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Common Bacterial Infections of the Skin in Children

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ABSTRACT

Bacterial infections such as erysipelas, cellulitis, furuncle, carbuncle, or folliculitis are common infections of the skin, which is the largest organ of the body that forms a protective layer by wrapping the body. These skin bacterial infections of the skin are very important in pediatric medicine and primary health care. These infections usually occur when skin integrity is impaired. Skin integrity should be preserved with personal hygiene measures, and a multidisciplinary approach should be given to these skin infections with appropriate antibiotic regimens and when necessary, with dermatology and pediatric infectious disease consultations.

Keywords: Bacterial infection, children, skin



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INTRODUCTION

The skin is the largest organ in the human body. It covers the body and is in continuous contact with various microorganisms.^[1] These microorganism sources can be categorized as those found in the normal microbial flora of the healthy skin, those found in other body parts such as the nose, and microorganisms resulting from the external environment. Despite this intense microorganism load, skin infections are rare in healthy people because of some protective factors. However, skin infections can easily be developed in the presence of some facilitating factors that disrupt skin integrity.

The presence of normal flora on the surface of the skin and the layers formed by acid and fatty secretion prevents the growth of microorganisms on the skin surface.^[2] Moreover, the stratum corneum layer of the skin acts like a barrier preventing microorganisms from invading the skin and continuous desquamation of the skin enables colonized bacteria to be removed from the skin. If these protective factors are interrupted for any reason, it becomes easier to develop some skin infections. These reasons include any conditions that disrupt the integrity of the skin (incision, insect bites, traumatic events, inflammatory skin diseases, eczema, itchy skin diseases, etc.), systemic diseases, clothing, and hygiene habits. Microorganisms can also reach the skin by the hematogenous way, or cause skin damage through bacterial toxins from an infection of another part of the body.

Many bacteria may cause bacterial infections of the skin (BIS).^[3] When evaluated based on the major categories, gram-positive bacteria and gram-negative bacteria take the lead. The most common pathogens in BIS are streptococci and staphylococci, which are gram-positive bacteria. Moreover, skin infections can be seen with *Corynebacterium*, *Bacillus anthracis*, *Erysip-*

elothrix rhusiopathiae, spirochetes, chlamydia, rickettsia, and mycoplasma.

In childhood, many diseases with different clinical manifestation can present with skin infections. Therefore, careful skin examination is very important in the diagnosis of diseases in pediatric medicine. The most common BIS in children is summarized in Table 1.^[4-6]

Impetigo

Impetigo is a contagious superficial bacterial infection most observed in children aged between two and five years; however, older children and adults can also be affected.^[7,8] The infection usually occurs in warm and moist conditions and easily spreads among individuals who are in close contact. Risk factors include poverty, overcrowded living conditions, poor hygiene, underlying itchy diseases, and primary skin lesions such as herpes virus infections, scabies, and eczema.

Group A Streptococcus carriage (Streptococcus pyogenes) and Staphylococcus aureus are typical causes of impetigo.^[9] Impetigo contagiosum manifests as yellowish crusted papules and plaques frequently located on the face, neck, and extremities (Fig. 1a) Bullous impetigo, which accounts for 30% of impetigo cases, is caused by Staphylococcus aureus, and characterized by bullous lesions mainly affecting the skin folds areas. The bullae are found in the upper layer of the skin and result from exfoliative toxins of Staphylococcus aureus (Fig. 1b). In immunocompromised patients, it may lead to Staphylococcal scalded skin syndrome that has a mortality rate of 3% in infected children. Topical antibiotics, especially mupirocin and fusidic acid can be used in the treatment of impetigo. Oral antibiotic treatment is recommended for patients with widespread lesions.^[10] To prevent recurrent attacks, provoking risk factors should be reduced, with provision of advice on general hygiene measures.

Table 1. Common bacterial infections of the skin in children

Disease	Clarification	Common Pathogens	Treatment
Impetigo	Contagious superficial bacterial infection	Group A streptococcus Staphylococcus aureus	Localized: Topical antibiotics (mupirocin or fusidic acid) Disseminated: systemic antibiotics
Folliculitis	Infection of the superficial or deep part of the hair follicle	Staphylococcus aureus Gram-negative bacteria	*Localized: Topical mupirocin, fusidic acid or topical clindamycin Widespread: systemic antibiotics
Furuncle	Deep, acute, necrotic infection of the hair follicle and its surroundings. It usually occurs when the infection in folliculitis progresses to form deep inflammatory nodules	Staphylococcus aureus	*Often, a combination of topical (mupirocin, fusidic acid) and systemic antibiotic treatment is required. If abscess occurs, drainage is needed
Carbuncle	The presence of several interrelated furuncles is called a carbuncle	Staphylococcus aureus	*Systemic antibiotic Drainage, surgical interventions is often required.
Erysipelas	Acute, superficial, non-necrotizing infection of dermal lymphatics. It is in the form of superficial cellulite	Group A streptococci are the most common agents. H. influenza Pneumococcus	Systemic antibiotics PO or IV depending on the disease severity (A combination of beta-lactam and beta-lactamase inhibitor)
Cellulitis	Acute infection of the lymphatics of the deep dermis and subcutaneous fat tissue.	Group A streptococci (S. pyogenes) Staphylococcus aureus.	Systemic antibiotics (A combination of beta-lactam and beta-lactamase inhibitor), Cefazolin (IV), Cephalexin (PO), Vancomycin or linezolid for toxic patients

IV: Intravenous; PO: Per os.

*Patients who had frequent infection episodes should be screened regarding nasal carriage of the Staphylococcus aureus. Mupirocin and prophylactic low dose antistaphylococcal penicillin or clindamycin can be given for recurring infections.

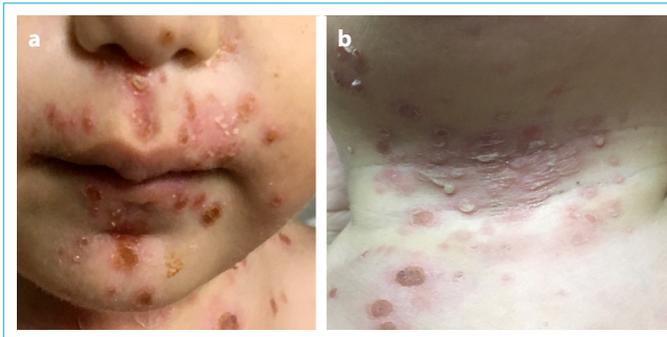


Figure 1. (a) Impetigo contagiosum. (b) Bullous impetigo.

Folliculitis

Folliculitis refers to the inflammation of the superficial or deep part of the hair follicle.^[11,12] Superficial folliculitis manifests clinically as follicular pustules and follicular erythematous papules on hair-bearing skin. Nodules are a feature of deep follicular inflammation (Fig. 2a). Folliculitis can be infectious or less commonly non-infectious. Various bacteria, fungi, viruses, and parasites can cause folliculitis. Bacterial agents, mainly *Staphylococcus aureus* and gram-negative bacteria, are the most common cause of infectious folliculitis.

Infants, children, or adults can experience bacterial folliculitis. The factors that can increase the risk include nasal carriage of *S. aureus*, hyperhidrosis, atopic dermatitis, and long-term use of topical corticosteroids.^[13]

Topical antibiotic treatment is sufficient for most bacterial folliculitis infections.^[14] Among the first-line agents, topical mupirocin, topical fusidic acid or topical clindamycin are used. Apart from treatment, it is important to consider primary prevention by general hygiene measures.

Furuncle

It is the name given to a deep, acute, necrotic infection of the hair follicle and its surroundings, and is mainly caused by *Staphylococcus aureus*.^[15] It usually occurs when the infection in folliculitis progresses to form deep inflammatory nodules (Fig. 2b). Although it is rare in children, it is commonly seen in boys during puberty.



Figure 2. (a) Folliculitis with erythematous papules and pustules. (b) Furuncle with a deep erythematous nodule. (c) Carbuncle. *Inflammatory deep nodule with multiple drainage sinuses.*

It can manifest clinically wherever hair follicles are found.^[16] Head and neck and anogenital region are the places where lesions are frequently observed. Lesions begin as a hard, painful, red follicular nodule in the dermal part of the skin. Subsequently, the nodule progresses to a painful abscess formation that is most localized in the dermis, and then usually a pustule develops on the lesion and eventually the purulent material drains with the rupture of the pustule.

Warm-moistened compresses may facilitate the drainage of the lesion during treatment.^[15,17] A single lesion that has drained during its course can heal without treatment. Topical antibiotics or antiseptics accelerate healing and prevent the spread of the disease. In the presence of a fluctuating abscess that cannot drain on its own, drainage can be facilitated by an incision. Topical and systemic antibiotic treatment should be initiated in these cases. Long-term treatment may be required for persistent or frequently recurring furuncles.

Carbuncle

The presence of several interrelated furuncles is called a carbuncle (Fig. 2c). Common risk factors are obesity, diabetes, and other chronic diseases.^[10,18] Carbuncles are usually found on the back of the neck, body, or thigh. This multistage fusion of multiple abscesses can be painful, and main signs such as fever and malaise are often accompanied. If systemic symptoms develop, patients should be closely monitored for sepsis. Purulent secretion can be expressed from multiple drainage sinuses. Incision and drainage are required for carbuncles and large furuncles. Penicillinase-resistant antibiotics can be initiated among systemic antibiotics. Moreover, if there is a nasal carriage, mupirocin and prophylactic low dose antistaphylococcal penicillin or clindamycin can be given for recurring infections. Consultation for surgical interventions is often recommended in cases with carbuncles.

Erysipelas

It is an acute, superficial, non-necrotizing infection of the dermal/hypodermal lymphatics.^[19] It is known as superficial cellulitis (Fig. 3a). It is usually located on the face or on the lower body regions. It manifests as a painful, hot, shiny erythematous, and edematous plaque that usually has a sharp edge and can easily be distinguished from the surrounding intact skin area. Vesicles, bullae, and ecchymoses may develop over the erythematous plaque. Group A streptococci are the most common causative agents. *H. influenzae* and pneumococcus are among other causative agents. Diagnosis is usually made clinically. When signs of systemic toxicity develop in soft tissue infections, laboratory testing is recommended

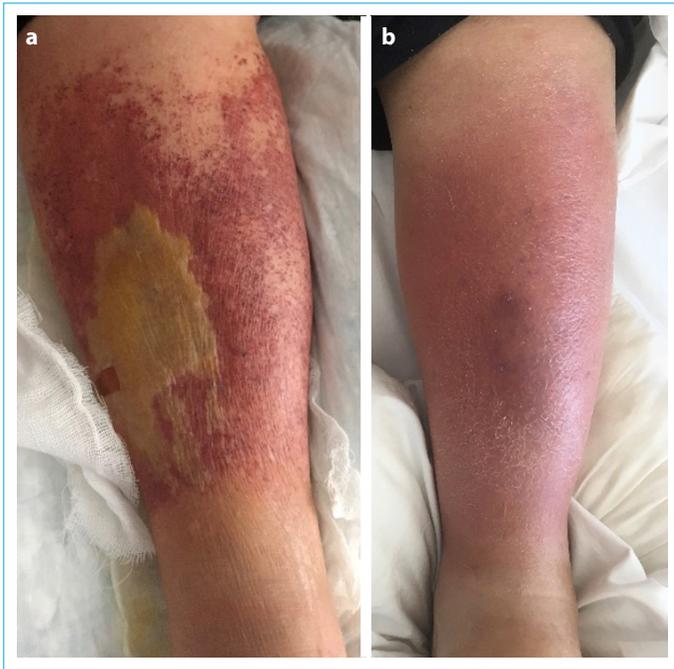


Figure 3. (a) Erysipelas.
The border of lesion is well defined.

(b) Cellulitis with erythematous, edematous infiltrated plaque.

including complete blood cell counts, blood cultures, and levels of creatinine, bicarbonate, creatine phosphokinase, and C-reactive protein.^[10] Empirical antibiotic treatment should be initiated until the culture results are obtained.^[20,21] Oral antibiotics including penicillin, cephalosporin, dicloxacillin, or clindamycin are used for mild diseases. In moderate to severe cases, intravenous penicillin or clindamycin or ceftazolin or ceftriaxone may be initiated, and a combination of a beta-lactam and a beta-lactamase inhibitor is often used. If the patient has a penicillin allergy, macrolide group antibiotics are preferred. If the lesion is localized in the leg, elevation should be done. Wet dressing on the infection site (2-3 times a day) can reduce the severity of the inflammation. The determination and treatment of the primary entry site such as tinea pedis or nasal carriage are important for the prevention of infection recurrence. Treatment should be continued at least for 10 days; however, it can be extended depending on the clinical improvement.

Cellulitis

Cellulitis is an acute infection of the lymphatics of the deep dermis and subcutaneous fat tissue.^[22-24] It is characterized by edema, warmth, erythema, and tenderness. Lesion borders are not sharply defined (Fig. 3b). Common symptoms include regional lymphadenopathy, fever, chills, pain, and weakness. Risk factors include disruption of the skin or lymphatic integrity, diabetes, burns, ulcers, venous insufficiency, and obesity. The causative agent is usually group A streptococci

(*S. pyogenes*) or *Staphylococcus aureus*. Microorganisms can cause infection in different ways.

- a. Similar to erysipelas, there may be an entry point for the bacteria and the cases should be investigated in this respect. Conditions such as abrasions, itching marks, insect bites, and tinea pedis can be an entry point for the bacteria in normal skin flora.
- b. In some cases, microorganisms may reach underneath the skin with passing through the hematogenous way.
- c. The infection may occur with the local spread of infections in nearby tissues such as furuncles, abscesses, and osteomyelitis.

As in erysipelas, laboratory testing should be made in toxic patients. If there is a suspicion of an additional complicated or deep infection, further imaging studies are required. Patients with non-purulent cellulitis should be treated with appropriate empirical antibiotic therapy for infections resulting from beta-hemolytic streptococcus and methicillin-sensitive *Staphylococcus aureus* (Table 1). Other common options are ceftazolin for intravenous therapy and cephalexin for oral therapy. Treatments can be revised according to the clinical response. Since the prevalence of methicillin-resistant *S. aureus* has been increasing, vancomycin or linezolid can be initiated empirically in toxic and recalcitrant patients. Clindamycin may be preferred in severe group A streptococcal infections.

CONCLUSION

In conclusion, family physicians and pediatricians who first meet with children should be able to properly recognize and manage these infections. A well-taken history and a careful physical examination are important in the diagnosis and treatment of superficial infections of the skin, which is the largest organ of the body and presents valuable findings for the diagnosis of some diseases. In cases where a complete clinical response cannot be achieved or partial response is obtained, the diagnosis should be reconsidered, and pediatric infectious diseases and/or dermatology consultations should be requested when necessary. Apart from all these, personal hygiene measures are also important in the prevention of skin diseases.

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