Adult SNHL: Hearing Aids and Assistive Devices

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Hearing loss affects 28 million Americans
Sensorineural Hearing loss 17 million
People with hearing loss suffer emotional, social and communicative dysfunction
Only to increase with aging population
History

- 1551: Bone conduction device consisting of metal shaft or spear
- 1670: Sir Samuel Moreland, England invented a large speaking trumpet
- 1892: First patent for electric hearing aid in the U.S.
- 1912: First volume control for a hearing aid
- 1931-first electric hearing aid eyeglass patent
- 1937-first wearable vacuum tube HA in US
- 1953-first all-transistor hearing aid
SNHL

- Attenuation
- Recruitment
- Distortion
Attenuation

- Loss of auditory sensitivity
Recruitment

- A large increase in the perceived loudness of a signal produced by relatively small increases in intensity above threshold.
Distortion

- Qualitative effect: when sound is heard sufficiently loud, its quality in other terms may be poorer than for normal hearing listener.
- Makes hearing in background noise difficult.
Conventional Hearing Aids

- Only 10-20% use hearing aids
- 4.5 million hearing aid users
- 12% who have them don’t wear them
- Only 58% “very satisfied”
Basic Hearing Aid Structure

FIGURE 155.1. Basic components of a hearing aid system.
Hearing Aid Types

- Body Aids
- Behind-the-ear (BTE)
- In-the-ear (ITE)
- In-the-canal (ITC)
- Completely-in-canal (CIC)
- CROS and biCROS
BTE

- Attached to earmold
- Powerful
- Wide range of HL
- Can have open earmolds
- Less repair problems
- Less feedback
- Telecoils
Disadvantages

- Large size
- Does not take advantage of pinna and concha benefit
- Vulnerable to scalp perspiration
- Microphone above pinna
ITE

- Fits in concha
- Microphone at ear canal level
- Mild to severe HL
Disadvantages

- Visible
- Does not take advantage of pinna and concha
- One piece design
- Need some dexterity to insert
ITC

- Only face sticks out into concha
- Wide range of HL
- Microphone at opening of ear canal
- Takes advantage of most of the auricle
Disadvantages

- Easily dislodged
- Need dexterity for insertion/removal/adjustment
CIC

- Hidden in canal
- Full effect of auricle
- Receiver very close to tympanic membrane so requires less amplification
Disadvantages

- Patient needs very good dexterity to place and remove
- Easily lost because of small size
- Some circuitry not available in this size
- Feedback can be a problem
CROS

- Contralateral routing of signal
- Use with good hearing ear a bad hearing ear
- Prevents “head shadow effect”
- Microphone at bad ear sends signal to good ear
biCROS

- Used with bad hearing ear and poorer hearing ear
- Same routing of signal from poorer hearing ear
- Provides amplification to better ear
Circuitry

- Analog
- Linear
- Compression
- Digitally controlled analog
- Digital signal processing
Analog

- The majority of hearing aids are still analog or digitally programmable analog
- Converts acoustic to mechanical to electrical signal and then back
Linear amplification

- Oldest type of hearing aid amplification
- Amplifies all inputs same amount
- Does not address nonlinear nature of loudness growth in SNHL
- Uses peak clipping to prevent reaching LDL
- Causes substantial distortion at high input levels
Compression

- Control of hearing aid output to within dynamic range
- Weak intensity inputs are amplified more than high intensity
- Nonlinear relationship
- Cuts down on distortion and uncomfortable output levels
Compression

Figure 2. Input-output function of a hearing aid with linear amplification and peak clipping and a hearing aid with nonlinear dynamic range compression and compression limiting (adapted from Killion).
Digitally controlled analog

- Multiple parameters can be adjusted under computer control
- Allows more options in smaller size aids
- One size fits all production
- Can adjust HA easily as hearing loss progresses or fluctuates
- Memories for special listening situations
Digital Signal Processing

- Latest technology
- Converts sound to numerical data
- Higher fidelity “CD quality sound”
- Allows for more complex algorithms for control
Microphones

- Directional versus omnidirectional
- Using Directional can be helpful in noisy situations
- The best hearing aids can switch between the two.
Assistive Listening Devices

- Provide assistance for special situations
- Alarm devices and communication devices
- Include devices for listening to television or radio, being made aware of a fire alarm, doorbell ringing, TTY
- FM systems in which input to a microphone is sent to a headset or directly to HA
TV Ears ®
Implantable Devices

- Bone anchored hearing aids (not for SNHL)
- Middle ear implants
- Cochlear implants
Middle Ear Implants

- Devices being researched that attach to the tympanic membrane, ossicular chain, even the round window membrane
- One device recently approved for use is the Vibrant Soundbridge System
- Transformation of sound to vibrations via electromagnetic device which directly move the ossicular chain
- Eliminates feedback, occlusion effect, cuts down on distortion
The Implant
The Vibrant Soundbridge

Audio Processor

VORP™ (Implanted Receiver)

Floating Mass Transducer
The Audio Processor Is Easily Concealed
Cochlear Implants

Adult Selection Criteria

- At least 18yo
- Bilateral severe-to-profound hearing loss
- Minimal benefit from conventional hearing aids
- No medical contraindications for surgery
- Results best in postlingually deaf
Mechanics

- Contain 3 main parts:
  - Microphone
  - Speech processor
  - Implanted electrode array
- Inner coil is placed in a cavity created in the skull during surgery
- Electrode array is placed through a cochleostomy into the scala tympani
- Multichannel, multielectrode implants take advantage of the tonotopic organization of the cochlea
Benefits

- Patient is able to hear conversation and environmental sounds at comfortable levels
- Detection of warning signals
- Almost all have improved lip reading
- Improved communication in quiet and noise without lipreading
- 35-51% can, with limited ability use the telephone.
- Sentence recognition scores improve in the majority of patients
Case Study

A 74 yo female presents to your clinic stating that her hearing has slowly worsened in both ears which is making conversation difficult, especially with background noise. An audiogram demonstrates a symmetric moderate to severe high frequency SNHL. Physical exam is normal. She has bad arthritis in her hands and has difficulty handling small objects. She has come for advice on hearing aid choice.