

# **Skin infections**

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## **Introduction**

Skin diseases can be caused by viruses, bacteria, fungi, or parasites. The most common bacterial skin pathogens are *Staphylococcus aureus* and group A  $\beta$ -hemolytic streptococci. Herpes simplex is the most common viral skin disease. Of the dermatophytic fungi, *Trichophyton rubrum* is the most prevalent cause of skin and nail infections.

## **Pathogenesis**

Skin infections may be either primary or secondary. Primary infections have characteristic morphologies and courses, are initiated by single organisms, and usually occur in normal skin. They are most frequently caused by *Staphylococcus aureus*, *Streptococcus pyogenes*, and coryneform bacteria. Impetigo, folliculitis, boils, and erythrasma are common examples. Systemic infections may also have skin manifestations. Secondary infections originate in diseased skin as a superimposed condition. Intertrigo and toe web infections are examples of secondary infections.

## **Causes of bacterial skin infections**

Skin infections can be caused by bacteria (often Staphylococcal or Streptococcal) either invading normal skin, or affecting a compromised skin barrier (eg, skin affected by atopic dermatitis, or surgical wound sites).

The skin is our first line of protection against the environment. A local or systemic response is activated when this protective barrier is invaded. Microorganisms that invade the skin can be part of the external environment or the normal skin microbiome.

## **Who gets bacterial skin infections?**

Bacterial skin infections are a common reason for emergency visits. Children under five years and adults over 65 years old are affected more often than other age groups. In 2005, the World Health Organisation (WHO) reported a high prevalence. Gender may also play a role; in one North American study, men comprised 60-70% of all cases of cellulitis.

Certain comorbid conditions increase susceptibility to bacterial skin infections, such as diabetes, vascular insufficiency, and being immunocompromised (eg, chemotherapy patients with neutropaenia). Some people, such as those who inject drugs, are at increased risk. Among hospitalised patients, skin infections are prevalent and often complicate the hospital course.

## **The clinical features of bacterial skin infections**

Bacterial skin infections can result in diverse clinical presentations. Clinical manifestations vary from disease to disease. Generally, they will present with erythema, pain, warmth, swelling, and, depending on severity, dysfunction. Focal accumulations of pus (furuncles) or fluid (vesicles and bullae) may form, but lesions may also be scaling without obvious inflammation.

In severe infections, the following signs may be present:

- Temperature instability (higher than 38<sup>0</sup>C or lower than 35<sup>0</sup>C)
- Tachycardia
- Altered mental status
- Rapid progression of infection
- Haemorrhagic or violaceous bullae
- Signs of necrosis
- Crepitus.

## **The complications of bacterial skin infections**

- Skin breakdown
- Abscess formation
- Sepsis (can be life-threatening)
- Septic emboli
- Scarring or postinflammatory hyperpigmentation
- Rheumatic fever (may result from Streptococcal skin infection)
- Recurrent infection
- Infections due to resistant bacteria (eg, methicillin-resistant *Staphylococcus aureus*/MRSA) may be more difficult to treat.

## Primary Infections

### ▪ Impetigo

Three forms of impetigo are recognized on the basis of clinical, bacteriologic, and histologic findings. The lesions of common or superficial impetigo may contain group A  $\beta$ -hemolytic streptococci, *S aureus*, or both, and controversy exists about which of these organisms is the primary pathogen. The lesions have a thick, adherent, recurrent, dirty yellow crust with an erythematous margin. This form of impetigo is the most common skin infection in children. Impetigo in infants is highly contagious and requires prompt treatment.

The lesions in bullous (staphylococcal) impetigo, which are always caused by *S aureus*, are superficial, thin-walled, and bullous. When a lesion ruptures, a thin, transparent, varnish-like crust appears which can be distinguished from the stuck-on crust of common impetigo. This distinctive appearance of bullous impetigo results from the local action of the epidermolytic toxin (exfoliation). The lesions most often are found in groups in a single region.

Ecthyma is a deeper form of impetigo. Lesions usually occur on the legs and other areas of the body that are generally covered, and they often occur as a complication of debility and infestation. The ulcers have a punched-out appearance when the crust or purulent materials are removed. The lesions heal slowly and leave scars.

### ▪ Cellulitis and Erysipelas

*Streptococcus pyogenes* is the most common agent of cellulitis, a diffuse inflammation of loose connective tissue, particularly subcutaneous tissue. The pathogen generally invades through a breach in the skin surface, and infection is fostered by the presence of tissue edema. Cellulitis may arise in normal skin. However, the lesion of cellulitis is erythematous, edematous, brawny, and tender, with borders that are poorly defined.

No absolute distinction can be made between streptococcal cellulitis and erysipelas. Clinically, erysipelas is more superficial, with a sharp margin as opposed to the undefined border of cellulitis. Lesions usually occur on the cheeks.

## ▪ Folliculitis

Folliculitis can be divided into two major categories on the basis of histologic location: superficial and deep.

The most superficial form of skin infection is staphylococcal folliculitis, manifested by minute erythematous follicular pustules without involvement of the surrounding skin. The scalp and extremities are favorite sites. Gram-negative folliculitis occurs mainly as a superinfection in acne vulgaris patients receiving long-term, systemic antibiotic therapy. These pustules are often clustered around the nose. The agent is found in the nostril and the pustules. *Propionibacterium acnes* folliculitis has been misdiagnosed as staphylococcal folliculitis. The primary lesion is a white to yellow follicular pustule, flat or domed. Gram stain of pus reveals numerous intracellular and extracellular Gram-positive pleomorphic rods. The lesions are more common in men than in women. The process may start at the age when acne usually appears, yet most cases occur years later.

In deep folliculitis, infection extends deeply into the follicle, and the resulting perifolliculitis causes a more marked inflammatory response than that seen in superficial folliculitis. In sycosis barbae (barber's itch), the primary lesion is a follicular pustule pierced by a hair. A furuncle (boil) is a staphylococcal infection of a follicle with involvement of subcutaneous tissue. The preferred sites of furuncles are the hairy parts or areas that are exposed to friction and macerations. A carbuncle is a confluence of boils, a large indurated painful lesion with multiple draining sites

## Methods for Laboratory Diagnosis

### Specimen Collection

Bacterial skin infection is commonly diagnosed clinically, although laboratory studies may be useful, such as:

- Swab of the skin lesion/s sent for microscopy, culture, and sensitivities.

**Specimens:** are collected with a blade or by swabbing the involved areas of the skin. When pustules or vesicles are present, the roof or crust is removed with a sterile surgical blade. The pus or exudate is spread as thinly as possible on a clear glass slide for Gram staining.

For actinomycetes, pus is collected from closed lesions by aspirations with a sterile needle and syringe. Material is collected from draining sinuses by holding a sterile test tube at the edge of the lesion and allowing the pus and granules to run into the tube. Granules are aggregates of inflammatory cells, debris, proteinaceous material and delicate branching filaments. Pus and other exudates are examined microscopically for the presence of granules.

**Culture:** Most pathogenic skin bacteria grow on artificial media, and selection of the medium is important. For general use, blood agar plates (preferably 5 percent defibrinated sheep blood) are recommended. In many situations, a selective medium combined with a general-purpose medium is recommended. For example, *Staphylococcus aureus* may overgrow *Streptococcus pyogenes* in blood agar medium when both organisms are present. When crystal violet (1 µg/ml) is added to blood agar, *S pyogenes* is selected over *S aureus*.

- Full blood count: bacterial infection often raises the white cell and neutrophil count
- C-reactive protein (CRP): elevated >50 in serious bacterial infections (note there can be a delay of >24 hours between onset of symptoms and CRP rise)
- Procalcitonin: blood test marker for generalised sepsis due to bacterial infection
- Blood culture: if fever (>38°C)

## **Prevention of bacterial skin infections?**

- Regular hand washing, especially before and after touching broken skin.
- General lifestyle factors to improve overall health and immune function (eg, weight management if overweight or underweight, smoking cessation, reducing alcohol intake).
- Optimising management of other medical conditions (eg, diabetic control).
- Maintaining skin barrier (eg, through appropriate management of atopic dermatitis, and skin irritant/allergen avoidance).

## **The treatment for bacterial skin infections**

Cleansing and degerming the skin with a soap or detergent containing an antimicrobial agent may be useful. Drying agents, such as aluminum chloride, and keratinolytic agents, such as topical salicylate, are also helpful. Topical antimicrobial agents can be used for some infections, but systemic therapy may be necessary for patients with extensive disease.

Minor bacterial infections often resolve without treatment. Due to increasing antibiotic resistance, first-line use of topical antibiotics, such as fusidic acid, is generally discouraged; topical antiseptics are often used as an alternative for minor infections. More serious or persistent bacterial infections are treated with oral, intravenous, or sometimes intramuscular antibiotics.

It is best to take samples (eg, swabs or blood cultures) to test which organism is responsible for an infection before commencing antibiotics. If the infection is serious (eg, suspected meningococcal disease), do not delay treatment with a broad-spectrum antibiotic. As culture and sensitivities become available, change to an appropriate narrow-spectrum antibiotic.

Antibiotics should not be prescribed if they are not indicated or unlikely to be of benefit, for example, if the infection is viral in origin. Adverse reactions include cutaneous effects and gastrointestinal side effects. Antibiotic stewardship is also an important consideration.

## **Recommendations for bacterial skin infections**

Antibiotic resistance has increasing implications for the treatability and outcome of many bacterial skin infections moving forwards. And as many bacterial skin infections resolve without treatment or without serious morbidity. Antibiotic should be used only for severe skin infections that can be cause a significant burden of disease worldwide, which sometimes resulting in sepsis and death, particularly in vulnerable patient groups such as the elderly, hospitalised, and immunocompromised.