Chapter 3

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The options available for treating hearing impairment in elderly people are generally the same as for younger people. However, the suitability and effectiveness of various treatments differ considerably among age groups because of the type of hearing loss most frequently encountered and because of other physical, psychological, and social characteristics of each group (10).

Preventing hearing impairment is an obvious first approach. Even if hearing impairment cannot be completely avoided, preventive measures can slow the rate of deterioration or reduce the ultimate severity of the impairment. A second approach is medical and surgical treatment. While these treatments are effective for some types of hearing impairment, the types of hearing problems that are most common in elderly people are not presently treatable with medical or surgical methods. Thus alternatives are needed. These generally do not change the underlying hearing loss but instead help compensate for hearing loss and maintain adequate communication. They include the use of hearing aids, assistive listening devices, telecommunication devices, signaling and alarm devices, and environmental design technologies. In addition, aural rehabilitation services can help hearing impaired people communicate more successfully with or without the use of amplification devices.

PREVENTION

Some causes of hearing impairment in elderly people are not well enough understood to allow effective preventive measures. For example, dietary factors and circulatory changes have been implicated as accelerators of deterioration in the auditory system. Yet the specific relationship of these factors to hearing loss is not known, and further research is needed before preventive strategies can be developed (10).

other causes of hearing impairment are well understood and often preventable; these include untreated ear infections, exposure to loud noise, and some medications. Untreated or inadequately treated ear infections at any time in life can cause conductive hearing loss, though it may not be immediately disabling. In old age, however, as sensorineural loss further reduces hearing acuity, serious disability may develop. Thus better health care throughout life could prevent some hearing impairments in old age (10).

Exposure to loud noise at any age can cause irreversible sensorineural damage and significant hearing loss. Airplanes, motorcycles, heavy traffic, farm and industrial machinery, gunfire, and loud music are sources of noise that can permanently damage hearing. Other sources of loud noise have also been identified. For example, the American Academy of Otolaryngology-Head and Neck Surgery has recently warned that some types of cordless telephones can cause hearing loss because the phones continue to ring at a high decibel level after being answered until a switch is flipped to the ‘(talk” position. Seven million of these cordless phones were estimated to have been sold in 1984 (2).

The popularity of loud rock music, along with a rise in other environmental noise, creates a severe threat to the auditory acuity of young people. A 1968 study of hearing impairment among students in Knoxville, Tennessee, showed that 4 percent of sixth graders had hearing loss at high frequencies. This proportion increased to 11 percent of ninth graders and 33 percent of freshmen at the University of Tennessee. A year later, a similar study showed that more than 60 percent of the next freshman class had some hearing loss (70). As these individuals grow older, their noise-induced hearing loss may be exacerbated by the auditory changes associated with aging.

Self Help for Hard of Hearing People, one of the self -help groups for hearing impaired people, has

developed a “Quiet School Program” to provide information and educational materials to school administrators, teachers, students, and parents about the relationship between loud noise and hearing loss. The materials include colorful posters and a device that flashes a warning light when noise in the school cafeteria reaches a dangerous level (101).

The increased use of portable radios and tape players with earphones may cause a greater prevalence of noise-induced hearing loss. A study in New York City found many listeners playing their portable radios at 100 decibels, the equivalent of a car horn 3 feet away (65). A recent British report concluded, however, that portable radios and tapeplayers are a less serious threat to hearing than are other sources of loud noise such as industrial machinery and gunfire (38).

Federal legislation to control noise includes the Occupational Safety and Health Act of 1970 and the Noise Control Act of 1972. Federal regulations define the amount of time that workers may be exposed to noise of a given intensity. Noise control procedures have been implemented in some industries. In addition, some local governments have enacted noise control legislation and violators are being prosecuted (111). These efforts eventually may reduce the prevalence and severity of noise-induced hearing loss. Many incidents of exposure to loud noise, however, are not within government regulatory control. Increased public education is needed to alert people of all ages to the impact of loud noise on hearing and the long-term damage that can result.

Some drugs also damage auditory mechanisms. Although not a major cause of hearing impairment, these “ototoxic” drugs must be considered in any discussion of prevention. The best known of these drugs are the aminoglycosides, a class of antibiotics that includes streptomycin. These drugs can be life-saving; unfortunately, they also sometimes damage hearing (10). Even commonly used, over-the-counter drugs such as aspirin can be ototoxic, although probably only in the high dosages sometimes used to treat arthritis. Fortunately, aspirin-induced hearing loss is usually reversible if it is recognized early and aspirin dosage is reduced (10).

ototoxic drugs can create problems in people of any age. Nevertheless, diseases that require their use are more prevalent in later life. Too little research has been done to provide a full understanding of the mechanisms of ototoxicity and of the essential chemistry of the agents that may be ototoxic. Educational efforts have been effective in informing most physicians of the potential hazards of streptomycin, but the ototoxic effects of other drugs have been less well publicized (10).

Hearing loss is a symptom with many possible causes and accurate diagnosis can sometimes help prevent permanent hearing impairment. Yet some elderly people do not receive thorough diagnostic evaluation. Symptoms such as sudden onset of hearing impairment and unilateral deafness suggest a diagnosis other than presbycusis, and medical evaluation of patients with these symptoms can sometimes lead to effective treatment (73).

MEDICAL AND SURGICAL TREATMENT

Medical and surgical treatment can resolve conductive hearing losses that originate in the outer or middle ear, but the sensorineural losses that are most common among the elderly generally cannot be treated with available medical and surgical methods. Cochlear implants can alleviate profound sensorineural hearing loss in some individuals and research continues to improve these devices.

Treatment of Conductive Hearing Impairments

Wax buildup in the outer ear is common among the elderly and interferes with the passage of sound to the middle ear. Recognizing this problem and removing the impacted ear wax can improve hearing even if there are other auditory deficits.[1]

Middle ear disease is most common in childhood but it also occurs in adulthood and old age. Otitis media (infection of the middle ear) can be caused by allergies or upper respiratory infection and effective treatment may require medication. Perforation of the eardrum can occur at any age as the result of middle ear infection or direct trauma. Repair occurs without treatment in some cases, while **surgical** repair is needed in other cases.

Otosclerosis impairs movement of the stapes, a small bone in the middle ear. The impaired movement causes progressive hearing loss. While the most common age of onset is in the third or fourth decade of life, surgery can be beneficial at any age and carries only a small risk of complication (27).

Treatment of Sensorineural Hearing Impairments

Although most sensorineural losses cannot be corrected through medical or surgical intervention, some losses due to tumors, sudden vascular changes, or fluid pressure changes affecting the inner ear or auditory nerve can be treated. These disorders, however, are relatively infrequent in elderly people (12).

[1]Removal of impacted ear wax can be difficult and painful and should be done under the supervision of a physician.

Acoustic Tumors

Acoustic tumors can cause sensorineural hearing loss, vertigo (dizziness), tinnitus, facial paralysis, or numbness. These tumors generally occur during the third or fourth decade of life but may also occur in the sixth and seventh decade (13.5). These tumors can be fatal and surgical removal is a life-saving measure, but it does not usually result in improved hearing.

Meniere's Disease

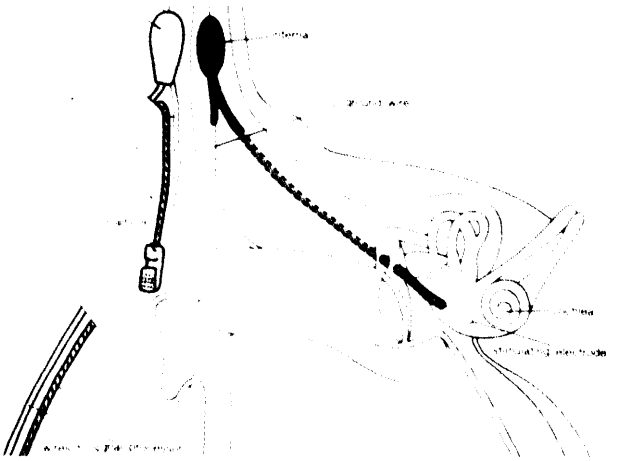
Sensorineural hearing loss can also result from Meniere's disease, the symptoms of which include fluctuating hearing loss, tinnitus, pressure in the ears, and vertigo (93). The cause of Meniere's disease is not known. Treatment with medication is the first choice, and surgery is used only when hearing loss or disabling vertigo persists despite drug therapy. Rates of success with surgery vary from 62 to 95 percent, depending on the type of surgery performed (92).

Cochlear Implants

The cochlear implant is an electronic device designed to give persons with profound bilateral sensorineural hearing loss an improved sense of sound. Part of the device is surgically implanted in the inner ear and part of it is worn externally (see figure 5). The cochlear implant is intended to neuroelectrically simulate natural hearing, but full attainment appears far in the future (10). The sound produced by these devices has been described as fluctuating, grating noises and buzzes (88), and users need extensive training to learn to interpret the sound. Yet implants have improved speechreading ability—at least in isolated experiments—by giving rudimentary clues to a speaker words (25). These devices also provide a sense of the duration, rhythm, and loudness of sound that can be helpful in understanding speech and identifying environmental sounds (8, 71).

Cochlear implants hold most promise for deaf people whose transducing organ in the cochlea is ineffective but whose auditory nerve endings are still responsive to direct stimulation (88). In the past 20 years, hundreds of people worldwide

Figure 5.—Cochlear Implant in Place



The cochlear implant translates sound into electrical signals, bypassing damaged tissues in the inner ear and allowing the brain to receive auditory information. It works as follows: An external microphone detects sound which is translated into electrical impulses by a signal processor and then transmitted to an external coil positioned behind the ear. This coil induces a like signal in another coil implanted inside the skull. From the internal coil, the signal is carried to an electrode in or on the cochlea, stimulating nearby auditory nerve fibers to transmit messages to the brain. This diagram shows the parts of the implant designed by William House and his colleagues. Other systems are similar, except that the external coil and microphone may be worn on a headset and multichannel devices have more electrodes.

SOURCE: D. Grady, "Sounds Instead of Silence," *Discover,* 1983.

have received experimental cochlear implants, and many of them have been enthusiastic about the results (71). No statistics are available on the number of elderly persons who have received implants or their response to them. In 1984, the Food and Drug Administration (FDA) approved one type of cochlear implant for clinical use in the United States, a device developed by William House and 3M Corp. In 1985, FDA approved a more sophisticated implant developed in Australia.

Research on cochlear implants continues at the House Ear Institute of Los Angeles; the Kresge Hearing Research Institute at the University of Michigan; Stanford University Medical School; University of California, San Francisco; Johns Hopkins University School of Medicine; and other hearing research centers. One focus of research is improving the sound processing capabilities of the devices. Another focus is the development of multichannel devices that are expected to allow more realistic sound perception for the individual (71). The House implant illustrated in figure 5 is a single-channel device with a single stimulating electrode, and the Australian device mentioned above is a single-channel device with 22 stimulating electrodes. Four- and eight-channel devices are now being tested and some people report significant improvement in speech recognition with these devices. Researchers believe that with enough channels, the cochlear implant could restore normal hearing. However, the difficulties involved in designing a multichannel device and successfully placing and maintaining it in the tiny, spiral-shaped cochlea are formidable (71).

Cochlear implants can damage remaining nerve fibers and other delicate tissues in the patient's ear. As a result, researchers in England, Austria, and Switzerland are working on '(extra cochlear " devices, where the electrode is implanted outside the cochlea (45).

In its present form the cochlear implant is not appropriate for most elderly people because they have partial hearing loss rather than the profound deafness for which the device is now used. Anecdotal evidence indicates that some people who have had implants have been severely disappointed by limitations on the sounds they are able to hear (128). Cochlear implants are expensive, ranging from $12,000 to $15,000 for preoperative evaluation, surgery, the device, and postoperative auditory training (8). In the future, however, as cochlear implants are improved through research and test - ing they may become an important treatment option for elderly people.

HEARING AIDS

Since only a small portion of elderly people with hearing impairments can benefit from medical or surgical treatment, other approaches to mitigate the problem are essential. For many years, hearing aids were the only available option. Recently there has been increased interest in other devices

that can help individuals with hearing impairments and these devices are discussed later in this chapter.

Hearing aids are amplification devices that compensate for partial hearing loss. The individual must have some residual hearing to benefit from a hearing aid. The earliest hearing aids were mechanical "ear trumpets" that gradually evolved into the small, more effective, battery-powered technology that is available today.

Hearing aids are available in five basic styles: on-the-body, over-the-ear, eyeglass, and two in-the-ear styles (see figure 6). On-the-body aids have a receiver that is attached to clothing or carried in a pocket, Ear-level aids are worn over the ear or fitted into the temple bar of eyeglasses. In-the-ear aids include one style that fits into the auricle or outer area of the ear and a smaller device, the canal style aid, that fits almost completely into the ear canal.

Until recently, the most frequently sold hearing aids were over-the-ear aids, but beginning in 1983 in-the-ear styles have outsold the other types. In-the-ear aids are popular because of their small size, and the canal style aid, which first appeared on the market in 1982, is extremely popular for this reason. Table 4 shows the types of hearing aids sold in 1984. Canal style aids are included in the "in-the-ear" category. Sales of canal style aids increased from less than 1 percent of total hearing aids sold in 1982 to 9 percent in 1983, and 22 percent in 1984 (23). About 65 percent of people who bought hearing aids in 1984 were fitted for one aid, while about 35 percent were fitted for two aids, one for each ear (23).

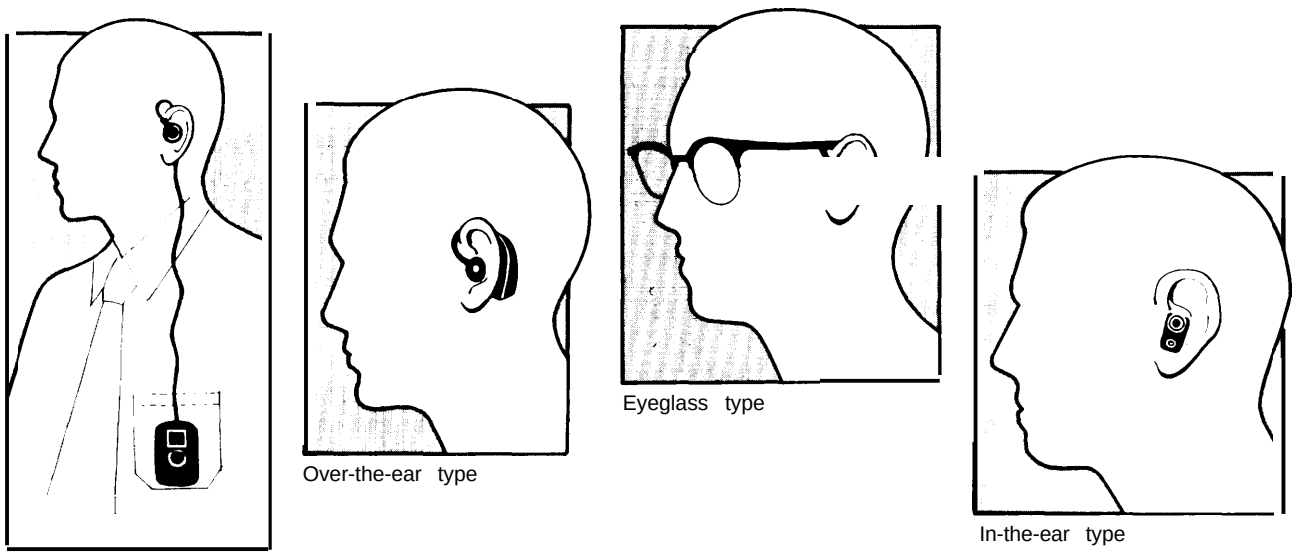
In the past, on-the-body aids could provide more amplification than other types of aids and were therefore recommended for people with severe hearing impairments. Recent technological advances in the miniaturization of hearing aid components now make it possible for individuals with severe hearing impairments to use ear-level aids. Increased miniaturization, however, has raised concern about the quality of sound provided, par-

Table 4.—Types of Hearing Aids Sold in the United States, 1984

Type of aid	Percent of total sales
In-the-ear	60.00/0
Over-the-ear	37.0
On-the-body	1.5
Eyeglass	1.5

SOURCE: Cranmer, 1965 (23).

Figure 6.—Hearing Aid Types



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ticularly with devices as small as canal style aids. Miniaturization of the microphone and speaker elements of hearing aids has been less effective than miniaturization of the electronic circuitry, and this can result in sound distortion—a serious drawback for elderly people who have difficulty with auditory discrimination (54, 60). While research continues to improve the miniaturized components of hearing aids, some hearing specialists worry that people may select a small hearing aid that is not well suited to their needs because of its cosmetic appeal.

Over the years, hearing aids have helped millions of people by maximizing their residual hearing and allowing them to function in communication situations that otherwise would have been impossible. Yet most people with hearing impairments do not use hearing aids. Estimates of the percentage of hearing impaired people who use hearing aids vary depending on the source of the data and the figure that is used for overall prevalence of hearing impairment. A recent analysis using three different prevalence rates estimates that between 8 and 17 percent of all hearing impaired people use hearing aids (41). A 1984 industry survey indicated that of the 16 million people of all ages with hearing impairments in the United States, about 4 million (25 percent) own hearing aids. About 2 million others (12.5 percent of hearing impaired people) do not admit to having a hearing impairment, and the remaining 10 million (62.5 percent) admit to having a hearing impairment but do not have a hearing aid. Of those who own hearing aids, about 14 percent do not use them (49).

The majority of hearing aid users are elderly. Table 5 gives the age breakdown of individuals who bought hearing aids between 1983 and 1985.

Table 5.—Proportion of Hearing Aid Purchasers by Age, 1983-85

Age	Proportion of all hearing aid purchasers	
2 to 39	8%	
40 to 49	3	
50 to 59	11	
60 to 69	31	
70 to 79	30	78%
80 to 89	14	
90 to 99	3	

SOURCE: Market Facts, 1985 (75).

Elderly people with hearing impairments are more likely to use hearing aids than younger people with comparable hearing loss. Data from the 1977 National Health Information Survey show that about 20 percent of all hearing impaired persons over 65 used a hearing aid, compared to 4 percent of hearing impaired persons age 3 to 44 and 10 percent of hearing impaired persons age 45 to 64 (118). Among elderly people, hearing aid use increased with increasing severity of hearing impairment (see table 6).

Even though elderly people with hearing impairments are more likely to use hearing aids than younger people with similar impairments, most hearing impaired elderly people do not use hearing aids. Many reasons for this have been suggested. Some elderly people are unaware of their hearing impairments and therefore do not buy an aid, others reject the use of a hearing aid because they associate it with getting old or becoming handicapped. Still others believe that their hearing loss is not severe enough to require the use of a hearing aid or that hearing aids are not effective for the kinds of impairments they have. Cost is an additional deterrent for some people (49).

Among those who do buy hearing aids, some are very satisfied; others are less satisfied; and some are disappointed with the aid. A nationwide survey of people of all ages who purchased hearing aids between 1983 and ,1985[2] asked respondents how satisfied they were with their hearing ability with the current hearing aid. Responses are shown in table 7.

Those who answered that they were somewhat dissatisfied (6 percent) or very dissatisfied (4 percent) were asked about specific problems they experienced in using the aid. These people identified the following problems (75):

- ***amplification*** of unwanted noise,

[2]This survey, commissioned by the Federal Trade Commission (FTC), was designed to produce a representative sample of all U.S. households and to reflect the experiences of all hearing aid purchasers nationwide (86). The FTC requested public comment on the methodology of the survey, and no serious problems in survey methods were identified by the time the public record was closed (87). Since then, analysts have pointed out that the survey might be biased because it was a mail survey and because the respondents were members of a panel of consumers who had agreed to participate in Market Facts surveys (107).

Table 6.—Persons Age 65 and Over Who Use a Hearing Aid, United States, 1977

Known hearing aid use	All levels of hearing trouble	Unilateral hearing trouble	Can hear words spoken in a normal voice	Can hear words shouted across a room	At best can hear words shouted in ear
Use a hearing aid	19.9°/0	10.80/0	12.70/o	27.50/o	58.40/o
Do not use an aid	80.1	89.2	87.3	72.5	41.6

SOURCE" NCHS, 1982 (1 18)

Table 7.—Satisfaction With Hearing Ability Using a Hearing Aid

Degree of satisfaction	Percent of all hearing aid purchasers
Very satisfied	47%
Somewhat satisfied	37
Neither satisfied nor dissatisfied	6
Somewhat dissatisfied	6
Very dissatisfied	4

SOURCE: Market Facts, 1985 (75).

- inability to hear in crowds,
- having to ask people to repeat themselves,
- feedback from the hearing aid,
- difficulty hearing phone conversations,
- friends/relatives complaining about their hearing.

Those who said they were somewhat satisfied or neither satisfied nor dissatisfied (43 percent of the total sample) were not asked about problems they experienced in using the aid. If they had been asked, they might have identified similar problems.

Dissatisfaction with a hearing aid can result from several problems: 1) deficiencies in the design and/or performance of the aid itself, 2) selection of an aid that is not well matched to the person's needs, 3) inability to adjust to the aid, or 4) a combination of all three. In many cases, it can be difficult to determine the cause of dissatisfaction.

problems in Hearing Aid Design and Performance

The sound produced by hearing aids is sometimes described as mechanical. one reason for this is that most hearing aids amplify sound in the frequency range of 500 to 4,000 Hz, although a full frequency range from about 50 to 10,000 Hz is needed to provide reasonably accurate timbre (the quality given to sound by its overtones). In addition, hearing aids do not handle all tones evenly, resulting in further sound distortion (21).

Another problem with hearing aids is that they amplify background noise as well as speech, and users of all ages have difficulty learning to tune out distracting background noise. As a result, some hearing aid users turn off their aids in noisy environments (67). Recent changes in transducer design can intensify the speech signal in contrast to background noise and thus improve the speech-to-noise ratio (89). However, amplification of unwanted background noise remains a problem for many hearing aid wearers. For elderly people who have diminished ability to tune out background noise, this problem is particularly severe.

Since many elderly people have more severe hearing loss at high frequencies than low frequencies, uniform amplification of all frequencies is often ineffective. One approach to this problem is a ***high -frequency emphasis hearing aid*** that amplifies only high-frequency sounds, allowing low-frequency sounds to enter the ear without amplification (115). Another approach is *frequency* ***lowering,*** an electronic sound processing technique that lowers the frequency of received sound. This technique is in the developmental stage and sound distortions produced by the frequency lowering systems limit their effectiveness (88).

Difficulty with sound discrimination is a common element of hearing impairment in elderly people. Thus technical limitations in hearing aids that distort sound can actually worsen the hearing ability of some individuals (54). Sophisticated sound processing techniques that have been developed for military and space applications may someday be used to overcome the problems of sound distortion, background noise, and high-frequency hearing loss. Using these advanced techniques:

> ... minute signals are successfully pried out of a profusion of far stronger noises that have often been accumulated over great distances in space. Communication in present day air battles depends upon stunning solutions to the problem of signal (and speech) selectivity for multicommunication

among pilots and between pilots and ground control. Such solutions employ sophisticated logic software in which the distinguishing physical characteristics of the desired signals are recognized while those of the undesired competing signals are rejected (11).

Adaptation of these techniques to hearing aid design is a high priority at the National Institute of Neurological and Communicative Disorders and Stroke and other hearing research centers across the country (81). Obstacles include miniaturization of the necessary equipment and the final cost of the device.

Several other problems can also interfere with hearing aid performance. Hearing aids need frequent cleaning and if the user does not clean the aid it will not work properly. Hearing aids can be damaged by heat and moisture, causing a need for adjustments or repair. The batteries can die, and although checking the batteries is an obvious first step for most hearing aid users, hearing specialists encounter people who complain that their hearing aids do not work, only to find that the batteries are dead. Portable battery testers are available and can help solve this problem. In the future, hearing aids could be designed with a detector circuit to sense low battery voltage and alert the user by a visual, auditory, or tactile signal. Obviously, new users need a thorough hearing aid orientation to forewarn them about these potential problems.

Problems in Selecting the Appropriate Hearing Aid

At present, there is no technique to make a hearing aid that exactly matches an individual's hearing deficits, the way eyeglass lenses are ground to match a prescription. Instead, hearing aid dealers and dispensers attempt to custom fit the aid to the individual's hearing deficit by combining and adjusting available components.

One problem faced when selecting an appropriate hearing aid is identifying the individual's precise hearing deficits, Hearing specialists disagree about what tests are needed to select a hearing aid and who is qualified to perform the tests. Audiologists are trained to evaluate hearing deficits, and some hearing specialists believe that a comprehensive audiologic evaluation is necessary to select a hearing aid. Yet many elderly individuals buy hearing aids without seeing an audiologist (10). other hearing specialists argue that while a comprehensive audiologic evaluation is essential for diagnosing some ear diseases, only certain hearing tests are relevant to the selection of a hearing aid and these tests can be performed effectively by hearing aid dealers (62, 90, 133).

Another problem that arises when selecting an appropriate hearing aid is that little information is available comparing different brands and types of hearing aids. Hearing aid manufacturers provide technical performance data on their devices, but information about the relative merits of various brands and models is scarce.

The National Technical Institute for the Deaf and the Massachusetts Institute of Technology have designed a device to simulate the characteristics of a variety of hearing aids. This "Master Hearing Aid" provides information about the most appropriate hearing aid for the individual (19). Computer programs also have been developed to analyze audiometric data and select specific models of hearing aids that most closely match the individual's hearing deficits. Eventually, it is hoped that a computer chip programmed by a "Master Hearing Aid" could be installed in the individual's hearing aid to provide an exact match between the individual's hearing deficits and the signal processing characteristics of the aid (19). This would constitute a "prescription hearing aid." Research on various aspects of the prescription hearing aid is in progress at the Central Institute for the Deaf in St. Louis, the Lexington School for the Deaf in New York City, and other hearing research centers.

Problems in Adjusting to a Hearing Aid

Emotional and psychological factors can interfere with a person's adjustment to hearing aid use. For example, some people fail to adjust to their hearing aids because they are embarrassed by the appearance of the aid. Small, "invisible" aids are popular for this reason. Larger aids that provide better sound fidelity and are more easily manipulated by arthritic hands are sometimes rejected in favor of smaller, more expensive, and less ef -

fective instruments (10). The use of two aids, one for each ear, may also be rejected for this reason even though two aids can provide better hearing acuity for many people (134).

Unrealistic expectations can also interfere with a person's adjustment to the hearing aid. Some individuals buy a hearing aid expecting it to restore normal hearing and are disappointed with the results. This disappointment can cause significant acceptance problems (10). Research indicates that 30 percent of those who purchased hearing aids from 1983 to 1985 expected that their aids would restore normal hearing. of these people, one-third said their hearing aids did restore normal hearing, about one-half said it somewhat restored normal hearing, and the remaining 12 percent were unsure or said it did not restore normal hearing (75).

Some people believe that elderly people have more difficulty adjusting to hearing aids than younger people because of an assumed age-related inability to adjust to anything new; however, no research justifies this conclusion. In fact, little conclusive information is available about the precise reasons why individuals of any age fail to adjust to hearing aids, and more research is needed in this area.

Anecdotal evidence suggests that some elderly people who are severely confused and hearing impaired may be unable to learn to use a hearing aid or even to understand its purpose. For these people, environmental design technologies and assistive listening devices that require less adjustment could be more appropriate. These approaches are described later in this chapter.

All people fitted with hearing aids need assistance adjusting to the aid. Someone must answer questions, reassure the person during discouraging periods, make needed adjustments to the hearing aid and attachments, counsel the individual and the family regarding expectations, and assist in the adaptation to environmental sounds. Otherwise, the aid will remain unused. These factors point to a strong need for competent professional involvement in the evaluation, selection and fitting, and adjustment of hearing aids (10).

ASSISTIVE LISTENING DEVICES

In addition to hearing aids, four types of assistive listening devices can be used to increase auditory effectiveness: hardwire devices, audio loop systems, radio frequency devices (AM and FM), and infrared amplification devices. These devices transmit sound directly from the speaker or other source to the listener, thus reducing interference caused by background noise. They have been used primarily in classrooms and public meeting rooms and are often referred to as "large room systems. " They are now being used by some people for one-to-one or small group listening as well as TV and radio listening.

Assistive listening devices can be used by elderly people who have hearing aids and have difficulty tuning out background noise. In addition, these devices can give some elderly persons with mild to moderate hearing loss enough amplification to allow them to hear effectively without a hearing aid in some situations.

Hardwire devices provide a direct wire link between the listener and the source of sound. Examples are the earphones used with portable radios, tape players, TV, and stereos. Hearing impaired people can obtain earphones with adjustable volume. Some hardwire devices have a microphone that can be placed on a table or held by the speaker (see figure 7). Some can be used with a hearing aid. The simplicity of these devices makes them useful for radio and television listening and some one-to-one conversation, but the wire connection to the source of sound is too restrictive for many purposes.

An audio ***loop system is*** composed of a microphone that is worn or held by the speaker and a length of wire called an induction loop that can be installed or simply placed in a room. Sound from the microphone is converted into an electromagnetic signal that is transmitted by the loop and picked up by any hearing aid with a telephone

Figure 7.— Hardware Device for One-to-One Consultation

SOURCE' Williams Sound Corp

Figure 8.—Audio Loop Wand Receiver

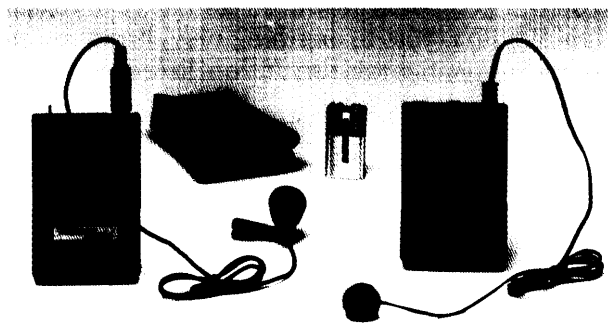
SOURCE: VA Medical Center, Birmingham, Alabama

switch. Loop systems can also be used by people who do not have hearing aids but wear or carry a receiver that can pick up the electromagnetic signal[3] (see figure 8). Loop systems have been used extensively in schools for the deaf and are now being used in churches, theaters, and other meeting rooms.

Hearing impaired people who want to use the loop system must sit within the area of the loop, but people with no hearing problems can sit in the same area. Sound quality is not always uniform throughout the area and the devices sometimes pick up interference from fluorescent lighting (103).

An FM ***amplification device*** is composed of a small, wireless, battery-operated FM microphone that can be placed near the source of sound (a person, television, radio, etc.) and a tiny portable stereo radio equipped with earphones that are worn by the hearing impaired person (see figure 9). Sound is transmitted from the microphone to the receiver by radio wave. The transmission range is 100 feet or more, which allows the person to move about while listening to radio, television, or conversation. Individuals with hearing aids can use FM amplification devices if their hearing aids have a telephone switch and they use a neckloop or if their hearing aids are designed for direct audio input.[4]

Figure 9.—FM Personal Amplification Device: Transmitter and Receiver



SOURCE. Williams Sound Corp

Until a few years ago, the Federal Communications Commission (FCC) limited the use of radio signals for amplification devices to educational settings. This restricted the development of FM amplification devices for personal use. Since 1982, however, changes in Federal regulations have allowed increased public access to radio frequencies. This has stimulated the development and mar-

[3]In some museums, audio loop systems are used for self-guided tours for nonhearing impaired persons. The individual carries a wand receiver that is activated as he approaches an exhibit.

[4]Over-the-ear, eyeglass, and on-the-body aids that are designed for direct audio input use an adapter cord that can be plugged into the hearing aid at one end and into the FM receiver at the other end. In-the-ear aids can use a button receiver that is snapped onto the hearing aid for direct audio input.

keting of FM amplification devices for use in the home and in public facilities such as theaters, churches, and large meeting rooms. These devices are also being used in automobiles.

An AM amplification ***device*** transmits sound using AM radio wave lengths, and the sound is picked up by a special AM receiver worn by the listener or by a portable pocket radio. The sound quality provided by AM amplification devices is usually not as good as that provided by FM devices. AM amplification devices are subject to the same sources of interference as AM radios (e.g., thunderstorms and lamp dimmers). In addition, AN I devices can only be used within an area enclosed by four walls, while FM amplification devices can be used indoors and outdoors. As a result, FM amplification devies are used more frequently (103).

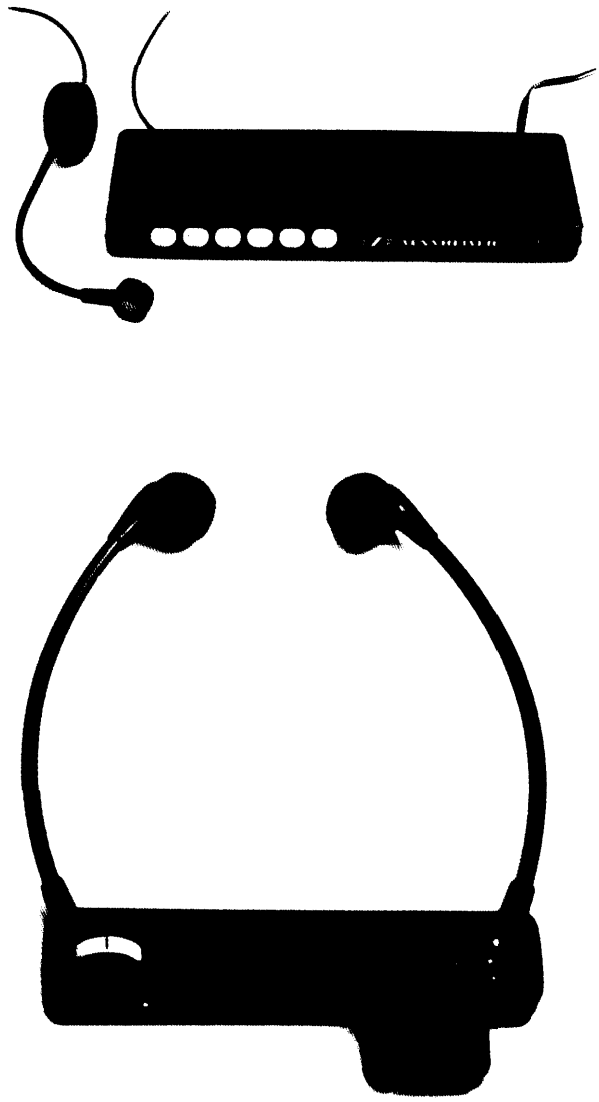
An *infrared* ***amplification device*** is composed of a battery-operated transmitter and a receiver (see figure 10). The transmitter transforms sound into an electrical signal that modulates an infrared light beam. This invisible light beam is picked up by a receiver worn by the listener (67). Infrared hearing devices are used primarily in theaters and some institutional settings, but they can also be used in the home (68).

one advantage the infrared device has over t he All and FM amplification devices is that the infrared light signal is absorbed by any opaque surface. Thus a person in one room can use an infrared amplification device to hear a speaker in that room while people in other rooms can use infrared devices to hear other speakers. There is no spillover of the infrared signal and privacy of communication is maintained. In contrast, AM and FM radio signals can radiate from one room to another. In an institutional setting or any private situation, the spillover of AM and FM signals is unacceptable (67).

one disadvantage of infrared devices is that they cannot be used in direct sunlight, and thus cannot be used outdoors like FM amplification devices. Large amounts of incandescent light in a room can also cause interference (103).

Although assistive listening devices have been used primarily to amplify sound in large rooms and public settings, they are now being used more frequent}' by individuals for interpersonal communication and TV and radio listening. Many applications that are especially relevant for elderly people have been suggested. For example, physicians and other professionals who talk with elderly people could have these devices available in their offices. In hospitals and nursing homes, the devices could be used by staff to communicate with hearing impaired patients, and patients could use them to listen to radio or TV without bothering other patients. Assistive listening devices could be especially helpful in banks and other offices where

Figure 10.—Infrared Amplification Device: Transmitter and Receiver



SOURCE: VA Medical Center, Birmingham, Alabama

people communicate through glass barriers. Unlike hearing aids, no training is required to use them so they can be immediately helpful in many listening situations.

Assistive listening devices are particularly appropriate for many elderly people with mild or moderate hearing loss because these devices can provide satisfactory auditory function in some listening situations even without the use of a hearing aid. When a hearing aid is needed, assistive listening devices can help tune out bothersome background noise.

one obstacle limiting the use of assistive listening devices is the resistance many hearing impaired people feel to using devices that are visible (140). Another obstacle is lack of awareness among the hearing impaired elderly of the kinds of devices that are available. Many hearing specialists—including physicians, audiologists, and hearing aid dealers—know very little about these devices and do not encourage their use (74). Some of these specialists believe that a correctly fitted and functioning hearing aid is a better treatment option than an assistive listening device because the hearing aid does not require microphones, transmitters, or induction wires, and thus appears more "natural ." Advocates of assistive listening devices point out, however, that hearing aids can be ineffective in some listening situations (102). These experts believe that until hearing aids can be designed to effectively filter out background noise, other devices are also needed.

TELECOMMUNICATION DEVICES

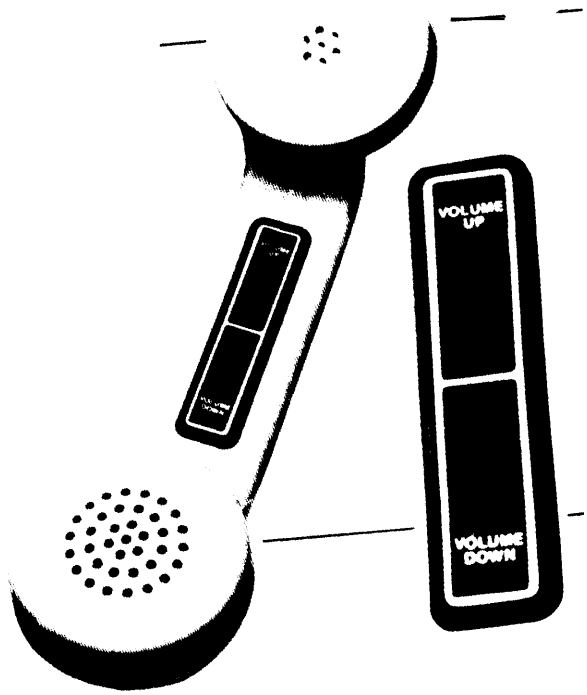
One of the most handicapping aspects of hearing loss for hearing impaired people of all ages is the inability to use the telephone. For the elderly, particularly those who live alone, the telephone is a link to the outside world and inability to use it can compromise safety, interfere with independent functioning, and deprive the individual of social interaction with family and friends. Anecdotal evidence indicates that when family members and friends are not able to contact the elderly hearing impaired person regularly by telephone, they become increasingly anxious about his or her welfare. In some cases, this results in suggestions that live-in help or nursing home placement is needed.

Hearing over the telephone is difficult even for those elderly people who have very mild hearing loss and are able to hear well in person. This is because telephone signals are transmitted in a limited frequency range, and very low and high frequency sounds that can be important for understanding speech are omitted in transmission. Line noises and other sound distortions also interfere with the quality of sound transmission. In the future, as the need grows to transmit more conversations over a limited number of telephone lines, this problem may become worse. Some methods for increasing line capacity involve removing parts of the speech message that are considered unimportant;[5] however, the standards for what is unimportant are based on the hearing ability of younger people with normal hearing. Research is needed to document the effect of removing parts of the speech message on the hearing ability of elderly and other hearing impaired individuals. This could be a first step toward public policy requiring transmission of telephone signals that can be heard by hearing impaired people up to a certain level of hearing loss (11).

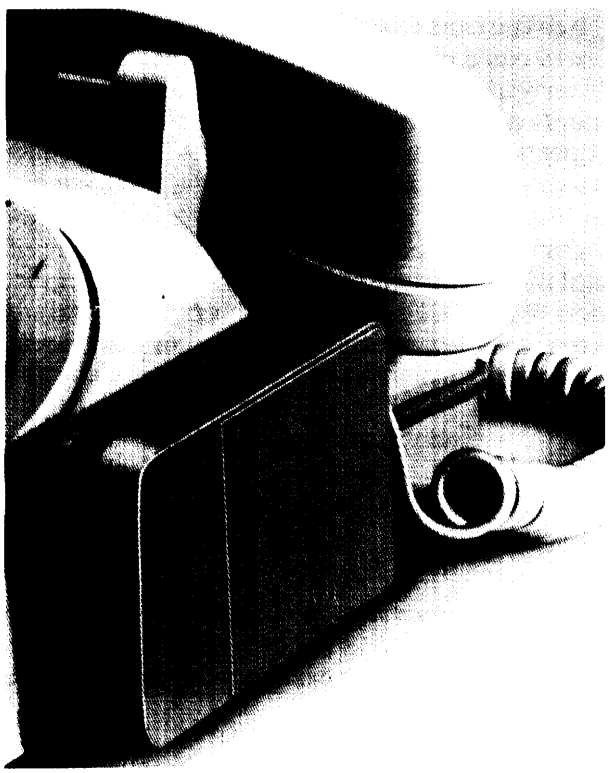
A variety of devices are available to help hearing impaired people use the telephone. The simplest of these, which is most effective for individuals with mild to moderate hearing loss, is a volume control device that can be built into the telephone handset or attached to the side of the telephone. Portable telephone amplifiers are also available, although many elderly individuals do not know about them (see figure 11). Some research indicates that telephone amplifiers are more effective for individuals with relatively constant hearing loss across all frequencies and less effective for those with marked loss at only the high frequencies (58).

[5] "These telephone engineering procedures, called "time processing, " include voice switching, time division multiplex, and pulse code modulation (11).

Figure 11.—Three Types of Telephone Amplification Devices



SOURCE VA Medical Center, Birmingham, Alabama



SOURCE Courtesy of Radio Shack, A Division of Tandy Corp

Before the breakup of AT&T, telephone handsets with amplifiers and other specialized equipment for hearing impaired people were available through the telephone company and the cost of these devices was regulated by State public utility commissions. Following the breakup of AT&T, Federal legislation and FCC regulations allowed State public utility commissions to choose whether to regulate or deregulate this equipment (84). [6] Some States no longer regulate the cost of these devices, while others regulate all devices, or only new orders. This has created confusion for hearing impaired customers because now prices of equipment vary from State to State, the availability of

[6] AT&T has created a National Special Needs Center in New Jersey and many telephone customers continue to rent or buy telephone handsets with amplifiers from AT&T.

equipment is uncertain, and it is often difficult to find repair service. Legislation to require State regulation of these devices was introduced in Congress in 1985 (S. 402) (91) and hearings probably will be scheduled in 1986.[7]

Another device to help hearing impaired people use the telephone is the telephone switch or "T switch" on a hearing aid. The telephone switch allows the hearing aid to pick up electronic leakage from compatible telephone receivers and bypass the hearing aid microphone. Unfortunately, many hearing aids do not have telephone switches.[8] In addition, anecdotal evidence indicates that some people do not know whether their hearing aids have telephone switches, or if they do, how to use them (106). Furthermore, not all telephones are compatible with these hearing aids. The Telecommunications for the Disabled Act of 1982, which became law in 1983, requires that all telephones installed in '(essential places" be compatible with hearing aids by January 1, 1985. Included as essential are public pay telephones; telephones for emergency use (e.g., on bridges, in tunnels, and along highways); and telephones in hospitals, convalescent homes, homes for the aged, and other public facilities (97). S.402, as proposed by Senator Pressler, would require that all new telephones be compatible with hearing aids.

Other telecommunication devices are available or being developed for people with severe hearing impairments. Some devices are used primarily by younger people with severe hearing impairments and may be inappropriate for many elderly persons. Telecommunication devices for the deaf (TDDs) were first developed in 1965. These devices allow users to type a message that is converted to tones and carried over a phone line, At the other end of the line, another TDD converts the message back to typewritten copy. In the past 10 years, small, portable TDDs have become available and many deaf individuals have these devices at home, Public agencies, such as fire departments, police departments, and hospitals, are being equipped with TDDs. Some communities have TDD switchboards to relay communication from people who rely on these devices to people and institutions that do not have the required equipment (10).[9]

other devices are in the development stage, including Teletex and ***Viewdata.*** These are information retrieval systems that transmit text and simple graphics to a television receiver. Viewdata has a message service so subscribers can communicate with one another. Viewdata, if and when extensively accepted throughout the country, will provide electronic mailbox capability to both deaf and hearing people (35).

Picturephone and ***Vistaphone*** are devices designed to transmit a visual image of the speaker over an ordinary telephone line, thus allowing some hearing impaired individuals to communicate by speechreading or sign language. Commercial production of these devices was expected to increase use and reduce cost, but neither has caught on and there has been no support for production (35).

No data exist to show how many elderly people use or could use these telecommunication devices. Elderly individuals who have had hearing impairments since childhood or early adulthood can be expected to continue using the devices they have used throughout life. For those who become hearing impaired in old age, however, use of these devices requires both the hearing impaired person and those who communicate with him to acquire new skills. TDDs and Viewdata require users to know how to type and have the necessary equipment. The hearing impaired person must be able to see well enough to read typed messages. Picturephone and Vistaphone are only helpful to those who communicate by speechreading or sign language. Since few elderly people use these methods of communication, the usefulness of these devices is limited for them.

Computerized speech recognition systems are being developed that could greatly simplify telecommunications for hearing impaired people.

7 A. Gilroy, "Telecommunications Specialized Customer Premises Equipment for the Disabled Federal Actions Affecting Its Provision," Congressional Research Service report, Mar. 22, 1985, provides more information on the current status Federal regulations in this area,

Telephone switches work best in over-the-ear and on-the-body hearing aids. It is more difficult to incorporate a telephone switch in an in-the-ear aid (97).

"Selected Telecommunications Devices for Hearing-Impaired Persons, " OTA background paper, 1982, *reviews the* history of **TDDs**, current problems in accessibility, and legislation affecting use (1 14)

These systems convert spoken words into printed output that could be displayed on a screen attached to the telephone. Since messages do not have to be typed, this system could allow much faster communication between hearing impaired individuals and between hearing and nonhearing persons.

The speech recognition systems available now have major limitations. They recognize only a few words and sometimes confuse words. Most are speaker dependent, which means that the system must be adapted to the idiosyncrasies of the speech of a particular individual. Some very expensive systems (up to $35,000) offer vocabularies of 500 words, good background noise tolerance, and ability to respond to speech variations (57).

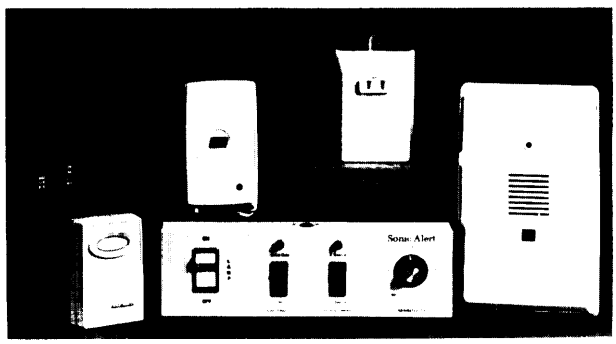
Most research on speech recognition systems is not being conducted for the benefit of hearing impaired people. It is being pursued primarily to encourage the broader use of computers by all people. However, the results of this work are likely to benefit hearing impaired people. As research continues and prices fall, these systems could provide an easier way for individuals without a hearing problem to communicate by telephone with the hearing impaired.

Closed caption television is a technology that is increasingly available to deaf and hard-of-hearing people. Captions transmitted with the television signal appear on the screen when decoded with a special device. These captions can be difficult for some elderly people to see if they also have visual impairments, but they can make television news and entertainment available to many hearing impaired elderly people. As of November 1985, 94 hours of closed caption programming were available each week. ABC provides closed captions for all its prime time programming, and NBC, CBS, and PBS each provide some closed captioned programs (79). However, the cost of a decoder ($200 to $500) prevents some elderly people from using closed caption television (10).

SIGNALING AND ALARM DEVICES

Signaling and alarm devices that convert sound to visual or tactile signals are important for the safety and independence of hearing impaired persons. Flashing lights or vibrating devices can substitute for the sounds of a fire alarm, smoke alarm, telephone, doorbell, or alarm clock (see figure 12). The Rehabilitation Comprehensive Services and Developmental Disabilities Amendments of 1978 requires adaptation of warning systems in public facilities, housing units, and health care facilities serving older people. Federal regulations set forth standards for audible and visual alarm systems in these facilities (10).

Figure 12.—Sonic Alert Signaling System, Including a Paging Device and Door Bell Signaler



SOURCE: VA Medical Center, Birmingham, Alabama

Tactile Paging Devices use radio signals to generate vibrations in a portable receiver carried by the hearing impaired individual. The person feels the vibrations and can respond to the signal. The devices can be used to contact the individual within a one-quarter mile radius of the transmitter.

These devices can be used alone or combined with a hearing aid or other assistive listening devices and telecommunication devices. A combination of devices can compensate effectively for most hearing impairment in elderly people. But these devices cannot be useful to hearing impaired elderly people unless they know such options exist. While information generally is available in the deaf community, elderly people are seldom part of this group. Since elderly people seldom receive comprehensive aural rehabilitation services, they do not learn about devices from hearing specialists

Public information about available devices and treatment options almost always focuses on "new" and dramatic approaches. For example, cochlear implants are now receiving considerable coverage although very few patients have received them. The emphasis on revolutionary breakthroughs in medical and surgical treatment distracts attention from the far less dramatic rehabilitative procedures and devices that could benefit the majority of hearing impaired elderly people (10).

Advertising by hearing aid manufacturers and distributors has been an important source of public information about hearing loss and hearing aids. While it undoubtedly contributes to public awareness and greater acceptance of hearing aids, advertising is selective and does not give equal weight to all treatment options (10). Chapter 4 discusses some alternate methods for increasing people's awareness of the many devices available.

ASSISTIVE DEVICE DEVELOPMENT

In the United States today, assistive devices for hearing impaired people are developed by:

- universities and colleges for the deaf;
- universities and colleges with rehabilitation training programs and/or speech and hearing clinics;
- Rehabilitation Engineering Centers for the Hearing Impaired, funded by the National Institute for Handicapped Research;
- the Veterans Administration,[10] Department of Defense, and other agencies of the Federal Government that offer rehabilitative services and are also engaged in the development of assistive devices;
- laboratories of commercial firms;
- independent inventors and entrepreneurs; and
- the Small Business Innovative Research Initiative of the National Institutes of Health.

With few exceptions, the major financial responsibility for research and development of hearing aids and innovative devices for hearing impaired people has been borne by commercial manufacturers. Although competition among manufacturers has brought some achievements, there have also been problems. For example, miniaturization of hearing aids has improved their marketability but it also sometimes reduces performance (54, 60). Furthermore, relatively little effort has been made to develop highly specialized devices that benefit only a small number of people because the potential market is limited (10).

Problems in developing and disseminating all kinds of assistive devices for handicapped people are discussed in a 1982 OTA report, Technology and ***Handicapped People.*** Problems that limit development and dissemination of devices for elderly people are discussed in a 1985 OTA report, Tech***nology and Aging in America.*** Many of the problems discussed in these reports affect the development of devices for hearing impaired elderly people. For example, it is often difficult to identify potential users, and small companies—frequently the source of innovative products—lack financial and staff resources to launch a marketing campaign to reach these people. Without an identifiable market, companies are reluctant to invest in research, development, and manufacture of new devices. Lack of third-party reimbursement for devices and erratic funding guidelines by public programs that pay for these devices also limit the market.

In some industrial countries, such as Sweden, the development of assistive devices is considered a government responsibility. Public funding is provided not only to develop and manufacture devices, but also for distribution and repair. In the United States, where distribution of assistive devices has been left primarily to the private sector, lack of an identifiable market discourages development of these devices (10).

[10]The VA program of medical device development and testing is the topic of a 1985 OTA report, ***Medical Devices and the Veterans Administration.*** This report discusses VA policies for research and device development for all kinds of medical conditions, including hearing impairment.

ENVIRONMENTAL DESIGN

Building design characteristics affect the behavior of sound and the relative ease or difficulty of hearing. For example, hard-surfaced walls and floors reflect sound, creating reverberations that interfere with hearing, while sound absorbent wall-covering materials decrease reverberations (66). Attention to the acoustic characteristics of buildings could decrease the impact of hearing impairment for people of all ages.

Background noise is a major impediment for hearing impaired individuals, regardless of whether they use hearing aids. Proper planning and building design can help limit unnecessary background noise. For example, in a nursing home or congregate housing facility the dining room should not be located between a noisy kitchen and a noisy laundry room or mealtime conversation will be difficult for hearing impaired residents. Daily events should be scheduled to account for the problem of background noise. Thus, vacuuming and other noisy activities should not be scheduled when residents are involved in a discussion group.

Room arrangement and lighting can also affect hearing. In a large room where several conversations may occur at once, space dividers that absorb sound can create a sense of privacy and decrease ambient noise levels that interfere with hearing (52). Similarly, good lighting and an unobstructed view of a speaker can facilitate use of speechreading techniques (73). While much is known about design characteristics that affect hearing, this knowledge has not been widely applied. Relatively inexpensive measures that reduce reverberations and background noise in buildings used by elderly people could benefit many people with hearing loss.

AURAL REHABILITATION

Few hearing impaired elderly people receive aural rehabilitation services. Yet these services can bean important part of treatment. Some aural rehabilitation services, such as auditory training and speechreading, are primarily provided by audiologists, if at all. other services, such as hearing aid orientation, can be provided by both audiologists and hearing aid dealers.

S@ language is taught to many younger persons with severe hearing impairments, but it is not widely used by the elderly for several reasons. First, it is difficult for elderly people who develop hearing loss late in life to learn a completely new language. In contrast, many younger people with severe hearing impairments have used sign language since childhood,[11] Young people with severe hearing impairments often attend school and interact with other severely hearing impaired people who use sign language. Thus, they develop a network of friends and associates who communicate by sign language. In contrast, the friends and associates of elderly people who become hearing impaired late in life seldom know sign language. Finally, hearing impaired elderly people usually retain some residual hearing and other methods to maximize residual hearing can be more effective and more acceptable than sign language (136).

Hearing Aid Orientation

Hearing aid orientation can help people overcome problems that interfere with the successful use of the aid. The user needs instruction in the care and maintenance of the aid and earmold, an opportunity to practice inserting the earmold and batteries and changing volume controls, and advice and encouragement about gradually increasing the use of the hearing aid in a variety of listening situations (10).

Unrealistic expectations about the ability of a hearing aid to restore normal hearing can interfere with adjustment to the aid for some people.

[11] Hearing specialists who treat young persons with severe hearing impairment disagree about whether sign language or an alternative procedure for understanding normal speech, such as speechreading and Cued Speech, is the best method of communication (37). This controversy applies primarily to young people and is not discussed in this report,

Hearing aid orientation should begin before the aid is purchased and provide information about problems that can be expected and the need for training. It should also continue after the aid is purchased. All users should return to the hearing aid dealer or audiologist for a followup check on the functioning of the aid and the individual's adjustment to it.[12]

Auditory Training

Intonational patterns created by variation in the pitch, intensity, and duration of sound give clues about the content and meaning of speech. Auditory training teaches the individual to use these clues to supplement his residual hearing. The person learns to recognize and differentiate sounds by practicing with live or recorded sounds (136). Auditory training now is used almost exclusively with hearing impaired children. But the elderly, who usually have some residual hearing, can also benefit and some auditory training programs include elderly people.

Speechreading

Speechreading is the use of visual cues to facilitate the understanding of speech. The hearing impaired person is taught to recognize lip, facial, throat, and body positions and movements involved in speech production (26, 96). Few elderly individuals are taught speechreading techniques, although these techniques can be particularly effective for people who have only partial hearing loss, including those who use a hearing aid.

Negative attitudes about the rehabilitation potential of elderly people among elderly individuals themselves, their families, and health and social service professionals contribute to the failure to offer training in speechreading. It is often assumed that most elderly people are not willing or able to learn speechreading. Clearly this assumption should not go unchallenged when training has not been offered to many of those who might benefit from it.

Cued Speech is a system of communication that supplements speechreading and is being used with elderly people in a few places in the United States. Developed by R. Orin Cornett, Cued Speech involves the use of eight hand shapes that clarify consonant sounds and four hand positions that clarify vowel sounds. For example, the words "mit," "bit)" and "pit" are virtually indistinguishable with only speechreading techniques. Cued Speech uses a hand signal to designate which consonant is being spoken (136). Cued Speech differs from sign language in that it clarifies spoken language rather than replacing it with manual communication (36).

To use Cued Speech, the hearing impaired individual and others who want to communicate with him must learn the hand signals and positions. This takes up to 20 hours for most adults, plus extensive practice. Learning requires motivation and Cued Speech trainers have noted that some family members are reluctant to learn this new communication technique, While very few elderly people have been taught Cued Speech thus far, those who do master it report great satisfaction with their renewed ability to communicate clearly using normal spoken language (136).

Microelectronic aids to speech comprehension such as visual and tactile devices may soon be available. For example, the Upton eyeglass speech reader projects voice-spectrum information onto the wearer's eyeglasses to augment speechreading. Although the display of speech-sound categories are far from error free, some information of modest consistency is better than no information at all. Some design improvements are necessary before the Upton system is ready to be field tested (88).

An automatic cuer has been developed by R. Orin Cornett and Robert Beadles as an aid to Cued Speech. This device, the "Autocuer," uses a microprocessor to classify speech into cue groups and activate 56 tiny light-emitting diodes on the user's eyeglasses (39) (see figure 13). A l-year trial of the Autocuer using children and adults was scheduled to begin in 1985 (99).

Vibrating devices that give cues to facilitate speechreading are also being developed. One example is the "Teletactor belt, " which is worn around the abdomen and produces vibrations that are felt as a tickling sensation by the user. Different sounds cause distinctive patterns of vibrations that the individual must learn to recognize (15).

[12]Some dealers and audiologists include the cost of a followup check in their initial price, while others charge extra for it (104).

Figure 13.—Lip Reading Glasses

As Illustrated in these photographs, different sounds are difficult to distinguish using only visual cues. The "Autocuer" is designed to help speech readers distinguish sounds that appear similar. A microphone on the glasses frame picks up the voice as much as 12 feet away and transmits it to a microprocessor that analyzes the sound and relays signals back to light-emitting diodes on the glasses lens The diodes produce an Image that represents the sound. The series above shows the images that represent the sentence He can go.

SOURCE Research Triangle Institute, RTI Park, North Carolina.

The inventor of this device, Frank Saunders, has received a Small Business Innovative Research Initiative award from the National Institutes of Health to develop it; it is being tested for efficacy in middle aged and elderly people (59).

Some hearing researchers believe that tactile stimulators will be most useful for people with some residual hearing who use the sensations to enhance speechreading (60). Others believe that people who have lost their hearing after learning to speak will probably never be able to learn to use the vibratory cues effectively and that the devices will be most useful to the prelingually deaf (25).

These electronic speechreading aids are in the development stage. Furthermore, each will require users to undergo substantial training. when they become available, their advantage over current speechreading techniques will be that they provide cues to differentiate sounds that are visually identical. Their advantage over Cued Speech will be that the hearing impaired individual will be able to communicate with anyone in any setting, with - out depending on the speaker's ability to cue.

Counseling

Counseling can help hearing impaired people overcome negative attitudes that interfere with

rehabilitation and develop strategies to manage listening situations in ways that lessen their disability (26). Problems that interfere with the rehabilitation of hearing impaired elderly people include: 1) physical conditions such as poor vision, arthritis, limited manual dexterity, and limited mobility; 2) lack of motivation and a sense of hopelessness; and 3) cost factors. Counseling can be effective in addressing each of these problems.

Physical impairments that are common among elderly people can interfere with aural rehabilitation, For example, the elderly person with reduced visual acuity may be unable to see well enough to use speechreading techniques. Individuals with arthritis may be unable to insert a hearing aid earmold properly due to reduced mobility of the shoulder or manual dexterity (10). Similarly, those with diabetes or other conditions that decrease sensitivity in their fingers may have trouble inserting the earmold and adjusting the aid. The total physical condition of the individual should be evaluated before an appropriate treatment is recommended. Counseling can help develop methods for overcoming the obstacles that hinder treatment.

Lack of motivation and a related sense of hopelessness also interfere with aural rehabilitation. Elderly people are particularly likely to believe that nothing can be done to correct their hearing problems. This belief is exacerbated by society's negative attitudes about the rehabilitation potential of elderly people, Some elderly individuals have been known to suggest that services be directed toward a younger person who could derive greater benefit. Denial of hearing impairment also limits motivation (l).

A first step in dealing with lack of motivation is to understand the meaning of the hearing loss to the individual, the situations in which he/she has difficulty hearing, and how important these situations are to him/her (96). Second, the rehabilitation process should be adapted to the needs and abilities of the individual. Healthy, active elderly people may be capable of obtaining services provided in the community. However, others with financial or health-related problems are often unable or unwilling to seek out such services and an outreach program may be needed (26). Diagnostic and rehabilitative services could be provided in the person's home, a senior center, or a nursing home. Hearing specialists also could provide in-service education to the individual's caregivers (family, day program counselors, nursing home staff, etc.). Including "significant others" in the rehabilitative process enhances the hearing impaired individual's chances of success,

Obstacles to the increased use of aural rehabilitation services, hearing aids, assistive listening devices, and telecommunication, signaling and alarm devices include problems in the service delivery system (ch. 4) and lack of funding (ch. 5). Whether an elderly person elects to seek aural rehabilitation or fitting for amplification devices often depends on financial status and the relative value he places on communication compared to other products and services he needs.