

Chapter 2: Hearing Aids and Hearing Assistive Technologies

Learning Outcomes

Upon completion of this chapter, readers should be able to:

- List the four basic components found in hearing aids
- Describe each of the following types of hearing aids: in-the-ear, behind-the-ear, completely-in-the-canal, and bone-anchored
- Define acoustic feedback
- Identify the three factors to consider when determining hearing aid candidacy
- Describe what gain, frequency response, and maximum output refer to regarding the electroacoustic properties of a hearing aid
- List nine elements that should be included in a hearing aid orientation with a new hearing aid user
- Define assistive listening devices (ALDs)
- Explain contralateral routing of the signal fittings
- Distinguish between frequency-modulated (FM), infrared, and audio-loop listening systems
- Explain closed captioning and its uses

Relevant Knowledge and Skills Acquisition (KASA) Standards

A18, D1, D2a, D6, D7, F1

Outline

Introduction

History of Amplification

Hearing Aid Components

Microphone

Amplifier (Digital Processor)

Receiver

Batteries

Hearing Aid Styles

Behind-the-Ear

In-the-Ear/Completely-in-the-Canal

Receiver-in-the-Canal

Extended-wear Hearing Aids

The Earmold

Who Is a Hearing Aid Candidate?

Degree of Hearing Loss

Degree of Communication Disability

Motivation to Use Amplification

Hearing Aid Fitting Protocol

Selection

Quality Control

Fitting

Hearing Aid Orientation

Validation/Outcome Measures

Pediatric Fittings

Special Fittings

Contralateral Routing of the Signal (CROS) Fittings

Bone-Conduction Hearing Aids

Bone-Anchored Devices

Middle Ear Implantable Hearing Aids

Cochlear Implants

Hearing Assistive Technology or When a Hearing Aid May Not Be Enough

Types of Assistive Devices

The Role of the Audiologist in Hearing Assistive

The Bottom Line: Cost Management and Payment for Hearing Aids and HATS

Summary Points

- The basic components of a hearing aid are the microphone, amplifier, and speaker (receiver). Using algorithms designed to improve speech perception, modern digital instruments are programmed to individualize the fitting.
- Hearing aids come in a variety of styles, including BTE, ITE, ITC, and CIC models.
- Earmolds and all ITE hearing aid shells are often molded to fit the client's ear and couple the hearing aid to the ear. The audiologist can use the ear- mold's style, tubing, venting, and damping to change the sound going into the ear.
- Hearing aids are appropriate for individuals with hearing loss that cannot be medically or surgically remediated. The fitting process must include a full hearing evaluation and an evaluation of the client's communication difficulties and motivation.
- Most individuals with hearing loss benefit from wearing two hearing aids: a binaural fitting. A hearing aid in both ears improves listening in background noise and helps in sound localization.
- Hearing aid fitting protocols must include selection of the device, quality control, orientation/fitting, and validation with outcome measures. All aspects of the protocol are vital to a successful hearing aid fitting.
- Individuals with unilateral hearing loss can benefit from CROS hearing aids or implantable bone-anchored hearing aids.
- Successful pediatric fittings require a team approach with members including the audiologist, speech pathologist, teachers of the deaf and hard of hearing, and the parents. The audiologist must ensure that the wearer or, in the case of the pediatric fitting, the caregivers know how to remove and work the controls, troubleshoot the instrument, do a listening check, and care for and clean the instruments.
- HATS/ALDs are designed for specific listening situations, such as television, telephone, or auditorium listening. ALDs can be helpful for people with hearing loss and also helpful to all of us when in difficult listening environments, such as watching television in the airport by using the captions.

Chapter 2 Question Test Bank

Multiple Choice (Select the best, most complete answer.)

1. Which of the following could not cause a BTE hearing aid to cease functioning properly?
 - a. Broken cord to external receiver

- b. Bad battery
 - c. Earmold plugged with cerumen
 - d. Malfunctioning microphone
2. Which of the following assistive devices is especially suited for use by the deaf for telephone communication?
- a. Telephone amplifier
 - b. TDD or Relay
 - c. Infrared transmitter/receiver system
 - d. Closed captioning device
3. Which of the following is/are true concerning hearing aids?
- a. In-the-canal hearing aids generally are not appropriate for clients with profound hearing loss.
 - b. CROS hearing aids are a good option for cases with bilateral conductive hearing loss.
 - c. The shell of an ITE hearing aid is custom made for each person to be fit.
 - d. Two of the above
4. Which device designed to assist in telephone use by those with hearing loss is found inside a hearing aid?
- a. TDD
 - b. CROS
 - c. Telecoil
 - d. Call waiting
5. Which set of frequencies is used in computing a hearing aid's HF Average Full-On Gain and OSPL-90 values?
- a. 1000, 1500, and 2000 Hz
 - b. 500, 1000, and 2000 Hz
 - c. 1000, 1600, and 2000 Hz
 - d. None of the above
6. Of the components of a hearing aid fitting discussed, which contributes most to the success of the patient adapting to amplification?
- a. The most advanced hearing aid technology available
 - b. A motivated patient with realistic expectations
 - c. An experienced professional
 - d. A good quality hearing aid
7. A patient with realistic expectations regarding his/her hearing aids understands that:
- a. With advances in technology, little or no maintenance is required in the upkeep of today's hearing aids.
 - b. Hearing aids need never be noticed by other people.
 - c. Hearing aids may not help in every communication setting
 - d. Most insurance policies cover at least some of the cost of hearing aids.
8. The main difference between analog and digital hearing aids is:
- a. digital hearing aids are smaller because fewer components are needed
 - b. how the sound is processed
 - c. digital hearing aids are programmable, analog aids are not
 - d. digital hearing aids always result in greater patient satisfaction
9. The main components of all electronic hearing aids include:
- a. microphone, amplifier, power supply, frequency rectifier
 - b. power supply, volume control, A/D converter, acoustic coupler
 - c. receiver, integrated circuit, acoustic coupler, microphone
 - d. microphone, receiver, power supply, acoustic coupler
10. Which hearing aid component transduces acoustic energy to electrical energy?
- a. microphone
 - b. A/D converter

- c. receiver
 - d. rectifier
11. Hearing aids may be turned on and off using all but which of the following methods?
- a. MTO switch
 - b. detent in the volume control wheel
 - c. remote control
 - d. disconnecting the receiver
12. Telecoils:
- a. are included on all hearing aids except CICs
 - b. are only helpful when using telephones (as the name implies)
 - c. work on the principle of electromagnetic induction
 - d. are only available with digital hearing aids
13. Two methods of limiting output are:
- a. peak clipping, distortion reduction
 - b. compression amplification, transducer control
 - c. ethereal transduction, peak clipping
 - d. peak clipping and compression amplification
14. The term “Dynamic Range” refers to:
- a. the range of frequencies that an individual can hear
 - b. the range of usable hearing, defined by the softest sounds an individual can hear and the loudest sounds he/she can tolerate.
 - c. the range of sounds a hearing aid can process
 - d. a 5,400 acre ranch located outside of San Antonio, Texas
15. A rule of thumb when choosing the style of hearing aid for a patient is:
- a. An increase in size results in an increase in cost
 - b. An increase in size results in an increase in fitting range
 - c. A decrease in size results in a decrease in cost across all technologies
 - d. A decrease in size results in an increase in available options
16. All of the following are true regarding the OSPL of a hearing aid except:
- a. should be set according to the patient’s LDL
 - b. it is the most critical setting for a successful fitting
 - c. describes the On-going Sound Pressure Level of a hearing aid
 - d. it is the highest level of sound the hearing aid can produce
17. According to ANSI S 3.22 (2003), the basic test parameters for an electroacoustic check of a hearing aid include all but which one of the following:
- a. gain
 - b. volume control taper
 - c. compression characteristics
 - d. maximum power output
18. When the input signal is 45 dB and the output from the hearing aid is 95 dB, the gain value is:
- a. dependent on the compression ratio
 - b. 50 dB
 - c. 2.1 dB
 - d. 95 dB
 - e. 5. 140 dB
19. Gain is defined by the formula:
- a. $\text{output} - \text{input} = \text{gain}$
 - b. $\text{input} - \text{output} = \text{gain}$
 - c. $\text{input} + \text{output} = \text{gain}$
 - d. $\text{output} / \text{input} = \text{gain}$

20. Which of the following is not a purpose for earmolds?
- couple hearing aid to ear
 - dampen wind noise in the ear canal
 - prevent feedback
 - alter the frequency response of the sound reaching the ear canal
21. A CROS hearing aid:
- puts a microphone on the bad ear, the receiver on the good ear
 - puts a microphone on the good ear, the receiver on the bad ear
 - puts a microphone on the bad ear, a receiver on each ear
 - puts a microphone on either ear, does not need a receiver
22. The following are common types of earmolds:
- integrated, tube type, skeleton
 - resonator, custom molded, tube type
 - shell, skeleton, canal
 - diotic, tube type, custom molded
23. BAHA stands for:
- Better Acoustic Hearing Aid
 - Bone Advanced Hearing Accessory
 - Bilaterally Available Hearing Amplification
 - Bone Anchored Hearing Aid
24. An earmold can be used to do all but which one of the following:
- improve the signal to noise ratio
 - allow low frequency amplification to escape from the ear canal
 - reduce the occlusion effect
 - allow normal input of unamplified sound
25. The right hearing aid style for an individual can be determined by considering all but which of the following:
- cosmetic concerns
 - physical limitations
 - financial concerns
 - whether a digital or analog hearing aid is needed
26. According to your text regarding Hearing Assistive Technology, all of the following are examples of the different categories of Assistive Devices except:
- Hardwire devices
 - Infrared systems
 - Hearing Aids
 - Audio loop systems
 - Telephone Listening Devices
27. Binaural amplification for a person with a bilateral hearing loss is a more desirable option than a monaural fit because:
- Speech perception is optimized when in difficult listening settings.
 - Sound localization is enhanced.
 - Hearing is more natural and balanced.
 - All of the above.
28. Which set of frequencies is used in computing a hearing aid's HF Average Gain and OSPL-90 values?
- 1000, 1600, and 2500 Hz
 - 500, 1000, and 2000 Hz
 - 1000, 1800, and 2000 Hz
 - None of the above
29. The speaker component in a hearing aid is also referred to as a(n):
- amplifier

- b. receiver
 - c. gain control
 - d. coupler
30. Gain is described by all but one of the following:
- a. The level of internal noise generated by the hearing aid
 - b. Describes how much the input signal is amplified
 - c. The difference between the output SPL and the input SPL
 - d. is different as the volume control on an amplifier is adjusted
31. Which auditory system has a transmitting system which will generally keep the signal from being transmitted outside of the space where it is contained?
- a. FM
 - b. ILA
 - c. Infrared
 - d. FM/ILA
32. All of the following types of hearing aids have internal receivers:
- a. Body aid, BTE, ITE
 - b. BTE, ITE, CIC
 - c. Body aid, ITC
 - d. ITE, eyeglass aid, body aid
33. When the input signal is 30 dB and the output from the hearing aid is 75 dB, the gain value is:
- a. 45
 - b. 50
 - c. 60
 - d. 75
 - e. 140
34. Which of the following is not a purpose for earmolds?
- a. couple hearing aid to ear
 - b. prevent damage of hearing aid receiver
 - c. prevent feedback
 - d. alter frequency response of hearing aid
35. All amplification systems include three basic components:
- a. microphone, speaker, receiver
 - b. microphone, receiver, output limiter
 - c. tone control, output limiter, volume control
 - d. receiver, amplifier, microphone
36. Distortion:
- a. is present when the output signal is changed unfavorably from the original signal
 - b. is when sound is made louder than it was originally
 - c. is when sound is amplified
 - d. always improves the clarity of sound
37. The Count the Dot audiogram is used:
- a. to estimate the OSPL90
 - b. to estimate the aided SRT
 - c. to estimate the percent of speech that is audible
 - d. to estimate the degree of hearing loss
38. Dynamic range refers to the area between:
- a. SRT and discomfort level
 - b. 125 Hz and 8000 Hz

- c. no gain and full on gain
- d. pure tone average and SRT

True / False

- 39. A hearing aid fitter can use real ear measures to see if the gain is adequate.
- 40. Individuals with losses of 26-30 dB who also experience communicative difficulty will not benefit from amplification because they are so close to normal limits.
- 41. Most candidates for hearing aids are people with sensorineural hearing loss.
- 42. Feedback happens because signals or acoustic energy from the output goes from the receiver to the microphone over and over.
- 43. The uncomfortable level for a person gives us a guide in setting the tone control on the hearing aid.
- 44. One purpose of the ear mold is to transmit sound from the receiver to the ear canal without bothersome feedback.
- 45. A cochlear implant costs between \$4000 and \$6000
- 46. Zinc air cell batteries generally are not affected by “shelf life” problems observed with other types of batteries.
- 47. BTE, eyeglass and ITE hearing aids all use tube type molds.
- 48. OSPL 90 is the average sound pressure level when volume is 1/2 on and input is at 90 dB.
- 49. Acclimatization makes it harder to fit hearing aids and know what they will do two months later.
- 50. Equivalent input noise is the prescribed way to measure environmental noise.
- 51. It is very important that the earmold provide a very tight seal when used in a slight/mild hearing loss case in order to prevent bothersome feedback.
- 52. The microphone is an example of a transducer.
- 53. Cases with conductive hearing loss should never be fit with a hearing aid.
- 54. Internal noise is the relationship between acoustic signal and electrical background sounds arising from the amplifying device.
- 55. Frequency response characteristics of an amplification system are determined entirely by the response of the microphone.
- 56. Although digital amplification is becoming increasingly common, ITC and CIC hearing aids cannot utilize digital circuitry at the present time due to size issues.
- 57. CROS hearing aids are designed for use with persons having a profound loss in one ear and normal hearing in the other ear.
- 58. The new bone-anchored hearing aid was designed to be used with cases having bilateral sensorineural hearing loss.
- 59. If a BTE hearing aid squeals while in the person’s ear, the earmold may be too small or may not fit well.

60. Hardwire assistive listening devices utilize FM radio wave technology to provide improved signal –to-noise listening ratios for users.
61. Assistive Listening Devices can only be used by those with telecoils in their hearing aids.
62. The purpose of directional microphones is to increase the signal to noise ratio for the wearer.
63. Real Ear Measurement is one method of determining whether or not hearing aids are properly adjusted for the patient’s hearing loss.
64. Behind-the-ear hearing aids can fit any degree of loss except slight to mild.
65. In attempting to determine which hearing aid to fit on an individual, obtaining optimum acoustic results is most important, and cost should not be considered.
66. With an Inductive Loop system the amplified signal is fed to the user through an electromagnetic field.
67. One major advantage of group amplification systems is that they can improve signal to noise ratio for multiple listeners.
68. The frequency response of a hearing aid describes the amount of gain at each frequency.
69. ALDs using FM technology are only available for group systems.
70. The “C” in HIO-BASICS stands for “Compression”.
71. FM systems will often produce a better signal-to-noise ratio for the listener than conventional hearing aids in a classroom setting.

Short Answer /Essay

72. List two major ways in which using binaural hearing aids is significantly better when compared with using a single hearing aid for a person with significant hearing loss in both ears.
73. Identify three different specialized devices which a hearing impaired person might find helpful in using the telephone.
74. List the elements and briefly describe the HIO BASICS.
75. List and briefly describe the elements of the CLEAR handout.
76. List five hearing aid styles and briefly describe an advantage and disadvantage of each.
77. Explain why each of the following hearing aid characteristics is important to consider when selecting the correct hearing aid for an individual (6 pts.).
 - a. gain
 - b. frequency response
 - c. maximum output
78. Briefly define/describe each of the following as they pertain to hearing aids or cochlear implants:
 - a. Telecoil
 - b. Venting
 - c. Electroacoustic analysis
 - d. Audibility Index (AI) (Count-the-dots)
 - e. CIC
 - f. Acclimatization

Chapter 2

Multiple Choice

1. a
2. b
3. d
4. c
5. d
6. b
7. c
8. b
9. d
10. a
11. d
12. c
13. d
14. b
15. b
16. c
17. b
18. b
19. a
20. b
21. a
22. c
23. d
24. a
25. d
26. c
27. d
28. a
29. b
30. a
31. c
32. b
33. a
34. b
35. d
36. a
37. c
38. a

True/False

39. True
40. False
41. True
42. True
43. False
44. True
45. False

46. True
47. False
48. False
49. True
50. False
51. False
52. True
53. False
54. True
55. False
56. False
57. True
58. True
59. True
60. False
61. False
62. True
63. True
64. False
65. False
66. True
67. True
68. True
69. False
70. False
71. True