Definitions, Terminology, and Classification

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For the past 25 years, the scientific community interested in the clinical and research aspects of otitis media has made a concerted effort to agree on the definitions and terminology of the disease.\textsuperscript{1,2} Before that time, many terms existed to describe the inflammatory conditions of the middle ear, including secretory otitis media, middle-ear catarrh, and suppurative otitis media. This resulted in confusion and misunderstanding among clinicians who provided health care to infants and children with middle-ear disease. This confusion also impeded appropriate evaluation of studies reported in the literature because interpreting the results of investigations depends on precise definitions of the disease studied.

In the past, many of the terms were defined before the advent of modern otology, which gives us an opportunity to examine patients with the operating microscope in the ambulatory setting and at the time of otologic surgery. The more recent availability of radiologic imaging technology has also allowed us to visualize the contents of the temporal bone and the intracranial cavity in a way that the pioneers in otology could not.

Fortunately, there is now a broad consensus for using the terms \textit{acute otitis media} (AOM) and \textit{otitis media with effusion}, but there is no consensus
on how to grade these disease entities, nor is there any agreement on the classification, definitions of terms, or staging systems used to describe the complications and sequelae of otitis media. (The grade of otitis media, and of related diseases and disorders, relates to the severity of the condition, whereas a stage is a period or distinct phase in the course of otitis media or one of its complications or sequelae.) If available, such agreement would improve our ability to study the natural history of otitis media and to conduct and evaluate research in a more uniform manner from center to center and country to country. That, in turn, would result in more effective management of patients and allow us to achieve evidence-based information in the future. Many of the following terms, definitions, and classifications of otitis media and its complications and sequelae have been used in international symposia, conferences, guidelines, and textbooks related to the disease.3–19

Recently, to address these issues, an international committee was convened as part of the Seventh Research Conference, which followed the Seventh International Symposium on Otitis Media. This committee came to a consensus on the definitions, terminology, and classification of otitis media and its complications and sequelae, much of which is reflected in the contents below. This document is recommended to the reader for in-depth discussion of the terminology, definitions, and classification.9

**TERMINOLOGY AND DEFINITIONS**

The terms most commonly used in relation to otitis media are defined as follows:

*Otitis media* is an inflammation of the middle ear without reference to etiology or pathogenesis.  
*AOM* is the rapid onset of signs and symptoms, such as otalgia and fever, of acute infection within the middle ear.  
*Otitis media with effusion* is an inflammation of the middle ear with a collection of liquid in the middle-ear space. The signs and symptoms of acute infection are absent, and there is no perforation of the tympanic membrane.  
*Otitis media without effusion* is a stage of middle-ear inflammation in which the mucosa of the middle ear is involved, but no effusion is present. This stage of otitis media was recently substantiated, employing tympanocentesis as confirmatory evidence.20,21 This stage classically precedes the development of an acute effusion and can be associated with the acute onset of otalgia. One form of this stage of inflammation is commonly encountered in infants and children who have functioning tympanostomy tubes in place. They typically present with acute otalgia, with or without fever, and erythema of the inferior portions of the tympanic membrane, but no otorrhea is present.

*Middle-ear effusion* designates a liquid in the middle ear but not etiology, pathogenesis, pathology, or duration. An effusion may be (1) serous—a thin, watery liquid; (2) mucoid—a thick, viscid, mucus-like liquid; (3) purulent—a pus-like liquid; or (4) a combination of these. An effusion can be the result of either AOM or otitis media with effusion.22 The effusion can be of recent onset (acute) or longer lasting (subacute or chronic).

*Bullous myringitis* typically appears as an acute inflammation of the tympanic membrane in which one or more bullae (blisters) are present on the eardrum. It is most commonly present during an attack of AOM and should be treated as such.23 Also, this finding with AOM represents a more severe infection and should be treated aggressively with antimicrobial agents.21b This condition should not be confused with segmental bulging of the tympanic membrane during an attack of AOM because bulging of the posterosuperior quadrant of the tympanic membrane is commonly present when there is purulent effusion under pressure within the middle ear.

*Persistent middle-ear effusion* is an effusion that persists in the middle ear after an episode of AOM.

*Otorrhea* is a discharge from the ear originating at one or more of the following sites: the external auditory canal, middle ear, mastoid, inner ear, or intracranial cavity.

**CLASSIFICATION**

The classification of otitis media in Table 1 is derived from our present knowledge of otitis
Initial classification of otitis media is into AOM and otitis media with effusion and its related disorder, eustachian tube dysfunction. Complications and sequelae of otitis media are classified into intratemporal (extracranial) complications and sequelae, which are those that occur within the temporal bone, and intracranial complications, those that occur within the intracranial cavity. Several conditions may be complications or sequelae not of otitis media but of a related condition. An example of this is the presence of a retraction pocket of the tympanic membrane, in which a discontinuity of the ossicular chain occurs or an acquired cholesteatoma develops.\(^{24,25}\)

We have grouped (and presented in this text in Chapter 9) the intratemporal complications and sequelae of otitis media into related conditions, such as atelectasis of the middle ear with retraction pocket, followed by adhesive otitis media and then cholesteatoma, because cholesteatoma frequently progresses in this order. The suppurative complications are also grouped, such as mastoiditis, petrositis, labyrinthitis, and facial paralysis. The proposed staging systems for each of the complications and sequelae of otitis media are presented with each of these conditions in Chapters 9 and 10.
Acute Otitis Media

The rapid and short onset of signs and symptoms of inflammation in the middle ear is characteristic of AOM. Acute suppurative otitis media and purulent otitis media are synonyms still used by some but are not recommended terms. One or more local or systemic signs are present: otalgia (or pulling of the ear in the young infant), otorrhea, fever, recent onset of irritability, anorexia, vomiting, or diarrhea. The tympanic membrane is full or bulging, is opaque, and has limited or no mobility to pneumatic otoscopy, all of which indicate middle-ear effusion. Erythema of the eardrum is an inconsistent finding.

The acute onset of ear pain, fever, and a purulent discharge (otorrhea) through a perforation of the tympanic membrane (or tympanostomy tube) is also evidence of AOM. This is known as acute otitis media with perforation, a complication discussed later.

Clinical Practice Guideline Definition

AOM has been defined in a clinical practice guideline presented by the American Academy of Pediatrics and the American Academy of Family Physicians. The criteria for AOM were: (1) a history of acute onset of signs and symptoms, (2) the presence of middle ear effusion, and (3) signs and symptoms of middle ear inflammation. Furthermore, the following elements were described: (1) recent, usually abrupt, onset of signs and symptoms of middle ear inflammation and middle ear effusion and (2) the presence of middle ear effusion that is indicated by any of the following: bulging of the eardrum, limited or absent mobility of the tympanic membrane, air-fluid level as visualized through the tympanic membrane, or otorrhea. The signs and symptoms of middle-ear inflammation are by either distinct erythema of the eardrum or distinct otalgia that results in interference with or precludes normal activity or sleep.

Grading of Severity

There may be some advantage to grading the severity of AOM because the outcome of treatment, or of no treatment, may vary. Kaleida and colleagues graded acute otitis media in infants and children who were entered into a clinical trial of the efficacy of antibiotics, myringotomy, or both in subjects who had acute severe otitis media. The efficacy of the antibiotic was compared with its placebo in subjects who were judged to have acute nonsevere otitis media. Enrollment criteria were based on an otalgia scoring system that took into account estimated parental anxiety and reliability; 1, 3, or 12 points, respectively, were assigned for each hour of otalgia or apparent discomfort (in infants, ear pulling or irritability) rated as mild, moderate, or severe. An episode of acute otitis media was classified as severe if the subject’s temperature had reached 39°C orally or 39.5°C rectally within the 24-hour period before presentation or if the child attained an otalgia point score of 12 points or higher. Episodes of AOM not meeting these criteria were classified as nonsevere (see Chapter 8). Also, the recently published clinical practice guideline distinguishes between severe and nonsevere AOM related to the presence or absence of a high fever, moderate to severe otalgia, or both followed by recommendations for management for each condition.

The following grading system can be used:

Acute severe otitis media: the presence of moderate to severe otalgia or a temperature of 39°C or higher orally or 39.5°C rectally or both

Acute nonsevere otitis media: the presence of mild otalgia and a temperature below 39°C orally or 39.5°C rectally or no fever

As stated above, in the earliest stage of AOM, only inflammation of the mucous membrane and tympanic membrane of the middle ear will be present without a middle-ear effusion, that is, AOM without effusion. Pneumatic otoscopy may reveal only myringitis in the appearance of the tympanic membrane in which there is usually erythema and opacification of the eardrum but relatively normal mobility in response to applied positive and negative pressure. Blebs or bullae may be present when the disease is acute, and positive pressure may be present within the middle ear; positive middle-ear pressure can be visualized with the pneumatic otoscope or identified by tympanometry.
Children who have functioning tympanostomy tubes in place may present to their physician early at the acute onset of fever and otalgia and with an erythematous tympanic membrane but no otorrhea.

Evidence for the existence of this type of otitis media, which may also be chronic, has been provided by examination of histopathologic specimens of the temporal bone. The absence of a middle-ear effusion when tympanocentesis is performed in the presence of AOM—the child is symptomatic and the tympanic membrane is thick and opaque—has provided clinical proof that this condition exists in certain cases, especially when pathogenic bacteria are isolated after irrigation and aspiration of the middle ear with nonbactericidal saline (see Chapter 8).

The term persistent middle-ear effusion can be used to describe asymptomatic middle-ear effusion persisting for weeks to months after the onset of AOM. It should be defined, however, because this stage of acute otitis media is clinically and pathologically indistinguishable from otitis media with effusion (see later). Otitis media with effusion is not preceded by a clinically evident episode of AOM, whereas persistent middle-ear effusion continues after an attack of symptomatic AOM. When middle-ear effusion persists for 3 months or longer after an attack of AOM, it is considered to be chronic. Management at this stage is similar to that for chronic otitis media with effusion (see Chapter 8).

**Otitis Media with Effusion**

There are many synonyms for relatively asymptomatic effusion developing in the middle ear, such as secretory otitis media, nonsuppurative otitis media, and serous otitis media, but the most acceptable term is *otitis media with effusion*. Because the effusion may be serous (transudate), the term *secretory* may not be correct in all cases. Likewise, the term *nonsuppurative* may not be correct; asymptomatic middle-ear effusion often contains bacteria and may even be purulent. The term *serous otitis media* has been used if an amber or bluish effusion can be visualized through a translucent tympanic membrane, but it is not recommended today. Also, the most frequent otoscopic finding is opacification of the tympanic membrane, which prevents assessment of the type of effusion (eg, serous, mucoid, or purulent).

Pneumatic otoscopy frequently reveals either a retracted or convex tympanic membrane with impaired mobility. Fullness or even bulging may be visualized in some patients. An air-fluid level, bubbles, or both may be observed through a translucent tympanic membrane. The most important distinction between otitis media with effusion and AOM is that the signs and symptoms of acute infection (eg, otalgia and fever) are lacking in otitis media with effusion. Hearing loss is usually present in both conditions.

**Grading of Severity and Duration**

As with AOM, there may be an advantage to grading otitis media with effusion according to severity because the natural history, effect of treatment, or both may vary. One system proposes treating young children with chronic otitis media with effusion associated with bilateral hearing loss of 20 dB hearing threshold or worse in the better-hearing ear. Children who have better hearing, a unilateral effusion, or both are candidates for observation. An alternative grading method is to use a tympanometric pattern classification. For example, a flat pattern is considered more severe than those patterns with any degree of gradient. Still another system grades according to otoscopic appearance. For example, a tympanic membrane that is completely opaque and immobile to pneumatic otoscopy is considered more severe than a tympanic membrane that is translucent and mobile to pneumatic otoscopy, in which bubbles, an air-fluid level, or both can be seen through the eardrum.

The following grading and staging system can be used. It distinguishes mild, moderate, and severe on the basis of otoscopic appearance, tympanometric patterns, or hearing thresholds; the duration (not the severity) of the effusion is acute (less than 3 weeks in duration), subacute (3
weeks to 3 months), or chronic (longer than 3 months):

**Acute**: mild, moderate, or severe otitis media with effusion

**Subacute**: mild, moderate, or severe otitis media with effusion

**Chronic**: mild, moderate, or severe otitis media with effusion

### Eustachian Tube Dysfunction

Eustachian tube dysfunction is a middle-ear disorder that can have symptoms similar to those of otitis media, such as hearing loss, otalgia, and tinnitus, but with no middle-ear effusion. The dysfunction may be related to a eustachian tube that is too closed (ie, obstructed) or too open (ie, patulous). The latter condition is most frequently associated with symptoms of autophony.

### Grading of Severity and Duration

The severity of this condition can be graded into those patients with mild, moderate, or severe symptoms. This is based on the frequency, duration, and severity of symptoms and the degree of disability caused by the symptoms, such as tinnitus, otalgia, autophony, dysequilibrium or vertigo, and hearing loss. The duration of this condition can be acute, subacute, or chronic, similar to the duration recommended for grading otitis media with effusion (see Chapter 8).

The following grading system can be used:

**Acute**: mild, moderate, or severe eustachian tube dysfunction

**Subacute**: mild, moderate, or severe eustachian tube dysfunction

**Chronic**: mild, moderate, or severe eustachian tube dysfunction

### INTRATEMPORAL (EXTRACRANIAL) COMPLICATIONS AND SEQUELAE OF OTITIS MEDIA

The intratemporal complications of otitis media are hearing loss; vestibular, balance, and motor dysfunctions; acute perforation of the tympanic membrane; mastoiditis; petrositis; labyrinthitis; facial paralysis; and external otitis. The intratemporal sequelae of otitis media are atelectasis of the middle ear, adhesive otitis media, cholesteatoma, cholesterol granuloma, tympanosclerosis, and ossicular discontinuity and fixation. Some, however, may be both a complication and a sequela, such as hearing loss. Another disease or disorder that is concurrent with the otitis media is considered a complication, whereas a sequela of otitis media is a disease or disorder that follows, is a consequence of, or is caused by otitis media. A complication or sequela may also cause another complication or sequela; for example, a cholesteatoma may cause a facial paralysis (see Chapter 9).

Many of the complications and sequelae of otitis media can also be iatrogenic, such as those that may follow tympanostomy tube insertion, tympanoplasty, or tympanomastoidectomy. These can include tympanosclerosis, adhesive otitis media, ossicular discontinuity or fixation, and cholesteatoma, all of which, in turn, may cause conductive hearing loss.

Hearing loss can be either a complication or a sequela of otitis media. Almost all children who have a middle-ear effusion have some degree of hearing loss, but hearing loss can also occur when another suppurative complication (eg, perforation of the tympanic membrane or labyrinthitis) or sequela of otitis media develops, such as perforation of the tympanic membrane, adhesive otitis media, cholesteatoma, tympanosclerosis, or ossicular discontinuity or fixation.

### Hearing Loss

Hearing loss is the most common complication and sequela of otitis media and can be conductive, sensorineural, or both. When it is conductive, the loss may be either transient or permanent. When it is sensorineural in origin, the impairment is usually permanent.

### Conductive Hearing Loss

Fluctuating or persistent loss of hearing is present in most children whose middle-ear effusion is due to AOM or otitis media with effusion. The hearing
loss can be either mild or moderate, with the maximal loss being no greater than 60 dB. However, the loss is usually between 15 and 40 dB. When hearing loss is due to otitis media with effusion, there is an average loss of 27 dB. The hearing usually returns to normal thresholds when the middle-ear effusion resolves. Permanent conductive hearing loss can occur, however, as a result of recurrent acute or chronic inflammation owing to adhesive otitis media or ossicular discontinuity or fixation. Negative pressure in the ear, in the absence of middle-ear effusion, can also be a cause of conductive hearing loss. Patients with eustachian tube dysfunction and intermittent or persistent high negative pressure may have an associated conductive hearing impairment.

Although a debated subject, hearing loss caused by chronic and recurrent middle-ear effusions may be associated with delay or impairment of speech, language, and cognition in young children, which may or may not affect performance in school (see Chapter 9).

**Sensorineural Hearing Loss**
Sensorineural hearing loss can be caused by otitis media or by one of its complications or sequelae. The hearing loss can be mild, moderate, severe, or profound. Reversible sensorineural hearing impairment is generally attributed to the effect of increased tension and stiffness of the round window membrane. Permanent sensorineural hearing loss is most likely due to the spread of infection or products of inflammation through the round window membrane into the labyrinth, development of a perilymphatic fistula in the oval or round window, or a suppurative complication, such as labyrinthitis or even meningitis. Ryding and colleagues reported that recurrent AOM may affect cochlear function.

**Perforation of the Tympanic Membrane**
A perforation of the tympanic membrane can be acute or chronic; otitis media or may or may not be present, and when otitis media is present, otorrhea may or may not be present. Classification of perforation should include the site, extent, and duration of the perforation, but no classification has received widespread acceptance.

A reasonable classification related to site, extent, and duration is the following:

- **Site:** (1) pars tensa, anterosuperior, anteroinferior, posterosuperior, or posteroinferior quadrant; (2) pars flaccida
- **Extent:** pars tensa: (1) limited to one quadrant (less than 25%); (2) involving two or more quadrants, but not total; (3) total perforation (ie, all four quadrants)
- **Duration:** (1) acute; (2) chronic

**Vestibular, Balance, and Motor Dysfunctions**
Otitis media is the most common cause of vestibular disturbance in children. Studies of labyrinthine function in children with and without middle-ear effusion confirm that the vestibular system is adversely affected, and after tympanostomy tube placement, these dysfunctions return to normal. Test results of motor proficiency have also been demonstrated to be abnormal in children when middle-ear effusion is present.
One of the most common complications of AOM is perforation of the tympanic membrane accompanied by acute drainage (otorrhea) through the defect. This is acute otitis media with perforation. An acute perforation can also be present in which there is otitis media but no evidence of otorrhea (see Table 1). Acute otitis media with perforation was more frequently encountered before the widespread use of antimicrobial therapy. It is still prevalent in developing countries, where primary health care is inadequate. An acute perforation can occur as a complication of chronic otitis media with effusion, however, as reported in Australian Aborigines.

When an attack of AOM is complicated by a perforation (usually accompanied by otorrhea), one of four outcomes is possible: (1) the AOM resolves and the tympanic membrane defect heals; (2) the AOM resolves, but the perforation becomes chronic; (3) the perforation and otitis media persist to become chronic (ie, chronic suppurative otitis media); or (4) a suppurative complication of otitis media develops.

**Chronic Perforation**

Chronic perforation occurs when an acute perforation of the tympanic membrane fails to heal after 3 months or longer. It may be present with or without otitis media; with the former, it may or may not be associated with otorrhea. Some clinicians have termed a chronic perforation that is without otorrhea “inactive” chronic suppurative otitis media and a chronic perforation associated with otorrhea “active” chronic suppurative otitis media. This classification is not only confusing, it is also inappropriate in some cases, such as when there is a chronic perforation and the middle ear does not become infected. Inclusion of chronic perforations under the term chronic otitis media regardless of the status of the middle ear should be avoided. The term is confusing and potentially misleading.

A chronic perforation that is not associated with either AOM or chronic suppurative otitis media does not usually heal spontaneously. The middle ear is susceptible to AOM, however, and subsequently to chronic suppurative otitis media when a perforation is present. This can result from contamination of the middle ear through the external auditory canal or occur by reflux of nasopharyngeal secretions into the middle ear (see later).

When a chronic perforation is associated with otitis media, the middle-ear (and mastoid) infection may be either acute or chronic. The mastoid gas cell system is invariably involved when the inflammatory process is chronic. Otorrhea may or may not be evident when either acute or chronic middle-ear infection is present.

When a chronic perforation is present and the middle ear becomes acutely infected, the appropriate term for the disease is chronic perforation with acute otitis media; otorrhea may or may not be present (see Table 1). The otitis media, with or without otorrhea, has one of four possible outcomes: (1) AOM occurs but resolves without progressing to the chronic stage; (2) recurrent AOM occurs but does not progress to the chronic stage; (3) AOM persists into the chronic stage (ie, chronic suppurative otitis media); or (4) recurrent AOM and chronic suppurative otitis media occur periodically over time.

**Chronic perforation with chronic otitis**, or, more commonly, chronic suppurative otitis media, is a stage of ear disease in which chronic inflammation of the middle-ear cleft (middle-ear cleft is a term frequently used for the middle ear, eustachian tube, and mastoid gas cells) is present and there is a chronic perforation of the tympanic membrane. Mastoiditis is invariably a part of the pathologic process. The condition has been called chronic otitis media, but this term can be confused with chronic otitis media with effusion, in which no perforation is present. It is also called chronic suppurative otitis media and mastoiditis, chronic purulent otitis media, and chronic otomastoiditis. The most descriptive term is chronic otitis media with perforation, discharge, and mastoiditis, but this is not commonly used. When a cholesteatoma is also present, the term cholesteatoma with chronic suppurative otitis media is used; cholesteatoma can be present even if there is no acute or chronic otitis media.
Mastoiditis

Mastoiditis may or may not be a suppurative complication of otitis media because both AOM and otitis media with effusion can also involve the mastoid. Mastoiditis may be acute, subacute, or chronic. Even in this new century, acute mastoiditis still occurs, which can lead to complications. The following is a classification of the stages of this suppurative complication that has been revised on the basis of an understanding of the pathogenesis and pathology and on computed tomographic (CT) scans:

- Acute mastoiditis without periostitis or osteitis
- Acute mastoiditis with periostitis
- Acute mastoid osteitis

Acute Mastoiditis without Periostitis or Osteitis

Acute mastoiditis without periostitis or osteitis is the natural extension and part of the pathologic process of acute middle-ear infection. No periostitis or osteitis of the mastoid is present. Most likely, all patients with acute otitis media have extension of the middle-ear disease into the mastoid gas cell system, but this stage of acute mastoiditis is not strictly a complication of otitis media. It can nevertheless be misinterpreted as a complication of otitis media, especially when CT scans are obtained for other reasons during an episode of otitis media (eg, after head trauma).

Specific signs or symptoms of mastoid infection, such as protrusion of the pinna, postauricular swelling, tenderness, pain, and erythema, are not present in this most common type of mastoiditis. This stage of mastoiditis can either resolve (most common) or progress into a true complication of otitis media (ie, acute mastoiditis with periostitis). This, in turn, can progress to acute mastoid osteitis.

Acute Mastoiditis with Periostitis

Acute mastoiditis with periostitis can develop when infection within the mastoid spreads to the periosteam covering the mastoid process. The route of infection from the mastoid cells to the periosteum is by venous channels, usually the mastoid emissary vein. This stage of acute mastoiditis should not be confused with the presence of a subperiosteal abscess. Acute mastoiditis with periostitis is characterized by erythema, mild swelling, and tenderness in the postauricular area. The pinna may or may not be displaced inferiorly and anteriorly, with loss of the postauricular crease; sagging of the posterior external auditory canal is infrequently present.

Acute Mastoid Osteitis

Acute mastoid osteitis has also been termed acute "coalescent" mastoiditis or acute surgical mastoiditis, but the pathologic process is osteitis. When infection within the mastoid gas cell system progresses, rarefying osteitis can cause destruction of the bony trabeculae that separate the mastoid cells. The postauricular area is usually involved, but mastoid osteitis can occur without evidence of postauricular involvement. The signs and symptoms are similar to those described for acute mastoiditis with periostitis; a subperiosteal abscess may or may not be present (see Table 1).

Subacute Mastoiditis

Although relatively uncommon, subacute mastoiditis may develop if an acute middle-ear and mastoid infection fails to totally resolve within the usual 10 to 14 days. This stage has also been termed "masked" mastoiditis. The classic signs and symptoms of acute mastoiditis, such as pinna displacement, postauricular erythema, and subperiosteal abscess, are usually absent, but otalgia with postauricular pain and fever may be present. The diagnosis is made by CT scan. In this stage, the infection in the mastoid can progress into another intratemporal complication or even an intracranial complication.

Many cases of subacute mastoiditis occur in patients with persistent signs and symptoms of AOM; these patients are considered "treatment failures" if antimicrobial treatment was initially administered. Tympanocentesis for diagnosis of the causative organism and myringotomy for drainage of the middle ear and mastoid in conjunction with culture-directed antimicrobial

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therapy will usually cure this condition without the need for mastoidectomy. If no middle-ear effusion is present, the aditus ad antrum may be obstructed and the patient may require more aggressive management, such as mastoidectomy.

**Chronic Mastoiditis**

When the mastoid is chronically infected, it is usually due to *chronic suppurative otitis media* with a *chronic perforation* of the tympanic membrane. Chronic mastoiditis may also occur in the absence of chronic suppurative otitis media. Patients with relatively asymptomatic chronic otitis media with effusion frequently have some or all of the mastoid gas cell system involved in the chronic disease process. This is commonly visualized on CT scans of the temporal bones. Chronic infection may also be present in the mastoid, even in the absence of middle-ear disease owing to obstruction of the aditus ad antrum; the otitis media resolved, but the disease in the mastoid did not. Symptoms can include low-grade fever and chronic otalgia and tenderness over the mastoid process.

**Petrositis**

Infection from the middle ear and mastoid gas cells can spread into the petrosal gas cells of the mastoid apex, which is called *petrositis*, also termed *petrous apicitis* or *apical petrositis*. This suppurative complication may be either acute or chronic and may result from AOM or chronic ear disease and can be recurrent. When chronic infection is the cause, it is usually due to chronic suppurative otitis media, cholesteatoma, or both.

**Labyrinthitis**

When infection spreads from the middle ear, mastoid gas cells, or both into the cochlear and vestibular apparatus, the resulting complication is *labyrinthitis*. The classification proposed by Schuknecht is appropriate, describing the complication as either *serous labyrinthitis* (also termed *toxic labyrinthitis*) or *suppurative labyrinthitis*. Labyrinthitis may also be due to meningitis, which may or may not be a complication of otitis media. Serous and suppurative labyrinthitis may be acute or chronic and circumscribed or generalized, respectively. The end stage of chronic labyrinthitis is *labyrinthine sclerosis*.

**Facial Paralysis**

Facial paralysis caused by otitis media or one of its complications or sequelae may be either acute or chronic. It may result from AOM or chronic middle-ear and mastoid disease, such as cholesteatoma, chronic suppurative otitis media, or both. The grading system of the degree of injury to the face proposed by House and Brackmann is generally accepted and correlates with recovery, but it has been developed only for chronic facial paralysis, not acute.

**External Otitis**

AOM with perforation and otorrhea or chronic suppurative otitis media can cause an infection of the external auditory canal, *external otitis* (also termed *infectious eczematoid external otitis*). An infection in the mastoid may also erode the bone of the ear canal or the postauricular area, resulting in dermatitis. The skin of the ear canal is erythematous, edematous, and filled with purulent drainage; yellow-crusted plaques may be present. The organisms involved are usually the same as those found in a middle ear–mastoid infection, but the flora of the external canal usually contributes to the infectious process.

Classification is based on duration as follows:

- **Acute external otitis**: the duration of the external auditory canal infection is less than 3 months
- **Chronic external otitis**: the duration of the external auditory canal infection is 3 months or more

**Atelectasis of the Middle Ear**

Atelectasis of the middle ear is a sequela of eustachian tube dysfunction. Retraction or collapse of the tympanic membrane is characteristic
of the condition; the tympanic membrane is a component of the lateral wall of the middle ear. Collapse implies passivity (absence of high negative middle-ear pressure), whereas retraction implies active pulling inward of the tympanic membrane, usually from negative middle-ear pressure, owing to eustachian tube dysfunction. Middle-ear effusion is usually absent in atelectasis. The condition may be acute or chronic, localized (with or without a retraction pocket) or generalized, and mild, moderate, or severe.

Sadé classified atelectasis on the basis of the position of the tympanic membrane as follows: stage 1, slightly retracted; stage 2, retracted onto the incus; stage 3, retracted onto the promontory; and stage 4, adherent in the sinus tympani, with accumulation of keratin (ie, cholesteatoma). This system does not provide mutually exclusive staging or include all anatomic sites or duration.

Partial Atelectasis
Partial (localized) atelectasis of the tympanic membrane may or may not be a retraction pocket because the depth of the retraction may be mild, moderate, or severe. When partial (with or without a retraction pocket), it may be found in one of the four quadrants of the pars tensa (anterosuperior, anteroinferior, posterosuperior, postero inferior), in the pars flaccida, or in two or more of these anatomic sites. Localized atelectasis results from recurrent or chronic moderate to severe underpressure in the middle ear, which, in turn, is due to eustachian tube dysfunction.

Partial Atelectasis without a Retraction Pocket. Partial atelectasis without a retraction pocket occurs when one or more but not all quadrants of the pars tensa are atelectatic. The atelectatic area can be mild, moderate, or severe and acute or chronic. When it is severe, a retraction pocket is usually present.

Partial Atelectasis with a Retraction Pocket. Partial atelectasis with a retraction pocket is marked by a retraction pocket characterized by a localized area of atelectasis of the tympanic membrane. An indrawing of the membrane forms borders (an edge or margin), most frequently at the site of an osseous anatomic structure (eg, the notch of Rivinus or scutum) or the malleus. The retraction pocket can be in one or more of the four quadrants of the pars tensa or in the pars flaccida; it may be acute or chronic or reversible or irreversible.

Sadé classified posterosuperior retraction pockets in which the pocket is stage 1, slightly retracted and self-cleansing; stage 2, deeper and needing cleansing; stage 3, deeper still and partly hidden, requiring excision; and stage 4, so deep that the pocket can be removed only by exposing the scutum and the rest of the framework (ie, retraction pocket cholesteatoma). This staging system is helpful but does not include the duration, presence, or absence of adhesive changes—which relates to reversibility—or other sites.

Persistent and progressive partial atelectasis with a retraction pocket can lead to sequelae commonly attributed to otitis media, such as hearing loss, ossicular chain discontinuity, and cholesteatoma.

The four stages of a retraction pocket may be subclassified as acute (less than 3 months in duration) and chronic (3 months or longer in duration). The following key factors affect the progression of a retraction pocket from stage 1 to stage 4:

1. Relation to middle-ear structures: The pocket does or does not approximate (touch) or is or is not adherent to (ie, adhesive otitis media) an ossicle (ie, incus, incudostapedial joint, stapes, head of malleus, or incudomalleolar joint) or other middle-ear structure, such as the promontory of the cochlea.
2. Expands with pressure: The entire pocket does or does not easily expand to the normal position when negative pressure is applied with a pneumatic otoscope or with the Bruening otoscope with a nonmagnifying lens under the otomicroscope or when
positive pressure is applied when the patient is anesthetized with nitrous oxide.

3. **Extent visualized:** The entire pocket is visualized or parts are not seen even after pressure is applied. This is because the pocket extends beyond the visible portion of the middle-ear space (e.g., sinus tympani, facial recess, epitympanum, or medial to other parts of the tympanic membrane).

4. The retraction pocket is *self-cleansing and free of infection:* Epithelial debris, crusting, or purulent material is or is not within the pocket.

Combining the preceding classifications, the following staging system may be used:

- **Stage 1a, acute mild retraction pocket:** The membrane of the pocket neither approximates nor is adherent to any middle-ear structure and expands with pressure. The entire contents of the pocket are readily visible, and it is self-cleansing.

- **Stage 1c, chronic mild retraction pocket:** Same as stage 1a but chronic.

- **Stage 2a, acute moderate retraction pocket:** The membrane of the pocket is applied to one or more middle-ear structures, but it is not adherent. The pocket expands with pressure, its extent can be visualized, and it is self-cleansing without infection.

- **Stage 2c, chronic moderate retraction pocket:** Same as stage 2a but chronic.

- **Stage 3a, acute severe retraction pocket:** The tympanic membrane is adherent to one or more middle-ear structures, its extent is visualized, and it is without infection. It cannot be expanded with pressure.

- **Stage 3c, chronic severe retraction pocket:** Same as stage 3a but chronic.

- **Stage 4a, acute retraction pocket or cholesteatoma:** The tympanic membrane is adherent to one or more middle-ear structures. Its extent cannot be visualized, and it is not self-cleansing or free of infection.

- **Stage 4c, chronic retraction pocket or cholesteatoma:** Same as stage 4a but chronic.

**Total (generalized) atelectasis** may be acute (duration less than 3 months) or chronic (3 months or longer). It involves all four quadrants of the pars tensa, with or without involvement of the pars flaccida, and can be staged as follows:

- **Stage 1a, acute total mild atelectasis:** The middle ear is aerated.

- **Stage 1c, chronic total mild atelectasis:** Same as stage 1a but chronic.

- **Stage 2a, acute total severe atelectasis:** The middle ear is not aerated (i.e., no apparent middle-ear space).

- **Stage 2c, chronic total severe atelectasis:** Same as stage 2a but chronic.

**Adhesive Otitis Media**

Adhesive otitis media is a result of healing after chronic inflammation of the middle ear and mastoid. The mucous membrane is thickened by proliferation of fibrous tissue, which frequently impairs movement of the ossicles, resulting in conductive hearing loss. The pathologic process is a proliferation of fibrous tissue within the middle ear and mastoid termed *fibrous sclerosis.* When cystic spaces are present, it is called *fibrocystic sclerosis,* and when there is new bone growth in the mastoid, it is termed *fibro-osseous sclerosis.*

In addition to fixation of the ossicles, adhesive otitis media may be the cause of ossicular discontinuity and conductive hearing loss owing to rarefying ossicular osteitis, especially of the long process of the incus. Severe localized atelectasis (a retraction pocket) in the posterosuperior portion of the pars tensa of the tympanic membrane may cause adhesive changes to bind the tympanic membrane to the incus, stapes, and other surrounding middle-ear structures and cause resorption of the ossicles. The development of a cholesteatoma then becomes possible.

Adhesive otitis media may be staged as follows:

- **Stage 1:** Adhesive otitis media within the middle ear, mastoid, or both, with no functional deficit secondary to the adhesive changes (i.e., hearing loss). The middle ear remains aerated.
Stage 2: Adhesive otitis media within the middle ear (with or without mastoid involvement) with mild hearing loss secondary to an adhesive pathologic process. This may involve fixation or discontinuity of the ossicular chain (see “Ossicular Discontinuity” and “Ossicular Fixation”), limit tympanic membrane compliance, or both. The middle ear remains aerated.

Stage 3: Similar to stage 2 but with maximal conductive hearing loss secondary to an ossicular pathologic process. No middle-ear space is present. Both conditions are due to extensive adhesive otitis media.

**Cholesteatoma**

Cholesteatoma occurs when keratinizing stratified squamous epithelium accumulates in the middle ear or other pneumatized portions of the temporal bone. The term *aural* distinguishes this type of cholesteatoma from a similar pathologic entity that occurs outside the temporal bone. *Acquired* distinguishes it as a sequela of otitis media or related conditions (eg, retraction pocket of the tympanic membrane) distinct from aural congenital cholesteatomas. Even though this term is a misnomer—*keratoma* is more consistent with the pathologic change—cholesteatoma is in common use and is thus accepted.9,73

Cholesteatoma can be classified as *congenital* or *acquired*. Acquired cholesteatoma may be further subclassified as a sequela of otitis media or related conditions (eg, retraction pocket of the tympanic membrane) distinct from aural congenital cholesteatomas. Congenital cholesteatoma is not a sequela of otitis media, whereas acquired cholesteatoma is. Classically, *congenital cholesteatoma* develops as a rest of epithelial tissue within the temporal bone in the absence of a defect in the tympanic membrane. In contrast to this strict definition, an *aural acquired cholesteatoma* develops from a retraction pocket in the pars tensa or pars flaccida (see earlier), migration of epithelium through a preexisting defect of the tympanic membrane (eg, perforation), or, more rarely, metaplasia of the middle ear–mastoid mucous membrane. A cholesteatoma may involve only the middle ear, mastoid, or both, and it may or may not extend beyond the temporal bone.

Cholesteatoma may or may not be associated with otitis media and mastoiditis, but when otitis media is present, the infection may be acute or chronic and otorrhea may or may not be present. The cholesteatoma may be a cyst-like structure with no signs of infection. A cholesteatoma that is present in association with chronic inflammation of the middle ear and mastoid is defined as *cholesteatoma with chronic suppurative otitis media*. Thus, cholesteatoma may or may not be associated with chronic suppurative otitis media. It is inappropriate to include cholesteatoma, lacking an associated infection such as chronic suppurative otitis media, under the term *chronic otitis media*.

*Aural acquired cholesteatoma* can be classified under the following categories of presence and duration of otitis media or its absence:

**Cholesteatoma without infection:** Cholesteatoma that is not associated with infection within the cholesteatoma or in any other portion of the middle-ear cleft (can be further classified by its site and extent).

**Cholesteatoma with infection:** The infection may be acute (with or without otorrhea) or chronic suppurative otitis media.

The following staging system can be used7:

Stage 1: Cholesteatoma is confined to the middle ear (hypoepitympanum or mesoepitympanum), with no erosion of the ossicular chain.

Stage 2: Same as stage 1, but with erosion of one or more ossicles.

Stage 3: The middle ear and mastoid gas cell system are involved without erosion of ossicles.

Stage 4: Same as stage 3, but with erosion of one or more ossicles.

Stage 5: Extensive cholesteatoma of the middle ear, mastoid, and other portions of the temporal bone and not totally accessible to surgical removal (eg, medial to labyrinth), with one or more ossicles involved. A fistula of the labyrinth may or may not be present.
Stage 6: Same as stage 5, but cholesteatoma extends beyond the temporal bone.

**Cholesterol Granuloma**

Cholesterol granuloma is a relatively uncommon sequela of otitis media. It has often been termed *idiopathic hemotympanum*, but this term is a misnomer because there is no evidence of blood in the middle ear. The blue appearance of the tympanic membrane is most likely due to the reflection of light from the thick liquid (granuloma) within the middle ear. The tissue is composed of chronic granulations with foreign body giant cells, foam cells, and cholesterol crystals within the middle ear, mastoid, or both.

Staging of cholesterol granuloma is based on the site and extent of the cholesterol granuloma as follows:

- **Stage 1**: Cholesterol granuloma localized to one portion of the mastoid gas cell system or middle ear
- **Stage 2**: Cholesterol granuloma involving the entire middle-ear cleft

**Tympanosclerosis**

Tympanosclerosis is characterized by whitish plaques in the tympanic membrane and nodular deposits in the submucosal layers of the middle ear. The pathologic process occurs in the lamina propria in the tympanic membrane and affects the basement membrane if it is within the middle ear. Hyalinization is followed in both sites by deposition of calcium and phosphate crystals. Conductive hearing loss may occur if the ossicles become embedded in the deposits. Tympanosclerosis is usually a sequela of chronic middle-ear disease (chronic otitis media with effusion or chronic suppurative otitis media), but it is also associated with trauma, such as tympanostomy tube insertion. Conductive hearing loss secondary to tympanosclerosis involving only the tympanic membrane is rare, although scarring of the eardrum at the site of tympanostomy tube insertion is common.

Tympanosclerosis can be staged as follows:

- **Stage 1**: Tympanosclerosis limited to the tympanic membrane (ie, little or no involvement of the middle ear) and the hearing is unaffected, which is commonly termed *myringosclerosis*. This stage can be subclassified as follows: stage 1-1, tympanosclerosis limited to one quadrant of the pars tensa; stage 1-2, tympanosclerosis limited to two or more quadrants but not total involvement of the tympanic membrane; and stage 1-3, the tympanic membrane is totally involved.
- **Stage 2**: Same as stage 1 (designate subclass), but hearing loss secondary to the tympanosclerosis is present.
- **Stage 3**: Tympanosclerosis involving the middle ear but with no hearing loss.
- **Stage 4**: Same as stage 3 but with hearing loss. This stage can be subclassified on the basis of the ossicle or joint involved (see “Ossicular Fixation”).
- **Stage 5**: Tympanosclerosis involving the tympanic membrane (designate subclass) and middle ear but with no hearing loss.
- **Stage 6**: Extensive tympanosclerosis involving both the tympanic membrane (stage 1-3) and middle ear (designate ossicle or joint involved) with hearing loss.

**Ossicular Discontinuity**

Ossicular discontinuity, a sequela of otitis media and certain related conditions, is the result of rarefying osteitis caused by inflammation; a retraction pocket or cholesteatoma can also cause resorption of ossicles. The most commonly involved ossicle is the incus; its long process usually erodes, resulting in a disarticulation of the incudostapedial joint. The second most commonly eroded ossicle is the stapes; the crural arches are usually involved initially. The malleus may also become eroded but not as commonly as the incus and stapes.

Ossicular discontinuity can be classified by the site of pathologic change as follows:

- **Stapes crura**
- **Incudostapedial joint**
Ossicular Fixation

The ossicles can become fixed as a sequela of chronic middle-ear inflammation, usually by fibrous tissue caused by adhesive otitis media, tympanosclerosis, or both. Each of these has a staging system for the extent and presence or absence of hearing loss. The ossicle itself or one or both of the joints (ie, incudostapedial or incudomallear) may be fixed.\(^8^0\)

Ossicular fixation can be classified by the site of pathologic change as follows:

- Stapes footplate
- Incudostapedial joint
- Incus
- Incudomallear joint
- Malleus

INTRACRANIAL COMPLICATIONS OF OTITIS MEDIA

There are seven intracranial suppurative complications of otitis media. These may be caused by an intratemporal complication such as mastoiditis, labyrinthitis, or one or more of the other complications of otitis media within the intracranial cavity.\(^6,^8^1\) These complications are still life-threatening even in the antibiotic era.\(^8^2\)

Meningitis

Meningitis is an inflammation of the meninges; when it is a suppurative complication of otitis media or certain related conditions (eg, labyrinthitis), it is usually caused by a bacterium associated with infections of the middle ear, mastoid, or both.\(^8^3\) The infection may spread directly from the middle ear–mastoid through the dura and extend to the pia-arachnoid, causing generalized meningitis. Suppurative complications in an adjacent area, such as a subdural abscess, brain abscess, or lateral sinus thrombophlebitis, may also cause an inflammation of the meninges.

Extradural Abscess

Extradural abscess, also termed epidural abscess, is an infection that occurs between the dura of the brain and the cranial bone. It usually results from the destruction of bone adjacent to the dura by cholesteatoma, chronic suppurative otitis media, or both. This occurs when granulation tissue and purulent material collect between the lateral aspect of the dura and the adjacent temporal bone. Dural granulation tissue within a bony defect is much more common than an actual accumulation of pus. When an abscess is present, a dural sinus thrombosis or, less commonly, a subdural or brain abscess may also be present.

Subdural Empyema

A subdural empyema occurs when purulent material collects within the potential space between the dura externally and the arachnoid membrane internally. Because the pus collects in a preformed space, it is correctly termed empyema rather than abscess. Subdural empyema may develop as a direct extension or, more rarely, by thrombophlebitis through venous channels.

Focal Otitic Encephalitis

Focal otitic encephalitis (also termed cerebritis) is a potential suppurative complication of AOM, cholesteatoma, or chronic suppurative otitis media. It may also be a complication of one or more of the suppurative complications of these disorders, such as an extradural abscess or dural sinus thrombophlebitis, in which a focal area of the brain is edematous and inflamed. The signs and symptoms of this complication are similar to those associated with a brain abscess, but suppuration within the brain is not present.
Brain Abscess

Otogenic brain abscess is a potential intracranial suppurative complication of cholesteatoma, chronic suppurative otitis media, or both. It may also be caused by acute otitis media or acute mastoiditis. Even though otogenic brain abscess is a rather uncommon complication in the antibiotic era, it is still encountered in the United States.\textsuperscript{84} In addition, an intratemporal complication such as labyrinthitis or apical petrositis may be the focus, or the abscess may follow the development of an adjacent intracranial otogenic suppurative complication, such as lateral sinus thrombophlebitis or meningitis.

Brain abscesses can be classified on the basis of the following:

- **Site in the brain** (eg, temporal lobe or cerebellum).
- **Number of lesions** (solitary or multiple).
- **Definition** (well defined or ill defined [cerebritis]). This is related to management and outcome.

Dural Sinus Thrombosis

Lateral and sigmoid sinus thrombosis or thrombophlebitis arises from inflammation in the adjacent mastoid.\textsuperscript{85} The superior and petrosal dural sinuses are also intimately associated with the temporal bone but are rarely affected. This suppurative complication can result from AOM, an intratemporal complication (eg, acute mastoiditis or apical petrositis), or another intracranial complication of otitis media.

Otitic Hydrocephalus

Otitic hydrocephalus describes a complication of otitis media in which there is increased intracranial pressure without abnormalities of cerebrospinal fluid. The pathogenesis of the syndrome is unknown, but because the ventricles are not dilated, the term *benign intracranial hypertension* also seems appropriate. The disease is usually associated with lateral sinus thrombosis.\textsuperscript{86}

CONCLUSIONS

This classification, which provides definitions, terminology, grading, and staging of otitis media and its complications and sequelae, makes it clear that the clinician or investigator must define the specific disease or disorder being managed or studied. There is also a critical need to establish a consensus regarding the definitions, grading, and staging of many of these disease entities.

REFERENCES

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