Gram positive Bacterial Infections

1. **Staphylococcus aureus:**
   S. aureus is the most common cause of pyogenic infection of the skin and soft tissue, causing impetigo, cellulitis, boils, abscess, lymphadenitis, paronychia, omphalitis and wound infection. Osteomyelitis, suppurative arthritis, pneumonia, scalded skin syndrome and rarely meningitis are among other diseases due to S. aureus infection.

**EPIDEMIOLOGY:**
Most neonates are colonized within the 1st week of life; 20–30% of normal individuals carry at least 1 strain of S. aureus in the anterior nares at any given time. Spread via fomites is rare.

Factors that increase the likelihood of infection include wounds, skin disease, ventriculoperitoneal shunts, intravenous or intrathecal catheterization, corticosteroid treatment, malnutrition, acidosis, and azotemia.

**PATHOGENESIS:**
The intact skin and mucous membranes serve as barriers to invasion by staphylococci. Defects in the mucocutaneous barriers produced by trauma, surgery, foreign surfaces (sutures, shunts, intravascular catheters), and burns increase the risk for infection.

**CLINICAL MANIFESTATIONS:**
The signs and symptoms vary with the location of the infection.

- **Newborn:** Staphylococcus is an important cause of neonatal infections.

- **Skin:** It causes pyogenic skin infections, including impetigo contagiosa, ecthyma, bullous impetigo, folliculitis, furuncles, and carbuncles.

- **staphylococcal scalded skin syndrome:** It causes separation of the epidermal layer. In young children and infants, they develop fever, malaise and may have purulent, crusting localized infection around the eyes, nose and mouth with erythema and skin tenderness. Areas of skin separates on gentle pressure
(Nikolsky’s sign), leaving denuded areas of skin. Managed by IV AB, analgesia and good fluid balance.

- **Respiratory Tract**: Infections of the upper respiratory tract due to S. aureus are rare. Staphylococcal sinusitis is relatively common in children with cystic fibrosis or defects in leukocyte function. Suppurative parotitis is a rare infection, but S. aureus is a common cause. A membranous tracheitis that complicates viral croup may be infected with S. aureus. Pneumonia due to S. aureus may be primary (hematogenous) or secondary after a viral infection such as influenza.

- **Sepsis**: bacteremia and sepsis may be primary or associated with any localized infection.

- **Bones and Joints**: S. aureus is the most common cause of osteomyelitis and suppurative arthritis in children.

- **Central Nervous System**.

- **Meningitis**: Is not common; it is associated with penetrating cranial trauma and neurosurgical procedures (craniotomy, CSF shunt placement)

- **Heart**: Infective endocarditis may follow staphylococcal bacteremia.

- **Kidney**: S. aureus is a common cause of renal and perinephric abscess, usually of hematogenous origin.

- **Toxic Shock Syndrome**: S. aureus is the principal cause of TSS.

- **Intestinal Tract**: Staphylococcal enterocolitis rarely follows overgrowth of normal bowel flora by staphylococci.

- **Food poisoning**: May be caused by ingestion of preformed enterotoxins produced by staphylococci in contaminated foods.

**DIAGNOSIS:**

The diagnosis of staphylococcal infection depends on isolation of the organisms from nonpermissive sites such as cellulitis aspirates, abscess cavities, blood, or other sites of infection. Isolation from the nose or skin does not necessarily imply causation because these may be normally colonized sites.
**DIFFERENTIAL DIAGNOSIS:**

Skin lesions due to S. aureus and those due to group A streptococci may be indistinguishable; the former usually expands slowly while the latter is more prone to spread rapidly. Staphylococcal pneumonia can be suspected on the basis of chest roentgenograms.

**TREATMENT:**

Loculated collections of purulent material should be relieved by incision and drainage. Foreign bodies should be removed, if possible. Penicillin or amoxicillin are not appropriate. Vancomycin (40–60 mg/kg/24 hr divided every 6 hr IV) can be used as the initial treatment. Dicloxacillin (50–100 mg/kg/24 hr divided qid PO) and cephalaxin (25–100 mg/kg/24 hr divided tid–qid PO) are absorbed well orally and effective for MSSA. Amoxicillin-clavulanate (40–80 mg amoxicillin/kg/24 hr divided tid PO) also is effective. Clindamycin (30–40 mg/kg/24 hr divided tid–qid PO) has proved effective.

**PROGNOSIS:**

Untreated staphylococcal septicemia is associated with a mortality rate of ≥80%.

**PREVENTION:**

Staphylococcal infection is transmitted primarily by direct contact. Strict attention to handwashing is an effective measure. All persons with acute staphylococcal infections should be isolated.

**2. Coagulase-Negative Staphylococci:**

S. epidermidis is just one of the recognized species of coagulase-negative staphylococci (CONS). CONS is now recognized to cause infections in patients with indwelling foreign devices, including intravenous catheters; hemodialysis shunts and grafts, CSF shunts (meningitis), peritoneal dialysis catheters (peritonitis), pacemaker wires and electrodes (local infection), prosthetic cardiac valves (endocarditis), and prosthetic joints (arthritis). CONS are a common cause of nosocomial neonatal infection.
**EPIDEMIOLOGY:**
CONS consist of normal inhabitants of the human skin, throat, mouth, vagina, and urethra. S. epidermidis is the most common and persistent species, representing 65–90% of staphylococci present on the skin and mucous membranes.

**PATHOGENESIS:**
CONS produce an exopolysaccharide protective biofilm, or slime layer, that surrounds the organism and may enhance adhesion to foreign surfaces, resist phagocytosis, and impair penetration of antibiotics.

**Bacteremia:**
CONS, specifically S. epidermidis, are the most common cause of nosocomial bacteremia, usually in association with central vascular catheters. In neonates, CONS bacteremia, with or without a central venous catheter, may be manifested as apnea, bradycardia, temperature instability, abdominal distention, hematochezia, meningitis in the absence of CSF pleocytosis, cutaneous abscesses.

**Endocarditis:**
Infection of native heart valves or the right atrial wall secondary to an infected thrombosis at the end of a central line may produce endocarditis.

**Central Venous Catheter Infection:**
CV Line sepsis is usually manifested as fever and leukocytosis; tenderness and erythema may be present at the exit site or along the subcutaneous tunnel.

**Cerebrospinal Fluid Shunts:**
CONS, introduced at the time of surgery, is the most common pathogen associated with CSF shunt meningitis.

**Urinary Tract Infection:**
S. saprophyticus is 1 of the most common causes of primary urinary tract infections in boys and girls.
**DIAGNOSIS:**

Blood culture is mandatory for recovering the organism.

**TREATMENT:**

Most CONS strains are resistant to methicillin. Vancomycin is the drug of choice for methicillin-resistant strains. The addition of rifampin or gentamicin to vancomycin may increase antimicrobial efficacy. Associated with foreign bodies, the catheter, valve, or shunt must be removed to ensure a cure.

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**3. Streptococcus Pneumoniae (Pneumococcus):**

Streptococcus pneumoniae, or the pneumococcus, frequently colonizes the upper respiratory tract and may cause upper respiratory tract infection (otitis media, sinusitis) or invasive disease (pneumonia, bacteremia, meningitis). S. pneumoniae is a common cause of community-acquired bacterial pneumonia and otitis media.

**ETIOLOGY:**

S. pneumoniae is a gram-positive, lancet-shaped, polysaccharide-encapsulated diplococcus, occurring occasionally as individual cocci or in chains.

**EPIDEMIOLOGY:**

>90% of children 6 mo to 5 yr of age harbors S. pneumoniae in the nasopharynx at some point during that time. Carriage rates are highest in institutional settings and during the winter, and rates are lowest in summer.

S. pneumoniae is the most frequent cause of bacteremia, bacterial pneumonia, and otitis media, and the second most common cause of meningitis in children. Males are more commonly affected than females.

**CLINICAL MANIFESTATIONS:**

Signs and symptoms are related to the anatomic site of disease. Common clinical syndromes include pneumonia, otitis media, sinusitis, occult bacteremia in infants and young children, and sepsis. Bacteremia may be followed by meningitis, osteomyelitis, suppurative arthritis, endocarditis and rarely, brain abscess. Hemolytic-uremic syndrome and disseminated intravascular coagulation also occur as rare complications.
**TREATMENT:**

Pneumococcal meningitis should be treated with vancomycin 60mg/kg/q 6 hr IV, and cefotaxime 300mg/kg/q 8 hr IV or ceftriaxone 100mg/kg/q 12 IV. For invasive infections outside the central nervous system (lobar pneumonia with or without bacteremia), high-dose cefotaxime and ceftriaxone are usually effective.

Higher doses of amoxicillin-clavulanate (80–90 mg amoxicillin/kg/day divided tid PO) have been successful in the treatment of otitis media caused by resistant strains.

**PREVENTION:**

Vaccination by PCV 13, 7 before 2 years of age and PPSV23 after 2 year is effective in reducing infection by more than 90%. Oral penicillin or IM benzathin penicillin is used for prophylaxis in high risk children like asplenia, and sickle cell disease.

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4. **Group A streptococcus (Streptococcus pyogenes):**

Are gram-positive coccoid-shaped bacteria that tend to grow in chains. Humans are the natural reservoir for GAS. These bacteria are highly communicable and can cause disease in normal individuals of all ages except in neonates. It’s a common cause of infections of the upper respiratory tract (pharyngitis) and the skin (impetigo, pyoderma) in children. Rheumatic fever and APSGN are among other serious infections.

**Scarlet fever**

Scarlet fever is an upper respiratory tract infection associated with a characteristic rash. The rash appears within 24–48 hr after onset of symptoms. It often begins around the neck and spreads over the trunk and extremities. It is a diffuse, finely papular, erythematous eruption producing a bright red discoloration of the skin, which blanches on pressure. It is often more intense along the creases of the elbows, axillae, and groin. The skin has a goose-pimple appearance and feels rough. The face is usually spared, although the cheeks may be erythematous with pallor around the mouth. After 3–4 days, the rash begins to fade and is followed by desquamation, sheetlike desquamation may occur around the free margins of the fingernails, the palms, and the soles. The tongue is usually coated and the papillae
are swollen. After desquamation, the reddened papillae are prominent, giving the tongue a strawberry appearance.

Milder form with equivocal pharyngeal findings can be confused with viral exanthsms, Kawasaki disease, and drug eruptions. Staphylococcal infections are occasionally associated with a scarlatiniform rash.

**Impetigo**

Impetigo (or pyoderma) classified into 2 clinical forms: bullous and nonbullous. **Nonbullous impetigo** is the more common form and is a superficial infection of the skin that appears first as a discrete papulovesicular lesion surrounded by a localized area of redness. The vesicles rapidly become purulent and covered with a thick, confluent, amber-colored crust and are more common on the face and extremities. Regional lymphadenitis is common.

**Bullous impetigo** is less common and occurs most often in neonates and young infants. It is characterized by flaccid, transparent bullae usually <3 cm in diameter on previously untraumatized skin. The usual distribution involves the face, buttocks, trunk, and perineum.

**Erysipelas**

Is a rare acute GAS infection involving the deeper layers of the skin and the underlying connective tissue. The skin in the affected area is swollen, red, and very tender.

**DIAGNOSIS:**

Culture of a throat swab is the gold standard of diagnosis. Rapid antigen detection tests have been developed for the identification of GAS with high sensitivity.

**TREATMENT:**

Antibiotic therapy for patients with GAS pharyngitis can prevent acute rheumatic fever, shorten the clinical course of the illness, reduce transmission of the infection to others, and prevent suppurative complications. Treatment with oral penicillin V (250-500 mg/dose bid–tid for 10 days is recommended. Erythromycin, clindamycin and macrolides are alternative choices.
5. Group B streptococcus (Streptococcus agalactiae):

GBS is a major pathogen in neonates, its facultative anaerobic gram-positive cocci that form chains or diplococcic. Two patterns of disease are seen: early-onset disease, which presents at <7 days of age, and late-onset disease, which presents at 7 days of age or later.

CLINICAL FEATURES:

Early-onset neonatal GBS disease presents is often associated with maternal obstetric complications, including chorioamnionitis, prolonged rupture of membranes, and premature labor. Infants appear ill within the 1st 24 hr of birth. The most common manifestations of early-onset GBS disease are sepsis (50%), pneumonia (30%), and meningitis (15%). Nonspecific signs such as hypothermia or fever, irritability, lethargy, apnea, and bradycardia may be present. Respiratory symptoms are prominent like cyanosis, apnea, tachypnea, grunting, flaring, and retractions. Clinically and radiographically, pneumonia associated with early-onset GBS disease is difficult to distinguish from respiratory distress syndrome. Patients with meningitis often present with nonspecific findings.

Late-onset neonatal GBS disease commonly manifests as bacteremia (45–60%) and meningitis (25–35%). Focal infections involving bone and joints, skin and soft tissue, the urinary tract, or lungs have been reported in approximately 20% of patients. Invasive GBS disease in children beyond early infancy is uncommon.

DIAGNOSIS:

The diagnosis is established by isolation and identification of the organism from a normally sterile site, such as blood, urine, or cerebrospinal fluid (CSF).

TREATMENT:

Penicillin G is the treatment of choice. Initial empiric therapy of neonatal sepsis should include ampicillin and an aminoglycoside (or cefotaxime), high doses of penicillin (450,000-500,000 U/kg/day) or ampicillin (300–400 mg/kg/day) are usually needed.

According to current recommendations, vaginorectal GBS screening cultures should be performed for all pregnant women at 35–37 wk gestation. Any woman with a positive prenatal screening culture, GBS bacteriuria during pregnancy, or a
previous infant with invasive GBS disease should receive intrapartum antibiotics. Women whose culture status is unknown (culture not done, incomplete, or results unknown) and who deliver prematurely (<37 wk gestation) or experience prolonged rupture of membranes (≥18 hr) or intrapartum fever (≥38.0°C) should also receive intrapartum chemoprophylaxis.

6. **Listeria monocytogenes:**

Listerias are facultatively anaerobic, non-spore-forming, motile, gram-positive bacilli. In the pediatric population, perinatal infections predominate and occur usually secondary to maternal infection or colonization.

**CLINICAL MANIFESTATIONS:**

Two clinical presentations are recognized for neonatal listeriosis: early-onset disease, which is a predominantly septicemic form and late-onset disease, which is a predominantly meningitic form.

**DIAGNOSIS:**

By culture of L. monocytogenes from blood or cerebrospinal fluid.

**TREATMENT:**

ampicillin (100–200 mg/kg/day divided every 6 hr IV; 200–400 mg/kg/day divided every 6 hr IV if meningitis is present) alone or in combination with an aminoglycoside (5.0–7.5 mg/kg/day divided every 8 hr IV).