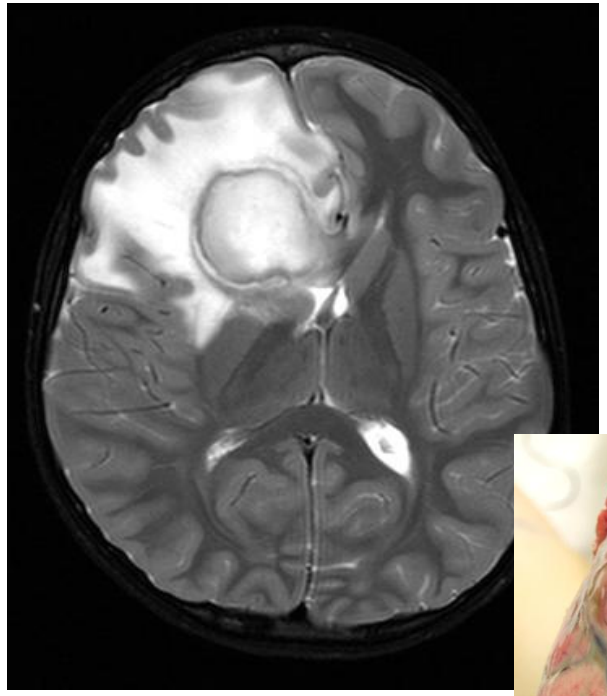
Microbiology of the central nervous system



Anas Abu-Humaidan
M.D. Ph.D.

Eye and middle ear infections

Ocular infections

- "Red eye" is a common presenting complaint. **A small percentage of patients with red eye need urgent ophthalmological referral** and treatment, but the vast majority can be treated by the primary care clinician.

- **Conjunctivitis (allergic or viral) is probably the most common cause of red eye** in the community setting.

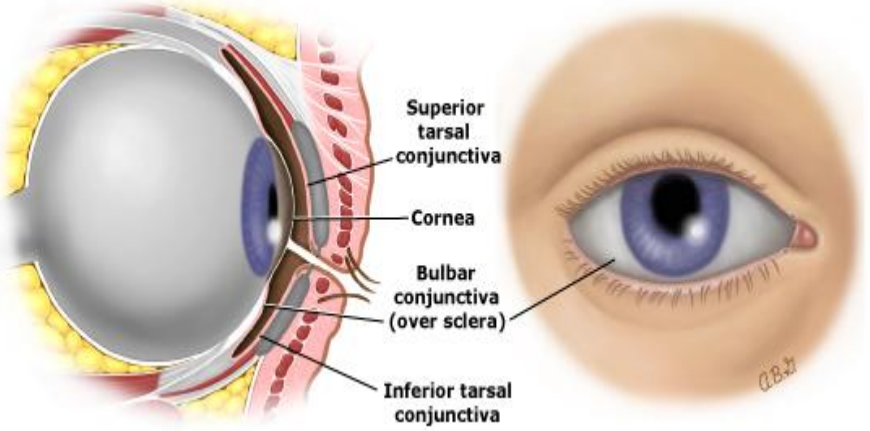
- The differential diagnosis of the red eye **includes serious conditions that require ophthalmologic evaluation** and **benign conditions that may be managed by the primary care provider**

Conjunctivitis / overview

- Conjunctivitis refers to **inflammation of the conjunctiva and is common in patients who present with a red eye (most common etiology)**. It is typically a **benign and self-limited condition**. Conjunctivitis can be categorized as infectious (predominantly viral or bacterial) or noninfectious (allergic, toxic, or noninfectious, noninflammatory).

- 80% of acute cases of conjunctivitis are viral—the most common pathogen being **adenovirus**. Adenoviruses are responsible for 65% to 90% of cases of viral conjunctivitis..

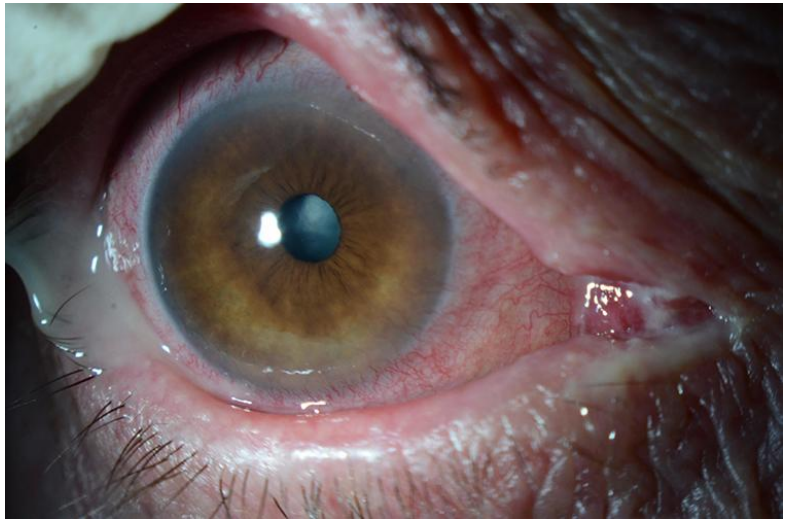
- In children, most infectious conjunctivitis is bacterial. Bacterial causes include (**Staphylococcus aureus, followed by Streptococcus pneumoniae and Haemophilus influenza**), are the most common bacterial causes in adults



The conjunctiva is a thin, transparent tissue that covers the outer surface of the eye. It consists of two continuous parts, one on the inner surface of the eyelid (the tarsal conjunctiva) and the other over the sclera (the bulbar conjunctiva). These are outlined in the drawing as a thin, pink line

Conjunctivitis/ signs and symptoms

- Conjunctivitis is characterized by **ocular discharge**, **engorgement of conjunctival blood vessels ("injection"),** and various amounts of **conjunctival edema** ("chemosis"), and in viral or allergic cases may be associated with systemic symptoms.



Alarm symptoms and signs — Features that are **not** typical of common bacterial or viral conjunctivitis include:

- Decreased visual acuity
- Profuse mucopurulent discharge
- Inability to spontaneously open the eye
- Atypical time course, including rapidly progressive/worsening symptoms over hours; **or** chronic conjunctivitis lasting weeks to months
- Conjunctivitis in a newborn

Conjunctivitis/ evaluation and management

- **Labs and cultures are rarely indicated** to confirm conjunctivitis diagnosis. Eyelid cultures and cytology are **usually reserved for** recurrent conjunctivitis, those resistant to treatment, suspected gonococcal or chlamydial infection, suspected infectious neonatal conjunctivitis, and adults presenting with severe purulent discharge

- When treating viral or bacterial conjunctivitis, educating the patient to **reduce the spread of the infection** is important. Bacterial conjunctivitis, while typically self-limiting, can be treated to help **reduce the duration of symptoms**.

- Viral conjunctivitis usually worsens for about 4 or 5 days before improving over the next 1 to 2 weeks, with a total duration of 2 to 3 weeks. Bacterial conjunctivitis usually lasts 7 to 10 days, but taking antibiotics within the first 6 days of onset can shorten the duration

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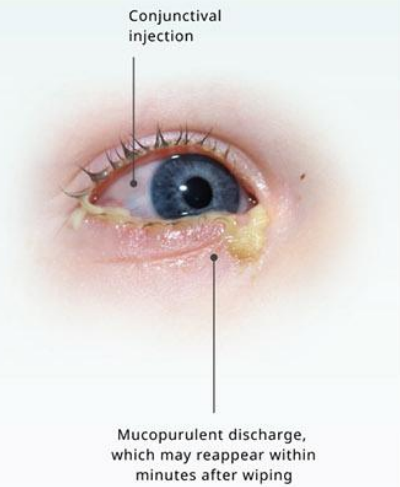
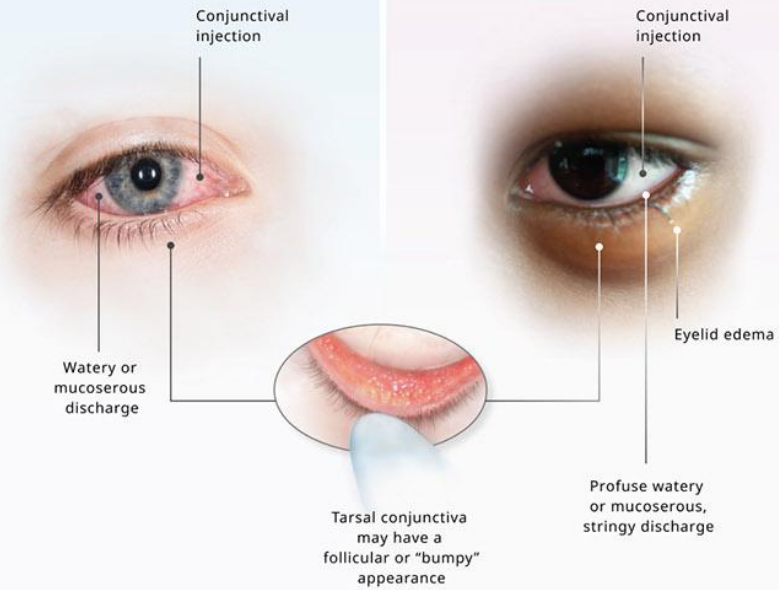
Bacterial vs. Viral vs. Allergic Conjunctivitis

BACTERIAL



VIRAL



ALLERGIC

Other Features - Bacterial

Demographics
- Most common in children

Distribution
- May be unilateral or bilateral

Eye Symptoms
- Discharge is the most prominent symptom

Other Symptoms
- May be associated with acute otitis media

Other Features - Viral

Demographics
- Most common in adults

Distribution
- May be unilateral or bilateral

Eye Symptoms
- Sensation of grittiness, burning, or irritation

Other Symptoms
- May be part of viral upper respiratory tract infection, with associated nasal congestion or pharyngitis
- Preauricular lymphadenopathy may be present

Other Features - Allergic

Demographics
- Most common in young adults and adults

Distribution
- Typically bilateral

Eye Symptoms
- Itching
- Sensation of grittiness, burning, or irritation

Other Symptoms
- May have other allergic symptoms, such as nasal congestion, sneezing, cough, or wheezing

KEY CONCEPTS

Bacterial, viral, and allergic conjunctivitis are common, usually self-limited causes of "red eye" in the community setting. Although certain signs and symptoms are more common in each type of conjunctivitis, no single sign or symptom distinguishes these conditions with certainty. In addition to the eye examination, a careful history is essential for determining the most likely diagnosis.

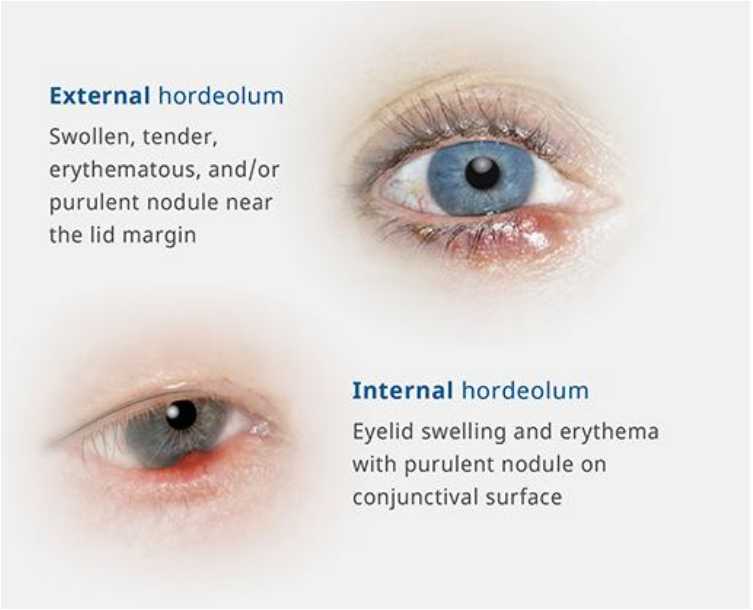
Distinguishing bacterial, viral, and allergic conjunctivitis can avoid unnecessary or inappropriate treatment:

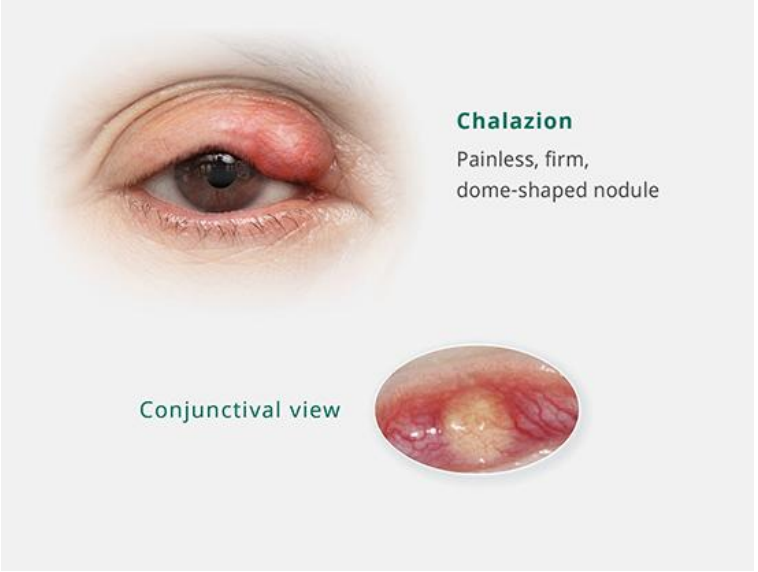
- **Bacterial conjunctivitis:** Most cases are self-limited and improve with supportive care. Antibiotics are required for contact lens wearers. In non-contact lens wearers, antibiotics are reserved for patients with immunodeficiencies or concurrent medical issues, who cannot return for clinical follow-up, or with conjunctivitis that is not following a typical course of resolution.
- **Viral conjunctivitis:** Topical antihistamines and/or topical decongestants and warm or cool compresses may provide symptomatic relief.
- **Allergic conjunctivitis:** Patients with allergic conjunctivitis should minimize exposure to the allergen. Use of topical lubricants, cool compresses, and topical or systemic antihistamines may provide symptom relief.

A "red eye" can be caused by other disorders. Examples of findings that support urgent ophthalmologic referral include loss of visual acuity, photophobia, inability to spontaneously open the eye, decreased extraocular motility, or pain with eye movement.

Other “benign” eye conditions

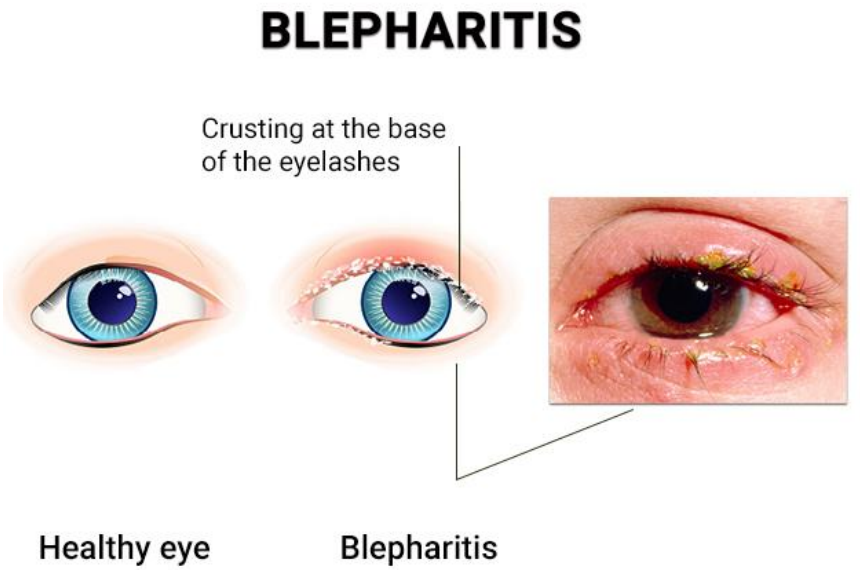
- **Eyelid lesions** — Hordeolum (stye) is an acute inflammation of the eyelid that presents as a localized painful and erythematous swelling or nodule. Chalazion is a painless localized eyelid nodule.



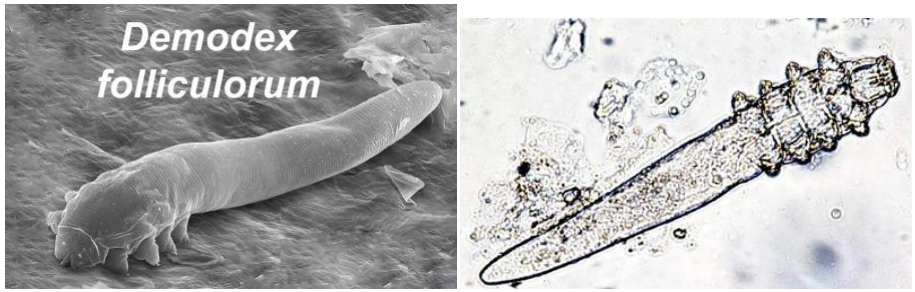


Other “benign” eye conditions

- **Blepharitis** — Blepharitis refers to inflammation of the eyelids. Patients generally present with chronic recurrent symptoms, which may vary over time, involving both eyes. Symptoms include pink eyes; red, swollen or itchy eyelids; gritty or burning sensation; excessive tearing; and crusted eyelashe



- Blocked/Malfunctioning Oil Glands (Meibomian Glands): The primary cause of posterior blepharitis, where oil glands at the base of eyelashes become clogged.
- **Bacterial Overgrowth: Staphylococcal bacteria normally** found on the skin can overpopulate the eyelids.
- Skin Conditions: Seborrheic dermatitis (dandruff), rosacea, eczema, and psoriasis.
- **Parasites: Demodex mites or lice in the eyelashes**



Examples of ocular infections causing sight loss.

- Serious infectious diseases affecting the eye often cause unilateral or asymmetric visual loss in children and people of working age.

- This group of conditions includes **viral, bacterial, fungal and parasitic diseases**, both common and rare presentations which, in aggregate, may account for a significant portion of the global visual burden.

- Pathology may be **restricted to the ocular tissues**, or manifest in the eye **as part of a systemic infectious disease.**

- As soon as recognized, they should be referred to an ophthalmologist

Emergency versus urgent referral for red eyes

Emergency referral (same day)
▪ Bacterial keratitis ▪ Hyphema ▪ Hypopyon ▪ Angle-closure glaucoma
Urgent referral (1 to 2 days)
▪ Viral keratitis ▪ Iritis (anterior uveitis) ▪ Scleritis

Conditions are ordered anatomically (from anterior to posterior).

Examples of ocular infections causing sight loss.

Classification	Diagnostic category	Organisms involved
Viruses	Keratitis	Measles virus, herpesviruses, adenovirus
	Cicatrising conjunctivitis	Adenovirus, herpes simplex
	Uveitis	Herpesviruses, rubella, HIV, Ebola, Chikungunya, Zika
	Retinitis	Herpesviruses, Rift Valley Fever virus, Zika virus, Chikungunya, measles
	Foveolitis	Dengue
	Chorioretinitis	West Nile virus, Ebolavirus
	Orbital apex syndrome, optic neuritis, scleritis	Varicella zoster virus
	Post-infectious maculopathies	Influenza, Coxsackie, SARS-CoV2
	Retinal vascular occlusion	Dengue, SARS-CoV2
	Congenital retinopathy and/or retinal lesions	Rubella, Zika, HSV-2

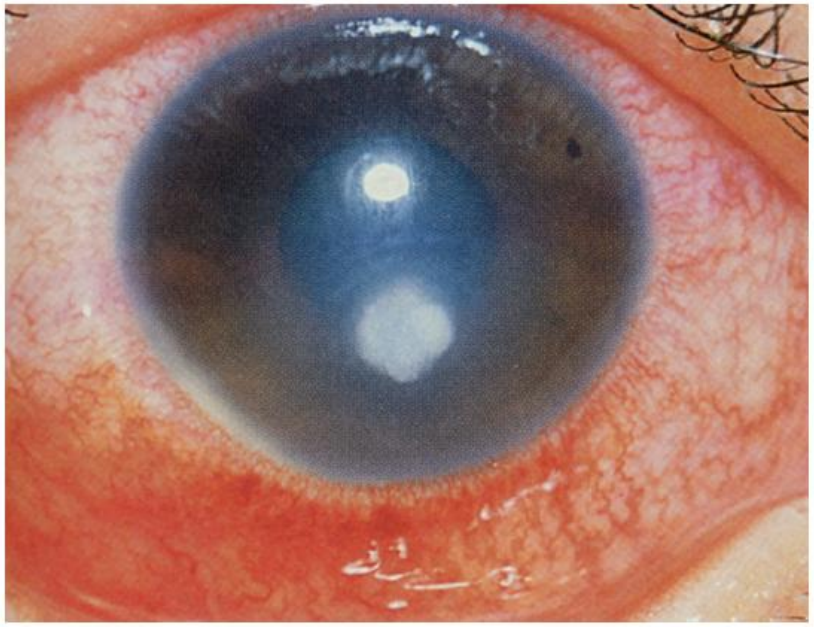
Examples of ocular infections causing sight loss.

Bacteria and fungi	Trachoma	*Chlamydia trachomatis*
	Keratitis	Various e.g., *Staphylococcus aureus, Fusarium* spp.
	Endophthalmitis	Various e.g., coagulase-negative staphylococci, *Candida albicans, Klebsiella* spp.
	Orbital cellulitis	Various e.g., *Streptococcus pneumoniae, Haemophilus influenzae*
	Neuroretinitis	Spirochaetes (e.g., tick-borne borrelioses, leptospirosis), *Bartonella* spp., rickettsioses
	Ocular syphilis (placoid chorioretinitis, optic neuritis, multifocal retinitis, vitritis, granulomatous uveitis)	*Treponema pallidum*
	Hypopyon uveitis	Leptospirosis (Weil's disease)
	Multifocal retinitis	Rickettsioses, *Bartonella* spp.
	Ocular tuberculosis (granulomatous uveitis, occlusive retinal vasculitis, serpiginous-like and ampiginous choroiditis, choroidal granulomas, and/or optic nerve granuloma)	*Mycobacterium tuberculosis*
	Ocular leprosy, erythema nodosum leprosum, iris leproma	*Mycobacterium leprae*
	Choroidal granuloma	*Brucella* spp., TB
	Multifocal choroiditis	*Nocardia* spp., paracoccidioidomycosis, coccidioidomycosis, presumed ocular histoplasmosis syndrome
	Post-streptococcal uveitis	β-haemolytic (Group A) streptococci
	Optic disc oedema	*Tropheryma whipplei*

Examples of ocular infections causing sight loss.

- **Bacterial keratitis** — Bacterial infectious keratitis warrants evaluation by an ophthalmologist on the same day. The patient will have objective foreign body sensation and have **trouble keeping the involved eye open**, a sign of an active corneal process. **Decreased visual acuity may also be present**.

- Bacterial pathogens include Staphylococcus aureus, Pseudomonas aeruginosa, coagulase-negative Staphylococcus, diphtheroids, Streptococcus pneumoniae, and polymicrobial isolates



The white corneal opacity suggests purulent necrosis.

- **Improper contact lens wear** is the **biggest risk factor for bacterial keratitis**

Examples of ocular infections causing sight loss.

- **Viral keratitis** — A number of viruses, including **herpes simplex, herpes zoster**, mpox, and some strains of adenovirus, can cause viral keratitis.

- **Iritis (anterior uveitis)** — Inflammation of the anterior uveal tract is called iritis (also known as anterior uveitis); when the adjacent ciliary body is also inflamed, the process is called iridocyclitis. Patients with iritis may present with **eye redness, pain, and photophobia**. Decreased visual acuity may be present.

Summary

- Patient history, measurement of visual acuity, and findings on penlight examination are important features in determining the cause and management of red eye

- The differential diagnosis of the red eye includes serious conditions that require ophthalmologic evaluation and benign conditions that may be managed by the primary care provider.

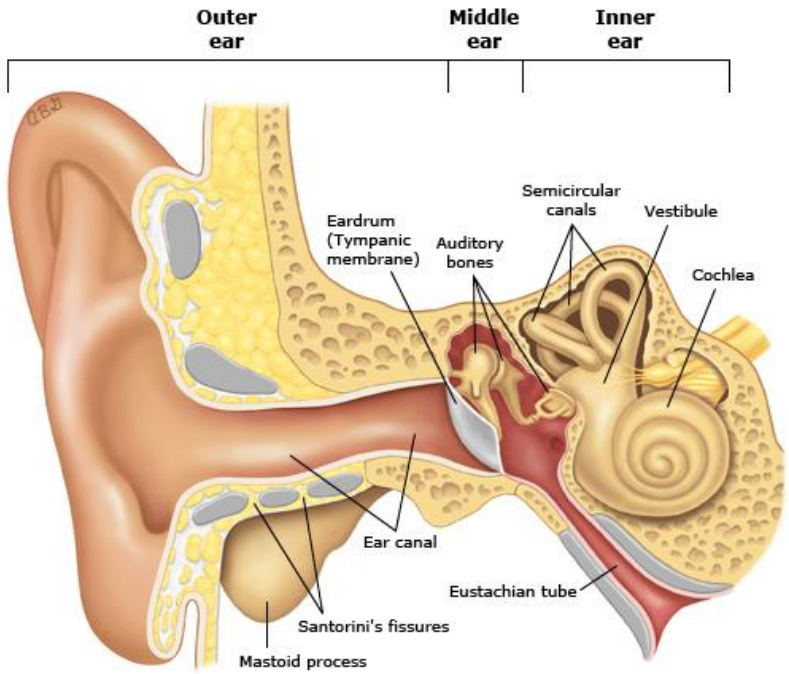
- In the patient with red eye, if vision is unaffected, the pupil reacts, there is no objective foreign body sensation or photophobia, and there is no corneal opacity, hyphema, or hypopyon, it is reasonable for the primary care clinician to manage the condition.

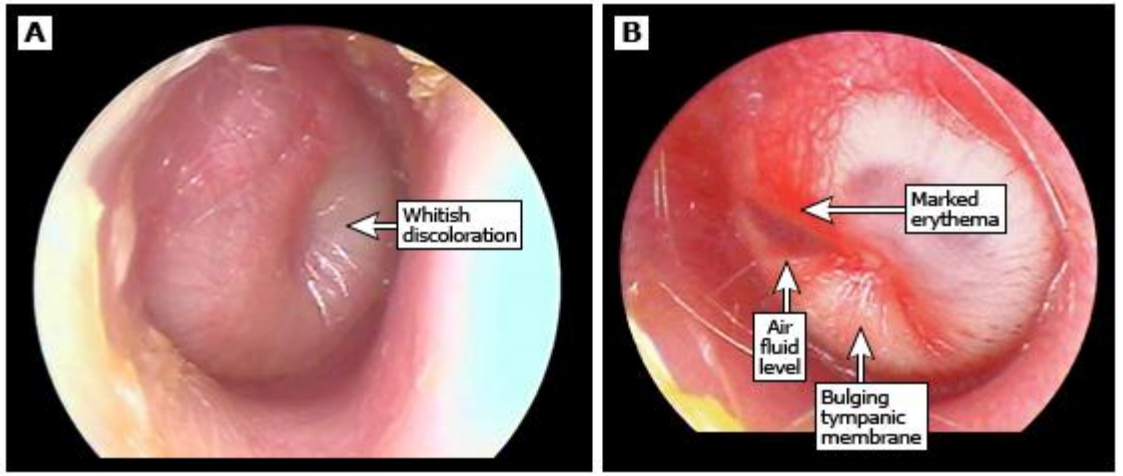
Middle ear infections (Otitis media)/ overview

- Acute otitis media (AOM) is an **acute, suppurative infectious process marked by the presence of infected middle ear fluid and inflammation** of the mucosa lining the middle ear space.

- The infection is most frequently precipitated by **impaired function of the Eustachian tube**, resulting in **the retention and suppuration of retained secretions**.

- AOM may also be associated with purulent otorrhea if there is a ruptured tympanic membrane. AOM usually responds promptly to antimicrobial therapy.





Examples of the white, bulging tympanic membrane seen in acute otitis media

Middle ear infections (Otitis media)/ epidemiology and etiology

- Acute otitis media (AOM) occurs much more commonly in children than in adults.

- **The most common bacterial pathogens** are *Streptococcus pneumoniae* and nontypeable *Haemophilus influenzae*, with *Moraxella catarrhalis* the third most common bacterial etiology

- A **viral upper respiratory infection** is a common **predisposing factor** for AOM in children, and viruses may coinfect the middle ear along with bacteria.

- **Eustachian tube dysfunction**, entities causing Eustachian tube compression or outlet obstruction, or an abnormality of **host immunologic response** can be a **predisposing factor** in the development of acute otitis media (AOM).

Middle ear infections (Otitis media)/ presentation and management

- In adults, an upper respiratory tract infection or exacerbation of seasonal allergic rhinitis often precedes the onset of AOM.

- In adults, **AOM is typically unilateral** and is associated with **otalgia (ear pain)** and **decreased or muffled hearing**.

- If the tympanic membrane has ruptured, the patient may report a sudden relief of pain, possibly accompanied by **purulent otorrhea**.

- In adults with suspected AOM, **the diagnosis is confirmed by the presence of typical features on otoscopic examination**

- **Antibiotics are the mainstay of treatment** of uncomplicated acute otitis media (AOM) in adults, and initial antibiotic choice is determined by knowledge of the most common causative pathogens**.**

Middle ear infections (Otitis media)/ possible complications

Complications may result from seeding of vascular channels and extension along preformed pathways.

- **Mastoiditis** — The mastoid bone contains air cells and is connected by the mastoid antrum to the middle ear. It causes severe pain, fever, hearing loss, and swelling that pushes the earlobe outward.

- **Labyrinthitis** — rare, may present as nausea, vomiting, vertigo, tinnitus, and hearing loss following bacterial AOM, but most common cause of labyrinthitis **is a viral infection of the upper respiratory tract**.

- **Facial paralysis** — malfunction of the facial nerve (cranial nerve VII), although it is mostly idiopathic (70%), it can happen after bacterial or viral infections, including AOM.

- **Epidural, subdural, and brain abscess**

Further reading:

The following titles in UpToDate were used in this lecture

- The red eye: Evaluation and management
- Acute otitis media in adults