Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Chapter 11

'ENT' and eye infections

EAR, NOSE AND THROAT INFECTIONS

Normal Flora of the Upper Respiratory Tract

Many different bacterial species normally colonize the mouth and main examples are included in *Table 11.1(1)*. Host defence mechanisms, including those associated with the ciliated epithelium in the nose and sinuses, lysozyme in saliva and IgA and other immunoglobulins in mucous secretions or serum, may help to reduce the incidence of infections due to respiratory pathogens (p. 205, Section on immune deficiency, in Chapter 8 and also oral candidiasis in Chapter 21). The normal mouth flora probably contributes to the prevention of attachment of exogenous pathogens to the mucosa. Nevertheless, certain 'respiratory pathogens' are sometimes carried asymptomatically in the mouth or nose of healthy individuals (*Table 11.1(2)*). The administration of broad-spectrum antibiotics may greatly disturb the normal flora and predispose to colonization by organisms which are not normally evident in the mouth (*Table 11.1(3)*); ultimately this might result in superinfections, such as thrush (*see* p. 270).

Table 11.1. Normal flora of upper respiratory tract (throat or nose)

1. *Bacteria carried in the majority of people*	
Streptococcus viridans	
Neisseria spp.	
Diphtheroids	
Anaerobic cocci, fusiforms and *Bacteroides*	
2. *'Respiratory bacterial pathogens' that may be carried asymptomatically*	
Streptococcus pyogenes	(2–5% carriage rate)
Streptococcus pneumoniae	
Haemophilus influenzae	
Corynebacterium diphtheriae	(less than 0·1% carriage rate)
3. *Organisms sometimes associated with transient colonization secondary to antibiotic therapy*	
Coliforms—*Klebsiella* spp., *E. coli*, etc.	
Pseudomonas spp.	
Candida albicans	

Frequency of Upper Respiratory Tract Infections in Relationship to Age

Upper respiratory tract infections are extremely common in infants and young school children. An average pre-school child is said to have about six upper respiratory tract infections a year. Most of the infections are of viral aetiology

and occur in winter. Bacterial infections are also very common in young children. The relationship between age and infections due to viruses, *Streptococcus pneumoniae*, *Haemophilus influenzae*, capsulated Pittman type b strains, *Bordetella pertussis* and other organisms affecting the upper respiratory tract are mainly discussed in Chapters 8 and 10. The eustachian tubes in infants are relatively wider and more horizontal than in adults; this might partly explain the greater incidence of acute otitis media in infants since the causative organisms may spread directly from the throat to the middle ear via the eustachian tube. Older children and adults usually have good immunity to a wide range of respiratory pathogens but the 'common cold' continues to be prevalent in these age groups. Sinusitis frequently occurs in adults and children.

The 'Common Cold' (Coryza)

Clinical features

The incubation period is usually between 2 and 4 days and the main clinical features include nasal discharge, sneezing and sore throat. Some patients are febrile and also complain of headache. The peak incidence of this most common of all infectious diseases is in children aged 2–7 years, but colds are common at most ages. The symptoms have usually disappeared within a week.

Causative organisms

Rhinoviruses (over 100 serotypes) are by far the most common cause.

Other viruses also often cause colds including:

- Coronaviruses
- Respiratory syncytial virus
- Para-influenza viruses (four types)
- Coxsackie viruses A_{21} and B_3
- Echoviruses types 11, 20
- Adenoviruses

Bacteria may cause mild secondary bacterial infection in the later stages of a cold.

Investigation and treatment

Microbiological investigations and chemotherapy are not indicated. Antibiotic treatment may occasionally become advisable in certain patients with chronic bronchitis who develop a cold (*see* Chapter 12).

Sore Throat and Tonsillitis

Clinical features

Sore throat and tonsillitis are most common in young children. The main presenting features of tonsillitis in children under 3 years old include fever and a refusal to eat. Common presenting features of pharyngitis and tonsillitis in older children or young adults include sore throat, dysphagia and sometimes a painful cervical lymphadenopathy. On examination of the throat a purulent follicular

tonsillitis may be seen. Frequently only a mild pharyngitis is observed without any pharyngeal exudate.

It is not possible clinically to distinguish between the common viral and bacterial causes of sore throat, even when purulent follicular tonsillitis is present, which is why bacteriology investigations should be carried out whenever possible.

Diphtheria should be suspected clinically when there is a membranous exudate present in the throat or when there is serious constitutional upset—urgent expert advice is then necessary. (Some laboratories still look routinely for *Corynebacterium diphtheriae* as well as *Streptococcus pyogenes* when culturing throat swabs from all patients with acute sore throat. However, the bacteriological investigations are of secondary importance to prompt clinical diagnosis and the administration of diphtheria antitoxin—*see* Diphtheria, in Chapter 8.)

Sore throat may be severe in glandular fever (infectious mononucleosis) and sometimes a thick white shaggy exudate is present on the tonsils. There may be marked constitutional upset followed by prolonged malaise.

Pharyngitis in adults aged 20 to 40 years is occasionally caused by *Corynebacterium haemolyticum* and, when a rash accompanies a sore throat, this cause should be especially considered.

Causative organisms

Viruses

These are the most frequent causative organisms of sore throat and include:

Adenoviruses (33 types causing pharyngitis and conjunctivitist)
Epstein–Barr virus—cause of glandular fever
Enteroviruses
Other viruses that cause the 'common cold' (mentioned above)
} common causes

Viruses causing childhood infectious diseases such as measles (prodromal stages)

Cytomegalovirus	may occasionally cause a Paul–Bunnell negative glandular fever type illness
Herpes simplex	may cause severe primary stomatitis in children. Recurrent secondary lesions may occur afterwards at the mucocutaneous junctions (herpes labialis)

Bacteria

Streptococcus pyogenes (Lancefield group A beta-haemolytic streptococcus)—isolated from about 30% of patients with acute sore throat and is *the only common bacterial cause*

Beta-haemolytic streptococci belonging to Lancefield groups C or G—occasional causes

Corynebacterium diphtheriae
Corynebacterium ulcerans
} rare causes

Corynebacterium haemolyticum	an occasional cause in adults, less frequent in children

Vincent's organisms	*Borrelia vincenti* (spirochaetes) and anaerobic Gram-negative fusiform bacilli, together may cause painful ulcers in the throat or an ulcerative gingivitis
Treponema pallidum	primary chancres may occur inside the mouth but sore throat is more frequently associated with secondary rather than primary syphilitic lesions
Neisseria gonorrhoeae	gonococcal pharyngitis should be considered in patients with possible sexually transmitted disease who have a history of recent oral intercourse

Bacteriological investigations

Throat swab

A Gram-stain of a throat swab may reveal numerous Vincent's organisms when Vincent's infection is clinically suspected. Microscopy is not carried out for the investigation of other bacterial infections.

The throat swab should be collected for the culture of streptococci before the start of antibiotic therapy. Care should be taken to sample the inflamed site and not to contaminate the swab by touching the other parts of the mouth. The swab should be put into Stuart's or other suitable transport medium if a delay of more than 1 hour is expected before the swab can be plated out on blood agar. If no beta-haemolytic streptococci are isolated after overnight incubation of the culture plate, viruses are the probable cause of the sore throat. However, if a bacitracin-sensitive beta-haemolytic streptococcus is isolated, it is likely that the sore throat is due to *Strep. pyogenes* (but *see* p. 17). Recently tests have been developed to detect *Strep. pyogenes* antigen in throat swabs, which allows rapid diagnosis, but they are not yet reliable enough to be recommended routinely. Cultures are also preferable because antibiotic sensitivity tests and typing investigations on isolates can be carried out. Cultures for *C. diphtheriae* are essential when diphtheria is clinically suspected (*see* p. 199 and Chapter 1). *C. haemolyticum* should be looked for, especially in patients with a sore throat and a scarlet fever-type rash, and antibiotic sensitivity tests carried out if this organism is isolated because some strains are more sensitive to erythromycin than penicillin.

Nose swab

A nose swab should be collected in addition to a throat swab for culture for streptococci to see if there is nasal carriage of *Strep. pyogenes* as well as throat infection due to this organism. This is particularly necessary during a suspected outbreak and may be of epidemiological importance as *Strep. pyogenes* is more likely to spread when there is nasal carriage.

Virus isolation investigations

Virus isolation attempts are not indicated routinely. Exceptionally in an unusually severe case or during an unexplained outbreak of acute sore throats, virus isolation can be attempted by taking a throat swab from the inflamed lesions in the first couple of days of the infection. The swab should be put immediately into viral transport medium and sent at once to the laboratory.

Blood and serological tests

When glandular fever is suspected clinically a blood count in the acute stage will help to show whether there is a lymphocytosis and atypical lymphocytes present which are characteristic of this condition. Heterophile antibodies can also be looked for in the Paul–Bunnell test. This serological test may need to be repeated since it can take up to 3 months to become positive. When the patient has a glandular-fever-like illness and the Paul–Bunnell test is negative, other serological tests may be indicated to diagnose possible infection with cytomegalovirus (CMV complement fixation test) or *Toxoplasma* (toxoplasma dye test) using paired sera.

Anti-streptolysin O (ASO) or anti-streptococcal DNAase B antibody titres should be estimated in the serum where evidence of recent streptococcal infection is sought and the throat swab culture result is negative. A rise in anti-streptococcal antibodies can be demonstrated using these tests in between 80 and 100% patients within 2–4 weeks of a previous *Strep. pyogenes* pharyngeal infection. These serological tests may be particularly indicated when possible indirect complications of *Strep. pyogenes* infection are suspected (*see below*).

Antibiotic treatment of sore throat and tonsillitis

If *Strep. pyogenes* is isolated from the patient penicillin should be given if the patient is not allergic to it. All strains of this organism are sensitive to penicillin. Treatment should be given with a single intramuscular injection of benzathine penicillin or by oral penicillin V for 10 days (*see also* Duration of therapy p. 65, in Chapter 3). Erythromycin is an alternative antibiotic especially suitable when the patient is allergic to penicillin.

In general practice, the results of bacteriological investigation are often not available and 'blind' antibiotic treatment of acute sore throat should be with penicillin or erythromycin (as for *Strep. pyogenes* above) on the assumption that there is a streptococcal cause present. Ampicillin or amoxycillin should not be given as these drugs are particularly likely to cause a rash when the patient's sore throat is due to glandular fever which may not be distinguished from streptococcal infection (as discussed above). If *C. haemolyticus* is isolated erythromycin is usually the drug of choice for treatment.

If there is clinical or bacteriological evidence for Vincent's infection, effective treatment with either metronidazole or penicillin can be given.

Complications of Strep. pyogenes Throat Infections

Strep. pyogenes can cause both direct and indirect complications.

Direct complications

1. Peritonsillar abscess ('quinsy')

Untreated streptococcal tonsillitis may become complicated by the development of a peritonsillar abscess but this is much less common than in the past. The abscess may require surgical drainage under penicillin cover.

2. *Otitis media*

This is discussed below.

3. *Scarlet fever*

Certain strains of *Strep. pyogenes* produce an erythrogenic toxin as a result of the presence of a particular lysogenic phage (*see* Scarlet fever, p. 192, in Chapter 8).

Indirect complications

1. *Rheumatic fever*

Rheumatic fever most often occurs in children aged 6–15 years, with a peak incidence at about 7 years old, but the disease is rarely seen in Britain today. The decline in the incidence of the disease in developed countries is probably mainly due to an improvement in general living conditions.

Pathogenesis

The exact pathogenesis of rheumatic fever is unknown but there is no doubt that it is related to a previous *Strep. pyogenes* throat infection which occurs usually 2–4 weeks before the clinical onset of the disease. Antibodies develop to cell wall antigens of the streptococcus which cross-react with the sarcolemma of human heart and other tissues. Characteristic rheumatic granulomata develop in connective tissue in many different sites in the body and, in the heart, these are known as Aschoff's nodules. Rheumatic heart valvular disease can ultimately occur especially if there are repeated attacks of rheumatic fever. Certain children appear to have a genetic predisposition to developing rheumatic fever following *Strep. pyogenes* infection. They may develop repeat attacks of rheumatic fever following infection due to a wide range of M types of *Strep. pyogenes*.

Diagnosis

Major clinical features of rheumatic fever may include fleeting polyarthritis, evidence of myocarditis or pericarditis, chorea, subcutaneous nodules and erythema marginatum. Supporting laboratory evidence of a recent streptococcal infection is usually provided by demonstrating a rising serum ASO titre, or a raised ASO titre greater than 200 Todd units per ml. The diagnosis of rheumatic fever is unlikely if the ASO and anti-streptococcal (DNAase B) titres are not raised. Occasionally, *Strep. pyogenes* is also isolated from a throat swab but this is of little diagnostic value since this merely indicates streptococcal carriage.

Prophylaxis

Following the first attack of rheumatic fever, prophylaxis to prevent repeated episodes of rheumatic fever developing is effectively carried out by giving either monthly injections of benzathine penicillin or twice daily oral penicillin V. Penicillin prophylaxis against throat infections is necessary throughout childhood and the early teenage years.

2. *Acute glomerulonephritis*

Post-streptococcal acute glomerulonephritis characteristically affects children

or young adults and usually occurs about 10 days after *Strep. pyogenes* infection.

Pathogenesis

This complication only follows infection due to a small number of 'nephritogenic' types of *Strep. pyogenes*, including M types 12, 1, 3, 4 and 25 when the site of infection is the throat. (Different M types, including M types 49 and 52, are implicated when nephritis follows streptococcal pyoderma; *see* Chapter 16, p. 380). The pathogenesis of the disease involves the deposition of circulating immune complexes in the glomerulus and there have been recent reports of streptococcal plasma membrane having been identified in affected glomeruli. Characteristically the serum complement components are reduced during the active stage of the disease, especially C3. Activation of the complement and coagulation systems at the sites of deposition of the immune complexes in the glomeruli results in local tissue inflammation and histology of the lesions shows typical proliferative changes.

Diagnosis, prognosis and use of penicillin

Clinical features include haematuria and signs of acute nephritic syndrome. The prognosis is good in children—they usually recover completely. Subsequent serious complications, such as renal failure, may rarely occur and this is possibly more likely in adults. The serum ASO titre is usually elevated and a rising titre may be demonstrated after streptococcal throat infection (in contrast anti-DNAase B antibodies only are elevated after previous streptococcal skin infection). Penicillin may be given to treat any residual. *Strep. pyogenes* infection. Subsequent prophylaxis with penicillin is not indicated as it is unlikely that a repeat infection due to a nephritogenic type of *Strep. pyogenes* would occur.

3. *Streptococcal skin rashes*

Erythema nodosum, Henoch–Schönlein purpura and guttate psoriases may result from the immune sequelae of previous streptococcal infection although there may also be other causes for these conditions. Erythema marginatum may occur as part of the rheumatic fever syndrome (*see above*).

Oral Candidiasis ('Thrush')

Candida albicans is the main *Candida* species that causes an acute infection in neonates (*see* p. 177 in Chapter 7) and the elderly, with typical white plaques which are only loosely adherent, covering the tongue and other mouth surfaces.

The candida organisms may also behave as 'opportunists' in patients who have impaired immunity or severe debilitation due to infection with human immunodeficiency virus (*see* Chapter 21), malignancy or other causes especially when there has been recent antibiotic therapy. White plaques or erythematous lesions may form in the throat of these patients due to candida infection and occasionally these lesions may extend into the oesophagus in severe cases of infection.

Diagnosis of 'thrush' can usually be quickly confirmed by a Gram-stain of a throat swab of the lesion which shows typical budding Gram-positive yeast-like organisms. Culture of the swab on blood agar or Sabouraud's medium will yield growth of the causative *Candida* species after 24–48 hours, incubation at 35 °C.

Treatment with topical nystatin or amphotericin B lozenges is usually effective. Severe lesions in immunocompromised patients may need treatment with a systemic anti-fungal drug such as ketoconazole.

Acute Otitis Media

Acute otitis media is most common in infants and young children (*see* Age and upper repiratory infections *above*). The most frequent symptom is pain in the ear but the condition should be considered in any child with unexplained fever, diarrhoea or vomiting. The ear drum characteristically shows dilated vessels and in the later stages bulging of the drum and disappearance of the 'light reflex'. If the condition is not recognized and treated early, the drum may perforate. Rupture of the drum is followed by relief from the pain.

Causative organisms

Viruses cause acute otitis media in up to about 50% of cases, but it is not usually possible to distinguish clinically between a viral and bacterial cause; management of acute otitis media should be on the assumption that a bacterial cause is present.

Bacterial causes include:

Strep. pneumoniae
Haemophilus influenzae
Strep. pyogenes
Staph. aureus
} the main causative bacteria

Mycoplasma pneumoniae may rarely cause acute bullous myringitis

Microbiological investigation

Gram-stain microscopy and culture of pus from the middle ear of a patient are feasible when a myringotomy is performed to drain pus but this is an infrequent situation.

Treatment

Amoxycillin is probably the best antibiotic at present for treating acute otitis media although large doses of penicillin V may also give satisfactory results. Most children are successfully treated with no more than a 3 day course of amoxycillin. If the patient is allergic to penicillin, cotrimoxazole or erythromycin can be given. Cephalexin has failed to cure some patients with haemophilus otitis media (it is possible that cefaclor might produce better results as it is more active than cephalexin against *Haemophilus*). Beta-lactamase-producing strains of *H. influenzae*, which are resistant to amoxycillin (or ampicillin), cause otitis in a few patients. If there is no improvement in the ear drum after 2–3 days' treatment with amoxycillin, a change to cotrimoxazole or clavulanic acid plus amoxycillin (Augmentin) or as an oral cephalosporin resistant to bacterial beta-lactamase, such as cefuroxime axetil should be considered. Repeat examination of the drums is necessary before treatment is stopped. A few months later, there should preferably be further examination of the ears to detect possible complications.

Complications of acute otitis media

Chronic suppurative otitis media (CSOM)

This condition is more likely to occur when there has been no adequate treatment of attacks of acute otitis media. The patient has chronic discharge of pus through a perforation in the ear drum, and there is often some obvious loss of hearing present. The causative bacteria include those mentioned above for acute otitis media, especially *Staph. aureus* and *Strep. pneumoniae*, but Gram-negative bacilli are also important, such as *Proteus* spp., *Pseudomonas aeruginosa* and *Bacteroides* spp.

Other suppurative complications

These include mastoiditis, detected by tenderness or swelling behind the pinna, meningitis and otogenic brain abscess. A few authorities have questioned the need for antibiotic treatment of acute otitis media, but a recent report emphasizes the continued need for early treatment of this condition to prevent suppurative complications, such as meningitis (*see* Bates and Drake-Lee, 1988).

Secretory otitis media ('glue ear')

This condition may follow a previous attack of acute otitis media but sometimes the aetiology is uncertain. Characteristically, there is an effusion present in the middle ear, which is serous or mucinous, and there is fluctuating hearing loss. A persistent effusion may require drainage by performing a myringotomy and the insertion of a grommet may be indicated. Recurrent attacks of 'glue ear' may occur.

Otitis Externa

Clinical features include irritation in the outer ear and a scanty discharge. Infective causes include:

Staph. aureus *Proteus* spp. *Pseudomonas aeruginosa*	Bacterial
Aspergillus niger *Candida albicans*	Fungal

Recurrent superficial infections are common. Rarely, a 'malignant otitis externa' may occur in elderly diabetic patients associated with a deep infection of the cartilage and bone of the outer ear due to *Pseudomonas aeruginosa*.

Culture of an ear swab for bacterial and fungal organisms is desirable. Topical treatment with ear drops containing polymyxin or other antibiotics can be given according to the results of culture and antibiotic sensitivities. However, repeated topical application of antibiotics can result in the selection of antibiotic-resistant strains and agents such as neomycin are contraindicated if a perforated ear drum is present.

Acute Sinusitis

Clinical features include periodic facial pain and localized tenderness over the affected sinus. If the maxillary antrum is affected, a failure to trans-illuminate clearly may be demonstrated.

Causative organisms

These include the same three main bacteria that cause acute otitis media, but *Haemophilus influenzae* and *Strep. pneumoniae* appear to be much more frequent causes than *Strep. pyogenes*. Also many other organisms may cause sinusitis including anaerobes, viridans streptococci, *Staph. aureus* and viruses.

Microbiological investigation

Gram-stain microscopy and culture of pus aspirated from the affected sinus often reveals the causative bacteria and antibiotic sensitivities may help guide subsequent treatment.

Antiobiotic treatment

Initial treatment with parenteral ampicillin followed by large doses of oral amoxycillin is recommended as 'blind' treatment for severe cases. Amoxycillin plus clavulanic acid (Augmentin) may be effective when beta-lactamase-producing strains of bacteria are the causative organisms. Alternative drugs that may be effective include erythromycin or cotrimoxazole. If an anaerobe is isolated from the sinus fluid, metronidazole may be indicated.

Complications

Chronic sinusitis is the most frequent complication. Complications of osteomyelitis, meningitis or cerebral abscess may rarely develop especially in patients with frontal sinusitis.

Other Upper Respiratory Tract Infections

Acute epiglottitis and some other respiratory tract infections that mainly affect children are included in Chapter 8.

EYE INFECTIONS

Normal Flora

The conjunctiva is often lightly colonized with *Staph. epidermidis* and diphtheroids. Lysozyme and IgA present in lacrimal secretions help to protect the eye against infections.

Causative Organisms

Conjunctivitis, keratitis and cataract

1. Bacteria

Neisseria gonorrhoeae. Severe purulent conjunctivitis due to a gonococcus from the mother's genital tract classically occurs on the first or second day of life—ophthalmia neonatorum. Unless this is promptly treated, corneal damage may occur resulting in blindness in later life. Prophylaxis with silver nitrate eye drops is not indicated today.

Staphylococcus aureus. 'Sticky eye' in neonates due to *Staph. aureus* conjunctivitis usually occurs 5–10 days after birth. Sometimes this is associated with an outbreak of staphylococcal sepsis in a maternity unit. In later life autogenous infection can develop, the staphylococcus having been introduced into the eye from the patient's nose or skin by his/her fingers.

Haemophilus influenzae. Conjunctival infection due to *Haemophilus* can develop at any age, sporadically or as part of an outbreak.

Neisseria meningitidis, *Streptococcus pneumoniae* } rare causes of severe purulent conjunctivitis

Pseudomonas aeruginosa is an opportunist cause of serious eye infection following trauma to the eye, the presence of a foreign body or operations on the eye. It may also occur when there is a defective immune response in a patient. This organism rarely causes harm to the healthy conjunctivae. Invasion of the eye and blindness can result as complications of the infection. Sources of *Pseudomonas* include contaminated multi-dose containers of eye drops, wet nail brushes and soap dishes. Prevention of infection involves use of single dose containers of sterile solutions and the elimination of other potential sources in the wards, theatre and eye out-patient department.

Treponema pallidum. Interstitial keratitis may develop as part of the congenital syphilis syndrome leading to blindness.

Leptospira. Conjunctivitis can occur as part of Weil's disease (*see* p. 513).

2. Chlamydia

'*Chlamydia trachomatis*'. Can cause trachoma inclusion conjunctivitis (TRIC) as a congenital infection in developed countries or trachoma in certain less developed countries.

Congenital trachoma inclusion conjunctivitis is characterized by a follicular kerato-conjunctivitis developing 4–7 days after birth.

Chlamydia is an intracellular organism that requires at least a couple of cycles of reproduction, each lasting about 48 hours for a sufficient number of epithelial cells to be damaged to cause a clinically evident lesion. TRIC can also occur in later life, sometimes contracted in swimming pools. Often the infection is mild but severe kerato-conjunctivitis occasionally occurs and may result in corneal damage.

Trachoma is endemic in several African countries and the Middle East. The chlamydia organisms are spread from eye to eye by hands and a chronic follicular kerato-conjunctivitis occurs particularly involving the upper tarsal conjunctivae. In the later stages, a cicatricial entropion develops with inturned eye lashes which abrade the cornea. Secondary bacterial infection is common amongst these overcrowded and unhygienic conditions and this also

contributes to the corneal scarring and development of blindness. More cases of blindness are due to *Chlamydia trachomatis* than to any other cause.

3. *Viruses*

Rubella. The virus is contracted during intra-uterine life and may cause cogenital eye lesions, including cataracts (*see* pp. 178–181).

Adenoviruses. Sporadic cases or outbreaks of non-purulent conjunctivitis may be caused by various adenoviruses often in association with pharyngitis. Occasionally the cornea is also infected.

Epidemic kerato-conjunctivitis, due to adenovirus type 8, is particularly associated with factories ('Shipyards eye') or hospitals where dust particles or manipulations on the eye (especially with a tonometer) can cause sufficient trauma to predispose to this viral infection.

Herpes simplex. An initially superficial corneal 'dendritic' ulcer may result from herpes simplex keratitis. This is more likely to occur in debilitated or immunosuppressed patients and the ulcer may extend and cause serious corneal damage, particularly when steroids are administered.

Varicella-zoster. The ophthalmic division of the trigeminal nerve is frequently involved with varicella-zoster and conjunctivitis is sometimes a presenting feature.

Vaccinia. Smallpox vaccination is not necessary nowadays, so accidental inoculation of the eye with the vaccine is less likely to occur than in the past. Emergency prophylaxis involving treatment with methisazone and immunoglobin may be advised by a clinical virologist whose advice should be sought immediately.

4. *Fungi*

Fusarium, Candida and *Aspergillus* species may very rarely cause corneal ulcers with serious consequences. These infections may occur in some immunosuppressed patients or may follow operations on the cornea in immunologically normal patients.

5. *Protozoa*

Free living amoebae may rarely cause keratitis. Most cases of acanthamoeba keratitis have occurred in patients with contact lenses who have used contaminated home-made saline preparations to clean the lenses—this condition can often be prevented by the proper use of sterile solutions.

6. *Worms*

In parts of Africa near freshwater rivers, *Onchocerca volvulus*, a filarial worm spread by a simulian fly, may be endemic and affected patients can develop a keratitis and other eye lesions which may cause 'river blindness' in later life (*see* p. 565).

Loa loa, another filarial helminth found in Africa, can involve the eye and cause serious eye lesions. Often no eye damage occurs but the worm crosses the eye deep to the conjunctiva (*see* p. 565).

Eyelid infections

Staphylococcus aureus is the main cause of eyelid infections: blepharitis, 'styes', are infections of the eyelash follicles.

Orbital and inner eye infections

A cellulitis of the skin around the eye or a spreading infection from adjacent sinuses can cause orbital cellulitis with possible further dangerous complications of inner eye infection or cavernous sinus thrombosis. A mixed infection is often present.

Bacterial causes include:
Staphylococcus aureus
Streptococcus pyogenes
Streptococcus pneumoniae
Diphtheroids
Streptococcus viridans
Coliforms and *Pseudomonas*
Haemophilus influenzae
Anaerobic cocci and *Bacteroides*

Endophthalmitis or panophthalmitis can result from spreading orbital cellulitis, progressive ulcerative kerato-conjunctivitis or direct penetrating injuries to the eye complicated by infection, particularly when a foreign body is present. Any of the above bacteria can be involved and pseudomonas infections are particularly difficult to treat effectively.

Choroidoretinitis

Viral:	Cytomegalovirus—congenital and acquired (including cases of AIDS)—*see also* Chapter 21 Rubella—congenital
Protozoa:	*Toxoplasma gondii*
Helminths:	*Toxocara canis* and *catis* A granuloma due to *Toxocara* can be associated with a peripheral eosinophilia. This condition should not be mistaken for malignant retinoblastoma, which may give a similar ophthalmoscopic appearance, otherwise an eye may be unnecessarily enucleated (*see* p. 562)

Microbiology Investigations

Conjunctivitis, keratitis and cataract

1. Direct smears and inoculation of plates

Many eye pathogens such as the gonococcus or *Haemophilus* are delicate and special care is necessary to obtain satisfactory specimens for microbiology. Ideally a sterile platinum loop should be used to collect infected material from the conjunctival fornix and then this is immediately streaked onto warm

chocolate agar and blood agar plates. This is the best method of culture. Smears for Gram-stain are collected at the same time. The plates are transferred to a moist carbon dioxide incubator and results are often available the following day.

A small serum-coated cotton-wool swab can be used instead of a loop to make direct smears and immediate inoculation of culture plates. Great care is necessary to avoid contamination of the swab with the skin flora of the eyelids during collection of the specimen.

Amoebae can be cultured on bacterial coated agar plates (*see* Warhurst and Mann, 1988).

2. *Swab in Stuart's transport medium for bacterial cultures*

If direct inoculation of the plates is impractical then the swab must be placed in appropriate transport medium. Dry swabs are of limited value for culture but may be useful for a Gram-stain. Both swabs should be sent promptly to the laboratory.

3. *Conjunctival scrapings and cultures for Chlamydia*

Superficial pus should be removed with a swab moistened in sterile saline and scrapings collected for Giemsa, iodine or fluorescent antibody stains to look for the characteristic chlamydial inclusion bodies in the epithelial cells.

Culture for *Chlamydia* is possible in some centres and the swab should first be placed in chlamydia transport medium. Treatment of clinically suspected chlamydial lesions should be started after collection of the swab without waiting for the results of culture.

4. *Swab for virus isolation*

When viral conjunctivitis is suspected clinically, particularly in outbreaks of infection, it may be advisable to do some virology investigations. These investigations are also indicated when a serious viral keratitis lesion is suspected.

i. A swab of the eye lesion is put into viral transport medium.
ii. A throat swab should also be collected and placed in viral transport medium, particularly when pharyngitis is also present and adenovirus infection is suspected.

5. *Mycological investigations*

Suitable scrapings should be collected by an ophthalmologist for microscopy and culture on Sabouraud's medium.

6. *Serology and blood films*

Syphilis and rubella serological tests are indicated when congenital lesions of the cornea or lens are suspected. Serology for filarial diseases may be rarely indicated in patients with suspected loiasis or onchocerciasis. Blood films to demonstrate the microfiliariae in these patients and skin snips may be helpful (*see* p. 396, Chapter 16 and p. 565, Chapter 24).

Eyelid infections

Swabs of eyelid lesions are not routinely indicated.

When recurrent 'styes' are causing a problem a nose swab as well as a swab of the lesion should be taken. If carriage of the same strain of *Staph. aureus* is demonstrated then it is possible that autogenous infection is occurring and a course of chlorhexidine nasal cream may be of value.

Orbital and inner eye infections

1. Blood cultures
2. Pus or swabs of discharging lesions of the eye for microscopy and culture

Choroidoretinitis

Serology for:

1. Rubella HAI antibodies—if IgM is positive this indicates congenital infection
2. CMV IgM fluorescent antibody tests are also necessary if the CFT is positive
3. Toxoplasma dye test
4. Toxocara fluorescent antibody test

Antimicrobial Treatment

Conjunctivitis and keratitis

The choice of initial therapy after the collection of specimens depends on the clinical clues as to the likely infecting organisms. In serious cases, the result of an urgent Gram-stain may be of help. Subsequent treatment depends on the results of culture and sensitivities. Chloramphenicol ointment should not be used if infection with *Chlamydia* or gonococci is supected. Gonococcal conjunctivitis should be promptly treated locally and systemically with benzylpenicillin. Cefuroxime may be indicated when penicillinase-producing gonococcal strains are isolated.

Chlamydial conjunctivitis responds to tetracycline ointment and, in severe cases, systemic erythromycin is also indicated.

When herpes simplex keratitis is suspected acyclovir is usually indicated. If there is an insufficient response, other agents may be tried depending on the advice of the microbiologist and ophthalmologist.

Vaccinial lesions should be treated with topical idoxuridine and systemic antivaccinal immunoglobulin (oral methisazone may also be necessary).

Eyelid infections

Eyelid staphylococcal infections sometimes require surgical drainage and local neomycin ointment.

Systemic antibiotics like flucloxacillin should only be given in addition if the lesion is severe or associated with spread of infection constituting a risk of cavernous sinus thrombosis.

Orbital and inner eye infections

After the collection of specimens, 'blind' systemic treatment with benzylpenicillin, cloxacillin and gentamicin may be indicated. If there is doubtful allergy to penicillin, a cephalosporin may be used instead of penicillin plus cloxacillin. Erythromycin plus gentamicin may be given to a patient with a definite history of penicillin allergy.

Surgical intervention and local antibiotic therapy, depending on the results of culture and sensitivity, are also often necessary.

Choroidoretinitis

Unfortunately toxoplasma eye lesions often do not respond well to pyrimethamine and sulphonamide which might be tried in some cases.

Toxocariasis can be treated by diethylcarbamazine, but the eye lesions may not be affected.

Cytomegalovirus retinitis may sometimes be successfully treated with ganciclovir (*see* Chapter 21).

Further Reading

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