

Anatomy and Pathophysiology for ICD-10

Module 11



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Content

Module 11

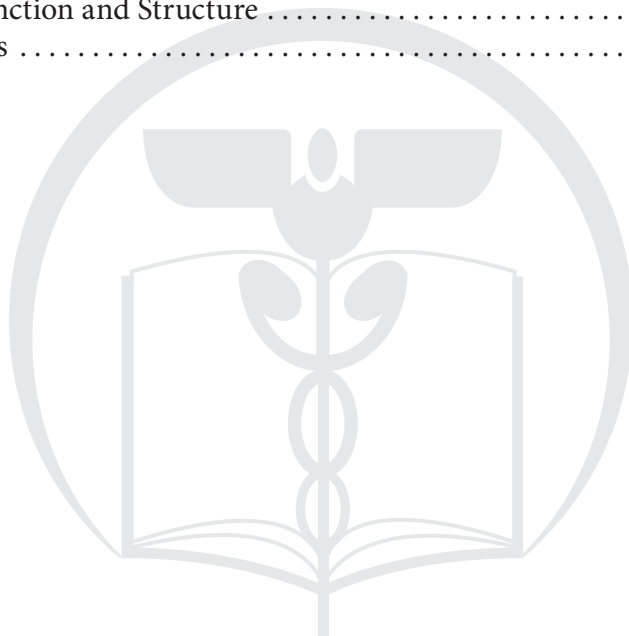
Ear and Mastoid Process.....1

Terminology1

Introduction1

Auditory Organs—Function and Structure2

Diseases and Disorders6



Terminology

Auditory—Means of or relating to the process of hearing.

Contralateral—The opposite from another structure.

Corti—Refers to organ in the inner ear.

Media—Middle.

Meniere's Disease—Disorder of the inner ear that can affect hearing and balance to a varying degree.

Ossicles—Three smallest bones contained within the middle ear space and serve to transmit sounds.

Pinna—Outer part of the ear—also referred to as the auricle.

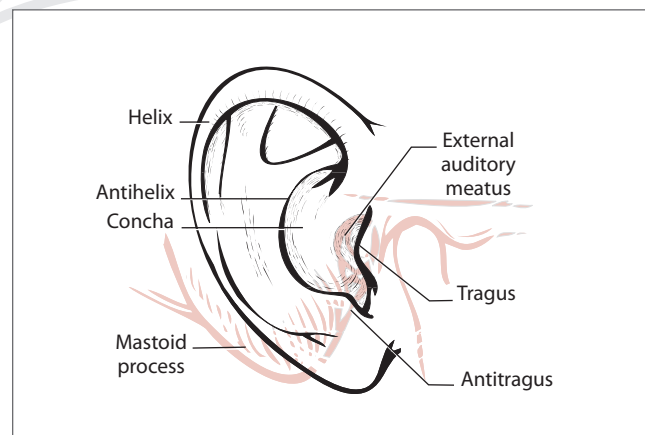
Introduction

The ear is the organ of hearing and equilibrium. The ear is able to recognize at least 400,000 different sounds, matching them up against those stored in the brain. Sound is a form of energy that moves through air, water, and other matter in waves of pressure. Although the ear is the sense organ that recognizes sound, it is the brain and central nervous system that “hears.” Sound waves are perceived by the brain through the firing of nerve cells in the auditory portion of the central nervous system. The ear changes sound pressure waves from the outside world into a signal of nerve impulses sent to the brain. The ear consists of three divisions; the external ear, the middle ear, and the inner ear.

The external ear collects sound waves in the air and channels them to the inner parts of the ear. It consists of the pinna (or auricle) and the external auditory meatus. The pinna serves to direct sound waves to the external auditory meatus, which is a short (1 inch) canal that extends to the ear drum (tympanum). The tympanum or ear drum is a thin, double-layered, epithelial partition between the external auditory meatus and the middle ear.

The middle ear transforms the acoustical vibration of the sound wave into mechanical vibration and passes it onto the inner ear. The three tiny bones of the middle ear, the hammer (malleus), the anvil (incus), and the stirrup (stapes) act as a lever to bridge the eardrum with the oval window.

The semi-circular canals in the inner ear allow us to maintain balance and coordination. The cochlea, which is a bundle of three fluid-filled canals coiled up in a spiral, is set in motion by the stirrup in the middle ear. As these waves travel to and from the apex of the spirals, they cause the walls separating the canals to undulate. Along one of these walls is a sensitive organ called the Corti. It is made up of many thousands of sensory hair cells. From here thousands of nerve fibers carry information about the frequency, intensity, and timbre of all these sounds to the brain, where the sensation of hearing occurs.



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Auditory Organs— Function and Structure

External Ear

The external portion of the ear collects sound and includes the pinna, the external auditory meatus, and the very most superficial layer of the tympanic membrane. It is the only visible portion of the ear and serves to collect the vibrations of the air by which sound is produced. The pinna is composed of a thin plate of yellow fibrocartilage with its larger end directed upward. It is covered with skin and connected to the surrounding parts by ligaments and muscles. Its lateral surface is irregularly concave, directed slightly forward, and presents numerous eminences and depressions to which names have been assigned:

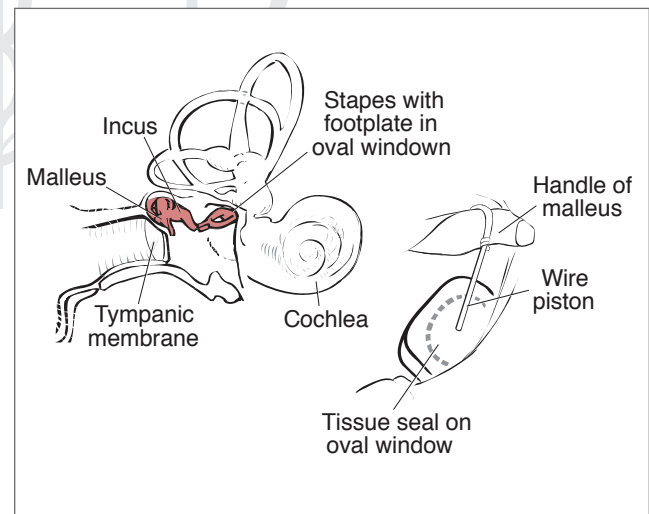
- Helix—The prominent rim of the pinna
- Tubercle of Darwin—Tubercle located behind where the helix turns downward
- Antihelix—Another curved prominence, parallel with and in front of the helix which divides above into two crura
- Fossa triangularis—Triangular depression between the two crura
- Scapha—The narrow-curved depression between the helix and the antihelix
- Concha—A curve around a deep, capacious cavity
- Crus—Commencement of the helix
- Cyma conchae—The upper part of the helix
- Cavum conchae—The lower part of the helix
- Tragus—Small pointed prominent eminence in front of the concha, and projecting backward over the meatus
- Antitragus—Small tubercle opposite the tragus
- Intertragic notch—Separates the tragus from the antitragus
- Lobule—Below the antitragus and is composed of tough areolar and adipose tissue

The external auditory meatus leads inward from the bottom of the auricular and conducts the vibrations to the tympanic cavity. If the meatus is blocked (by cerumen, for example), hearing will be impaired. Cerumen is produced by glands in the skin of the outer

portion of the external auditory meatus. The outer ear canal skin is applied to cartilage; the thinner skin of the deep meatus lies on the bone of the skull. The thicker cerumen-producing ear skin has hair. The external ear ends at the most superficial layer of the tympanic membrane. The pinna helps direct sound through the ear canal to the tympanic membrane. It is made up of a single piece of yellow fibrocartilage with a concave side and a convex side.

The ligaments of the pinna consist of two types: extrinsic, which connects it to the side of the head; and intrinsic, which connects various parts of its cartilage together. There are two extrinsic ligaments, the anterior and posterior. The intrinsic ligaments are:

1. A strong fibrous band, stretching from the tragus to the commencement of the helix; and
2. A band between the antihelix and the cauda helix.



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There are two sets of muscles in the pinna:

1. The extrinsic, which connect it with the skull and scalp and move the pinna as a whole; and
2. The intrinsic, which extend one part of the pinna to another. The extrinsic muscles are the auriculars anterior, superior, and posterior.

The auricularis anterior (attrahens aurem) is the smallest of the three. It is thin, fan-shaped and its fibers are pale and indistinct. The auricularis superior (attolens aurem) is the largest of the three. It is thin and fan-shaped. The auricularis posterior (retrahens aurem) consists of two or three fleshy fasciculi.

Middle Ear

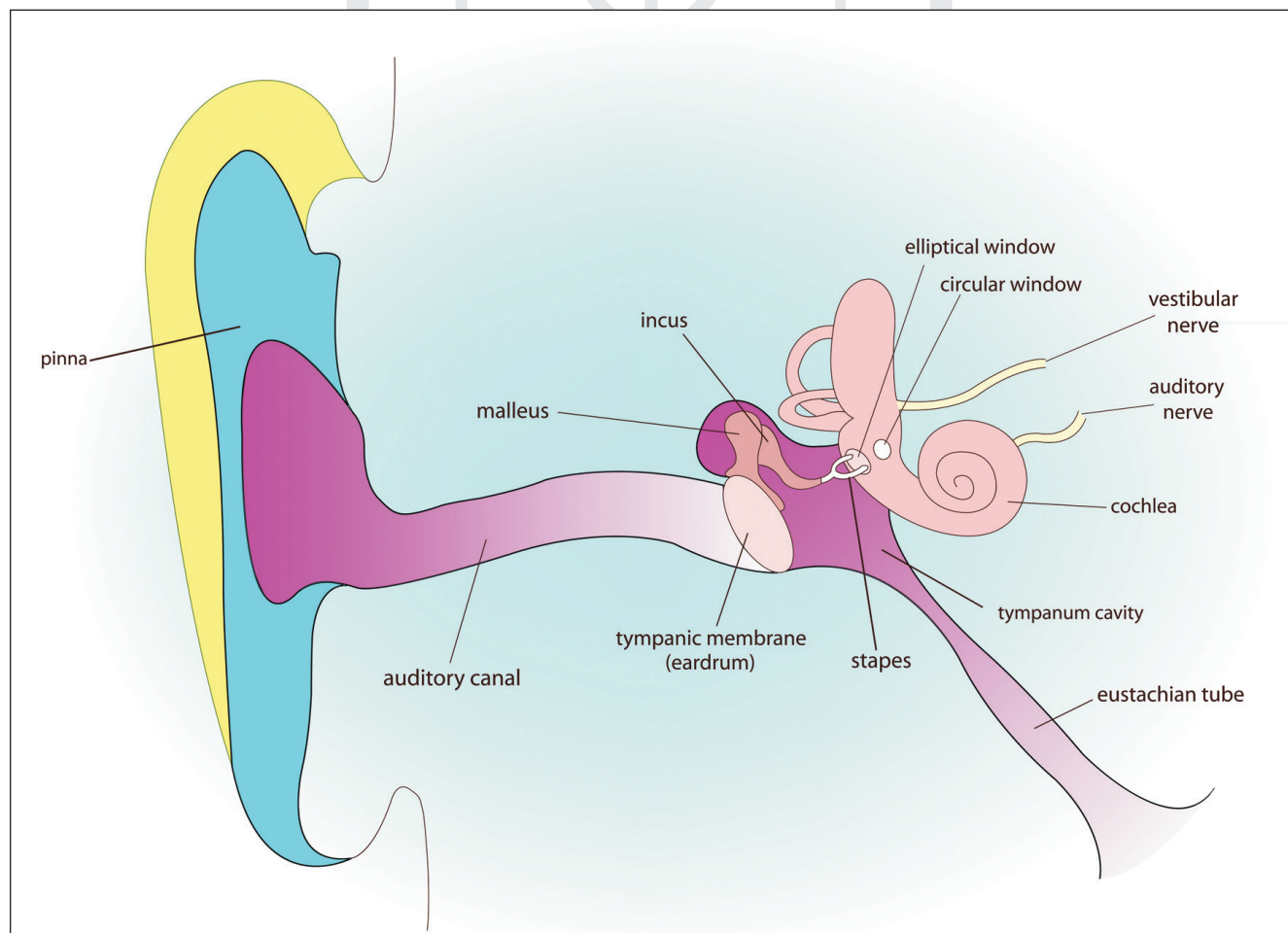
The middle ear, also called the tympanic cavity, is an irregular compressed air-filled cavity behind the tympanic membrane. It includes a chain of the three movable bones or ossicles: the malleus (or hammer), incus (or anvil), and stapes (or stirrup).

Malleus—Hammer-shaped small ossicle which connects with the incus and is attached to the inner surface of the eardrum. It consists of a head, neck, manubrium,

anterior process, and lateral process. It transmits the sound vibrations from the eardrum to the incus. It has a manubrium (or handle) that is attached to the mobile portion of the tympanum.

Incus—Anvil-shaped small ossicle in which connects the malleus to the stapes. It has two roots that differ in length and are widely separated from other. It is made up of a body and two crura. It transmits the sound vibrations from the malleus to the stapes.

Stapes—Stirrup-shaped small ossicle which transmits the sound vibrations from the incus to the membrane of the inner ear inside the fenestra ovalis. It is made up of a head, neck, two crura, and a base. The stapes is also stabilized by the stapedius muscle, which is innervated by the facial nerve. The stapes is the smallest named bone in the human body.



Source: AAPC

The middle ear (like the ear canal) is normally filled with air. Unlike the open ear canal, however, the air of the middle ear is not in direct contact with the atmosphere outside the body. The Eustachian tube connects from the chamber of the middle ear to the back of the nasopharynx. The middle ear is very much like a specialized paranasal sinus, called the tympanic cavity. The tympanic cavity has two parts: the tympanic cavity proper, which is opposite the tympanic membrane; and the epitympanic recess (attic), which is above the level of the membrane and contains the upper half of the malleus and the greater part of the incus. The opening of the Eustachian tube is also within the middle ear. The three bones are arranged so that movement of the tympanic membrane causes movement of the malleus, prompting movement of the incus, which causes movement of the stapes. When the stapes footplate pushes on the oval window, it causes movement of fluid within the cochlea (a portion of the inner ear). The mastoid portion of the human temporal bone, which can be felt as a bump in the skull behind the pinna, also contains air ventilated through the middle ear.

The tympanic membrane separates the tympanic cavity from the bottom of the external acoustic meatus. It is a thin membrane that is semitransparent and nearly oval in form. It is composed of three layers: a lateral (cutaneous), an intermediate (fibrous), and a medial (mucous). The lateral layer is derived from the integument lining the meatus. The intermediate has two layers: a radiate layer, in which the fibers diverge from the manubrium of the malleus; and a circular layer, in which the fibers are mostly located around the circumference but scattered and sparse near the center of the membrane.

The arrangement of the tympanic membrane and ossicles works to efficiently couple the sound from the opening of the ear canal to the cochlea. There are several simple mechanisms that combine to increase the sound pressure. The first is the “hydraulic principle.” The surface area of the tympanic membrane is many times that of the stapes footplate. Sound energy strikes the tympanic membrane and is concentrated to the smaller footplate. A second mechanism is the “lever principle.” The dimensions of the articulating ear ossicles lead to an increase in the force applied to the stapes footplate compared with that applied to the malleus. A third

mechanism channels the sound pressure to one end of the cochlea and protects the other end from being struck by sound waves.

Abnormalities such as impacted ear wax (occlusion of the external ear canal), fixed or missing ossicles, or holes in the tympanic membrane generally produce conductive hearing loss. Conductive hearing loss may also result from middle ear inflammation causing fluid build-up in the normally air-filled space.

Inner Ear

The inner ear is the essential part of the organ of hearing and receives the ultimate distribution of the auditory nerve. It is called the labyrinth due to the complexity of its shape and has two parts:

- The osseous labyrinth—A series of cavities within the petrous part of the temporal bone and consists of three parts: the vestibule, semicircular canals, and cochlea. These are cavities hollowed out of the substance of bone and lined by periosteum. They contain perilymph, a clear fluid in which the membranous labyrinth is situated.
- The membranous labyrinth—A series of communicating membranous sacs and ducts contained within the bony cavities. It is smaller and partly separated from the bony walls by a perilymph. In certain places it is fixed to the walls of the cavity. The membranous labyrinth contains fluid called endolymph. The osseous vestibule consists of two membranous sacs: the utricle and the saccule.

The balance portion of the inner ear consists of three semi-circular canals and the vestibule. There are three semicircular canals:

- **Superior** (*canalis semicircularis superior*)—This canal makes up about 2/3 of a circle. It is vertical in direction and placed transversely to the long axis of the petrous portion of the temporal bone on the anterior surface of which its arch forms a round projection. Its lateral extremity is ampullated, and opens into the upper part of the vestibule. The opposing end joins with the upper part of the posterior canal to form the crus commune, which opens into the upper and medial part of the vestibule.

- **Posterior** (*canalis semicircularis posterior*)—This canal is the longest of the three. It is also vertical, directed backward, and nearly parallel to the posterior surface of the petrous bone. Its lower or ampullated end opens into the lower and back part of the vestibule, its upper into the crus commune.
- **Lateral** (*canalis semicircularis lateralis; external semicircular canal*)—This canal is the shortest of the three. Its arch is directed horizontally backward and lateral, thus each semicircular canal stands at right angles to the other two. Its ampullated end corresponds to the upper and lateral angle of the vestibule, just above the fenestra vestibuli, where it opens close to the ampullated end of the superior canal. Its opposite end opens at the upper and back part of the vestibule. The lateral canal of one ear is very nearly in the same plane as that of the other; while the superior canal of one ear is nearly parallel to the posterior canal of the other.

The inner ear is encased in the hardest bone of the body. Within this ivory hard bone, there are fluid-filled hollows. Within the cochlea are three perilymph-filled spaces:

Scala tympani—Extends from the round window to the helicotrema, where it continues as scala vestibuli. It transduces the movement of air that causes the tympanic membrane and the ossicles to vibrate to movement of liquid and the basilar membrane. This movement is conveyed to the organ of Corti inside the scala media, composed of hair cells attached to the basilar membrane and their stereocilia embedded in the tectorial membrane. The movement of the basilar membrane compared to the tectorial membrane causes the stereocilia to bend. They then depolarize and send impulses to the brain via the cochlear nerve. This produces the sensation of sound.

Scala vestibuli—Conducts sound vibrations to the scala media. It is separated from the scala media by Reissner's membrane and extends from the oval window to the helicotrema where it joins scala tympani.

Scala media—Also called the cochlear duct and is an endolymph filled cavity inside the cochlea located in between the scala tympani and the scala vestibuli. It is separated by the basilar membrane and Reissner's

membrane (the vestibular membrane) respectively. It houses the organ of Corti.

The eighth cranial nerve comes from the brain stem to enter the inner ear. When sound strikes the ear drum, the movement is transferred to the footplate of the stapes, which presses it into one of its fluid-filled ducts through the oval window of cochlea. The fluid inside this duct is moved, flowing against the receptor cells of the Organ of Corti, which fire. These stimulate the spiral ganglion, which sends information through the auditory portion of the eighth cranial nerve to the brain.

Mastoid Process

The mastoid process is a prominence projecting from the undersurface of the mastoid portion of the temporal bone and is roughly pyramidal or conical in shape. It is located just behind the external acoustic meatus, and lateral to the styloid process. This process serves for the attachment of the posterior belly of the digastric, sternocleidomastoid, splenius capitis, and longissimus capitis muscles. Its size and form vary somewhat; it is larger in the male than in the female as men have bigger muscles as a general rule and require larger points of attachment.

The mastoid process is a part of the skull located just behind the ear. It is part of the temporal bone, the large bone that runs along the middle bottom of the skull. Several different roles are filled by the mastoid process and this bone is one of the areas of the bone structure that usually clearly differs between men and women. Men have a more pronounced mastoid process than women and this is helpful when examining human remains belonging to an unidentified person.

The term “mastoid” is derived from the Greek word for “breast,” a reference to the shape of this bone. The temporal bone contains another protrusion, the styloid process, located in close proximity to the mastoid process. The styloid process also serves as a point of attachment for muscles and has a distinctive pointed shape akin to that of a stylus, explaining the origins of the name.

Inside the mastoid process there are a number of air-filled cavities known as mastoid cells. These cells communicate with the middle ear. These cavities are not lined with ciliated epithelium so they are not equipped with the cleansing motion that ciliated mucosa provides

for clearing out sinuses of the respiratory tract. Drainage is only through primary respiration.

Diseases and Disorders

Hearing loss occurs when the normal ability to hear is impaired to some degree. The extent depends on the cause, but the normal function of the ear is disrupted. The ear allows the body to transmit sound waves to the brain. The most common cause of hearing loss is through the aging process. There are three different types of hearing loss:

- Conductive hearing loss is caused by a failed transmission of sound waves through the outer ear to the inner ear.
- Sensorineural hearing loss is caused by a problem in the inner ear or nerve pathways to the brain.
- Mixed hearing loss is a combination of conductive and sensorineural.



Source: AAPC

Sometimes hearing loss can be attributed to impacted cerumen in the ear and once that is removed, the hearing loss resolves.

The ICD-10-CM code range for hearing loss is H90–H91.

To code hearing loss in ICD-10-CM, the following is necessary:

- Site
- Laterality

Conductive hearing loss, bilateral	H90.0
Conductive hearing loss, unilateral, right ear, with unrestricted hearing on the contralateral side	H90.11
Conductive hearing loss, unilateral, left ear, with unrestricted hearing on the contralateral side	H90.12
Conductive hearing loss, unspecified	H90.2

Sudden idiopathic hearing loss, unspecified ear	H91.20
Sudden idiopathic hearing loss, right ear	H91.21
Sudden idiopathic hearing loss, left ear	H91.22
Sudden idiopathic hearing loss, bilateral	H91.23

Other specified hearing loss, right ear	H91.8x1
Other specified hearing loss, left ear	H91.8x2
Other specified hearing loss, bilateral	H91.8x3
Other specified hearing loss, unspecified ear	H91.8x9

In the above table, the site and laterality issues are shown. Note that the fifth digit represents different sides of the body than the sixth characters do.

Ear Infections

Otitis externa is an inflammation of the external ear and ear canal, and is usually accompanied by an infectious process. Accumulation of cerumen in the ear canal, when mixed with water, can produce bacteria and fungi. Otitis externa can also be caused by dermatologic conditions, such as seborrhea and psoriasis. Trauma to the ear canal, such as using Q-tips or trying to scratch inside the canal with a foreign object, can also increase risks for developing the condition.

Otitis media is inflammation of the middle ear, which is normally air-filled. The inflammation is caused by a build up of fluid behind the tympanic membrane and can occur unilaterally or bilaterally. There are two classifications of otitis media:

- Serous (nonsuppurative) otitis media consists of fluid that is clear and relatively sterile.
- Suppurative otitis media consists of fluid that is purulent and painful.

Infections are the principal cause of tympanic membrane perforation (TMP). Acute infection of the middle ear may cause pressure to build, which can lead to a tear or rupture of the eardrum that is usually preceded by severe pain.

The Eustachian tube (or auditory tube or pharyngo-tympanic tube) is a tube that links the pharynx to the middle ear. It is a part of the middle ear. In adults the Eustachian tube is approximately 35 mm long. The Eustachian tube extends from the anterior wall of the middle ear to the lateral wall of the nasopharynx, approximately at the level of the inferior nasal concha.

There are four muscles associated with the function of the Eustachian tube:

- Levator veli palatini (innervated by the vagus nerve)
- Salpingopharyngeus (innervated by the vagus nerve)
- Tensor tympani (innervated by the mandibular nerve of CN V)
- Tensor veli palatini (innervated by the mandibular nerve of CN V)

Some people are born with a dysfunctional Eustachian tube, which is much slimmer than the usual Eustachian tube. This may be genetic, but it has also been suggested to be a condition in which the patient did not fully recover from the effects of pressure on the middle ear during birth. This disorder may result in a large amount of mucus accumulating in the middle ear, often impairing hearing to a degree. This condition is known as otitis media with effusion, and may result in the mucus becoming very thick and glue-like, a condition known as glue ear.

Eustachian tube dysfunction can be caused by recurring and chronic cases of sinus infection. This results from

excessive mucus production which causes obstruction to the openings of the Eustachian tube.

Mastoiditis is an infection of mastoid process, the portion of the temporal bone of the skull that is behind the ear which contains open, air-containing spaces. It is usually caused by untreated acute otitis media.

Some common symptoms and signs of mastoiditis include pain, tenderness, and swelling in the mastoid region. There may be ear pain (otalgia), and the ear or mastoid region may be red (erythematous).

The pathophysiology of mastoiditis is straightforward: bacteria spread from the middle ear to the mastoid air cells, where the inflammation causes damage to the bony structures.

The ICD-10-CM code range for diseases of the middle ear and mastoid is H65–H75.

To code for ear infections in ICD-10-CM, the following is necessary:

- Site
- Type of infection
- Laterality
- Rupture, as necessary
- If the condition is recurrent

Acute serous otitis media, unspecified ear	H65.00
Acute serous otitis media, right ear	H65.01
Acute serous otitis media, left ear	H65.02
Acute serous otitis media, bilateral	H65.03
Acute serous otitis media, recurrent, right ear	H65.04
Acute serous otitis media, recurrent, left ear	H65.05
Acute serous otitis media, recurrent bilateral	H65.06

Acute serous otitis media, recurrent, unspecified ear	H65.07
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Chronic serous otitis media, unspecified ear	H65.20
Chronic serous otitis media, right ear	H65.21
Chronic serous otitis media, left ear	H65.22
Chronic serous otitis media, bilateral	H65.23

Acute suppurative otitis media without spontaneous rupture of the eardrum, right ear	H66.001
Acute suppurative otitis media without spontaneous rupture of the eardrum, left ear	H66.002
Acute suppurative otitis media without spontaneous rupture of the eardrum, bilateral	H66.003
Acute suppurative otitis media without spontaneous rupture of the eardrum, recurrent, right ear	H66.004
Acute suppurative otitis media without spontaneous rupture of the eardrum, recurrent, left ear	H66.005
Acute suppurative otitis media without spontaneous rupture of the eardrum, recurrent, bilateral	H66.006
Acute suppurative otitis media without spontaneous rupture of the eardrum, recurrent, unspecified ear	H66.007
Acute suppurative otitis media without spontaneous rupture of the eardrum, unspecified ear	H66.009

Acute Eustachian salpingitis, right ear	H68.011
Acute Eustachian salpingitis, left ear	H68.012
Acute Eustachian salpingitis, bilateral ear	H68.013
Acute Eustachian salpingitis, unspecified ear	H68.019

Chronic Eustachian salpingitis, right ear	H68.021
Chronic Eustachian salpingitis, left ear	H68.022
Chronic Eustachian salpingitis, bilateral	H68.023
Chronic Eustachian salpingitis, unspecified ear	H68.029

In the above table, the issues of site, laterality, and type of infection are shown as well as mention of rupture of the eardrum.

Disorders of the Inner Ear

Vertigo is a type of dizziness, where there is a feeling of motion when one is stationary. The symptoms are due to a dysfunction of the vestibular system in the inner ear. It may cause nausea or vomiting as well as make standing or walking difficult. The most common causes are benign paroxysmal positional vertigo and vestibular migraine, but vertigo can also result from Meniere's disease and vestibular neuritis. Spinning repetitively as children do can induce vertigo as it disrupts the inertia of the fluid in the vestibular system.

The ICD-10-CM code range for disorders of the inner ear is H80–H83.

To code inner ear disorders in ICD-10-CM, the following is necessary:

- Origin
- Laterality

Meniere's disease, right ear	H81.01
Meniere's disease, left ear	H81.02

Meniere's disease, bilateral	H81.03
Meniere's disease, unspecified ear	H81.09

Benign paroxysmal vertigo, unspecified ear	H81.10
Benign paroxysmal vertigo, right ear	H81.11
Benign paroxysmal vertigo, left ear	H81.12
Benign paroxysmal vertigo, bilateral	H81.13

Labyrinthitis, right ear	H83.01
Labyrinthitis, left ear	H83.02
Labyrinthitis, bilateral	H83.03
Labyrinthitis, unspecified ear	H83.09

In the above table, the origin and laterality issues are shown.

Sources

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