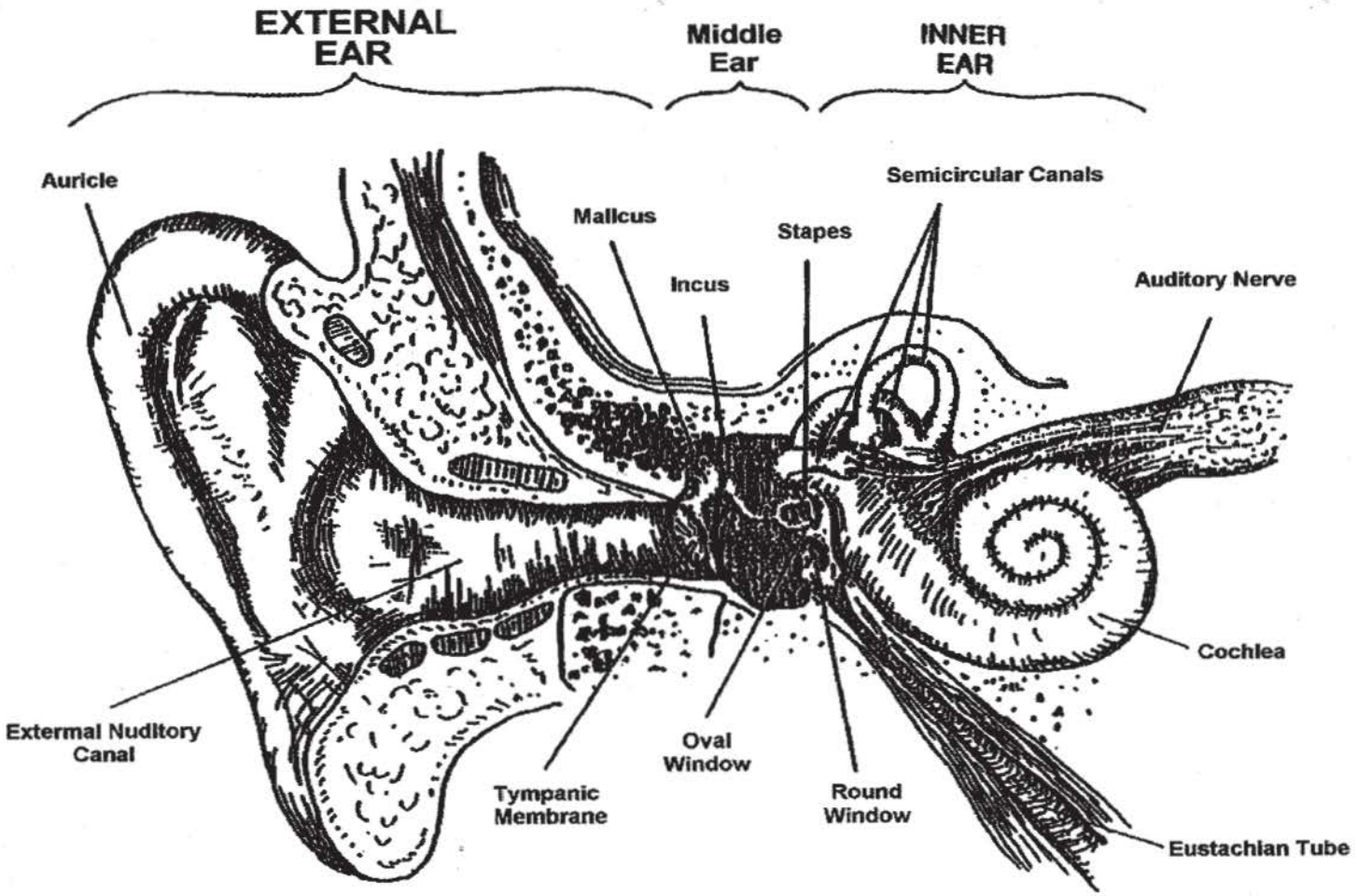
The external auditory canal is slightly curved and is approximately 1.25 inches in length and .25 inches in diameter among adults. This canal carries sound to the eardrum. Within the external auditory canal are hair follicles, sweat glands, and oil glands. The shape of the canal, the hair follicles, and the wax (cerumen) produced by the aforementioned glands serve to protect the delicate eardrum from foreign objects. This also helps to maintain constant temperature and humidity in the region surrounding the eardrum.

B. THE MIDDLE EAR

In an adult the middle ear is an air-filled cavity about the size of an aspirin tablet or 2 cubic cm (Figure 1). The walls of this cavity are characterized by certain landmarks. The outer wall contains the tympanic membrane (eardrum) which is the entrance into the middle ear cavity. The eardrum is a very thin, translucent membrane which vibrates in response to the sound waves funneled through the external auditory canal. The posterior or back wall of the middle ear cavity provides an entrance into the boney mastoid process, which is the posterior portion of the temporal bone that is situated behind the external ear. The anterior or front wall of the cavity contains the opening of the Eustachian tube. This tube extends from the middle ear to the back wall of the mouth. It serves to equalize air pressure between the person's environment and the cavity of his middle ear. It further provides an avenue for the drainage of fluid from the middle ear cavity. The internal wall of the middle ear contains two important windows. The Oval window serves as the entrance for sound energy to enter the inner ear and the Round window serves to release pressure of this energy from the inner ear.

The primary function of the middle ear is to transfer movements of the eardrum through the ossicular chain to the fluid in the inner ear. The ossicular chain is composed of the three smallest bones in the body. These bones are commonly called the hammer, anvil, and stirrup, while the anatomical terms for these tiny bones are the malleus, the incus, and the stapes. The malleus is attached to the

eardrum and moves in synchrony with it. The malleus is also attached to the incus, which is, in turn, attached to the stapes. Thus, these three bones form a bridge across the middle ear space and transmit sound vibrations to the fluid medium of the inner ear.



ANATOMY OF THE HUMAN EAR

Fig. 1

C. THE INNER EAR

The inner ear is composed of two sensory organs: the organ for balance and the organ for hearing. These organs are encased in a bony capsule of the temporal bone and are both fluid filled. The organ for balance (vestibular mechanism), consists of semicircular canals which helps to maintain a person's equilibrium. The organ of hearing (cochlea) resembles a snail shell which is coiled two and three-quarter turns. The cochlea consists of three fluid-filled chambers, or tunnels, which run the entire length of the coil (Figure 2). These chambers are termed the scala vestibuli, the scala media, and the scala tympani. The scala vestibuli and the scala tympani are filled with an outer fluid known as perilymph. The opening from the middle ear into the scala vestibuli is referred to as the oval window. This window contains the footplate of the stapes. When the stapes begins its pumping action, the fluid within the inner ear is set into motion. Because the bony capsule cannot expand, it is necessary to have some type of a release valve so the fluid can move. The release valve is located in the scala tympani. It is covered by a thin membrane and is called the round window. The footplate of the stapes pushes inward on the oval window, the fluid movement results in an outward bulge of the membrane covering the round window.

Located between the scala vestibuli and the scala tympani is the scala media. The middle compartment in the cochlea is filled with inner fluid (endolymph). The scala media is most important as it houses the sensory receptor for hearing called the organ of Corti, which rests on the very flexible basilar membrane. This receptor has thousands of microscopic hairs, which detect the fluid movements within the inner ear. The bending of these hairs results in nerve impulses in the auditory nerve. Each of the tiny receptors transmits specific information about the sounds being heard.

D. THE AUDITORY NERVOUS SYSTEM

The auditory nervous system is composed of the auditory nerve (eighth cranial) beginning at the cochlea and its associated pathways to the brain (Figure 3). The nerve impulses, initiated by the bending of the hair cells on the organ of Corti, travel along thousands of fibers of the auditory nerve. These fibers twist in a manner similar to a wire cable and progress through a bony canal (internal auditory canal) entering the lower portion of the brain stem. From the brain stem, the fibers progress along a well-defined pathway to their final destination in the auditory portion of the temporal lobe of the brain.

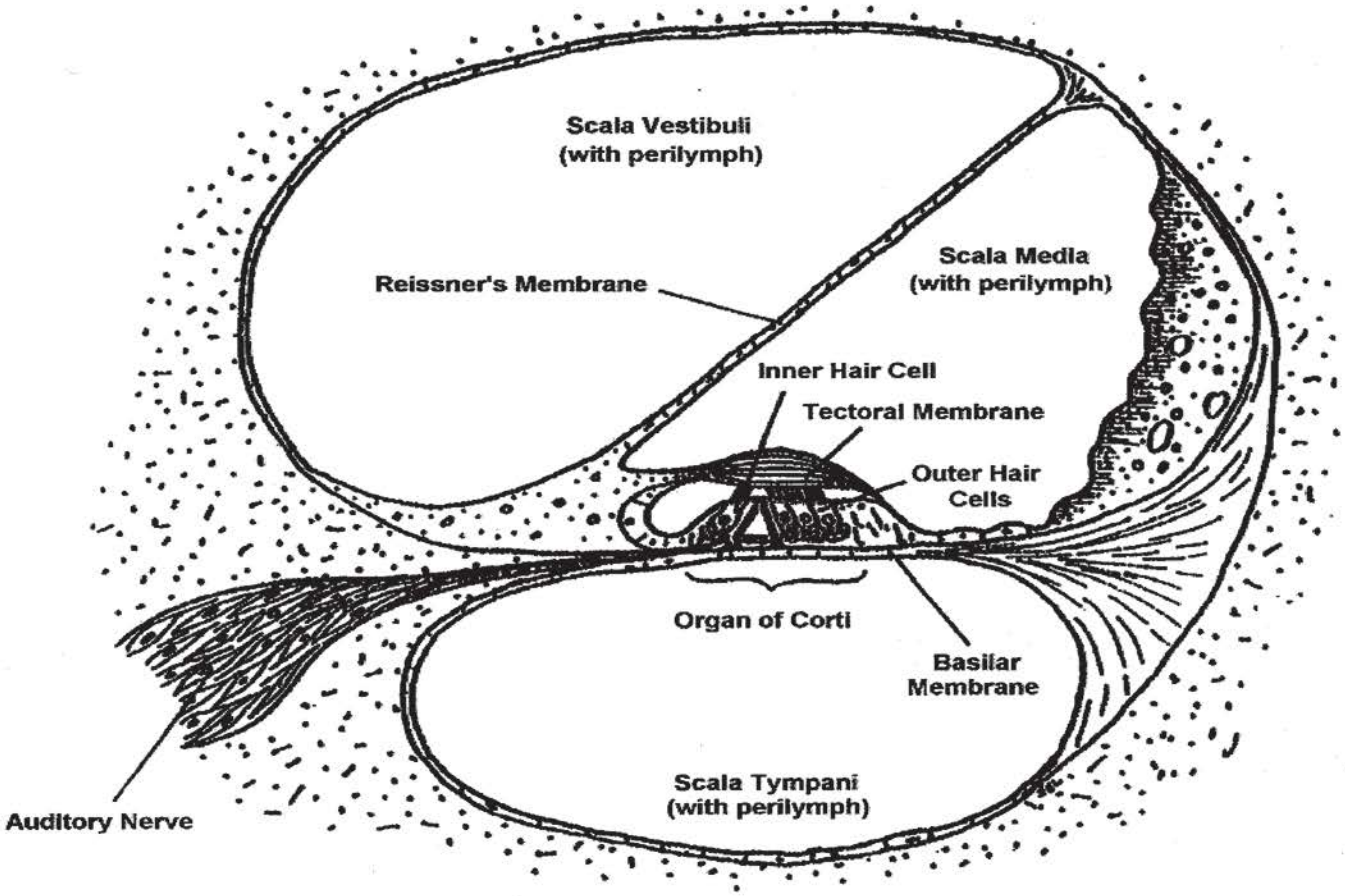


Fig. 2 CROSS - SECTION OF COCHLEA

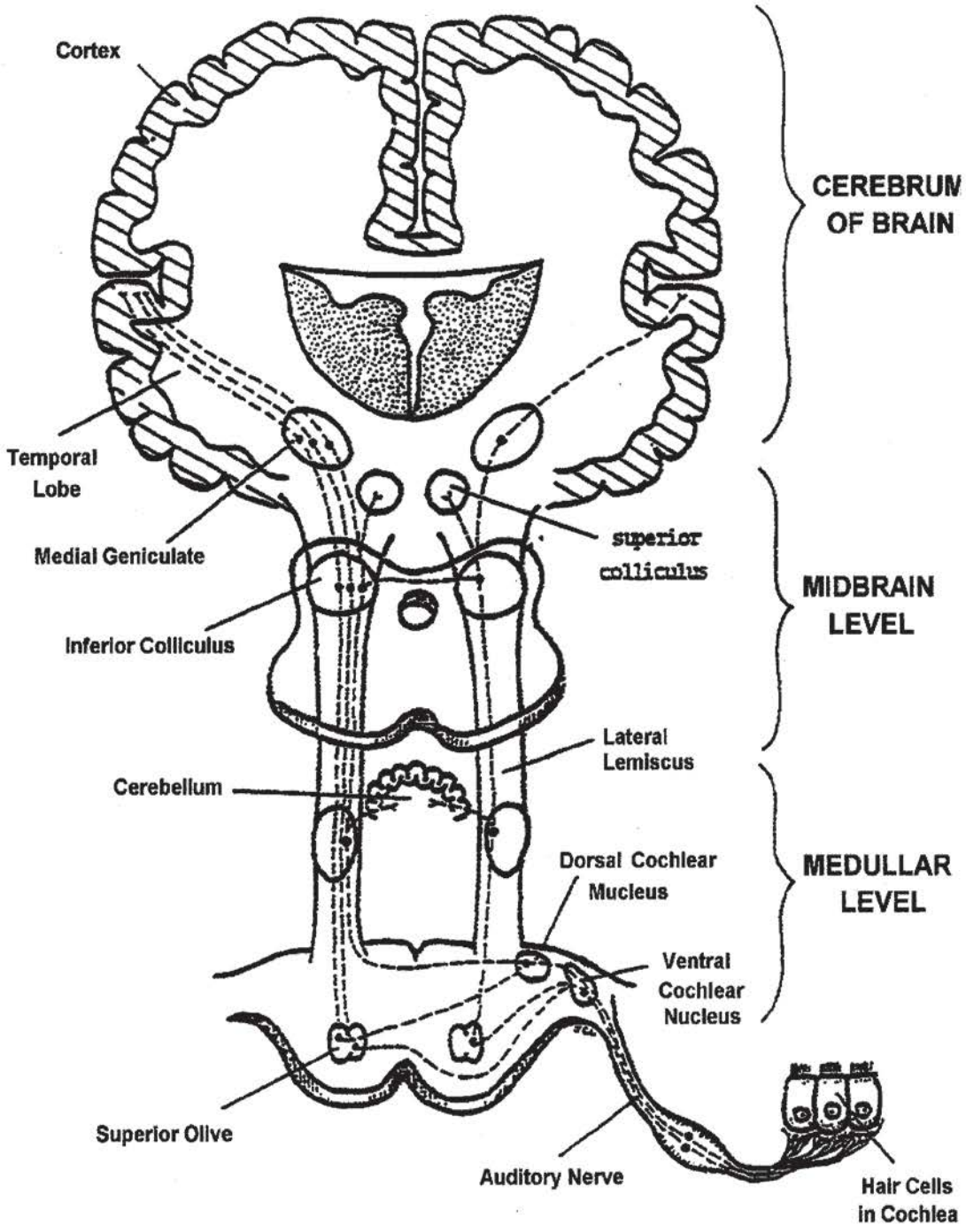


Fig. 3 **AUDITORY PATHWAY OF THE CENTRAL NERVOUS SYSTEM**

HEARING DISORDERS

A disorder of hearing may be defined as a problem with any part of the hearing mechanism, which prevents it from functioning normally. Hearing disorders are commonly classified into major categories: *conductive, sensorineural, mixed, nonorganic* hearing losses, and *central auditory processing.*

A. CONDUCTIVE HEARING LOSS

A conductive hearing loss is defined as a malfunction of the external and/or middle ear while the Inner ear and nerve are normal. The effect of a conductive hearing loss is reduction in the level of sound being conveyed or "conducted" to the inner ear. The symptoms associated with this type of impairment may vary with the degree of the hearing loss but, in general a person with a conductive hearing loss:

- demonstrates either a hearing loss predominately in the **low frequencies** or a hearing loss **extending equally across all frequencies**;
- understands speech well when the **loudness of the speaker is increased** sufficiently to overcome the amount of the conductive hearing loss;
- is usually **not annoyed** by the presence of **loud sounds** in his/her environment;
- appears to **understand speech in a noisy environment better** than a person who has normal hearing;
- may **speak** in a relatively **soft voice.**

The causes of a conductive hearing loss are described according to the part of the hearing mechanism, which is affected: the *external ear* or the *middle ear*.

1. The External Ear

a) The absence or malformation of the pinna and the external auditory canal. This condition is most often a birth defect commonly referred to as atresia. The treatment may involve the surgical construction of the pinna and the external canal.

b) Obstruction of the external auditory canal. The presence of a foreign object or a build up of cerumen in the external canal may cause a reduction in the level of sound reaching the eardrum. The treatment is the removal of the obstruction.

2. **The Middle Ear**

a) Inflammation or infection of the lining of the middle ear cavity. This inflammatory process is commonly referred to as *otitis media* and may result from an upper respiratory infection which has gained access to the middle ear through the Eustachian tube. The infection often results in a build up of fluid in the middle ear space, which, because of its presence, reduces the normal transmission of sound across the ossicular chain. Also, a similar problem occurs when the opening of the Eustachian tube is blocked because of enlarged adenoids. In both cases, if drainage from the middle ear space does not occur and the volume of fluid is increased within the cavity, the eardrum begins to bulge from the force of the fluid pressure. The fluid build up is referred to as middle ear effusion or "serous otitis media". A further increase in fluid build up may result in severe pain and possibly a ruptured eardrum. A short-term problem of otitis media is referred to as *acute otitis media*, whereas, a long-term involvement is referred to as *chronic otitis media*. Another cause of hearing loss among children is related to allergies. The result of this condition is very similar to those described above.

The treatment for middle ear infections may depend on the severity of the problem or, on the specific cause. Therefore, the treatment may vary from the administration of antibiotics, to the insertion of ventilation tubes through the eardrum, the removal of the tonsils and adenoids, or allergy management. If the presence of a long-term infection has destroyed or damaged the ossicles, or has entered the air-filled spaces of the mastoid, it may be necessary for the physician to remove the infected area and surgically rebuild the damaged structures at a later time.

(b) Perforation of the eardrum. Damage to the eardrum may be the result of punctures produced by foreign objects, extremely loud sudden sounds such as an explosion or gun fire, increased external pressure, or by fluid pressure build up within the middle ear space. If the eardrum does not spontaneously repair itself, the physician may find it necessary to patch the perforation.

(c) Otosclerosis. This conductive hearing loss is not thought to be a disease process found in children, but is restricted usually to young adult and older age groups. However, there are isolated reports of this condition occurring among children. Otosclerosis is caused by deposits of a bony substance around the footplate of the stapes. Upon the hardening of the bony substance, the stapes cannot move and the level of the sound reaching the inner ear is reduced.

The treatment for otosclerosis consists of the surgical removal of the stapes or other affected members of the ossicular chain. Following the removal of these bones, the surgeon may insert a synthetic device to bridge the gap between the working portion of the ossicular chair and the oval window, which housed the footplate of the stapes.

(d) Malformation. The ossicles of the middle ear may be malformed at birth causing the sound reaching the inner ear to be reduced. The treatment for this is removal of affected area and insertion of a synthetic device to bridge the gap between the tympanic membrane and the inner ear.

B. SENSORINEURAL HEARING LOSS

A sensorineural hearing loss is defined as a malfunction of the inner ear (cochlea) and/or the auditory nerve, in the presence of a normal external and middle ear. A sensorineural hearing loss may result in both a reduction in the loudness level of sound, and a loss of the ability to discriminate speech sounds. The symptoms associated with a sensorineural hearing loss may vary with the severity of the problem or the location of the problem. A person with a sensorineural hearing loss:

- demonstrates a hearing loss, which may range from mild to profound in one or both ears which may be greater for the higher frequency sounds;

- may demonstrate a reduced ability to understand speech with the common complaint of "I can hear, but I can't understand". The limitations imposed upon the understanding of speech may vary with the amount of the hearing loss. The high frequency sounds represent majority of the consonant sounds which give most of the information to understand what is being said. Refer to figure 4 and 5 in identifying the speech range and visual clues of consonant sounds.

- may display an inability to tolerate loud sounds;

- may have poor speech because of the inability to hear others as well as to monitor oneself;

- may speak in a relatively loud voice;

- will often complain of a ringing or buzzing sound in his ears. This problem, although not totally understood, is referred to as tinnitus.

The cause of sensorineural hearing loss can best be described according to the time in life when the hearing loss begins. If the hearing problem develops before birth, it is termed congenital; if it occurs after birth, it is termed acquired.

1. Congenital Hearing Loss

A congenital hearing loss is one that is present at the time of birth. The causes of congenital hearing problems are listed in the Joint Committee on Infant Hearing (JCIH), 2000 Position Statement which can be found online at: http://www.jcih.org/posstatemts.htm

2. Acquired Hearing Loss

An acquired hearing loss is one that occurs after birth. This loss can be caused by ototoxic medications, infections, exposure to loud noise and others factors. Review the causes of acquired hearing loss listed in the JICH, 2000 Position Statement (http://www.jcih.org/posstatemts.htm).

Since the sensorineural hearing loss is rarely corrected through the use of medication or surgery as is a conductive hearing loss, the first and most practical approach to the reduction of sensorineural hearing loss is through a program of prevention. This program should include the identification of drugs that damage the inner ear (ototoxic drugs), inoculation against childhood diseases, control of noise levels, and counseling with regard to hereditary and Rh blood incompatibility problems.

For those individuals who have been born with or have acquired a sensorineural hearing loss, there are rehabilitation programs designed to reduce the effects of these problems. These may include selection of a suitable hearing aid, a cochlear implant (which is a electronic device surgically implanted into the cochlea with external transmitter and microphone) for those with a profound hearing loss, development of auditory speech reading skills (lip reading), speech therapy, sign language, special educational placement, and psychological counseling.

C. MIXED HEARING LOSS

A mixed hearing loss is a combination of a conductive and a sensorineural loss in the same ear. An example of this is the individual who has a sensorineural congenital hearing loss, while at the same time, is experiencing a conductive hearing loss because of the presence of a middle ear infection.

The symptoms associated with a mixed hearing loss may be either characteristic of a sensorineural or conductive problem, or may be a combination of the symptoms of both disorders. Causes and treatments for mixed hearing losses

are the same as those discussed previously in the sections entitled "Conductive Hearing Loss" and "Sensorineural Hearing Loss".

D. NONORGANIC HEARING LOSS

A nonorganic hearing loss may be defined as a hearing loss for which there is no known physical basis but is thought to be a result of the psychological state of the individual. Some of these children may have a positive history of ear infections, a factor which can be misleading to the audiometrist. The following are symptoms which may be associated with this hearing disorder:

- The hearing test usually reflects mild to moderate, flat, bilateral "hearing loss".
- A child who displays a nonorganic hearing loss usually has good speech and no difficulty in communicating in normal conversation. When the hearing of the person is audiometrically tested, however, the results are significantly poorer than would be predicted.
- The results of repeated hearing tests are often inconsistent for an individual manifesting a nonorganic hearing loss.

In these cases it is essential to determine if a hearing loss is indeed present and to find out if there are factors that may have led to the child falsely elevating their thresholds. In children these factors are more commonly a desire for increased attention and may be accompanied with disruptive social behaviors. Dealing with these behaviors will be the necessary treatment.

E. CENTRAL AUDITORY PROCESSING DISORDER

Central auditory processing refers to the way the brain uses the auditory information it receives that originated from the outer, middle and inner ear. A central auditory processing disorder (CAPD) is an auditory communication disorder. CAPD is not a dysfunction of the mechanisms of hearing. People with this disorder have difficulty understanding, interpreting, and using the information they hear. Children may exhibit poor language and/or listening skills and, although, they may have adequate to high intelligence, their academic performance falls below their estimated potential. The major complaint of parents and teachers is that the child is performing below expected levels at school and doing so for reasons that are not clear. While the cause of CAPD is not known, the resulting communication problems are well documented. Those affected have trouble following verbal directions and may seem distracted and inattentive. CAPD can exist alone or with other problems such as attention deficit disorder, learning disabilities, and language disorders. There is a higher incidence in children with middle ear pathologies.

Children with CAPD often give the impression that they are not listening. Listening, one of the basic tools of learning is a skill used to develop speech, language, and psychosocial behavior. In the first two years of school, children are exposed to verbal information between 75 and 95 percent of the time. The child with CAPD has difficulty listening and following rapid verbal information, this difficulty leads to frustration and to an ever widening learning gap. As academic and social demands increase, children frequently become discouraged, and may lose self-esteem. Children with auditory processing difficulties need to experience success and build self-esteem, even more than they need to increase memory and listening skills. When a central auditory problem is suspected or identified, immediate measures must be taken to improve the child's listening environment, especially in the classroom.

The child with normal hearing on traditional audiologic tests, but with a case history that leads one to suspect the child's auditory skills, is a prime candidate for central auditory evaluation and can be confirmed by central auditory testing.

Children with central auditory processing disorder will show some or all of the following behaviors:

- Inconsistent responses to sound. Parents/teachers may suspect a hearing loss, though audiometric test results are normal.
- Academic performances below their estimated potential, especially in reading, spelling, and language arts.
- Speech problems such as omissions, distortions, and substitutions of sounds in words. Poor vocal monitoring of loudness of his/her voice.
- Poor auditory attention and comprehension, especially in the presence of background noises. Does not pay attention or listen carefully to instructions. Short attention span.
- Difficulty following verbal instructions. Inability or confusion with carrying out verbal instructions.
- Difficulty distinguishing between similar words. Difficulty recalling the oral spelling of a simple word.
- Good performance in a one-to-one situation, but poor performance in the classroom.

SUGGESTIONS FOR PARENTS WITH CHILDREN WHO HAVE CAPD

Experiencing success and developing self-esteem are extremely important for anyone with learning difficulties.

Learn as much as you can about your child's disorder. Consult with teachers and other professionals regarding therapy and progress. Ask questions!

Become familiar with the management techniques used in the classroom and apply them, when appropriate, to home activities.

Create an atmosphere for success:

a. Provide a quiet room for homework away from distractions such as television or music. Children with auditory processing problems have difficulties in competing situations.

b. Expect good listening behavior, eye contact, sitting or standing still. When giving verbal instructions make sure you have your child's attention.

Experiencing success and developing self-esteem are extremely important for anyone with disabilities that interfere with learning. Focus on your child's strengths and offer praise for any accomplishment which exceeds previous levels, the result will be improved self esteem.

Information Sources:

SCHOOL: Audiologist, Speech-Language Pathologist, Special Education Teachers

COMMUNITY: Local college or university speech & hearing departments, yellow pages under Audiologists or Speech-Language Pathologists, public or hospital-based medical libraries.

AUDIOGRAM

An audiogram (figure 4) is a graphic representation of a person's ability to hear. The vertical lines on an audiogram represent pitch or frequency. The horizontal lines of the audiogram represent loudness or intensity (the strength of the sound wave vibrations).

Frequency refers to the number of sound wave vibrations occurring per second. Frequency may be written as **cps** (cycles per second) or **Hz** (Hertz). One cycle per second is one Hertz. On the audiogram, figure 4, the 250Hz vertical line on the left side represents a very low pitch sound and each vertical line to the right represents a higher pitched sound. For screening purposes the most important frequencies are 1000, 2000, and 4000 Hz because most human speech falls within this range. An individual who has a problem hearing within this range will have difficulty in understanding speech and language.

Intensity, or volume, is measured in decibels (dB). Zero dB is usually the softest sound that can be heard by a normal hearing population at any pitch or frequency. The zero (0) decibel (dB) line near the top of the audiogram represents an extremely soft sound. Each horizontal line below represents a louder sound and may go as loud as 110dB. Decibels are measured on a logarithmic scale; each increase of 10 on the scale represents a 10-fold increase in loudness. 20dB is 10 times as loud as 10dB and 30 dB is 100 times as loud as 10dB, and so on. Normal human conversation is around 60dB; a rock concert can average between 110 and 120dB. Sound becomes painful at 125dB for most people.

A diagnostic hearing evaluation includes determining for each frequency tested the lowest intensity level at which the individual can hear the sound. The lowest intensity (loudness) at which the individual can perceive the sound is called the "threshold level." Plotting the threshold levels (up and down) by the frequency levels (left to right) on the audiogram helps to describe a person's hearing ability. Zero to 25dB at each of the three screening frequencies is considered to be normal hearing, 25-40dB is mild hearing loss, 40-70dB is moderate hearing loss, 70 to 90dB is severe hearing loss and anything over 90dB is considered profound hearing loss or deafness.

The CHDP program requires a hearing screening test and if problems are found, children should be referred to an audiologist for further testing, including the threshold level testing. The screening frequencies required in the CHDP program are 1000, 2000, and 4000Hz. 3000Hz is not required but it is recommended as very useful for obtaining reliable results. The CHDP hearing screening technique uses a constant loudness or dB level of 20 to 25 dB. 20dB is recommended as the best screening level. However, some screening facilities are not quiet enough to obtain accurate results at 20dB and screening at 25dB is acceptable.

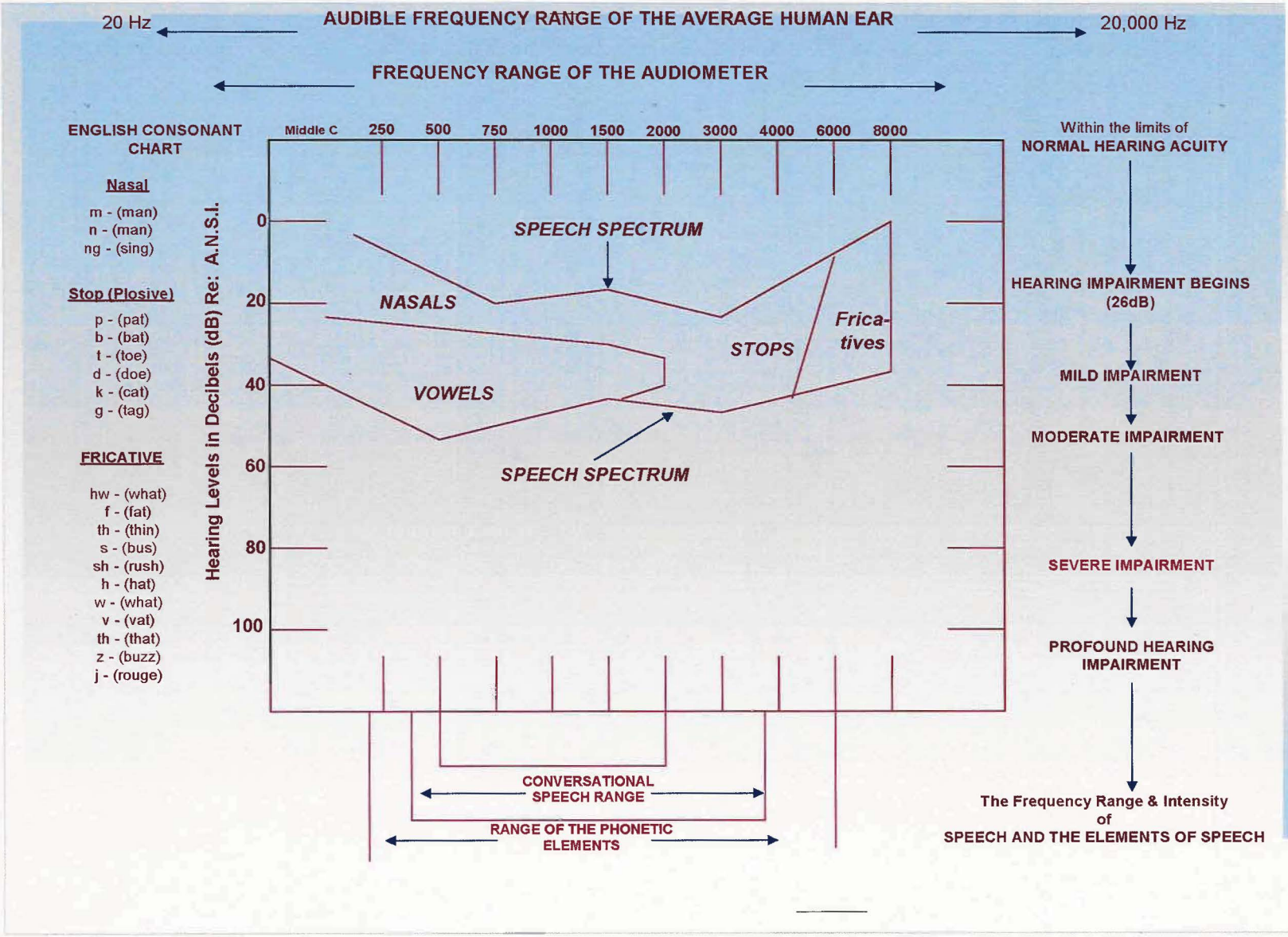

20 Hz
AUDIBLE FREQUENCY RANGE OF THE AVERAGE HUMAN EAR
20,000 Hz
FREQUENCY RANGE OF THE AUDIOMETER
ENGLISH CONSONANT CHART
Nasal
m - (man)
n - (man)
ng - (sing)
Stop (Plosive)
p - (pat)
b - (bat)
t - (toe)
d - (doe)
k - (cat)
g - (tag)
FRICATIVE
hw - (what)
f - (fat)
th - (thin)
s - (bus)
sh - (rush)
h - (hat)
w - (what)
v - (vat)
th - (that)
z - (buzz)
j - (rouge)
Hearing Levels in Decibels (dB) Re: A.N.S.I.
Middle C
250
500
750
1000
1500
2000
3000
4000
6000
8000
0
20
40
60
80
100
SPEECH SPECTRUM
NASALS
STOPS
Frica-tives
VOWELS
SPEECH SPECTRUM
CONVERSATIONAL SPEECH RANGE
RANGE OF THE PHONETIC ELEMENTS
Within the limits of NORMAL HEARING ACUITY
HEARING IMPAIRMENT BEGINS (26dB)
MILD IMPAIRMENT
MODERATE IMPAIRMENT
SEVERE IMPAIRMENT
PROFOUND HEARING IMPAIRMENT
The Frequency Range & Intensity of SPEECH AND THE ELEMENTS OF SPEECH

FIGURE: 4

TWO FORMS USED FOR AUDIOMETRIC SCREENING

There are two types of audiograms which may be used for screening and testing hearing illustrated in figure 5. The first audiogram is a graph; using "O" to represent the right ear and "X" to represent the left ear.

- This audiogram is a diagnostic audiogram used by audiologists to perform threshold testing to identify the degree of hearing loss, location of hearing loss and what kind of amplification is needed.
- This audiogram is not an easy to use screening audiogram
- The audiogram will take an excessively long time to complete.
- Identifying where the X's and 0's need to go can be confusing and also time consuming
- When using this audiogram there is a possibility for intensity levels to become too loud causing the sound to cross over to the opposite ear giving inaccurate results.

The second simplified audiogram is CHDP approved. This form uses a check for pass and a dash for no response. This is the recommended audiogram when performing a hearing screening because:

- This audiogram is easy to fill out.
- Scoring the audiogram is fast.
- It is impossible to have cross over with this technique.

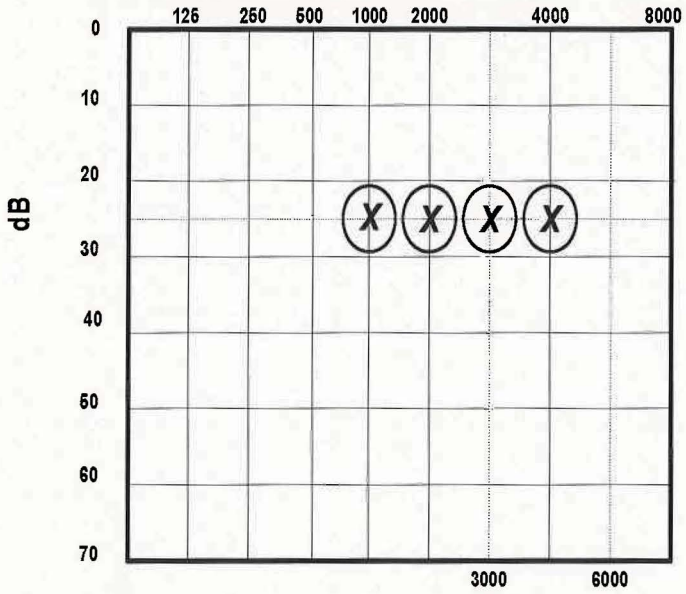
Figure 6, page 20, is an easy to use form which can be duplicated for private clinic use. There are two audiograms on one page which can be helpful when recording re-screen for the same client. These audiograms illustrate the essential elements for recording screening results. Facilities may also recreate the audiogram with personalized facility information included.

FIGURE: 5

AUDIOGRAM

TWO FORMS USED FOR AUDIOMETRIC SCREENING

1. GRAPHIC METHOD: This audiogram illustrates normal hearing screen.



ANSI calibration date: _____

Comments: _____

Key To Record Information

O Ear

X Left

⊠O Right Ear to Response

⊠X Left Ear to Response

---

2. RESPONSE / NO RESPONSE: This audiogram illustrates normal hearing screen.

ANSI calibration date: _____

Comments: _____

Key To Record Information

☑ Responded at a level not exceeding 25 dB

▬ Did not respond at screening level

FIGURE: 6

APPROVED CHDP SCREENING AUDIOGRAM

Child's Last Name	*First Name*	*MI*	*Age*	*Date*
Place of Screening	*Audiometer*	***ANSI***		*Date last Calibrated*

		1000	2000	3000	4000		1000	2000	3000	4000	
(Date of) 1st Screen	Right Ear					Left Ear					
(Date of) 2nd Screen											

☑ A Check mark indicates that the child responded at a level not exceeding 25dB

▬ A hash mark indicates that the child did NOT respond at the screening level.

Comments: _____

_____

Referred to: _____

APPROVED CHDP SCREENING AUDIOGRAM

Child's Last Name	*First Name*	*MI*	*Age*	*Date*
Place of Screening	*Audiometer*	***ANSI***		*Date last Calibrated*

		1000	2000	3000	4000		1000	2000	3000	4000	
(Date of) 1st Screen	Right Ear					Left Ear					
(Date of) 2nd Screen											

☑ A Check mark indicates that the child responded at a level not exceeding 25dB

▬ A hash mark indicates that the child did NOT respond at the screening level.

Comments: _____

_____

Referred to: _____

THE AUDIOMETER

Puretone audiometers used for CHDP hearing-screening tests shall be those manufactured to meet or exceed specifications for audiometers as described by the most current American National Standards Institute (ANSI) S3.6 standard. Each audiometer must be calibrated annually, be alternating current (AC) powered, and have the minimum ability to:

- produce intensities between 0-80 dB
- produce frequencies 1000, 2000, and 4000 Hz (3000 Hz optional)
- have a headset with right and left earphones
- be operated manually

Recommended optional accessory but not required:

- pulse tone

The audiometer will produce several different *FREQUENCIES* of pure tones at electronically calibrated *INTENSITIES* or levels of loudness. Generally, these audiometers are portable and simple in design. The manufacturer may arrange the dials, switches, and controls in different ways. However, there are controls and switches on all audiometers with which you must be completely familiar *BEFORE* you attempt to use an audiometer for screening.

1. **POWER SOURCE:** The instrument shall be powered by AC current.

2. **POWER SWITCH:** The "on" and "off" control. This may be a knob, a metal switch, or combined with the "ear selector" control.

3. **EAR SELECTOR CONTROL:** A knob, switch, or push button that enables you to direct the "tone" to one or the other earphone, e.g., *RIGHT(Red)* or *LEFT(blue)*.

4. **FREQUENCY SELECTOR DIAL:** This is an easy to read dial that indicates the frequencies (pure tone), i.e., 250, 500, 1000, 2000, 3000, 4000, 6000 Hz (Hertz or cycles per second). Some instruments display the frequencies in a "window", controlled by a dial on the side of the audiometer; others may have a "push button" frequency selector.

5 **ATTENUATOR (INTENSITY) DIAL:** (This may be designated: Hearing Threshold Level, HTL, Hearing Loss, etc.): The attenuator controls the "loudness" or intensity of the tone. It is calibrated to produce levels in 5 decibels (dB) increments, e.g., 0, 5, 10, 15, etc., decibels. "0" decibel is the average intensity level at which the normal ear is barely able to detect any one of the frequencies or pure tones.

6. **TONE CONTROL SWITCH ("INTERRUPTER SWITCH"):** This is a lever, touchplate or button that is used to present the tone.

7. **EARPHONES AND HEADBAND:** Matched earphones are "color coded". The *RED* phone is for the *RIGHT EAR* and the *BLUE* phone is for the *LEFT* ear. Earphones must meet the latest ANSI standards, S3.6. CHDP-approved ear phones meet current ANSI specifications.

CHDP-Approved earphones meet ANSI specifications

The "Audiocup" meets ANSI specifications but NOT APPROVED by the CHDP PROGRAM because it is;

(a) Difficult to manipulate and uncomfortable for children.
(b) Misplacement can create a 10-15 dB hearing loss.
(c) Primarily used for noise reduction in an industrial environment.

Audiocup
Not Approved by the CHDP Program

8. **MASKING:** A dial which introduces a noise to the non-test ear to eliminate the non-test ear from participating in the test. This is for threshold testing and should always be in the off position for hearing screenings.

9. **PULSE TONE:** A button used to change a continuous tone into one that pulsates. Recommended by the CHDP program for screening.

Four Things Needed for a Successful Screening

There are 4 things you need to have for a successful screening!

1. Qualified person to perform the screening who has a basic understanding of the ear and hearing, is familiar with the audiometer and is trained in screening procedures. Attending the CHDP workshop, review of the syllabus, and multiple practice sessions, meets this requirement.

2. A calibrated audiometer which meets the most current ANSI S3.6 Standards for Audiometer Calibration. A sticker of completion or complete performance certificate shall be with the audiometer at all times. Calibration is performed annually.

3. A properly functioning audiometer. Each day prior to screening, the audiometer should be checked by the screener. The steps to checking audiometer functions are found on page 24.

4. An appropriate, quiet screening environment. The screening environment is very important. The area must be reasonably quiet and should accommodate a small child's table with at least two children's chairs. The site should be away from stairs, windows, street noise, hall traffic, cafeterias, gyms, heating/cooling vents and equipment, bathrooms, play areas and machine rooms, etc. Noise levels in the screening environment must be checked prior to any hearing screening procedures. The person performing the check should have normal hearing sensitivity. The noise level check is accomplished with the audiometer. Wearing the earphones the screener should be able to hear each of the screening frequencies at a level of 15 dB. If any frequency cannot be heard at 15 dB do not screen in that environment.

If an appropriately quiet screening environment cannot be found, the screening procedure should not be implemented. If noise levels become too high during the screening, testing should be stopped! Do not increase frequency levels to compensate for background noise.

CHECKING AUDIOMETER FUNCTIONS

These checks do not replace calibration but are designed to aid the operator in detecting gross malfunction that will affect the results obtained. If repair of the audiometer is required as a result of any of the following "checks", it may also be necessary to have the audiometer recalibrated. The manufacturer's representative should advise accordingly.

A. Checking for Electrical Power

Plug in the instrument. Be sure the power switch is on. The dials or an indicator light should glow. Allow the instrument to warm up for at least five minutes.

If the audiometer does not function:

(a) Check the electrical outlet for power by using a lamp or some other convenient electrical appliance.

(b) If there is power in the outlet, unplug the audiometer and check the fuse which is usually located at the back of the audiometer or where the earphones are stored. Replace, if necessary, with the spare.

(c) If neither of these conditions is responsible for the audiometer's failure to operate, discontinue testing. Contact the company responsible for calibration and servicing.

B. Checking Earphones, Cushions and Headband

Routinely clean earphones with a cleaning agent like alcohol-free wipes. Do not use alcohol because it may dry out the rubber cushions on the earphones. Remove the cushions from the earphones and clean and dry thoroughly before replacing. Keep all moisture away form the diaphragm (hole in the center of earphones). Do not interchange the headphones with other audiometers.

While the audiometer is warming up, check the earphone cushions--they should be reasonably soft, resilient, and free from cracks. Check the shape of the headband--the ear cushions should lay together with a small amount of tension. If the cushions do not meet, or if they seem to lie together with too much tension, shape the headband by bending it with a twisting motion.

All of the following checks are made with the earphones properly placed on the audiometric screener, and assume that the screener has normal hearing for 1000 Hz through 4000 Hz.

C. Checking for Hum in the Earphones

Any extraneous noise present in the earphones may affect test results. Check for this condition as follows:

(a) set frequency at 1000 Hz;
(b) set attenuator to 50 dB (tone on) and listen for noise or hum;
(c) interrupt tone and listen for noise;
(d) decrease attenuator to 40 dB (tone on) and listen for noise;
(e) interrupt tone and listen for noise;
(f) decrease attenuator to its lowest setting and listen for noise (tone on);
(g) interrupt tone and listen for noise.

If humming or extraneous noises are heard at the above setting with the tone on or off, the instrument requires service.

D. Checking for Crosstalk in Earphones

An audiometer sometimes develops "crosstalk". This means that when the tone is sent to one earphone it is also heard in the other phone. The crosstalk is usually weak, but it may cause false testing results. To check for "crosstalk", set the audiometer to the right ear and present a tone. Next, disconnect or unplug the right phone from the audiometer but leave the selector switch in the "right earphone" position. This can be performed by following the wire from the right earphone to where it connects to the audiometer. Pull the metal jack labeled right or red out of the socket. Move the frequency selector dial from 1000 to 4000 Hz while you listen for a tone in the left earphone. With the right earphone connected disconnect the left earphone. Listen to the right phone while it is plugged into the audiometer and the tones are being sent simultaneously to the disconnected left phone. If the earphone cords can only be disconnected by unscrewing the cord connections, this test need not be done prior to each use, but should be done at regular intervals.

E. Checking Earphone Cords

The earphone cords should be checked for breaks and loose connections in the following manner:

(a) set hearing level dial at 50 dB or higher;
(b) set frequency selector at 2000 Hz;
(c) while listening to the tone, flex the cord along its length and especially at its connections (at earphones and audiometer);
(d) if scratchy noise is heard or the tone is intermittent, discontinue testing until cords have been replaced or the connections are made secure;

(e) under no circumstances should headphones from one audiometer be interchanged for headphones of another audiometer. Earphones are calibrated as an integral part of the instrument. Earphones cannot be interchanged, even temporarily, without recalibration on the artificial ear.

F. Checking for Noise from Attenuator

Lack of lubrication or the presence of dirt deposits in the attenuator (hearing level dial) may cause noise to be heard in the earphones when the hearing levels are changed. In order to check for this:

(a) set frequency to 2000 Hz;
(b) slowly increase attenuator from 0 to 50 dB and listen for scratchy noise in the earphones;
(c) if noise is heard, move the attenuator back and forth with rapid motion about ten to twelve times. This will many times alleviate dirt deposits, which may be causing the noise.

If noise does not disappear after following the above procedure, the audiometer will have to be serviced. However, the instrument may be used, if necessary, as long as adjustments of the attenuator are made **only when the tone is off.**

G. Checking for Noise from Frequency Selector

Scratchy noises or clicks may develop in the frequency switch. To prevent this noise from getting to the headphones, the operator should change the frequency dial **only when the tone is off.**

SCREENING PROCEDURES

Flow charts (Figure: 8) on pages 32 and 33 illustrate the screening process.

Play Audiometry:

- Play audiometry is the preferred method when screening children 2.5 to 6 years old and children with developmental delay.
- To accommodate this age group a child's table and two chairs will be required.
- Position the chairs at the table so that the child will sit at the dominant side of the screener.
- Place 12 blocks being of the same color, size and free of numbers and pictures and basket on the table.
- Place an ANSI Calibrated audiometer set to the **right ear, 90dB and 4000Hz (pulsed tone if possible)** also on the table in front of the screener's position.
- Place the earphones on the table so that the cushions are not together, allowing the tone to be heard in the room.
- Helpful Hints:
  - Visually demonstrate all verbal instruction as English may be a child's second language.
  - Never present your instructions as a question, i.e.; "Do you want to play a game?" They may say "NO". Say, "We are going to play a game."
  - Use one word to identify the tone i.e.; birdie, beep, noise or sound, do not call it all of the four names in one screening.
  - At any time the child does not follow the directions correctly do not go on to the next procedure. Repeat that step until the child catches on to the correct behavior.
  - Do not give visual or auditory cues when depressing the tone switch.
  - Avoid establishing a rhythm or pattern when presenting the tone.
  - Do not accept smiles or other facial expressions as a response. Only the block in the bowl is acceptable.
  - **If the child does not respond to the presentation of a "beep", it is because the child did not hear it, does not understand the procedure or wasn't paying attention.** When you perform the procedure correctly you will be able to determine why the child did not respond.

INSTRUCTIONS **(Child with normal hearing)**

1. Bring the child in by having physical contact with the child by either holding the child's hand or placing your hand on the back of the child and guiding them to the direction you want.

2. "We're going to play a game and it sounds like this. Listen". Present the beep and say "WOW". Repeat step.
3. Give a child a block and you take a block. "When you hear the beep put your block in the basket."
4. Say "listen." Present the beep and you put the block in first and watch the child follow.
5. Give the child a block and you take a block. "When you hear the beep put your block in the bowl real fast. Let's see how fast you are!" Your voice should sound excited.
6. Say "listen" present the beep and let the child win.
7. Give the child a block. Do not take a block for yourself. "When you hear the beep put the block in the bowl."
8. Say "listen." Present the beep and the child will place the block in the bowl without you having to participate.
9. Give the child a block. Turn the audiometer down to 50dB and place the earphones on.
10. Say "listen." Present the beep. If you were successful in conditioning the child and the child is not distracted and has normal hearing the child will place the block in the bowl. **If the child does not respond correctly review the instructions below.**
11. Give the child a block. Turn the audiometer down to 20dB.
12. Say "listen." Present the beep. If you are successful continue to 3000, 2000, 1000 and then switch ears and do 1000, 2000, 3000 and 4000Hz.

Alternate Situations

Child who does not respond at 50dB

Child does not respond correctly at 50dB from (from step 10 of the previous instructions).

- This may occur when the earphones are placed on for the first time. You're at 50dB, Right Ear and at 4000Hz you present the tone and there is no response. This means: The child does not respond to the presentation of a "beep", it is because the child did not hear it, does not understand the procedure or wasn't paying attention.
- Without giving new instructions or acting like something negative occurred switch the audiometer to the left ear.
- Present a "beep". If the child responds correctly then you can assume the no response at the right ear was due to either did not hear it or wasn't paying attention. You do know the child knows how to play the game. When you finish the left ear and go back to the right ear you will discover the reason for a no response.
- Complete the screening at the left ear and return to the right ear.

- At the right ear the audiometer should be at 20dB, Right Ear at 1000Hz. Screen at 1000, 2000, 3000 and 4000Hz. If the child responds at 4000Hz at 20dB then the original no response was because of not paying attention. If the child does not respond at 4000Hz at 20dB, increase the intensity to 50dB. Still no response, place a minus on the audiogram at 4000Hz Right Ear and you can guess that the no response is because the child cannot hear it. The child knows how to play the game and is paying attention.

Child who does not respond at 20dB

Child with a possible hearing loss

1. Same instructions for a normal hearing child.
2. You do 4000, 3000, 2000Hz at the right ear but when you get to 1000Hz the child does not respond at 20dB. What does that mean? The child did not hear it or the child was not paying attention. To identify which is the correct answer to this question**, increase the intensity to 50dB and present the beep.** You get a response. This tells me the child is paying attention.
3. Give the child a block. Turn the audiometer down to 20dB.
4. Say "listen." Present the beep and the child still does not respond. The no response is because the child cannot hear it.
5. Give the child a block. Score the audiogram as a no response for that frequency and switch ears.
6. Say "listen" present the beep. This time the child responds until you get to 4000Hz. The child does not respond at 4000Hz at 20dB. Increase the intensity to 50dB and present the beep. No response. Since the child has demonstrated he/she knows how to play the game and that he/she is paying attention this no response has to mean a hearing loss.
7. Score the audiogram. We are finished with the screening but the child still has the last block in their hand. Before removing the earphones you need to have the child place the block into the basket so they don't suspect there is a problem.
8. Increase the intensity to 50dB and present the beep. The child responds. Remove earphones and praise the child for their good work.

This scenario has the child not responding at 1000Hz at the right ear and 4000Hz at the left ear. Wait 2 to 6 weeks repeat the screening. If the child still does not pass refer the child for medical/audiological evaluations.

Child does not understand the game

If a child never understands how to play the game and/or you cannot get them to place earphones on, stay with the child for 3 minutes playing the game without earphones. Stop at 3 minutes and have the child come back for a re-screen. If the child is still unable to catch on to the game, refer this child. Instruct parents on the game so they can practice with their child at home.

Child not paying attention

As demonstrated in the past screening scenarios anytime a child does not respond at 20dB increase the intensity to 50dB. In doing this you get their attention and will have the child cooperate to get reliable results at 20dB. With some children it is necessary to repeat this several times in a screening to obtain successful results.

Uncooperative Child

This is the most difficult of all to screen but the most important to screen. This behavior may be due to a hearing loss. So it is imperative that you give 3 minutes of your time to attempt a screening as if the child was cooperative. Ignore the behavior. Most children want to play a game they just need the opportunity. If after three minutes you are still unsuccessful, stop the screening and repeat this procedure in 2 to 6 weeks. Have the parents practice this game at home. If the child still is not cooperative for the second screening, refer the child to the appropriate health professional, physician or audiologist.

Screening using hand raising

For children over 6 years of age you may use hand raising to demonstrate a response. It is not necessary for the child to know right or left when raising hands. When screening at 20dB the only ear the child can hear the beep is at the ear you are screening.

Instruct the child to raise their hand every time they **think** they hear the beep. You can do one practice with the child with earphones off and the audiometer at 90dB. Say "listen" and present the beep. If the child responds go down to 50dB and place the earphones on. If you get a response at 50dB go down to 20dB, doing 4000, 2000, 1000. Switch ears and do 1000, 2000 and 4000 Hz. Follow the same sequence for using play audiometry.

Screening results and referrals

Following completion of the screening, results must be evaluated on a "pass" or "does not pass" basis. **Not responding at the screening level (20-25dB) at any frequency in either ear shall constitute a "does not pass".** Record the hearing screening results in the appropriate area on the screening form.

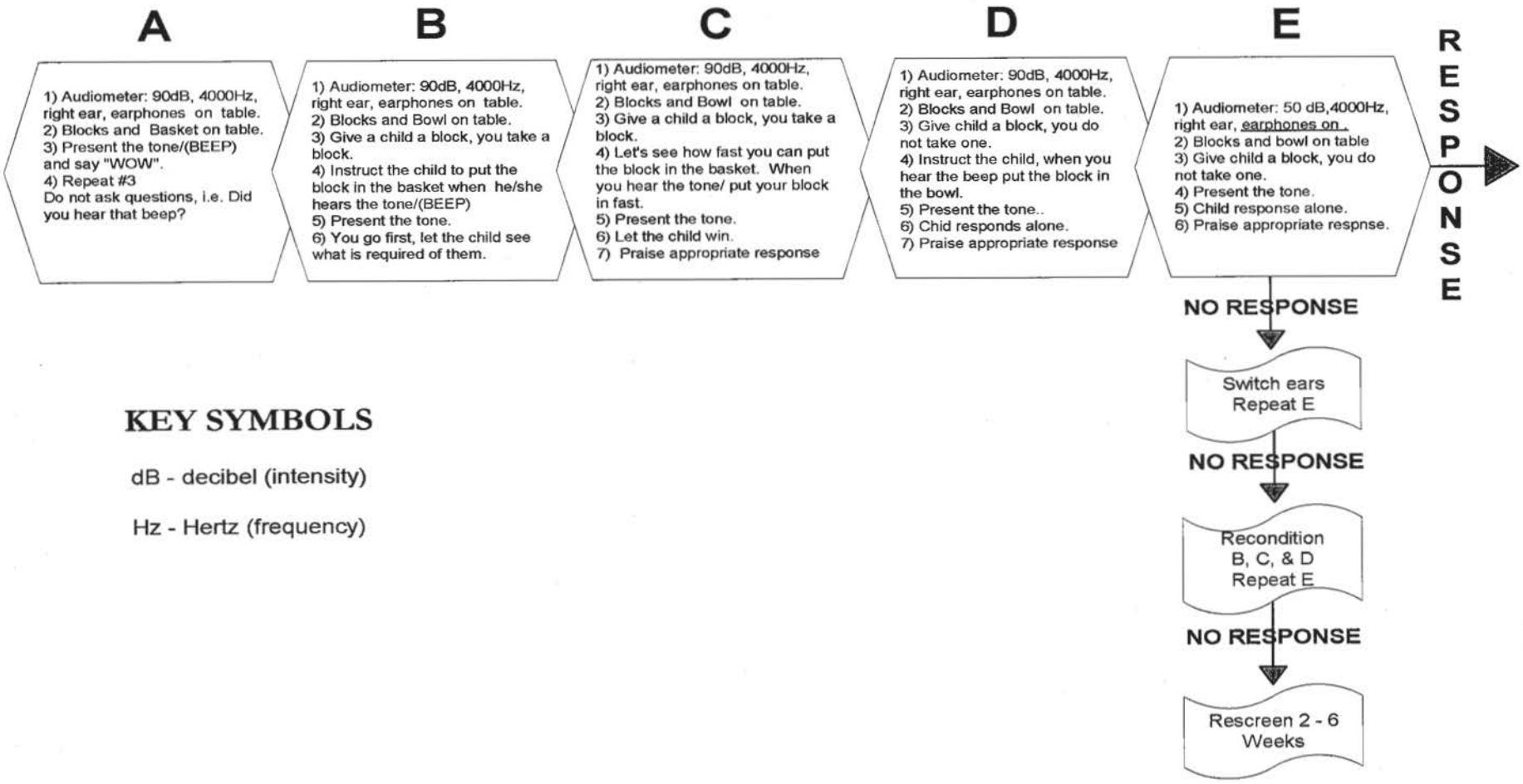
Rescreen the child after two to six weeks. If the second screening is "does not pass", the child needs to be referred to the appropriate health professional, physician or audiologist. Not passing a hearing screening does not mean the child has a hearing loss. The results indicate a possible hearing problem and that further testing is necessary.

Children may be referred to the California Children's Services (CCS) program if they have met the "does not pass" criteria for two screenings done at least six weeks apart. Please contact the local CCS program for specific information on referral requirements.

Notification of Results and Follow-up

A crucial component of a hearing screening is follow-up if a child has not "passed" all the screening measures. Ensure that further evaluation was performed in determining if there is a hearing loss, degree of hearing loss, location of hearing loss and recommended treatment. The sooner a child with a hearing loss receives necessary treatment or intervention, the more likely the child will adequately develop speech, language and communication skills.

PLAY AUDIOMETRY
CONDITIONING



KEY SYMBOLS

dB - decibel (intensity)

Hz - Hertz (frequency)

FIGURE: 8

SCREENING

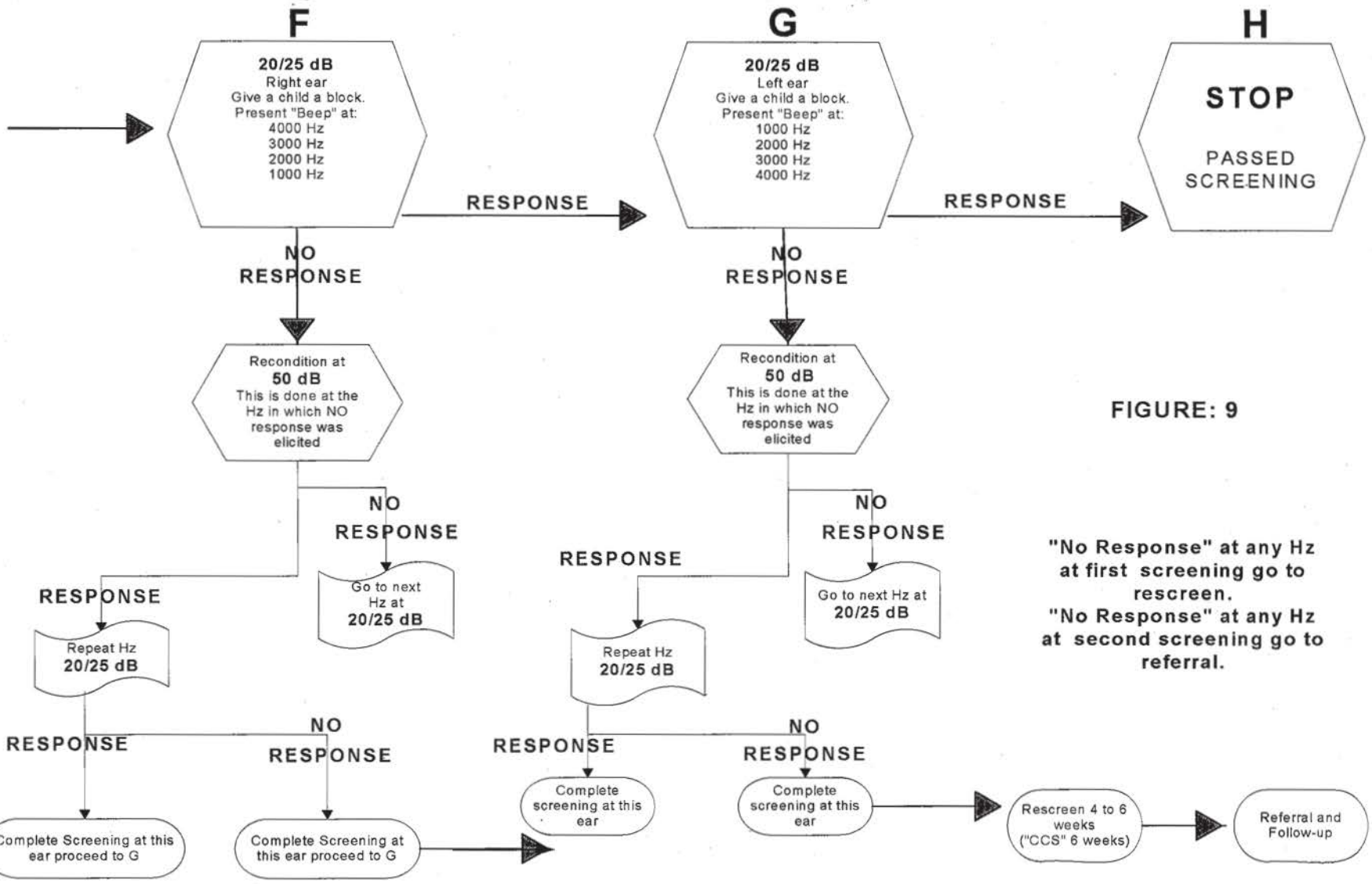


FIGURE: 9

"No Response" at any Hz at first screening go to rescreen.
"No Response" at any Hz at second screening go to referral.

Rescreen 4 to 6 weeks ("CCS" 6 weeks)

Referral and Follow-up

FIGURE: 8 (cont'd)

GLOSSARY

Acquired - Obtained or developed subsequent to birth (post-natally) nonhereditary.

Acuity - The sharpness, clearness, or distinctness with which one is able to hear a sound.

Adenoids - A mass of lymph (tonsil-like) tissue surrounding the Eustachian tubes in the back of the throat and/or nasopharynx.

Air Conduction - A term denoting the movement of the sound waves through the air. For example, a hearing test, conducted with earphones, is called an "air conduction" hearing test in as much as the sound wave moves through the external ear canal striking the eardrum bringing about an accompanying vibration which is transmitted through the middle ear via the ossicles.

Ambient Noise - In audiometry this term refers to any noise exclusive of an intentional signal in a test room environment. The noise may come from outside or from within the room.

ANSI - Refers to American National Standards Institute.

Artificial Ear - A device used to "couple" an earphone to a microphone for the purpose of checking calibration of the audiometer.

ASA - Refers to American Standards Association, renamed ANSI

Atresia - The absence of closure of the external or middle ear.

Attenuate - In audiometry this term refers to the reduction in intensity of tone or speech sounds.

Audiogram - A record of hearing levels measured at several different frequencies. A graphic picture of hearing.

Audiologist - Refers to an individual who is professionally trained to administer and interpret complex hearing evaluations.

Audiology - Refers to the science of hearing; particularly the hearing function. It is a diagnostic profession concerned with the determination of the type of hearing loss being manifested by a particular individual.

Audiometrist - Refers to an individual who, after appropriate training, has the skills necessary to administer, but not interpret, basic hearing tests.

Audiometry - It is the technique of measuring hearing. Measurements may be made of the auditory response to any of several auditory stimuli, but fixed frequency pure tones and speech sounds are most commonly used.

Auditory - Pertaining to the organs of hearing.

Auditory Brainstem Response (ABR) - Electrophysiological procedures assess the functional status of an individual's central or peripheral sensory nervous system by presenting auditory stimuli and recording the evoked response through electrodes.

Auditory Nerve - Sensory nerve (VIII cranial nerve) composed of fibers which arise from the cochlea and vestibular apparatus terminating in the brain stem

Bone Conduction - The process by which sound is conducted to the inner ear through the cranial bones.

Brain Stem - The bundle of nerve fibers, which is located below the cerebrum and above the spinal cord.

Central Auditory Processing (CAP) - Refers to the way the brain uses the auditory information it receives.

Cochlea - The snail shaped fluid-filled cavity, which serves as the receptor for hearing.

Conductive Hearing Loss - An interference with the movement of the sound wave as it passes through the external and middle ear on its way to the inner ear. A conductive hearing loss usually can be corrected and/or improved via medical treatment.

Congenital - Existing at birth. Could be a hereditary condition.

Decibel (dB) - Is a measurement of intensity (loudness).

Discrimination Score - A percentage score, which reflects a person's ability to understand speech.

Eardrum - A thin, translucent membrane which moves in response to sound waves traveling through the external auditory canal.

Endolymph - The fluid found within the scala media.

E.N.T. - Refers to a physician whose practice is confined to the treatment of disorders of the ear, nose, and throat. Otolaryngologist, synonymous with E.N.T.

Environmental Sound - Sounds that surround us in our everyday life. See Ambient Noise.

Eustachian Tube - A tube-like passage way which extends from the middle ear cavity to the back of the throat (nasopharynx). There is one Eustachian tube for each ear. Adenoidal tissue usually surrounds the Eustachian tube openings at the back of the throat.

External Auditory Canal - A cylindrical passageway, which funnels sound waves from the pinna to the eardrum.

Frequency - Is the number of vibrations per second and may be written as c/s, cps, or Hz (Hertz). A higher number of vibrations per second a higher pitch is perceived.

Hereditary - The passing on of genetic qualities through ancestry.

Hertz (Hz) - The international term for cycles per second. See Frequency.

Identification Audiometry - Refers to the application of hearing testing procedures to persons for the purpose of identifying those individuals with hearing acuity less than generally defined as within normal limits. The actual findings of hearing problems with an audiometer.

Incus - The second or middle bone of the ossicular chain which is located between the malleus and the stapes.

Internal Auditory Canal - A tube-like passage way in the temporal bone, which houses the auditory nerve.

Interrupter Switch - The tone presentation control switch on an audiometer.

Malleus - The first bone of the ossicular chain, which is attached to the eardrum, and to the incus. It is the largest bone in the ossicular chain.

Mastoid - A bone composed of a series of air-filled cells located behind the middle ear cavity.

Middle Ear Cavity - A small air-filled space which houses the ossicular chain and from whence the eustachian tube originates.

Mixed Hearing Loss - A hearing loss, which has both a conductive and sensorineural component.

Noise - Any unwanted sound. The most obnoxious sound known to man, a metal spoon scraping on the bottom of a sauce pan.

Noise Induced Hearing Loss - A term referring to the slowly progressive inner ear hearing loss that results from exposure to intermittent and/or continuous loud noise over a long period of time. This is a sensorineural hearing loss.

Non-Organic Hearing Loss - A loss of hearing for which there is no known organic basis.

Organ of Corti - The highly sensitive receptor of hearing which contains the hair cells and the auditory nerve findings. It is housed within the cochlea.

Ossicles or Ossicular Chain - The bridge of three small bones (malleus, incus, and stapes) across the middle ear cavity. Sometimes referred to in layman terms as the hammer, anvil, and stirrup.

Otitis Media - Inflammation or infection of the middle ear.
Acute: An ear infection lasting for a short period of time.
Chronic: A long-term or continuing ear infection.

Otoacoustic Emission (OAE) – When an auditory stimulus is presented into the external ear canal, a normal ear responds by emitting a subaudible sound or echo back through the middle ear. OAE procedures measure the echo with a microphone placed in the external ear canal and connected to a computer.

Otolaryngologist - Refers to a physician whose practice of medicine deals with the ear, nose and throat.

Otologist - Refers to a physician whose practice is confined to the medical treatment of ear disorders.

Otology - Refers to that branch of medicine that is concerned with the ear.

Otosclerosis - A disease process by which the bone surrounding the oval window becomes abnormal and may hamper the movement of the stapes' footplate.

Oval Window - A small opening in the cochlea which accommodates the footplate of the stapes.

Pinna - The most visible portion of the external ear.

Pure Tone - A single frequency sound without accompanying overtones or other sounds.

Reliability - Refers to the ability of a test to furnish consistent results under similar testing conditions.

Reticular Formation - Groups of cells and fibers through the brain stem. They are important in controlling or influencing alertness, waking, sleeping, and directing attention.

Rh Incompatible - A problem with certain blood components which can result in damage to the newborn child's hearing.

Round Window - A small opening covered by a thin membrane located below the oval window.

Rubella - German measles, a virus which may cause hearing loss.

Scala Media - The middle fluid-filled tunnel of the cochlea which houses the organ of Corti.

Scala Tympani - The outer fluid-filled tunnel of the cochlea, which communicates with the middle, ear via the round window.

Scala Vestibuli - The fluid-filled tunnel of the cochlea which communicates with the middle ear via the oval window.

Sensorineural Hearing Loss - A dysfunction of the sensory or neural structures of the ear. This is a noncorrectable disorder.

Sound Level Meter - An instrument used to measure sound levels in decibels. It is used in conjunction with the artificial ear when checking calibration.

Stapes - The third smallest bone of the ossicular chain which is located between the incus and the oval window.

Threshold of Hearing - In pure tone audiometry, threshold is defined as the minimal intensity or hearing level at which an individual is able to respond to a tone at least 50 percent of the time. It is this minimal hearing level that one plots on an audiogram that indicates an individual's best level of hearing for that particular frequency.

Tinnitus - A noise in the ears or head, which may sound, like ringing, buzzing, roaring, etc.

Tone - A sound wave perceived as an auditory sensation of definite pitch.

Validity - A valid test. A test which tests what it is supposed to test.

Vestibular Apparatus - The organ of balance located in the inner ear. Sometimes referred to as the semicircular canals.

Children's Medical Services
Child Health and Disability Prevention Program
(CHDP)

GUIDELINES FOR AUDIOMETRIC TESTING

Qualifications of Personnel Performing an Audiometric Screening:

All persons administering a pure tone audiometric screening test must have completed a training course in screening and audiometry from the State Department of Health Care Services, or through a program approved by the State Department of Health Care Services, and received a certificate.

If a screener has not administered a hearing-screening test within a year of their training course, the screener must repeat the training.

Audiometric Testing:

Screen at each health assessment visit for hearing problems of children age two months through three years by history and clinical observation, using measured noisemakers, OAE (otoacoustic emissions) tests, sound generators, or behavioral techniques. Screen for hearing problems of children age 3 - 21 years at each health assessment visit using a pure tone air conduction audiometer with intensity levels not exceeding 25 decibels (dB) at frequency levels of 1000, 2000, and 4000 Hz.

The pure tone audiometer must meet or exceed specifications for type 5 audiometers as defined by the American National Standards Institute (ANS) S3.6-1989 (revision of S3.6-1969). The audiometer must operate by AC, alternating current as required for their accuracy and long life.

When testing by air conduction, cover both ears with an earphone and cushion, ANSI S3.6-1989.6. Do not use speech materials for the testing procedure because these materials fail to identify individuals with hearing impairments in the frequency range above 500 Hz.

Test the audiometer each day prior to use to determine if it is working properly. This can be done by a person with normal hearing. Listen to the sounds from each earphone. If unwanted sounds or interruptions occur, do not use the audiometer. Instead, arrange for the audiometer to be serviced.

Assess the testing room for noise level prior to the start of the testing. To ensure the testing room is quiet enough to perform the hearing screening, a person with normal hearing should put the earphones on and be able to hear each frequency (1000-4000 Hz) at 15 dB.

An audiometer must have an electroacoustic calibration check at least every 12 months or more frequently, if indicated. If the audiometer fails to meet any of the ANSI S3.6-1989 or current specifications, provide for electroacoustic adjustments so that all standards are met before using the audiometer for screening.

Vendors of audiometric testing equipment should be able to identify qualified businesses to perform the check. Keep a calibration chart or sticker with the audiometer showing proof of performance. Preferably use play audiometry methods to administer an individualized pure tone air conduction audiometric screening test to children three to six years of age. Repeat an audiometric screening in two to six weeks when a child does not pass at frequency levels of 1000, 2000 and 4000 Hz at an intensity level not exceeding 25 dB (decibels). Refer specialty care children who fail to respond to any frequency on two screenings separated by an interval of at least two weeks and no later than six weeks after the initial screening. Refer any suspected hearing loss to a medical specialist and/or California Children's Services (CCS) when a child has failed their audiometric screening.

Further explanation of the CHDP requirements for hearing screening assessments is available in the CHDP Health Assessment Guidelines for comprehensive well child health examinations.

CALIFORNIA CHILDREN'S SERVICES (CCS)

MEDICAL ELIGIBILITY REGULATION

California Code of Regulations, Title 22
§ 41839 Diseases of the Ear and Mastoid Process

A. CCS Applicants shall be eligible for participation in the CCS program for diagnostic services to determine the presence of a hearing loss when the applicant:

1. Fails two pure tone audiometric hearing screening tests performed at least six weeks apart at levels not to exceed 25 decibels and at the minimum number of frequencies of 1000 2000 and 4000 hertz; or
2. Fails to have normal auditory brain stem evoked response, or otoacoustic emission or behavioral responses to auditory stimuli as determined by two tests performed at least six weeks apart; or
3. Fails to pass hearing screening provided through the Newborn and Infant Hearing Screening, Tracking and Intervention Program, as per Health and Safety Code Sections 123975 and 124115 through 124120.5
4. Has documentation of risk factors associated with a sensorineural hearing or conductive hearing loss such as:

    a.) A family history of congenital or childhood onset of hearing loss.
    b.) Congenital infection known or suspected to be associated with hearing loss.
    c.) Craniofacial anomalies
    d.) Hyperbilirubinemia at a level exceeding the indication for an exchange transfusion.
    e.) Ototoxic medications used for more than five days.
    f.) Bacterial meningitis
    g.) Severe depression at birth, defined as:

        - Apgar score of three or less, or
        - Failure to initiate spontaneous respirations by ten minutes of age, or
        - Hypotonia persisting to two hours of age

    h.) Receiving prolonged mechanical ventilation for a duration of at least ten days.
    i.) Presence of findings of a syndrome know to be associated with hearing loss.

5. There are symptoms known to be associated with hearing loss such as poor speech for age or delay in appropriate behavioral milestones.

B. If either of the test referenced in (a) (1) and (3) above are performed by an audiologist or otolaryngologist, only one exam shall be required for eligibility for diagnostic testing.

C. CCS applicants shall be eligible for participation in the CCS program for treatment services when there is a hearing loss present as defined by the following criteria.

1. In children over five years of age, a pure tone audiometric loss of 30 decibels or greater at two or more frequencies in the same ear tested at 500, 1000, 2000, 3000, 4000, 6000, 8000 hertrz.

2. In children from three to five years of age, a pure tone audiometric loss of 30 decibels or greater at any frequency tested at 500, 1000, 2000, 3000, 4000, 6000, 8000 hertz.

3. In children unable to complete a pure tone audiometric test and whose auditory brain stem evoked response, or otoacoustic emission, or behavioral responses to auditory stimuli indicate hearing loss of 30 decibels or greater.

D. CCS applicants shall be eligible for participation in the CCS program for treatment services when there is:

1. Perforation of the tympanic membrane that requires tympanoplasty
2. Mastoiditis
3. Cholesteatoma
4. Congential anomalies of the ear and mastoid process that meet criteria outlined in the CCS regulations.

E. Authority cited Section 100275, Health and Safety Code, Reference: Sections 123830, 123835, and 123975. Health and Safety Code.

Appendix III

HEARING TEST PROCEDURES FOR INFANTS, TODDLERS AND CHILDREN

The initial evaluation and assessment of infants, toddlers and children up to 21 years of age, at the minimum should include:

1. Review of medical and/or case history;

2. Informal behavioral observation(s) and/or parent concerns and reports; and

3. One or more hearing test procedures appropriate for the age, development, and unique needs of the child. Such procedures include:

    a. electrophysiologic;
    b. otoacoustic emissions; and
    c. behavioral assessment measures.

Preferred practice is a combination of procedures a-c, as appropriate for the child.

Optional procedures include:

1. tympanometry in conjunction with electrophysiological, acoustic emmittance, or behavioral assessments and
2. visual inspection of the ears.

1. Review of Case History

While reviewing the infant's medical and/or case history, the reviewer(s) must note any factor(s) indicative of a possible hearing loss. Such factor(s) place the infant at high risk for a hearing loss and, therefore, warrant continuous monitoring and possibly in-depth testing. The Joint Committee on Infant Hearing (JCIH) Position Statement 2000 offers information on these indicators for hearing loss and can be observed at www.jcih.org . If any of the indicators for hearing loss are present, the child must receive a comprehensive audiological evaluation/assessment by an audiologist. This review can be part of the required review of the pertinent records related to the child's current health status and medical history.

The reviewer needs to have knowledge of the various medical conditions and terms. Doctors and nurses have such knowledge. Other team members, especially those from the allied health fields, may also have such knowledge or could be trained specifically to recognize the criteria.

2. Informal Behavioral Observation, Informal behavioral preservation and/or parent report(s)

FIGURE: 9

SAMPLE TOOL

INFORMAL OBSERVATIONAL ASSESSMENT OF HEARING

Child's Name _____ *Age* _____
DOB _____

According to:	Parent Report		Observation		Notes
Does/Did the infant/toddler:	YES	NO	YES	NO	
at 0 -3 months of age					
Startle to loud sounds?					
Respond to familiar voices?					
Coo, making vowel-like sounds?					
at 3 - 6 months of age					
Smile when spoken to?					
Stop crying when spoken to?					
Laugh or giggle?					
Vocalize or babble?					
Enjoy playing with sounds?					
at 6 - 9 months of age					
Localize to speech or environmental sounds?					
Recognize family members names?					
Attend to music or singing?					
Shout or vocalize to gain attention?					
Initiate sounds?					
at 9-12 months of age					
Point to two body parts on self when named?					
Look at familiar objects or people when named?					
Babble using various sounds and multi-syllables?					
Say "mama" or "dada"?					

Child's name:	YES	NO	YES	NO	NOTES
at 12 - 18 months of age					
Speak in single words (usually a noun to express a complete thought)?					
Understand 50 words?					
Point to 3-6 body parts on a doll?					
Imitate new words spontaneously?					
Say 10 - 15 words?					
at 18 - 24 months of age					
Follow one-step commands?					
Say two word phrases frequently?					
Say 50 different words? (range 5-200)					
Understand new words rapidly?					
at 24 - 30 months					
Speak intelligibly 50% of the time?					
Regular speak in 2 & 3 word phrases?					
Name one color?					
Identifies four objects by function?					
at 30 - 36 months of age					
Follow two-step commands?					
Say 3 word simple sentences?					
Answer yes/no questions correctly?					
Say first and last name?					
Speak intelligibly 75% of the time?					
Have an expressive vocabulary of 300 words? (range 200-900)					

Completed by _____ ***Date(s)*** _____

_____

SPEECH AND LANGUAGE DEVELOPMENT

Speech	Speech Sounds (Articulation)	Vocabulary and Basic Concepts	Hearing & Understanding (Receptive Language)	Verbal Language (Expressive Language)
0-6 months	* Coos * Produces some sounds		* Startles or cries at loud noises * Listens to speech * Turns head toward sound	* Uses cries, sounds, and/or gestures to indicate wants
7-12 months	* Imitates some adult speech sounds and intonation patterns * Babbles using a variety of sounds (e.g., baba, dada) and intonation patterns * Likes to make the sounds of familiar animals and noises	* Uses one or more words although they may not be clear * Recognizes words for common objects (e.g., cup, shoe, juice)	* Responds to own name * Responds to simple requests * Understands "no" * Listens when spoken to	* Uses speech, sounds, and/or crying to get attention * Begins to use jargon (babbling that sounds like real talking) * Uses speech intentionally for the the first time * Uses gestures to communicate (e.g., waving bye, pointing)
13-18 months	* Speech is mostly difficult to understand * Omits some beginning & most ending consonant sounds (e.g., "_at" for "cat" " _ha" for "hat") * May hum simple tunes	* Uses 3 - 20+ words which are primarily nouns * Knows one or more body parts * Recognizes pictures of familiar persons and objects	* Follows simple commands (e.g., "Get the ball" "Come here") * Responds to simple questions through use of gesture (e.g., head shake/ nod, pointing	* Expresses wants/needs using gestures and vocalizations
19-24 months	* Child's speech can be understood approximately 25 - 50% of the time	* Uses new words monthly * Uses 50 - 100+ words * Understands 300+ words * Knows five body parts	* Answers "What's that?" * Enjoys listening to stories	* Uses words more frequently than jargon * Begins using two-word phrases (e.g., "More cookie" "Mommy play") * Begins to use pronouns (e.g., me, it)

FIGURE 10

Speech	Speech Sounds (Articulation)	Vocabulary and Basic Concepts	Hearing & Understanding (Receptive Language)	Verbal Language (Expressive Language)
2-3 years	* Child's speech can be understood 50 - 75% of the time * Uses the consonants (p, b, m, n, h, w) correctly * Consistently uses beginning consonants, although may not be clear * Frequently omits middle consonants * Frequently omits or substitutes ending consonants (.e.g., "dod" for "dog"	* Uses 50 - 250+ words * Understands 500-900+ words * Understands concepts such as *one/all* and *on/off*	* Continues to notice environmental sounds (e.g., telephone, doorbell) * Answers simple questions * Understands most things are said to him/her	* Gives first name * Refers to self as "me" * Uses 3 to 4 word phrases * Asks 1 to 2 word questions * Grammatical complexity increases, although many errors continue * Uses some pronouns, past tense verbs, and possessives (e.g., he, walked, baby's) * Uses the verb "is" and its contracted form (e.g., "It is mine." "It is raining.")
3-4 years	* Child's speech can be understood 80% of the time * Uses the consonants (p, b, m, n, h, w, t, d, f, y) * Begins to use the consonants (k, g, s, z, v, r, l, j, sh, ch, th, ng)	* Uses 800 - 500+ words * Understands 1200 - 2000+ words * Understands object functions (e.g., scissors cut) * Understands concepts such as *little/big, day/night, yesterday, summer, in, on, and under*	* Follows two to three part commands (e.g., "Please go get your shoes and coat.") * Answers simple *who, what, where,* and *why* questions	* Uses four to six word sentences * Uses mainly nouns and verbs * Asks simple *who, what, where,* and *why* questions * Consistently uses regular plurals, possessives, the verbs *is, are,* and *am,* and present progressive verbs (e.g., "He is walking.") * Participates in conversations
4-5 years	* Child's speech can be understood most of the time * Produces *most* sounds correctly although (r, l, s, z, v, th, sh, ch) continue to develop * Significant reduction in the number of persistent sound errors * Continues to omit some middle consonants	* Uses 900 - 2000+ words * Understands 2800+ words * Recognizes 1 or more colors * Understands number concepts up to three * Counts up to 10 * Identifies basic shapes (e.g., circle, square, triangle) * Continues to develop basic concepts	* Answers questions regarding object function (e.g., "What do you do with a fork"?) * Answers complex questions * Pays attention to a story and can answer questions regarding the story	* Communicates easily with other children and adults * Uses four-to-eight word sentences, begins to use a lot of detail * Uses grammatically correct sentences, although irregular plurals, irregular past tense verbs, and future tense verbs continue to emerge (e.g., feet, ran, will run) * Talks about past experiences * Accurately relays a lengthy story

FIGURE: 10 (Cont'd)

Other areas of concern may include a voice noticeably different from other children's voices or stuttering (dysfluent speech patterns)
If you have concerns regarding your child's development, discuss them with your pediatrician. You may contact your county's Infant Development Program for children birth to three years of age or the Speech-Language Pathologist at your local public school for children three years and above. The yellow pages of your telephone book can also provide you with information regarding local Speech-Language Pathology and Audiology Services. Information compiled by California Speech-Language Association District 2 Better Hearing and Speech Month Committee (1997), from a variety of sources which include the American Speech-Language-Hearing Association (1983); Shipley & McAfee (1993); and Lippke, Dickey, Selmar, and Soder (1997).

3. Hearing Test Procedures

A. Electrophysiologic Procedures

Electrophysiologic procedures assess the functional status of the central of peripheral sensory nervous system by presenting auditory stimuli and recording the evoked response through electrodes. Electrophysiologic procedures may be called:

Automated Auditory Brain-Stem Response (AABR),
Auditory Brain-Stem Response (ABR),
Brain-Stem Auditory Evoked Response BAER), and
Evoked Response Audiometry (ERA)

Electrophysiologic procedures are reliable and objective for infants younger than six months as well as for older infants who are difficult to test or have developmental, cognitive, or physical involvement. The test is noninvasive, although the infant is required to remain very still during testing. If the infant is not sleeping, the use of sedation may be necessary. The procedure involves the placement of electrodes on the infant's head while rapid clicking sounds are presented at the ear through a headphone. A computer-generated waveform is printed which can be interpreted in terms of hearing sensitivity. Primarily high-frequency sounds of varying levels of loudness are used.

Electrophysiologic procedures may be either screenings or comprehensive procedures. If an infant fails a screening twice, indicating a possible loss, a comprehensive audiological evaluation must be conducted by an audiologist.

The electrophysiological screening procedures may be conducted by an audiologist or by personnel experienced in handling infants/toddlers and trained specifically to conduct the electrophysiological screening procedure. All personnel must be under the supervision (direct or indirect) of a physician or an audiologist.

B. Otoacoustic Emissions

When an auditory stimuli is presented into the external ear canal, a normal inner ear (cochlea) responds by emitting a subaudible sound or "echo" back through the middle ear. Otoacoustic emissions (OAE) procedures measure the "echo" by a microphone placed in the external ear canal and connected to a computer. The OAE is noninvasive and objective. The infant must be in a quiet state with a properly fit probe so that stimulus presentation is reliable. The two types of OAE procedures are:

Distortion Product Otoacoustic Emissions (DPOAE) and
Transient Evoked Otoacoustic Emissions (TEOAE)

The OAE screening is a fast and simple process that is extremely accurate in identifying both sensorineural and recurrent conductive hearing losses. Failure of an OAE screening constitutes a referral for a complete audiological evaluation.

An audiologist may conduct the OAE or personnel experienced in handling infants/toddlers and specifically trained to conduct the OAE. All personnel must be under the supervision (direct or indirect) of a physician or an audiologist.

C. Behavioral Assessments

Behavioral assessments involve the observation of behavioral response to sound. These assessments often involve reinforcing the infant to make a simple, observable motor response to a sound while the infant's responses in the absence of sounds are not reinforced. This process eventually results in learned (conditioned) response to sounds. Sounds of varying pitch and loudness may be presented.

Behavioral assessments include:

Behavioral Observation Audiometry (BOA);
Visual Reinforcement Audiometry (VRA);
Conditioned Orienting Response Audiometry (CORA); and
Play Audiometry (PA);
Identification Audiometry.

Behavioral Observation Audiometry (BOA) is a subjective measure of hearing acuity. Testing is performed either inside a sound booth or a quiet room where the infant is seated on the parent's or other adult's lap while various sounds (i.e., speech sounds, spoken words, warble tones, or narrow band noises) are presented via loudspeakers, portable sound generators, or measured noise makers. The infant is observed for subsequent reflexive responses (i.e., eye widening, startle reflex, or head turn).

Visual Reinforcement Audiometry (VRA) and Condition Orienting Response Audiometry (CORA) are subjective measures on an infant's hearing. Testing is performed inside a sound booth where the infant is seated on the parent's or other adult's lap in between two loudspeakers. Sounds (i.e., speech sounds, warble tones, or narrow band noises) are presented in conjunction with a visual reinforcement (i.e., a mechanical toy on each loudspeaker moves when the infant turns toward the speaker that emitted the sound). The infant is then conditioned to turn toward the sound in anticipation of the visual reinforcer, thus indicating a response to the emitted sound.

Play Audiometry (PA) requires a learned response from the infant/toddler after hearing a sound presented through loudspeakers or earphones. Usually pure tone sounds are presented; however, any sounds previously mentioned can be used. For this procedure, the infant/toddler places an object (block or other small toy) into a container every time she/he hears the sound.

Children who fail any of the behavioral assessment procedures **twice** must receive a comprehensive audiological evaluation by an audiologist.

Identification Audiometry Identification audiometry is a screening procedure to identify those children who have no hearing problems and those who need a further evaluation. This procedure is very similar to performing "play audiometry" in that it uses the same audiometer, earphones, screening frequencies and intensities. The only difference is how the child responds to the tone. In this method the child will raise his/her hand when he/she thinks they hear the tone. Typically this procedure is performed on children 6 years of age to 21 years of age.

An audiologist may administer behavioral procedures or personnel experienced in handling infants/toddlers and specifically trained to conduct behavioral assessment(s). Trained personnel must be under the supervision of an audiologist, a physician, or school official.

VISUAL CLUES OF THE CONSONANT SPEECH SOUNDS

BPM	FV	DTNL	SH ZH CH J	GK
The lips come together and release quickly for the **B** and **P** sounds. They come together in the same manner for the **H** sound but usually held a little longer. **B, P, AND M** **LOOK ALIKE**	The upper teeth come in contact with the lower lip. With some people the only clue you will see will be a turning in the lower lip.	With all of these sounds, the lips will be opened slightly. For the **D, T, N,** and **L.** The lip of the tongue reaches up just behind the upper teeth.	For the **SH** and **ZH** you will see a slight relaxed rounding of the lips with them protruding slightly. The **CH** and **J** sounds, look like **SH** and **ZH** but are faster like an explosion.	There is not much to see with these sounds. For the **G** and **K.** The mouth opens slightly and there may be some movements of the throat at the same time.
W WH R (RUH)	**TH**	**S Z**	**R (ER)**	**H**
For the **W, WH,** and **R (RUH)** sounds, the lips form a rounded pucker and then move through a more relaxed position for the following vowel sound.	For the **TH** sounds, the tongue tip comes up and touches the back of the cutting edge of the upper teeth. You may see the tip of the tongue between the teeth.	The front teeth are usually almost together. The position of the **S** and **Z** is greatly influenced by the preceding or following vowel. **(ZOO, SUE, AS, ASK)** For the **S** and **Z** sounds, the corners of the mouth draw apart slightly. **(SEE, ZEE EASY, ESSAY)**	The **(ER)** sound is usually in the middle or ending of a word. It is easily confused with the **SH, ZH, CH,** and **J.**	The **H** will be seen as an opening of the mouth. A cockney accent uses no **"H"** sound. However we understand **HELLO, HARRY, WHEN, WE HEAR"_ELL_ARRY"**