

**A LAYMAN'S GUIDE TO THE UNDERSTANDING OF
THE EAR AND ITS PROBLEMS**

Reg. No. 1

**An Independent Project Presented To University of Mysore
In Partial Fulfilment of The Requirements For The Degree
Master of Science in Speech and Hearing**

1 9 8 2

To

My Loving Parents

CERTIFICATE

This is to certify that the Independent Project entitled "**A Layman's Guide to the Understanding of the Ear and its Problems**" is the bonafide work in part fulfilment for M.sc., in speech and Hearing of the student with Reg. No.




Director,

All India Institute
of Speech & Hearing,
Mysore - 570 006.

CERTIFICATE

This is to certify that the Independent Project entitled "**A Layman's Guide to the Understanding of the Ear and its Problems**" has been prepared under my Supervision and Guidance.



John M.
Guide.

D E C L A R A T I O N

This Independent Project is the Result of my own study undertaken under the guidance of Dr.(Miss)Shailaja Nikam, Professor of Audiology and Head of the department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any unit for any other Diploma or Degree.

Mysore:

Reg.No. 1

Dated:

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CHAPTER S

INTRODUCTION

All of us at some time or the other are afflicted by some disease or another in our lives. The faster these diseases are identified and proper treatment instituted early, the better are the results. But if they are neglected and ignored, they could turn out to be fatal to the person or can cause such serious handicap that he would have to live with it the rest of his life, making it miserable for himself and for the people around him. However, some of the diseases do resolve themselves, but the results will not be as satisfactory as they would have been if seen by a professional.

Treating an ailment is not new to us. It has been there since time immemorial. Today this treatment has become better because scientists have been working hard to understand all about disease, what causes them, etc., For this, they also should know about normal conditions, so that abnormal conditions can be identified properly. Identifying, preventing, Controlling and curing of diseases is not only the job of a Doctor or a Scientist or a Specialist. The afflicted and the society around him have their own part to play in building up a healthy population.

The afflicted himself should know about what his problem is, what could happen if he ignored it, how it can be treated , etc. But, if the afflicted individual is a child who is unaware of such things, then it is the responsibility of his near and dear ones to see to it that such conditions are identified, and identified as early as possible and proper treatment started as fast as possible.

For these reasons a proper understanding and awareness of the problem, how it should be normally functioning, and why it is not, is necessary.

Lots of Literature has been published about the diseases like cancer, tuberculosis, etc., and about conditions like blindness, orthopedically handicapped, etc. The dramatic presentation of these diseases and condition, arouse interest and sympathy in the general population. But, only a person who has enjoyed the previlege of hearing for some time and then become deaf can say how the condition is: To see lips move but not hear a word, to see a record play, but not hear music, to bear the suspicion of thinking people are talking about you, or laughing at you; In short to bear the silence, in silenoe, is as dreadful if not more, as any other conditions mentioned.

May be this was a person who could have avoided this condition if only he had taken a little more care, a little more interest in preventing his condition progress, would not be suffering so much. But what is lost is lost. No treatment can bring back what he has lost to a normal conditions he enjoyed before.

such a person would agree with us when we say that every one should have the basic knowledge and conditions that can bring about a hearing loss, the ones that can be treated medically or surgically, the ones that cannot be treated and what can be done about themy ao that he can recognise them as soon as they appear in him or others, and, get immediate help. To understand about conditions that cause hearing loss, the normal ear structure and function have to be known to us also.

This booklet aims at just that - to help a layman understand about the ear and its problems and what should be done about it.

A Tour Of The Ear.



CHAPTER 2

A TOUR OF THE EAR

The ear is not all that we can see, and we refer to as "ear". It is only a part of the ear - the most prominent and ironically the least useful! This is the External ear.

Beyond this structure is the most complex and most useful parts of the ear - the Middle and inner ears.

The ear can therefore be divided into 3 parts - the External Ear, the Middle Ear and the inner ear.

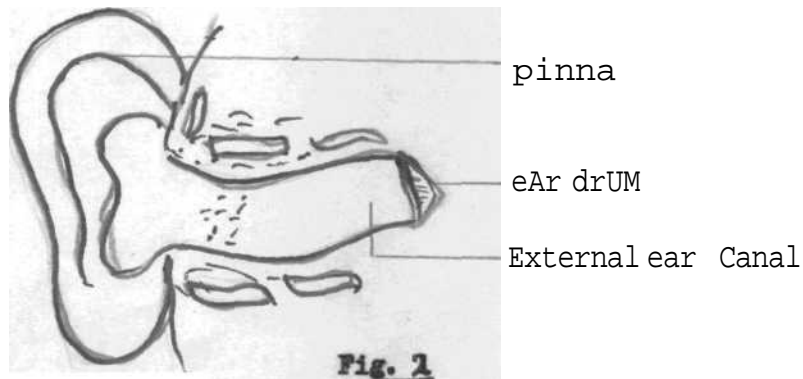
In the following sections, these different divisions are dealt in detail.

THE EXTERNAL EAR



The external ear is the most prominent part of the ear visible outside. It consists of 2 flap like structures on either side of the head called "pinna", and a short curved tube that leads into the head called the External Ear canal,

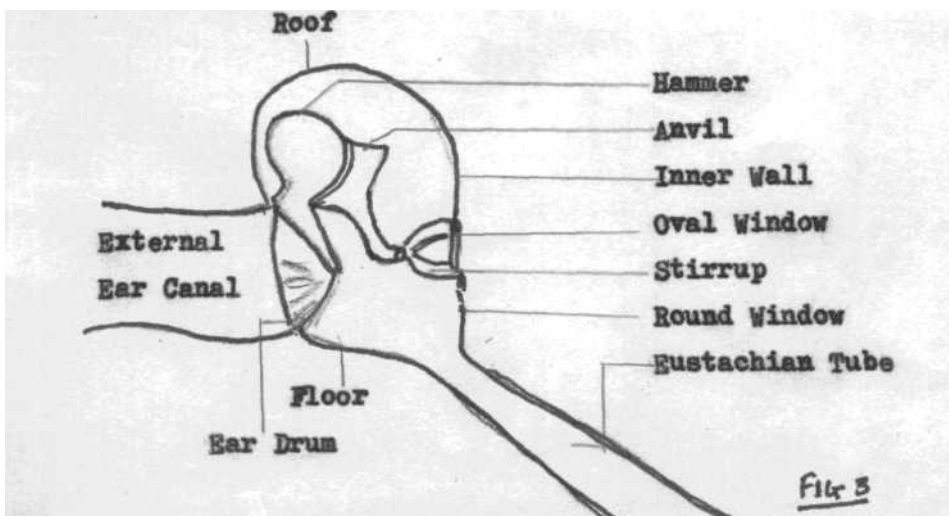
The pinna helps in collecting the sound waves and directing it into the external ear canal. Unlike in other animals, the pinna in man is immobile in most people.



The external ear canal is about 1 inch long and about $\frac{1}{2}$ inch wide. It contains hair and wax glands. Both these help in protecting the ear. The wax glands secrete wax.

The external ear is so designed that some sounds that are important for the understanding of speech are made louder. At the end of the ear canal is a thin delicate membrane called the ear drum or tympanic membrane.

THE MIDDLE EAR



The tympanic membrane separates the external ear from the middle ear. The middle ear is a bony cavity which is box-like(it has 6 sides). It is called tympanic cavity. They are the roof, the floor, the front wall, the back wall, the outer wall and inner wall.

The roof is formed by a thin plate of bone which separates the middle ear from the brain substance above it. The outer wall(the side of the cavity facing the outside) is formed by the tympanic membrane. The back wall is formed by a small opening which leads to a space in the skull bone called the "mastoid antrum". This space is sparsely filled with cells and covered with mucous membrane. The wall in front contains a tube that connects the middle ear with the throat. This is called the Eustachian tube. It helps to equalise the pressure inside the middle ear with the pressure of the atmosphere outside, i.e., it keeps the pressure on either side of the ear drum equal. This tube is usually in a collapsed state. It opens when chewing, talking and yawning, and the air moves in and out of the middle ear cavity through it.

This mechanism is very important when you are flying in an aeroplane or when going uphill or down hill. As you move higher, the atmospheric air pressure

-7-

decreases. Therefore the air pressure inside the middle ear cavity is higher compared to the outside. When you swallow, you hear a popping sound in your ear. This is the sound of air moving out of the middle ear, to equalise the pressure.

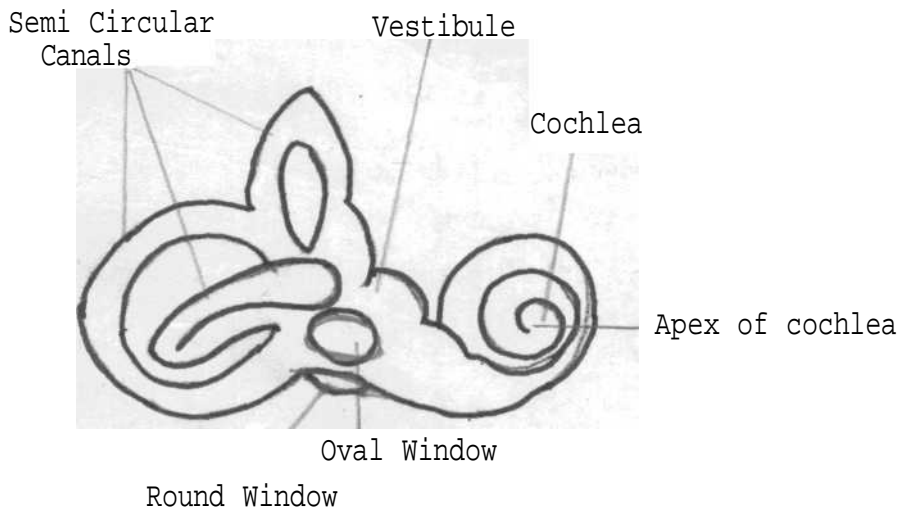
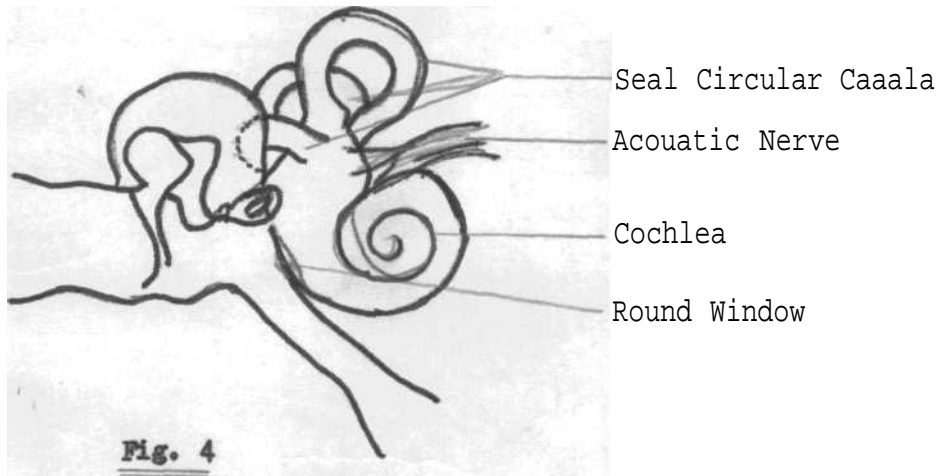
Similarly when you are diving or swimming underwater, the pressure outside the ear drum is very high compared to the inside of the middle ear. This again is equalised by swallowing.

In the middle ear cavity are found 3 tiny bones. Together they are called the 'ossicles'. They are held in place in the middle ear cavity by ligaments. Each ossicle has its own name. The first bone is called Malleus(which means 'hammer'), the second is called 'Incus' (which means anvil) and the third one is called the Stapes (which means Stirrup). They are named so because of their resemblance to these objects.

Of these 3 bones the biggest - the hammer or Malleus is closely connected with the tympanic membrane, and the smallest bone, the Stapes or Stirrup is placed in an oval opening found on the inner wall of the middle ear cavity. The incus or anvil connects the malleus and stapes.

As said earlier, the ossicles are held in places by ligaments. The malleus has 3 ligaments and the stapes is held in place by the annular ligament. There are 2 muscles attached to the ossicular chain. They help in smooth movement of the ossicular chain, and also protects the inner ear(as it will be seen later). Of the 2 muscles, the longer one, the tensor tympani is attached to the malleus. The shorter one - the stapedius is attached to the stapes.

THE INNER EAR



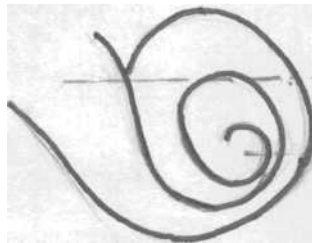
The Bony Part

The inner ear consists of 2 important organs -
(1) The organ of hearing and (2) The organ of balance.
Both of these are found close together and are made up
of a system of interconnected tubes and fluids. The
inner ear is very well protected in the hardest bone of
the skull called the 'Petrous bone'.

The organ of Hearing - The Cochlea(say "kok-lia")

(Latin : cochlea means Snail)

This is a snail shaped organ with its base towards
the middle ear. It is wound on a bony shaft called the
'Modiolus'.



-- Basal end of the Cochlea

Apex of the Cochlea

THE BONY COCHLEA.

Fig. 6

The cochlea can be divided into two parts - the bony
part and the membranous part.

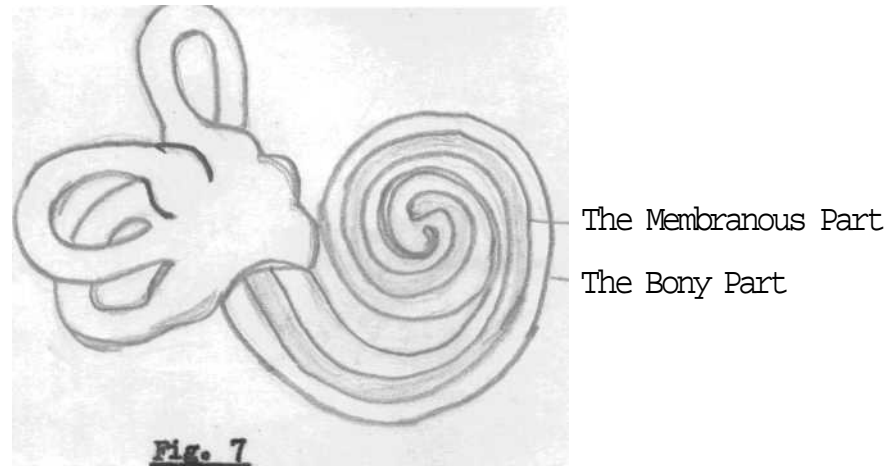
The bony part is snail shaped and has two openings or
windows into the middle ear cavity

- (1) The oval window - which is covered by the foot plate
of the third ossicle, the stapes.
- (2) The round window - found just below the oval window.

It is covered by the thin membrane called the "secondary

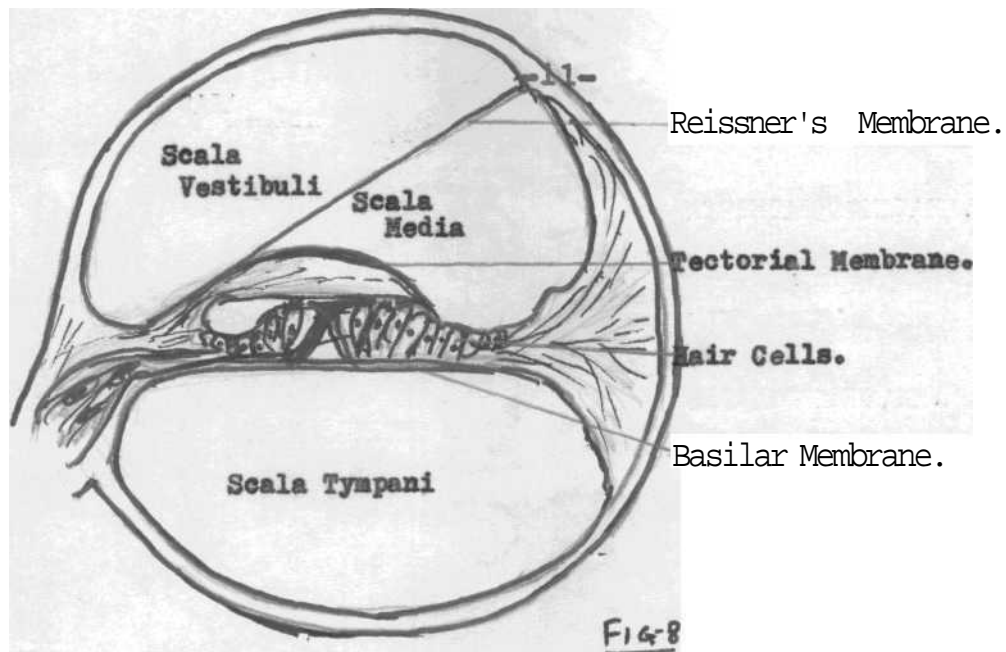
tympanic membrane".

Inside this bony part is the membranous part, and a fluid called the perilymph.



The membranous part is tube like and runs from the base to the apex. Because of this membranous cochlea, the perilymph is divided into two galleries. The upper gallery is called the 'scala vestibuli', and the lower one is called the 'scala tympani'. At the apex of the cochlea, the membranous tube comes to an end in such a way that there is a small connection between the upper and lower galleries. This point is called the "Helicotrama".

The membranous cochlea is actually made up of two membranes - (1) a thin delicate membrane called the 'Reissner's membrane' and (2) A tougher basilar membrane. A cross-section as they are seen is shown in the figure.



On the basilar membrane is found the organ of Corti. This contains the sensory cells of hearing called "hair cells" (They are called so because they have hair-like structures on their surface). Above these structures is a jelly-like transparent structure called the tectorial membrane.

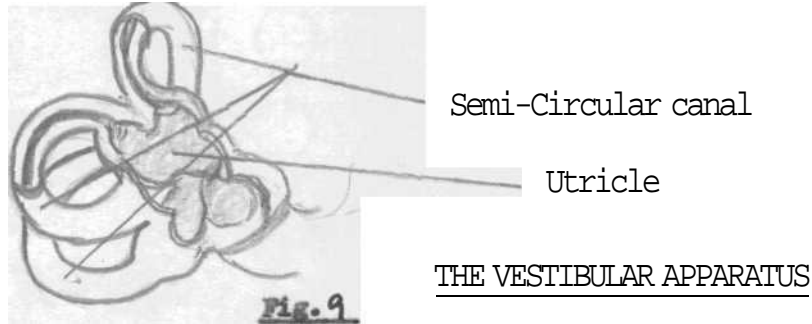
The hair cells are connected to the nerve endings of the auditory nerve in a complicated fashion.

The membranous cochlea is filled with a fluid called endolymph.

The Vestibular apparatus:

The organ for balance and equilibrium. This organ helps to maintain the balance of the body, no matter which position the head is in. It also helps in maintaining equilibrium when a person is walking, running, etc.

Like the cochlea, the vestibular apparatus is also divided into membranous and bony parts, with the membranous part inside the bony part. The membranous part consists of 3 semicircular ducts and the utricle and saccule.



The three semicircular ducts are found in their own bony canals. The utricle and saccule are found together in the vestibule of the bony inner ear(See fig.5).

The endolymph of the cochlea and the endolymph of the vestibular apparatus are connected by a short tube called the "reuniting duct". There is perilymph between the membranous and bony part of the vestibular apparatus. On the inner surface of the membrane of the vestibular apparatus, are found the sensory cells of balance and equilibrium. They also contain hair like structures on their surface and are hence called hair cells. Depending upon which part of the vestibular apparatus they are found, they are called "hair cells of the utricle, hair cells of the saccule; and so on. These hair cells are supplied with nerve endings of the vestibular part of

the VIII nerve. These hair cells are sensitive to movement of the endolymph. The endolymph movement depends upon the direction of head movement. When the endolymph moves, the "hair" of the hair cells are disturbed from their resting position; This causes generation of nerve impulses in the nerve endings and information is sent to the brain regarding the position of the head. Depending upon the information received, the brain controls the limbs and trunk in such a way the balance and equilibrium is maintained.

Auditory Pathway :-

The nerve impulses generated in the hair cell of the cochlea travel up the auditory nerve to the brain. Here they are heard as sound.

The auditory nerve is only about the thickness of a pencil head. But contains as many as 30,000 nerve fibres. These are formed by the long nerve fibres of the nerve cells that supply the hair cells and nerve fibres from the cortex to the cochlea. Thus the auditory nerve is a two way path for fibres to and from the cochlea.

Some of these nerve fibres of the auditory nerve starting from one ear, on their way to the brain, cross over to the opposite side and terminate in the opposite

side of the brain. Thus, some nerve fibres starting from the right ear would terminate in the left half of the brain, some other starting from the same ear ascend to the same half of the brain, thus some nerve fibres starting from the right ear end up in the right half of the brain. Thus each ear is bilaterally represented in the brain. On their way to the brain, the fibres of the auditory nerve form junctions at various levels in the pathway with other nerve cells and finally they reach the "hearing centre" in the brain i.e., the auditory cortex. This is found in the temporal lobe of the brain. Here is where the impulses which arrive through the nerve fibres are analysed and interpreted as sound.

CRAASH!
Brrrrrr

CHUG CHUG

BOW
BOW
SSSSSS

TICK
TOCK

CHIRP
CHIRP
T T

Sound

---ANNCHOO!

INFORMATION.

YAK YAK
YAK YAK

BOOM

BLAM

DING
DONG

RING
RING

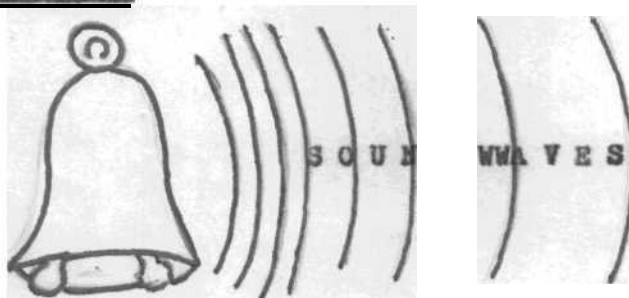
CHAPTER 3

SOUND AND ITS TRANSMISSION

What is Sound?

To understand what sound is, pull the strings of a guitar or veena, you hear sound and see the string vibrating (if you watch carefully!), beat on a drum and then gently place your palm on it. You will feel it vibrate. In both the cases of sound vibrations, sound is said to be produced when an object is set into vibration. In some cases, the vibration in the string can be seen (like in the guitar) and in the others it cannot be clearly seen (drum). But when you blow a whistle, nothing is seen to vibrate because it is in the air particles that are moving back and forth (vibrating).

Sound Source



Once the sound has been produced at the source by a vibrating object, it has to be carried in all directions away from the source. This is called sound propagation. This is done by the particles of the medium around the

sound source. If the source is in air, then the air particles carry the sound. If it is in water, the thin water particles carry the sound, if it is on a solid object like wood or a metal bar, then the particles of the solid object carry sound. Therefore to hear a sound there should be (1) A vibrating sound, (2) A force to set it into vibration, (3) medium to propagate the sound (either air or fluid or solid) to the ear of the listener (4) A good hearing mechanism to hear and recognise the sound.

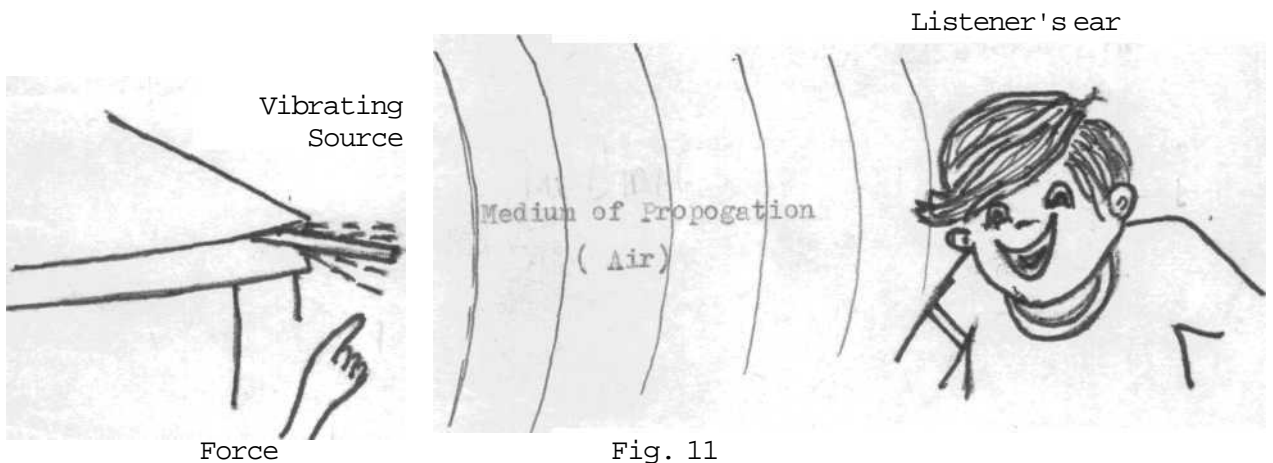


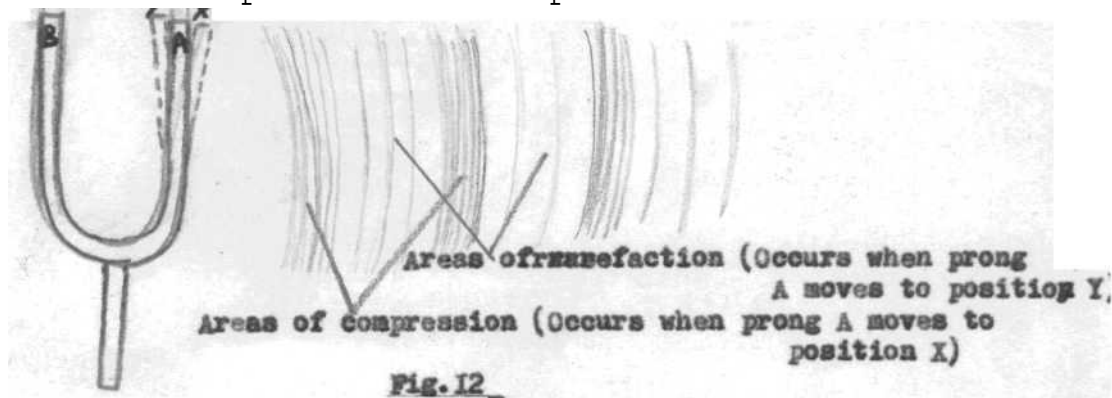
Fig. 11

Strings, membranes, reeds or air columns can act as vibrating sources and produce sound.

How is sound propagated through air? -

Strike the prongs of a tuning fork, it starts vibrating. Consider the air particles on one side of a prong, Say prong A. When it moves outwards

(away from prong B) then particles just behind it are set into motion, i.e., they are pushed to one side or compressed. Then air particles in turn set the air particles just beside them into motion. Thus the motion of each particle movement affects the position of the particle next to it.



Now consider the prong A moving inwards. The air particles are compressed on the opposite side of the prong but there is an area of decreased air particles on the outside and this is called rarefaction. As the prongs keep moving, many such compressions and rarefrations occurs when prong A moves to position Y. Thus a sound wave is carried through air by compressions and rarefrations of the air particles, these compression and rarefrations together form a wave that start from the sound source and move in all directions. Thus sound energy is propogated through air. Now if the wave motion enters the external ear and strikes the ear drum, it vibrates accordingly.

How do you describe a sound?

A sound wave can be described in terms of its frequency.

intensity and Quality.

Frequency refers to how fast the compression and rarefractions occurs in the air. This also means how fast the sound source is vibrating. Suppose the sound source is vibrating at the rate of 500 vibration/second, it produces 500 compression and 500 rarefractions. One compression and one rarefraction together is called one cycle. Therefore the frequency of the sound is 500 cycles per second or 500 Hertz. This is what is heard as "pitch" of a sound. The greater the frequency and the rate of vibration, the higher the "pich".

Intensity - This refers to the "strength" of the wave, or how much of sound energy is transmitted through the medium or loudness of the sound. Suppose a greater force is used to set the sound source into vibration, then more energy is transmitted through the medium, the loudness increases. Intensity is measured by measuring the pressure, of the sound wave or by measuring the power or flow of energy. It is expressed in decibels.

Quality - If two instruments say a Veena and a Guitar play the same note, do they seem the same? The ear can differentiate between the sounds produced by the two instruments. This is because of the quality of sound each produces. Quality of sound makes one judge sound as 'pleasant', 'harsh', 'strained', etc.

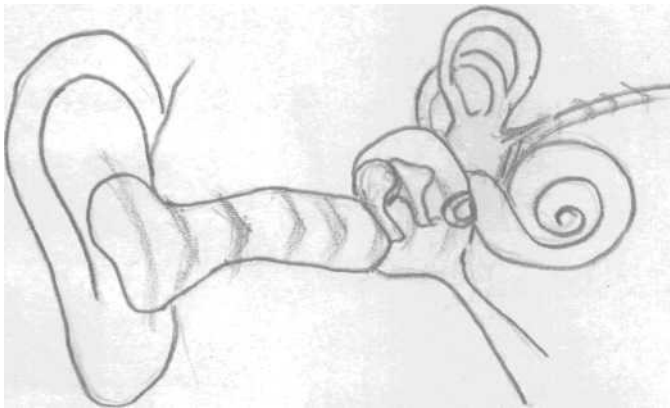
The simplest form of sound is called a 'Puretone'. A pure tone consists of only a single frequency. Thus you have pure tones of 500 Hz, 200 cps, 1700 cps, 8000cps, etc. The human hearing ranges from 200 cps to 20,000 cps or the human ear can identify frequencies of 20 Hz through 20,000 cps as sound. The frequencies below 20 cps is called 'infra sonics' and those frequencies above 20,000 cps is called 'Ultrasonics'.

The ear is not equally sensitive to all frequencies ranging from 20 to 20,000 cps. it is found to be maximally sensitive to the range between 1000 Hz to about 3500 Hz. At either end of this range, the intensity of the tones to be increased to be heard.

CHAPTER 4

HOW WE HEAR

Sound sources set up vibrations in the air particles which are carried in all directions. If it reaches the human ear, the pinna collects it and directs it into the external auditory canal. These waves move down the canal and strike the ear drum. This causes the ear drum to vibrate accordingly.



The ossicular chain is attached to the ear drum. When the ear drum moves in and out, the ossicular chain also moves along with it. Thus the stapes that is placed in the oval window moves in and out of the oval window.

At the ear drum, the sound energy which was in the form of air particle movement is converted to mechanical energy. In the middle ear the ossicles are so placed

that when they move in response to sound, they move with a much greater force and thus transmit more energy into the cochlea. But why is greater energy necessary?

To understand the need for this greater energy, we have to take you back in time - million of years ago when all life was found only in water. The ear of all these living creatures was filled with fluid. Sound was propagated through the water in which they lived. The density of the fluid inside the ear and outside the thin ears was equal and there was no loss of energy.

Then animals started moving towards land. The sound energy on land was propagated through air, and the ear of these animals were still filled with fluid. When air energy strikes water, 99% of it is reflected back. Only 1% is absorbed. Therefore the fluid filled ear was inadequate for hearing on land. To overcome these problems, in the course of evolution, there animals were provided with middle and external ears. This part of the ear (1) converts air energy into mechanical energy and (2) transmits sound with a greater force into the fluid of the inner ear. Both these mechanisms exist to reduce the loss of energy because of transmission.

As the stapes moves in and out of the oval window, waves are set up in the scala vestibuli of the inner ear. These waves travel throughout the length of the cochlea. It passes into the scala tympani through the helicotrema. These waves then travel in the scala tympani and vibrate the secondary tympanic membranes which cover the round window. The round window movements reciprocates the movement of the stapes in the oval window i.e., if the stapes moves inwards, the round window bulges outward into the middle ear cavity.

Process by which sound waves produce motion of the Ear drum, the Ossicles and thereby the motion of the Basilar Membrane.

Electrical impulse through the auditory nerve.

Steps moving in and out of the oval window.

Vibrating ear drum.

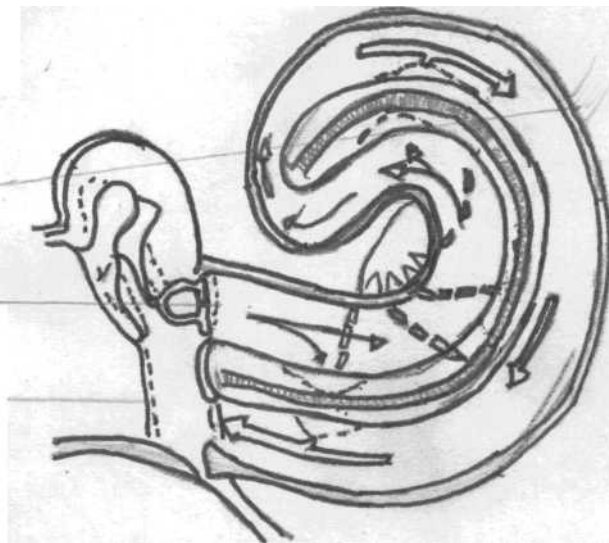


Fig.14

When the waves are moving in the perilymph of the inner ear, it disturbs the basilar membrane. When the basilar membrane moves, the 'hair' of the hair cells rub against the tectorial membrane. They bend. This

causes a nerve impulse to be set up. They are picked up by the nerve endings of the cochlear nerve and transmitted through the 8th cranial nerve to the auditory cortex where they are heard as sound.

Hearing by Air conduction:- This involves the mechanism just described i.e., the external ear and middle ear act as conductors to conduct sound into the inner ear which acts as the sensory part. This route is called air conduction route.

Hearing by Bone conduction:- If the sound energy is so strong that it vibrates the bones of the skull or if some vibration like a tuning fork is placed on the skull bone just behind the ear, the bones of the skull vibrates. This movement directly causes wave like motion in the inner ear fluids. The same process as described for air conduction takes place and sound is heard. This type of hearing is called hearing by Bone conduction. The sound bypasses the air conduction route and directly stimulates the inner ear via bones of the skull.

Normally most of the sound we hear through air conduction? Only very loud sounds are heard through bone conduction.



Causes Of Hearing Loss.



CAUSES OF HEARING LOSS

IN THE EXTERNAL EAR

(a) Congenital Malformation:-

(i) absence of the ear pinna : This condition does not cause a significant hearing loss, if the other structures of the ear(ear canal, middle and inner ears) are intact.

(ii) Closure of the ear canal : Closure can be complete or partial in one or both ears. It is usually accompanied by the malformation of the middle and inner ears, in such cases hearing loss is sever. However, if the middle and inner ear structures are intact and functioning normally, hearing loss is only mild.

(b) Blockage of ear canal:-

(i) by impacted wax: The ear wax that is produced in the ear canal may harden and completely or partially seal off the ear ear drum from the air and preventing the sound waves from reaching the drum, or the wax may lie so close to the drum that it prevents the drum from vibrating. Hearing loss is mild in such cases, and he may feel uneasy, as if his ears are full.

(ii) **by foreign body:** Children love to put things like seeds, chalk, beads, etc into their nose and ear canals. In adults the foreign bodies usually found are insects like beetles, ants, wool, etc.

- These foreign bodies cause hearing loss in two ways
- (1) By blocking the ear canal, not allowing the sound to reach the ear drum.
 - (2) By causing injury to the eardrum. If the foreign body is sharp it could damage the skin of the ear canal causing inflammation, pain and irritation. It could rupture the ear drum if it is pushed far, into the ear canal, and cause hearing loss.

CAUSES OF HEARING LOSS IN THE MIDDLE EAR:

In the middle ear, hearing loss can be caused by-

1. **Rupture or Perforation of the eardrum:** When this happen, the sound waves that strike the eardrum are not effectively transfered to the ossicles and hearing loss is caused.

The eardrum may break when trying to remove wax with some sharp instrument like a hair pin, by foreign bodies such as mentioned earlier or by exposure of the ear to sudden loud sound, or because of

some disease conditions in the middle ear cavity. It is sometimes surgically cut open in the treatment of middle ear diseases.

Severity of hearing loss caused by perforated ear drum depends upon which part of the drum is perforated and the size of the perforation. Perforation in the Upper right half of the drum brings about maximum loss and, one in the lower left half brings about the least loss.

2. Infection of the middle ear:-

Middle ear infection is the most common cause for conductive hearing loss. Inflammation of the nose or throat such as a cold or sore throat can be transmitted through the eustachian tube to the middle ear.

The eustachian tube itself may be malfunctioning or blocked. In such cases, there is no proper air way to the middle ear. The air already present in the middle ear is absorbed by the mucous membrane lining the middle ear. Thus pressure of the air in the middle ear cavity becomes less compared to the pressure outside the head (atmospheric pressure) and so negative pressure is created in the middle ear. Because of this difference in pressure, fluid from the mucous membrane of middle ear is sucked and gets collected in the middle ear cavity. This causes a mild hearing loss, and pain in the ear. If the eustachian tube

is opened(by a doctor) then the fluid drains out and hearing returns to normal.

In a person suffering from common cold, infection from the nose or throat can be carried to the middle ear via the eustachian tube. When he blows his nose hard, nasal secretion may be forced into the eastachian tube and from there to the middle ear where it can cause infection.

When it is infected, the middle ear gets filled with fluid, which may enter the mastoid antrum also. As the amount of fluid increases in the middle ear cavity, pain in the ear becomes worse. Finally, it tears open the ear drum and fluid drains out through the external auditory canal, and pain reduces, in the early stages, the discharge is profuse and watery, but later on it becomes thick and less.

In some ear infection the discharge is scanty and foul smelling. This indicates a dangerous condition, and it should not be taken lightly. Untreated middle ear infections can lead to several complications such as infection of the brain(encephalitis) or its outer coverings (meningitis), infection of of the inner ear, etc. The middle ear bones may be destroyed leading to a moderate hearing loss. However, if proper treatment is given

in the early stages itself, hearing returns to normal or near normal. Example: If the patient sees a doctor before his ear drum tears open the doctor surgically cuts open the ear drum and drains the fluid. He opens the ear drum in a place where it results only in a very little hearing loss. Also the opening of the drum by a surgeon heals quicker and better than a drum that broke spontaneously.

Conditions of the Ossicles that Cause Hearing Loss:

The ossicles have to be properly connected with each other, with the tympanic membrane at one end and the oval window at the other. If there is any discontinuity in this chain due to congenital absence of one or more ossicles or due to accidental fracture of one of the bones or due to improper connection among themselves, or due to fixation of one of the bones or due to fluids in the middle ear which impede the movement due to fluid, hearing loss results.

Another condition of the ossicles found to be hereditary, is "otosclerosis"(oto = ear; solerosis = hardening). The bone around the oval window into which the stapes is inserted begins to grow. The new bone is spongy and as it grows it hinders the stapes movement in the oval window. In the later stages the stapes may be completely fixed in the oval window. The spongy bone ultimately becomes hard.

Hearing loss when the stapes is completely fixed is moderately severe. The patient may also suffer from an annoying sound in his/her ear. This sound is called 'tinnitus'.

In early stages, otosclerosis is purely a conductive loss. However, as the condition progresses, the otosclerotic bone may involve the inner ear causing a mixed type of hearing loss.

Otosclerosis begins at adolescence, rarely after 30 years. In women, it has been found that a hearing loss which was noticed earlier, becomes evident after pregnancy, but pregnancy does not cause it.

CAUSES OF HEARING LOSS IN THE INNER EAR

Hearing loss can be caused by problems of the inner ear and the auditory nerve leading from it to the brain. Any hearing loss because of problems in the cochlea or the auditory nerve, is called "sensori-neural hearing loss" or SN loss in short.

Hearing loss in the inner ear can be caused by,

- (1) Congenital malformation of the inner ear.
- (2) Destruction of the hair cells(the sensory cells of the cochlea).
- (3) Due to changes in the pressure of the inner ear fluids.

(4) Destruction of the nerve cells of the auditory nerve by the presence of a tumor.

(1) Congenital malformations of the inner ear:-

Deaf parents or families that have members with hearing loss are more likely to have deaf children, especially if parents are blood related. In such hereditary causes, malformations can range from complete absence of the cochlea or a completely bone filled cochlea to just the loss of a few hair cells at one of the ends of the cochlea.

Other than hereditary causes, conditions of the mother during pregnancy could have caused maldevelopment of the inner ear.

Most of the important organs like the heart, kidney, hearing, etc., develop during the first three months of pregnancy. Any conditions like a bacterial or viral infection or drugs consumption etc., can come in the way of their normal development. As a result, problems of the heart, kidney, etc can also be seen along with hearing loss.

(2) Destruction of the hair cells of the cochlea:-

The cochlear hair cells can be destroyed because of (i) aging, (ii) Too much exposure to noise, (iii) by

consumption of drugs harmful to the ear(ototoxic drugs).

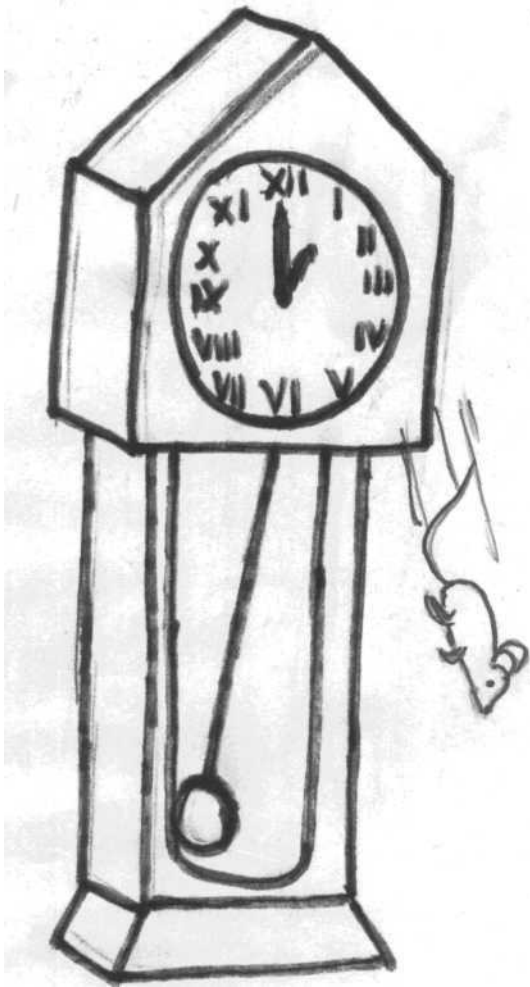
Hearing loss due to aging: This hearing loss is called "preabycusis". Advancing age is the most common cause for SN deafness.

At present it is thought that hearing loss occurs with advancing age because of aging process like loss of elasticity of the basilar membrane which makes it stiff and less mobile, of because of reduced blood supply to the cochlea, which leads to degeneration of the hair cells and the nerve endings that supply it, etc.. If blood supply to the auditory cortex (brain) is reduced, it may cause degeneration of the nerve cells there, resulting in central auditory disorders(discussed later in this chapter).

Usually, high frequency sounds are affected first. Why this happens is not well explained yet. Later the hearing loss is seen in the low frequencies also. It is only when it involves the speech frequencies that hearing loss becomes noticeable.

Presbycusis is not a disease of the old age, it is a disease of ageing. It is not noticeable in all people at the same time. There are some old people who have good hearing, and some young and middle aged people having a hearing loss due to presbycusis. This type of hearing loss

DING
DONG!



Hickory Dickory Dock

Hickory Dickory Dock,
The mouse ran up the clock,
The clock struck one,
The mouse fell down,
And found he had a hearing loss



exposing your ear to sudden loud noise can cause hearing loss and dizziness.

is hastened if the individual is exposed to excessive noise or by taking drugs that are harmful to the cochlea.

Exposure to noise:-

Permanent injury to the organ of corti can occur by exposure to the sudden blast of sound like an explosion, gun blast, etc. This is called "Acoustic trauma". This sudden sound may cause permanent sensorineural deafness by loosening pieces off the organ of corti or disorganise it. Profound hearing loss can result from such an injury.

A violent blow on the external ear can also be thought of as a sudden blast. This also causes permanent damage to the inner ear.

Noise induced hearing loss: Many of us must have at one time or another experienced ringing sound in our ears after coming out of a noisy bus, or a flour mill or after a day's work in a noisy factory. We also feel that our hearing sensitivity has decreased. After a few hours - or the following day, the hearing is found to return to normal. This temporary hearing loss can become permanent if you are exposed to loud sounds over longer periods of time. This happens because the hair cells of the cochlea are destroyed. How fast the hearing loss occurs depends upon how much sound is present, for how long and how susceptible the person is to hearing loss.

Consumption of Drugs that are Harmful to the Ear:-

certain drugs like quinine, Streptomycin, Kanamycin, etc., have been proved to be definitely harmful to the ear. These also destroy the hair cells of the cochlea. These drugs are therefore given, only if it is absolutely necessary to give it like when it is a matter of life and death.

**HEARING LOSS DUE TO CHANGES IN THE PRESSURE OF THE
INNER EAR FLUIDS**

Meniere's Disease:-

This is the only type of sensory neural hearing loss which is sometimes overcome by medical treatment. The first symptom is tinnitus (sound in the ear), dizziness and hearing loss are seen because of the increase of the fluid endolymph in the inner ear. The cause for this increase in fluid is not fully known, but it is attributed to changes in blood supply. Hearing loss is fluctuating, and there may be severe attacks of dizziness and nausea that he may have to be confined to bed sometimes, the attack lasts for a few days. It is usually seen in only one ear.

By Trauma or Accident:- SN loss can be caused by fracture of the temporal bone. This is however, rare, and is incurred

only during wars and automobile accidents. Hearing loss is caused because of damage to the organ of corti.

DESTRUCTION OF THE NERVE CELLS OF THE AUDITORY NERVE

Acoustic Tumour:-

These are tumours arising on the auditory nerve, They are also called "Acoustic neuroma". They can occur anywhere on the auditory nerve. The tumour presses on the auditory nerve and causes damage to it. If it presses on the surrounding structures, especially in later stages when it becomes very big, other problems like problems with balance, facial paralysis, visual problems, etc., are also seen.

Hearing loss, tinnitus, dizziness and nausea are the common symptoms seen in early stages. The ability to discriminate between speech sounds is severely impaired.

The tumour on the nerve does not allow information , to be conducted to the brain properly and this causes a hearing loss.

CENTRAL HEARING DISORDERS OR CENTRAL AUDITORY DISORDERS(CAD)

The fibres of the acoustic nerve reach the auditory cortex of the brain through several pathways, if any of these pathways are impaired due to head injury, brain tumours.

brain infections, etc., it causes what is called a central Hearing Disorder.

Such a patient hears the sound but can not understand what is it. He cannot recognize the sound or its meaning, central deafness is therefore not really a hearing problem, if we take hearing loss to be loss of the ability to hear. It is more a neurological problem than an ENT problem.

OTHER CAUSES OF HEARING LOSS

Functional or Non-organic hearing loss :-

This type of hearing loss is, as the name suggests - functional, psychological without any organic problem. The person develops a hearing loss either consciously or sub-consciously as an escape from emotional stress or responsibilities or to gain some financial help, etc.

A person who consciously or deliberately assumes a hearing loss to meet his own ends is called a "Malingerer" in contrast to the one who firmly believes that there is something wrong with his or her ears. Sometimes he may have a mild hearing loss, but he believes that it is profound.

Conclusion:

The signs and symptoms of any disease depends upon

the cause of the disease. Discussed here are some diseases and conditions of the hearing mechanism that cause hearing loss. However, there are several other conditions and diseases that are not mentioned either because they do not cause hearing loss or because they are very rare.

C H A P T E R 6

TESTING HEARING

Hearing testing in the pre-electronic era was done by crude and inaccurate ways using watch-tick, coin-click, normal conversation and tuning forks. These methods only gave the tester an idea if hearing loss was present, but not what the type of hearing loss was, or where the problem was in the ear. Severity of hearing loss of the patient with the tester's hearing. So if the tester had hearing loss, the case had hearing loss too!

Now-a-days hearing tested using an audiometer. It is an electronic device that measures hearing of a subject with reference to the average hearing of hundreds of normal hearing people from different parts of the world. It measures the minimum intensity required to hear a pure tone at different frequencies (usually 250Hz, 500Hz, 1000Hz, 2000HZ, 4000HZ, 6000HZ and 8000Hz). This minimum intensity that is required to hear a tone is called "Threshold" at that frequency. Hearing is also measured in two ways - (1) with the sound passing through the external and middle ears to the inner ear - the air conduction route. (2) with the sound passing through the bones of the skull and directly reaching the inner ear, bypassing the air conduction route - the bone conduction route.

The results of the hearing test are plotted on a graph using different symbols for the right and left ear. This graph is called the "Audiogram". Depending upon the pattern recorded on the audiogram, inferences are drawn as to what is the type of loss, where the possible problem might be, how severe it is and if it could be treated medically or surgically. Thus the audiogram gives a qualitative and quantitative measure of the hearing loss and helps the Doctor direct his course of treatment.

As speech is more meaningful than a pure tone, tests have been developed which use speech as testing material. Use of speech in testing gives a better basis for selecting an appropriate hearing aid.

These tests call for maximum co-operation from the patient (because he has to listen carefully and respond correctly). But such co-operation cannot be expected at all; and very young children (Below age of 4 yrs) are incapable of responding thus. So, we have other tests which require minimal co-operation from the patient, just sitting quiet. In cases when children do not co-operate to this, minimal extent, sedation can be given to quieten them up. One such test is the impedance audiometry. The findings of this test along with the tests of pure tone audiometry help in greater accuracy and precision in diagnosis.

Another similar test is the Electrical Response Audiometry. This records the electrical activity generated at different levels in the auditory system in response to sound. The absence or deduction of these activities indicate defective hearing.

All these tests aid in diagnosing where the problem lies, the possible treatment and its outcomes.

I!*!*I*!*I*!*I*!*

TREATMENT AND REHABILITATION

Once hearing loss has been identified and the severity and type of hearing loss determined, treatment has to be instituted as fast as possible.

As a rule all middle and external ear problems ie. all conductive hearing losses, can be treated medically surgically.

The aims of all medical / surgical treatment are:

- (1) Complete removal of the disease,
- (2) Conserving as much as hearing as possible, by
- (3) Restoring hearing by reconstruction of the diseased parts of the ear, where ever possible.

Treatment of Hearing loss:-

External Ear: Congenital malformation of the external ear pinna, are in some cases corrected by plastic surgery. But surgical correction of malformations of the external ear canal depends upon whether the inner ear structures are normal. This can be known from the audiogram of the person. If it is only conductive loss, then it can be assumed that the inner ear is normal; But if the audiogram shows a Sensori Neural hearing loss, then it is of no use reopening the external ear canal, as it is not going to help the person hear better. The wax produced in the ear, normally

comes out little by little unnoticed. But this does not happen in some. The common finding of the blockage of the external ear by impacted wax is rather frequent. When this occurs, the person had best visit a doctor, who will remove the wax with no injury to the external ear canal or to the ear drum. Trying to remove it with a match stick or hair pin will usually only push the wax further into the ear canal so close to the drum, that it has to be removed by a doctor. The sharp edges of the hair pin damages the skin of the external ear canal which can get infected and cause pain and irritation and a possible spread of the infection to the middle ear as well.

If the wax is too hard and adherent to the skin. Doctor may have to soften it with hydrogen peroxide before it is washed out.

Middle ear: As said earlier, medical treatment aims at first removing the disease condition of the middle ear. The cause of the problem is discovered and treated first.

Perforated Ear drum:-

Here the doctor first determines the cause of the perforation. If it occurred by accidental injury, like by a hair pin, etc, it usually heals on its own. However a doctor may help bringing the broken edges together to help it heal quicker.

If the perforation is because of an infection of the middle ear that has torn the eardrum to discharge the fluid, then the doctor first treats the infection. Only after it is completely healed and the ear is dry, will he start reconstructing or repairing the ear. The middle ear structures if damaged are dealt with first, and then the ear drum. Repair of the ear drum depends on how big the perforation is. If it is only a small pin hole perforation the doctor burns the edges with a needle dipped in silver nitrate. This helps in activating the edges to start growing towards each other. If the perforation is big then this is not done. The doctor places a paper patch on the ear drum after approximating the edges. The broken edges grow along the side of the patch and close the perforation.

However if the perforation is very large, then the doctor uses a skin graft to close the perforation. This operation is called "Myringoplasty".

Usually the results of these are good, and the persons enjoys normal hearing.

An untreated perforated drum sometimes heals spontaneously without any medical intervention. But such a healing may result in excessive scarring. Excessive scars

make the ear drum stiff and less mobile to sound falling on it.

Infection of the middle ear:- By eustachian tube blockage)

If this happen, the eustachian tube is opened by blowing air in to it through the eustachian tube opening in the throat, or by passing a catheter through it, or by shrinking the mucous membrane of the eustachian tube by drugs, when the eustachian tube opens, the pressure inside and outside the middle ear cavity equalises and pain reduces. If there is any fluid in the Middle ear cavity, it drains out through the eustachian tube. If the tube is only partially closed, then it can be opened by continuous swallowing.

If the eustachian tube is infected then appropriate antibiotics have to be given also.

If the patient comes to the doctor with a ear drum threatening to break because of increased fluid collection in the middle ear cavity, then the doctor himself makes a cut in the ear drum to help to relieve the pressure and prevent the drum from breaking on its own. The cut is made at such a place that it will effectively drain the fluid and also cause very little hearing loss. This cut is kept open till the ear is completely dry. Then it is allowed to heal on its own.

In cases of infection of the middle ear cavity, the cause of the infection is first found out. If the discharge is pus stained, it indicates that bacteria have also infected it. In such cases a little of the discharge removed is taken and tested to find out the type of bacteria present. Then an antibiotic that is effective with that particular bacteria is given to the patient.

Once the infection has died out and the ear is completely dry, repair of the middle ear is undertaken. This operation is called "Tympano-plasty."

In advanced cases where the infection has passed on to the mastoid antrum caused an operation would have to be performed to remove all the diseased parts.

For otosclerosis, the fixed stapes is removed and an "artificial stapes" which is a piston like structure made of "teflon" is put in its place. The bony over growth is scraped off. The results of this operation is usually good.

Treatment of sensori neural deafness:-

In contrast to conductive impairment which are almost always treated by medical / surgical treatment, sensori neural hearing loss generally cannot be helped through treatment, with the exception of Menieres disease.

Prompt medical treatment in this case can result in a dramatic restoration of hearing, in other cases once the cells of the cochlea or the auditory nerve are damaged, there is no way they can be restored as there is no regeneration. So medical care for a person with SN loss is to prevent further loss, by removing the causative factor. Like if it is because of noise exposure or due to dry intake, he is advised to wear a ear protector, if it is because of drugs, he is asked to discontinuous using it, and an alternate one is prescribed. The person is also advised to have proper nutritsation, rest and personal hygiene.

If the hearing loss is due to an acoustic nerve tumor the tumor is removed surgically as it may threaten the person's life, it is not removed. But once this operation is done, does not restore any hearing function that is lost.

So in cases of SN loss, the only hope for the patient to hear better is to use a hearing aid. His hearing is tested and depending upon the extent of hearing loss, and if a hearing aid trial shows that he benifits from an hearing aid he is prescribed one. But if he only hears the sound but does not understand what is being said, then a aid is usually not prescribed. He should try to learn

lip reading or speech reading.

A hearing aid does not improve hearing. It only helps to amplify the sounds to a level where he can hear.

CHAPTER 8

HEARING AIDS

By now you must be familiar with the word "Hearing aid." A hearing aid is an electrical device that helps a person with a hearing loss hear better with the little hearing he has left.

An adult who developed a hearing loss, or a child who was born deaf or acquired hearing loss later in life, which cannot be treated by surgical and medical treatment is advised the use of a hearing aid.

A hearing aid does not help regain the hearing already lost. It only helps to amplify the sounds loud enough to be heard by the wearer. But never buy a hearing aid just depending on how loud a sound it can produce. There is more to a hearing aid than just increased loudness alone! There are many models of hearing aids available today with very different characteristics to suit different types and severity of hearing loss. So the best thing to do is to go to a specialist and get your hearing checked and seek his advice as to which aid suits you best. Don't hastily buy yourself a aid just because it is cheap or looks impressive. You may soon find it unsuitable for you.

Buying a hearing aid without consulting a doctor or specialist can be even harmful for your ears. There are times when wearing a hearing aid is not advised for medical reasons. At such time if you wear a hearing aid, it only

aggravates the problem. If your ear is discharging, it can damage the hearing aid too!

Now a days hearing aids are available that can be worn in the ear, or hooked behind the ear, or can be built into the frame of a spectacle other than the ones that regularly used; ie. the pocket type, where the microphone is worn on the body and the receiver in the ear. A cord connects the microphone and receiver.

If you are already using an hearing aid here is some news for you.

A hearing aid does not help you regain your lost hearing. It only makes sounds louder for you, but it is not true that the louder the sound is, the better you will be able to hear. The louder the sound is made the more difficult it will be for you to understand what is being said. So don't simply raise the volume control of your aid, thinking it will help you better.

Remember that a hearing aids life span is about 4 to 5 years, if used every day. So it is better to have its performance checked at regular intervals. Also because of the rapid advances in hearing aid technology, there might be newer models, that might suit you better than the ones prescribed for you earlier.

In the case of children, the hearing aid recommended may not be the aid for him, as it is difficult to evaluate the child's hearing. Hence periodic reevaluation is necessary to find out the best aid for your child.

See that the ear mould fits well. In children have it changed periodically, as the child grows out of it. If the mould is loose, it is not only in-effective in keeping the receiver in its place, but also may cause leakage of the sound from the receiver. This produces a "squeal," sound.

It is important to have a periodical examination of Your ear, so that if there is accumulation of wax, etc. it can be removed. Presence of wax in the ear can either block the mold or may weigh on the ear drum and reduces the help got from the hearing aid.

It is always best to be in touch with a specialist for you and for your hearing aid. Don't try to prescribe a hearing aid for yourself, it could do more harm than help. Instead let him help you make maximum use of the residual hearing.

CHAPTER 9

HEARING IN CHILDREN

Introduction:

Speech and language are acquired by children very early in life. By 7 -8*- years they become fluent talkers. Most children around us talk. However being able to speak is not as automatic as it appears to be. It has to be learnt. To be able to speak a baby must be able to

- (a) hear,
- (b) understand,
- (c) express himself.

(a) Hearing by means of an intact hearing mechanism. A good hearing mechanism sees to it that the sound signals reach the brain without much disturbances or change.

(b) Understanding is done in the brain. The sound's that reach the brain are analyzed and their meaning is entrapolated.

(c) To express himself thechild must have a good neuro-physiological system for speech. The muscles and other systems such as the respiratory system required for speech must be properly developed. Speech is a very complex activity and therefore there has to be very precise muscular co-ordination for its production.

This, learning to talk is a laborious process. It has to go through several process of listening, imitating

and repeated, productions to be learnt. Its development - is related to the development of many other systems like muscular coordination and general growth and maturity. But, basically all speech is learnt through hearing. Even a mild hearing loss in a child who is still learning to talk can cause an educational retardation of about 1-1½ years. This becomes worse if the hearing loss is more severe. Therefore, it is necessary to identify hearing loss early in children. To do this it is important to know how hearing develops.

A small baby's reaction to sound is different from how adults or older children respond. Though the inner ear is fully developed by the fifth month of pregnancy. A new born child seems to have some amount of 'hearing loss' till about one month. After birth the responses to sounds are automatic and involuntary. They respond only to loud sounds like a handclap, fire cracker, etc. by a jump or startle or by an eye blink or grimacing.

Soon they start ignoring these loud sounds and any sound that is familiar and not interesting to him. He only listens to those sounds he thinks are worth paying attention to like the voice of his mother or the sounds of her making him feed, his own name, etc. In other words he starts selectively listening to the sounds that are present around him.

By 3 - 4 months he is able to turn round and look at the sound source, and is able to recognize a wider range of pitches (frequencies) at lesser loudness levels. By 5 months he starts making sounds with his own speech mechanism. He starts making cooing and gurgling sounds purposefully listening to their own voice seems to be pleasurable activity for babies. They continue it and try to produce many more sounds they hear around them.

By the end of 1 year they are able to automatically and very quickly localise sound.

In the period from 1 to 3 years rapid development of speech and language takes place through hearing. He learns to imitate the sounds he hears, and has better control over the muscles he requires for speech. He learns to attach meaning to the sounds he hears. He learns to say a few words usually referring to objects and people around him. Then he learns to put these words together into phrases and later sentences, and to understand sentences said to him.

After about 2 years there is a sudden spurt in the learning new words, their production, and tries in spoken language. This takes about 7 - 8 years, for a normally developing child. All children follow the same stages of speech development.

The period between 2yrs and 5yrs is when maximum learning takes place. It is therefore called the critical period. Research has shown that at no other time in an individual's life does such rapid and efficient hearing of speech and language takes place as in the critical period. Hence it is important that hearing through which most of the learning takes place be normal in this period.

Causes of Hearing loss in Children:-

What is the cause of hearing loss in children?

Hearing loss is generally grouped into 2 categories.

1. Hearing loss present at the time of birth (congenital)
2. Hearing loss acquired after birth (acquired).

Congenital hearing loss can result from problems during pregnancy ie. before delivery (pre natal), or during delivery (natal).

Some of the prenatal causes for hearing loss includes
a. hereditary and familial causes. Hearing loss which runs in families could be passed on to the baby through

It is during the first 3 months of the baby's development in the uterus, that different organs are formed. So any problem in the mother during this period of pregnancy can come in the way of normal development of these organs.

(b) Any infection (bacterial or viral) to the mother during pregnancy

(c) Trauma such as a fall or accident during pregnancy,

(d) Consumption of drugs by the mother like tranquilizers, sedatives, salicylates, metabolites, etc. are known to cause hearing loss in the foetus. Smoking and alcoholism can also cause maldevelopment of the ear of the unborn child.

(e) Environmental conditions like malnutrition, exposure to X-rays or other radiations during pregnancy are also dangerous. During delivery prolonged labour, instrumental delivery or a difficult labour may cause damage to the ear. Soon after birth low birth weight, delayed birth cry, or any complications in the first 24 hours like breathing pattern, sucking problem, nausea, etc. also indicates high susceptibility for hearing loss.

Hearing loss can be acquired any time after birth. It would be after

1. an attack of bacterial or viral infection (like mumps, measles, encephalitis, meningitis, typhoid, etc.
2. Because of trauma or accidental causes like hard blow on the ear, head injury, etc.
3. Drugs like streptomycin, neomycin, kanamycin, etc which are given for other diseases are harmful to the ear. They are called ototoxic drugs. Using these drugs in the treatment of other diseases can damage the ear.
4. Ear infections.

All these above mentioned causes lead to hearing loss that can range from a slight difficulty in hearing for very low or very high tones, to moderate or even severe deafness. Hearing loss could be in one or both ears.

Identification of hearing loss

Hearing loss can be identified in new borns by observing the way they respond to sound. These can easily be observed by the mother. Some of the responses to are sudden loud sounds are

1. **Eyeblink or eyelid activity**: This response may range from a slight blinking of the eyes to a contraction of the eyes and eyebrows.
2. **startle responses** : In this case there is a total response of the whole body. The arms and legs are suddenly drawn in towards the midline of the body. This lasts only for a moment.
3. **Stopping of an ongoing activity**:- A child who is crying and moving his arms and legs, in the presents of a sound stops doing so at least momentarily. This stoppage can last for a longer time.



TEN LITTLE DUCKS

TEN LITTLE DUCKS WENT OUT TO PLAY
O'ER THE HILS AND FAR AWAY
MOTHER DUCK SAID " QUACK QUACK QUACK "
ONLY NINE LI'LLE DUCKS CAME BACK.

MAMA DUCK DO YOU KNOW WHY YOUR TENTH DUCKLING
DID NOT COME BACK ? PERHAPS HE DID'NT HEAR YOU.
GET HIS HEARING CHECKED.



4. Arousal: A sleeping child or a child who is awake but quiet shows sudden body movement like eye opening, or shuddering of the whole body. If his eyes are open they may open wider or may raise his eye brows in a questioning look.

5. Turning of head away from / towards the sound:-

The head may turn towards the sound or away from the sound, or may show any movement upwards, downwards or sideways as if searching for the sound source.

Absence of any of these response in a baby may be an indication of hearing loss and it needs to be further investigated.

Some of the other signs of hearing loss are (a) Ear discharge (b) The child may rub his ear and or may complain of ear pain. This could be because of ear infection and usually there is an accompanying hearing loss.

(c) May show preference for listening through one ear. This indicates hearing loss in the other ear.

(d) Delayed acquisition of speech.

(e) Poor speech articulation.

(f) Poor performance at school.

(g) Strains to hear what is being said.

(h) Understands you better when he is facing you, rather than when is not.

These may not be always because of an underlying hearing loss, but they should not be ignored. When parents suspect hearing loss in their child, it is always safe to get a hearing test done immediately.

Testing:- Young and mentally retarded form the difficult to test group. Testing them and establishing a threshold of hearing is a challenge to audiologists today. Several, techniques have been tried to establish threshold of hearing.

In babies up till about 4 years hearing is tested by observing their behaviour in presence of sound. If any of the normal responses above mentioned are seen in the child being tested, it can be temporarily assumed that the child has normal hearing. In new borns these responses can be seen only at high intensity levels. As the baby grows it starts responding to sounds less loud. But this is not a sensitive way to test hearing, as the responses the child gives may not be reliable. So if the parents suspect hearing loss in a child and even if this type of informal hearing testing shows that the child can hear* they still have to have reevaluation done once in 3 months atleast to make sure that the child has definitely no hearing loss.

An older child about 4 years and above with normal intelligence can be trained to respond to sound. Several

techniques using toys, blocks, drums, pegs, etc. are used to make it interesting for the child. This is called 'play Audiometry'. Fairly reliable hearing threshold can be got by this method.

But this test calls for active cooperation from the child. For a child who is uncooperative for testing, other tests have to be done to rule out hearing loss, it is especially necessary in those children who have not acquired speech even after 3 years, or in children whose parents suspect a definite hearing loss, or in whom informal screening suggests the possibility of a hearing loss. These help determine the severity of hearing loss to a certain extent. These tests are the impedance audiometry and the electrical response audiometry. They can be done with un-cooperative children also, because the child can be tested under sedation.

Once the type and severity of hearing loss has been determined, treatment has to be started immediately. If the cause of the hearing loss can be treated medically or surgically, then it is done so. But if the hearing loss is sensory-neural, then the need for a hearing aid is considered, and an appropriate hearing aid is prescribed. After this, the child will need special training to learn speech. This process is generally referred to as "Speech therapy". This is done by trained Speech therapists.

However, the parents, teachers and other family members have to take active interest in this "therapy programme" to make it effective.

The main aim of such a program is "Auditory Training" or hearing training . It should be remembered that a hard of hearing child has not hear sounds, as a normal hearing child does, from the time of his birth till he starts using a hearing aid* Auditory training aims at making the child became aware of the presence of sound. The programme starts with easy hearing tasks for the child like discriminating between very different sounds. Gradually it is made more difficult. Finally, he is asked to discriminate between speech sounds that are very similar like /p/ and /b/. Auditory training aims at making the child make maximum use of the hearing that he still has left in his.

Along with auditory training, speech and language capabilities are also built up with books, toys, colour pencils, games, picnics, excursions, etc - in fact, through any means that will increase and intensify his experience. Initially these experiences are made as pleasant for him as possible by associating some tangible rewards. However the goal of such training is to see that the child himself/herself realises the value of speech and language development. The earlier the child

is identified as hard of hearing, and the earlier the rehabilitation started, the better hold it takes.

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CHAPTER 10

NOISE IS HARMFUL

"Stop that Noise"; "What a nuisance!"

Don't they sound familiar to you? I am sure they do. You must have used it yourself and heard others say it too. Noise hazard is a price human beings have to pay for advancement in civilization!

What is Noise? Noise is any sound that is unwanted, that irritates you, that gives you a headache, that makes you dizzy, that hurts your ear, that stops you from getting a good night's sleep. Noise need not have to be loud to irritate you. It need not be only as loud as a dripping tap or the buzzing of a mosquito at night; yet isn't it annoying? Noise to one person is not always noise to another. So it is rightly said that what is music to the children is noise to their parents.

But why all this interest in noise? There are other things in our environment that annoy us more!

The reason is that continued exposure to loud noise is harmful to our ears. As seen in the earlier chapter, it destroys the hair cells of the cochlea and the auditory nerve endings supplying it. Hearing loss is not noticed fast enough because it affects the higher

frequencies first. Its invasion is silent, and its effects noticed until its too late! Hence prevention is the cure!

What do we do to prevent hearing loss?

The only way to prevent it is to stop hearing noise, which is not easy to do considering noisy playthings, domestic appliances etc. that have invaded our lives} Our ear is a fantastic organ that can do unbelievable functions. No man has ever been able to devise an artificial ear, that can be compared with the natural ear, let alone replicate it; and in this era of advanced science and technology. Yet it has one main drawback It cannot completely shut off unwanted sounds reaching the ear. It does not have such a valve mechanism. So we must find out ways and means to prevent our ears from the noise we were responsible for generating!

There are noises that are continuous, noises that are intermittent, noises that are loud, noises that are soft, high frequency noises and low frequency noises. Are all noises dangerous?

It has been found that exposure to a continuous noise Level greater than 90 dB for 8 hrs/day continuously is dangerous to 95% of the people(These other 5% is either

not affected by it or need only a much lesser intensity to cause hearing loss). This "damage-risk-criteria" as it is called depends on the intensity of the noise and the duration. Eg. If a person has worked only 1 hour in a noisy area, but the noise level was about 100dB, then it causes the same damage as a 90dB tone for 8 hours. The Damage Risk Criteria also depends upon whether he was continuously exposed to a specified amount of noise or whether he was continuously exposed to a specified amount of noise or whether there were intervals of silent periods - like the coffee-break of an industrial worker. In such intervals, the ear is given a chance to recover a bit. So the Damage Risk criteria values have to be little higher, say 3-4 dB to cause danger to hearing.

Low frequency sounds, or sounds with greater energy in the low frequency area are known to cause more damage than high frequency sounds.

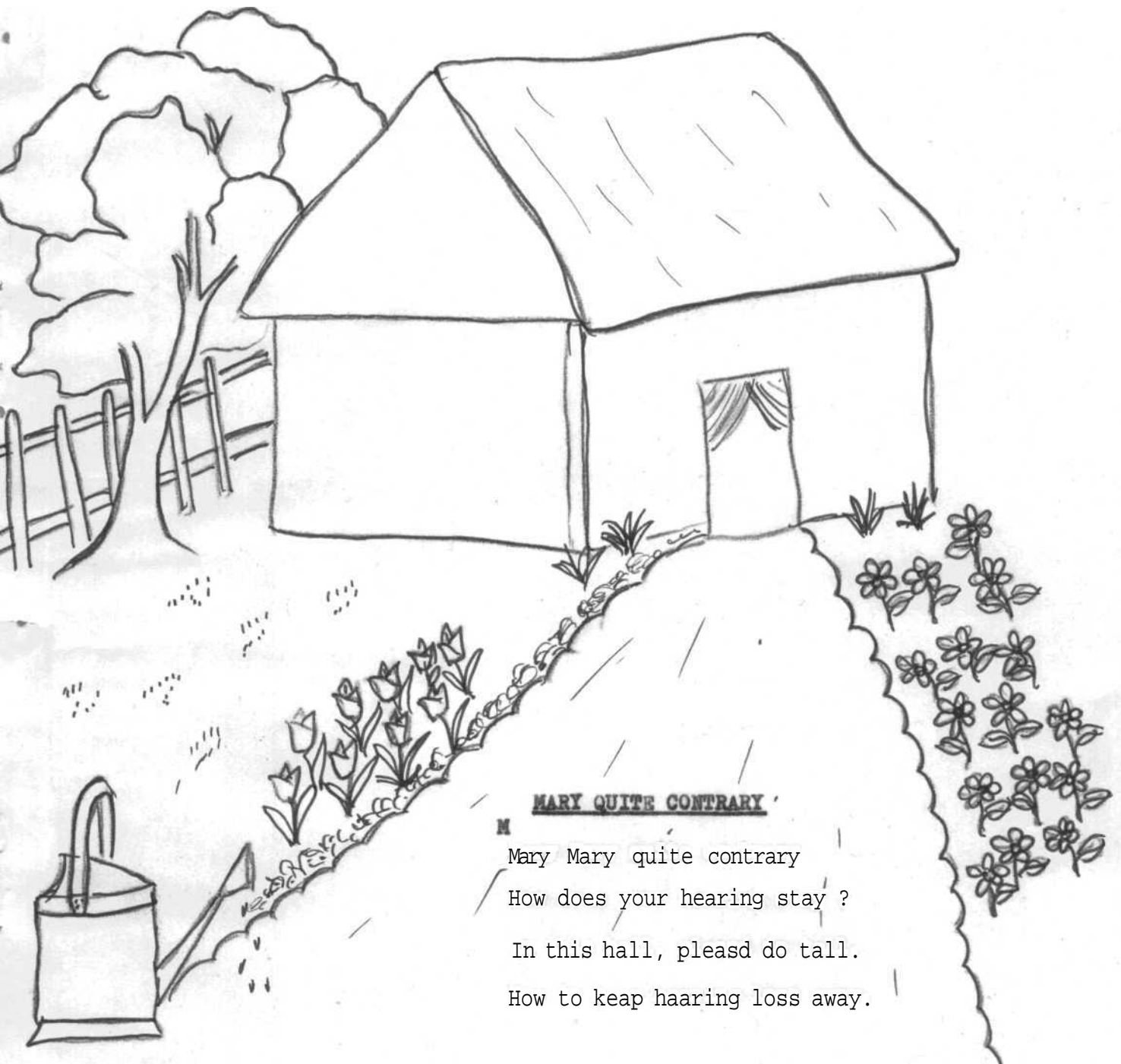
These levels of noise are seen in an industry, in a house situated near a busy highway, aerodrome, or railway station or in the homes of people who are fond of listening to a blaring roadio/record, or use kitchen appliances like a blender, washing machine, etc all together. So you see, noise can bring you problems at home too.

All steps taken to reduce noise reaching the ear can be grouped into 3 categories:

- (1) ones that employ noise reduction at the source where the sound is produced.
- (2) ones that reduce noise on its way to the listener, by stopping it during its transmission.
- (3) Stopping noise from entering the ear of the listener.

Noise at the source can be reduced by proper maintenance of the machine, proper oiling, placing them on rubber buffers, tightening loose and rattling parts, using silencers, etc. reduce noise to a large extent. So while buying an air conditioner, mixer, etc buy less noisy ones.

(2) During Transmission : This can be achieved by having either the noise generating machine separated from the workers by erecting barriers that stop sound, or by having the person work in a sound-proof chamber or by increasing the distance between the man and the noisy machine because a loud sound becomes softer as it travels over a distance). This is not a very practical thing to do, and cannot be employed especially in large factories with many men and many machines or to stop traffic noise,



MARY QUITE CONTRARY

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Mary Mary quite contrary
How does your hearing stay ?
In this hall, pleasd do tall.
How to keep haaring loss away.

Mary's ' secret : She uses ear protective devices .

(3) At the ear of the listener : This is the most effective way of reducing the level of noise reaching the ear. Wads of cotton wool, ear-plugs, flint/cotton dipped in wax), ear moulds, ear muffs and helmet are some of the materials and devices used as ear protectors to seal off the ear from the dangerous noise around.

But don't the ear protectors stop wanted sounds like speech etc. also?

Fortunately, no. infact research has shown that people hear better with their ear protectors in place!

How can we know that the noise levels are reaching the danger limits?

Easy! with the help of instruments such as a sound level meter and the accessories that go with it, the precise levels of the noise can be measured. However it's important that these measurements be done by a person who knows how to make these measurements according to procedures which have been laid down.

If this cannot be done, watch for other danger signals listed below. You must know the noise you are working in is dangerous, if

(1) You find it extremely difficult or impossible to communicate with somebody and you find your voice hoarse at the end of the day.

- (2) If you find that you have a slight hearing loss after noise exposure, but disappears after resting for sometime.
- (3) If you find that you have a slight hearing loss after noise exposure, but disappears after resting for sometime.
- (4) If you have a ringing sound or buzz in your ear after being exposed to the sound.
- (5) You experience a pain, or a piercing sensation in your ears on being exposed to noise.
- (6) If you feel giddy in the presence of sound.
- (7) If it makes you tense and disagreeable and gives you a head ache.

If you have experienced any of these danger signs, get your hearing checked too. It is a simple test and easily done, and in the long run a good investment, because the tests can show if the noise has been harmful to your ears even before you are yourself able to notice it.

BUT START USING A HEARING PROTECTOR RIGHT AWAY TO PRESERVE WHATEVER HEARING YOU HAVE.

Noise not only affects hearing, it affects other systems in the body too. It has been seen that noise exposure causes the constriction of the blood vessels, and so the blood flowing through them is reduced. This causes high blood pressure. The amount of oxygen reaching the cells is also reduced because of reduced blood supply so the person starts to breathe deeply.

Noise also creates digestive system problems over tension of the muscles, decrease in skin resistance, etc. All these reactions contribute to make a person feel tired, irritable and tense and evoke other psychological reactions in him like anxiety, depression and may ultimately cause a nervous breakdown. In short, continuous exposure to loud noise makes life miserable.

What can the Government or the industry do to prevent this?

The Government can pass laws that bans the use of machines that produce excessive noises. If it has to be used, then one of the methods of stopping the noise reaching the ear mentioned above has to be employed.

It can insist that all vehicles produce noise only within permissible limits and that the noise levels it produces be checked before the vehicles leave the factory itself. Ban the usage of loud shrill horns for vehicles.

Insist that an industrial audiologist be employed who can, from time to time, check the hearing of employees and measure the noise levels in the factory.

Insist that compensation be paid to those employees whose hearing has been damaged by the noise in the industry, or who had to resign from their job because of their hearing loss they got when on the job.

The industry can help by sticking to the rules set by the Government by providing better work conditions for the employees and by providing hearing protectors to those working in noisy situations.

You can help yourself by wearing the ear protectors (though sometimes it is not a pleasure wearing them) and remembering that noise is your enemy, try to reduce it or stay away from it. Remembering the famous quote "Ask not what your country/Industry can do for your hearing, ask what you can do for it", yours and others too!

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