

HEARING CONSERVATION IN THE PUBLIC SCHOOLS REVISITED

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Procedures to identify hearing loss in children have been in practice in the public schools for decades. When audiology entered the spectrum of public school services it was natural for hearing loss identification programs to be under the management of educational audiologists. Even though school hearing screening is sometimes scoffed at by audiologists due to its simplicity and shortfalls, the fact remains that without identification of hearing loss, effective management cannot occur. In other words, educational audiology begins by knowing which students in the school have hearing loss. The process of finding out who these students are can be quite complicated indeed when school schedules, personnel, equipment, and budgetary factors come into play. The audiologist, whether employed on-site by the school district, in private practice but under contract with the schools, or managing school-age children from a clinical setting, needs to be aware of "best practice issues" and potential compromises involved in school hearing conservation programs.

The purpose of this article is to provide a current look at the trends and issues surrounding the identification and management of children with hearing loss in the schools. The increasing awareness of the educational, behavioral, social, attentional, cognitive, and other subtle developmental effects of minimal sensorineural hearing loss, unilateral loss, and fluctuating conductive hearing loss also cause us to rethink how best to identify all hearing problems. However, mere identification of educationally significant hearing loss is fruitless unless actions take place to provide improved speech perception and habilitation to the child with a hearing loss of any type and degree. Anderson¹ purported that hearing screening without follow-up services is of less value than no screening at all since those involved in the program and the public whom they serve are deluded into thinking a hearing conservation program exists when indeed there is only a labeling service.

This article serves to emphasize the best practices to aim for in setting up or improving a school hearing conservation program. Accordingly, the following issues

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will be addressed: outcomes of an effective hearing conservation program, hearing screening program components (personnel, criteria, timelines, population screened, equipment and environment), referral practices, determination of needs, and hearing loss education as a part of the school curriculum.

OUTCOMES OF AN EFFECTIVE HEARING CONSERVATION PROGRAM

Such outcomes must consider *both* the ear and hearing problems:

1. recommendation of amplification devices for students as appropriate (includes hearing aids, personal FM units, soundfield FM systems)
2. medical referral of children with conductive hearing loss to treat the ear problem
3. determining which children have significant histories of recurrent otitis media and fluctuating hearing loss, and how frequently they will need monitoring of their middle ear function/hearing ability
4. determining which children are having difficulties performing in school due to hearing loss, and their individual needs for special support services
5. involving individual teachers and raising teacher awareness of the listening and/or speech perception problems of the child with hearing loss so that instructional consideration will be given to this child in the classroom
6. audiological monitoring of students with permanent hearing loss to determine if hearing loss, amplification devices, or academic needs have changed
7. education of students with apparent noise-induced hearing loss and their peers regarding the hazardous effects of excessive noise, including the need for hearing protection
8. in-service education for teachers (and parents) regarding the effects of hearing loss on listening, language development, and learning, including rec-

ommendations for how teachers can help identify and assist the child with a hearing problem

9. open dialogue between the local medical community and the school regarding children's hearing needs, for the purpose of facilitating optimal learning and behavior in school.

Outcomes of a hearing conservation program are summarized in Appendix A.

ISSUES IN IDENTIFICATION AUDIOMETRY

The purpose of identification audiometry is to sift out all children with hearing loss as defined by the criteria used. The challenge of the educational audiologist is to try to determine which of these identified children are at critical risk for developing educational difficulties due to hearing loss. The criteria and model used in an identification program can assist or confound the identification of the children with educationally significant hearing losses.

Programs that provide thorough and efficient identification of hearing loss in school populations have historically been at odds with the budget fluctuations of individual school districts. The justification of identification program personnel, training, equipment, and disruption of class routine must be defended on the basis of the savings in cost to the district for long-term expensive special education services by early identification and habilitation of students with hearing loss. We must stand firm in our efforts to proactively prevent educational problems by identifying children with hearing loss and addressing their hearing needs before their education, behavior, and self-esteem are permanently impacted.

Traditionally, the greatest emphasis in hearing conservation programs has been placed on identifying children with permanent hearing loss. However, research that has grown over the last 15 years or so has made the educational impact of fluctuating conductive hearing loss and minimal sensorineural hearing loss apparent. The

minimal to moderate hearing losses that usually accompany middle ear disease were not believed to be important until recent years; middle ear disease was considered to be solely a medical ear problem.² The majority of children who fail hearing screening will do so because of a temporary hearing loss due to otitis media. An analysis of hearing screening tests on more than 50,000 students found that at least 70% of hearing losses noted could be attributed to otitis media.³ However, because otitis media constitutes the most frequently diagnosed illness in children (it also accounts for the greatest number of physician office visits),⁴ it is impractical to consider every child with an apparent middle ear problem as having measurable educational needs.

The foremost purpose of any hearing conservation program is to identify the children in the population who have hearing impairment that will interfere with their educational development.⁵ In identifying the children with sensorineural hearing loss, a program must set criteria to determine the degree of hearing loss to be identified. For example, some older programs used a criteria of hearing loss of 30 dB or greater, some programs use failure at only one frequency, whereas others use failure at two or more frequencies. In other words, how much hearing loss can a child exhibit before he or she is no longer considered to have "normal hearing"? Current research leads us to want to identify children with average hearing ability of 15 dB or greater.

Identifying educationally significant fluctuating hearing loss due to recurrent middle ear problems is difficult. Because this type of hearing problem is fluctuating in nature, there will naturally be many children who will not be identified during hearing screening because they happen to be having normal middle ear function on the particular day of mass screening. If only pure tone screening is used, all of the children with active middle ear effusion that is causing less hearing loss than the specified criteria will not be identified. Of those children identified, some may be experiencing a middle ear problem as part

of a transient cold or may have only had one or two episodes of middle ear effusion in their lives so that the educational impact will be limited during a short time. The presence of hearing loss due to an ear problem is not unusual in young children. Approximately 75% of the preschool population will be affected by episodes of otitis media; 90% of this number will have had their first episode prior to age 1 year and about half of these children will have had six or more ear infections before the age of 3 years.⁶ The frequency of ear problems, how long the episodes last, and how much hearing loss is present are the factors that determine the impact on the development of language, listening skills, and cognition.⁷ In order to identify effectively the children who may experience educational difficulties due to fluctuating conductive hearing loss, we need to take their history of ear and hearing problems into account as part of the screening process.⁸

EVOLVING PHILOSOPHIES IN HEARING LOSS IDENTIFICATION

As identification audiometry has developed over the last few decades, there has been increasing recognition of the impact that fluctuating hearing loss as well as sensorineural loss has on a child's learning and development. Hence, this recognition is reflected in the hearing loss identification procedures that are in current use today. Historically, identification audiometry techniques centered on finding the child with the previously unrecognized permanent hearing loss.² As tympanometry became an available addition to identification efforts, the emphasis was often more medical than educational, perhaps due to the medical community's initial discomfort with seeing such a medically diagnostic technique used, albeit with few firm guidelines, in the public schools. As the medical community has become more accepting of tympanometry screening as part of the school hearing conservation program, many current identification programs emphasize

both the medical and educational aspects of identified hearing loss.

IDENTIFYING EDUCATIONALLY SIGNIFICANT HEARING LOSS

A SUGGESTED PROGRAM: PURE TONE, TYMPANOMETRY, AND HEARING HISTORY—PUTTING IT ALL TOGETHER AND GETTING THE TEACHERS INVOLVED

This hearing conservation program appears to be the most comprehensive one to date for identifying children with any hearing problem that places them at risk for school difficulties, and is considered by the author to represent best practice at this time. In this program, identifying the children with educationally significant hearing problems, sensorineural or conductive, is paramount.

Research has repeatedly indicated that children who have experienced recurrent middle ear problems and fluctuating hearing loss prior to the age of 2 years and continuing through the preschool years are at greatest risk for auditory, language, and cognitive development delays.⁹⁻¹⁵ Recognizing this impact of early middle ear disease, information on each child's hearing history is integrated into the hearing conservation program. The earlier children with significant histories of ear and hearing problems are identified, the greater the habilitative or preventative benefits can be in terms of speech language services, parent education, and consistent medical care.

In order to obtain this information for each child, it is suggested that a hearing history be obtained from the parent as part of the school enrollment process. Information obtained is typically more complete and accurate if it is obtained separately from other health or immunization information. The hearing history typically includes information about the age at which middle ear infections started, how many episodes the child has experienced, if the child continues to experience fluctuating hearing, history of ventilation tubes, if the

parent is concerned about hearing ability, if the child has a known permanent hearing loss, etc. (see Appendix B). It appears to be important for some redundancy to occur in the hearing history questionnaire as a check on reliability of information and recent occurrence of OME episodes. With this information in the possession of an active hearing conservation program team member, children entering school with significant histories of ear and hearing problems are then able to be "red-flagged" as being at risk for difficulties in educational development. Teachers can be made aware of the student's potential fluctuating hearing ability early in the school year and preferential seating (and hopefully sound-field amplification) can then be begun immediately. Medical information describing ear and hearing problems may also be requested for some of these "red-flagged" students following receipt of parental permission.

Mass screening (pure tone and tympanometry) is performed to identify previously unknown sensorineural hearing loss and current conductive hearing problems. By use of hearing history information and screening results, the educational audiologist can have a comprehensive list of which children are most at risk for speech perception and educational difficulties due to continued fluctuating hearing loss and sensorineural hearing loss. The teachers can then be involved immediately to determine if any educational difficulties are apparent or to be alert for developing difficulties. The red-flagged children are then monitored periodically for hearing loss throughout the school year (i.e., every 2 months, or 3-4 times per school year). The children who have evidenced fluctuating hearing loss can be screened for speech, language, and educational difficulties shortly after hearing screening or at least prior to the end of their first year in school so those with educational needs can be identified. It must be recognized, however, that otitis media by nature can be difficult for parents to identify behaviorally in the preschool years as evidenced by the finding that 25 percent of children during "well

baby" checks have current otitis media of which the parents were unaware.¹⁶ Therefore, a student who displays fluctuating hearing loss associated with otitis media who does not have a parent-verified history may still be at risk for school difficulties.

HEARING SCREENING PROGRAM COMPONENTS

Despite the obvious importance of identifying children with hearing loss, hearing screening is not mandated in all states in the nation nor do most states recognize and support tympanometry screening as a necessary part of the hearing conservation program. However, most if not all states do perform hearing screening in some manner at least for a limited portion of the public school population. In order to perform any type of hearing screening, the following components need to be in place:

1. personnel performing the actual screening
2. screening criteria for failure
3. timelines for mass screening and re-screen of identified children
4. children to be screened (ages, grades, programs)
5. screening equipment used
6. screening environment

SCREENING PERSONNEL

Hearing screening of regular education populations is performed by a variety of professionals, paraprofessionals, and volunteers throughout the nation including school nurses, speech-language pathologists, screening technicians, and parent volunteers. Mass hearing screening procedures are not difficult to master and may be competently performed by most adults with minimal training, preferably following instruction by an educational audiologist. Use of school nurses tends to encourage the medical model of hearing loss identification but does facilitate communication between medical offices and the schools. Use of speech-language patholo-

gists encourages communication of children's hearing problems with the teacher but sometimes does not provide good follow-through with families on the medical aspects of fluctuating hearing loss. Screening technicians and parent volunteers may be effective screeners but, obviously, they do not have the training or expertise to make referral decisions or contact families about screening results.

Due to budget constraints, school districts can be tempted to empower lesser trained paraprofessionals both to perform hearing screening and to refer identified children to doctors or audiologists. Empowerment of nonprofessionals takes a simplistic view of the task of communicating with families the importance of good, consistent hearing in school and the potential negative educational, behavioral, attentional, and physical effects undiagnosed and unmanaged hearing loss may have on a child's life and well-being. Use of personnel with lesser training and experience dealing with families of varying needs also assumes that all parents will take prompt, effective action once they are notified of a potential hearing problem by the school, a situation that is all too often not the case in our world of changing family, financial, and employment scenarios.

To identify and manage children with hearing loss most effectively, utilization of a screening team may be advantageous. The screening team could consist of 1) parent volunteers or screening technicians who perform the actual screening under supervision of an audiologist, school nurse, or speech-language pathologist, 2) a school nurse who contacts families and recommends medical evaluation as necessary (and provides financial resources if needed); the nurse could also provide the names of students with histories of hearing loss to teachers early in the school year, 3) a speech-language pathologist who reviews the identified children with the school nurse; communicates with the teachers in regard to seating needs, impact the hearing loss may be having on listening, attention, behavior, and school performance; and inquires about speech, language, and aca-

ademic performance and, 4) an educational audiologist who is responsible for training hearing screening personnel, providing audiological services as appropriate, and administering and district record-keeping relating to the hearing screening program.

Actual involvement with teachers and parents by the educational audiologist is dependent on the audiologist/student ratio. Naturally, it would be beneficial if the audiologist could communicate directly with parents about the need for medical attention and with teachers about the speech perception difficulties of their students with hearing loss, and to discuss the impact the hearing loss is having on the student's school performance. However, educational audiologists are typically itinerant and must serve many schools. Therefore, it is important for the audiologist to engage in educating and "raising the awareness" of school nurses and speech-language pathologists so that they can more effectively represent the difficulties and classroom needs of the child with a hearing problem in their assigned schools. This awareness raising can take place by the audiologist attending meetings of these groups regularly, holding information sessions in which the speech-language pathologist or school nurse could receive professional credit, and/or by putting together a brief newsletter that regularly discusses the impacts of hearing loss on child development. The newsletter can be sent to administrators and interested others as well. A well-informed, cohesive screening team, with the audiologist in the lead, may be the best practice at this time to achieve effective hearing loss identification and efficient communication with parents and teachers.

SCREENING CRITERIA

Individual rather than group hearing screening has been the recommended procedure for many years because there is no real time savings in group screening procedures.

dB Level

In choosing hearing screening criteria to use during individual pure tone hearing screening, considerable attention has been given to which decibel level provides the best hit rate and correct rejection rate and also has the lowest false positive and miss rate. For a clear address of this topic consult the text by Roeser and Northern.⁵ The 20 dB loudness level has been recommended in the ASHA Guidelines for Identification Audiometry.¹⁷ A failure to respond to the recommended screening levels at any frequency in either ear constitutes a failure.

As stated by Roeser and Northern,⁵ "By decreasing the level at which the test is performed, the sensitivity of the test can be increased and children with even minimal hearing loss can be identified. Since audiologists feel that even slight hearing losses affect the development of speech and language the goal of many programs is to reduce the screening level to identify these children. However, we are forced into accepting screening levels of 20 to 25 dB HL because of the conditions under which most screening is performed."

In utilizing a decibel criteria in screening, it is tempting to label children who pass screening as having normal hearing. Considerable research and commentary has supported that a child with a 15 dB hearing threshold in the speech frequencies is at risk for educational difficulties. Boyd¹⁸ and Humes¹⁹ found that children and adults with 15 dB–26 dB hearing loss through the speech frequency range experience considerable difficulty understanding speech, especially under adverse listening conditions, such as in an active classroom. Bess²⁰ reviewed evidence to support the premise that children with milder forms of hearing loss can indeed experience greater problems than we have traditionally expected. Yet, due to the relatively noisy screening environment available in the public schools, hearing screening at criteria levels that would identify minimal hearing losses is typically not practical.

Frequencies Tested

In regard to frequencies tested, the ASHA Guidelines for Identification Audiometry¹⁷ recommend the frequencies of 1000, 2000, and 4000 Hz, with 500 Hz to be included if tympanometry is not performed in conjunction with pure tone screening. The purpose of including 500 Hz is to identify children with conductive hearing losses due to middle ear disorders, which are primarily low frequency in nature. However, due to the ambient noise present during screening there is often a higher false positive rate due to failures at 500 Hz from noise interference. The screening school district must weigh the benefits of actually identifying the greatest number of children with middle ear problems (without the use of tympanometry) with the excess time expenditure necessary to re-screen children who failed to hear at 500 Hz due to noise. It is possible that the excess time expended by paid screeners and professionals would equal or exceed the dollar amount needed to purchase tympanometers to be used in screening.

Tympanometry Criteria

Guidelines for Screening for Hearing Impairment and Middle-Ear Disorders⁸ is a document that was released in 1990 from ASHA detailing the use of acoustic immittance in screening programs. The guidelines for pure tone screening were unchanged from the 1985 document.¹⁷ The 1990 document is the most current resource on the recommended pass-fail criteria for use of multiple screening components in screening programs; therefore, a summary will follow. It is strongly recommended that any audiologist who does not yet have these guidelines obtain and study them prior to changing or implementing a screening program that utilizes acoustic immittance.

1. Excessive over-referral rates occur when the referral is based on tympanometric results alone. Consequently, use of pure tone screening measures in addition to tympanometry, and adhering to retest after a specified time interval is paramount.
2. A brief history such as asking if the child has recently had ear pain or ear discharge can reveal events that are cause for immediate medical referral. These questions can be asked of the parent in written form prior to screening or can be asked of the child at screening time.
3. Otoscopy should be performed to reveal evidence of ear disease, ear canal or eardrum abnormalities, and any abnormalities of the ear, head, or neck that would necessitate a medical referral. These guidelines note that the skill and experience of the screeners performing otoscopic inspection will vary considerably resulting in more subtle visual evidence of middle-ear disorders being detected in some screening programs and not in others.
4. Static admittance is considered significant if 1) the value is very high ($>0.9 \text{ cm}^3$) and a large conductive hearing loss is present suggesting ossicular abnormalities or 2) if there is low static admittance ($<0.2 \text{ cm}^3$) suggesting active ear disease. Low static admittance is a cause for medical referral if it is identified on two successive occurrences in a 4- to 6-week interval.
5. A large equivalent ear canal volume ($>1.0 \text{ cm}^3$) when accompanied by a flat tympanogram suggests an eardrum perforation and is cause for immediate medical referral (assuming ventilation tubes are not present).
6. Tympanometric width is a gradient measure used to describe the shape of the tympanogram in the vicinity of the peak. Gradient measures have been primarily used for the detection of otitis media, which produces abnormally wide tympanograms. An abnormally wide tympanogram is considered to exceed the range of 60 to 150 daPa when this range is applied to the point that is one half of the distance from the peak to the tail value (see guidelines for example). Medical referral is suggested when abnormally wide

- tyimpanograms are found on two successive occurrences in a 4- to 6-week interval.
7. Tympanometric peak pressure, positive or negative, in association with an otherwise normally shaped tympanogram is reported to be a poor determinant of middle ear effusion. Due to the large fluctuations in tympanometric peak pressure that have been shown to occur in children who do not develop middle ear disorders, peak pressure has been excluded from consideration as a criterion for audiological/medical referral. Likewise, the use of acoustic reflex absence has been eliminated from the screening protocol.
 8. These criteria assume: 1) use of equipment that measures acoustic admittance in mmho, 2) use of a 226-Hz probe frequency, 3) a pump speed of 200 daPa/s, 4) a positive-to-negative direction of pressure change, and 5) a correction for ear canal volume obtained by subtracting the admittance at 200 daPa from the remaining admittance values.
 9. The screening personnel should be supervised by an audiologist who has training and experience related to the test procedures. The personnel should be sufficiently trained in the procedures to obtain accurate and reliable results.

In summary, the new guidelines add the critical aspect of obtaining hearing/ear problem history information to the screening process. If this information is obtained as part of the student enrollment process and children with significant histories of ear and hearing problems are subsequently "red-flagged," then the supervising audiologist will be aware of the children most likely to have ventilation tubes, draining ears, or active otitis media the day of screening. The new guidelines also provide specific pass-fail criteria for use of tympanometry in identification programs. In essence, as long as hearing history information is utilized, pass-fail criteria are

adhered to scrupulously, and timelines (re-screen in 4–6 weeks) are kept without exception, the annual identification program performed in the schools is quite effective for identifying children with hearing loss of mild or greater degree. Children with minimal hearing losses and those who experience fluctuating hearing due to unrecognized ear problems will continue to be identified haphazardly.

In practical terms, the use of these guidelines need not be confusing. Screening personnel should be trained to ask the children if their ears hurt or have been draining recently. Further, screening personnel need to be alert to abnormalities of the pinna, ear canal, or the presence of ear tags. Use of otoscopy would, of course, depend on the professional training and experience of the screening personnel. Tympanometers are available that display volume and gradient readings that would greatly enhance the training and use of these criteria by nonaudiologists.

Often, the actual screening criteria to be used is a minor battle compared with the efforts typically needed to obtain administrative approval to utilize tympanometry in the school screening program. With the equipment now available, it is often easier and faster for the screener to obtain tympanometry results than pure tone results. Some current tympanometers can be set for a certain criteria so that only the abnormal results are automatically printed. Negative pressure values are still in current use in many screening programs throughout the country. There may be value in identifying children with severe negative pressure (i.e., in excess of -250 mm/H₂O) behind their eardrums as well as those with flat or wide gradient tympanograms. Children with otitis media histories may display abnormal pressure behind their eardrums precedent to middle ear effusion and should be given "the benefit of the doubt" if such a finding is present during initial screening. They should be re-screened in 4 to 6 weeks just in case otitis media has developed. Also, negative pressure can impact on hearing ability to a minor degree, so that a child may fail

hearing screening at 1000Hz depending on the background noise present.

TIMELINES

The 1985 ASHA Guidelines for Identification Audiometry¹⁷ specify that children who do not pass initial screening need to be rescreened within the same session in which they failed. The 1975 ASHA Guidelines for Identification Audiometry²¹ recommended mandatory rescreening, preferably within the same session, based on a reduction in the number of failures by approximately one half due to repositioning of earphones and reinstruction. A time lag of 4 to 6 weeks between mass screening and rescreen of the children who did not pass immediate rescreening has been recommended by the 1990 ASHA Guidelines for Screening for Hearing Impairment and Middle-Ear Disorders.⁸ The purpose of this time lag is to prevent excessive over-referral of children for medical evaluations who have middle ear pathology that spontaneously clears in the intervening weeks.

The time of year for hearing screening to take place has also been considered. Gardner²² recommended that hearing screening take place as early in the school year as possible so that appropriate follow-up procedures could be set into motion. His study did find that, in general, there were more ear and hearing problems in preschoolers during colder weather months than in moderate weather.

CHILDREN TO BE SCREENED

Most school systems provide hearing screening for children in kindergarten through grade 3. Considerable variation occurs throughout the nation as to additional grades annually screened, although grades 7 and 10 are also common. With the advent of PL 99-457 it is likely that school systems will have to address screening procedures for infants, toddlers, and preschoolers as well as for the children

already in school. The 1985 ASHA Guidelines¹⁷ recommended that children functioning at a developmental level of 3 years through Grade 3 and any high-risk children including those above grade 3 be screened annually. In the 1985 guidelines it is also stated that the merit of routine screening after grade 3 is as yet unproven.

Most audiologists agree that the incidence of noise-induced hearing loss appears to be on the increase. With the advent of the Sony Walkman, Boomcars, and piercing rock concerts, the increase of high frequency hearing losses should not be surprising. A valid hearing conservation program should concentrate not only on identifying hearing loss in young children but should serve the adolescent student as well. The primary argument for screening hearing in grades 5 and above is to identify those students with new hearing loss apparently due to overexposure to noise so that these students can be informed and educated about this health and communication hazard.

SCREENING EQUIPMENT USED

Audiometers

A pure tone audiometer that utilizes two earphones and provides tones (pulsed and continuous) of at least 0 to 90 dB at the octave bands between 250 and 8000 Hz is recommended for hearing screening. There is equipment available that provides screening tones at 1000 to 4000 Hz or 500 to 4000 Hz at 25 dB, 40 dB, and sometimes 60 dB, often utilizing only one earphone or by a hand-held otoscope-type instrument through which tones are presented. Screening equipment with these limitations does not allow for screening at levels lower than 25 dB, thus failing to identify a significant percentage of students with hearing loss. Also, use of a hand-held single earphone requires a much quieter screening environment that is typically not available in a school setting (see Appendix C). Hence, children with hearing problems are often lost in a sea of false positives that

cause the screening program and those it identifies to be substantially less credible to teachers, administrators, and medical professionals. Battery-powered equipment is also available to the hearing screener and is attractive due to the limited and sometimes unusual places in which hearing screening is conducted. When battery-powered equipment has no mechanism that indicates if the batteries are weakening or dead, this equipment is not appropriate for use in a school setting because children may not pass hearing screening due to a weak signal rather than to actual hearing loss. Battery-operated equipment with a reliable low battery warning system would be acceptable and exceedingly convenient. However, screening programs need to be alert for equipment that is so light weight that it might not be durable under the rigors of itinerant hearing screening.

Tympanometers

Despite years of use in many school districts, controversy continues over the necessity and practicality of tympanometry in the school hearing screening program. Opponents of tympanometry often find the cost of equipment and manpower to use it during screening a sufficient deterrent to including tympanometry in a screening program despite repeatedly illustrated advantages. Experimental and uninformed use of tympanometers by school systems in the past 10 to 15 years have also caused some medical practitioners and parents to cry "over-referral."

Despite the difficulties found in unexperienced use of tympanometry within a screening program, the efficiency of tympanometry for detecting children with otitis media cannot be denied. The ASHA 1990 Guidelines⁸ summarized above recommend conservative referral criteria for tympanometry results.

Tympanometry has been utilized in school screening programs at different points during the screening process: 1) screen all students with pure tone and tympanometry as per the Guidelines recommended by ASHA, 2) perform tympanometry on just

the students who fail hearing screening to suggest whether the failure may be due to conductive, sensorineural, or functional reasons, or 3) use tympanometry during the rescreen only to provide current hearing and tympanometry results with medical referrals. In only the first case is tympanometry useful in identifying children who were not already identified by pure tone screening methods. When districts begin to utilize tympanometry in their screening program they may start with one of the "supplementary information" uses of the tympanometer rather than use tympanometry throughout the screening program in combination with pure tone screening. Best practice at this time would dictate the use of tympanometry and pure tone screening methods on preschool children at least through grade 3, along with all other high-risk populations, including all children with significant histories of fluctuating hearing loss due to otitis media ("red-flagged" students).

THE SCREENING ENVIRONMENT

Hearing screening equipment and methods may have improved over the years but little improvement has been detected in the school screening environment. Typically, screening environments are not suitable because they are chosen by space availability within the school rather than by selecting the most appropriate space relative to noise levels and traffic flow. School administrators frequently need reminding of the purpose and importance of hearing screening and the critical nature of a quiet screening environment. In general, if hearing screening personnel treat hearing loss as primarily an educational problem then the identification of these children will appear more critical to educational personnel.

Ambient noise requirements allowable in the hearing screening environment are included in Appendix C. In general, the screening frequency that is most greatly compromised by noise is 500 Hz. In one study, Harrison²³ recorded ambient noise

levels present at screening sites in each of 13 schools. The levels recorded ranged from below 40 dB up to 60 dB with the median noise level of 44 dB, although prolonged noise levels of above 50 dB were not uncommon. When 38 adult ears were screened in an anechoic room with 45 dB and 55 dB of ambient noise, 15.8 percent of ears tested failed a 20 dB screen at 250–8000 Hz and 86.4 percent failed when the noise was 55 dB. A follow-up test utilized 16 children aged 7–8 who had normal hearing. When tested at 45 dB of noise 5 ears passed, 27 failing; in 50 dB noise, 2 ears passed, 30 failing, and in 55 dB of noise only one ear passed the screening test. Both 250 Hz and 500 Hz were the frequencies most often failed. No child failed to respond to the 1000 Hz, 2000 Hz, or 4000 Hz tones at any of these levels of noise. If tympanometry is utilized, 500 Hz need not be screened¹⁷; therefore, the interference of noise in the screening procedures will be considerably less. If the screening audiometer has only one earphone a much quieter environment is required and responses at 500 Hz and 1000 Hz may be gravely affected by a significantly smaller amount of noise.

REFERRAL PRACTICES FOR MEDICAL/ AUDIOLOGICAL EVALUATION

Referral practices vary greatly depending on the availability of educational audiologists within a school system. Obviously, if an audiologist has the responsibility of 10,000 to 15,000 students he or she may have ample time to evaluate (in a sound-treated setting) all children who fail hearing screening and discuss the need for medical management with all parents. Many educational audiologists have much greater populations that require them to depend heavily on the screening professionals to refer (for audiological evaluation) children who have significant recurrent hearing and ear problems, previously unidentified permanent hearing loss, or children with apparent functional hearing losses. Many audiologists work for public schools within a

clinical format where all testing is performed in a sound-treated setting at a central or a mobile site. Other audiologists perform audiometric tests on regular and difficult to test students with portable equipment in the schools. Educational audiologists working in this format then make medical referrals with school-generated information and referrals for further audiological evaluation are made on children with newly identified hearing problems or those being considered for special support services. The main consideration when making medical referrals is to be sure that the hearing screening information is received, understood, and acted on by the parent. Follow-up is critical to ensure that the needed medical attention has been received by the child. Furthermore, open communication needs to occur between the physician and the school so that the child's hearing and middle ear function can be monitored and the results communicated with the physician to establish the return to normalcy or the need for further medical attention. Depending on manpower available, referral could be managed by the school nurse with guidance from the audiologist on a building by building basis, or by the educational audiologist on a district basis.

DETERMINATION OF NEEDS: A NECESSARY NEXT STEP

The vast majority of school programs have defined identification procedures, but fall short in providing adequate follow-up services. Once a child is found to have significant hearing impairment (i.e., failing hearing screening), provisions must be made for proper medical diagnosis and treatment, if prescribed, appropriate amplification when indicated, and, in all cases, exploration of educational performance to determine if further educational assessment is needed. Without provisions for these comprehensive follow-up services, children with significant hearing loss will continue to be sensorially deprived and will not attain their maximum educational

potential.⁵ All too often school systems behave as if the purpose of screening hearing in schools is to identify who to send to a doctor, and not who to consider for educational assistance. Without deliberate involvement of teachers in regard to the school performance and auditory needs of children with hearing loss, there is little hope of improving the educational plight of the child with a hearing problem.

DETERMINATION OF AMPLIFICATION CANDIDANCY

Once a student has been identified as having a hearing loss, some consideration must occur as to whether the student is a candidate for amplification. In the majority of cases, students will be able to seek medical solutions to their hearing problems; however, a small percentage of children with minimal, unilateral, or mild to moderate hearing losses can appropriately undergo at least a trial period with amplification. It must be emphasized and reemphasized to teachers, administrators, and parents that preferential seating is not the answer for the child with an educationally significant hearing loss. Favorable seating allows for better visualization of the teacher's face and likely increases student attention; however, intelligible speech is not available unless classroom amplification is appropriately fit to the child and used consistently in the classroom environment. The variety of hearing aid choices, personal and soundfield FM options, and assistive listening devices allow great flexibility in meeting the listening needs of the child with hearing difficulties. The procedures and options related to amplifying children will be discussed in depth in the following articles.

DETERMINATION OF EDUCATIONAL SIGNIFICANCE

Children at greatest risk for educational delays are those who experience hearing loss of approximately 25 dB or greater throughout the speech frequencies

on a frequent fluctuating or constant basis. However, children with lesser degrees of hearing loss, those with unilateral hearing loss, or those with hearing loss in a restricted pitch range may also display adverse listening, language, speech, behavioral, social, or academic affects related to degraded auditory abilities.

Currently, most school systems in the nation are practicing a failure-based model rather than preventative model of supportive service delivery. A great deal can be said against the logic of waiting for children to fail in school, especially for children with hearing loss; however, we currently must deal with providing appropriate rehabilitative services to these children as early as possible to prevent further educational erosion. Too frequently, the services to identified children end with their referral for medical treatment or audiological evaluation. Seldom is there a deliberate effort to explore the educational performance of children with hearing loss to determine if there are any areas of difficulty occurring in the classroom. Yet what is the value of screening for hearing loss in the schools if we do not screen for educational difficulties in the children we identify?

Several methods of screening for educational difficulties occurring for children with identified hearing loss are readily available to school systems: 1) asking the teacher how the child is performing, 2) using informal checklists, 3) using a formally designed checklist to screen for areas of difficulty, 4) screening of communication ability by a speech language pathologist, or 5) utilizing any of the above methods but screening only those children who have known hearing losses or identified histories of recurrent ear problems.

Asking the Teacher How the Child is Performing

The first and probably the most common method is to ask the teacher informally how the student is performing in the classroom (e.g., Mrs. Johnson, Johnny has some hearing problems. Is he having any

trouble in any areas, like reading or paying attention?). With this method there is a good chance that students who are having global difficulties achieving in the classroom or those with behavior problems will be identified. However, the affects of mild and fluctuating hearing loss are often subtle and masked by the appearance of inattention or lack of effort. Therefore, the teacher may not recognize that the student is performing at less than his/her ability due to hearing problems.

Using Informal Checklists about Student Behavior and Achievement

A second method of educationally screening students would be to ask the teacher to complete a checklist that has questions about student behavior and performance. Many educational audiologists have developed some kind of questionnaire or checklist that they ask teachers to complete in order to obtain insight on how students are performing in school. Through frequent use of an informally designed checklist, the audiologist can gain an idea of which students will benefit most from full assessment of the need for special support services. Unfortunately, informally used lists of questions can be interpreted only subjectively and are not usually definitive in identifying specific problem areas children may be experiencing in the classroom. Also, because of an instrument's informality, teachers may not complete it as carefully or with as much seriousness as if a more formally prepared checklist or screening instrument was used.

Using a Formally Designed Checklist to Screen for Areas of Difficulty

Another option is to use a formally designed teacher checklist, namely the Screening Instrument For Targeting Educational Risk (S.I.F.T.E.R.).²⁴ To date, the S.I.F.T.E.R. is the only instrument available that specifically screens the classroom performance of the child with hearing loss. The S.I.F.T.E.R. is a brief checklist that asks questions about student performance in five areas: academ-

ics, attention, communication, class participation, and school behavior. These 15 questions (3 in each area) strive to compare the student's performance to the average group of students in the class (e.g., What is the student's attention span in comparison to that of his/her classmates? How often does the student volunteer information to class discussions or in answer to teacher questions?). Teachers rate students from 1 to 5 for each of these questions and a section is also available for written comments.

The teacher's responses are then plotted on a scoring grid that indicates if the student passes, fails, or has marginal performance in each of the areas. The scoring grid was developed with the use of data from children with normal hearing and students with identified hearing problems. The make-up of the hearing problem group was weighted heavily toward children with lesser degrees of hearing loss: faint 18%, mild 34%, moderate 18%, severe 3%, unilateral 19%, high frequency 8%. Although as a screening device the S.I.F.T.E.R. provides only an indication of a student's areas of difficulty, it is easy and fast to use and provides some degree of validity to the educational screening process for children with hearing loss.

Matkin²⁵ reported that he has found the S.I.F.T.E.R. to be a valuable addition to the battery of screening tests used to identify children with educationally significant hearing loss. It must be stressed that the S.I.F.T.E.R. is for screening only and is not appropriate for use other than as a first indicator for which children are in need of full assessment of academics, communication, etc. Matkin has used the S.I.F.T.E.R. to screen the classroom performance of children with unilateral loss, minimal sensorineural hearing loss, and children with frequent otitis media. He also has found this screening device useful in monitoring the school performance of students who have been exited from restrictive special education programs and placed into mainstream classrooms. The S.I.F.T.E.R. allows a child to be compared to his or her class peers and to compare the

performance of an individual child over time. Further, Matkin reported that teachers frequently had complaints regarding the auditory attention of students with hearing loss, one of the areas in which the S.I.F.T.E.R. focuses, and which other behavior or academic screening scales do not generally include. The S.I.F.T.E.R. also provides a convenient way for the educational audiologist to contact teachers about children with hearing loss, and to gather pertinent information while simultaneously increasing the teachers' awareness of some of the areas of difficulty a child with hearing loss may experience.

Screening by a Speech-Language Pathologist

A fourth option for determining if a student is experiencing any educational delays would be to have the building speech-language pathologist perform speech and language screening on the students with identified hearing problems. It has been estimated that perhaps one third of the children receiving speech and language remediation may present histories of recurrent otitis media.²⁶ Unfortunately, the subtle affects of minimal, mild, or fluctuating hearing loss on language development do not always appear when using many test instruments. Subtle problems due to hearing loss may cause difficulty understanding directions, interpreting conversational cues, blending or discriminating sounds for phonics, etc. These aspects may not be revealed during screening by a speech-language pathologist. However, if a child's difficulties in the academics, attention, and communication areas have been identified, the speech-language pathologist may be able to select appropriate test measures to explore suggested areas of difficulty.

Screen Only those with Known Hearing Problems

A fifth option would be to educationally screen only specific students who fall into two categories. One category would be

those students with identified histories of recurrent middle ear problems and fluctuating hearing loss who have been found to have continuing ear and hearing problems throughout the school year. Although many children will fail hearing screening due to ongoing middle ear problems, not all of them will have significant histories of recurrent ear problems. Children who have experienced fluctuating hearing prior to the age of 2 years are at greatest risk for auditory, language, and cognitive development delays. Therefore, the children with significant ear problem histories who have evidence of continuing ear and hearing problems could be screened for educational difficulties.

A second category to screen for educational problems would be children with sensorineural hearing losses, typically of a degree that could qualify them as hearing impaired via an individual's state criteria. For example, students with unilateral hearing loss could be educationally screened in states that recognize unilateral hearing loss as being potentially hearing handicapping to a degree that could adversely affect school progress. Another example would be to screen students who have a sensorineural hearing loss of 20 dB or greater throughout the speech frequencies in the better ear. By screening just the students who may qualify for special support services based on the hearing loss criteria specified by the state in which the educational audiologist practices, the large number of children who need educational screening can be decreased to manageable numbers.

CATEGORIZING CHILDREN IDENTIFIED DURING HEARING SCREENING

Even fairly small school districts may have more than 100 students identified with hearing loss during hearing screening. In terms of educational, medical, and audiological management needs, it may be efficient to categorize identified students and to deal with them individually within their categories.

For example, following hearing screen-

ing some children are referred medically and some are evaluated audiometrically. The audiologist contacts teachers and requests information that will screen for educational difficulties of the children who fail hearing screening. If a child has been medically referred and it is known that there is no significant history of otitis media or if the permanent hearing loss is so mild as to not significantly affect speech perception (i.e., 30 dB at 1500 Hz in one ear only, unilateral mild low frequency loss at 250 Hz and 500 Hz following cholesteatoma surgery), then gathering teacher input need not be formal and can occur at the same time preferential seating is requested. If the child has had frequent otitis media or a permanent hearing loss is present that will contribute to listening problems in the classroom, then a more formal screening, like using the S.I.F.T.E.R., would be appropriate. Once this information is obtained, the children who failed hearing screening can be categorized as described in Table 1. It is important to note that children who experience changes in hearing and/or educational performance will likely change categories. Following the steps of screening, referral/evaluation of screen failures, and gathering educational information, the children with the greatest need for educational assessment, special services, or closer monitoring by the educational audiologist will be obvious, and the audiologist can be assured that all students' needs have been adequately explored.

POSSIBLE SERVICE OPTIONS AS DETERMINED BY STUDENT NEEDS

School systems are required to offer an array of services to special education students so that their individual educational needs can be met by an appropriate program. The needs of students with hearing loss can vary greatly depending on many behavioral, academic, social, emotional, motoric, cognitive, and language development levels. Services to the student with hearing loss may be divided into two

broad categories: educational support and audiological support.

Educational Support

Educational support services for students with educationally significant hearing loss can be considered on a continuum. This continuum could begin with informal monitoring of student educational achievement (i.e., having the teacher complete a S.I.F.T.E.R. each semester) and progress to auditory training/speechreading instruction, speech and language intervention, educational tutoring, educational support services provided in part-time resource room placement, instruction by a teacher of the hearing impaired, and proceed to full-time placement in a self-contained classroom. The amount of special support required by each student can vary considerably; however, children with different degrees of hearing loss typically experience some speech/language, psychosocial, and educational needs (see Appendix D).

Audiological Support

Audiological support for students with hearing loss may vary greatly depending on the educational audiologist's role within the school system. Most educational audiologists are directly involved in the annual reevaluation of students with hearing loss. Many audiologists are included on student Individual Education Plans to perform hearing aid monitoring services via electroacoustic analysis and/or informal behavioral listening checks. Audiologists may also be heavily involved in assisting students and families in the procurement of and adjustment to new hearing aids. For students identified with educational difficulties due to fluctuating hearing loss, the educational audiologist often plays a role in monitoring the child's hearing and middle ear function throughout the school year and interacting with parents and medical professionals regarding the student's current ear and hearing status. The audiologist may also informally monitor the hearing

TABLE 1. Categorizing Children who Fail the Annual Hearing Identification Program

<i>Category</i>	<i>Description</i>	<i>Example</i>	<i>Management</i>
Medically significant	A child who is currently experiencing otitis media but has no apparent significant history of recurrent ear problems	Otitis media associated with upper respiratory infection; occurs once or twice/year	Medical treatment; preferential seating, retest hearing following completion of treatment to insure health problem has resolved
Educationally significant	Sensorineural hearing loss or stable conductive hearing loss that has adversely affected a child's school achievement	30 dB sensorineural loss; moderate loss 750-2000 Hz; or sharply sloping high frequency loss including 2000 Hz	Personal hearing aids as needed, personal or soundfield FM system, annual hearing evaluation, favorable seating, support services as appropriate
Educationally and medically significant	A child with significant history of recurrent ear infections and fluctuating hearing loss that affects educational progress and continues to cause hearing loss frequently	Otitis media continuously since infancy; unoperated eardrum perforation, chronic draining ears	Medical treatment; personal or soundfield FM, special support services as appropriate; seat preferentially; monitor hearing (3-4 times/year)
Neither educationally nor medically significant	A child with a known stable hearing loss that has good school performance despite the hearing loss	Mild high frequency loss, mild unilateral hearing loss, loss at 1500 Hz in one ear only	Monitor hearing annually for hearing loss changes, seat favorably to allow easy visualization and encourage attention in classroom

of student's with known hearing losses (i.e., high frequency or stable conductive) to insure that changes in hearing ability have not occurred. Some educational audiologists are also involved in providing educational support services such as auditory training, speechreading instruction, and language habilitation.

HEARING LOSS EDUCATION

Without focused use of residual hearing, a student cannot be expected to progress optimally in the educational environment. The majority of school personnel and students are uninformed about the impact of hearing loss on listening and learning. The educational audiologist is in a unique position to provide information about hearing loss to teachers, school administrators, parents and students.

NOISE-INDUCED HEARING LOSS

One critical area of need for hearing loss education is informing students of the hazards of excessive noise on their hearing ability. Due to the rising numbers of children acquiring noise-induced hearing loss (increasingly in the elementary school years) education about the impact of excessive noise on hearing would be a worthwhile addition to the health curriculum of any school district. One survey performed of vocational/technical schools found that 1) many teachers and students may be exposed to hazardous noise levels, 2) hearing protection is not required in one third of the schools and is used less frequently than other safety equipment, and 3) teachers desire additional training in hearing conservation and would welcome the assistance of an audiologist.²⁷

The content expertise that the educational audiologist holds in this subject area

recommends the audiologist as a logical instigator of this curriculum and one who should play a crucial role in the development of curriculum materials. It is only through early and repeated education that we may reach these young people so that they may responsibly prevent permanent hearing loss. Some of the areas that could be covered in the hearing loss curriculum include:

- how the ear works
- how noise can damage hearing
- what is a hearing loss and how can it affect life quality
- what kind of noises or noisy activities are most dangerous to hearing
- warning signs of overexposure to noise or of hearing loss
- responsibly protecting your ears and hearing.

In addition to written and lectured materials, video tapes have become available through local Sertoma Club organizations that discuss the dangers of excessive noise in a format appropriate for upper elementary and high school age students. The information on hearing health can be presented to children as young as preschool and should be considered to be of the same importance as dental health, care of eyes and vision, and hygiene issues. Examination of elementary health textbooks found a lack of mobilizing information, which is key to enabling a reader to respond actively, and greater amounts of theoretical information, which encourages understanding but not active response in ways that maintain good hearing health.²⁸ Although the educational audiologist has the greatest knowledge of this topic area, it is unlikely that the audiologist could instruct all the children in a school system annually. Therefore, the educational audiologist needs to help establish the inclusion of motivating hearing loss information into the general curriculum, and assist teachers, school nurses and health educators (those most likely to teach the information) in their knowledge and understanding of the topic.²⁹

known acquired high frequency hearing losses is monitored annually, preferably by the educational audiologist, individual education and counseling will be necessary to prevent further degradations in hearing by uninformed students.

FLUCTUATING HEARING LOSS

Even with an excellent hearing screening program, some children with hearing loss will remain unidentified due to the inherent nature of screening programs. Teachers lack information about the cause and impact of fluctuating hearing loss on listening and attention and on discriminating word/sound differences. Simulation of mild hearing loss often opens the eyes of both teachers and parents to the listening difficulties and listening efforts put forth by children with even "borderline normal" hearing ability. Also, no valid teacher referral of students with suspected hearing loss can occur without teachers having a basic working knowledge of how hearing loss can affect a student's behavior. The educational audiologist is in a unique position to educate teachers about hearing loss, possibly by offering to present a 20 to 30 min in-service at a regular staff meeting held by each school. The audiologist can thus become visibly known to teachers in each school and will seem more approachable and less threatening when teachers have concerns about particular students.

CONCLUSION

In summary, a school hearing conservation program begins by improving the awareness of administrators and teachers of the educational impact of hearing loss. Administration of the hearing screening program ultimately involves teamwork of school professionals and paraprofessionals. A hearing screening program needs to focus on identifying all children who are at risk for educationally damaging hearing loss, and on sharing information with the teacher. Once children with hearing loss

are identified, they must be evaluated relative to the hearing technology that could maximize their auditory learning environment. To validate the hearing screening process within the public school context, children with identified hearing problems must also be evaluated for educational difficulties, including their needs for special support services. Finally, the educational audiologist has a role in providing services to students with hearing loss and in instigating the education of students about their hearing and prevention of hear-

ing loss. The educational audiologist must be a public relations master, an expert on hearing loss and amplification, a skilled administrator in understanding the all-too-limited budget, and a counselor who can sway a teenager away from using a boom box or encourage a budding adolescent to continue to use amplification. In other words, the educational audiologist must be thoroughly committed to improving the listening and lives of children with hearing loss.

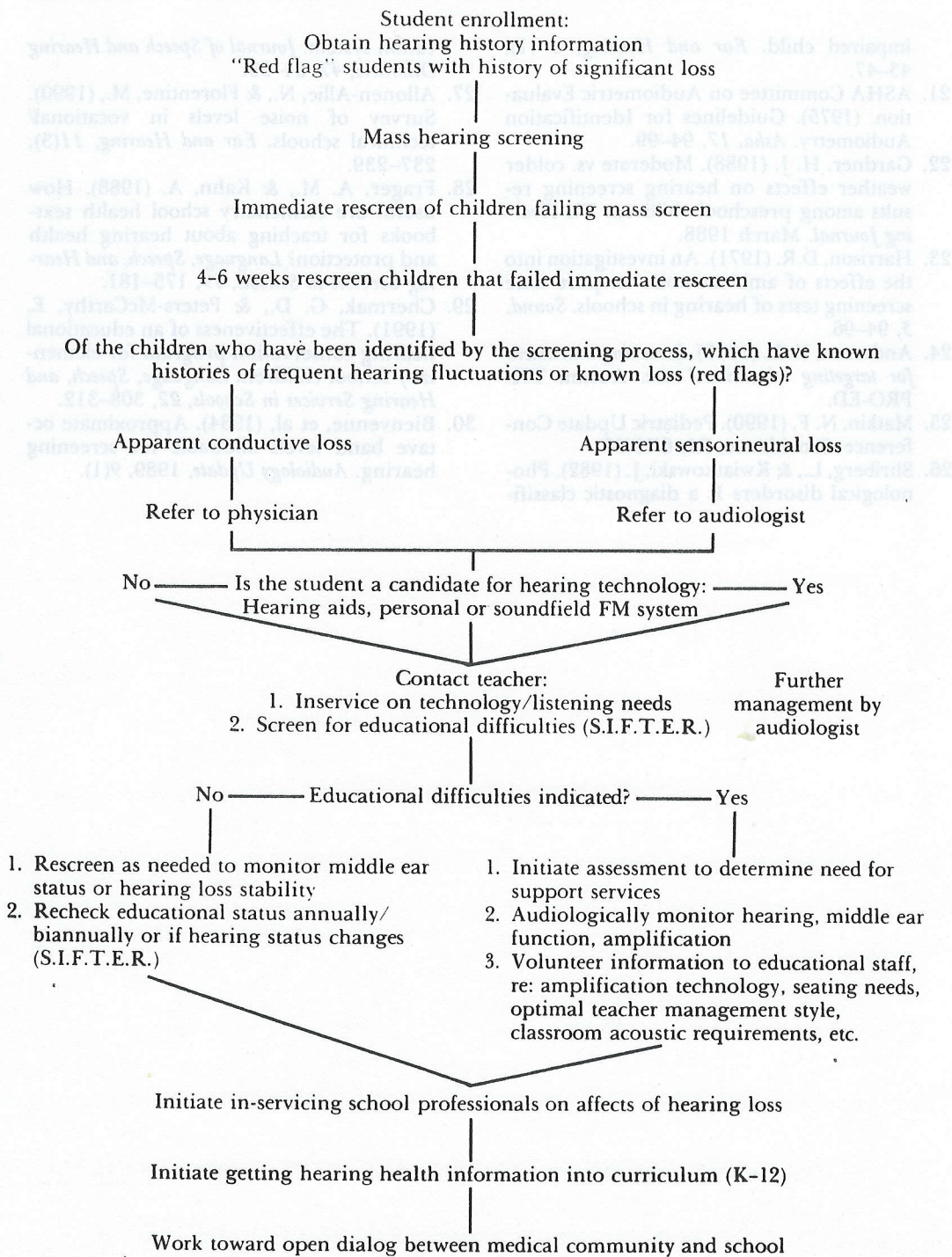
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APPENDIX A

OUTCOMES OF A HEARING CONSERVATION PROGRAM



APPENDIX B

HISTORY OF EAR AND HEARING PROBLEMS

Children who have had many ear infections and periods of hearing loss are more likely to have language, vocabulary and listening difficulties when they start school. We would like to identify these students so that we are more aware of their possible hearing problems and can be alert for developing learning problems.

Parent or guardian, please answer the following questions:

Child's Name _____ Birthdate _____

	No	Yes
1. Did your child have <i>any</i> ear problems before the age of 1?	_____	_____
2. Has your child ever had a draining ear?	_____	_____
3. Approximately how many ear problems has your child had in his life? 0-2 _____ 3-5 _____ 6-10 _____ 10 or more _____		
4. Does your child tend to have 4 or more ear problems each year?	_____	_____
5. Has your child had an ear problem in the last 6 months?	_____	_____
6. Has your child ever had an ear problem that lasted 3 months or longer? (with or without medication)	_____	_____
7. Has anyone related to the child had many ear problems? (parents, brothers or sisters, cousins)	_____	_____
8. Has your child ever been seen by an Ear Doctor (Otologist)? If yes, what Doctor _____ Mo/Yr of last visit? _____	_____	_____
9. Has your child ever had tubes placed in his/her eardrums? If yes, how many times? _____ At what age(s)? _____	_____	_____
10. Does your child have any permanent hearing loss that you know about? (for example: deaf in one ear; can't hear high pitch sounds) Please describe:		

EAR PROBLEM = ear infection, ear aches, draining ears, medicine taken for ears, doctor noticed fluid behind eardrum, hole in eardrum, etc.

APPENDIX C


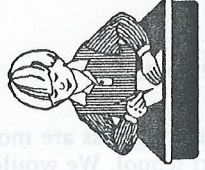
APPROXIMATE OCTAVE BAND LEVELS ALLOWABLE FOR SCREENING HEARING (dB SPL)

Test Frequency	500	1000	2000	4000	
Octave Band Cutoff Frequency	300-600	600-1200	1200-2400	2400-4800	
Allowable ambient noise for threshold at zero HL	26	29.5	34.5	42	Ears covered with earphones mounted in MX-41 AR cushions
		(14)	(33.5)	(9)	Hand-held otoscope/audiometer
Plus ASHA screening level ¹⁷	20	20	20	20	
Resultant maximum ambient noise allowable for ASHA screening	46	49.5	54.5	62	Earphones handheld
		(34)	(53.5)	(29)	

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APPENDIX D

RELATIONSHIP OF DEGREE OF LONG-TERM HEARING LOSS TO PSYCHOSOCIAL IMPACT AND EDUCATIONAL NEEDS

<p><i>Degree of Hearing Loss Based on Modified Pure Tone Average (500-4000 HZ)</i></p>	<p><i>Possible Effect of Hearing Loss on the Understanding of Language & Speech</i></p>	<p><i>Possible Psychosocial Impact of Hearing Loss</i></p>	<p><i>Potential Educational Needs and Programs</i></p>
<p>Normal Hearing -10-+15 dB HL</p>	<p>Children have better hearing sensitivity than the accepted normal range for adults. A child with hearing sensitivity in the -10 to +15 dB range will detect the complete speech signal even at soft conversation levels. However, good hearing does not guarantee good ability to discriminate speech in the presence of background noise.</p>		
<p>Minimal (borderline) 16-25 dB HL</p>	<p>May have difficulty hearing faint or distant speech. At 15 dB student can miss up to 10% of speech signal when teacher is at a distance greater than 3 feet and when the classroom is noisy, especially in the elementary grades when verbal instruction predominates.</p>	<p>May be unaware of subtle conversational cues which could cause child to be viewed as inappropriate or awkward. May miss portions of fast-paced peer interactions which could begin to have an impact on socialization and self concept. May have immature behavior. Child may be more fatigued than classmates due to listening effort needed.</p>	<p>May benefit from mild gain/low MPO hearing aid or personal FM system dependent on loss configuration. Would benefit from soundfield amplification if classroom is noisy and/or reverberant. Favorable seating. May need attention to vocabulary or speech, especially with recurrent otitis media history. Appropriate medical management necessary for conductive losses. Teacher requires inservice on impact of hearing loss on language development and learning.</p>
<p>Mild 26-40 dB HL</p>	<p>At 30 dB can miss 25-40% of speech signal. The degree of difficulty experienced in school will depend upon the noise level in classroom, distance from teacher and the configuration of the hearing loss. Without amplification the child with 35-40 dB loss may miss at least 50% of class discussions, especially when voices are faint or speaker is not in line of vision. Will miss consonants, especially when a high frequency hearing loss is present.</p>	<p>Barriers beginning to build with negative impact on self esteem as child is accused of "daydreaming," or "not paying attention." Child begins to lose ability for selective hearing, and has increasing difficulty suppressing background noise which makes the learning environment stressful. Child is more fatigued than classmates due to listening effort needed.</p>	<p>Will benefit from a hearing aid and use of a personal FM or soundfield FM system in the classroom. Needs favorable seating and lighting. Refer to special education for language evaluation and educational follow-up. Needs auditory skill building. May need attention to vocabulary and language development, articulation or speechreading and/or special support in reading. May need help with self esteem. Teacher inservice required.</p>

APPENDIX D

CONTINUED

<i>Degree of Hearing Loss Based on Modified Pure Tone Average (500-4000 HZ)</i>	<i>Possible Effect of Hearing Loss on the Understanding of Language & Speech</i>	<i>Possible Psychosocial Impact of Hearing Loss</i>	<i>Potential Educational Needs and Programs</i>
Moderate 41-55 dB HL	Understands conversational speech at a distance of 3-5 feet (face-to-face) only if structure and vocabulary controlled. Without amplification the amount of speech signal missed can be 50% to 75% with 40 dB loss and 80% to 100% with 50 dB loss. Is likely to have delayed or defective syntax, limited vocabulary, imperfect speech production and an atonal voice quality.	Often with this degree of hearing loss, communication is significantly affected, and socialization with peers with normal hearing becomes increasingly difficult. With full time use of hearing aids FM systems child may be judged as a less competent learner. There is an increasing impact on self-esteem.	Refer to special education for language evaluation and for educational follow-up. Amplification is essential (hearing aids and FM system). Special education support may be needed, especially for primary children. Attention to oral language development, reading and written language. Auditory skill development and speech therapy usually needed. Teacher inservice required.
Moderate to Severe 56-70 dB HL	Without amplification, conversation must be very loud to be understood. A 55 dB loss can cause child to miss up to 100% of speech information. Will have marked difficulty in school situations requiring verbal communication in both one-to-one and group situations. Delayed language, syntax, reduced speech intelligibility and atonal voice quality likely.	Full time use of hearing aids/FM systems may result in child being judged by both peers and adults as a less competent learner, resulting in poorer self concept, social maturity and contributing to a sense of rejection. Inservice to address these attitudes may be helpful.	Full time use of amplification is essential. Will need resource teacher or special class depending on magnitude of language delay. May require special help in all language skills, language based academic subjects, vocabulary, grammar, pragmatics as well as reading and writing. Probably needs assistance to expand experiential language base. Inservice of mainstream teachers required.
Severe 71-90 dB HL	Without amplification may hear loud voices about one foot from ear. When amplified optimally, children with hearing ability of 90 dB or better should be able to identify environmental sounds and detect all the sounds of speech. If loss is of prelingual onset, oral language	Child may prefer other children with hearing impairments as friends and playmates. This may further isolate the child from the mainstream, however, these peer relationships may foster improved self concept and a sense of cultural identity.	May need full-time special aural/oral program with emphasis on all auditory language skills, speechreading, concept development and speech. As loss approaches 80-90 dB, may benefit from a Total Communication approach, especially in the early language learning years. Individual hearing aid/personal FM system essential. Need

<p>and speech may not develop spontaneously or will be severely delayed. If hearing loss is of recent onset speech is likely to deteriorate with quality becoming atonal.</p> <p>Aware of vibrations more than tonal pattern. Many rely on vision rather than hearing as primary avenue for communication and learning. Detection of speech sounds dependent upon loss of configuration and use of amplification. Speech and language will not develop spontaneously and is likely to deteriorate rapidly if hearing loss is of recent onset.</p>	<p>Depending on auditory/oral competence, peer use of sign language, parental attitude, etc., child may or may not increasingly prefer association with the deaf culture.</p>	<p>to monitor effectiveness of communication modality. Participation in regular classes as much as beneficial to student. Inservice of mainstream teachers essential.</p> <p>May need special program for deaf children with emphasis on all language skills and academic areas. Program needs specialized supervision and comprehensive support services. Early use of amplification likely to help if part of an intensive training program. May be cochlear implant or vibrotactile aid candidate. Requires continual appraisal of needs in regard to communication and learning mode. Part-time in regular classes as much as beneficial to student.</p>
<p>Profound 91 dB HL or more</p>	<p>Child may be accused of selective hearing due to discrepancies in speech understanding in quiet versus noise. Child will be more fatigued in classroom setting due to greater effort needed to listen. May appear inattentive or frustrated. Behavior problems sometimes evident.</p>	<p>May benefit from personal FM or soundfield FM system in classroom. CROS hearing aid may be of benefit in quiet settings. Needs favorable seating and lighting. Student is at risk for educational difficulties. Educational monitoring warranted with support services provided as soon as difficulties appear. Teacher inservice is beneficial.</p>
<p>Unilateral One normal hearing ear and one ear with at least a permanent mild hearing loss</p>	<p>May have difficulty hearing faint or distant speech. Usually has difficulty localizing sounds and voices. Unilateral listener will have greater difficulty understanding speech when environment is noisy and/or reverberant. Difficulty detecting or understanding soft speech from side of bad ear, especially in a group discussion.</p>	<p>May benefit from personal FM or soundfield FM system in classroom. CROS hearing aid may be of benefit in quiet settings. Needs favorable seating and lighting. Student is at risk for educational difficulties. Educational monitoring warranted with support services provided as soon as difficulties appear. Teacher inservice is beneficial.</p>

Note: All children with hearing loss require periodic audiologic evaluation, rigorous monitoring of amplification and regular monitoring of communication skills. All children with hearing loss (especially conductive) need appropriate medical attention in conjunction with educational programming.

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ARTICLE FOUR

SELF-ASSESSMENT QUESTIONS

1. What is the scope of a school hearing conservation program?
 - (a) to use pure tone and tympanometry methods to identify hearing loss
 - (b) to identify children with hearing loss, refer for evaluation/treatment, determine educational significance, amplify appropriately, to provide information to students, parents and school staff regarding the impacts of hearing loss, and to provide special support services to the student as needed
 - (c) to let teachers know who is having hearing problems once children fail screening so that they can seat favorably in the classroom
 - (d) to send all children who fail hearing screening to doctors/audiologists so that their ear/hearing problems can be treated with medicine or amplification so that the children will be able to hear normally in school
2. Why is hearing screening performed at 20–25 dB?
 - (a) The level of ambient noise typically present prevents use of a more stringent decibel criteria.
 - (b) Most of the children with any hearing loss less than 20–25 dB manage to perform adequately in school.
 - (c) Screening at 20–25 dB identifies all children with significant ear and hearing problems.
 - (d) Normal hearing in children is in a range from 0–20 dB.
3. What are the most critical components of a hearing screening program?
 - (a) tympanometry and pure tone screening
 - (b) hearing history, otoscopy, and pure tone screening
 - (c) otoscopy, tympanometry, and pure tone screening
 - (d) hearing history, tympanometry, and pure tone screening
4. Once screening is completed, the children who have been identified can be placed into what categories?
 - (a) medical referrals and audiology referrals
 - (b) medically significant and educationally significant
 - (c) children who need favorable seating in school, those who can get by fine without any special consideration, those who need medicine for ear problems.
 - (d) medically significant, educationally significant, both medically and educationally significant, and neither medically nor educationally significant
5. How can the impact of hearing loss on education be best discerned?
 - (a) by asking the teacher how the child is performing in the classroom
 - (b) by having the teacher complete a brief formal classroom performance screening instrument
 - (c) by having the speech clinician screen the child's communication ability
 - (d) by having the teacher answer some general questions about the child's school performance
6. Which children with hearing loss require the most consideration by the educational team (teacher, audiologist, speech clinician, etc)?
 - (a) the children with the greatest hearing loss
 - (b) the children who require personal or soundfield FM systems
 - (c) the children who are experiencing the greatest educational difficulties
 - (d) the children whose ear problems are not being medically managed successfully.