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AUTHOR	Warick, Ruth; Clark, Catherine; Dancer, Jesse; Sinclair, Stephen
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ABSTRACT

This report examines the use of auditory assistive listening devices by students who are hard of hearing or deaf in the postsecondary educational setting. Individual sections address the following topics: (1) distinctions between hearing aids and assistive listening devices; (2) assistive listening devices and the college student; (3) types of assistive listening devices (including FM and infrared systems, FM radio microphone systems, infrared systems, and comparison between FM and infrared systems); (4) other assistive listening systems (induction loop systems, dove-tail systems, hardware systems, audiovisual amplification, cochlear implants, and telephones); (5) choice of assistive listening devices; (6) training; (7) campus roles and responsibilities concerning assistive listening devices; (8) assistive listening device maintenance and repair; (9) legal and safety considerations; (10) organizational resources; and (11) laws and regulations. (Contains 19 references, and an appendix on communication tips for instructors of students with assistive listening devices.) (DB)

National Task Force on Quality of Services in the Postsecondary Education of Deaf and Hard of Hearing Students

Report on ASSISTIVE LISTENING DEVICES

National Task Force on Quality of Services in the Postsecondary Education of Deaf and Hard of Hearing Students

Report on ASSISTIVE LISTENING DEVICES

AUTHORS:
Ruth Warick
University of British Columbia

Catherine Clark
National Technical Institute for the Deaf

Jesse Dancer
University of Arkansas

Stephen Sinclair
California State University at Northridge

EDITOR AND TASK FORCE CHAIR:
Ross Stuckless

NETAC COPY EDITOR:
Kathleen Smith
Rochester Institute of Technology
National Technical Institute for the Deaf
Rochester, New York

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Rochester Institute of Technology

National Technical Institute for the Deaf
Northeast Technical Assistance Center
52 Lomb Memorial Drive
Rochester, NY 14623-5604
716–475-6433 (V/TTY)
716–475-7660 (Fax)

Editor's note

This is one in a series of reports intended to assist postsecondary institutions in developing and maintaining special services of quality as needed by their deaf and hard of hearing students. Each report has been prepared with postsecondary administrators, faculty, and staff uppermost in mind, and particularly those most likely to have a role in providing services to these students. It is anticipated that these reports will be useful also to deaf and hard of hearing students in gaining more information about services for which they may be eligible.

A challenge in authoring and editing each of these reports is to avoid giving the impression that all the information they contain pertains equally to all deaf and hard of hearing students at the postsecondary level. Of course this is not so. These students are individuals first, and their needs and wishes for special services and other accommodations will vary, as will characteristics of the particular colleges and universities they as individuals choose to attend.

Also, it is a challenge to write about needs and services for both deaf and hard of hearing students together. While they do share a hearing loss, the magnitude of their hearing loss ranges collectively from mild to profound. But while the special needs of deaf students may be more apparent than those of hard of hearing students, the special needs of hard of hearing students are no less real.

Fifteen reports are scheduled for distribution in 1997 and 1998, each with a different focus and each authored by a working committee of experts on a particular subject. All are members of a **National Task Force on Quality of Services for Postsecondary Deaf and Hard of Hearing Students**. This task force was formed in 1994 and numbers 100 members associated with 32 two and four-year colleges in 28 states and provinces in the United States and Canada.

Readers are free to cite information and views from each of the reports and to duplicate and share copies. In return, they are asked to cite the names of its authors and make bibliographic reference to the report.

– *Ross Stuckless*

ASSISTIVE LISTENING DEVICES

Ruth Warick, Catherine Clark, Jesse Dancer, Stephen Sinclair[1]

At one time technology was viewed as dehumanizing and threatening. For me it was the opposite. Technology opened up brave new worlds. Through hearing aids and sound amplification devices I was able to be part of the mainstream of society (Warick, 1994).

Introduction

New technology. For most hard of hearing students, and for some who are deaf, hearing aids and related sound amplification devices are of great benefit in their communication and learning. We are all familiar with hearing aids. If we don't wear a hearing aid ourselves, almost certainly we know others who do.

Technology has more recently produced an additional array of electronic devices which benefit many hard of hearing students. This report will deal primarily with the relatively new and growing family of such devices called auditory assistive listening devices or ALDs, i.e., auditory amplification devices.

ALDs are used in face-to-face or telephone communication as a form of providing accessibility for people who are hard of hearing. Parenthetically, it should be added that while hard of hearing people (and of course those with whom they engage in communication), are the principal users of ALDs, they are sometimes used also by people considered to be deaf.

ALDs are used both with and without hearing aids and are most effective when the individual has developed speechreading, listening, and other techniques that help supplement verbal learning. Also, their effectiveness is greatly enhanced when persons with whom they are communicating understand how to communicate effectively with a person with a hearing loss. One such classroom example is for the instructor and peers not to speak with their backs to the hard of hearing listener. Another is for only one person to speak at a time. These and other strategies often improve communication for everyone in the classroom (See Appendix - "Communication tips for instructors").

But while recent and ongoing developments in ALDs, and their broader applications, have reduced barriers to communication for many hard of hearing persons, they cannot reproduce the normal listening environment for the hard of hearing person. Nor can they provide access in the same way that glasses do for persons with visual differences.

Distinction between hearing aids and assistive listening devices

Hearing aids. Hearing aids, the predecessor to ALDs, have been in existence for over a hundred years in one form or another, and have become increasingly sophisticated over the years. Unlike ALDs, hearing aids amplify sound through a single unit leading into the ear. There are different types of hearing aids such as behind-the-ear aids, in-the-ear aids and body aids.

Basically, a hearing aid system consists of a tiny microphone that picks up sound waves from the air and converts them into electrical signals, an amplifier that increases the strength of the electrical signals, a battery that provides electrical energy to operate the hearing aid, and a tiny loudspeaker called a receiver that converts the amplified signals back into sound waves and directs them into the ear through a specially fitted mold.

Most behind-the-ear and body aids have a "t-switch" that controls a telecoil which in turn picks up electromagnetic signals from a telephone or another listening device. This is reconverted into sound, magnified, and sent to the listener through his/her earmold. This offers enhanced sound quality and avoids picking up extraneous sounds. One disadvantage is that, besides blocking out erroneous sounds, it also blocks out the wearer's own voice. This problem can be solved by using a combined microphone/telecoil mode. If the student uses two hearing aids, he/she may choose to wear one in the customary microphone mode and the other in the telecoil mode. Alternatively, the student may be using only one hearing aid.

[1] In the order listed above, the authors are associated with University of British Columbia (Vancouver, British Columbia), National Technical Institute for the Deaf (Rochester, New York), University of Arkansas (Little Rock, Arkansas), and California State University at Northridge (Northridge, California)

Assistive listening devices. While some hard of hearing persons rely solely on their hearing aids, others find them inadequate in some environments, and choose to use an assistive listening device.

ALDs differ from each other in numerous respects, but they also have common features not shared by hearing aids. Like hearing aids, ALDs have transmitting and receiving components. However, whereas hearing aids package both these components in a single unit for wearing on the user's body, ALDs place the microphone/transmitter unit at or near the source of the sound, e.g., speaker, musical performance. The transmitter sends the signal through the air or by cable to the receiver being worn by the user. This separation of the two components enables an ALD to:

(a) amplify sound over a considerable distance,
(b) provide clear sound over distances by eliminating echoes and reducing surrounding noises,
(c) overcome poor sound quality when a microphone/public address system is in use,
(d) amplify sound from several vantage points.

ASSISTIVE LISTENING DEVICES AND THE COLLEGE STUDENT

ALDs have been used for some time in elementary and secondary schools, where services are provided in accord with individual educational plans (IEPs), tailored to the needs of each hard of hearing student, and supported by a cadre of specialists. Thus, many of the students entering postsecondary institutions have already had exposure to an ALD in their previous schooling. Nonetheless, its use will be different in a college or university setting, given the greater size and enrollment, and the larger physical dimensions of many college classrooms.

ALDs are still relatively new in the postsecondary environment, as are many other disability-related services. Their use in postsecondary settings has grown as a means of providing access to ensure student success and to fulfill the institution's legal responsibilities.

Hard of hearing students may also find other significant differences from their experiences in the K-12 setting. Special education services that may have been routinely available during their earlier education are not necessarily offered on college campuses, e.g., speech-language services, audiology services, or resource room assistance. The full range of professional expertise among personnel in public schools for meeting the communication needs of hard of hearing pupils is unlikely to exist on college campuses.

Another key difference could be that, while attending college, the student may be living away from home for the first time. The familiar audiologist and hearing aid dispenser who previously evaluated, fitted, and maintained the student's personal hearing aids and earmolds may be geographically inaccessible, and therefore the student experiences a disruption in community supports until new ones can be found.

Further, the hard of hearing student in the postsecondary setting is expected to be an adult. Thus, the student is expected to take greater responsibility for identifying and meeting his/her needs. Such a philosophical approach makes sense; however, it is also necessary to recognize that the level of skill in being able to identify and meet needs varies in different individuals.

Some hard of hearing persons may be unfamiliar with the use of ALDs or may be hesitant about their use. Others may have felt it was not necessary to use an ALD before but now find that previous auditory strategies no longer work in larger classes where more complex information is being shared. For some of these students, college will offer their first use of an ALD.

Other hard of hearing students may have had previous negative experiences with an ALD, finding the extra effort and maintenance burdensome, or finding that it interferes with their concentration and learning. For some students, it may be a matter of wanting to avoid being singled out as a person with a disability and being affected by the negative attitudes of others. Some worry that their lack of hearing will be misinterpreted as not being able to handle their academic studies with the same success as their hearing colleagues, and they do not want any negative bias to be reflected in evaluations of their academic performance. These dynamics need to be recognized in order to ensure that there are several possible points of decision-making about use of an auditory assistive listening system.

Student choice in the use of an ALD. It is a matter of student choice whether or not to use an ALD. While it may appear that a particular student would benefit from the use of a system, the individual student must choose whether to wear it; if he/she does not want to use an ALD, this choice must be respected, with the recognition that each hard of hearing person differs in his/her response to such devices.

It is possible that a student will change his/her mind about using an assistive listening system, influenced by seeing others use it successfully or recognizing that "going it alone" is insufficient. The institution, at that point, has a responsibility to respond to the student's expressed need for access.

The manner in which the institution responds to the access needs of hard of hearing students is guided, in part, by precedents in the K-12 setting, past practices or best practices in the particular college and/or in other colleges, and by emerging information and directives about meeting the access needs of hard of hearing students. Unfortunately, there is little available research on the actual use of auditory amplification by postsecondary hard of hearing students; most of the research that has been done (e.g., Roeser and Downs, 1995) focuses on elementary/secondary school settings.

The efficacy of the use of auditory amplification technology and the processes for its use remain largely unknown at the college level. However, the increasing use of ALDs by hard of hearing students in college settings is leading toward greater recognition of the value of their use.

Acoustic conditions in the classroom. Many hard of hearing students function well with a hearing aid in one-to-one interactions, but they may not be able to hear in large classrooms. A distinct acoustic advantage of ALDs compared to personal hearing aids is the position of the input microphone at a location close to the talker's mouth. While the noise and reverberation characteristics of a room generally are constant at all places, the intensity of the primary speech signal decreases as distance increases from the talker (called "speech-to-noise ratio"). By placing the microphone of the auditory amplification system close to the talker's mouth, the most advantageous ratio is obtained between the intensity of speech and the level of background noise.

ALDs maintain this favorable speech-to-noise ratio due to the fact that the signal is transmitted by electronic, magnetic, infrared, or radio media rather than acoustically (as in the case of the hearing aid) to each listener's ear.

The difficulty of hearing in a classroom may be compounded when the classroom is of poor acoustical quality. Large lecture halls with cement floors and walls, prevalent in so many postsecondary institutions, are often below acceptable standards. Conditions such as lack of window treatments, insufficient insulating seals on room doors facing common corridors, and noisy heating and cooling systems add to the problem.

The overall acoustic characteristic of classrooms in colleges and universities generally present a significant problem for students using hearing aids. For such students, background noise and sound reverberation present a greater problem in understanding speech than they do for normally hearing individuals. Whereas a young adult with normal hearing may experience a mild awareness of room reverberation and background noise, it may not significantly reduce the intelligibility of the spoken message for that student. For the person using a hearing aid, however, such conditions form an acoustic barrier to listening. Studies by Crandell and Smaldino (1995) show that a hearing aid user requires a classroom reverberation time to be under 0.4 seconds, and that the primary speech signal arrive at the listener's hearing aid microphone at least 15 decibels above any background noise. Furthermore, the overall room noise needs to be less than 35 to 40 dB.

After 40 years of field investigations, it may be assumed that virtually all classrooms in primary and secondary education fail to meet minimal design criteria for adequate control of noise and reverberation (Crandell and Smaldino, 1995; Bess, Sinclair, and Riggs, 1984; Pearsons, Bennett, and Fidell, 1977; Blair, 1977; McCroskey and Devens, 1975; Sanders, 1965; John and Thomas, 1957). Similar concerns exist about postsecondary facilities.

An unpublished study of instructional buildings at California State University at Northridge (CSUN) on classroom background noise levels found only the classrooms in the music facility met minimal acoustic design criteria (Sinclair, 1982). A study at the University of British Columbia found that only half of the 45 classrooms sampled rated "good" for speech intelligibility (Hodgson, 1994).

An assistive listening device helps reduce the effect of an acoustically unfriendly room. For some hard of hearing persons, a suitable acoustical environment will lessen the need for an ALD, but other persons will continue to require an ALD due to the nature of their hearing losses and their need for additional amplification.

Types of assistive listening devices

Several types of ALD systems are described in this section: the two most common for classroom use are radio microphone(FM) and infrared(IR). These will be described in some detail, with a brief mention of several other systems: magnetic loop, sound field, hardwire and dove-tail systems.

FM and infrared systems. Both the FM and infrared systems consist of a transmitter, used by the instructor, and a receiver, worn by the student, either in conjunction with, or without a hearing aid.

Common benefits. These two systems share some common benefits, limitations, and applications. Their common benefits are:

(a) both allow for direct transmission, thereby minimizing sound distortion and acoustical interference,

(b) both have volume control settings so the level of sound may be adjusted by the user,

(c) both are highly portable,

(d) both may be connected to, and used in conjunction with, a public address system.

In addition, some FM and infrared receivers have built-in environmental microphones that allow the student to selectively tune in on sounds other than that of the primary source (commonly that of the instructor), e.g., hear other students, monitor his/her own voice, other background sounds.

Common limitations. FM and infrared ALDs also share some limitations. Among these are:

(a) they are larger and more visible than hearing aids, and sometimes mistaken for a recording device which can make others nervous,

(b) an expense is involved in acquiring the transmitter and the receiver, and in their maintenance,

(c) unlike a hearing aid, they require institutional administration, e.g., monitoring their use, assuring their availability as needed, maintenance.

Typical locations where used. FM and infrared systems are frequently used in settings such as:

Classrooms	Meeting rooms
Conference rooms	Auditoriums
Service counters	Theatres
Museums	Arenas
Sport stadiums	

The reader is referred to Compton and Bengtsson (1993) for further discussion of appropriate locations.

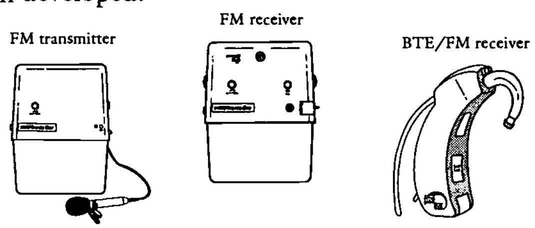
Using FM/infrared ALDs together with hearing aids. Students who routinely wear hearing aids are likely to use FM and infrared systems with their hearing aid turned to their telecoil (t-switch), referred to previously. This enables the person to have sound fed directly into the ear without it passing through the air (i) to avoid its picking up other extraneous sounds or (ii) becoming less perceptible because of its distance from the listener. The receiver of the ALD connects to the hearing aid by means of a wire and silhouette receiver or neck loop, both of which have induction capacity. The hearing aid can also be connected to the ALD receiver by what is known as a direct audio input cord, i.e., a cord that actually attaches to the hearing aid.

Using FM/infrared ALDs without hearing aids. The use of FM, infrared, and other ALDs is not limited to persons wearing hearing aids. A headset may be used in place of a hearing aid. An earphone, earplugs, or audio input all enable the direct use of an ALD. Many headset receivers have a volume control and can be used effectively by persons with mild to moderate losses. Headsets are also used by persons with normal hearing who find that the headset assists them in concentrating on what is being said (e.g., persons with certain types of learning disabilities).

The auditory assistive listening systems about to be described have various benefits and limitations. For such systems the positioning of the microphones and receivers is crucial to enhancing effective sound reception. The human element is equally important, i.e., how the system is used by the instructor and the student or other students.

FM (radio microphone) systems. An FM system consists of a receiver and a transmitter whereby radio signals are transmitted on an FM frequency. The ranges of FM systems extend from 30 feet to more than 200 feet, depending upon their power and antennae.

The transmitter unit usually consists of a lavalier microphone, linked by a short cable to a small transmitter unit that is carried in the talker's pocket or clipped to his/her clothing. Recently, behind-the-ear (bte) hearing aids have become commercially available which house both conventional circuits and the entire miniaturized FM receiver unit in the same casing, which eliminates the need for a separately worn FM receiver and cable to the earpiece. As well, FM direct audio boots for use with hearing aids have been developed.



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Several manufacturers offer more than one model of FM systems. Instruments that produce lower levels of auditory output may be marketed as assistive listening devices. The more powerful models may be identified as auditory trainers or educational amplification systems.

A typical FM system costs about $1,500, transmitters range from $350 to $2,000 each, and receivers from $50 to $350. Continuing costs for FM-wireless systems include monitoring, repair, and annual calibration.

Specific benefits. FM systems have several distinctive benefits:

(a) the wearer can face and sit anywhere within the sound's perimeter (usually 200 feet) in order to hear the sound,

(b) several wearers can receive the system signal,

(c) the system can be used indoors or outside,

(d) the system allows for multiple channels, so it can be used in the same room by different groups or in adjacent rooms.

FM units are small enough to be easily transported from one site to another by students. In large auditoriums, FM base station transmitters can easily be set up and coupled to public address systems so that the signal can be broadcast throughout the entire facility. With 40 FM channels exclusively reserved by regulations of the U.S. Federal Communications Commission for use by the hard of hearing public, several classrooms in close proximity can use FM systems without crossover of signals.

Specific limitations. FM systems also have several limitations:

(a) the sound broadcast may carry outside of the room, reducing confidentiality. Privacy is compromised if people can listen in by tuning in to the same frequency,

(b) electrical interference can occur when used with certain attachments, i.e., induction neckloop/ silhouette,

(c) instructors and students need to learn how to use the system effectively; students also need to know how to monitor and troubleshoot the system,

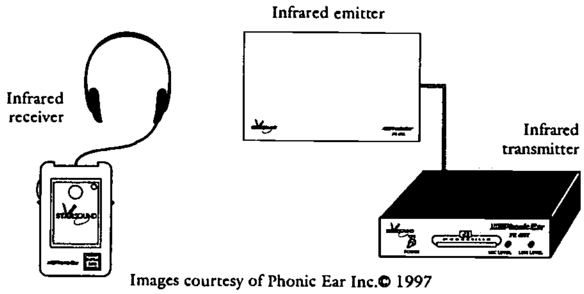
(d) not all systems are compatible with each other, some using a narrow-band frequency channel, and others using a wide-band frequency channel. Because of this, they cannot be used with each other. The signal from a narrow-band transmitter cannot be picked up by a wide-band receiver.

There are precautions that must be observed in providing FM systems to students. First, as shown by Freeman, Sinclair and Riggs (1980) in laboratory settings and by Bess, Sinclair and Riggs (1984) in a field investigation, certain FM-wireless devices are capable of producing maximum sound pressure levels exceeding 140 decibels. The Food and Drug Administration has determined that consumers must be warned of potential risk to residual hearing if an auditory amplification device exceeds 132 dB sound pressure level of output.

Second, it should also be noted that many of the commercially available FM-wireless devices have trimmer screws (settings on the receiver) that alter the performance characteristics of the systems. The trim screws are intended by the manufacturers to be set by the audiologist to meet the listening needs of specific end-users. They are not intended to be adjusted by consumers or non-clinicians.

Infrared systems. An infrared system is similar to an FM system in that a modulated carrier signal conveys the talker's speech to a receiver unit worn by the listener. The difference is that the transmitting medium is an infrared wave, a part of the light spectrum invisible to the human eye, which is broadcast from an emitter unit. In this limited respect, infrared systems used as ALDs are similar to the remote control units we use with our TV sets.

The emitter for the infrared system is sometimes located within its transmitter, or it may be mounted on a stand or on the wall of the room. The infrared signal is detected by a sensor located on the listener's receiver unit. The receiver unit converts the infrared carrier signal into an electrical signal, amplifies it, and transduces it as an acoustic signal to the listener's ear.



Images courtesy of Phonic Ear Inc.© 1997

The range of large infrared systems can extend to 150 feet or more; for some compact units, their range may be as little as 20 feet. Receivers average $120 to $300 each while transmitters are $600 to $1,800 depending on the power and the characteristics of the unit. A typical system costs about $1,000.

Specific benefits. Among the benefits of infrared systems are:

(a) their receivers are compatible with most infrared emitters,

(b) some receivers have built-in environmental microphones so their wearers can hear sounds around them if they choose,

(c) several wearers can receive the system signal,

(d) they maintain privacy and confidentiality since, unlike FM systems, there is no spill-over into adjacent rooms,

(e) infrared systems lend themselves to the design of a table apparatus that uses several light beams to pick up and transmit sound,

(f) as another application, with special multi-function receivers, they can be used for multi-language translation.

Limitations. The major disadvantage in using an infrared system is that the correct positioning of the transmitter and the receiver is critical; there must be a direct line of sight between the two. In other words, the speaker and the user must be facing in each other's general direction without any physical objects in between. This assumes the speaker is wearing the transmitter and the user is wearing the receiver.

More specifically, the visible components of the transmitter and the receiver must face each other without obstruction. For practical classroom applications, this suggests that the instructor and the hard of hearing student user position themselves carefully and that they try to contain their movements when the instructor is speaking.

Another limitation in the use of an infrared system is that it should not be used in the presence of direct sunlight or in a room containing large amounts of incandescent light. If used outdoors, it should be used only in the shade or on overcast days.

It should be added that large area infrared systems require installation, and that once installed their portability is restricted.

Comparison between FM and infrared systems. Infrared systems have several advantages over FM systems. First, the infrared's broadcast signal is secure within the room, since infrared light cannot penetrate walls and reflects poorly around corners.

Second, its sound quality can be better than that of FM since there is minimal distortion and internal amplifier noise in its signal. This is one reason that infrared technology may be preferred over FM technology for public lectures.

Third, since the acoustic output of infrared systems is less than that found in many FM-wireless systems, there is less risk of injury and less need for audiologic consultation.

The "line of sight" property of infrared is also its major disadvantage. FM is free of the several restrictions already mentioned that are imposed by this infrared characteristic.

A second advantage of FM for many students is its greater acoustic output. The more severe the student's hearing impairment, the greater the advantage of FM is likely to be - given a favorable audiological appraisal.

Other assistive listening systems

Induction loop systems. This type of system has been used in educational settings for more than 40 years. The system includes a wire that loops around the perimeter of a space such as a classroom or even a school auditorium. Sounds are picked up by a microphone, amplified, and sent through the loop, creating an invisible magnetic field.

A telecoil in the student's hearing aid (see "Hearing aids" discussed earlier in the report) picks up the signal from the loop. His/her hearing aid then reconverts this signal into sound, amplifies it, and feeds it directly into the ear.

The loop system can be used by anyone with a hearing aid without requiring another piece of equipment. Users can simply switch their hearing aids to the t-switch mode. The system can also be used by people who don't have a hearing aid if they have a portable induction receiver.

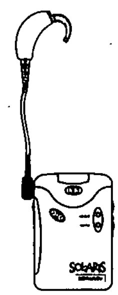
The loop system costs from $350 for a small room to as much as $1,000 for a large loop and a powerful amplifier. Loop receivers cost about $75 each. A typical system costs about $1,000 or less. Correct loop placement is important and expert assistance is recommended. Loops are sometimes constructed into walls or floors, but this is expensive and difficult to repair. Loops can also be fastened to the floors or walls. However, if this is not done carefully, the loose wires can pose a safety hazard.

The electromagnetic energy in the loop can pass through walls, ceilings, and floors. This is known as spill-over. Normally, two IL systems in adjacent spaces cannot operate simultaneously adjacent to each other because of this interference. It is difficult and expensive to shield energy.

Some of the limitations of conventional loops have been overcome with a three-dimensional loop. A three-dimensional loop presents a uniform and consistent signal to the users' hearing aids, regardless of where they are sitting. This loop system uses special mats instead of a wire around the room to generate the electromagnetic signal. Three-D loops can be used in adjacent rooms without experiencing spill-over from their electromagnetic signals.

Despite the disadvantages of IL systems, there are numerous college campus locations in which they can be used effectively. For example, a loop system might be installed in a dormitory lounge in which hearing and hard of hearing students view and listen to TV together, enabling the audio signal to be adjusted to comfortable listening levels for both.

Dove-tail systems. The term dove-tail system was coined by Bess and Gravel (1981) to convey the notion of combining one or more ALD technologies, which usually include the personal hearing aid. At present, one of the most commonly used dove-tail systems is known as FM direct audio input (DAI). With DAI, the FM signal that is broadcast from the speaker's transmitter is received by the listener's FM unit. The receiver unit is wired directly into the amplifier circuit of the listener's personal hearing aid through a special adapter, called a boot. The cable from the FM receiver, boot, and hearing aid are illustrated below.



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In this instance, the listener is able to retain use of his/her personal aid and even can elect to add the signal from the personal hearing aid's environmental microphone in order to hear both the FM broadcast signal and nearby speech.

DAI has the advantage of combining two systems. The student benefits by retaining the use of the personal hearing aid for classroom use. However, there are a few drawbacks to DAI. One is that not all behind-the-ear hearing aids are equipped to accept a DAI boot. Fortunately, many behind-the-ear hearing aids can be retrofitted by their manufacturers for this feature at a cost of less than $100.

Second, there may be no universal boots and cables. Each FM system and each hearing aid manufacturer requires unique combinations of sizes and pins on boots and cables to connect the FM receiver to the personal hearing aid. Third, the rechargeable batteries of the FM systems must be maintained. And last, the institution will not experience a cost savings with DAI, even though the student's personal hearing aid is part of the system, because acquisition of the microphone/transmitter unit and the receiver unit remain necessary, as are the additional accessories to link the receiver unit into the personal hearing aid.

Hardwire systems. The earliest versions of hardwire systems were designed for group amplification with hard of hearing and deaf children in school, and became available in the 1930's. With considerable refinement, they remain available for students today.

They consist of a speaker's microphone, which is attached by cable to an amplifier. The amplifier may have a single volume control or individual volume controls for each headset. One or more sets of headphones or earphones for the listeners also are cabled to the amplifier.

The system may be wired into the room's furniture and fixtures, as in a language lab, or used as a portable desktop unit. One small version uses an amplifier unit about the size of a hand-held calculator, with a cable of six to nine feet leading to a miniature microphone and another three-foot cable leading to a "walkman" style headset.

Some hard of hearing students may find that this type of unit lends itself particularly well to tutoring situations; others may not care to use it because of its size and cosmetic characteristics.

Hardwire systems are inexpensive, durable, simple to operate, and capable of producing relatively high levels of acoustic output with low distortion.

Audiovisual amplification. There will be situations in the classroom when a television program will be shown or sometimes a tape or radio program will be played. Even where the television program is captioned it is important that every effort be made to maximize the sound of the television set for the hard of hearing student. This can be achieved in a number of ways:

(a) an additional loudspeaker (placed near the hard of hearing student),

(b) earpieces connected to the television set with or without the use of a coupler (to enable use with the hearing aid t-switch),

(c) use of an ALD hooked up directly to the television set.

These suggestions apply also to tape recording machines and radios.

Cochlear implants. Cochlear implants are a form of auditory device aimed at providing some level of speech recognition for implant users. Most implants consist of a speech processor, microphone, transmitter and internal receiver, as well as cords. The internal receiver is implanted in the ear while other components are worn externally. Surgery is required to install a cochlear implant and extensive rehabilitation is often necessary for wearers to learn to hear the sounds of the device. While hearing is not restored, the device does improve the possibility of communication.

The cost of a cochlear implant may be covered by the student, health insurance, or some other plan. Postsecondary institutions are not responsible for the cost or maintenance of students' devices.

Students who have had, or are considering, a cochlear implant are attending postsecondary institutions in increasing numbers. Some of them combine use of their cochlear implants with campus FM systems. Like other hard of hearing and deaf students, they may request the use of ALDs and other services. If students are from out of town, they may also request referral to a local resource for dealing with their implant.

Telephones. Another report discusses telecommunication devices, including the telephone, in more depth. Here it is noted that the telephone, when used by a hard of hearing person, functions as an ALD.

The telephone is frequently used by hard of hearing students on what has been previously described as the t-switch of the hearing aid. For this to be possible, a magnetic field must be produced inside the telephone itself. A telecoil inside most hearing aids (not inside "in the ear" aids, because of their miniaturization except for some styles) then collects the magnetic signal through induction and changes it into an acoustic signal that is louder and free of the usual telephone "noise". Some hard of hearing students also use a built-in amplifier in the telephone receiver or a small external amplifier in conjunction with the telephone.

Postsecondary institutions should ensure that ALL of their telephones have a magnetic field (otherwise known as being t-switch compatible) and that several public telephones, particularly those used extensively by students, also have volume controls for increasing sound.

Choice of ALD systems

The postsecondary institution has a number of choices regarding the selection of ALDs for offering accessibility to hard of hearing students. Meeting the auditory needs of hard of hearing students through auditory assistive technology will require a collaborative effort on each campus by persons with expertise and a stake in the outcome. Solutions will vary since the needs of each institution will be as diverse as the constituencies it serves.

The stakeholders for devising policies and acquiring ALD hardware include the following:

(a) leadership from the institution's office that is responsible for services to disabled students and is familiar with relevant legislation, e.g., ADA

(b) campus officials responsible for telecommunications, public events, public safety, physical plant management, and student housing

(c) one or more faculty members, who may contribute insights on pedagogical issues in the classroom

(d) an audiologist, either from the faculty or as a contracted consultant

(e) campus employees/students who are hard of hearing.

Most importantly, there must be wide consultation with the members of the hard of hearing community served by the institution. This includes not only current students, but also alumni, parents, and members of the hard of hearing public at large who wish accommodation on the campus.

The first question to ask is, "What do you need as an essential accommodation in order to hear?" In considering this question, institutions may find that it is desirable to avoid confusion by not having too many systems. As well, the cost could be prohibitive.

On the other hand, it may be desirable to have more than one system since different systems work best under certain conditions. For example, an FM system may be functional for use between an instructor and student, but in meeting situations infrared systems may be more functional because of the tabletop design of some infrared systems. No single technology is without limitations or can be expected to fulfill the essential auditory needs of all users.

The following could serve as a guideline in the choice of a specific ALD system:

(a) purpose for its use, e.g., lectures, group discussions

(b) type of environment

(c) ease of use of the equipment

(d) cost

(e) availability and turnaround time for repair service.

Institutions often loan out an FM or infrared device to students, but usually do not have a choice of devices, having only one type of device on hand. Sometimes funding sources such as vocational rehabilitation services may be approached to fund an ALD that best meets a student's needs.

Training

The effective use of an ALD system is enhanced by training in what to expect from the system as well as how to use it appropriately. Different individuals will need different amounts and kinds of training.

Some instructors will be uncomfortable around its technology and hence reluctant to use it in the classroom. To be effective, training should deal with this reluctance directly. Specifically, instructors need to know:

(a) what the ALD system is and how it functions,

(b) what can be expected and not expected from the system,

(c) how to use the system effectively in the classroom,

(d) how to deal with the situation if the system does not work or other problems result.

Hard of hearing student users of the system need to receive training on the above as well as:

(e) how to set up and operate the system

(f) how to monitor the equipment, recharge batteries, and how to do troubleshooting of common problems

(g) how to discuss the use of the system with instructors and classmates.

It is particularly important that all parties understand the limitations of a particular system and that no single device is suitable in every situation. Members of the audiovisual and disability services staffs who will be involved in the support of ALDs similarly need to know all the above, and one or both should be prepared to train others. If a staff member or team from one of these offices is unable to do the training, a community source should be available.

Most of the training is likely to be handled on a one-to-one basis, and should include the provision of on-site assistance. Follow-up training is useful for reinforcing and adding to what the users (both student and instructor) have already learned.

Brochures about the system, and other handouts such as copies of this report can be handed out to the users as a supplement to their training.

The training should also cover more general communications strategies involving hard of hearing students (see Appendix - "Communication tips for instructors").

Roles and responsibilities

On most campuses, the Office for Disability Services will be the central campus contact point for information about ALDs. In most cases the office will have established a loan bank system, either in its own office or through another campus office. This other office may be the audiovisual department because of its role in loaning equipment. At some institutions, equipment loans are done through the security office since it is open 24 hours daily.

For multicampus institutions there may be one site that serves as a central repository, from which each campus may borrow ALD systems as needed. For obvious reasons, where more than one office or location share responsibilities for the ALDs, communication and coordination are essential.

The institution should ensure that its policies on equipment use and loan are publicized. If it wishes the student to sign a waiver absolving the institution of responsibility for the impact of the ALD on the person (e.g., affecting hearing), the wording and legality should be checked with the institution's legal affairs office. In some jurisdictions, ensuring that documentation contains necessary specifications by qualified personnel may be sufficient to satisfy this concern.

The Office for Disability Services may work closely with its institution's architectural/construction department to develop a plan for creating an acoustically and hearing-accessible environment. Some postsecondary institutions have developed five-year plans for this purpose.

The Office for Disability Services may also assist the institution's facilities department with decisions about actual construction and renovation, and drawing on outside technical consultation. The issues raised in the earlier discussion about "Choice of ALD systems" bear attention in this regard. It is important to note here that cost alone should not be the major factor in a decision; cost-effectiveness and legal compliance must also be considered.

Ongoing classes. The student usually borrows the system for a full term. This follows his/her meeting the office's documentation and waiver liability requirements. An audiologist should recommend the necessary calibration and be available as a resource for the effective use of the equipment.

To ensure the return of equipment at the end of a semester some institutions have linked equipment return with registration procedures, i.e., a student is not eligible to register again until the equipment is returned.

Where students lack sufficient documentation or are unaware of ALDs and require further advice, the Office of Disability Services may refer the student to a recognized audiologist or to Student Health which may then make a subsequent referral.

Public events. For public events/lectures, the handling of equipment may be treated differently than for cases involving individual use. For any public event hosted by an institution, the notice for the event should ask that persons requiring ALDs identify themselves in advance of the event. It is the responsibility of the student to indicate his/her need for the device to the appropriate person or office, i.e., the host/sponsor of the event. If no such identification has been provided, it can be assumed that an ALD will not be required.

Upon receiving the request, it is the responsibility of the organizers to arrange for its set-up and availability.

ALD transmitter. The transmitter part of an ALD should be set up (or arranged to be set up) by the organizers. For large meeting places this may already be in a fixed location. The organizers should ensure that such equipment is in good working order, and they should also ensure that speakers are aware of the protocol for use of the equipment, just as they need to be aware of how to use a microphone system.

Most institutions find it necessary to secure this equipment when not in use, to prevent theft or damage.

ALD receiver. With respect to the receiver part of the equipment, the most common approach is for the organizer to provide the device onsite to the students requesting the system. This need not require additional personnel on site if the staff on hand can be given this task. However, they must be well trained about the equipment in order to respond to queries and to troubleshoot when problems arise.

Sometimes the loan of a receiver is conditional upon completion of a loan user form by the borrower. Also, some institutions require that an identification card be left as collateral to ensure return of the equipment.

ALD MAINTENANCE AND REPAIR

General maintenance and repairs. The settings on ALDs, like the settings on hearing aids, should be tuned to a student's hearing profile by a qualified professional. There may be specific regulations concerning dispensing and fitting of ALDs in your state or area. Contact the American Speech-Language-Hearing Association for more information. In Canada, contact the Canadian equivalent.

With respect to ongoing use, it is important that earmolds not be re-used since these are worn in the body and for hygienic reasons should only be used by one person.

And ALDs, like hearing aids, may also be expected to require periodic maintenance and emergency repairs. A number of things can cause a malfunction, including earwax clogging the receiver, a broken volume control or on-off switch, and corroded battery contacts. Earmolds and tubing must occasionally be replaced for behind-the-ear type hearing aids. Often, the malfunctioning device must be returned to the dispenser/audiologist, who in turn may send the instrument to a repair facility.

Even when a hearing aid or ALD is working properly, there is an ongoing need for a local supply of affordable replacement batteries. Hearing aid batteries may be sold over-the-counter through the college bookstore, health clinic, campus hearing and speech clinic, or by local audiologists and retailers.

It will be helpful to the college student who is living at a distance from home, if local audiologists and facilities can be identified for hearing aid support. Approximately 225 colleges and universities in North America have an academic program in audiology and speech-language pathology. On these campuses, there may be a hearing and speech clinic that can offer assistance. For a list of these institutions and for references to board- certified audiologists in the local community, contact the American Speech-Language-Hearing Association.

It is desirable to have a person with technical expertise available who can troubleshoot in relation to problems with equipment set-up and use. Often, equipment may need to be sent away for repairs. Usually, staff within an institution's technical aids department can be trained to provide the necessary on-the-spot trouble shooting, recognizing that major repairs will likely need to be done by manufacturers because of the highly specialized nature of the equipment.

Environmental factors. Postsecondary institutions should endeavor to provide an optimal environment for ALDs. ALDs function best when the environment meets certain conditions:

(a) minimal internal room noise (e.g., not near overhead projectors or air conditioners)

(b) minimal external noise (e.g., not near heavy traffic)

(c) area treatments conducive to good acoustics, (e.g., carpeting).

The environment should be free of electric currents and electromagnetic interference. ALDs can be affected by electric currents interfering with the sensitivity of the coil within the hearing aid. Fluorescent lights or other pieces of electrical equipment such as an overhead projector nearby might cause buzzing and interfere with sound quality.

As reported by Cederbaum (1996), certain types of ultrasonic sensors, designed to detect movement in rooms, can cause some models of hearing aid amplifiers to produce loud buzzing and can cause very rapid depletion of hearing aid batteries. This occurs every time that the unfortunate hearing aid user walks into a room wherein motion sensors are turned on. These sensors are placed in ceilings and walls to control room lighting and heating/cooling systems, and may also be used for security purposes.

Cederbaum (1996) performed an experiment in newly built university buildings for schools of education and business and reported that students experienced loud buzzing or complete shutdown of personal aids when ultrasonic sensors emitted signals ranging between 25 to 27 KHz. At 32 KHz, the problem was unnoticed.

Cederbaum stated that the ultrasonic sensor manufacturer was able to install the higher frequency devices at no greater cost. She also pointed out that the problem did not occur with infrared motion sensors. In California, motion sensors are mandated in new public construction, such as universities, under state law governing energy conservation.

There also are recent reports of hearing aid interference produced by signals emitted from personal digital communication devices. Postsecondary institutions should investigate this matter carefully before purchasing remote pagers or telephone equipment that utilizes broadcast digital technologies.

Legal and safety considerations

Accessibility and accommodation. The provision of ALDs enables thousands of hard of hearing students at the postsecondary level to participate more fully in the range of activities available to their peers. The Americans with Disabilities Act (ADA), enacted in 1990 (i) refers to regulations on accessibility in public services and (ii) acknowledges the need for appropriate auxiliary aids to be provided for individuals.

The Architectural Barriers Act refers to an obligation to provide an auditory assistive listening system in lecture halls, indicating that the appropriate system will be geared toward the "aggregate needs of various individuals" and goes on to cite that, at the present time, i.e., 1984, magnetic induction loops are the most feasible type of listening system for people who use hearing aids equipped with telecoils.

Telephones: A special case. With respect to telephones, in the United States, hard of hearing persons have the right to essential telephone access under several laws, including the Telecommunications for the Disabled Act of 1982 and the Hearing Aid Compatibility Act of 1988, as well as by several rulings of the Federal Communications Commission (Musket, 1995). The scope of these laws is further strengthened by the mandates for public access under the Americans with Disabilities Act of 1990.

Under federal law, essential auditory access includes new telephones installed for coin and credit card use, as well as telephones used in emergency, workplace, and hospital settings. Ten percent of hotel/motel rooms must have hearing aid compatible telephones. According to Musket (1995), compatibility as defined by law involves the emission of a magnetic field by the telephone receiver's internal components that is sufficient to reach the t-coil in the user's personal hearing aid. In this case, the listener places the telephone's handset receiver next to the hearing aid, with the t-coil option switched on.

Safety. The U.S. Food and Drug Administration (FDA) recognized in 1980 that ALDs, especially the types used on a long-term basis in educational settings, in applying amplified sound to the human body were performing essentially the same function as conventional hearing aids. ALDs were classified as Type II medical devices in rules promulgated by the FDA, placing ALDs under the same manufacturing, labeling and sales regulations as hearing aids (Federal Register, 1980).

In most states, practice acts and business code regulations govern the evaluation and remediation of hearing loss and the dispensing of hearing aids. However, the enforcement of state practice acts regarding audiology and hearing aid dispensing tends to be lax in situations where the risk of injury to the consumer is considered to be low. This might include public facilities such as a theater, for one-time use of ALD devices, especially those with low auditory output systems. Lax regulatory oversight may apply as well to colleges and universities where hard of hearing persons must be accommodated on a one-time basis at a public or institutional function.

In other circumstances, however, postsecondary institutions may expect students to experience repeated or even daily use of ALDs that produce relatively high levels of amplified sound output. As the risk of injury can be expected to increase with frequent usage of higher output amplification devices, these should be evaluated and dispensed with the same standard of care as conventional hearing aids.

The risk of injury to the residual hearing of a student poses two related liability issues for the postsecondary institution. First, there is a duty imposed upon a provider to offer safe, efficacious amplification devices when meeting reasonable accommodation mandates. This requires that the persons providing the devices to the consumer on behalf of the institution be properly trained and licensed to evaluate, recommend, modify and adjust, monitor, and repair them. The second concern is product liability, where the damages from an injury caused by a malfunctioning device may be shared by the manufacturer and the person or institution providing the device and its accessories.

Resources

Information about assistive listening systems is available from the following national organizations, many of whom have state/local affiliates:

Self-Help for Hard of Hearing People (SHHH)
7800 Wisconsin Avenue
Bethesda, Maryland 20814
(301) 657-2248 (voice); (301) 657-2249 (tty)

SHHH is a non-profit educational organization of and for hard of hearing persons. It has chapters in 48 states and a national demonstration center where assistive listening devices and systems are shown.

National Association of the Deaf (NAD)
814 Thayer Avenue
Silver Spring, Maryland 20910
(301) 587-1788 (voice); (301) 587-1789 (tty)

NAD is a non-profit organization of deaf people; it has an assistive listening device center where assistive listening systems are demonstrated.

National Information Center on Deafness
Gallaudet University
Washington, DC 20002
(202) 651-5051 (voice); (202) 651-5052 (tty)

This center offers listings of assistive device demonstration centers across the nation and technical assistance on installing assistive listening systems.

Information about additional resources may be available from:

U.S. Architectural & Transportation Barriers Compliance Board
1000 - 1331 F Street N.W.
Washington, DC 20004-1111
Phone: (202) 272-5434 (voice or tty)

Postscript pertaining to laws and regulations[1]

In addition to clear guidance regarding the types of assistive listening devices (ALDs) currently available, this report sets out practical policies and procedures which are not only helpful in making the use of ALDs effective, but also provides a framework for the provision and use of adaptive equipment/ technology on college campuses in general. This type of framework is important in providing better services and in avoiding liability for non-compliance.

Key to compliance with the ADA is collaboration between the legally responsible party (the institution) and the person with disabilities. This report makes clear the roles and responsibilities of both sides to this equation. The best equipment in the world is useless, if not used or maintained properly. By the same token, the users of ALDs need to know how to care for the equipment so as to feel comfortable using it, because a simple fact of life is that when people understand how to use equipment, they use it. When they don't understand it, they avoid it. When an institution's faculty and staff avoid using ALDs out of ignorance or discomfort, complaints are inevitable. The law is clear that adaptive equipment which is not useable (whether through lack of training or lack of maintenance) is not access.

This report is also important because it speaks to the primary methods available for bringing effective communications to a population of people who are often overlooked – persons who are hard of hearing. They often fall between the cracks, being neither hearing nor deaf, and often go unaccommodated as a result of inaccurate perceptions. This report also addresses the responsibilities of institutions to publicize the availability of ALDs and the process by which one may make use of them, whether students, employees, or members of the public using an institution as a public accommodation.

An important caveat arises in this context: the possibility that liability for improper maintenance of ALDs may not be limited to that which results from a charge of discrimination, but may also arise from personal injury where an improperly calibrated instrument overamplifies and causes severe pain, or in some cases, further loss of hearing. While the latter scenario is not highly probable, it is possible and should not be dismissed lightly. The solution: maintenance and education.

[1] Contributed by Jo Anne Simon, consultant/attorney specializing in laws and regulations pertaining to students with disabilities.

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APPENDIX

Communication tips for instructors

When speaking

- Speak normally without over-enunciating or speaking loudly unless the circumstances require it. If you tend to speak quickly, try to moderate your pace.
- Re-phrase a word or sentence if not understood the first time, rather than repeating the sentence.
- Avoid unnecessary movement so that your face is visible to the student. When writing on a chalkboard, turn to face the class when speaking.
- Use a neutral background. Avoid a window or bright light; the glare may obstruct your face.
- Turn off the overhead projector when not in use; its hum can be distracting for hard of hearing students.
- Avoid communication when the student is moving as facial visibility may be reduced and background sounds may be distracting.
- Repeat questions or statements from other students.

When using materials

- Provide in advance, as much as possible, a copy of the material to be covered and a list of highly technical words and unfamiliar proper names.
- Reinforce your verbal presentation with written text as much as possible, and provide in writing such vital information as the due date for an assignment or change in class schedule.
- Face the student rather than the instrument/ equipment when explaining its operation. This applies particularly to laboratory situations. When this is not possible, consider use of a mirror so your face is visible.
- Try to avoid referring to a class handout while lecturing, since it is difficult for the hard of hearing or deaf student to focus on both the instructor and the handout at the same time.
- Allow for a few moments when referring to manuals, texts or other materials so that the student has time to shift to the material.

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