Medical Committee
The University of Jordan

The Skin and
MUSCULOSKELETAL
System

MICROBIOLOGY

SLIDES ☐
SHEET ■
LECTURE # 4

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Bacterial Infections of Skin & Soft Tissues

- Skin infection:

- Could be of bacterial, viral or fungal origin.
- It may involve one or several layers of Skin and Soft Tissues (epidermis, dermis, sub-cutis, muscle).
- It might involve superficial layers (limited to the epidermis and dermis), or it might reach the subcutaneous tissue and become associated with more inflammatory reaction and necrosis.
- May be associated with systemic infection (only in certain cases) which means that it can spread to the blood stream, lymphatics or any other organ.

- Acute skin infection is easily recognized and is characterized by:

1) High fever & warm skin.
2) Edema and fluids (accumulation of pus cells).
3) Redness/Erythematous eruption.
4) Presence of blisters (with a black or white head), ulceration and abscesses.
5) Swelling.
6) Tenderness.
7) Headache.

- Skin infections rarely cause chronic lesions and sepsis.

- Skin infection increases by :

1) The presence of minor skin injuries.

2) Abrasions.

3) Manipulation with the skin with your finger (may produce very small eruption or mild damage that can not be discovered by naked eyes which leads localized infection) .

4) Increasing the production of some Androgenic Hormones especially after Puberty ⟶ Sebaceous ducts activity increases. ⟶ Sebum oil (Fatty Acid Peptides) and keratin amounts increase ⟶ Skin desquamation ⟶ Anaerobic (considered to some extent anaerobic) Propionibacteria acnes (gram +ve small bacilli) & Staph spp (will excrete certain enzymes ⟶ Split sebum & cause inflammation ⟶ Developing Acne.

- The causing agent of Acne could be Propionibacteria alone or could be a mixed infection between Propionibacteria and Staph (could be Cogulase +ve or -ve).

➢ Only a Few types of bacteria could be involved in skin infection (majorty of them; 95% of skin infection such as:

1) Staphylococci
2) hemolytic Streptococci (Group A)
3) Micrococci
4) Propionibacteria
5) Acinetobacter
6) Pityrosporum (yeast)
7) Other classical Yeasts e.g. Candida species.

8) Some of the above bacteria might be considered part of skin normal flora. They could be found on hair follicles or on the skin. And they can't cause any infection without stimulation especially Staph bacteria, Propionibacteria and Acinetobacter.

- Some types of organisms following systemic infection; blood septicemia, localized infection in bones might be associated with development of skin ulceration or skin rashes .
- Certain Systemic Infection may be associated with skin inflammation reaction like N. meningitides the causative agent of meningtis (Hemorrhagic Lesions), S. typhi (skin Rash, Rose spots), Treponema pallidum (First developed by the presence of ulcerations on the external genitalia, in later stages it may only be associated with skin rashes), P. aeruginosa (gram –ve) Acinetobacter(gram -ve) , Klebsiella (garam -ve), and some other types of fungi and viruses (skin Rash) .

Now we will talk about some types of bacteria that could cause some skin infections.

S. Aureus:

- Coagulase +ve
- Produce various extra-cellular products, exotoxins & enzymes e.g. Lipases. These products make S. Aureus pathogenic.
- Associated with the most common human Skin diseases & sepsis in community & hospital .
- Up 50% of skin infections (the most common) are caused by S. Aureus. But why?

1) It is considered very pathogenic because of its products and toxins.

2) It is considered as a common part of our skin flora and it is found in the nose and feces. So we have a large reservoir of it in our body, and mostly it is not acquired from outside (endogenous infection).

- S. Aureus is the most common causative agent of skin infections (simple infections) and it can cause : Folliculitis, accumulation of pus cells , ulceration of the region , erethymatous regions (Allergic reactions then ulceration and pus cells)
- It mainly affects Children and causes **Impetigo** (this disease occurs due to staphylococcus aureus or group A strepcocci).
- Impetigo is 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 small blisters in many parts of the exposed skin associated later with more damage in the subcutaneous tissues that may crusted and become serious. 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. (endogenous not exogenous)
- Certain strains of S. Aureus can produce two important types of toxins :

1) **Toxic shock syndrome toxin (TSST)**: It is enterotoxins which has some super-antigen activities that induce **toxic shock syndrome (TSS)**. This is characterized by fever, erythematous rash, hypotension, shock, multiple organ failure, and skin desquamation. Lack of antibody to TSST-1 plays a part in the pathogenesis of toxic shock syndrome.

It can be fatal and causes death. However the outcome depends on the amount of the toxin released. Only 20-30% of S.Aureus strains can produce this type

of toxin. The strain must be infected by a specific bacteriophage and it should carry specific genes responsible for the production of these toxins.

Endotoxins 1 and 2 are responsible for the skin damage , cardiac failure and death.

2) **Epidermolytic/ Exfoliative Toxins (A, B):** These Toxins cause **Scalded Skin Syndrome**. After their secretion, some minor skin lesions appear causing destruction skin intercellular connection, Large blisters containing fluid & Skin scaling. They can affect the skin of children; start in the superfecial layers and later on could destroy the subcutaneous tissue, they will cause severe damage especially to infants , but then a specific immunity could be acquired (antitoxins) .

S. Epidermidis

- It is the second type Staphylococcus of importance in skin infections.
- Coagulase –ve.
- There are many subtypes of S. Epidermidis, but they are less pathogenic than S. Aureus.
- It causes mild infections and ulcerations following minor injuries.
- If the patient is immune-compromised or infnants, it can cause bacteremia but in healthy people it is not really serious.
- It is considered as normal flora of the skin and nose.
- Most of its infections occur in normal individuals as mild wound infections. But the risk of systemic infection increases in infants & immune-compromised patients.

Susceptibility to Penicillin

- In the past these bacteria were easily treated by penicillin. But nowadays they became resistant to penicillin and at least 50% of isolated staph bacteria all over the world are considered to be penicillinase resistant. So we **can't** use any type of penicilinase-resistant drugs such as: Methicillin , Floxillim , Augmentin (amoxicillin + clavulonic acid).
- 80% of the isolated bacteria are MRSA so the only way to treat them is by using specific anti- bacterial drugs directed against only staph such as: Vancomycin, Teicoplanin, Imipenem and Fusidic acid.
- lab diagnosis is easily done by culturing the bacteria and using gram stain to recognize the presence of staph, then biochemical test: coagulase test (to distinguish between coagulase –ve and +ve).
- However it is not easy to be treated directly with drugs without first doing surgical drainage to remove dead cells , debris, fluids and the foreign bodies because foreign bodies will became bio-filaments and resist anti-microbial drugs. Then you can use anti- microbial drugs after removing them.
- In certain cases, where there is a chronic infection , we must first cure the underlying disease before using antimicrobial drugs.

Streptococcus pyogenes / B-H-Group A

- We have other groups; B,C, D,E,F but they are rarely associated with skin infections.
- Group A can produce some Extracellular products and toxins that are involved in infections . It may also produce toxic shock syndrome, the same one that is produced from S.Aureus (different in the composition but the same mechanism of action on the skin).
- Group A produces potent toxins (Erythrogenic, pyrogenic exotoxins A, B, C) so it is important. These toxins produce :

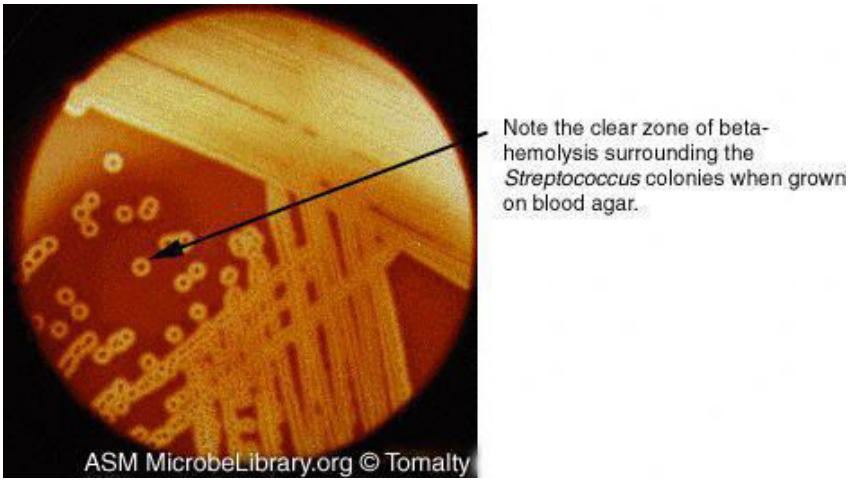
1) scarlet fever , following sore throat .

2) localized infection .

3) **Impetigo** in children, following infection in upper respiratory tract, e.g. sort throat. Impetigo can result from direct contact between children.

4) It can produce cellulitis at any age but it is more sever in children.

5) It affects the subcutaneous and superficial layers and unless it is treated it will reach the blood stream and cause bacteremia.



- **complete destruction of RBC when culturing Streptococcus A . However when we culture Viridians streptococcus there will be only a change in the color of RBC from red to green.

** In order to distinguish between the different species, we can use gram stain to recognize the chains of cocci. Also we can use serological test to detect antibodies, or agglunitation test .

Necrotizing fasciitis: -

- Related to streptococcus.
- Production of the same toxin which develop arithmetic lesion (AMP exotoxins)
- It was recognized 25 years ago.
- Patients developed severe skin infection that involves subcutaneous tissue and connective tissue, and causes liquefaction of the tissue in a short period (48 hours) due to the presence of Group A Streptococci that produces 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 (esp. kidney) and cause death.
- It's a very serious disease, so the patient has to be treated without delay.
- The patient should be treated with surgical debridement.
- Necrotizing Fasciitis might be confused with gas gangrene (Clostridium perfrengens).
- clinical features and culturing the bacteria help with the diagnosis of this disease.
- It can result during surgical procedure (contamination).
- Might result in severe damage in subcutaneous fascia and may cause bacteremia and 30% of the patients may die .

**In the first picture there are only some erythematic lesions. These lesions are not due to fungi, viruses or bacteria. They are not well characterized.

- In the second picture we can see some complications of Scarlet fever. There is erythema and the color of the tongue will change to intensive red recognized during clinical examination.

Less Common Bacterial Skin Infections

- They are related to all ages not only to children.

  Rarely associated with skin infections but these can be recognized during differential iagnosis in certain cases.

Bacillus anthracis

- Cause cutaneous Black Lesions. And ulceration (esp. to farmers).
- Treated via surgical methods and antibiotics.

Clostridium perfingens

- Anaerobic bacteria.
- Affects the Skin, fascia and Subcutaneous layers.
- The infection could be a mixed Infection.
- Can cause gas gangrene.
- Causes localized lesions following injuries in the skin but later on reaches the subcutaneous tissue causing gas gangrene .

Borrelia Burgdorferi:

- It is considered a spirochete.
- Causes **Lyme disease** (the state where it was discovered in USA)
- Transmitted by Tick (Insect bites).
- Causes superficial lesions then it can go to the blood and reaches cutaneous layers , then the disease will became chronic and known as Lyme disease.
- Causes Annular Rash.
- Causes Chronic Skin Lesion, Cardiac & Neurological Abnormality and Arthritis.
- It is endemic in USA, China and Japan rarely found in Arab countries.
- It must be treated early to prevent complications.

Mycobacterium Tuberculosis:

- It is an acid- fast bacterium so it is not easily cultured and we need to use a special medium.
- It is the causative agent of tuberculosis that is related to pulmonary infections in lungs.
- Cutaneous tuberculosis is atypical mycobacteria.
- Atypical mycobacteria is found widely in nature, water and soil. It can produce infection in the superficial layers of skin then might spread to lymph system and cause granuloma.
- There are two important species that cause skin lesions especially to swimmers : **M. marinum, M. ulcerans**. (sometimes they are considered together as a complex M. marinum-ulcerans)
- It rarely causes any complication in the lung since it is atypical.
- It is not easily detected. We have to prove first the development of granuloma and second demonstrate the acid- fast bacilli and third if possible to do culture.

Leprosy: الجُذام

- Acid-fast bacilli .
- Famous disease: **M. leprae.**
- Studies on this bacteria are done using experimental animals, since it is very hard to culture it in vitro.
- The Incubation period is very long (1-40 year) .
- The Root of infection is unknown, and there is no prove how the host acquires the infection. But close contact plays a role in acquiring the disease but there is no prove until now.

- M . leprae is a devastating disease. It first affects the cooler parts of the body (mucous membranes, peripheral nerves , nose, ears, eye brows and external genitalia) . It slowly damages tissues and ending of nerves; some part of the body later on will be liquificated and seperated.
- There are two forms of leprosy :

1) Tuberculoid form: it causes infections similar to mycobacteria's infections. Also it causes granuloma , and we can find few acid-fastbacilli that are recognized by allergic reactions . This form of disease can be controlled.

2) lepromatous form : this form is more dangerous and causes severe damage . We can find numerous acid-fast bacilli. It can't be recognized by any allergic reaction since there is some tolerance. It's difficult to control it and it causes damage to all internal organs including CNS.

Problems about leprosy:

- This bacteria can't be cultured and the only way to recognize it is by clinical examination or by the presence of acid-fast bacilli .
- There is no antibiotic to this disease and no cure is found till now not like tuberculoisis where we have certain drugs against it; here we have drugs that control the growth of acid-fast bacili but can not eliminate them completely so the infection persist life-long..
- There is about 10 million cases world- wide , especially in closed communities e.g. India and Sudan

Fungi and skin infections

Dermatophytes

- Filamentous fungi
- Causes superficial infection.
- There are three genera of Dermatophytes: Trichopyhton, Microsporum and Epidermatophyton spp. Each one of these genera is composed of many species.
- They cause lesion in more than one part of the body: (superfecial infections of skin: hair, nails,skin...).

1) Tinea corpois.

2) Tinea Versicolor/Pityriasis: it causes red batches on the skin. The yeast the causes it is a lipophilic yeast. There is a change in the color of the skin; the skin may become darker or lighter according to the original color of the skin. It appears under stress condition and can disappear without treatment.

3) Tinea pedis: affects interdigital spaces in fingers .Once it is established, it can't be cured easily, it can be only controlled producing less erythema and allergic reaction and the organism can not be eliminated causing long-life infection.

4) Tinea cruris: in relation to folded part of our body.

5) Tina unguium /Onychomycosis: (could be caused by dermatophyte or yeast) It affects the tip of the fingers and spread to the fold (the space between the nail and the finger) or it may start in the fold of the finger and spread to the tip. The only way to treat it is to remove the finger. No anti-fungal drug is available to treat it. It is found widely in Jordan.

6) Tinea capitis: it damages hair follicles. There are large numbers of spores from filamentous fungi. It can be treated using anti-fungal drugs. It can easily spread . It is found in close communities and families. One person can affect 100s of people.

- Lab diagnosis is concerned on filemantous fungi and yeast: All of these forms are easily recognized clinically by examination of the skin.
- No vaccine is available to protect against these types of infection.
- They are all easily recognized by wet preparations from hairs, skin or nails in the lab; we look for the spores or fragments of the hyphi. Second we can culture the fungi but it need few days or few weeks; on dermatophytes at least we need four weeks. we classify them according to the color and the arrangement of spores.
- Treatment: specific antifungal drugs e.g. Imidazole drugs, miconazole, clotrimazole, econazole, ketoconazole and fluconazole.
- Infections in the hair and the body can be controlled to some extent. But infections in the nails can't be treated and we have to use surgical methods to remove the nail or the finger.
- Some skin lesions related to dermatophytes, which are true filamentous fungi, can't disappear without treatment.
- The infection of the nails may start first on the tip of the finger then reaches the folding of the finger or vice versa.

Dedications to Raghda Yassin

"في الضيق تتبدى السّعة ، وفي الألم يتجلى الامل ، وفي الكرب يجد المرء مخرجاً وإن كان بعيدا في الرؤية الأولى و في الحزن يبعث الله للمحزون من يُسري عنه ولو كان خيالا من ماضٍ ، أو طيفا من ذكريات ... لو خلق الله الضيق دون سعة والالم دون أمل والكرب دون فرج و الحزن دون سرور ما طاب العيش لمخلوق ، وما وجد المرء لحياة يمكن ان ينتظر قساوتها على أمل العبور إلى لينها و لو بعد حين"