Increasing the IMPACT of assistive technology

Hearing impairments
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This IMPACT courseware module focuses on assistive technology (AT) that supports people with hearing impairments.

The module begins with an overview of hearing and hearing impairments, the different kinds of assistive technology, and how assistive technology can be made available to people who need it. This is followed by a discussion of how health and social service professionals can ensure that people with hearing impairments who have unmet assistive technology needs are put in touch with the services that they need.

By the end of the module, you will have been shown the extent and consequences of the main hearing impairments, and the wide range of assistive technology approaches currently available.

You will also have seen how people with hearing impairments acquire - or sometimes fail to acquire - the assistive technology they need, and how health and social service personnel play an important role in ensuring that needs are adequately met.

Finally, you will have been shown the key role that health and social service staff can play as ‘assistive technology intermediaries (ATIs)’ in three particular client settings where unidentified hearing impairments and/or unmet needs for assistive technology relevant to hearing impairments can be picked up:

- in the home environment (e.g. a visit from a community nurse, social worker or home help);
- in general medical consultation (e.g. visit to a family doctor);
- at the hospital (e.g. as an in-patient or at the point of discharge).

ASSISTIVE TECHNOLOGY INTERMEDIARIES (ATIs)

In the introductory module you learned the following:

An ATI is a health and social service professional who, though not being a specialist in assistive technology, nevertheless helps to ensure that clients acquire the assistive technology they need. Being an ATI means watching...
out for unmet needs that arise because of disability or because of age-related functional problems, and taking appropriate action when such needs are identified.

As an ATI you may help clients acquire assistive technology themselves, refer them to an occupational therapist or other specialist in assistive technology, or take a more direct role yourself. All health and social care professionals dealing with disabled or older clients need to include within their competencies the ability to act as an ATI.

Throughout the module, you’ll follow the case of Mary, who you have already met in the introductory module. You’ll encounter other cases that illustrate particular points as the need arises.

Mary

Mary Sommers is 91 and has been living since 1925 in her own house in a small town. She has a daughter living nearby, within 300 metres. Mary doesn’t think ‘going to a nursing home’ is a necessary or a good option: “I’m so happy living here – I wouldn’t dream of leaving. This place has many good memories of Will, my husband, who died 15 years ago. And all our children were born in this house.” Since the death of her husband, Mary has become very independent. Different kinds of assistive technology help her to cope with the problems she experiences with getting older. She is open to tools that make life easier – an attitude that she developed within the past ten years. It all started with the problems she experienced due to her hearing impairment, although at the time she didn’t recognise the cause of the problems and didn’t know the problems could be improved by assistive technology.
1 HEARING IMPAIRMENTS AND ASSISTIVE TECHNOLOGY SOLUTIONS

This section presents key facts about hearing impairment in Europe today. It gives you epidemiological data about hearing impairments, shows you how the ear works, and explains how hearing problems arise.

The section outlines the consequences of hearing impairments for people who have them and describes some clear signs that indicate a person may have a hearing impairment.

This is followed by an overview of the main types of assistive technology that can help people with hearing impairments, and an account of how people whose needs are recognised typically get access to hearing assistive technology.

The section finishes by outlining the competencies that are required of health and social service personnel to enable them to act as effective ATIs.

1.1 Impairments vary widely

The effects of a hearing loss can cause it to be an impairment and for this to become a handicap. However, as you know from the introductory module, whether an impairment becomes a handicap depends on the environment and can also be a personal and sensitive issue. A plumber, for example, may be severely hard of hearing and still not experience this as a handicap (at least in the context of the main part of their work). A pianist with only a small hearing loss, however, may find this a significant handicap.

Being hard of hearing or deaf should be considered as an impairment rather than a handicap. It becomes a handicap only if the living environment doesn’t deal with the impairment. A group of deaf-born people relying on sign language may have no significant problems resulting from their hearing impairment, provided they stay within the community and neighbourhood where their sign language is used.
Once outside that community, their impairment becomes a handicap. Compare it to not knowing a foreign language. People from another part of Europe may not understand a word of Greek (an impairment caused by education?) and it may not bother them much. But when they go to Greece for a short trip and have to make calls to book accommodation and take a local bus, then the impairment becomes a handicap.

In speaking about degrees of hearing impairment, a distinction between being deaf and hard of hearing is commonly made. Since there are no legal definitions of 'deaf' or 'deafness' these terms can have a variety of meanings.

Possible definitions are:

- “Persons with a mild to severe hearing loss are termed hearing-impaired. Those with hearing losses with an average loss above 110 dB are termed deaf” (Oticon, 1997). (However, sometimes you may find this definition with 100 dB rather than 110 dB).
- “Hard of hearing is a decrease in power of hearing, but with the ability to detect speech or other sound impressions through the auditory organ, even by hearing aid” (Chorus, Kremer, Oortwijn, & Schaapveld, 1996)
- Being unable to understand speech - even with a hearing aid under optimal conditions - without lip-reading.

Referring to everybody with hearing problems as ‘deaf’ or ‘hearing-impaired’ obscures the fact that there is great variation within the group. To appreciate the nature of this variation, some information on different hearing impairments is useful. First, however, let’s examine some of the core concepts involved in showing how hearing works: sound and ears.

### 1.2 Prevalence of hearing impairment

As mentioned in the introductory module, it has been estimated that about 4.7% of any Western population have a hearing problem. This suggests that within the European Union...
there are about 18.8 million people (roughly the population of the Netherlands and Flanders combined) with a hearing problem!

Older people are more likely than any other age group to have hearing problems. For example, figures from the US indicate that people aged 65 years and older are eight times more likely to have a hearing impairment than people in the 18-34 age bracket. (National centre for health statistics, 1994)

As the European population ages, we can expect a parallel increase in the prevalence of hearing impairments.

Hearing impaired people that you know

Think about people you know who have a hearing impairment. Answer the following questions:

- How do you know these people have a hearing impairment?
- How severe is their hearing impairment?
- What age categories do they fit into?
- How does your experience compare with the statistics provided in this section? Explain any differences.

How many people have a hearing impairment in your country?

In this module, you are being given some statistics on hearing impairment in Europe. Find statistics showing how many people in your country have hearing impairments. Try to gather statistics that also relate hearing impairments to other variables, such as age or gender.

Hearing problems arise for a variety of reasons. Only 4.4% report hearing loss at birth, 33.7% report hearing loss due to some sort of noise, 28% due to ageing, while 17.1% report that the loss is due to infection or injury.

Hearing loss can be slow and insidious in developing, as shown in the case of hearing loss due to the natural ageing process. It can also be chronic, for example due to continuous ear infections, or can arise in an acute fashion, for example due to exposure to a loud brief noise.

In many cases, hearing loss is gradual and progressive, taking a number of years before effects become apparent. What the hearing-impaired person is aware of is not the hearing loss itself, but the fact that people seem to talk less clearly than they once did. Or that the world is apparently much noisier than it used to be. There is an initial tendency to project the difficulty onto external circumstances: “Why are you always shouting at me - I'm not deaf!”
Review activity

What is the message of this section? Choose the best answer:

- The incidence of hearing impairments is increasing in Europe.
- Hearing impairments can arise for many different reasons.
- Hearing impairments are widespread and are multiplying as the population ages.

1.3 How hearing works and what causes impairments

Sound

Sounds differ in terms of frequency, volume and timbre. Frequency is described as low or high, or bass or treble. Loudness is referred to as quiet and loud, while timbre is talked about as being warm or cold. On a piano, you can play low (left-hand) notes and high (right-hand) notes, but you can choose to play them either quietly or loudly. A violin may play the same notes, at the same volume, as a saxophone, but have a totally different timbre.

The ear

Our ears are fascinating pieces of equipment for capturing sound waves, or vibrations, and transforming them into information that our brain can understand. To do this, the ear has three different parts:

- the external ear
- the middle ear
- the inner ear

Figure 1: The anatomy of the ear

Virtual ears

If you search on the Internet for 'anatomy' and 'ear' you will find many examples of images of ears, ear anatomy examinations etc. Two examples of examinations are:

- http://www.gen.umn.edu/faculty_staff/jensen/1132/webanatomy/wa_nervous/wa_ear_1.html
- http://www.kumc.edu/research/medicine/pharmacology/CAI/webCAI/ear.htm
Human ears can detect sounds from very low frequency (100 Hz) to very high frequency (20,000 Hz). This doesn't mean that the sounds can be detected equally well in this whole range: human ears are specialised in detecting sounds in the 500 to 8000 Hz range, which fortunately is also the main frequency range of the human voice.

**What causes hearing impairments?**

It is a misconception to think that most people with hearing problems live in a silent world. A person who is hard of hearing doesn't usually inhabit a world where the radio seems to be permanently turned down, or where everyone behaves as if they have put their fingers in their ears. Sounds are still present, but are filtered and distorted in certain frequency ranges.

What different people with hearing problems actually hear of a particular sound can vary widely. No two hearing problems are the same, and what people hear depends on the damage or injury to the ear.

![Hear a hearing loss](image)

On the multimedia CD-ROM that accompanies this material, we have tried to simulate hearing losses. Listen to some of the examples. What are your observations?

Problems in each of the three parts of the ear can result in loss of hearing.

In the *external ear* there may be wax balls, inflammation of the external canal or a little hole in the eardrum. Where any of these are the source of hearing problems, the condition is usually treatable either by medication or an operation. Also usually treatable is inflammation of the *middle ear* or loss of mobility of the ossicles.

Most people who are hard of hearing, however, have an injury of the *inner ear*. When the haircells of the cochlea are (partly) destroyed, sounds from outside are captured but not properly relayed to the brain. This kind of hearing impairment is often due to natural ageing and is not operable or treatable with medication, so other solutions must be looked for.

Other factors that may cause hearing impairments include nerve and brain damage, medication that is harmful to the ears, fracture of the base of the skull, diabetes mellitus, a stroke, AIDS, or certain hereditary factors. In addition, subjection to very loud sounds, for example loud music in a disco, or continuous use of a personal stereo, can cause damage to the inner ear.
Classifications of hearing loss

By location of hearing loss

Conductive Hearing Loss
A hearing loss is described as ‘conductive’ when it is located in the external or middle ear. As you’ve already seen, this type of loss is temporary and can be reversed through medical intervention in the form of surgery, or oral or topical medication. Most conductive hearing loss occurs in children as a result of recurrent ear infections, objects inserted into the ear, or injuries affecting the ear. In many cases conductive hearing loss benefits from a special type of hearing aid called a bone conductor hearing instrument.

Sensory Hearing Loss
Sensory hearing loss is typically permanent and occurs due to damage to the haircells in the cochlea. This kind of hearing loss can occur as a result of the natural ageing process (sometimes referred to as ‘presbycusis’). It usually affects both ears equally, gradually getting worse over time, and it unfortunately cannot be remedied medically.

Because of the large and growing number of older people in Europe and the high prevalence of hearing impairments, most attention is paid to this type of hearing loss.

Neural Hearing Loss
Neural hearing loss results from dysfunction of the auditory nervous system and is also permanent. Sensory hearing losses and neural hearing losses can also be classified under the term sensorineural hearing loss. Sensorineural hearing loss, depending on its severity, can usually be remedied by the use of hearing instruments.

Mixed Hearing Loss
Mixed hearing loss occurs when there is a combination of a conductive and a sensorineural hearing loss. Mixed loss may also benefit from a hearing instrument.

By affected ears
Hearing loss may affect one or both ears. The loss may be monaural (in one ear) or binaural (in both ears). It may also be symmetrical (similar in both ears) or asymmetrical (different in each ear).

By severity
Hearing loss is not described by percentage of loss. Instead a description of severity is used: mild, moderate, moderately severe, severe, and profound.

**By slope**
The term *slope* describes the relationship between the frequencies affected by the loss. For example, the slope may be described as gently sloping, steeply sloping, flat, or reverse (more loss in low frequencies). Hearing loss usually has a larger effect on the high frequencies. Unfortunately, this is where speech is situated.

**By frequency**
Describes the frequency range affected by the loss. For example, low, mid or high frequency hearing loss, or noise notch (around 4000 Hz).

**Hearing loss due to a natural ageing process**

Becoming hard of hearing due to natural ageing usually affects the high tones. People affected in this way may not be able to hear speech, but they may hear passing cars or whistling birds. They may be able to hear somebody speak but not be able to understand what is spoken. This is like being in a roomful of people speaking a foreign language of which you don’t understand a word.

Hearing loss in the high tones often makes it hard to distinguish consonants. For example, it may prevent someone from distinguishing 'bed' from 'pet' or 'red'.

Written language in the Roman alphabet consists of vowels (a, e, u, i, o) and consonants (all other letters). In spoken language, we talk about phonemes. To understand speech, consonants are more important than vowels. Consonants consist of high tones and usually sound soft in speech. Vowels consist of lower tones and usually sound firm.

If we omit vowels from a word we can usually still understand the word, particularly when context is taken into account. However if we hide the consonants it usually becomes harder to understand.

---

**Happy Birthday**
You receive the following birthday cards. Which is easier to understand? Why?

```
CHGRTLNS
```

```
OAUAI0
```
Vowels and consonants in language

Why is spelling words out loud not a good solution?

- Write down a few words or sentences.
- Skip the vowels and write down what is left.
- Now skip the consonants and write down the vowels of the words
- Can anybody else decode the words?

Another type of hearing difficulty occurs when a person with a hearing impairment is in a group, or in a noisy environment. People without hearing problems can distinguish between sounds that they want to hear and other noises in the background. For example when talking to one person in a group, they pay attention only to what that person says, filtering out the background sounds. Some people with hearing problems have difficulty in distinguishing between foreground and background sounds. For them, background sounds, such as the rattle of cups in a café, can be very disturbing. This has been described as the ‘cocktail party effect’, although it doesn’t have to be related to social gatherings. For example, the cocktail party effect is present in the following situation. “When I'm sitting in the garden with my daughter, I sometimes feel I’m going crazy from the noise of the birds. This is because I can't hear speech well, but I can hear very high tones very well.’ (NVVS, 1998)

Review activity

Write down the main causes of hearing impairment and discuss their characteristics.

1.4 Impacts of hearing impairments

Mary

One day, Eveline, Mary’s daughter, got a worried telephone call from a friend of Mary’s: “I unexpectedly wanted to visit Mary yesterday afternoon, but she wasn’t at home. This morning I went back and she still wasn’t at home. Do you know were she is?”

Eveline was surprised: “Mum not at home? That’s strange. I called her yesterday evening and got her on the phone! I’ll go and check on her and call you back, OK?”
Eveline goes straight to her mother, and finds Mary reading in her living room. She is shocked when her daughter is suddenly standing in front of her. She didn’t hear her knocking or entering the house.

They had a cup of tea in the garden and Eveline asked Mary if she had been away. “No, I’ve been at home all the time, mostly in the garden.” At that moment, the doorbell rang. Mary didn’t respond.

A hearing problem is an impairment that you can't see, but can have a very big impact on your quality of life. The impact is not limited to the life of the person with the hearing problem, but extends to everyone involved with him or her.

<table>
<thead>
<tr>
<th>Loss of power of hearing</th>
<th>Consequences for understanding language and speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 30 dB</td>
<td>normal to mild hearing loss</td>
</tr>
<tr>
<td></td>
<td>In general, there are no problems except in a very quiet conversation or a conversation over a great distance.</td>
</tr>
<tr>
<td>30 - 50 dB</td>
<td>mild to moderate hearing loss</td>
</tr>
<tr>
<td></td>
<td>Understanding a conversation will be no problem unless the conversation is quiet or the distance is greater than 1 metre. This can give rise to problems with conversations with more than one person.</td>
</tr>
<tr>
<td>50 - 70 dB</td>
<td>severe hearing loss</td>
</tr>
<tr>
<td></td>
<td>Only very loud conversation can be understood.</td>
</tr>
<tr>
<td>70 - 90 dB</td>
<td>severe to profound hearing loss</td>
</tr>
<tr>
<td></td>
<td>The person can understand very loud sounds from about thirty centimetres from the ear and can identify environmental sounds. They can understand vowels but not all consonants.</td>
</tr>
<tr>
<td>90 - 120 dB</td>
<td>deaf</td>
</tr>
<tr>
<td></td>
<td>The person can perhaps identify some very loud sounds but this usually is due to the vibrations of the sound.</td>
</tr>
</tbody>
</table>

**Simulation experience: mild hearing loss**

Carry out this experiment with two people:

The first person occludes the ears by using foam earplugs, available at pharmacies. This simulates a small conductive loss, which means that things will sound the same as normal, but not loud enough. Set up the situation so that communication is possible by gesture, pantomime or writing a note, but not by speaking.

The second person stays near the first person, to observe what happens.

Discuss your observations, experiences, feelings, insights and any changes in perception of people with hearing loss.
Problems in areas of daily life

In which of these areas of daily life would a hearing impairment cause problems?

Getting in and out of bed; waking up; taking a shower/bath; washing; brushing your teeth; shaving; combing your hair; putting on make-up and jewellery; caring for your nails; getting dressed; visiting the toilet; watching TV; making tea or coffee; cooking; eating; drinking; washing the dishes; cleaning; shopping; cleaning the windows; vacuuming the house; mopping the floor; making beds; washing and ironing; emptying the dustbin; taking care of flowers; playing party games; doing hobbies and sport; walking; social contacts; reading; writing; telephoning; communicating by speech; taking medicine; opening/closing doors; hearing the doorbell; looking at the clock; smoking; taking care of others.

Mary

On a Monday morning, Mary went to her dentist, who has a new assistant. This assistant periodically called, or rather shouted, a name from the dentist’s surgery to the people in the waiting room. Mary didn’t hear her name being called. People who arrived after her had already been seen by the dentist while she was still waiting. After checking, her form appeared to be still on the desk - the assistant thought she hadn’t shown up.

Hearing loss is not the only problem that might result from hearing impairments. As the inner ear regulates the sense of balance, a hearing impairment may also have an impact on this. Equally, a person with loss of hearing may suffer from tinnitus. Tinnitus or ‘head noises’ causes a person to have ringing ears or perceive other noises when there is in fact no real noise. It is fairly common to ‘hear’ such noises in the absence of external sounds. For people with severe hearing loss who do not perceive any external sounds, tinnitus may become a significant nuisance.

Tinnitus

Tinnitus is too complex to be fully discussed here, as there is more than one cause and type of tinnitus, and several treatments. Searching on the Internet will easily provide more information.
Implications of hearing impairments

Mary

Mary loves to sing, and has been singing in a choir for years now. She also goes there for the social aspect of the good company. In recent years, it has cost her more and more effort to go to the rehearsals. She doesn’t hear the hints from the conductor very well, since he often looks towards the ground while talking. The pianist often plays in the background or members chat with each other, and sometimes they start somewhere in the middle of a song, so that while everybody has already started to sing Mary is still searching for the right page. She becomes very tired from these rehearsals and decides to stop singing in the choir altogether.

Hearing is very important in our contacts with other people. It is the foundation for speech and language development. We communicate with each other by language. Usually it is the language we hear and speak that we use to communicate: to inform each other, to plan, to act, to comfort, to make jokes. People not able to hear very well and understand what the communication is about find it more difficult to get into contact with people. This can lead to isolation.

Normally, we are hardly aware of the large amount of information we get through sound: conversation and stories, telephone, radio and TV, lessons and lectures, announcement of visitors by intercom, and much more. We hear sounds, and we create them. Using sound, we can determine in which direction something is moving. We can hear through the walls, e.g. the neighbours shouting at the dog, or at the children, or the noise of their television.

You hear and know that someone is walking down the hall, that a baby is crying, that someone is at the door etc. We can hear if someone is angry or making a joke, and we can recognise people by voice. Using hearing we feel connected with the people and the world around us.

If you are hard of hearing, you miss a lot of information, and this can cause a lot of confusion. You can’t trust your own observations. For example a sound may be coming from outside, but you think it is coming from indoors. Or you think the phone is ringing, but it’s only a few cups rattling. Such things can make someone very insecure.

Gradually the social life changes

Loss of hearing can have large social consequences, but the real problems are usually only slowly detected. What the hearing-impaired person is aware of is not the hearing loss itself, but the fact that people seem to be talking less clearly than they once did, or that the world is apparently much noisier than it used to be. Some people
become resigned: “You can’t do anything about it - you just have to live with it”. But life changes gradually, in step with the loss of hearing. Contacts change, and some activities or hobbies become impossible. Sometimes hearing-impaired people become tired more quickly because they have to concentrate intensely to understand what is being said.

Some people with hearing impairment may not have too many problems in a one-to-one conversation in ideal circumstances (good lighting, articulate speech, …) but have to struggle with communication when in a group and/or in unhelpful circumstances (e.g. with friends in a busy restaurant). Consequently, hearing impairment can lead to withdrawal from social life, and on to isolation.

**Reactions from others**

Others are often impatient with hearing-impaired people. For many people, it is hard to understand that someone can hear you but doesn’t understand you. It is tedious to have to repeat what you say, and for a hearing-impaired person it is hard to ask: “What did you say?” repeatedly.

At a certain point, the hearing-impaired person says: “Forget it”, and withdraws. And the other person, who has been getting impatient, is equally inclined to think: “Forget it”. Thus communication ceases and the hearing-impaired person gradually becomes isolated.

<table>
<thead>
<tr>
<th>Mary</th>
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<tbody>
<tr>
<td>At a crowded party, Mary met her old friend Helen, whom she had not seen for years. They had a brief chat, but then became separated. After some time, Helen called over to Mary to join her and continue their conversation but Mary didn’t react. Getting the same result on the second try, Helen assumed Mary wasn’t that happy after all to see her again and left the party. Several weeks later, a mutual friend who Helen tells about being annoyed with Mary tells Helen about Mary having a hearing loss. Helen now feels guilty and supposes Mary must think her rude for leaving the party without saying goodbye. A hearing loss can cause others to think you are rude, uninterested in what they are saying or distracted. It is not dissimilar to having poor vision, when friends think you are rude because you do not return their greetings.</td>
</tr>
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</table>

**Hearing and language**
Hearing and loss of hearing are not only critical in receiving information/language from others, but also in our own speech. Through hearing, we continuously monitor what we speak and this enables us to correct our speech (e.g. speak slower if we start to stumble over our words). Loss of hearing interferes with this process. In cases of loss of hearing at an early age, before the child has acquired spoken language, the impact can be significant.

**What can we do?**

Hearing loss doesn’t have to be such a distressing experience. Most people can be helped to improve hearing and communication with hearing aids and other types of AT. More information about these solutions is provided in the next section.

Even if these technologies don’t recover the hearing loss totally, they can offer a solution for many hearing-impaired people, enabling them to continue their independent life. Unfortunately, many people wait too long before considering a hearing aid and many people (including health and social service personnel) are unaware of the variety of other technological supports available. This can have very harmful consequences, because lost contacts and activities are very difficult to re-establish. Of course, the reaction and support of the people in the environment can have a great influence in preventing loneliness, dependency and isolation, too.

---

**Mary**

Mary attended a very lively wedding, and afterwards was invited to go for a drink. As usual, the conversation soon became increasingly loud and more fragmented. After a while, her daughter-in-law noticed her beginning to stare and, joining Mary, started a conversation with her. It wasn’t long before Mary cheered up.

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**Outcomes of hearing impairments**

List the most significant outcomes of hearing impairments.

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**1.5 Assistive technology for hearing impairments: from Quasimodo to Clinton**

**Assistive technology for hearing impairments**

List some of the main assistive technology products that are relevant for people with hearing impairments. Check your list with the overview in this material.
Apart from products like wheelchairs and walking aids, hearing aids are probably among the best known of the many different AT products now available. This is no wonder, given the prevalence of hearing impairments briefly described in the introduction to this module. Additionally, until about twenty years ago most hearing aids were of the body-worn or behind-the-ear kinds, which are quite visible and noticeable.

<table>
<thead>
<tr>
<th>History of hearing aids</th>
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</thead>
<tbody>
<tr>
<td>Denmark has a museum on the history of hearing instruments. You can pay them a virtual visit at <a href="http://www.oticon.com/HeaIns/HeaInsSU.html">http://www.oticon.com/HeaIns/HeaInsSU.html</a></td>
</tr>
</tbody>
</table>

But a hearing aid is not the only technology available to people with hearing impairments and nowadays people can avail of a whole range of products and services to support, facilitate or replace hearing. New technology continuously improves these products.

The pre-history of hearing aids

A universal, simple, and always available technique to improve hearing is the cupped hand behind the ear. Though primitive, it can help reduce background noise and focus on the sounds you want to hear. As such, it is probably the earliest ‘hearing aid’ and one occasionally used by everybody.

Before the early 1800s, few other solutions were available to people with hearing impairments, apart from ‘speaking up’ or being shouted at. Similarly, in the early 19th century when Ludwig van Beethoven became hard of hearing at the age of 28, there was not much AT around to help him. Though completely deaf by the age 49, he remained active as composer.

The first hearing aids

It was only from the middle of the last century onwards that simple hearing aids started being used. From about 1850 to 1950, these were based on acoustic amplification of sound through a ‘listening horn’. Although the device itself may look archaic today, modern hearing aids still work on the same principles.
This method of amplifying the sound that normally reaches the ear can be reversed so that sound is amplified at its origin instead. A person speaking can use a device, such as a megaphone, to amplify the words. While useful for addressing groups of people (e.g. making a public speech), it is quite uncomfortable and impractical for one-to-one communication.

### Make your own listening horn

Though it is an instrument that is no longer available or used, it is fairly easy to make your own listening horn and experience the effect of using one. Simply attach a funnel, such as used in the kitchen, to about 1.5 metres of garden hose. Put the end of the garden hose to your ear and have somebody speak in the funnel.

From around 1870 onwards, people started developing hearing aids that made use of electricity. One of them was Alexander Graham Bell. While trying to perfect a hearing aid, Bell invented the telephone. Later on, he did develop a hearing aid. It had to be carried in the pocket or around the neck, and unfortunately produced poor quality sound and had a problem with battery power. It wasn’t until the time of the Second World War, with the invention of plastics, that ear-level devices replaced these body-worn hearing aids.

The first ear-level devices included eyeglass hearing aids (built into eyeglasses) and, later, the well-known behind-the-ear hearing aids. In the 1950s, the late US president’s wife Eleanor Roosevelt publicly talked about her hearing loss and the eyeglass hearing aids she used. Her public appearances made a significant contribution to public awareness on hearing aids.

### Currently available assistive technology

AT currently available for hearing-impaired people covers a wide range of products and services, extending far beyond the simple ‘hearing aid’. A range of AT products and services is available to support or replace hearing. The following discussion mentions the most significant of these, without going into too much detail or giving information about particular models.

**Amplification system for telephone, radio, hi-fi or television**

In daily life, we use a whole range of devices to produce sounds, for example the telephone, radio, hi-fi and television. For each of these, built-in or added amplification facilities exist. For instance, most modern telephones have a button or switch that allows anybody to boost the sound by 6 dB or more. This can be useful when the line is weak, when children are playing in the background, or when your hearing is not optimal. For people with hearing impairments, 6 dB is
often not enough and special telephones that amplify by 20 dB to 30 dB are needed.

**Transmission of sound from telephone, radio, hi-fi, …**
Sometimes, it is not so much amplification that is needed, but a way of bringing the source of the sound closer to the ear and reducing the interfering background noise.

<table>
<thead>
<tr>
<th>Mary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary likes watching television, but sets the sound volume very loud in order to understand what is being said. She could use a set-top box with any modern television set to enable her to use headphones (connected by cabling or by wireless infra-red) and adjust the volume level to her own needs without bothering family, friends, or neighbours.</td>
</tr>
</tbody>
</table>

To achieve this it’s possible to use headphones or direct transmission to hearing aids. Several techniques for transmission are available and include a wired connection that works well if the distance isn’t too long and the position of sound source and listener are relatively immobile; wireless using FM, which gives better quality and is more mobile; wireless using infra-red, which is cheaper but can be hampered by lighting conditions; or magnetic transmission directly to hearing aids. This greatly improves the sound quality.

Many hearing aids have a switch which can be set on M (for microphone) or T (for telecoil) or both. In the T setting, the hearing aids pick up magnetically transmitted audio content from, for example, the telephone.

**Induction loop system**
While hearing aids capture intelligible sound through their microphones, they also capture much surrounding sound that is less useful to the user. Though the latest microphone-based hearing aids have made good progress in reducing this background noise, a valuable approach is to replace the microphone by a system of capturing sound transmitted through a magnetic field. This field is created by an induction loop - basically a loop of insulated wire that is placed in the room – or by using infra-red. The sound is either taken directly from the radio, television or other medium, or indirectly through a microphone.
Some public places (e.g. cinemas, theatres, and ticket booths at railway stations) have induction loop systems installed. They indicate this by using the universal symbol for hearing impairments with a T-symbol added.

Is your city accessible?
Go to the main public buildings in your city (railway station, post office, banks etc) and note whether they have this sign for induction loop systems. If not, ask whether it’s because they have no sign, or because they have no induction loop system. Discuss how this relates to the medical and social model of disability described in the introductory module of this material.

Alarms with flashing lights or vibrations
Many devices in and around the house sound an alarm to draw attention to something happening. Examples include the doorbell, the telephone bell, the alarm clock, baby alarm, kitchen timer, watch, and smoke or fire alarms. Each of these is available in versions where the audible alarm is replaced or supported by either a flashing light or vibrations, or a combination of these. The vibrating alarm clock takes the form of a pad that you can put under your pillow, or a vibrating semaphone.

Most of these products are standard alarms or bells fitted with an extra alarm. Others have been designed specifically with deaf or hard of hearing people in mind. Prices range from about 30 Ecu to something like 150 Ecu. There is seldom reimbursement for these from social security, but often these products can be borrowed for some time from the local home care department. Even if one is likely to be needed for long-term use, it is a good idea to borrow the product first to learn more about its use and find out whether it fits the user’s needs.

Text and video telephones
If amplifying the telephone bell and sound aren’t enough to enable somebody to use the telephone, text telephones provide an alternative. These include a keyboard to allow conversations to be typed rather than spoken, and a screen to allow the parties to read what has been typed.

People who have been profoundly deaf from early childhood have problems with written language and can benefit from telecommunication using their preferred - and often first - language: sign language. Video telephones are now making this possible. Although cost is still relatively high, video telephony will definitely be an important solution for many deaf people in the near future. Unfortunately, the currently available bandwidth does not allow the transmission of pictures with sufficient resolution or a rate of change.
to allow easy sign language. To interpret signing you need to see all the sender’s movements, even the smallest. In some countries, telephone access across the TV cable network is offered and this creates new opportunities for video telephony.

For communication of this kind to work, both users need to have access to text telephones or video telephones. And these need to be compatible with each other, which is not always the case. More than half of the countries of Europe now have a text telephone relay service where specially trained staff translate between text and speech. In Sweden, a national video telephone relay service is already in place.

Although developments such as e-mail and display phones offer many new opportunities for deaf and hard-of-hearing people they don’t yet provide the instantaneous and flexible calling and answering capabilities that text telephones provide.

**Fax**

Though a standard tool in office environments and increasingly found in private homes, fax can be an important communication tool for the hard of hearing. While those relying on sign language tend to prefer the video telephone (as text based language is not their native communication language), access to fax is very useful for those who acquired a severe hearing loss at a later age.

**Captioning**

For many deaf and hard-of-hearing people, it is difficult to follow TV programmes. Captioning (or subtitling) of programmes provides a solution for many, but unfortunately, the number of programmes actually being captioned is still limited in many countries. In addition, most video recorders ‘forget’ to record the captioning when recording programmes that have the European (teletext-based) method of caption delivery.

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### Telecommunication and hearing impairments

Although the telephone has been around for more than a century, it can claim to have become more important with the introduction of mobile phones. Explore the different issues of this development for hearing-impaired people.

### Advantages and disadvantages of assistive technology for hearing impairments

Mention advantages and disadvantages of different products that amplify or transmit the sound from a given source to the listener.
Hearing ear dogs

In a similar way to the use of guide dogs by visually impaired people, hearing-impaired people can make use of hearing ear dogs. ‘Many deaf people have feelings of isolation and loneliness as well as social alienation; not only are they cut off from the sounds of conversation but also from the signals of danger, emergency and alarm. By responding to everyday sounds within the home, the dogs communicate by touch and then lead to the sound source, thus providing a deaf person with greater independence and confidence, more awareness of their environment as well as the blessing of companionship and feeling of security.’ (Hearing dog web site)

More information on hearing dogs is available at

- [http://www.hearing-dogs.co.uk/](http://www.hearing-dogs.co.uk/)

Cochlear implants

Most hearing aids are based on the (filtered) amplification of sound. While this helps many people with hearing impairments, it is of little use to, or insufficient for deaf people. Some of these people can benefit from cochlear implants, which are small electronic devices that do not amplify sound but ‘translate’ it into stimulation of the nerves in the inner ear. A cochlear implant is expensive as it involves not only the device itself, but also a surgical operation and training in using it.

Tinnitus masker

As tinnitus is mostly perceived in the absence of external sounds, one way of reducing it is to create background or ‘white’ noise, which will reduce the effects. Tinnitus maskers are designed to produce such background sound, e.g. music or nature sounds. Playing ordinary music on a radio or CD player may be as helpful.

But treatment of tinnitus is far more complex than creating background sounds: it often involves medical treatment when there are pathological causes. The psychological aspect is also important.
Hearing aids

Obviously, this range of hearing-related assistive technology needs to be expanded to include the traditional hearing aid. While basically these all make use of the same approach (amplifying sound to support residual hearing), they come in many different forms. Two basic characteristics are useful to differentiate the major types of hearing aids. These are the size (sometimes referred to as ‘style’) and the technology used.

**Size of hearing aids**

Though older versions such as eyeglass and body-worn aids are still available, most hearing aids are now worn at ear level. With technological advancement, there has been a gradual development from the behind-the-ear hearing aid to in-the-ear aids and to completely-in-the-canal aids.

Clearly, from an aesthetic point of view, the smaller the hearing aid the better. However, smaller size also implies smaller controls to handle and smaller batteries, resulting in lower amplification. Additionally, because of their small size, there is a higher risk of feedback between speaker and microphone. This may cause the hearing aid to beep. Consequently, the smallest hearing aid is not always the best choice.

<table>
<thead>
<tr>
<th>Common abbreviation</th>
<th>Behind the ear</th>
<th>In the ear</th>
<th>In the canal</th>
<th>Completely in the canal</th>
</tr>
</thead>
</table>

![Hearing aid images]
Technology of hearing aids
It’s possible to differentiate between traditional, advanced and digital hearing aid technologies.

The traditional technology is based on circuits that perform a linear amplification of incoming sounds, so hearing aids based on this technology add the same amount of ‘loudness’ to all frequencies. This means that low bass frequencies are amplified to the same extent as high frequencies. This technology is similar to the volume control on a hi-fi, which increases or decreases the volume in a similar linear way.

The advanced technology enables a more sophisticated approach by working with filtered amplification. This means that different ranges of frequencies can be amplified to differing extents, so they can be better fitted to the needs of specific users. Somebody with a hearing loss in specific ranges of frequencies (mostly the higher frequencies) can use a hearing aid with this filtered amplification and have sounds in the higher frequencies strengthened without the low bass sounds being made louder too. These hearing aids deliver a more natural sound, compared with traditional technology. Equally, somebody with a reduced tolerance to low sounds can have these reduced by this filtered amplification technology. This technology is similar to the bass and treble controls on your typical hi-fi (or the ‘equaliser’ controls on more sophisticated hi-fis), which increases sounds only in a specific frequency range.

The newest technology used in hearing aids is digital: the hearing aid contains a computer chip that can be programmed for even better accommodation of a given patient’s hearing needs, allowing greater flexibility and more accurate fine-tuning. If the user’s hearing changes over time, these hearing aids can be reprogrammed to reflect these changes.

Finally, there is also a hearing aid that is not based on amplifying sound but on replacing it with vibrations: a bone conductor hearing instrument, also called a Bone Anchored Hearing Aid (BAHA). It involves having a small receptacle screwed into the skull (usually just behind and above the ear). First a small hole is drilled into the skull and equipped with a receptacle in the form of a Parker-like screw about 8mm long. One end of the receptacle is accessible to the outside. A vibrator is inserted, kept in place using a rubber ring. If something bumps against the end of the vibrator it will come out of the receptacle instead of damaging the skin or bone. The vibrator is connected to the usual microphone, amplifier and sound processor (all externally, somewhat like the cochlear implant).
Henry

Uncle Henry has had a hearing impairment for many decades now. Since he was a teenager, he has worn a hearing aid, starting with the traditional technology of behind-the-ear aids and, for several years now, programmable in-the-ear aids. However, going out with his wife and enjoying a cup of coffee or pint of beer in a pub was not one of his life’s pleasures, because the noise in almost any public place (train stations, pubs, cafés) was amplified to an unbearable level by his hearing aid. Naturally, he could diminish the sound level, but then he didn’t hear anything anymore.

Since last year Uncle Henry has been using a new hearing aid, based on the latest digital technology. The filtering effects are so strong that he can now easily go into public places again, and he is a happy man these days.

Given the several options regarding size and technology, hearing aids come in many varieties. Though the tendency is to prefer the smallest size and the latest technology, this is by no means always the best option, as has already been stated. Each hearing aid should be selected to fit the user’s needs. Consequently, the process of selecting the optimal hearing aid depends on the details of the hearing impairment, and the preferences of the user, in addition to the available options. An audiologist or otolaryngologist (ear, nose and throat specialist) should be consulted to determine the most appropriate hearing aid for a specific person and situation.

### Smaller hearing aids

Now that smaller hearing aids are available, is there still a need for the bigger models? Give reasons for your answer.

### Hearing aids

Describe the main characteristics of hearing aids and their benefits.

### Getting details on products

Make a list of the assistive technology for hearing-impaired you’ll find on these Internet pages and compare them with the assistive technology mentioned in this section. What are the differences?

A number of producers and retailers operate in the ‘market’ for assistive technology for people with hearing impairments. Some of the producers provide information on the World Wide Web, e.g.:

Beyond technology

The range of available technology to support or replace hearing should not make people forget the less tangible but no less important support available. While hard-of-hearing people can often make use of hearing aids, these have limited functionality for deaf people. Lip-reading and sign language then become critical ingredients of communication.

Attitude of speakers

To facilitate conversations with hard-of-hearing or deaf people special attention should be given to these aspects of communication:

- You need to talk in a relaxed manner and articulate well;
- You need to ensure you aren’t talking with your mouth covered, e.g. by your hand, a handkerchief, a cigarette, pipe or large moustache;
- You need to make sure your mouth is clearly visible: don’t talk with your back to somebody, try to provide good light (both direct and indirect);
- Don’t shout or talk loudly, as this distorts sounds;
- Try to support your speech with natural arm and body movements;
- Reduce background noise, e.g. by turning down the TV or closing the window;
- Try not to switch topics of conversation too suddenly, especially when talking to somebody with severe hearing loss.

The ‘human’ support to hearing

Spend a day doing the things you would normally do, but pay special attention to the way people handle the various aspects of communication while talking to you. You will notice, for example, that some people unconsciously have their hand in front of their mouth while talking, talk without facing you, or talk at their ‘speed of talking’ rather than the ‘speed of listening’ of the other people involved in the communication.

Make a report of your observations. Address some of the people and explain to them how their behaviour makes their communication hard to understand for all, but specifically for those with hearing impairments.

Acoustics and physical environment

The way sound travels through the air and the quality of our hearing are greatly influenced by the surroundings. Attention to a few elements can help to make communication far easier, for example,
providing good overhead lighting and soft furnishing, avoiding
distractions and interruptions, or limiting background noise as much
as possible - maybe closing the window, or turning off the radio.

**Lip-reading and speech-reading**
When we listen to somebody, we all tend to look at that person to
capture the non-verbal aspects of communication. This is more
pronounced in lip-reading (or speech-reading as more than just the
lips are ’read’) - people elaborate their skills to lip/speech-read.

Relying totally on lip-reading for communication with others is very
difficult and requires considerable expertise on the part of the listener
and a positive attitude on the part of the speaker. However, lip-
reading is often used as a technique to provide at least a limited form
of ‘hearing’. The combination of getting information from the
movement of lips and mouth, especially where there is some residual
hearing, enables the listener to communicate. With some skill and
expertise as well as a good knowledge of the language, a lip-reader
can recognise up to 40% of the phonemes.
Bear in mind that speech-reading can be important in other
communication contexts, whether one is hearing impaired or not.

**Sign language**
For profoundly deaf people, amplifying sounds through a hearing aid
is of little use. Consequently, spoken language cannot be heard and
an alternative is needed. This may take the form of written text (e.g.
by text telephone or passing notes on paper), but it can also be
through sign language. For people who acquired their hearing loss at
a young age, sign language is likely to be their first language.

Unlike lip reading, sign language is not a skill that supports
understanding of spoken language, but a proper language in itself. It
is as natural, complex and rich as any other natural language. And
there is national variety. A North-American sign language user will
not easily understand a Dutch sign language user.

As hearing loss is related to age, only a relatively small proportion
(about 10% in Europe, with slight variations across countries) of
those with severe hearing impairments rely on sign language.
However, the ability to communicate in their natural language is very
important for people who rely on sign language and all health and
social service personnel should try to learn at least some basic signs.
The video telephone is likely to be a very important technology for
persons using sign language. The text telephone or fax are not
adequate instruments for them as text-based language is not their first
language.
Sign language
Search for information on sign language and learn some basic words, similar to ‘a survival language kit for the foreigner travelling to Greece’.

Total communication
This refers to the combination of every possible means to communicate. It is usually a combination of speech supported with signs, gestures, facial expressions, and other elements of communication.

‘Human technology’ for hearing impairments
Describe the main elements of daily communication that can easily be changed to accommodate the needs of hearing-impaired people.

1.6 Ensuring people with hearing impairment get the assistive technology they need

This section looks first at the question of whether people with hearing impairment are actually acquiring the assistive technologies that they need and at how AT for hearing impairments tends to be made available in Europe. It offers a quick reminder of how you, as an ATI, can make a positive contribution in this area. Later, you’ll look in more detail at the specifics of the ATI role in particular client settings.

Are deaf and hard-of-hearing people getting the assistive technology that they need?

It will be clear from the course so far that a significant proportion of the population are likely to experience hearing problems at some stage in their lives. It should also be clear that developments in AT can alleviate many of the difficulties that such hearing problems can cause. It is disappointing to have to note that many people who could benefit from these technologies are not doing so. This means that many people are suffering unnecessarily and, in some cases, are at risk of serious consequences ranging from social withdrawal and isolation to potentially fatal consequences arising from an inability to perceive emergency situations.

There are a number of factors that contribute to this unsatisfactory situation:

- Failure to appreciate the problem and the potential solutions that are available;
- Limitations of the publicly-provided AT service delivery systems;
- Occasional reluctance to avail of useful technologies even when the need is recognised.
**Problem not recognised**
As noted earlier, problems associated with hearing loss are often slow and insidious in their development. This means that they can go unrecognised for a long time, both by the people with the problem and by their families, and by the various health and social service professionals themselves. Later modules will show how health and social service personnel can identify unmet needs in various client settings, such as general medical consultation, hospital and the home environment.

**Poor quality assistive technology service delivery systems**
Even where unmet needs have been recognised, many people with hearing problems still experience difficulties in actually getting access to the technologies that they need. In the case of assistive technologies supporting hearing problems, there are a number of features of the service delivery system that can be pointed to.

One important source of difficulty arises from fragmentation of services and, in particular, the separation often found between hearing aid services and services that provide other forms of assistive technology. Usually, once a hearing loss problem has been identified, there will be contact with some publicly provided service covering hearing aids or, alternatively, clear referral paths to private services in the area.

The situation is often much less clear for other assistive technologies. On the one hand, the specialists dealing with hearing aids typically do not deal with other assistive technologies. They may not be knowledgeable about the other technologies (for example text telephones, adapted household bells and other alarms, or headphones and individual amplification for TV or radio). Or, for various reasons, they may not make referrals to those who do provide such services. On the other hand, services providing these other technologies are often less well developed and may, themselves, be fragmented into a number of areas.

For example, the provision of text telephones to deaf and hard-of-hearing people varies widely in extent across the European countries. Where services are provided, it is sometimes by the telecommunications companies and sometimes by public AT services within the health and social services. Likewise, for the other technologies, the range of items provided, and the conditions under which they are provided, varies widely across countries. Later modules oriented towards particular client settings show what different professionals under different circumstances can do to help their clients get the assistive technology they need.
Reluctance to avail of useful technologies
In some cases, clients may know they have a problem but may be reluctant to seek solutions from assistive technology because of a perceived stigma or other negative connotations. In such cases, it is important to make clients aware of the latest developments, such as the increasing miniaturisation of hearing aids.

Non-take-up of hearing aids
Describe the main reasons for non-take-up of hearing aids and strategies to overcome this non-take-up.

Assistive technology services for people with hearing impairments
Public service delivery systems for assistive technology for hearing impairments differ considerably between countries throughout Europe. Some countries, especially the Nordic ones, have comprehensive services that make all of the main types of equipment and devices widely available, at little or no cost to the user. Others have a fairly wide range of equipment on offer, but apply various eligibility criteria, such as degree of disability, circumstances of use (work, education, home etc.) and/or financial means of the client.

European service delivery systems vary in many different ways. There are variations in the extent of integration (e.g. whether there is ‘one-stop-shop’ access). There are also variations in:

- the extent of public sector, voluntary sector and private sector involvement
- the range and types of assistive technologies that are available
- the levels of financial support provided to help with the costs of equipment
- the branches of the health and social services, and the particular professional groupings, that are involved

How do people get assistive technology for hearing impairments in your country?
Do some research on your own country to see how services are organised.

Things to keep in mind:
- What organisations provide equipment: the state, centres providing equipment for disabled people (e.g. disabled living centres), organisations for and of deaf and hearing-impaired people, other charitable organisations?
• What assessment procedures are used to identify the equipment needed?
• Is there any state funding to provide this equipment, and what are the requirements of this funding e.g. is it means tested and is only a limited range of items provided?

The effectiveness of any service delivery system depends on the initial pick-up of potential problems and the making of an appropriate referral. This pick-up can be by the person with a hearing impairment themselves, by a carer, or by a professional. It is at this stage, where needs are first picked up and appropriate actions initiated, that the ATI role comes into play. If this does not happen then no assistive technology service delivery system will be effective, no matter how well developed and provided-for.

The role that health and social service staff can play as ATIs

Many people slip through the net and their needs aren’t picked up in the first place. This means that they do not get onto the appropriate referral routes and so do not acquire the assistive technologies that could help them.

It is here that all health and social service professionals have a role to play as ATIs. The schema below shows the types of action appropriate to an ATI that were identified and discussed in the introductory module.

The role of the ATI is quite straightforward – you need to be alert to hearing impairments and to unmet needs for assistive technology solutions. Once these are identified, you need to take appropriate action to help your clients acquire what they need.

You have three basic options:
• give advice to your clients on how to deal with the situation themselves
• refer on to someone with more expertise and resources
• deal with the problem yourself.

And, of course, in all cases you need to ensure appropriate follow-up.

Which option you choose depends very much on the situation, your familiarity with hearing impairments, the professional boundaries and competencies that apply in your situation, the assistive technology solutions available, and the characteristics of the prevailing assistive technology service delivery system in your area.

Be aware that these options aren’t necessarily mutually exclusive; it may sometimes be appropriate to advise clients to purchase some simple technology, while at the same time referring them to a specialist for thorough assessment.

In addition, whether or not you refer your client/patient to another professional for further treatment and advice, it is critical that you remain involved, to ensure that the problem gets addressed, and that you follow up once assistive technology has been acquired.

<table>
<thead>
<tr>
<th>Context activity: What to do about Mary’s problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revise Mary’s case as presented in this module. What could someone do to help Mary? Choose the best option.</td>
</tr>
<tr>
<td>1. Do nothing, it is Mary’s decision.</td>
</tr>
<tr>
<td>2. Support her finding some assistive technology that can help her with her problem.</td>
</tr>
<tr>
<td>3. Help her to accept her impairment and convince her to go to the GP.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summary activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discuss how you can take hearing impairments into account in your future or current professional work. How can you detect persons with hearing impairments, what services can you offer them, what are the most useful sources of information that you can use?</td>
</tr>
<tr>
<td>Write down the most important critical factors from this module.</td>
</tr>
</tbody>
</table>
2 SPOTTING UNMET NEEDS

2.1 At home

Mary

Mary had to hurry after her visit to the dentist. Her home help came to help her with cleaning the house. She arrived home just in time. She told the home help she had been to the dentist and waited for an hour because they forgot all about her. Coincidentally, the home help meets the dental assistant and hears the other side of the story, that the assistant thinks Mary has hearing loss. Then the home help thinks about other situations that gave clues about Mary having hearing loss. For example the time that she rang the doorbell and Mary didn’t open the door. She had to walk to the kitchen and knock on the window to get Mary’s attention. Or the time when Mary wanted to show a videotape of the family, and put the TV volume very high. And of course Mary stopped singing in the choir some time ago.

As a carer, whether with daily or occasional involvement, you have a vital role to play in helping the hearing-impaired person that you care for to improve their quality of life and to maintain independence for as long as possible. For many people, the onset of hearing impairment is slow and progressive, sometimes over many years. So it’s important that you know the signs that indicate that the person you care for may be experiencing hearing difficulties. You should also know who to refer the person to for further diagnosis, and be aware of the range of assistive technologies that exist to support the hearing-impaired person to carry out daily living tasks.

There are a number of different personnel working with older people in their homes - community nurse, home help, social worker and housing adaptations worker. These people come from different backgrounds, have varying degrees of education and training, and have a diverse range of responsibilities. They all have one thing in common in relation to the people they care for - they see them in
their home environment over extended periods of time and are therefore much more likely to encounter the difficulties they experience in daily life.

It is easy not to notice the hearing impairment of some older people because these people do not stand out in any way or may even try to hide their impairment. You may find that despite their hearing loss, they are able to manage effectively with very little help. They get around, dress, clean the house, read, write etc. As you know, however, the impact of hearing impairments is slow and progressive, often causing social isolation and depression. Unrecognised hearing impairments can greatly influence an individual’s quality of life, and many of the problems and effects caused by a hearing impairment can be improved. As a professional working in the home environment of these individuals, you can have a big impact on their quality of life. Making them aware of resources, such as agencies for and of hearing-impaired people, support groups, services, and AT, can help make their lives more comfortable.

When helping hearing-impaired people to adjust to the idea of using assistive technology or other strategies to help them to live independently, it is important to remember that every hearing-impaired person is an individual with individual needs. Even two people with the same diagnosis can have very different needs depending on their lifestyles, coping skills and interests. Only the hearing-impaired person can really say what they do or don't need. Strategies, which suit one person, may be irrelevant, even hampering, to another.

The roles of the different professions and groups working in the community (community nurses, social workers, home helps and others) differ throughout Europe. To be an effective ATI, however, all of these carers need to know the same basic things:

- How to identify hearing impairments, and any unmet needs arising from them.
- How various kinds of assistive technology can provide solutions to these needs (the introductory part of this module described these in some detail).
- What you can do to help ensure that assistive technologies are acquired when needed and that they are used appropriately.

**Context activity - Your experience of people with hearing impairments**

Think about someone (perhaps a client with whom you have been involved previously) who developed a hearing impairment. Discuss the following issues:
• How was the problem first identified i.e. who signalled the hearing problem and how, who validated the hearing problem, who referred to whom, etc.?
• What were the weaknesses of this approach, and why?
• What were the strengths of this approach, and why?

**Home environment and hidden impairments**

Anne, a social worker for a home help organisation, received information about Mr. Smith and a possible problem that he might have with his hearing. What could Anne do about this the next time she goes to Mr Smith's house?

Choose the best option and provide justifications for your choice.
• Tell him to go to the GP to get an ear examination.
• Ignore the possibility that he has a hearing impairment. Mr. Smith didn't get a home help for a problem with his ears.
• Call his niece and tell her what you suspect.
• Validate your hypotheses by doing some simple tests and asking about problems he may have with his hearing. If he wants help, you should give him information about hearing problems and possible assistive technology and try to persuade him to go the GP or other services about the problem.
• Go to the GP and tell him or her what you suspect about Mr. Smith.

**Spotting unmet needs for assistive technology**

You may work with an older person who’s hearing problems have already been diagnosed. They may tell you about their limitations and make suggestions about ways in which they can be helped. Other people for whom you may be caring, however, may suspect that they have hearing difficulties but hold back from admitting that they have them. Alternatively, they may view the problem as just one more condition that cannot be helped when a person gets on in years. Often something can be done, and that is why anyone who works with older people should be alert for signs of hearing loss.

The person experiencing hearing loss may not complain, for a number of reasons. These might include any of the following: the hearing difficulties they are experiencing may have been developing over a period of time and they may have got used to them; they may not like to talk about their problems; they may simply put it down to old age; they may perceive the problems they experience not as their problems, but as environmental changes.

You need to be aware of changes in behaviour and appearance that could be related to hearing loss. For example, you may notice that someone who is usually listening to classical music on the radio
doesn’t listen anymore, or that someone is getting depressed or isolated and no longer goes to meetings anymore.

**Signals of hearing impairments**

There are several signs that, once encountered, should trigger the question whether a person has hearing problems without either realising it or addressing the issue. Being aware of these signs will allow you to identify people among your clients or patients who may have unmet needs for assistive technology or other interventions and solutions. Such signs can include:

- Talking more loudly than normal;
- Having the TV, radio etc. on too loud;
- Regularly asking to have something repeated;
- Difficulties in having a telephone conversation;
- Being surprised when someone enters the room or suddenly stands behind them;
- Appearing to be inattentive, distracted and not participating in the conversation.

**Validating your first impressions**

You cannot rely solely on such signs: once you notice them you need to validate your suspicion. This can be done using simple techniques that may not even be noticed by the client/patient. For example, you can ask a question using a low voice, making sure your mouth cannot be seen. Alternatively, you can administer the questionnaire in the factsheet that accompanies this module to your client/patient (they may either fill it in themselves or, if preferable, you can ask them the questions and fill it in yourself).

 ألّفية الأخطاء، مثل تلك الجمل، لا تزال في النص الأصلي.

**Validate your first impression**

In a factsheet, we have provided an easy questionnaire to validate your first impressions. It is a copy of an American Academy of Otolaryngology - Head and Neck Surgery public service brochure. Check our factsheet and their web site for more information:


If you think that a child may have a hearing problem, you can do some simple tests to validate your impressions. For instance, in silent surroundings you could rub together the hairs close to the ear and ask the child whether it hears this. Or you could take a personal stereo to check if the child hears soft sounds, using one headphone yourself to monitor the sound level and content, and having the child use the other headphone.

**Review activity**
List five items that can signal that somebody has a hearing problem. Discuss how you would react upon encountering them with one of your clients.

In some cases, your client will already have been in contact with specialist services for hearing impairment and will have received advice, treatment, and possibly various items of AT. Even so, you may notice that some of their needs are still not being met and that these may be in areas that fall within the scope of your responsibilities and competencies.

If you are acting as a home help, for example, you can do a number of simple things to help the hearing-impaired person deal with the problems they experience. You can play an important role in helping them accept the hearing impairment and improve the quality of their life by following the hints below:

- Don't talk extra loudly - articulate clearly instead;
- Explain to your client that a good place for them to sit is next to the window, where the light will fall on the face of the person who is speaking;
- Don't hide your mouth and keep in eye contact when talking to your client;
- Explain to your client that the hearing problems probably can decrease with the use of carpets and curtains in the house to avoid echo;
- Gently wake up a patient who is hard of hearing;
- Wait until the background noise is decreased, the radio and cooker turned off, etc, before starting to speak;
- Stand beside the client when asking a question;
- Avoid asking the client something when walking behind them;
- Explain when you laugh, if your client reacts differently due to their hearing impairment;
- Show the patient a list of available assistive technology in the local health services.

### Simple AT

Remember the situation of Mary’s friend, who became concerned about Mary’s health when she didn’t respond to his telephone calls. This could easily have been avoided by using some kind of AT. What kind of assistive technology would you suggest?

Mention one or more examples of good moments to talk about this AT. And a few bad moments?

Manuel
Manuel is a 21-year-old man, living and studying in Barcelona. He has a hearing problem and finds communicating with people quite difficult—it demands a lot of his energy. In the evenings, he likes to quieten down and relax after a day of hard listening by watching TV. Unfortunately, the thin walls of his student accommodation mean the neighbours can hear his television set very clearly. They complain, but offer no solution. Fortunately, cheap and easy technology can help here. It is standard technology to replace the television set’s sound with headphones (either wired or infra-red) which minimise the level of sound for neighbours, while allowing the owner to use amplifiers.

2.2 During a medical consultation

Mary

Since the death of her husband, Mary has become very independent. She is very insistent about living alone in her own house and does everything to stay independent. When her daughter Eveline told her about her suspicion that Mary could be hard of hearing she denied this and started getting angry. Eveline carefully told her about the times she entered Mary’s home when the TV was turned up very high, and the times her young son thought they were quarrelling all the time because they were talking more loudly than average.

Mary was very upset at first, but after a while started reading more carefully the articles in her senior citizens’ magazine about being hard of hearing. First she thought: “OK, I'm getting older. There's nothing I can do about it”, but after she’d read a few articles about people relating their experiences with hearing aids and the technology of hearing aids she went to her GP. Her daughter accompanied her.

The GP asked a lot of questions about the severity of earache or hearing impairments in the family, and also when the loss of hearing caused problems in personal and social life (with telephone-calls, watching TV etc.) and what Mary's opinion was about hearing-aids. Then Mary was tested with audiometry and appeared to have a hearing loss of more than 30 dB at both ears, caused by a natural ageing process. With her positive motivation to wear hearing aids she then got a referral to the ENT-specialist.

Mary’s case deals with a situation where the hearing problem is explicitly raised as a presenting problem, and this is quite a common reason for consultation. As noted before, medical practitioners in primary care have an important role to play in helping clients/patients acquire assistive technology when needed. Unfortunately, many hearing problems are not presented, and undiagnosed hearing impairments are common among older people.

As previously stated, hearing loss is invisible but can be an impairment with a very big impact on someone’s quality of life, both
for the person with the hearing problem and for others in their social environment and other networks. As you know, hearing impairment increases the risk of becoming socially isolated. The real problem usually is detected slowly. What the hearing-impaired person is aware of is not the hearing loss itself, but the fact that people seem to be talking less clearly than they once did, or that the world is apparently much noisier than it used to be.

Another situation that may confront a primary care physician is when a client has a presenting condition or history that may have hearing impairment as one of its consequences. Examples include stroke, diabetes, meningitis, dementia, and AIDS. It is important that the physician treats the whole problem, not just the primary condition, and that proper attention is given to hearing loss when it occurs.

Mr Pietersen goes to the GP because he is suffering from back pain. The GP examines his back and asks him to do some exercises. He doesn't understand and asks what the GP said. The GP repeats the question, while bending over the back in order to examine it. He then realises that his patient doesn't understand what he says because he's standing behind him when asking his question. There could be a possibility the patient is becoming hard of hearing.

GP and hidden handicaps

What should you do in the situation of Mr. Pietersen? Choose the best option.

- Stand in front of the patient when asking questions.
- Ignore the possibility he's hard of hearing. The patient isn't here because of a problem with his hearing.
- Refer him to the ENT specialist to have an ear-examination.
- Validate your hypothesis by doing some simple tests and asking about problems the patient has with his possible hearing impairment. If appropriate, give him information about being hard of hearing, possible assistive technology and possible referral routes.

Detecting unmet needs for assistive technology

The primary care physician can play a crucial role as an ATI. Many hearing problems that can be decreased by assistive technology can be identified in a medical consultation and it is important to look out for these.
When a person goes to their doctor with a complaint about their hearing, the doctor starts by examining the cause of the loss of hearing. However, a hearing impairment can be invisible and unrecognised. Geriatric deafness is often neglected, since hearing loss among older people frequently accompanies more debilitating health problems. Age-associated hearing loss isn’t easily traced to diagnosable medical problems.

Some simple hints to help detect a hearing loss are:

- If a client is talking more loudly than average;
- If a client is turning up the volume of the TV, radio, etc too high (or, if you only see the client in your office, receiving complaints from others about this);
- If a client regularly asks you to repeat something that has been said;
- If a client is surprised when someone enters the room or suddenly stands behind them;
- If a client appears to be inattentive and distracted, not participating in conversation;
- If a client is wearing a very old-fashioned hearing aid.

In line with the standard professional care cycle, this process will be followed by a diagnosis, the taking of action and an evaluation. In the case of hearing impairment a medical consultant will ask certain questions about the hearing loss, will inspect the ears for the presence of factors that can cause hearing loss and, if necessary, will do additional tests to assess objectively the hearing loss. One way to do this is with a screening audiometer. Another possible test that doesn’t require additional instrumentation is the whisper speech test. It is important to remember that such objective information about hearing loss does not provide any information about the level of functional disability caused by the hearing problem in everyday living. That depends on the person's factual hearing loss but also on his dependency on hearing in his daily activities.

Context of assistive technology delivery

Think about a patient with whom you have been involved who recently acquired a hearing aid and answer the following questions:

- How was the hearing aid delivery process organised, i.e. signalling of hearing problem, validation of hearing problem, referral, etc?
- What were the weaknesses of this approach, and why?
- What were the strengths of this approach and why?

The next phase is to take some action. Depending on the diagnosis the action could be to wait and see, to initiate a treatment (e.g. remove a cerumen prop) or referral to the ENT specialist. In many cases, of course, the referral might be to an occupational therapist or
other provider of assistive technology services. At all times the medical consultant must make available information and advice: about the supposed cause and possible treatments of a patient’s problem and about possible AT, or assistive technology services to support them. It is these latter two aspects of the professional care cycle you’ll focus on later.

### Professional standards

Professional standards or protocols are a much-debated instrument for increasing and/or monitoring the quality of professional practice. Some medical organisations, e.g. the Dutch association of family doctors, have protocols on how to deal with hearing impairments in medical consultations.

Check whether any similar organisation in your country has such protocols.

### Mary

Mary received some valuable information and advice from her doctor. She is interested in trying out a doorbell with higher volume and asks her doctor where it can be obtained and if there is some financial support for it. The medical consultant doesn’t know and since this reminds her she has other patients who could benefit from this assistive technology as well, she decides to collect some information about possible products and financial support.

### Which information sources are valuable in this case?

Try to find out which are the products available in your region for assistive hearing of doorbells, telephones and TV and radio. Collect brochures that would be useful to leave in the waiting room of your practice.

### 2.3 In hospital

Mary had been suffering from stomachache for three weeks. Yesterday she went to hospital for an investigation. She had an appointment with Radiology at 1500. Since they were going to investigate her stomach, she wasn't allowed to eat for 2 hours prior to the investigation.

In the hospital she was placed in front of the X-ray machine, given a bottle of thick barium meal liquid, told to keep as much meal liquid in her mouth as possible, and to swallow when a sign was given. She put the barium meal liquid in her mouth and waited. After a while she saw the radiology
assistant return. She was surprised to see Mary with the liquid still inside her mouth - she had told her to swallow it about 4 minutes previously. But Mary didn't hear her saying to swallow. They repeated the investigation and this time it was successful. In three days Mary is to hear the results of the investigation from her GP.

Older people, in particular, have an increased likelihood of being hospitalised for various health problems relating to increased age. This means that health and social service personnel in hospital settings have an important role to play as ATIs. One aspect of this is to look out for hearing problems in all patients, especially older ones, and be on the alert for unmet assistive technology needs.

One department that causes many problems for people with hearing impairments is the X-ray department, where the wearing of hearing aids is not permitted. For protection, the assistants usually leave the room and shout instructions to the patient, and for people with hearing problems, recognised or not, this is a very difficult situation. If the hearing problems are recognised the patient and assistant can use pre-arranged signals. If the hearing problems are not yet recognised, this can lead to inadequate communication and subsequently, in the worst case, failure of the examination.

What can the assistant do to avoid this kind of situation?

Indicate which of the following statements is true or false.

- The assistant should shout a little louder.
- The assistant should be near the patient when giving the sign.
- The assistant should try to recognise patients who have hearing problems before the investigation starts. It is then possible to use a sign like briefly switching on a lamp, or raising a hand when the patient is able to see the assistant.
- The assistant can put a sticker on the file of the patients, which says this patient has some problems with hearing.
- The assistant can explain the investigation while walking around to set up the equipment.
- The assistant should ensure there is enough light during the explanation of the investigation.

In departments like radiology, hearing problems are causing increasing difficulties. The staff of these departments have a very good opportunity of recognising people with hearing problems and therefore have a very important potential role as effective ATIs.

Another key aspect, and the main focus of this section, concerns the point of discharge from the hospital environment. It is crucial that the discharge of patients following treatment for conditions likely to impact on their hearing gives a high priority to daily life implications.
and ensures that appropriate steps are taken to link patients with the assistive technology they may need.

There is no single method of hospital discharge. There are variations between different countries, between different hospitals, between different wards, and even between different healthcare workers within wards. Professionals who are involved in the actual discharge can be specialists, general practitioners, nurses, social workers, occupational therapists, ward assistants, etc.

### Context activity - discharging people with hearing problems

Think about a recent experience in which you were involved in hospital discharge. Make brief notes in relation to the following questions:

- Who was involved in the hospital discharge?
- What information was given to the patient?
- What information was given about AT?
- What were the weaknesses of this approach, and why?
- What were the strengths of this approach and why?

### Detecting unmet needs for assistive technology

Problems with hearing impairments can be overlooked very easily because they are not visible, can be hidden by the patient and can be misinterpreted very easily as disorientation due to stroke, meningitis, Alzheimer’s disease or other conditions that were the immediate reason for hospital admission. As an illustration, here’s a true story:

**Mary**

Mary had to go to the hospital suddenly after a fall in the garden. She had to be operated on immediately. The nurses found it difficult to communicate with her: “She is a little bit confused - she doesn’t respond very well to what we say.”

They thought it was due to the anaesthetic, or that Mary was suffering from dementia. That is, until Mary’s daughter came to bring some things, including Mary’s hearing aid.

Some simple hints to help signal a hearing loss are:

- A client is talking louder than average;
- A client is raising the volume of TV or radio too high;
- A client is regularly asking you to repeat something that has been said;
- A client is surprised when someone enters the room or suddenly stands behind them;
• A client appears to be inattentive and distracted, not participating in conversation;
• A client is wearing a very old-fashioned hearing aid.

Additionally, you need to be aware that some diseases are frequently associated with hearing problems:

**Dementia**
Research indicates that there is a higher incidence of hearing problems in people suffering from dementia. A significant difference was found in a study which compared the amount of hearing impairment of a group of people suffering from Alzheimer’s disease and a control group of older people (Gold, 1996). An extra difficulty in recognising hearing loss in this group is that difficulty in communication can be due to a hearing loss but can also be due to dementia. Some symptoms of hearing loss and dementia are similar, for example, surprise when someone enters the room or suddenly stands behind a person, or appearing to be inattentive and distracted, not participating in conversation. In the case of a correctable hearing loss, a hearing aid may help to reduce the communication problem.

**AIDS**
There is a lot of literature about deafness and AIDS, because of the high incidence of AIDS in the deaf population. There is a lack of information about this relatively new disease, and hearing loss is common among HIV-infected individuals and is associated with antiretroviral therapy in those aged 35 years or older.

**Diabetes**
Diabetes is an important cause of microvascular complications and has been presumed as a risk factor for hearing loss. The literature is not definitive about this point. Some indicate that the effects of diabetes and hypertension are causative factors in the development of sensorineural hearing loss while others show no significant difference in hearing loss between people with diabetes and people without diabetes.

**Meningitis**
Bacterial meningitis is a disease that has been proven to correlate with hearing loss. About 12% of children suffering from bacterial meningitis show hearing impairments in the early stages of the disease. Of those 75% recover from the hearing impairment before discharge (Richardson M P, Reid A, Tarlow M J, & T., 1997).

**Stroke**
Stroke can be defined as rapidly developing clinical signs of focal (or at times global) disturbance of cerebral function lasting more than 24 hours, or leading to death with no apparent cause other than that of
vascular origin (Aho, 1980). Other symptoms, less frequent in occurrence, might include convulsions, coma, loss of hearing or sight, double vision, or a general malaise with general aches. In the article *Assistive devices for home-based older stroke survivors* a study is presented in which 30 people over the age of 60 years who had had a stroke were interviewed about the use of assistive devices. About 1 in 4 people from this group had a hearing device. Usually hearing loss caused by stroke cannot be improved with a hearing aid and sufferers can benefit from other AT, such as a flashing doorbell.

Once you have noticed signs of hearing problems with one of your clients, you need to validate your idea by doing a few simple tests. Ask questions about the sound volume of the TV or radio, try to hide your mouth when talking to your client, stand behind them or lower the volume of your conversation. If these confirm your suspicion that your client has a hearing problem, you need to take some action:

**Provide information about products and/or refer to specialists.** Whether you do both or one depends on the situation, the client’s problem and your familiarity with hearing impairments and available AT. It is however not a viable option to do nothing, especially in this situation where aftercare has to be organised anyway. In the hospital, some assistive technology will be available for patients and a helpful tool could be a comprehensive list of all relevant AT.

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**Assistive technology available in hospital**

A first investigation will reveal what assistive technology for hearing impaired people is available in the hospital, and whether it is possible to get, for example: an amplified telephone, headphones for the TV, a listening horn if the hearing aid isn't allowed (for example after surgery), stickers with the universal hearing-impaired symbol for the patient’s bed and patient’s record, sign with the text ‘Are you hearing-impaired? Please let us know!’ etc.

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**Where can I find information sources about AT?**

Try to find out which products are available in your region that help with hearing the doorbell, the telephone, the TV and radio. Collect brochures which are useful to give a to client suffering from hearing loss.

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**Possible action: examination**

Mary is being discharged from hospital. You know she is hard of hearing because she is wearing a hearing apparatus but the speech therapist Mr Janson noticed it is quite an old fashioned one.
You want to draw attention to the hearing impairment in the discharge letter from Mr Janson to the GP. Write the discharge letter. Think about linking to other AT.

Being an ATI starts with signalling the problem. A hearing impairment can be invisible and unrecognised. Geriatric deafness is often neglected because the loss of hearing among older people frequently accompanies more debilitating health problems. Age-associated losses in hearing are not easily traced to diagnosable medical problems.

### Hospital discharge and hidden handicaps

Mr Pol is in hospital because he broke his hip a few days ago. For transportation through the hospital the nurses use a wheelchair or stretcher. One of the nurses found out that Mr. Pol didn't participate when she was trying to start a conversation with him, although it was on a subject in which he was very interested yesterday. Then the nurse realised he didn't hear her because she was walking behind him as she pushed his wheelchair.

What should you do with this situation? Choose best option

- Stand in front of Mr Pol when asking questions or communicating.
- Ignore the possibility he's hard of hearing. Mr Pol isn't in hospital for a problem with his hearing.
- Give him a referral to the ENT specialist to have an ear examination.
- Validate your hypotheses by doing some simple tests and ask about problems Mr Pol has with his possible hearing impairment at home. Ask him if he wants you to pay attention to this hearing problem in the discharge letter.

If the person's hearing has been damaged, a range of hearing and other environmental aids (like echo-reducing aids) are available. In the earlier section about the assistive technology service delivery system attention is paid to that subject.

For a hospital setting, some simple hints and attitudes can also make a very important difference:

- Place a person with hearing impairments next to the window. This way the light will fall on the face of the person who is speaking to them;
- Ask the patient which ear they hear best with. This ear should be towards the room;
- Use the universal hard of hearing symbol on the patient’s bed and record;
- Gently wake up a patient who is hard of hearing;
- Wait until background noise (such as the sound of trolleys or curtain rails) is decreased before starting to talk;
• When asking the patient something, stand next to the bed;
• Avoid asking the patient something when walking behind them;
• Show the patient a list of available assistive technology in the hospital;
• Use signals and rehearse them before X-ray investigation, CT-scan, taking a shower etc;
• When a patient is wearing a hearing aid that is going to be removed for surgery, rehearse with listening horn before the operation.

### Into a nursing home

Mr Pol is going to a nursing home to rehabilitate. You write a discharge letter to the specialist and the OT there to draw attention to the hearing loss in his right ear. Include a drawing of the ideal place for this patient’s bed. You know there are 6 patients per room in this particular nursing home. The room looks like the figure below and you are allowed to move all the beds.
This module was designed to give you a brief overview of hearing impairments and the relevant assistive technology. You can extend this information easily by collecting publications either from an accessible higher education library or a local association for deaf or hard-of-hearing people.

Alternatively, you can browse the World Wide Web for further information. Although you can start by searching with words like ‘deaf’, ‘hearing impairment’ or ‘hearing aid’, we suggest you start at one of these sites and follow the links provided there:

- The International Federation of Hard of Hearing People at http://www.ifhoh.org/
- The UK Royal National Institute of Deaf at http://www.rnid.org.uk/


Other sources of information cited in the text include:

4 GLOSSARY

- **Audiogram**: a graphical visualisation of the hearing capacity of both the right and left ear.
- **Audiologist**: a specialist in the problems of hearing and deafness, trained in audiology, but not a medical doctor.
- **BTE**: Behind-the-ear: hearing aid worn behind the ear.
- **CIC**: Completely-in-the-canal: hearing aid worn completely in the canal, hence nearly invisible. Bill Clinton makes use of these.
- **Conduction loop**: wire to amplify transmitted sound; can be found in public places (e.g. theatres) or private homes. They are useful because they transmit only the desired sound (e.g., speaker, orchestra) and not the background noise.
- **Cochlear implant**: a prosthesis, which is surgically placed partly in the inner ear, partly behind the outer ear. It stimulates the auditory nerves by transmitting sounds directly as electric impulses, rather than amplifying them.
- **Conductive hearing loss**: limited hearing due to less than optimal transmission of sound signals through the outer and/or middle ear.
- **Frequency**: together with volume and timbre, one of the characteristics that make up sound. Frequency refers to the number of vibrations per second. A higher frequency equals higher tones, and a lower frequency lower or bass tones.
- **Hearing aid**: device to amplify sounds to improve an individual’s hearing. Can be body-worn but more often behind-the-ear (BTE), in-the-ear (ITE), in-the-canal (ITC) or completely-in-the-canal (CIC). Incoming sounds are reproduced as sounds but amplified, as opposed to a cochlear implant which reproduces incoming sounds as electric impulses.
- **ITC**: In-the-canal: hearing aid fitted in the canal and nearly invisible.
- **ITE**: in-the-ear: hearing aid fitted inside the outer ear.
- **Lip reading**: communication relying on the observation of facial expressions. As this involves more than just lips, it is referred to as speech-reading.
• Ménière’s disease: named after a French 19th century doctor. Malfunction of hearing and sense of balance resulting from excessive inner ear fluids.
• Sensorineural hearing loss: limited hearing due to less than optimal transmission of sound signals through the inner ear.
• Sign language: a language based on the use of signals, mostly by hand. It is not uniform across the world but varies like spoken languages from country to country.
• Speech reading: communication relying on the observation of the facial expressions. This term replaces the incorrect term ‘lip reading’.
• Timbre: together with frequency and volume, one of the characteristics that make up sound. Timbre refers to the specific nature of the sound.
• Tinnitus: noises that seemingly originate from within the ear or head, rather than from the outside world.
• Total communication: use of a combination of hearing supporting tools and techniques.
• Volume: together with frequency and timbre, one of the characteristics that make up sound. Volume refers to the loudness of a sound, which can be quiet, loud or something in between.
5 FURTHER INFORMATION

Research & development in hearing aids
With the current level of innovation in information and telecommunication technology, it should not be a surprise that the latest research and development in hearing aids focuses on digital processing of sound. This allows for far greater flexibility and refinement in the latest hearing aids.

The European Union (through DG XIII-c5, telematics for disabled and elderly) is funding some of this research and development activity. Examples of the EU-funded projects in this area are HEARDIP, LISCOM and SPACE.

HEARDIP: Hearing Aid Research with Digital Intelligent Processing
The project focuses on the compensation of impaired hearing by optimal fitting, restoration of the auditory dynamics and noise reduction algorithms in order to optimise speech intelligibility. The objective is to develop fitting procedures and signal processing techniques which will introduce a new generation of intelligent digital hearing aids that are selective. This means that there are three separate aspects to this project: fitting procedures, signal processing to deal with impaired auditory processing, and signal processing to deal with noise reduction.

LISCOM: Listening Comfort System for Hearing-Instruments and Telephones
LISCOM’s objectives are to enhance the listening comfort of hearing-impaired people by introducing noise reduction technology into hearing aids. The same technology can also enhance stationary and mobile telephone sets. The work of the project relies on the use of new noise reduction technologies that can cope with the non-stationary nature of background noise.

SPACE: Signal Processing for Auditory Communication in noisy Environments
SPACE focuses on the compensation of impaired communication by hearing impairment and/or noise by noise-reduction algorithms and restoration of auditory dynamics in order to optimise speech intelligibility. The results will lead to the development of better hearing aids and communication devices. Signal processing algorithms will be developed aimed at substituting impaired auditory functions by special pre-processing. Their primary aim is noise reduction in general and aiding in...
specific communication problems. The algorithms will be evaluated in field tests using wearable units. The devices should optimally be fitted to the ear, compensating impaired auditory functions in hearing-impaired listeners. However, noise reduction techniques for the restoration of the communication function of hearing-impaired listeners will also be applicable to normal hearing listeners with auditory communication problems at noisy working places. SPACE aims to describe the auditory demands for communication in a number of well-defined working places and the benefit of technical solutions to restore communication by means of intelligent 'communication devices'. The major work is directed towards the application of signal processing schemes and there will be a strong emphasis on feedback by a panel of potential end-users.

### An audiogram

An audiogram is a graphical visualisation of the hearing capacity of both the right and left ear. It is very simple to read - a matrix with the frequency range (in Hertz or Hz) on the vertical axis. The low frequencies (bass or low sounds) are on the left-hand side of the matrix, the high frequencies (high tones) on the right hand side. The horizontal axis represents the loudness of sounds (in decibels or dB), with soft sounds at the top of the audiogram, loud sounds on the bottom. This is a less traditional orientation of axis but improves readability.

On an audiogram, you can situate sounds as you encounter them in every day life. The most important sound, human speech, can be situated between 250 and 5000 Hz and 10 to 50 dB.

When an audiogram is made as an assessment of hearing difficulties, the hearing specialists registers when sounds with a certain frequency and loudness are noticed (at least 50 % of the time) through the left and right ear.

The resulting information is graphically represented on the audiogram by two lines. These give an indication at what loudness the patient can hear a sound of a given frequency with the left and the right ear. By convention, these audiograms use blue or a series of X for the left ear, and red or a series of O for the right ear.

### Sound

Any sound can be characterised by its:
- Frequency
- Volume or intensity
- Timbre

### Frequency

The frequency of sound is the number of cycles of a sound wave in one second. It is specified in Hertz (Hz). The frequency of a sound increases as the number of cycles per second increases.

High-pitched sounds, such as a police whistle or piccolo, have a high frequency with thousands of cycles per second. Low-pitched sounds, such as far away thunder or a tuba, have a low frequency with only a few cycles per second.

Vibrations or frequencies between 20 to 20,000 cycles per second (or 20 to 20,000 Hz) are interpreted as sound by a healthy young adult ear. Certain animals such as dogs, dolphins or bats can hear far higher frequencies.

### Intensity

The intensity (loudness) of a sound refers to the amplitude of the sound and is specified in dB (decibels). This is expressed in a logarithmic scale which means 10 dB more is 10 times louder, 20 dB is 100 times louder.

**Table: Different sounds expressed in decibels (dB).**

The healthy young adult is most sensitive to sounds with frequencies in the range of 500 to 8000 Hz, which matches the frequency range of speech sounds. The softest sound (threshold of hearing) that the normal human ear can perceive is around 0 dB. The most intense sound (uncomfortable loudness or pain level) that a listener can tolerate is 120-140 dB.

<table>
<thead>
<tr>
<th>dB</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>Space rocket at blastoff</td>
</tr>
<tr>
<td>140</td>
<td>Jet engine at take off</td>
</tr>
<tr>
<td>130</td>
<td>Machine gun fire at close range</td>
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<td>120</td>
<td>Rock &amp; roll band</td>
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<td>110</td>
<td>Loud thunder</td>
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<td>City traffic</td>
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<tr>
<td>80</td>
<td>Loud radio</td>
</tr>
<tr>
<td>70</td>
<td>Inside moving car</td>
</tr>
<tr>
<td>60</td>
<td>Average speaking voice</td>
</tr>
<tr>
<td>50</td>
<td>Department store</td>
</tr>
</tbody>
</table>
40 Quiet residential community
30 Very soft whispering
20 Leaves rustling
10 Normal breathing
0 Softest sound a human can perceive

Validate your first impression

This is a copy of an American Academy of Otolaryngology - Head and Neck Surgery public service brochure. Check their www site for more information: [http://www.netdoor.com/entinfo/hrtstaao.html](http://www.netdoor.com/entinfo/hrtstaao.html).

Answer each of the following questions.

The possible answers are:
1. Almost always
2. Half of the time
3. Occasionally
4. Never

1. I have a problem hearing over the telephone.
2. I have trouble following the conversation when two or more people are talking at the same time.
3. People complain that I turn the TV volume too high.
4. I have to strain to understand conversations.
5. I miss hearing some common sounds like the phone or doorbell ringing.
6. I have trouble hearing conversations in a noisy background such as a party.
7. I get confused about where sounds come from.
8. I misunderstand some words in a sentence and need to ask people to repeat themselves.
9. I especially have trouble understanding the speech of women and children.
10. I have worked in noisy environments (assembly line, jackhammers, jet engines, etc.)
11. Many people I talk to seem to mumble (or don't speak clearly).
12. People get annoyed because I misunderstand what they say.
13. I misunderstand what others are saying and make inappropriate responses.
14. I avoid social activities because I cannot hear well and fear I'll reply improperly.
15. (To be answered by a family member or friend): Do you think this person has a hearing loss?

**Scoring**

To calculate your score, give yourself 3 points for every time you checked the ‘Almost always’ column, 2 for every ‘Half the time’, 1 for every ‘Occasionally’, and 0 for every ‘Never’. If you have a blood relative who has a hearing loss, add another 3 points. Then total your points.
The American Academy of Otolaryngology - Head and Neck Surgery recommends the following:
0 to 5 - Your hearing is fine. No action is required.
6 to 9 - Suggest you see an ear-nose-and-throat (ENT) specialist.
10 and above - Strongly recommend you see an ear physician.

This quiz was field-tested on 71 older patients in five cities; audiograms were also run on them. Results showed that those whose quiz scores indicated a need to see a physician were confirmed on the audiogram as having a hearing impairment.