



INFECTIONS IN DIABETIC PATIENTS



Objectives

- Define the term Diabetes Mellitus (Diabetic foot).
- Know the common infections in Diabetes Mellitus (Diabetic foot).
- Know the pathogenesis in the common infections in Diabetes Mellitus (Diabetic foot).
- Know the organisms that cause the common infections in Diabetes Mellitus (Diabetic foot).
- Know the clinical features of infections in Diabetes Mellitus (Diabetic foot).
- State the laboratory diagnostic tests and the radiological test of the infections in Diabetes Mellitus (Diabetic foot).
- State the complications of Diabetes Mellitus (Diabetic foot), mainly those common infections in Diabetes Mellitus (Diabetic foot).
- Know the management of infections in Diabetes Mellitus (Diabetic foot) including nursing management and anti-microbial management.

Introduction

- ★ Diabetic patients are predisposed to infections.
- ★ Nearly half of all diabetic patients had at least one hospitalization or outpatient visit for infections compared to non-diabetic patients.
- ★ Infections may increase the morbidity and mortality in diabetic patients.

Why diabetic patients are at increased risk to have infections? Because of Host related factors & Organisms related factors

1. Organism-Specific Factors

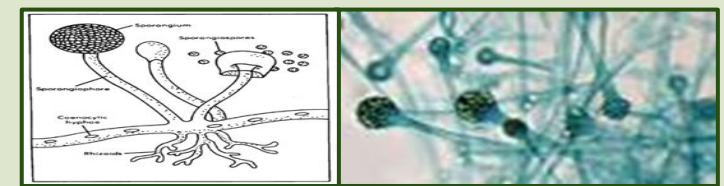
Candida Species

Glucose inducible proteins promote **adhesion** of *C.albicans* to buccal or vaginal epithelium which in turn, impairs phagocytosis, giving the organism advantage over the host.



Rhizopus Species

Ketoacidosis allow *Rhizopus spp.* (a non -septate hyphae) which cause **Mucormycosis (Zygomycosis)** to thrive in high glucose acidic conditions



2. Host-Related Factors

Vascular Insufficiency

- Result in local tissue ischemia that enhances the growth of microaerophilic and anaerobic organisms while depressing the O2 dependent bactericidal functions of leukocytes.
- There may be also impairment of the local inflammatory response and absorption of antibiotics.

Sensory Peripheral Neuropathy

Minor local trauma may result in skin ulcers, which leads to diabetic foot infections. because they won't notice it

Autonomic Neuropathy

Diabetic patients may develop **urinary retention and stasis, hence, predisposes UTIs.**(urinary tract infections)

Immune Defects

- Depressed Neutrophil function.
- Affected adherence to the endothelium.
- Decreased chemotaxis and phagocytosis.
- Compromised intracellular bactericidal activity.
- Opsonization.
- Depressed cell mediated immunity.

Increased Skin and Mucosal Colonization

- Diabetics on insulin have asymptomatic nasal and skin **colonization with Staphylococcus Aureus**, particularly **MRSA (Methicillin-Resistant Staphylococcus Aureus)**.
- Colonization predisposes to skin infection and transient bacteraemia which may result in distal sites infection such as damaged muscle.
- In type 2 diabetes, mucosal colonization with *Candida Albicans* is common.
- Vulvovaginitis caused by **Non-Albicans Candida** species is common in patients with poor glycemic control.

Surgical Site Infections

Associated with postoperative hyperglycemia which is related to deleterious effect on chemotaxis, adherence, and phagocytosis by granulocytes.

Hyperglycemia

Metabolic derangements in diabetes may facilitate infection, especially candidiasis. (bc high blood sugar fasciculate the growth of the organism) & Its also plays a role in UTIs.

Different Infections in Diabetic Patients

Very important

Upper Respiratory Tract Infections

Invasive (Malignant) Otitis externa Uncommon but potentially life-threatening		Rhinocerebral Mucormycosis A life-threatening fungal infection	
Cause	<i>Pseudomonas Aeruginosa</i>	Cause	<i>Rhizopus(mucormycosis)</i> , <i>Absidia</i> and <i>Mucor</i> species
MOA	Slowly invades from the external canal of the ear into adjacent soft tissues, mastoid and temporal bones, and eventually spreads across the base of the skull.	Risk Factor	Diabetic Ketoacidosis always accompany mucormycosis
Clinical	Severe pain, otorrhea, hearing loss, intense cellulitis and edema of the ear canal.	Clinical	Intranasal black eschars or necrotic turbinate, facial or ocular pain, nasal stuffiness, generalized malaise, fever.
Diagnosis	CT or MRI to define the extent of bone destruction.	Diagnosis	Biopsy of the necrotic tissue + Direct smear examination for hyphae.
Treatment	1.Surgical debridement. 2.IV anti-pseudomonas.e.g. 3rd generation cephalosporins like Ceftazidime.	Treatment	1.Surgical debridement. 2.Prolonged IV Amphotericin B.

Lower Respiratory Tract Infections

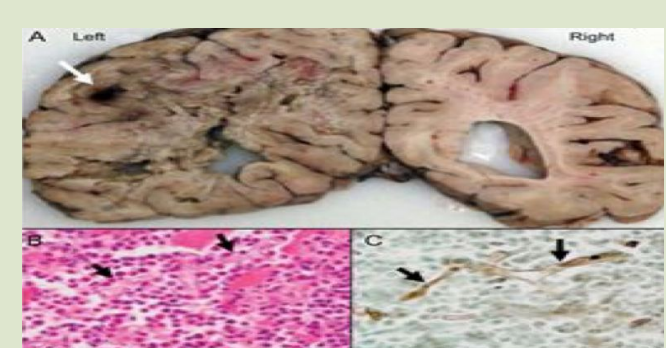
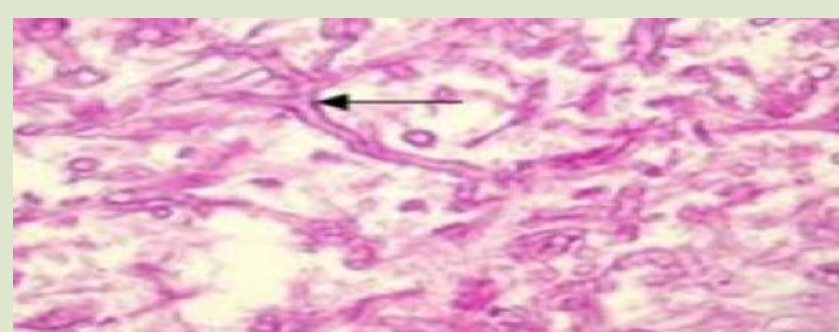
Pneumonia and Influenza

Diabetic patients are 4 times more likely to die from pneumonia or influenza than non-diabetic patients

Cause	<ul style="list-style-type: none"> ❖ Gram positive bacteria: <i>Staphylococcus Aureus</i> and <i>Streptococcus Pneumoniae</i>. ❖ Gram negative bacteria: <i>Enterobacteria</i> and <i>Legionella</i>. ❖ Other organisms: <i>Influenza Virus</i> and <i>Mycobacterium Tuberculosis</i>.
Prevention	Routine pneumococcal and influenza vaccination are recommended.



Rhinocerebral mucormycosis



Genitourinary Infections

Asymptomatic Bacteriuria > 10 ⁵ bacteria/ml urine (common)		Cystitis Bladder infection		Pyelonephritis Kidney infection	
Clinical	Symptoms, Signs, and duration of onset are similar to non-diabetics.	Clinical	Same as non-diabetics.. Incomplete bladder emptying and high incidence of unsuspected upper UTI.	Types	❖ Bilateral: Diabetes predisposes to a more severe infection of the upper urinary tract. The kidneys will be like a bag of pus ❖ Emphysematous: Exclusively present in diabetics (60%). Carries grave prognosis (30% fatal).
Prevention	Screening is not indicated for diabetic patients to treat asymptomatic bacteriuria. The only two indications: Pregnancy and pre-ureteric procedure	Cause	❖ Gram positive: <i>Group B Streptococcus (Streptococcus Agalactiae).</i> ❖ Gram negative: <i>Escherichia Coli.</i> ❖ Fungal: <i>Candida Albicans.</i>		
Diagnosis	Flank mass(in the clinical examination), crepitus, and CT scan shows gas in the renal tissues.				
Treatment	Supportive + IV antibiotics(14 days) + Nephrectomy if needed. {We gave IV antibiotics if not responding we might need to drain the kidney (nephrostomy) And we might need to remove it (nephrectomy)}				

Abdominal Infections

Severe Fulminating Cholecystitis

Cause	<i>Enteric Gram Negative Bacteria and Anaerobes.</i>
Complications	❖ Gall stone or Peritonitis may be present. ❖ Gas gangrene and perforation may occur.
Treatment	Cholecystectomy + Broad spectrum antibiotics.



Skin and Soft Tissue Infections (**very important**)

Necrotizing Fasciitis and Myositis

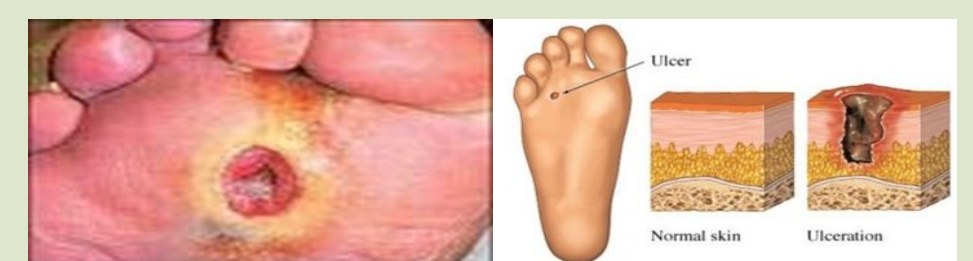
Deep life threatening infection of **subcutaneous** tissue with progressive destruction of fascia, fat, muscles, and bones

Risk Factors	<ul style="list-style-type: none"> - Sensory neuropathy with no pain perception. - Atherosclerotic vascular disease. - Hyperglycemia: >250 mg/dl. - History of cellulitis, peripheral vascular diseases, tinea infection, and dry skin.
Organism	<ul style="list-style-type: none"> - <i>Streptococcus Pyogenes</i> (Group A Streptococcus) - 10% of Necrotizing Fasciitis Group A streptococcus might cause type 2 necrotizing fasciitis. - <i>Staphylococcus Aureus</i>. - CA-MRSA (Community Acquired MRSA) - 77 of skin and soft tissue infections. - <i>Clostridium Perfringens</i> (Gas producing gram positive bacilli) - Especially in Myositis. - Anaerobes - Requires wound discharge.
Clinically	<ul style="list-style-type: none"> - Very severe pain of proportion of skin and anesthesia of overlying skin. - Violaceous discoloration of skin that evolves into vesicles and bullae. - Acute illness with painful induration of the limb especially the thigh, foot may be involved. - Foul wound discharge suggest anaerobes - Crepitus. - Soft tissue gas seen in radiograph or CT scan.
Treatment	<p>Aggressive surgical debridement with wound discharge + IV antibiotics.</p>

Diabetic Foot



Significance	<p>The most common and most important soft tissue in diabetic patients because it is related..</p> <ul style="list-style-type: none"> - Peripheral neuropathy may lead to incidental trauma that goes unrecognized. - Compromised microvascular circulation which limits the access of phagocytic cells to the site of infection. - Poor concentration of antibiotics in the affected area.
Complicated By	<ul style="list-style-type: none"> - Chronic Osteomyelitis. - Gas Gangrene(due to Clostridium Perfringens) - Amputation - Death



Skin and Soft Tissue Infections (Cont)

Diabetic Foot

The most common and most important soft tissue in diabetic patients

Spectrum	<ul style="list-style-type: none"> - Ranges from superficial cellulitis to chronic osteomyelitis. - Infection may be involving bone or soft tissue or both. - Sinus tract may be present.
Pathogenesis	<p>Compromised local blood supply predisposing foot to infection, that is due to:</p> <ul style="list-style-type: none"> - Microvascular disease limits blood supply to the superficial and deep structures. - Pressure from ill-fitting shoes. - Trauma. - Compromises local blood supply predisposing foot to infection.
Diagnosis	<ul style="list-style-type: none"> - Vascular and neurological state examination. - Radiology: <ul style="list-style-type: none"> - Doppler ultrasonography. - Transcutaneous oximetry. - MR angiography. - CT, MRI, or Gallium scan for soft tissue and bone. - Exploration of ulcer to determine its depth and the presence of sinus tract. - Deep specimens (tissues) for culture and susceptibility testing.
Treatment	<ul style="list-style-type: none"> - Control blood sugar and hydration. - Continuous evaluation of neuropathy and vasculopathy. - Mild case: Debridement of necrotic tissue + Antibiotic according to the causative bacteria e.g. Cloxacillin, Cephadrine, Clindamycin, TMP-SMX (for CA-MRSA), Aminoglycosides, Quinolones. - Moderate to sever case: Hospitalization + IV antibiotics + Possible surgery (amputation).
Prevention	<ul style="list-style-type: none"> - Blood sugar should be controlled promptly (shift to insulin if oral hypoglycemic agents were not effective), weight reduction, a diet low in fat and cholesterol. - Proper foot care, using protective footwear and pressure reduction. - Self and family member examination of foot.

Cellulitis

Causes	beta-hemolytic streptococci (group A,B streptococci), <i>S.aureus</i> , <i>Enterobacteriaceae</i> (<i>E.coli</i> , <i>Klebsiella</i> , <i>Proteus spp.</i>) in chronic ulcers.
Clinically	<ul style="list-style-type: none"> - Tender, erythematous, non-raised skin lesion on the lower limb, may be accompanied with lymphangitis (which suggests <i>Group A Streptococcus</i>). - Bullae Suggests <i>Staphylococcus Aureus</i> and occasionally <i>Group A Streptococcus</i>.



Bone Infections

Chronic Osteomyelitis

Acute Osteomyelitis

Risk Factors

- **Grossly visible bone or ability to probe to bone.**
- ESR > 70 mm/h.
- Size > 2x2 cm.
- Depth > 3mm.
- Duration > 1-2 weeks.

Cause

- **Group A and B Streptococcus.**
- *Staphylococcus Aureus.*
- *Enterobacteriaceae.*
 - *Escherichia Coli*
 - *Proteus Mirabilis*
 - *Klebsiella Pneumoniae*
- *Bacteroides Fragilis.*

Clinical

- Pain at the involved bone.
- Fever.
- **Adenopathy.**

Clinically

- **Fever.**
- **Foul discharge.**
- **Pain (possible).**
- No lymphangitis.
- Deep penetrating ulcers and sinuses on the plantar surface of the foot.

Treatment

- Control blood sugar and hydration.
- Continuous evaluation of neuropathy and vasculopathy.
- Mild case: **Debridement of necrotic tissue + Antibiotic** according to the causative bacteria.
- Moderate to severe case: Hospitalization + IV antibiotics + Possible surgery (amputation).

Prevention

- Is the cornerstone of diabetic foot care.
- It is multidisciplinary including family physician, social worker, home care nurse and specialist.
- Patient education about the control and complication of diabetes.
- **Blood sugar should be controlled promptly** (shift to insulin if oral hypoglycemic agents were not effective), weight reduction, a diet low in fat and cholesterol.
- Proper foot care, using protective footwear and pressure reduction.
- Self and family member examination of foot.



Summary

Upper and Lower Respiratory Tract Infections	
Upper respiratory tract infections	Lower respiratory tract infections
Invasive otitis externa	<ul style="list-style-type: none"> Caused by P.aeruginosa. Symptoms and Signs <ul style="list-style-type: none"> severe pain otorrhea hearing loss. Intense cellulitis and edema of the ear canal. Diagnosis: CT and MRI Treatment: surgical debridement & IV anti-pseudomonas antibiotics.
Rhinocerebral Mucormycosis (life threatening fungal infection)	<ul style="list-style-type: none"> Cause: (Mucormycosis) Rhizopus, Absidia and Mucor species. Clinically: facial or ocular pain and nasal stuffiness, generalized malaise and fever. May be intranasal black eschars or necrotic turbinates. Diagnosis: biopsy of necrotic tissue Treatment: surgical debridement and prolonged IV therapy with Amphotericin B
	<ul style="list-style-type: none"> Common organisms: <ul style="list-style-type: none"> Gram positive bacteria : S.aureus , S.pneumoniae. Gram negative bacteria: Enterobacteria and Legionella. Other organisms: Influenza virus & Mycobacterium tuberculosis . ----- Routine pneumococcal vaccination and influenza recommended.
Genitourinary infections	
Asymptomatic bacteriuria (> 100,000 /ml urine)	<ul style="list-style-type: none"> Symptoms/ Signs and time of onset similar to non-diabetics. Diabetes is not an indication for antibiotic treatment The only 2 indications is pregnancy and pre-uological procedures
Cystitis	<ul style="list-style-type: none"> same as non-diabetics, incomplete bladder emptying and high incidence of unsuspected upper UTI. Bacteria (Gram negative rods or group B streptococci) or fungi (Candida albicans) may be involved.
Bilateral Pyelonephritis	diabetes predisposes to a more severe infection of the upper urinary tract.
Emphysematous Pyelonephritis	<ul style="list-style-type: none"> exclusively an infection of diabetics (60%) prognosis (30% fatal). Diagnosis: flank mass & crepitus . CT show gas in the renal tissues. Management: supportive & IV antibiotics , nephrectomy may be needed.
Vulvovaginitis	-----
Abdominal infections	
Severe fulminating Cholecystitis	<ul style="list-style-type: none"> Common causes: Enteric Gram negative bacteria and anaerobes. Gall stone or peritonitis may be present. Gas gangrene and perforation may occur. Management: Cholecystectomy and broad spectrum antibiotics

Summary

Skin and soft tissue infections

Necrotizing fasciitis

- ❖ **Definition:** severe infection of subcutaneous tissue progressing to the fascia, fat and muscle.
- ❖ **Causes :** GAS group A streptococci (10%) ,with or without S.aureus, and anaerobes
- ❖ **Clinically:** pain of proportion of skin, anaesthesia of overlying skin. Violaceous discoloration of skin that evolves into vesicles and bullae, crepitus ,soft tissue gas seen in radiograph or CT scan.
- ❖ **Management :** aggressive surgical debridement & IV antibiotics.

Diabetic foot infection (most common)

- ❖ **Why it is common and important (risk factors)**
 - peripheral neuropathy
 - compromised microvascular circulation which limits the access of phagocytic cells to the infected area and poor concentration of antibiotics in the affected area.
- ❖ **Complicated by:** chronic Osteomyelitis, gas gangrene, amputation and death.
 - Combined infection involving bone and soft tissue may occur
- ❖ **Pathophysiology:**
 - Diabetic neuropathy may lead to incidental trauma that goes unrecognized.
 - microvascular disease limits blood supply to the superficial and deep structures. Pressure from ill fitting shoes ,trauma compromises local blood supply predisposing foot to infection.

Organisms involved in diabetic foot infections

- **Cellulitis:** : beta-hemolytic streptococci (group A,B streptococci), S.aureus, Enterobacteriaceae (E.coli, Klebsiella, Proteus spp.) in chronic ulcers.
- **Macerated ulcer or nail injury (sinus) :** P.aeruginosa .
- **Deep soft tissue infections (necrotizing fasciitis, or myositis).** GAS (Clostridium).
- **Chronic Osteomyelitis** beta-hemolytic streptococci, S.aureus, Enterobacteriaceae & Bacteroides fragilis

Clinical presentations of diabetic foot infections

- **Cellulitis:** tender, erythematous non-raised skin lesion on the lower limb ,may be accompanied with lymphangitis which **suggests GAS.**
- **Bullae** S.aureus ,occasionally GAS.
- **Deep skin and soft tissue infections:** patient acutely ill, with painful induration of the limb especially the thigh Foot may be involved.
 - Wound discharge suggest anaerobes
- **Acute Osteomyelitis:** pain at the involved bone, fever, adenopathy.
- **Chronic Osteomyelitis:** fever ,foul discharge , may be pain, no lymphangitis, deep penetrating ulcer ,and sinuses on the plantar surface of the foot

Diagnosis of foot infections

- **vascular and neurological examination**
- **Radiological:**ultrasound ,transcutaneous oximetry MR angiography,MRI and gallium,CT
- **Exploration of ulcer** to determine its depth and presence of sinus tract.
- **Deep specimens (tissues)** for culture and susceptibility testing

Management & Treatment

- **Control blood sugar and hydration**
- **Evaluation of neuropathy and vasculopathy**
- **Mild cases:** **debridement of necrotic tissues antibiotics** eg. Cloxacillin, Cephadrine, Clindamycin , TMP-SMX (for CA-MRSA), Aminoglycosides, Quinolones.
- **Moderate to severe cases :** places the foot at risk of amputation. Needs hospitalization ,IV antibiotics and surgical intervention if needed.

Prevention

- **Patient education** about the control and complication of diabetes.
- **Blood sugar should be controlled promptly,** a diet low in fat and cholesterol.
- **Proper foot care,** using protective footwear and pressure reduction.
- **Self and family member examination of foot.**



Doctor's Notes

Host-Related Factors

- Infection is important in diabetic patient because they have host factors make them more susceptible to severe infection
- The wound healing in diabetic patients is longer than normal people.
- It has strong relation with viral infection and also genetic.
- All sorts of immune system will be affected

Candida albicans:

- Low virulent organism.

Rhizopus spp:

- We only see it in diabetic patient and especially **diabetic ketoacidosis (more severe)**

Invasive Otitis externa:

- Inflammation in the auditory meatus (Very painful)
- تـجـي للناس الي يلعبون بأذانهم بالمفتاح
- Cause **P.aeruginosa** →in uncontrolled hyperglycemia (very severe malignant)

Story: a patient came to the clinic complaining from severe pain in his ear ,and vertigo,tinnitus ,on examination you noticed that the ear canal is inflamed but mildly, the radiological investigations showed that the infection didn't spread to the bones and the middle and inner ear and there is no other masses ?

- **Why did he develop tinnitus and vertigo!?**
 - Because he was treated with **gentamicin** which causes 8th nerve palsy

Rhinocerebral Mucormycosis

- Comes with black necrosis in the nose and then after hours it could spread to the sinus, orbit , brain patient die quickly
- Usually in diabetic ketoacidosis patients.
- **Diagnosis?** We look for hyphae

Lower respiratory tract infection

- Pneumonia more severe in diabetic patient
- We give diabetic patient influenza vaccine because it is predispose to bacterial infection



Doctor's Notes

Genitourinary infections

- Diabetic patient once they develop UTI they might lose one kidney or both of them
- we treat them as UTI not Lower
- Group B streptococci common in diabetic and pregnant
- In Bilateral pyelonephritis there is degradation, necrosis and liquefaction of the kidney.
- **Story:** Patients died suddenly by Staph.Aureus in the biopsy of the kidney they found a lot of microabscess (pus).

UTI in diabetic patient:

1. **Group B streptococcus is common**
2. **Very severe lead to pyelonephritis**
3. **Might lose kidney function**
4. **End up with nephrectomy and dialyses and might need transplant**

- If a severely ill diabetic patient comes to the ER complaining of flank pain we should suspect it
- **Vulvovaginitis is more common in type 2 diabetes and its caused by non albicans candida**

Skin and soft tissue infection

- **The thigh is close to the urogenital area and has less blood supply which promotes the growth of anaerobes like clostridium perfringens→it is common cause of necrotizing fasciitis.**
- **Story:** Diabetic patient obese lady has necrotizing fasciitis we saw gas gangrene in X-ray. First thing you think about Clostridium perfringens but in this case E.coli (unusual).

Diabetic foot

- Can be misdiagnosed with diabetic ulcer
 - It is important to differentiate between skin, soft tissue and bone infections because the management is different.
 - Neuropathy → atherosclerosis of the vessels → ischemia → limited access of phagocytic cells → poor antibiotic concentration to that area
 - Why is it usually recognized very late? Bc the patient will have anesthesia so they won't feel any pain
 - How to know the depth of the ulcer: how to know the depth of the ulcer in case of diabetic foot?
 - You use a metal probe and insert it to the tissue and see how did it reach,if the ulcer reach the bone it will produce a special sound.
 - **Superficial cellulitis: is minor.**
 - **Chronic osteomyelitis: if the patient has ulcer for long period of time.**
 - **Cellulitis we don't take sample we know it either staph or strept**
 - **We do surgery in osteomyelitis for 2 reasons**
- 1- Debridement. 2-To take biopsy for culture
- **In management we control blood sugar because if you don't control DM the Antibiotics will not work.**
 - **IV antibiotics broad spectrum until we know the organism**



MCOs:

1- Which of the following is especially seen in diabetics much more commonly than others?

- A- Rhizopus spp,group B streptococcus
- B- Group D streptococcus,aspergillus
- C- Staph aureus and H.influenza
- D-Hepatitis A,E viruses

2- which of the following Pts needs to be given antibiotics?

- A- Bacteriuria (>10,000 /ml urine) in diabetics
- B- Bacteriuria (>100,000 /ml urine) in diabetics
- C-Bacteriuria (>100,000 /ml urine) in pregnant
- D- B&C

3- a 30 year old female came to the clinic with ocular pain and nasal stuffiness the microscopic exam of a performed biopsy showed a non-septate broad hyphae (zygomycosis) the Patient most likely coming with(____) because she is at risk.

- A-pregnancy at the 1st semester
- B- type 2 diabetes and hyperglycemia
- C- diabetic ketoacidosis
- D- type 1 diabetes and hypoglycemia

4- the best sample for diagnosing diabetic foot?

- A-blood (5-10ml)
- B- BAL
- C- swab
- D- deep tissue biopsy

MCOs & SAQ:

1-A 2-C 3-C 4-D

A 60-year-old man with diabetes mellitus complains of deep burning pain and sensitivity to touch over his hands and fingers. Nerve conduction studies show slow transmission of impulses and diminished muscle stretch reflexes in the ankles and knees. Sensations to vibrations and light touch are also markedly diminished.

Q1: The development of polyneuropathy in this patient correlates best with which of the following conditions?

- (A) Anti-insulin antibody titer
- (B) Hyperglycemia
- (C) Insulin deficiency
- (D) Ketoacidosis

Q2: List 3 “Host Related factors” other than hyperglycemia:

- Vascular insufficiency
- Sensory peripheral neuropathy
- Autonomic neuropathy
- Immune defect.

Q3: In the above case, which of the following is the most common infection in diabetic patients related to peripheral neuropathy?

- (A) Necrotizing fasciitis
- (B) Vulvovaginitis
- (C) Diabetic foot
- (D) Pyelonephritis

Q4: Explain the pathophysiology of diabetic foot infection:

Microvascular disease limits blood supply to the superficial and deep structures.

Pressure from ill fitting shoes ,trauma compromises local blood supply predisposing foot to infection.

Q5: Which of the following is life-threatening infection related to diabetic foot infection:

- (A) Necrotizing fasciitis
- (B) Vulvovaginitis
- (C) Cellulitis
- (D) Pyelonephritis

Q6: What is the best specimen to collect in such case?

Deep tissue specimen.

1-B 3-C 5-A

Q7: Explain the management and treatment of “moderate to severe” cases:

Needs hospitalization with IV antibiotics and surgical intervention if needed ,and risk of amputation.





THANK YOU!



TEAM LEADERS:

ALANOUD AL-MANSOUR & KHALED AL-OQEELY

TEAM MEMBERS:

ABDULLAH AL-ANGARI

ANAS AL-SAIF

KHALID AL-DOSARI

NASER AL-RASHDAN

SAAD AL-HADDAB

SAIF AL-MESHARI

Designed by:

Aseel Badukhon (:

