

Disease	Suspected pathogens	Antibiotic therapy	Remarks
Impetigo	<i>S. aureus</i> , group A streptococci	First generation cephalosporin, erythromycin, penicillin, dicloxacillin.	
Folliculitis	<i>S. aureus</i> , <i>Candida</i> spp., <i>Pseudomonas aeruginosa</i> , <i>Pyrazosporium ovale</i>		Local therapy usually sufficient, antibiotic treatment only with cellulitis.
Erysipelas	Group A streptococci (occasionally group B, C, G), <i>S. aureus</i>	Penicillin (if no underlying disease are possible to observe), 1st-generation cephalosporin, flucloxacillin.	Enterobacteriaceae in diabetes: 3rd generation cephalosporin or carbapenem.
Cellulitis	Group A streptococci, <i>S. aureus</i> ; rarely, various other organisms	Flucloxacillin, 1st-generation cephalosporin, erythromycin (for severe penicillin allergy).	Resistance in <i>S. pyogenes</i> and <i>S. aureus</i> against erythromycin exists.
Necrotizing fasciitis	Type I: Anaerobic species (<i>Bacteroides</i> , <i>peptostreptococcus</i> spp.), together with facultative anaerobes non-A streptococci, enterobacteriaceae (<i>E. coli</i> , <i>Enterobacter</i> , <i>Klebsiella</i> , etc.) Type II: group A streptococci alone or with <i>S. aureus</i>	Carbapenem, 3rd-generation cephalosporin plus clindamycin	Surgical debridement absolutely essential. Empirical therapy must cover for all pathogens.
Pyomyositis	<i>S. aureus</i> ; group A streptococci (rarely), Gram-negative bacilli (very rarely), anaerobic bacteria other than <i>Clostridium</i>	Flucloxacillin, or 1st generation cephalosporin plus clindamycin.	Surgical drainage absolutely essential. Cave compartment syndrome. Change to penicillin, if streptococcal origin.
Myonecrosis	<i>Clostridium perfringens</i> , <i>C. septicum</i>	High dose penicillin plus clindamycin 3 x 600 mg i.v.	Surgical exploration and debridement: crucial with open wound healing; hyperbaric oxygen debated.

*Once causative pathogen(s) has(ve) been identified, antibiotic choice can be modified and spectrum narrowed.

aetiology & treatment

General

- In a patient presenting with a wound infection, cellulitis or sepsis, which may be related to contact with water (eg in fishermen, swimmers or aquarium owners), the following organisms may be encountered:

- (i) *Aeromonas* species (source: fresh or brackish water);
 - (ii) *Mycobacterium marinum* (source: fish tanks);
 - (iii) *Shewanella putrefaciens*,
 - (iv) *Vibrio vulnificus*, *Vibrio alginolyticus* and other noncholera vibrios (source: salt or brackish water).
- Treatment of most of these infections is difficult and advice should be sought from a clinical microbiologist or an infectious diseases physician.

Mycobacterium marinum

- *Mycobacterium marinum* causes a localised papular or nodular skin lesion associated with exposure to fresh water (fish-tank or swimming-pool granuloma).
- Diagnosis is often made by biopsy, and antibiotic therapy may not be required if a single lesion is successfully excised - seek expert advice.
- There have been no controlled trials that compare the multiple treatment regimens for *M. marinum*. Combination therapy may be preferable to monotherapy, particularly in severe or unresponsive cases.
- The optimal duration of therapy is not known, but treatment is suggested for 1 to 2 months after the resolution of all lesions (typically 3 to 4 months in total). Use: clarithromycin 500 mg (child: 12.5 mg/kg up to 500 mg) orally, 12-hourly
OR
doxycycline 100 mg (child >8 years: 2.5 mg/kg up to 100 mg) orally, 12-hourly
OR
trimethoprim+sulfamethoxazole 160+800 mg (child: 4+20 mg/kg up to 160+800 mg) orally, 12-hourly.
- In severe or unresponsive cases, consider combination therapy (eg clarithromycin plus rifampicin or ethambutol).

Vibrio species

- Vibrio species should be suspected in skin infections in patients who have been exposed to salt water.
- Life-threatening infection can rapidly develop in patients with cirrhosis or iron overload.
- Local management of skin lesions may include incision, drainage and debridement.
- There is considerable variability in antimicrobial susceptibility.
- Initial treatment should include: doxycycline 200 mg (child >8 years: 5 mg/kg up to 200 mg) orally or IV, for the first dose, followed by doxycycline 100 mg (child >8 years: 2.5 mg/kg up to 100 mg) orally or IV, 12-hourly.
- Alternative antibiotics which could be considered are cefotaxime, ceftriaxone, ciprofloxacin or minocycline.

Coral cuts

- Coral cuts are often infected with *Streptococcus pyogenes*, but infection may also occur with marine pathogens.
- For mild infection, treat as for impetigo, and if unresponsive or severe, treat as for severe cellulitis.
- Treatment may need to be modified depending on response and culture results.

Aeromonas species

- Infections by *Aeromonas* species are associated with exposure to fresh or brackish water or mud (water activities, caving) through cuts and abrasions. The resulting illness may be a superficial skin infection, myositis or sepsis with metastatic complications.
- In about 25% of cases the patient has an underlying systemic illness. Use: ciprofloxacin 400 mg (child: 10 mg/kg up to 400 mg) IV, 12-hourly or ciprofloxacin 500 mg (child: 10 mg/kg up to 500 mg) orally, 12-hourly.
- meropenem or imipenem are possible alternatives for polymicrobial infection.

water-related infections

skin infections

general

- *Staphylococcus aureus* is the most common cause of cutaneous infection as a primary pathogen, a source of secondary infection on an underlying dermatosis, and as a superantigen where it causes an inflammatory cascade manifesting clinically as recalcitrant dermatitis.
- In all longstanding cases of *S. aureus* infection, a nasal or perineal carrier state should be suspected. Other family members easily acquire the bacteria, with or without frank infection, and they may become carriers. *S. aureus* most often causes superficial infections, which are not hazardous and can sometimes be managed by topical therapy only.
- Cutaneous infections may also be due to beta-haemolytic streptococci, usually group A (*Streptococcus pyogenes*).
- Although this organism may also cause trivial superficial infections, it has a tendency to become invasive, resulting in cellulitis.
- Streptococcal skin infections may be complicated by a variety of post-infectious immune-mediated diseases (eg glomerulonephritis and vasculitis) and should therefore always be treated with systemic antibiotics.
- Other bacteria causing skin infection are encountered uncommonly.
- The incidence of *Haemophilus influenzae* cellulitis previously seen in young children is now much lower because of immunisation.
- *Pseudomonas aeruginosa* rarely causes frank infection, although moist areas or ulcers may be colonised.

cellulitis

- The causative organism in spontaneous rapidly spreading cellulitis is almost always *Streptococcus pyogenes*.
- *Staphylococcus aureus* is important with wound-associated purulent cellulitis.
- Now that Hib vaccination is widespread, *Haemophilus influenzae* rarely causes cellulitis.
- Cellulitis following an injury in fresh or seawater may be caused by *Aeromonas* or *Vibrio* species and appropriate specimens should be taken and initial antimicrobials commenced
- In immunosuppressed patients, a wide variety of organisms including Gram-negative bacteria, fungi and mycobacteria may also be responsible.
- Cellulitis in children is often periorbital.
- Cellulitis in adults most often affects the lower legs.
- It is often unilateral, at least initially, and there is usually an underlying condition or abnormality (eg tinea pedis, fissured dermatitis, lymphoedema, lymphatic malformation, previous deep vein thrombosis, vascular surgery, radiotherapy).
- A search for a portal of entry should be made to prevent possible recurrences.
- Recurrent cellulitis may result in lymphoedema, which in itself worsens the situation.
- Cellulitis may also complicate wounds (eg cuts, abrasions), insect bites or scabies.
- Erysipelas is a localised superficial form of cellulitis classically involving the face.
- It presents with a sudden onset of butterfly erythema associated with fever, and constitutional upset.
- There may be an underlying facial sinus or dental infection.
- It is almost always caused by *Streptococcus pyogenes*.
- Dental examination and imaging of sinuses is recommended.
- Recent evidence indicates that erysipelas is also commonly found on the lower legs where it resembles a well-demarcated superficial cellulitis.
- Severe cellulitis
 - If patient has significant systemic features or is not responding to oral therapy after 48 hours, commence IV therapy.
 - Rest and elevation of the affected area are advisable.
 - If the skin has eroded, use nonstick dressings.
 - IV therapy should be continued until the patient is afebrile and the erythematous rash has substantially improved. This may vary from 3 days to 2 weeks.
 - The patient can then change to oral therapy for a further 10 days.
 - To treat infection with either streptococci or staphylococci, use initially: flucloxacillin 2 g (child: 50 mg/kg up to 2 g) IV, 6-hourly.
 - For patients hypersensitive to penicillin (excluding immediate hypersensitivity), use initially: cephalothin 2 g (child: 50 mg/kg up to 2 g) IV, 6-hourly
OR
cephazolin 2 g (child: 50 mg/kg up to 2 g) IV, 8-hourly.
 - For patients with immediate penicillin hypersensitivity, use initially: clindamycin 450 mg (child: 10 mg/kg up to 450 mg) IV or orally, 8-hourly
OR
lincomycin 600 mg (child: 15 mg/kg up to 600 mg) IV, 8-hourly
OR
vancomycin 25 mg/kg up to 1 g (child <12 years: 30 mg/kg up to 1 g) IV, 12-hourly (monitor levels)

diabetic foot infections

- Always regard diabetic foot infections as serious, and treat vigorously.
- Culture may be unhelpful because of polymicrobial infections and superficial colonisation, but may guide therapy particularly if *Staphylococcus aureus* or multiresistant pathogens are found. Anaerobic organisms are almost always involved, often with mixed Gram-positive and Gram-negative aerobic organisms.
- Surgical debridement is often necessary and antibiotic therapy should be effective against the mixed aerobic and anaerobic organisms frequently responsible.
- Consider underlying osteomyelitis or septic arthritis.
- Assess vascular supply.
- For severe limb- or life-threatening infection (systemic toxicity/septic shock, bacteraemia, marked necrosis/gangrene, ulceration to deep tissues, severe cellulitis, presence of osteomyelitis), use initially: piperacillin+tazobactam 4+0.5 g IV, 8-hourly
OR
ticarcillin+clavulanate 3+0.1 g IV, 6-hourly
OR
meropenem 500 mg IV, 8-hourly.
- Alternatively, and for patients with penicillin hypersensitivity, use initially: ciprofloxacin 400 mg IV, 12-hourly or ciprofloxacin 750 mg orally, 12-hourly
PLUS EITHER
clindamycin 900 mg IV, 8-hourly (slow infusion required)
OR
lincomycin 900 mg IV, 8-hourly (slow infusion required).
- Depending on the organisms subsequently isolated from deep tissue specimens, other antibiotic combinations may be indicated.
- The duration of IV treatment will depend upon the response.
- Change to oral therapy after substantial improvement