

A Review on Common Staphylococcal Bacterial Skin Infections in Pediatrics and their Management

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Abstract

The skin provides a remarkably good barrier against bacterial infections. Although many bacteria meet or reside on the skin, they are normally unable to establish an infection. When bacterial skin infections do occur, they can range in size from a tiny spot to the entire body surface. They can range in seriousness as well, from harmless to life threatening. Bacterial skin infections are usually caused by gram-positive strains of *Staphylococcus* and *Streptococcus* or other organisms. *Staphylococcus* (sometimes called «staph») is a group of bacteria that can cause a multitude of diseases. *Staphylococcus* infections may cause disease due to direct infection or due to the production of toxins by the bacteria. Boils, impetigo, food poisoning, cellulitis, and toxic shock syndrome are some of the examples that can be caused by *Staphylococcus*.

Keywords: Infection; *Staphylococcus*; Treatment; Skin

The skin provides a remarkably good barrier against bacterial infections. Although many bacteria meet or reside on the skin, they are normally unable to establish an infection. When bacterial skin infections do occur, they can range in size from a tiny spot to the entire body surface. They can range in seriousness as well, from harmless to life threatening [1].

Bacterial skin infections are usually caused by gram-positive strains of *Staphylococcus* and *Streptococcus* or other organisms [2]. An infection can take many different forms depending on the location, bacterial type, and even the age of the affected individual. Many bacterial infections may be treated by a general physician. More complex one may require the input of a specialist dermatologist [3].

Staphylococcus (sometimes called «staph») is a group of bacteria that can cause a multitude of diseases. *Staphylococcus* infections may cause disease due to direct infection or due to the production of toxins by the bacteria. Boils, impetigo, food poisoning, cellulitis, and toxic shock syndrome are some of the examples that can be caused by *Staphylococcus* [4].

Staphylococcus aureus causes the following infections

- Folliculitis
- Furunculosis (boils) and abscesses
- Impetigo (school sores) and ecthyma
- Methicillin (methicillin) resistant *Staphylococcus aureus*

- Staphylococcal scalded skin syndrome
- Toxic shock syndrome
- Tropical pyomyositis
- Botryomycosis (pyoderma vegetans) [5].

Folliculitis

Folliculitis is a relatively common skin disorder caused by inflammation and infection in the hair follicles. Types of folliculitis include razor bumps, hot tub rash, and barber's itch [6]. The type of inflammatory cells varies depending on the etiology of the folliculitis and/or the stage at which the biopsy specimen was obtained. In superficial folliculitis, the inflammation is restricted to the infundibular aspect of the follicle, whereas in deep folliculitis the inflammation not only involves the deeper aspect of the follicle, it also extends into the surrounding dermis. Deep folliculitis can eventuate from chronic lesions of superficial folliculitis or from lesions that are manipulated and may ultimately result in scarring.

Peri folliculitis, on the other hand, is defined as the presence of inflammatory cells, usually lymphocytes, within the perifollicular tissues with focal extension into the adjacent reticular dermis. Folliculitis and peri folliculitis can occur independently or together as a result of follicular disruption and irritation, adjacent reticular dermis [7].

Figure 1

Signs and symptoms

Small red bumps, white-headed pimples, pus-filled sores, crusty sores, red skin, inflamed skin, itching, burning, tenderness, pain, swelling, mild fever [8].

Treatment

The treatment for folliculitis varies based on the type and severity of the condition, mild cases often only require home remedies. However, severe or recurrent cases may need medication or other therapies [6]. Clindamycin 1% lotion or gel. Because most of the folliculitis is caused by *S. aureus*, clindamycin 1% lotion or gel may be applied topically bid for 7 to 10 days. Alternatively, benzoyl peroxide 5% wash may be used when showering for 5 to 7 days. Extensive cutaneous involvement may warrant systemic therapy (eg, cephalexin 250 to 500 mg po tid to qid for 10 days). If these measures do not result in a cure, or folliculitis recurs, pustules are Gram stained and cultured to rule out gram-negative or methicillin-resistant *S. aureus* (MRSA) etiology, and nares are cultured to rule out nasal staphylococcal carriage. Potassium hydroxide wet mount should be done on a plucked hair to rule out fungal folliculitis. Hot tub folliculitis usually resolves without treatment. However, adequate chlorination of the hot tub is necessary to prevent recurrences and to protect others from infection [8].

Furunculosis (boils)

Furunculosis is a skin condition characterized by the formation of lump filled with pus. It is a deep infection involving hair follicle that results to painful lumps while it is continuously being filled with bacteria and dead tissue. Furunculosis is a contagious skin condition that usually develops in moist or sweaty areas of the body and parts of the body where friction is present, Furunculosis can be recurrent or non-recurrent while it is an isolation of bacterial infection in a single hair follicle sent [9].

Signs and symptoms

Clinically, furuncles present as red, swollen, and tender nodules of varying size and at times with an overlying pustule. Fever and enlarged lymph nodes are rare. If several adjacent follicles are infected, they may coalesce and form a larger nodule, known as a carbuncle. Furuncles most frequently appear on the extremities and they may lead to scarring upon healing.³ Most patients present

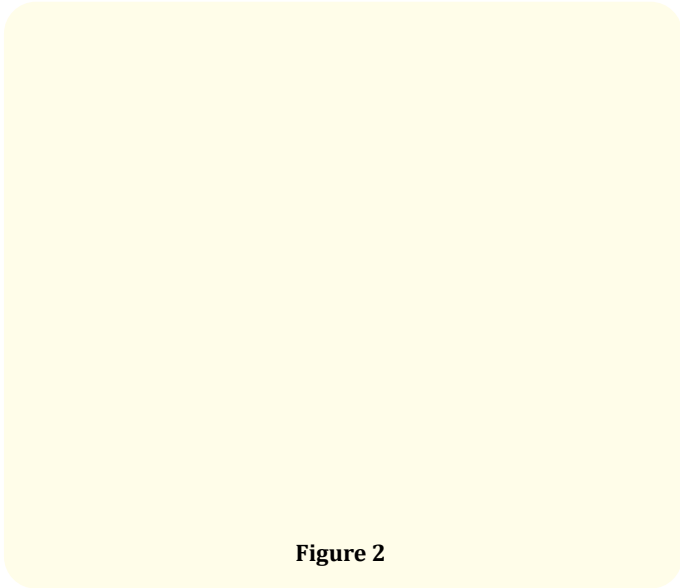


Figure 2

with one or two boils and after clearing experience no recurrences. However, furunculosis has a propensity to recur and in such cases, they often spread among family members [10].

Treatment

Treatment of furunculosis is geared towards draining of pus and hastens the healing process while preventing bacteria from spreading to other parts of the body. Furunculosis can also be cared at home although it is still important that prompt treatment is applied while it is strongly advised not to prick the boil as this may cause further infection.

Treatment of furunculosis may include the following

- Medicines such as antibiotics, acetaminophen or ibuprofen.
- Warm compress to encourage drainage
- Incision and drainage [11].

Abscesses

A skin abscess is a pocket of pus. It is similar to a pimple, but larger and deeper under the skin. It forms when the body tries to protect itself from an infection by creating a wall around it. The pus contains bacteria, white blood cells, and dead skin. The most common bacteria are *Staphylococcus aureus* (known as “staph”) and methicillin-resistant *Staphylococcus aureus* (known as MRSA). Most people carry these bacteria on their skin yet never

develop an infection. However, when the bacteria penetrate the skin (through a cut, along a hair follicle, or under the edges of a wound), they may lead to an infection [12].

Symptoms and signs

Cutaneous abscesses are painful, tender, indurated, and usually erythematous. They vary in size, typically 1 to 3 cm in length, but are sometimes much larger. Initially the swelling is firm; later, as the abscess points, the overlying skin becomes thin and feels fluctuant. The abscess may then spontaneously drain. Local cellulitis, lymphangitis, regional lymphadenopathy, fever, and leukocytosis are variable [13].

Treatment

A skin abscess will not heal on its own without further intervention by a health care provider. Initially, an abscess may feel firm and hardened (indurated), at which time incision and drainage may not be possible. However, once the abscess begins to “come to a head” and it becomes softer and fluid-filled, a minor surgery to lance it to evacuate the pus and relieve the pressure is the best course of action. A doctor will open and drain the abscess (incision and drainage) using the following technique. The area around the abscess will be numbed with local anesthetic. It is often difficult to completely numb the area, but in general, local anesthesia can make the procedure almost painless. A sedative may be given if the abscess is large. The affected area will be covered with an antiseptic solution and sterile towels placed around it. The doctor will cut open the abscess with a scalpel and drain as much of the pus and debris as possible. Sometimes, there will be multiple pockets of pus that must be identified and drained. Once the sore has drained, the doctor may insert packing into the remaining cavity to minimize bleeding and to keep the wound open for a day or two so any remaining pus can continue to drain. A bandage will then be placed over the packing, and the patient will be given instructions for home care. Most people feel better immediately after the abscess is drained. A doctor may prescribe pain medication, depending upon the location, size, and extent of the abscess.

Antibiotics are generally not necessary; however, they may be prescribed if the abscess is associated with a surrounding skin infection. Antibiotics such as trimethoprimmethoxazole (Bactr

im), cephalexin (Keflex), or azithromycin (Zithromax Z-pak) may also be prescribed, depending upon the location of an abscess and whether or not the individual has a compromised immune system [14].

Impetigo

Impetigo is a common cutaneous infection that is especially prevalent in children. Historically, impetigo is caused by either group A β -hemolytic streptococci or *Staphylococcus aureus*. Currently, the most frequently isolated pathogen is *S. aureus* [15].

There are two types of impetigo: non-bullous (i.e., impetigo contagiosa) and bullous. Nonbullous impetigo represents a host response to the infection, whereas a staphylococcal toxin causes bullous impetigo and no host response is required to manifest clinical illness. The diagnosis usually is made clinically and can be confirmed by Gram stain and culture, although this is not usually necessary. Culture may be useful to identify patients with nephritogenic strains of *S. pyogenes* during outbreaks of poststreptococcal glomerulonephritis or those in whom methicillin-resistant *S. aureus* is suspected [16].

Symptoms of impetigo

Reddish spots on the skin, often clustered around the nose and lips, are the first sign of the most common type of impetigo. The

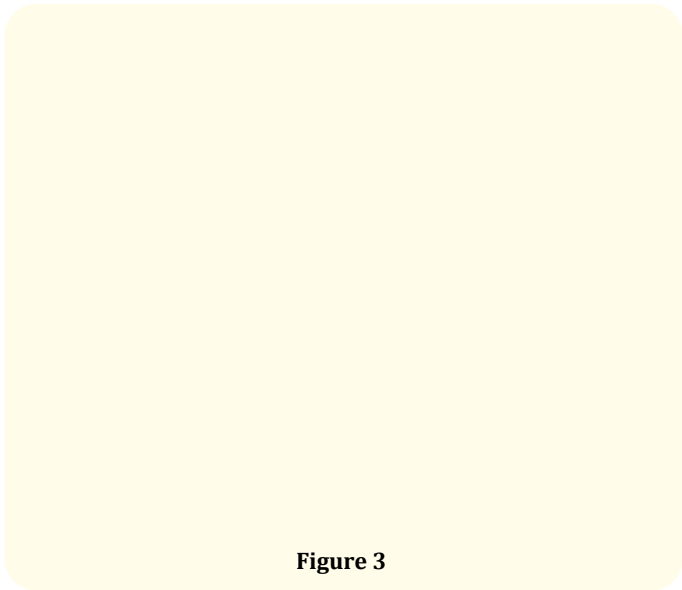


Figure 3

sores quickly grow into blisters, ooze and burst, and then form a yellowish crust. The crust is often described as honey colored. The clusters of blisters may expand to cover more of your skin. The sores are unsightly, itchy, and occasionally painful. After the crust phase, they leave red marks that fade without leaving scars.

Table 1

Infants often have a less common type of impetigo, with larger blisters around the diaper area or in skin folds. These fluid-filled blisters soon burst, leaving a scaly rim called a collarette.

Impetigo can be uncomfortable. Occasionally, it may involve swollen glands in the area of the outbreak. Fever and swollen glands can occur in more severe cases [17]. The treatment includes the following table [18].

Ecthyma

An ulcerative pyoderma usually caused by group A beta-hemolytic streptococcal infection at the site of minor trauma, predominantly involving the shins and feet, and generally healing with variable scar formation [19].

- The crust is grey-yellow and is thicker and harder than the crust of impetigo.
- A shallow, punched-out ulcer is seen if the crust is removed.
- The deep dermal ulcer has a raised and indurated margin
- Ecthyma lesions may remain of constant size and resolve without treatment or they can enlarge to 3 cm in diameter.
- Ecthyma heals slowly, usually with a scar.
- Regional lymphadenopathy is common, even with solitary lesions [20].

Treatment

Topical mupirocin ointment is very effective. Fusidic acid and retapamulin are alternatives. Topical antibiotics are usually satisfactory if the infection is localized.

More extensive lesions require oral antibiotics, possibly for several weeks to obtain full resolution. Penicillin should be adequate to treat streptococci. If *S. aureus* is also present, an antibiotic resistant to penicillinase may be advised. Consider parenteral antibiotics if there is widespread involvement [20].

Methicillin (methicillin) resistant *Staphylococcus aureus*

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major pathogen in hospitals and the community. In the past, most of the infections caused by MRSA were confined to elderly patients in healthcare facilities and they were described as healthcare-associated MRSA (HA-MRSA) [21].

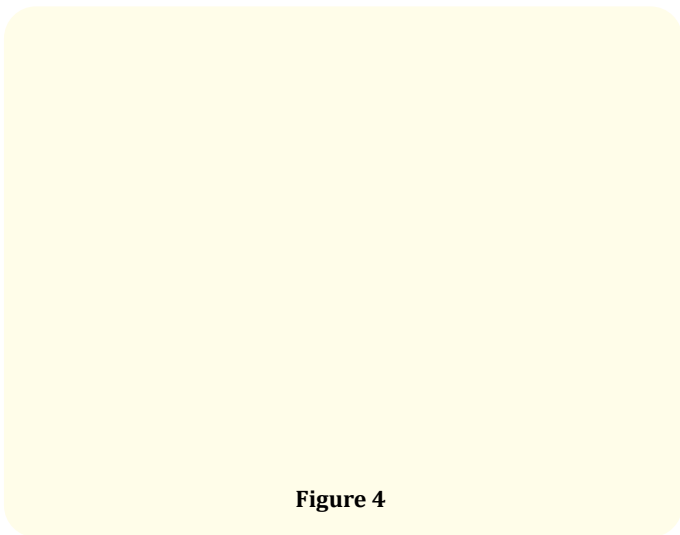


Figure 4

Symptoms

- Ecthyma usually arises on the lower legs or feet of children, those with diabetes, or neglected elderly people.
- Lesions are typically painful with associated lymphadenopathy.
- In tropical climates, ulcers are commonly found on the ankles and dorsum of the feet.

Signs

- The most commonly affected sites are buttocks, thighs, legs, ankles and feet.
- It starts as a vesicle or pustule over inflamed skin and then deepens to ulcerate with an overlying crust.

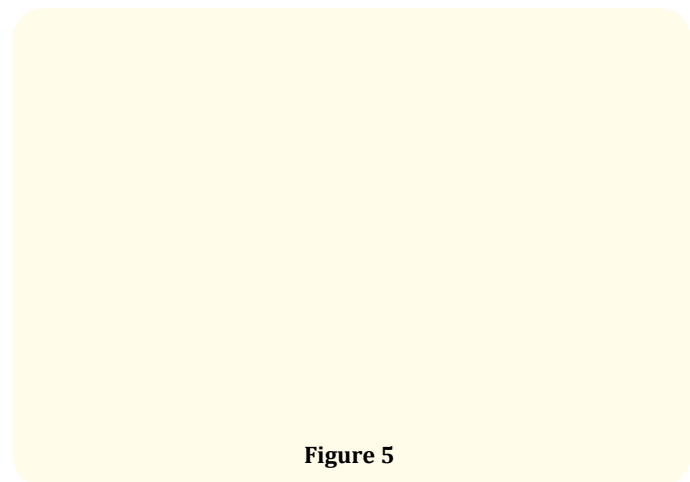


Figure 5

Signs and symptoms

Most MRSA infections are skin and soft tissue infections that produce the following signs and symptoms

- Cellulitis, an infection of the skin or the fat and tissues under the skin, usually starting as small red bumps in the skin. It includes redness, swelling of the tissues, warmth, and tenderness.
- Boils (pus-filled infections of hair follicles. Abscesses (collections of pus in or under the skin)
- Sty (an infection of an oil gland of the eyelid)
- Carbuncles (infections larger than an abscess, usually with several openings to the skin)
- Impetigo (a skin infection with pus-filled blisters)
- Rash or skin redness (skin appears to be reddish or have red-colored areas) [22].

Treatment

Medication options for MRSA skin and soft tissue infections may include:

- Clindamycin
- Tetracycline drugs - Doxycycline and Minocycline
- Trimethoprim and sulfamethoxazole
- Rifampin
- Linezolid [23].

Staphylococcal scalded skin syndrome

Staphylococcal scalded skin syndrome (SSSS) is a clinical dermatological condition associated with extensive desquamation caused by the gram-positive pathogen *Staphylococcus aureus* (SA) [24].

Signs and symptoms

The following are the most common signs and symptoms of staphylococcal scalded skin syndrome. However, each child experiences symptoms differently. The disease usually begins with a fever and redness of the skin. Then, fluid-filled blisters may form. The blisters rupture very easily, leaving an area of moist skin. Other symptoms may include the Red, painful areas around infection site, blistering, fever, chills, weakness, Fluid loss, Top layer of skin slips off with rubbing or gentle pressure (Nikolsky's sign).

Figure 6

After the top layer of skin has peeled off, the following symptoms may be present

- Fever
- Chills
- Weakness
- Fluid loss through the open areas of moist skin

In newborns, the lesions are often found in the diaper area or around the umbilical cord. Older children more commonly have the lesions on their arms, legs, and trunk. The symptoms of staphylococcal scalded skin syndrome may resemble other skin conditions always [25].

Treatment

Treatment of SSSS usually requires hospitalization, as intravenous antibiotics are generally necessary to eradicate the staphylococcal infection. A penicillinase-resistant, anti-staphylococcal antibiotic such as flucloxacillin is used. Other antibiotics include nafcillin, oxacillin, cephalosporin and clindamycin. Vancomycin is used in infections suspected with methicillin resistance (MRSA). Depending on response to treatment, oral antibiotics can be substituted within several days. The patient may be discharged from hospital to continue treatment at home. Corticosteroids slow down healing and hence are not given to patients with SSSS.

Other supportive treatments for SSSS include:

- Paracetamol when necessary for fever and pain.
- Monitoring and maintaining fluid and electrolyte intake.

- Skin care (the skin is often very fragile). Petroleum jelly should be applied to keep the skin moisturized.
- Newborn babies affected by SSSS are usually kept in incubators.

Although the outward signs of SSSS look bad, children generally recover well, and healing is usually complete within 5–7 days of starting treatment [26].

Toxic shock syndrome

Toxic shock syndrome (TSS) is a toxin-mediated acute life-threatening illness, usually precipitated by infection with either *Staphylococcus aureus* or group A Streptococcus (GAS), also called *Streptococcus pyogenes*.

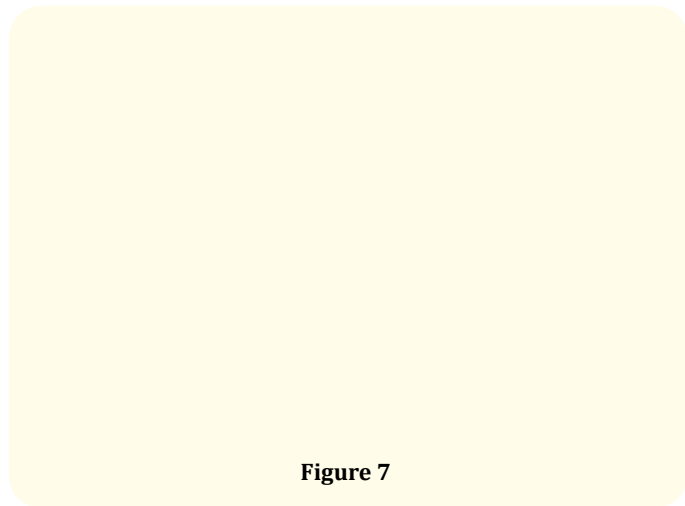


Figure 7

Signs and symptoms

High fever, rash, hypotension, multiorgan failure (involving at least 3 or more organ systems), and desquamation, typically of the palms and soles, 1-2 weeks after the onset of acute illness. The clinical syndrome can also include severe myalgia, vomiting, diarrhea, headache, and non-focal neurologic abnormalities [27].

Treatment

The treatment for TSS varies from patient to patient; however, the following treatments are common. Patients with TSS usually will be treated with two or more of the following treatments

- Intravenous fluids to treat shock
- IV antibiotics

- Deep surgical cleaning of any infected wounds
- Cardiac medications to help treat low blood pressure
- Oxygen and/or mechanical ventilation as needed
- Blood products if needed
- Dialysis for patients with kidney failure
- Hospitalization in an intensive-care unit [28].

Tropical pyomyositis

Tropical pyomyositis, a disease often seen in tropical countries, is characterized by suppuration within skeletal muscles, manifesting as single or multiple abscesses. The most common organism implicated is *Staphylococcus aureus*. In 20%–50% of cases there is a history of trauma to the affected muscles. Commonly involved muscles are quadriceps, glutei, pectoralis major, serratus anterior, biceps, iliopsoas, gastrocnemius, abdominal and spinal muscles [29].

Signs and symptoms

The disease is seen in all age groups, although young males are the most susceptible group. Maximum incidence is seen at 10–40 years of age with a male to female ratio of 1.5:1. Muscles frequently involved are quadriceps, glutei, pectoralis major, serratus anterior, biceps, iliopsoas, gastrocnemius, abdominal and spinal muscles. Usually, a single group of muscle is affected, but in 12%–40% of cases multiple groups are involved either sequentially or simultaneously [6,7,11].

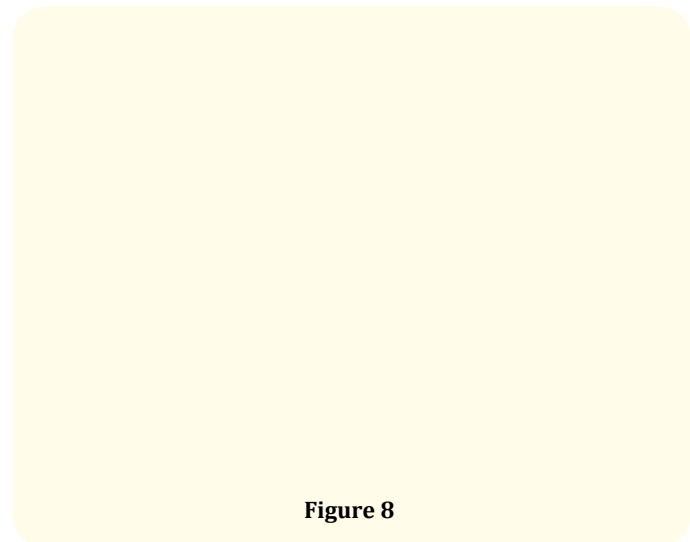


Figure 8

The clinical picture is divided into three stages

Invasive stage

This first stage is characterized by a subacute onset of variable fever, painful firm swelling, and minimal systemic symptoms with or without erythema (as infection is deep seated). The area is tender with a wooden consistency. Aspiration, if attempted at this stage, yields no pus as the phlegmonous inflammatory process is diffuse. Firm swelling, absence of erythema, and mild pain may divert the attention of a physician away from an infectious etiology. The invasive stage may resolve itself, mimicking fibromyalgia or may progress to next stage of suppuration.

Suppurative stage

From the second week to third week, abscess forms in the muscle. High spiky fever, with more severe systemic symptoms marks the beginning of the suppurative stage. The classical signs of abscess, fluctuation and erythema, may be lacking because the overlying muscle is tense. Needle aspiration at this stage yields pus. Regional lymph nodes are not involved.

Late stage

If the abscess remains untreated, dissemination of infection occurs. Bacteremia, followed by septicemia, septic shock, acute renal failure, and metastatic abscesses are some of the complications described [29].

Treatment

Surgical drainage of abscess, primary wound closure and vacuum drainage promotes better healing.

Appropriate antibiotics like Penicillin β -lactamase resistant penicillin (flucloxacillin) and vancomycin are the most commonly used drugs. Broad spectrum empirical antibiotics are needed for patients with HIV infection or other immunosuppressive state.

Treatment is continued till wound is clear of infection and the patient afebrile for 7–10 days [30].

Botryomycosis (pyoderma vegetans)

Botryomycosis is a rare chronic bacterial granulomatous disease that usually involves skin and rarely viscera. Main etiological agent is *Staphylococcus aureus* and less commonly *Pseudomonas* spp., *Escherichia coli*, *Proteus* spp., *Streptococcus* species [31].

Figure 9

Signs and symptoms

Botryomycosis most commonly affects the skin and presents as subcutaneous nodules, abscesses, large verrucous lesions, ulcers, fistulae and sinuses with purulent discharge. The lesions generally develop over several months and may drain pus. The pus may contain small yellow “grains” similar to the Sulphur granules of actinomycosis. Infection may extend to the subcutaneous tissues, muscles, and bones.

It is rare for botryomycosis to affect internal organs. Lungs are the most commonly infected and usually there is a predisposing factor such as surgery or impaired immunity [32].

Treatment

The treatment of choice for botryomycosis consists of prolonged (2 weeks to 2 months) antibiotic administration. The exact duration of therapy depends solely upon clinical response. The selection of antibiotic used is based upon the culture results and associated sensitivity studies. Almost every imaginable antibiotic has been successfully employed, particularly penicillin G, erythromycin, trimethoprim-sulfamethoxazole and minocycline., complete surgical extirpation of the affected area may be entertained. There is no place for physical modalities in the management of botryomycosis [33].

Bibliography

1. A Damian Dhar MD JD. "Private Practice, North Atlanta Dermatology. Overview of Bacterial Skin Infections". Last full review/revision November (2017).
2. Reviewed by Robert Cox, MD on 5/11/2016. Diseases and conditions Bacterial skin infections 101.
3. Heather Brannon. "10 Common Bacterial Skin Infections Ranging in Severity from Mild to Deadly". Updated June 17, (2018).
4. William C Shiel Jr. MD, FACP, FACR Staph Infection (*Staphylococcus Aureus*). (2014).
5. Amanda Oakley. Dermatologist, Waikato Hospital, Hamilton, New Zealand. Bacterial skin infections (2002).
6. Judith Marcin MD. "Everything you need to know about folliculitis". By Jayne Leonard, Last reviewed Mon 24 July (2017).
7. Elizabeth K Satter. Chief Editor: Dirk M Elstone, MD. Folliculitis. Updated: May 22, (2018).
8. A Damian Dhar MD JD. "Private Practice, North Atlanta Dermatology". Folliculitis (2017).
9. Medical content." Furunculosis - Pictures, Causes, Symptoms, Treatment" (2013).
10. Ibler K and Kromann C. "Recurrent furunculosis – challenges and management: a review". 18 February (2014). 7.
11. Medical content. "Furunculosis - Pictures, Causes, Symptoms, Treatment". updated on December 26, (2013).
12. Ioana Baiu MD MPH and Elliot Melendez MD. "Skin Abscess". *JAMA* 319.13 (2018): 1405.
13. A Damian Dhar. "Private Practice, North Atlanta Dermatology". Cutaneous Abscess. i© 2018 Merck Sharp and Dohme Corp., a subsidiary of Merck and Co., Inc., Kenilworth, NJ, USA (2018).
14. John P Cunha. DO, FACOEP. Abscess (2018).
15. Luciana Baptista Pereira. "Impetigo – review".
16. Charles Cole and John Gazewood. University of Virginia School of Medicine, Charlottesville, Virginia. "Diagnosis and Treatment of Impetigo". *American Family Physician* 75.6(2007): 859-864.
17. Debra Sullivan PhD MSN RN CNE. COI on October 24, 2017 — Written by Marjorie Hecht. Impetigo 101: Symptoms, Causes, and Treatment. On October 24, (2017).
18. Patty Ghazvini., *et al.* "Review Article Impetigo in the Pediatric Population". *Journal of Dermatology and Clinical Research* 5.1(2017): 1092.
19. Medical dictionary. Ecthyma.
20. Dr Louise Newson. Reviewed by Dr Laurence Knott on 12 Oct 2015. Ecthyma (2015).
21. Dr Louise Newson. Reviewed by Dr Laurence Knott on 12 Oct (2015).
22. Medical Author: Sandra Gonzalez Gompf, MD, FACP. MRSA.
23. Hannah Nichols. Reviewed by Alana Biggers, MD, MPH. All you need to know about MRSA. Last updated Mon 13 November (2017).
24. Menon Narayanankutty Sunilkumar. "Staphylococcal scalded skin syndrome - A case series with review of literature". *IAIM* 2.6 (2015): 214-219.
25. Stanford childrens health. "Staphylococcal Scalded Skin Syndrome". 2018 STANFORD CHILDREN'S HEALTH (2018).
26. Amanda Oakley. Dermatologist, Waikato Hospital, Hamilton, New Zealand, 2002; Updated, 2014. Reviewed and further updated by Jannet Gomez, Postgraduate Student in Clinical Dermatology, Queen Mary University, London, United Kingdom, January 2016. Staphylococcal scalded skin syndrome (2016).
27. Ramesh Venkataraman. MBBS; Chief Editor: Michael R Pinsky, MD, CM, Dr (HC), FCCP, MCCM more. "Toxic Shock Syndrome" (2018).
28. Charles Patrick Davis and Melissa Conrad Stöppler". Toxic Shock Syndrome (TSS)". Medically Reviewed (2018).
29. S Chauhan., *et al.* "Tropical pyomyositis (myositis tropicans): current perspective". Correspondence to Dr Sandeep Chauhan 126 A Sector 6, Panchkula 134109, Haryana, India.
30. Marie Hartley. Staff writer, Tropical pyomyositis Updated by Dr Jannet Gomez, Postgraduate student in Clinical Dermatology, Queen Mary University London, UK. February (2016).
31. B Devi., *et al.* *Indian Journal of Dermatology*. Botryomycosis. 58.5 (2013): 406.

32. Marie Hartley. Staff Writer, 2010. Reviewed and updated by Dr Amanda Oakley Dermatologist, Hamilton, New Zealand; and Vanessa Ngan, Staff Writer; June 2014. Further update by Dr Jannet Gomez, Postgraduate Student in Clinical Dermatology, Queen Mary University London, United Kingdom, February. Botryomycosis (2016).
33. Ted Rosen. "Botryomycosis (Bacterial pseudomycosis, Granular bacteriosis, Staphylococcic actinophytosis)" (2018).