Hearing Aids 1

CDS 484/529 Aural Rehabilitation
What does a HA do?

- Makes speech audible
- Optimizes intelligibility
- Assures optimal dynamic range

Hearing aids do not restore hearing to normal!
History of Hearing Aids
Improvements

- Advanced circuit design
- Digital/programmable
- Probe mic verification
- More functions
- Smaller
- Better sound quality
- More reliable
Use of Hearing Aids

- 5-6 million people need HAs
- 20% of individuals who need HAs actually wear HAs
- Cost of a single HA:
  - Digital: $1000 - $3000
  - Most insurance companies do not pay for HAs
Basic Components of Hearing Aids

- Microphone
- Amplifier
- Speaker
- Battery
Basic Components of Hearing Aids

- **Microphone:**
  - Pick up sound from environment and convert acoustic energy to electrical energy

- **Amplifier:**
  - Increase the amplification of the electronic/digital signals

- **Speaker (receiver):**
  - Convert electrical signals to acoustic signals

- **Battery:**
  - Last for 3-4 days to 3-4 weeks depend on the size of the battery and the duration of everyday usage.
  - Come in different sizes with the same voltage: 1.45 v
1. Microphone
2. Microchip
3. Amplifier
4. Battery
5. Receiver
Microphone

- Converts sound waves to electrical signals

- Susceptible to:
  - Moisture, water
  - Vibrations
  - Wind noise
  - Internal electrical noise
**Microphone**

- **Omni-directional microphone:**
  - Pick up sounds from all directions

- **Directional microphone technology:**
  - Conventional directional microphone
  - Dual microphones
  - Microphone array
Ideal Conditions for Directional Technology

- The noise originates from behind the HA user
- The speaker is in front of the HA user
- The HA user is close to the speaker
- The room has low reverberation
Amplifier: Increases and Strengthens the Signal

Technological advances:
1. Conventional - already gone
   - An analog circuit: can not be adjusted
   - Without dynamic compression
2. Programmable - already gone
   - An analog circuit: can be adjusted, but the flexibility is limited
3. Digital - all hearing aids are now digital technology
Amplifier

- Digital hearing aids: a sound processor
  - Monitors input sounds before amplifying them
  - Automatically adjustable
  - More frequency channels
  - More functions
Two Ways to Control the Level of HA Output

- **Method one: Peak clipping**
  - Cut all above a certain level
  - Adds distortion
  - Sounds unnatural
Two Ways to Control the Level of HA Output

- Method two: Compression
  - Compresses the peak
  - Reduces distortion
  - Comfortable, less harsh
  - Is electrically treated, not acoustically
  - The cut-off level is determined based on the patient’s uncomfortable level
Speaker (Receiver)

- Is an output transducer
- In general, larger receivers can supply louder output signals
- Is vulnerable to damage from ear wax
- Is vulnerable to moisture
Electroacoustic Properties of Hearing Aids

- **Gain**: How much has been added to the input (dB)
- **Output**: The total amount of sound that a HA can produce: Gain + Input (dB SPL) + Output
- **Maximum power output (MPO)**: The maximum possible acoustic output of a HA
- **Distortion**: The amount of unwanted signals or noise amplified
- **Equivalent noise**: The amount of noise produced when there is no input signal
Gain Example

- Input level: 30 dB SPL
- Output level: 80
- Gain = ?
- Most hearing aids have different gain levels for soft, moderate and loud incoming sounds
Battery

Battery sizes:

- **10** (or 230)
- **312**
- **13**
- **675**

How long will a battery last?

Why is there a tab on the zinc battery?
Hearing Aid Styles

- Body Aid
- Eyeglass Aid
- BTE Hearing Aid
- ITE Hearing Aid
- ITC Hearing Aid
- CIC Hearing Aid
- Bone Conduction hearing aid
- Implantable hearing aid
Body Aids

- Used in patients with:
  - very severe hearing loss
  - severe visual or handling problem

- Problems:
  - cosmetic concerns
  - wire breaks
  - inconvenience
  - body buffing noise from clothing
  - directional hearing

Eyeglass Aids

No longer in use
Behind the Ear (BTE)

- Microphone, amplifier, and speaker are located in a small case that is worn behind the ear.
- Sounds are delivered to the ear via a tube and an earmold.
- Fit all types and levels of hearing loss.
Behind the Ear (BTE)

Advantages:
- Most powerful
- Wide frequency response
- Less feedback noise
- Easy to handle
- More options

Disadvantages:
- Cosmetic concerns
- Wind noise
Behind the Ear (BTE)

- Best option for Children:
  - Change only the earmold as the child grows.
  - Safer when using a soft earmold
  - Most have a FM system option which is important for the school setting

http://w1.siemens.com/innovation/pool/highlights/healthcare/in20080902-01_458_276_wd.jpg
Open-Fit BTE

- Eliminates the occlusion effect
- Cosmetic appeal
- Suitable for patients with mild to moderate high frequency loss
In the Ear (ITE) and in the Canal (ITC)

- In the ear:
  - Fit in the whole concha
- In the canal:
  - Fit small portion of concha
- No external tubes or wires
In the ear (ITE) and in the canal (ITC)

**Advantages**
- Reduce the cosmetic concern
- Fit more securely in the ear than a BTE
- Less expensive than smaller models

**Disadvantages**
- Less fitting range, not suitable for severe hearing loss
- Wax problems
- More prone to feedback
Completely-in-the Canal (CIC)

- Cosmetic appeal
- Completely in the canal and pulls out with a thread
- Less wind noise
- Better for high frequency amplification due to:
  - Microphone location
  - No obstruction in the concha
Completely-in-the Canal (CIC)

Problems:

- Susceptible to damage (2-3 times more damage) and expense to repair
- Short battery life
- Easy to be blocked by ear wax
- Difficult to handle
- Less fitting range
- More expensive
Bone Conduction HA

- Used in patients with:
  - Chronically draining ear
  - Malformation of the middle/external ear (i.e. microtia)
  - Bilateral conductive loss due to ossicular disease who are not appropriate for surgical correction and are unable to be aided by a conventional air conduction device.

- Problems:
  - Pressure on the bone cause discomfort
  - Loss of the sensation of sound localization
Implantable HA

Benefits:
- Eliminates pressure buildup, feedback and distortion

Problems:
- Needs surgery to implant the device
- Needs a body part
- Has to be removed if MRI is needed

Phone Options of HA

- Telecoil (T coil):
  - Used for connecting directly to phone
  - Responds to magnetic fields rather than sounds
  - Usually controlled by a switch
  - Limitation: blank spots due to the unevenly-distributed magnet field

Phone Options of HA

- Bluetooth (wireless):
  - Hearing aids are paired to their call phone directly or with the use of a remote
Options for HAs

- On-off switch - must request now, not found on most HAs
- M (microphone), O (off), T (telecoil)
- Closing/opening the battery door

http://www.babyhearing.org/images/HearingAmp/Choices/hearing_aid.jpg
Options for HAs

- **Volume control:**
  - Most digital HAs do not need it
  - Experienced HA users often prefer it

- **Program switch:**
  - Select program to meet the differing listening conditions

- **Remote control**
Program Options

- Varies by level of technology and manufacturer:
  - Master/standard
  - Comfort/restaurant
  - Music
  - TV
  - Tinnitus sound therapy
  - Phone options
Coupling Choices

- Standard custom earmold
- Open fit domes
- Closed power domes
The Earmold for Behind-the-Ear HA

- Function: deliver sounds from a HA to the ear canal
- Composition: the mold and the tubing
- Comes in many different styles, sizes, and materials (silicone, acrylic)
Venting for HA

- Present in almost all HAs

- Function:
  - Reduces low freq (500 Hz and lower) gain
  - Reduces the occlusion effect
  - Minimizes moisture buildup between mold and ear drum

- Problem:
  - Can cause feedback, which can be corrected by adding a vent plug or narrowing the vent diameter
Modifying the Earmold and/or Tubing

- Affects the property of acoustic signals
- Venting: affecting low frequencies
- Damping: affecting mid-frequencies
- Horn tubing: affecting high frequencies
How to Describe an Audiogram (Hearing Loss)

The description of a HL should include:

- Lateralization:
  - symmetric vs. asymmetric
  - Or bilateral vs. unilateral
- Degrees: mild, moderate...
- Configuration: flat, sloping
- Types: Sensorineural, conductive or mixed HL

Bilateral mild to moderate flat sensorineural hearing loss
Normal hearing right ear, mild to moderate sloping sensorineural hearing loss above 1 kHz in the left ear
Bilateral mild to moderate flat conductive hearing loss