Lecture 4 - Hearing loss

The Hearing Mechanism

Outer ear
- pinna
- ear canal
  - cerumen - earwax
  - mastoid bone (supports the outer ear and is the back wall of the middle ear)
  - tympanic membrane (ear drum)

Middle ear
- Eustachian tube - goes from back of throat, inner nose, to middle ear
- ossicles - tiny bones
  - malleus (hammer)
  - incus (anvil)
  - stapes (stirrup)
- oval window - under the bottom part of the stapes
- round window - relieves pressure when fluid is set in motion

Inner ear
- Semi-circular canals (balance)
- vestibule
- cochlea (end organ of hearing)
- VIII cranial nerve - auditory nerve to the brain

How Sound Travels Through the Ear
1. Sound waves are directed into the ear canal by the pinna
2. Sound waves strike the tympanic membrane (ear drum)
3. The malleus (hammer) is attached to the ear drum and the vibration causes all the ossicles to move.
4. The stapes (stirrup) moves in and out of the oval window
5. This movement causes the fluid in the cochlea to move.
6. The fluid movement in the cochlear creates an electrical signal which is sent to the brain along the auditory (VIII) nerve

Sound can be graphed

There are several important aspects of sound
1. frequency (pitch) - measured in back and forth movements of air molecules
   - the faster the vibrations, the higher the pitch humans hear frequencies between 20-20,000 HZ (cycles/second)
   - children can hear higher pitches than adults
   - we cannot hear some pitches that several animals can hear
2. amplitude (loudness)
   - how far the movement of the molecules is from the midline
   - farther away, sound is louder
   - measured in decibels (dB)
     - 0 dB - the quietest sound the normal ear can hear
     - 60 dB - how loud we generally talk
     - 120 dB - can actually cause pain
3. Timbre (quality)
   - simple sounds - also called "pure tone" - vibrating at a single frequency (pitch)
   - rarely hear pure tones
   - in real life, most sounds are complex tones - combination of 2 or more simple tones

SUMMARY
- anything can vibrate
- when it vibrates, it makes a sound
- the vibration causes the nearby air molecules to move
- speaking produces a form of vibrating waves of air
REMEMBER
sound has both intensity (loudness) and a frequency (pitch)
intensity (loudness) is measured in decibels (dB)
frequency (pitch) is measured in Hertz (Hz) - cycles per second

How to test for a hearing loss
Need exams by
  a medical doctor
  an audiologist
Use a device called an audiometer

Frequencies and intensity tested
  250 Hz
  500 Hz
  1000 Hz
  2000 Hz
  4000 Hz
  8000 Hz
(eespecially important - speech frequencies - 500, 1000, 2000)

Intensity - minus 10 dB (-10 dB) to 100 dB

Results are recorded on an AUDIOGRAM

Pure tone Testing
  air conduction - sound is presented into the ear
  tests both for neural and conductive loss
  bone conduction - tests only the INNER ear

Conductive hearing loss
  air-bone gap - bone conduction is better than air conduction
  problem is with the outer or middle ear
  sound is not LOUD enough - problem with the QUANTITY of sound

Sensori-neural hearing loss - air and bone conduction are the same
  problem is in the inner ear, nerve of hearing or hearing parts of the brain
  problem with the QUALITY of sound - not CLEAR enough

Speech audiometry
  speech recognition thresholds
  speech detection thresholds
  tests of word discrimination

Hearing disorders

Prevalence
  28 million Americans
  27.8 million people in China (2008)
  Incidence increases as people get older
  Sensorineural loss - 17 million

Effect of the hearing loss depends on
  1. how severe the loss is
  2. when the loss started
  3. how much residual hearing is left
  4. type of hearing loss

Severity of loss
  normal hearing is 0-20 db
  mild hearing loss is 20-50 dB
  moderate hearing loss is 50-70 dB
severe hearing loss is 70-90 dB
profound hearing loss is 90 dB or greater

Types of hearing loss
unilateral - one ear
bilateral - both ears
conductive
sensori-neural
mixed

Conductive hearing loss
involvement of the outer ear
congenital atresia
blockage of the ear canal
infection
injury to the ear drum (tympanic membrane)
middle ear infection (otitis media)
myringotomy
cholesteatoma
otosclerosis

Sensori-neural hearing loss
may be hereditary
may be non-hereditary
rubella (German measles)
RH factor
infection to the mother in first 3 months of pregnancy
acquired
during childhood
viral infections
any illness with high fevers
meningitis
NOISE INDUCED - can happen to anyone
sounds above 80 DB are considered potentially hazardous
ways to prevent noise-induced hearing loss
hearing protectors
tumor
vasospasm
Meniere's disease
ototoxic drugs
presbycusis - hearing loss that comes with getting older

Signs which should lead you to suspect a hearing loss, especially in children

In the BEHAVIOR of the child
pays more attention to things he can SEE
understands better when he can see the speaker’ face
holds head in abnormal position
seems bored or restless
misunderstands
doesn't respond when questioned
asks you to repeat a lot
gives wrong answers
interrupts without being aware of it
withdraws from group conversation

In the HEALTH of the child
has lots of colds, earaches, draining ears, is a mouth breather
complains of ringing in the ears or "stopped-up" ears
has an illness with a high fever

In the SPEECH of the child
talks louder or more softly than you'd expect
can't tell the difference between certain words - thumb-some
omits or distorts sounds, especially higher frequency sounds
has a monotonous voice
denusal voice

Some hearing losses are treated MEDICALLY
Conductive losses
reconstruct the pinna
remove what is in the ear canal
treat middle ear infection
surgery
Sensory neural losses - cochlear implants
for people who cannot benefit from hearing aids
controversial

What is on the outside of a cochlear implant
Microphone
signal processor
Transmitting coil

What is on the inside of a cochlear implant?
magnet
receiver
two electrode arrays

How does a cochlear implant work?
Microphone picks up sounds and send to processor
Processor selects and codes sounds
Sounds (radio waves) go through the skin to the receiver
Sounds are changes into electrical signals
Auditory nerve is stimulated and sends sound to the brain

Summary
Cochlear implants do not make hearing "normal"
Some are helped a lot. Others are helped less
They do not make a deaf person into a hearing person.

Some hearing losses are treated with HEARING AIDS
are several types of hearing aids

A speech-language therapist helps a person with hearing loss
Oral language training
vocabulary
syntax
speech and voice rhythm training
Auditory training - learning to listen
Speech-reading (lip reading)
homophonous words - look the same on the lips
Non-verbal communication training
sign language
finger spelling
Cued speech
Tactile speech

Communicating with people who are hearing impaired
Make use of what the person can SEE
Ask questions
Control the environment
Become familiar with the topic
Repeat and rephrase
A few more things to remember