

Musculoskeletal System
Microbiology
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Sheet - 4 -

Ω Bacterial & Fungal Skin, Soft Tissue & Muscle Infections:

➤ **Skin infection:**

- It involves several layers of the skin: it might be only superficial (limited to the epidermis and dermis), or it might reach the subcutaneous tissue and become associated with more inflammatory reaction and necrosis.
- This super-infection might spread to the blood stream or internal organs and become associated with systemic infections.
- Some minor skin infections are associated with Osteomyelitis (bone infection) due to the dissemination of the organism via lymphatics, subcutaneous tissue, and the blood to bone that has some fractures.
- Skin infection is not always mild; it can be so severe and complicated depending on:
 1. Age.
 2. Presence of underlying diseases.
 3. The general immune status of the patient.
 4. Other factors.
- Nevertheless, the majority of superficial skin infections are considered mild.

➤ **Acute skin infection:**

- It's associated with a short period (less than 48 hours).
- It's characterized by:
 1. High fever.
 2. Edema.
 3. Redness/Erythema.
 4. Presence of blisters ,ulceration and abscesses .
 5. Severe Headache.
 6. Vomiting.
 7. Diarrhea.
- Severe headache, vomiting, and diarrhea are more commonly seen in children than in adults.
- In case of acute skin infection: you have to know the causative agent and how to treat it without delay.

Ω Staphylococcus Group:

➤ Features:

- It's a common causative agent of skin and soft tissue infections, due to the fact that:
 1. Staphylococcus group is part of our normal flora.
 2. It's found in hair follicles, nose, intestines, and also in the UT.
 3. It's a very common organism that can survive for a long time in the environment (not like H.influenzae or N.gonorrhoeae ..etc) , on the skin and hands (despite washing), and on our clothes.
- You might be infected with staphylococcus (contaminated wound for example), but you might not even notice it.

➤ In the 4 pictures:

- The most commonly recognized skin infections are in the form of:
 1. Erythema in the beginning.
 2. Mild abscesses.
 3. Edema.
 4. Later, the tip of the infected area becomes yellowish in color; indicative of the accumulation of pus cells/white blood cells.
- The infection starts in the face of young adults during the production of androgenic hormones as mild erythematous lesions. If you scratch these lesions you'll introduce more inflammatory reaction, and you'll have a more severe infection in the form of folliculitis or impetigo.
- Impetigo: might start as a mild skin infection due to staphylococcus or group A streptococcus, then it affects a larger surface of the skin (face, legs, and arms).

➤ Normal Skin Flora:

- There's a biological equilibrium on our skin that has to be controlled.
- Any damage to the surface of the skin might enhance the activity of one organism by releasing certain enzymes that allow the organism to be active and produce inflammatory reaction.
- Lipophilic yeast on the skin: if there's injury in the skin, they will produce lipases that cause splitting of sebum, and allows other organisms to be activated like staph
- Staphylococcus on the skin: if they increase in number, they will produce enzymes and toxins that produce an inflammatory reaction. This inflammatory reaction is followed by release of virulence factors (enzymes and toxins) by staphylococcus, which reach the blood stream and produce more complications.
- We have certain types of organisms that are often found on our skin associated with hair follicles or in the foldings of the skin.

- *Anaerobic Propionibacteria*: it's useful normal flora. It might contribute to infection under certain conditions due to increase in the amount of the organism.

➤ **Skin Infections:**

- Generally, most skin infections (90%) are associated with: Staphylococci, Beta-Hemolytic Streptococci (Group A), Micrococci, Propionibacteria , Acinetobacter , Pityrosporum (Yeasts).
- 50% of all mild/severe skin infections (abscesses, cellulitis, impetigo, etc) are associated with *Staphylococcus aureus*.
- *Staphylococcus aureus* skin infections are especially found in communities (Community-acquired *Staphylococcus* infection).
- Few percentage of skin infections are associated with: Beta-Hemolytic Streptococci (Group A), Diphtheroids, Micrococci, Propionibacteria , Acinetobacter , and Pityrosporum (Yeasts).
- ***Clostridium perfringens, Clostridium tetani, Pseudomonas aeruginosa, and Acinetobacter***: they are dangerous organisms that are associated with skin infections. They're recognized following accidents or injuries damaging the skin, and following hospitalization where certain instruments might introduce infection in the tissue and result in skin infection.

➤ **Systemic Infections:**

- Certain organisms produce systemic infections.
- These systemic infections might be associated with skin rashes.
- Some organisms might produce:
 1. Hemorrhagic skin: *N. meningitides*.
 2. Rose Spots/Skin Rash: *Salmonella Typhi* (mostly) and *Salmonella Paratyphi*.
 3. Ulceration of the Skin: *Treponema pallidum* (STD).

Ω ***Staphylococcus Aureus***:

➤ **Features:**

- It's referred to as coagulase positive. It's more virulent than other staphylococcus species.
- It's associated with majority of skin infections, because:
 1. It produces a variety of toxins and enzymes (lipases, proteases, hemolysins, and coagulase), which contribute to developing an inflammatory reaction, damaging the tissues, and disseminating the infection throughout the body.
 2. It's common: 20 – 30% of the population are healthy carriers.
- A person might be a healthy carrier of *Staphylococcus Aureus* for a short period.
- A person might easily acquire a staphylococcal infection:

1. Physicians and nurses easily acquire the infection from the hospital.
2. In the community, the infection is acquired through contact and during playing (children).

➤ **Common staphylococcal skin infections:**

Classified according to severity:

1. Folliculitis:

-Inflammation of the hair follicles.

It's observed in the form of a small localized infection in one hair follicle or more.

It might spread to other parts of the body (starting from the face or other parts of the body) to produce more than one infection in the body in the form of follicular infection.

It might be associated with lesions, especially in the folding part of the body, in many people who have underlying disease or are immunocompromised.

-The presence of lipophilic yeast enhances the infection.

-Lack of hygiene enhances the infection.

2. Impetigo:

One of the most common staphylococcal infections in children.

It's not necessarily associated with infection in the body (nose, throat, etc), but only the skin.

It's transmitted from one child to another.

It's a superficial skin infection that affects mainly the epidermis.

It produces blisters in many parts of the exposed skin.

Exposed parts of the body are mostly affected (face, arms, and legs).

Often recognized in children after a minor skin injury, due to lack of specific anti-staphylococcal antibodies.

Impetigo is rarely recognized in adults, because with time our body develops specific antibodies. The infection is more serious if it's caused by types of staph that produce toxins.

Keep in mind: Not all strains of staph produce enterotoxins (related to food poisoning or related to toxic shock syndrome). It differs from one community to another.

At least 30% of staph might produce enterotoxins (type 1 or type 2 or both).

If the Staph produces Type 1 Enterotoxin (Super-Antigen Toxin):

the skin infection might be associated with toxic shock syndrome (TSS), because this enterotoxin activates T-lymphocytes and causes more release of cytokines that contribute to an intense immune

reaction and more damage to the tissues. All these effects are in addition to the damage caused by the enzymes released by the staph.

TSS Progression:

1. At the beginning: Skin rashes and mild inflammatory reaction.
2. Later produces severe damage in the tissue.
3. Desquamation (peeling off) of the tissue.
4. Absorption of the toxin into the blood stream.
5. Toxin reaches internal organs.
6. Multi-organ failure (especially kidney failure).
7. Death.

Toxic shock syndrome is a serious disease, so the patient has to be treated immediately to prevent complications.
Impetigo infection might reoccur during the life-time of the patient.

3. Scalded Skin Syndrome:

It's a mild skin infection.

It's recognized in infants mainly aged less than one year, but rarely in children/adults.

It's recognized in infants due to the lack of specific antibodies against certain strains of staph aureus that produce Exfoliative toxins (epidermolytic toxins).

The infection starts due to mild injuries in the skin of infants, and within a short period (less than 48 hours) you will recognize presence of erythema and peeling of the skin, and it might be associated with accumulation of fluids under the epidermis.

It's very painful, and it can be very serious if the infant is not treated with topical or systemic anti-microbial drugs.

If the patient is not treated, there will be complications such as a massive inflammatory reaction, sepsis, and eventually multi-organ failure (especially kidney failure) and death.

Ω Coagulase Negative Staphylococcus Species:

➤ Coagulase Negative Staph:

- Other staphylococcus species are collectively referred to as coagulase negative staph.
- They can be: Staph. epidermidis, Staph. Saprophyticus, Staph. Citreus, and others.
- These species are associated with a variety of skin infections (minor/severe) and might be associated with sepsis or systemic infections.
- Infection is usually less severe and easily controlled.
- They're not associated with toxic shock syndrome.

- These skin infections are **rarely** found in healthy people.
- These skin infections are **often** found in:
 1. Immunocompromised patients.
 2. Patients with underlying diseases.
 3. Patients with damaged skin due to burns.
 4. Infants.
- **Recovery of The Organism:**
 - Recovering this organism from the blood of infants is problematic. Sometimes, it will be very difficult to know if this organism is in fact the causative agent of sepsis in infants or not, because:
 1. Infants' skin is more associated with staph epidermidis than staph aureus.
 2. The blood specimen from infants can be easily contaminated by staph epidermidis.
 - Recovering of Staph. Epidermidis from blood of infants should be evaluated in association with the presence of clinical features before treatment.
- **Problem of Staphylococcus Group:**
 - We have a large percentage of resistant staphylococcus isolates that produce beta-lactamases that inactivate the majority of penicillin and cephalosporin drugs.
 - If the Staph is resistant to one or other types of penicillin drugs, then we have to check if this Staph is susceptible to Penicillinase-Resistant Drugs (Methicillin/Oxacillin) or not.
 - If the Staph isolate is proved to be MRSA (Methicillin-Resistant Staphylococcus Aureus), then:
 1. We have to be careful in selecting any type of beta-lactam drug for treatment.
 2. Even if in vitro test showed that the MRSA is susceptible to certain cephalosporin drugs from the 3rd or 4th generation, then the strains will develop resistance during treatment.
 3. Use other drugs: Macrolides, Vancomycin, Aminoglycosides, or fluoroquinolones.
 - For MRSA, Vancomycin: can always be used, but it's more expensive and toxic (be careful of side effects).
 - In our country, MRSA has a prevalence rate of 70-80% in most hospitals. This prevalence rate might reach 100% in certain hospitals: due to misuse (by the community) and overuse (by physicians) of antibiotics.
 - Certain countries such as Sweden and Finland: have low prevalence rate of MRSA, due to proper use of antimicrobial drugs.
- **Diagnosis and Treatment:**

- Detection of staphylococcus is easy if you culture the specimen.
- It's not recommended to rely on direct smear (gram stain).
- Direct detection of Staphylococcus from clinical specimen (wound or abscess) might not give the impression that you have gram-positive Staphylococcus or Streptococcus, but only the impression of the presence of gram-positive cocci. You won't see cluster of cocci (staphylococcus) or long chains (Streptococcus) as you see it in the culture. You will recognize simply cocci, diplococci, and maybe short chains of cocci.
- Direct smear from clinical specimens doesn't help in distinguishing between Micrococci, Streptococci, and Staphylococcus. It requires a lot of experience

- **Recommendation is to do culture:** gives a result in 48 hs generally
 1. To recognize hemolytic activity.
 2. Classify group A streptococci.
 3. Prepare gram stain.
 4. See morphological structures.
 5. Do catalase, oxidase, and other biochemical tests.

- **Remember that:**
 1. Staphylococcus: Catalase and Oxidase positive.
 2. Streptococcus: Catalase and Oxidase negative.

- Susceptibility test must be done, especially for Methicillin.

- **Treatment of Skin Infections:**
 - It might be easy for immuno-competent patients.
 - The problem is recurrence of skin infections (as it might hint presence of underlying diseases or immunosuppression).
 - There's no vaccine to prevent staphylococcal infections.

Ω Streptococcal infection:

- **Streptococcal Infection:**
 - It's mainly related to **Group A Streptococci** (Beta-Hemolytic Streptococci/ Streptococcus pyogens).
 - Other Hemolytic Streptococci are less significant in skin infections, and are rarely associated with severe infections.
 - Group A Streptococci is a common causative agent of sore throat. Following acute or chronic streptococcal sore throat, the child might suffer from skin infections related to streptococcus, such as Cellulitis, or Erysipelas.

- **Erysipelas:**
An acute rapid superficial skin infection.

Severe infection is not usually recognized, although it might include the subcutaneous tissue sometimes, and gives the impression of burning in the skin due to edema and changing in the color of the skin.

Usually, you will recognize skin redness with no inflammatory cells (in contrast to staphylococcus skin infections where inflammatory cells are recognized). In addition, the lymph nodes might be involved (lymphadenitis), and blood sepsis.

- Cellulitis and Erysipelas due to Group A Streptococci can be mild or severe, depending on the clinical features associated with the infection.
- Cellulitis and Erysipelas due to Group A Streptococci are not necessarily associated with Streptococcal sore throat. They might be acquired directly through skin injuries from one child to another during playing.

- **Streptococcal Impetigo:**

It's similar to staphylococcal impetigo.

Culturing a smear from the throat of the patient is the only way to know whether the causative agent is Staphylococcus or Group A Streptococcus. Only patients with streptococcal sore throat might develop streptococcal impetigo skin infection.

It's rarely associated with direct infection; it usually comes with streptococcal sore throat.

It's considered as "complication of streptococcal sore throat".

The infection might reoccur during the life-time of the patient.

- **Scarlett Fever:**

- It's often associated with presence of severe untreated sore throat.
- It might be transmitted through oral cavity and saliva, contaminates the skin of children who often have minor injuries during playing. If these Group A Streptococci produce **erythrogenic toxins** (that are produced by lysogenic strains that make up 30% of Group A Streptococci), then the child will develop scarlett fever.
- In scarlett fever, there's no inflammation. Redness of the skin is present, and it affects many parts of the body including the tongue.
- Erythrogenic toxins → cause production of specific antibodies that prevent recurrence of the disease.
- There is no recurrence of scarlet fever (the person is only infected once during his life) while in impetigo (caused by either strep or staph) might reoccur .

- **Necrotizing fasciitis:**

- It was recognized 25 years ago by accident, where certain patients developed severe skin infection that involves subcutaneous tissue and connective tissue, and caused liquefaction of the tissue in a short period due to the presence of Group A Streptococci that produce Pyrogenic Exotoxins (A, B, and C).

- Necrotizing Fasciitis is mostly associated with releasing Pyrogenic Exotoxins (A and B).
- 30% of Streptococcus strains produce Pyrogenic Exotoxins (A and B).
- It can be so severe, and within a short period the subcutaneous and skin infection might result in systemic infection.
- If it reaches the blood stream; it might reach internal organs and cause death of the patient.
- It's a very serious disease, so the patient has to be treated without delay. In addition, the patient should be treated with surgical debridement.
- JU hospital: 20 cases of Necrotizing Fasciitis have been recognized in the past 5 years.
- Necrotizing Fasciitis might be confused with gas gangrene (*Clostridium perfringens*). Nevertheless, the clinical features and the culture help with the diagnosis of this disease.

- **Complications related to NF:**
 1. Streptococcal Toxic Shock Syndrome: similar to Staphylococcal TSS, and it involves blood sepsis, vomiting, diarrhea, high fever, confusion, and dizziness.
 2. Respiratory failure.
 3. General organ failure.

- **Fatality:** it can reach up to 30%, even with treatment.

- **Necrotizing Fasciitis:** it's not related to children. It's more recognized in elderly patients.
- **Diagnosis:**
 1. Culture the specimen.
 2. Identify the organism as Group A Streptococci.
- **Treatment:**
 - Treatment is easy due to the fact that they're still susceptible to penicillin drugs.
 - There's no need to use drugs other than penicillin, except in the case of penicillin-allergy.
 - Treatment with penicillin is excellent in sore throat.
 - **Necrotizing Fasciitis:** *might* be a mixed infection, so you might require combination in treatment, because you might have other organisms. So, the culture is helpful in this case to know whether it's a mixed infection or caused by Group A Streptococci only.
 - There's no vaccine available for Group A Streptococci.

- The End -

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