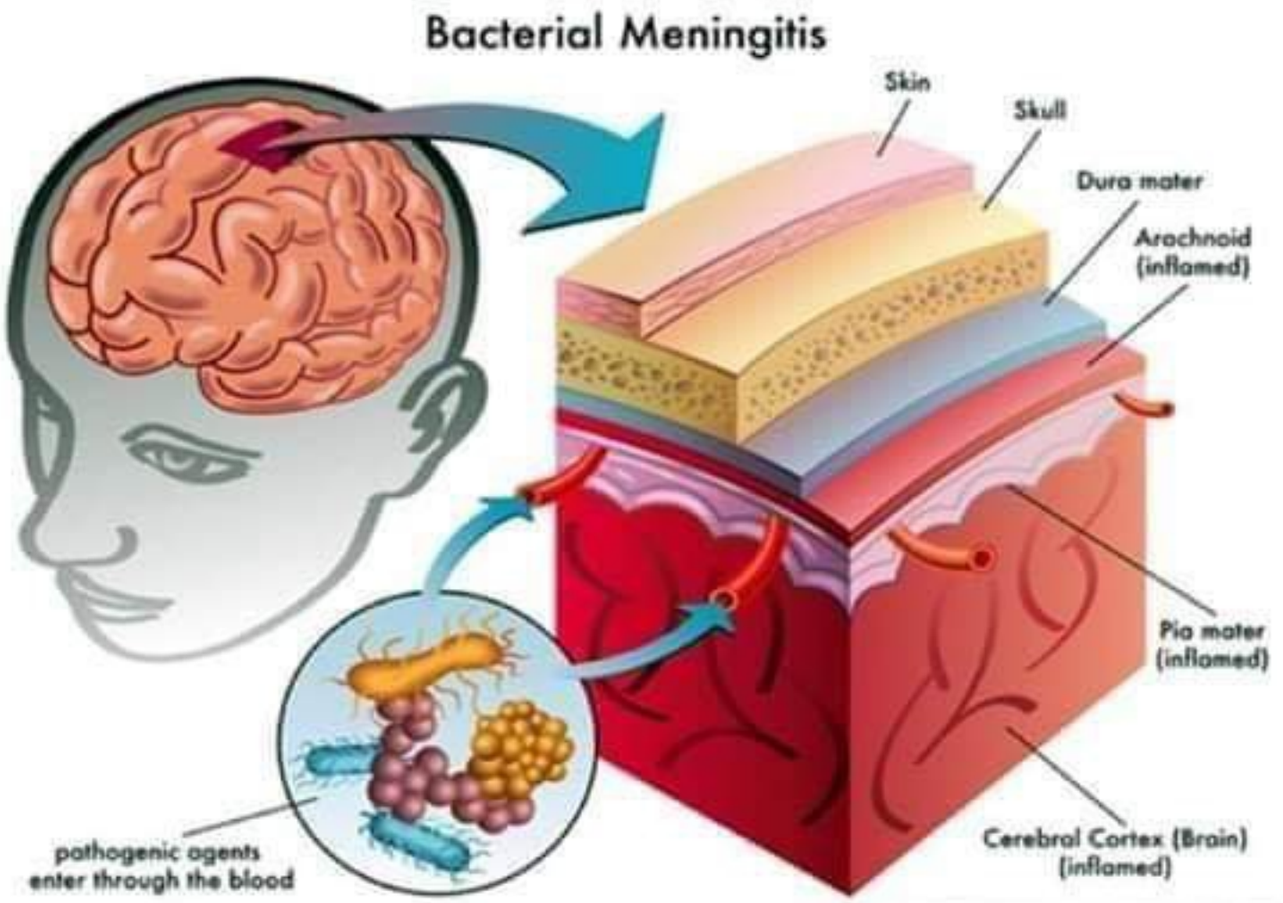
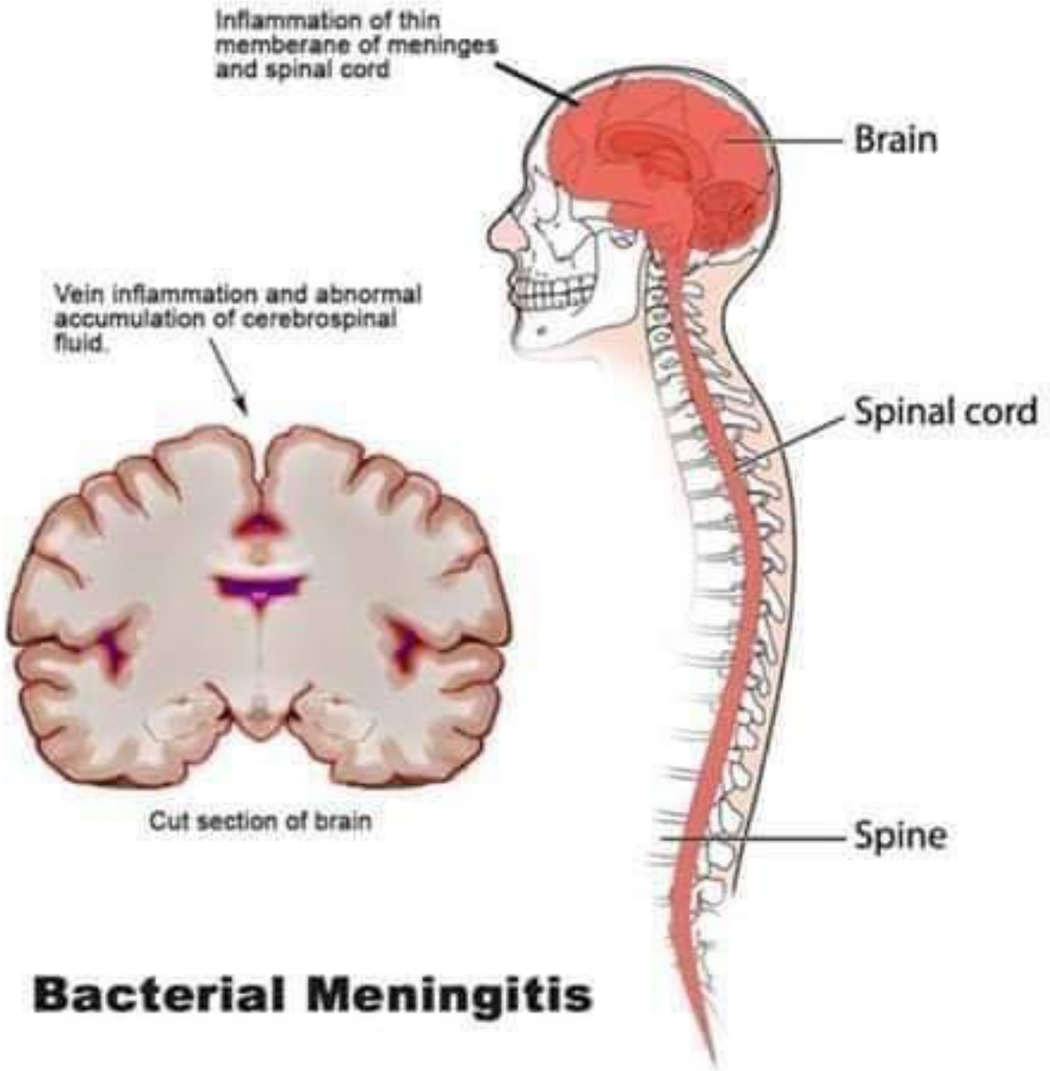
Bacterial Meningitis





What is meningitis?.....

The brain and spinal cord are covered by connective tissue layers collectively called the meninges which form the blood-brain barrier.

1-the **pia mater** (closest to the CNS)

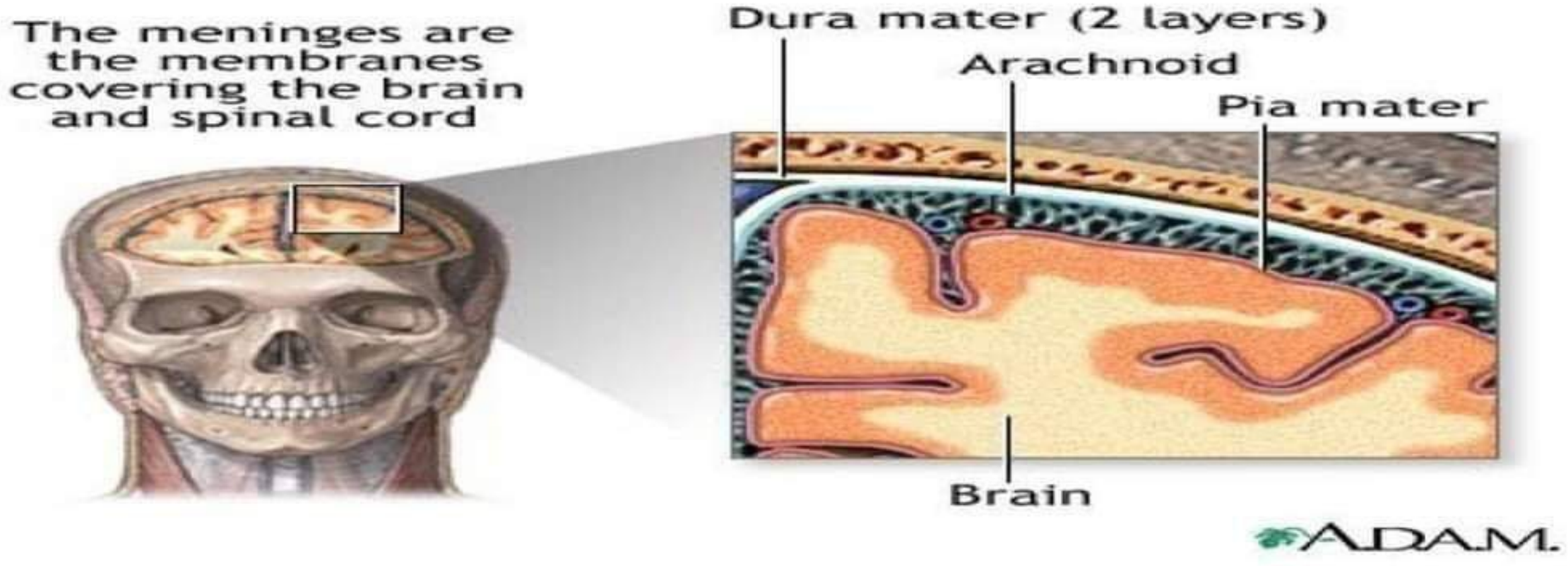
2-the **arachnoid mater**

3-the **dura mater** (farthest from the CNS).

The meninges contain cerebrospinal fluid (CSF).

Meningitis is an inflammation of the meninges, which, if severe, may become encephalitis, an inflammation of the brain.

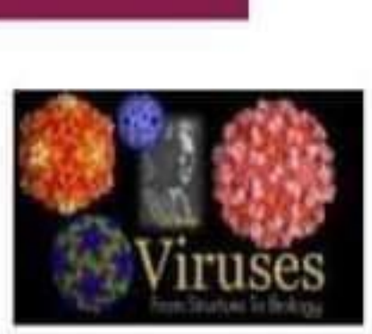
In Meningitis Meninges are infected and Inflamed



Causes of Meningitis

-**Bacterial Infections**

-Viral Infections



-Fungal Infections

(Cryptococcus neoformans
Coccidiodes immitus)

-Inflammatory diseases

(SLE)

Cancer

-Trauma to head or spine.

Introduction

- **Bacterial meningitis is an inflammation of the leptomeninges, usually causing by bacterial infection.**
- **Bacterial meningitis may present acutely (symptoms evolving rapidly over 1-24 hours), sub acutely (symptoms evolving over 1-7days), or chronically (symptoms evolving over more than 1 week).**

Epidemiology

- **Annual incidence in the developed countries is approximately 5-10 per 100000.**
- **30000 infants and children develop bacterial meningitis in United States each year.**
- **Approximately 90 per cent of cases occur in children during the first 5 years of life.**

Epidemiology

- **Cases under age 2 years account for almost 75% of all cases and incidence is the highest in early childhood at age 6-12 months than in any other period of life.**
- **There are significant difference in the incidence of bacterial meningitis by season.**

Bacterial meningitis.....

Etiological Agents:

- **Pneumococcal, *Streptococcus pneumoniae (38%)***
- **Meningococcal, *Neisseria meningitides (14%)***
- ***Haemophilus influenza (4%)***
- Staphylococcal, *Staphylococcus aureus (5%)*
- Tuberculosis, *Mycobacterium tuberculosis*

8

Etiology differs ....

- **Causative organisms vary with patient age, with three bacteria accounting for over three-quarters of all cases:**
  - **Neisseria meningitidis (meningococcus)**
  - **Haemophilus influenza (if very young and unvaccinated)**
  - **Streptococcus pneumoniae (pneumococcus)**

Other Bacterial Etiologies

- **Other organisms**
  - –Neonates and infants at age 2-3 months
    - Escherichia coli
    - B-hemolytic streptococci
    - Staphylococcus aureus
    - Staphylococcus epidermidis
    - Listeria Monocytogenes

Etiology in ....

– Elderly and immunocompromised

- Listeria Monocytogenes
- Gram negative bacteria

– Hospital-acquired infections

- Klebsiella
- Escherichia coli
- Pseudomonas
- Staphylococcus aureus

Etiology

- **The most common organisms**
  - **Neonates and infants under the age of 2months**
    - **Escherichia coli**
    - **Pseudomonas**
    - **Group B Streptococcus**
    - **Staphylococcus aureus**

Etiology

- **Children over 2 months**
  - **Haemophilus influenza type b**
  - **Neisseria meningitides**
  - **Streptococcus pneumoniae**
- **Children over 12 years**
  - **Neisseria meningitides**
  - **Streptococcus pneumoniae**

Routes of Infection

- **Major routes of leptomeninges infection**
  - **Bacteria are mainly from blood.**
  - **Uncommonly, meningitis occurs by direct extension from nearly focus (mastoiditis, sinusitis) or by direct invasion (dermoid sinus tract, head trauma, meningo-myelocele).**

Pathogenesis

- **Susceptibility of bacterial infection on CNS in the children**
  - **Immaturity of immune systems**
- **Nonspecific immune**
  - **Insufficient barrier (Blood-brain barrier)**
  - **Insufficient complement activity**
  - **Insufficient chemo taxis of neutrophils**
  - **Insufficient function of monocyte-macrophage system**
  - **Blood levels of diminished interferon (INF) -γand interleukin -8 (IL-8)**

Pathogenesis

- **Susceptibility of bacterial infection on CNS in the children**
  - **Specific immune**
    - **Immaturity of both the cellular and Humoral immune systems**
      - **Insufficient antibody-mediated protection**
      - **Diminished immunologic response**
  - **Bacterial virulence**

Pathogenesis

- **A offending bacterium from blood invades the leptomeninges.**
- **Bacterial toxics and Inflammatory mediators are released.**
  - **Bacterial toxics**
    - **Lipopolysaccharide, LPS**
    - **Teichoic acid**
    - **Peptidoglycan**
  - **Inflammatory mediators**
    - **Tumor necrosis factor, TNF**
    - **Interleukin-1, IL-1**
    - **Prostaglandin E2, PGE2**

Pathogenesis

- **Bacterial toxics and inflammatory mediators cause Suppurative inflammation.**

– Inflammatory infiltration

– Vascular permeability alter

– Tissue edema

– Blood-brain barrier destroy

– Thrombosis

Pathology

- **Diffuse bacterial infections involve the leptomeninges, arachnoid membrane and superficial cortical structures, and brain parenchyma is also inflamed.**
- **Meningeal exudate of varying thickness is found.**
- **There is purulent material around veins and venous sinuses, over the convexity of the brain, in the depths of the sulci, within the basal cisterns, and around the cerebellum, and spinal cord may be encased in pus.**
- **Ventriculitis (purulent material within the ventricles) has been observed repeatedly in children who have died of their disease.**

Pathology

- Invasion of the ventricular wall with perivascular collections of purulent material, loss of ependymal lining, and subependymal gliosis may be noted.
- Subdural empyema may occur.
- Hydrocephalus is an common complication of meningitis.
  - Obstructive hydrocephalus
  - Communicating hydrocephalus

Pathology

- Blood vessel walls may infiltrated by inflammatory cells.
  - Endothelial cell injury
  - Vessel stenosis
  - Secondary ischemia and infarction

- Ventricle dilatation which ensues may be associated with necrosis of cerebral tissue due to the inflammatory process itself or to occlusion of cerebral veins or arteries.

Pathology

- **Inflammatory process may result in cerebral edema and damage of the cerebral cortex.**
  - **Conscious disturbance**
  - **Convulsion**
  - **Motor disturbance**
  - **Sensory disturbance**
- **Meningeal irritation sign is found because the spinal nerve root is irritated.**
- **Cranial nerve may be damaged**

Symptoms of Meningitis and Septicemia

Meningitis and meningococcal septicemia may not always be easy to detect, in early stages the symptoms can be similar to flu. They may develop over one or two days, but sometimes develop in a matter of hours

It is important to remember that symptoms do not appear in any particular order and some may not appear at all.

Fever/vomiting

Severe headache

Stiff neck

Dislike of bright lights

Very sleepy/vacant/ difficult to wake

Confused/ delirious

Rash

Seizures

Clinical manifestation

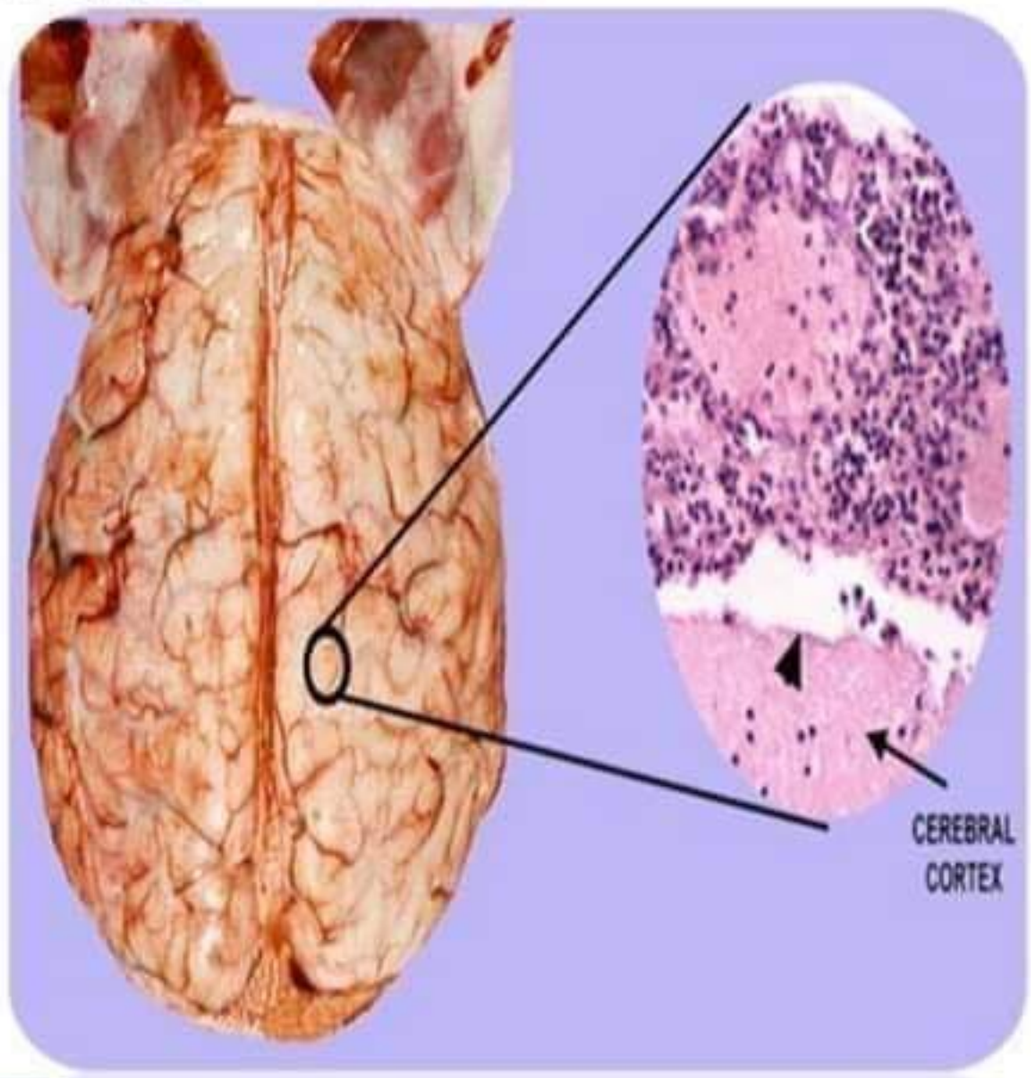
- **Bacterial meningitis may present acutely (symptoms evolving rapidly over 1-24 hours) in most cases.**
- **Symptoms and signs of upper respiratory or gastrointestinal infection are found before several days when the clinical manifestations of bacterial meningitis happen.**
- **Some patients may access suddenly with shock and DIC.**

Clinical manifestation

- **Toxic symptom all over the body**
  - **Hyperpyrexia**
  - **Headache**
  - **Photophobia**
  - **Painful eye movement**
  - **Fatigued and weak**
  - **Malaise, myalgia, anorexia,**
  - **Vomiting, diarrhea and abdominal pa**
  - **Cutaneous rash**
  - **Petechiae, purpura**

Clinical manifestation

- **Clinical manifestation of CNS**
  - **Increased intracranial pressure**
    - **Headache**
    - **Projectile vomiting**
    - **Hypertension**
    - **Bradycardia**
    - **Bulging fontanel**
    - **Cranial sutures diastasis**
    - **Coma**
    - **DE cerebrate rigidity**
    - **Cerebral hernia**

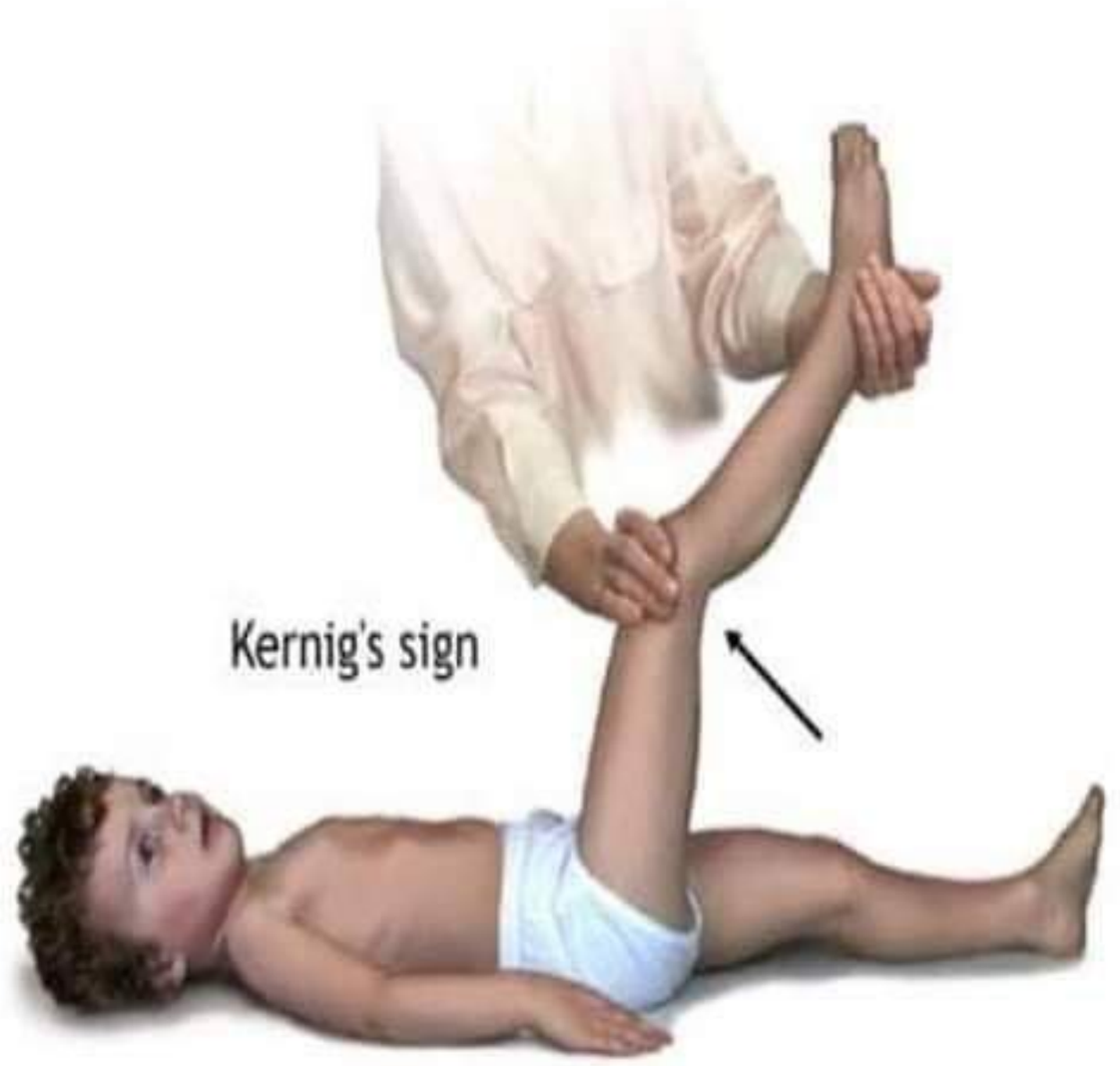


Clinical manifestation

- **Clinical manifestation of CNS**
  - **Meningeal irritation sign**
    - **Neck stiffness**
    - **Positive Kernig's sign**
    - **Positive Brudzinski's sign**

Kernig's sign.

One of the physically demonstrable symptoms of meningitis is Kernig's sign. Severe stiffness of the hamstrings causes an inability to straighten the leg when the hip is flexed to 90 degrees.



Brudzinski's sign

Another physically demonstrable symptoms of meningitis is Brudzinski's sign. Severe neck stiffness causes a patient's hips and knees to flex when the neck is flexed.

Clinical manifestation

- **Clinical manifestation of CNS**
  - **Seizures**
    - **Seizures occur in about 20%-30% of children with bacterial meningitis.**
    - **Seizures is often found in Haemophilus influenza and pneumococcal infection.**
    - **Seizures is correlative with the inflammation of brain parenchyma, cerebral infarction and electrolyte disturbances.**

Clinical manifestation

- **Clinical manifestation of CNS**
  - **Conscious disturbance**
    - **Drowsiness**
    - **Clouding of consciousness**
    - **Coma**
    - **Psychiatric symptom**
      - **Irritation**
      - **Dysphoria**
      - **dullness**

Clinical manifestation

- **Clinical manifestation of CNS**
  - **Meningeal irritation sign**
    - **Neck stiffness**
    - **Positive Kernig's sign**
    - **Positive Brudzinski's sign**

Clinical manifestation

- **Clinical manifestation of CNS**
  - **Transient or permanent paralysis of cranial nerves and limbs may be noted.**
  - **Deafness or disturbances in vestibular function are relatively common.**
  - **Involvement of the optic nerve, with blindness, is rare.**
  - **Paralysis of the 6th cranial nerve, usually transient, is noted frequently early in the course.**

Clinical manifestation

- **Symptom and signs of the infant under the age of 3 months**
  - **In some children, particularly young infants under the age of 3 months, symptom and signs of meningeal inflammation may be minimal.**
  - **Fever is generally present, but its absence or hypothermia in a infant with meningeal inflammation is common.**
  - **Only irritability, restlessness, dullness, vomiting, poor feeding, cyanosis, dyspnea, jaundice, seizures, shock and coma may be noted.**
  - **Bulging fontanel may be found, but there is not meningeal irritation sign.**

Skin rashes

- Is due to small skin bleed
- All parts of the body are affected
- The rashes do not fade under pressure
- Pathogenesis:

a. Septicemia
b. wide spread endothelial damage
c. activation of coagulation
d. thrombosis and platelets aggregation
e. reduction of platelets (consumption)
f. BLEEDING 1.skin rashes
2.adrenal hemorrhage

Adrenal hemorrhage is called Waterhouse-Friderichsen Syndrome.It cause acute adrenal insufficiency and is uaually fatal

‘Glass Test’

A rash that does not fade under pressure will still be visible when the side of a clear drinking glass is pressed firmly against the skin.

If someone is ill or obviously getting worse, do not wait for a rash. It may appear late or not at all.

A fever with a rash that does not fade under pressure is a medical emergency.

The glass test

Press the side of a glass firmly against the rash so you can see if it fades under pressure. If it doesn't fade, get medical help immediately. If you are feeling very ill, get help anyway, even if the rash fades or doesn't appear at all.

Complications

- **Subdural effusion**
  - **Subdural effusions occur in about 10%-30% of children with bacterial meningitis.**
  - **Subdural effusions appear to be more frequent in the children under the age of 1 year and in Haemophilus influenza and pneumococcal infection.**
  - **Clinical manifestations are enlargement in head circumference, bulging fontanel, cranial sutures diastasis and abnormal trans illumination of the skull.**
  - **Subdural effusions may be diagnosed by the examination of CT or MRI and subdural pricking.**

Complication

- **Ependymitis**
  - Neonate or infant with meningitis
  - Gram-negative bacterial infection
  - Clinical manifestation
- Persistent hyperpyrexia,
- Frequent convulsion
- Acute respiratory failure
- Bulging fontanel
- Ventriculomegaly (CT)
- Cerebrospinal fluid by ventricular puncture
  - WBC>50×10^9/L
  - Glucose<1.6mmol/L
  - Protein>o.4g/L

Complications

- **Cerebellar hyponatremia**
  - Syndrem of inappropriate secretion of antidiuretic hormone (SIADH)
    - Hyponatremia
    - Degrade of blood osmotic pressure
    - Aggravated cerebral edema
    - Frequent convulsion
    - Aggravated conscious disturbance

Complication

- **Hydrocephalus**
  - Increased intracranial pressure
  - Bulging fontanel
  - Augmentation of head circumference
  - Brain function disorder
- **Other complication**
  - Deafness or blindness
  - Epilepsy
  - Paralysis
  - Mental retardation
  - Behavior disorder

Meningococcal Meningitis

- Less common bacterial causes of Meningitis, such as Staphylococci, enteric bacteria, group B streptococci and Listeria, occur in sub-populations like the immunocompromised, neonates, or head trauma patients.
- Patients with Meningococcal Meningitis present with sudden onset of fever, intense headache, nausea, vomiting, stiff neck and, frequently, a petechial rash with pink macules or, very rarely, vesicles. Delirium and coma often appear.
- Case fatality rate is between 5% and 15%.

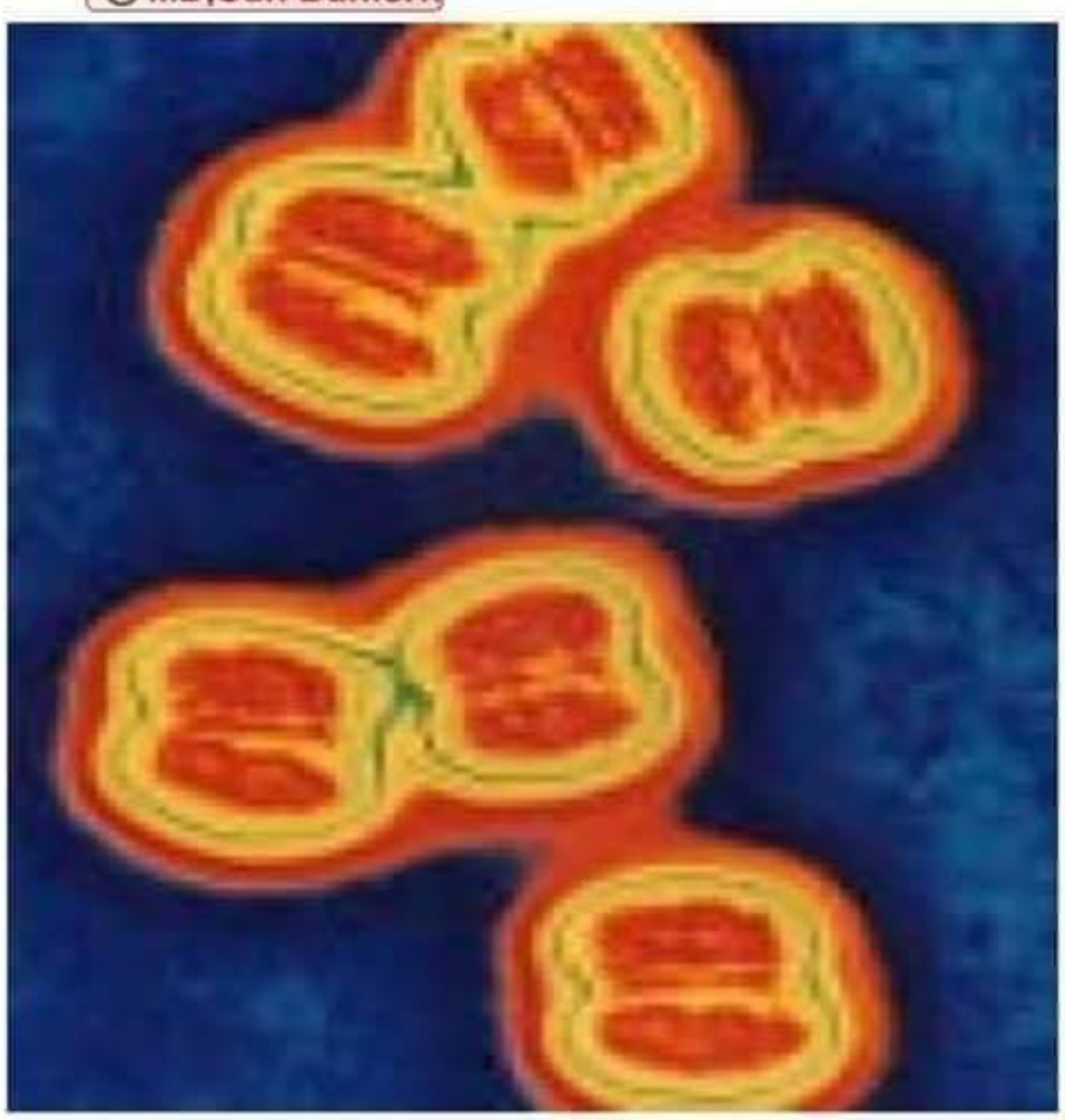
Laboratory Findings

- **Peripheral hemogram**
  - **Total WBC count**
    - **20×10^9/L ~ 40×10^9/L WBC**
    - **Decreased WBC count at severe infection**
  - **Leukocyte differential count**
    - **80% ~ 90% Neutrophils**

MD.Sun Bunlorn

Diagnosis

- Isolation of the organism from CSF or blood.



Characteristics of CSF on common disease in CNS

	PM	TM	VW	FM	TE
Pressure	↑	↑	- or↑	↑↑	↑
Cloudiness	+ + or + + +	+	-	±	-
Pandy T	+ + or + + +	+ or + + +	±or + +	+ or + + +	-
WBC	↑↑↑ N	↑ L	- or↑L	↑ M	-
Protein	↑↑↑	↑↑↑	- or↑	↑↑	- or ±
Glucos	↓ ↓ ↓	↓ ↓	-	↓ ↓	-
Chloridate	- or ↓	↓↓↓	-	↓ ↓	-
Cultivation	**Bacterium**	**TB**	**Viral**	**Fungus**	

Laboratory Findings

- **Rout examination of cerebrospinal fluid (CSF)**
  - **Increased pressure of cerebrospinal fluid**
  - **Cloudiness**
  - **Evident Increased total WBC count (>1000×10⁹/L)**
  - **Evident Increased neutrophils in leukocyte differential count**
  - **Evident Decreased glucose (<1.1mmol/l)**
  - **Evident Increased protein level**
  - **Decreased or normal chlorinate**
  - **CSF film preparation or cultivation : positive result**

Laboratory Findings

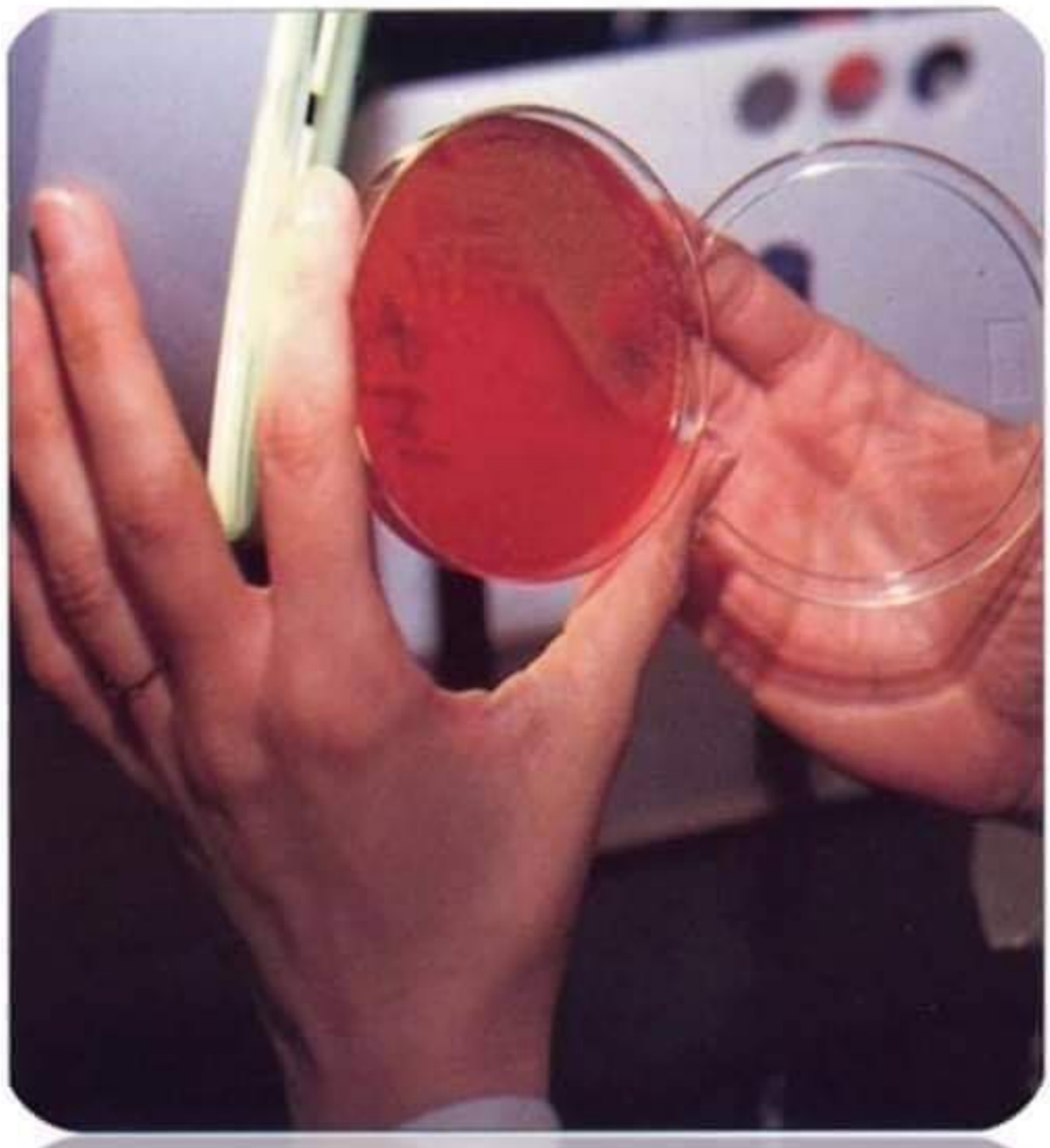
- **Especial examination of CSF**
  - **Specific bacterial antigen test**
    - **Countercurrent immuno-electrophoresis**
    - **Latex agglutination**
    - **Immunoflorescent test**
      - **Neisseria meningitides (meningococcus)**
      - **Haemophilus influenza**
      - **Streptococcus pneumoniae (pneumococcus)**
      - **Group B streptococcus**

Laboratory Findings

- **Especial examination of CSF**
  - **Other test of CSF**
    - **LDH**
    - **Lactic acid**
    - **CRP**
    - **TNF and Ig**
    - **Neuron specific enolase (NSE)**

Laboratory Findings

- **Other bacterial test**
  - **Blood cultivation**
  - **Film preparation of skin petechiae and purpura**



Diagnosis

- **Diagnostic methods**
  - **A careful evaluation of history**
  - **A careful evaluation of infant's signs and symptoms**
  - **A careful evaluation of information on longitudinal changes in vital signs and laboratory indicators**
    - **Rout examination of cerebrospinal fluid (CSF)**

Differential diagnosis

- Clinical manifestation of bacterial meningitis is similar to clinical manifestation of viral, tuberculosis , fungal and aseptic meningitis.
- Differentiation of these disorders depends upon careful examination of cerebrospinal fluid obtained by lumbar puncture and additional immunologic, roentgenographic, and isotope studies.

Treatment

Antibiotic Therapy

- Therapeutic principle
  - Good permeability for Blood-brain barrier
  - Drug combination
  - Intravenous drip
  - Full dosage
  - Full course of treatment

Antibiotic Therapy

- **Selection of antibiotic**
  - **No Certainly Bacterium**
    - **Community-acquired bacterial infection**
    - **Nosocomial infection acquired in a hospital**
    - **Broad-spectrum antibiotic coverage as noted below**
      - **Children under age 3 months**
        - » **Cefotaxime and ampicillin**
        - » **Ceftriaxone and ampicillin (children over age 1months)**
      - **Children over 3 months**
        - » **Cefotaxime or Ceftriaxone or ampicillin and chloramphenicol**

Antibiotic Therapy

- **Certainly Bacterium**
  - **Once the pathogen has been identified and the antibiotic sensitivities determined, the most appropriate drugs should selected.**
    - ***N meningitides :*** **penicillin, - cephalosporin**
    - ***S pneumoniae:*** **penicillin, - cephalosporin, Vancomycin**
    - ***H influenza:*** **ampicillin, cephalosporin**
    - ***S aureus:*** **penicillin, nefcillin, Vancomycin**
    - ***E coli:*** **ampicillin, chloramphenicol, - cephalosporin**

Antibiotic Therapy

- Course of treatment
  - 7 days for meningococcal infection
  - 10 ~ 14 days for H influenza or S pneumoniae infection
  - More than 21 days for S aureus or E coli infection
  - 14 ~ 21 days for other organisms

Treatment

General and Supportive Measures

- Monitor of vital sign
- Correcting metabolic imbalances
  - Supplying sufficient heat quantity
  - Correcting hypoglycemia
  - Correcting metabolic academia
  - Correcting fluids and electrolytes disorder
- Application of cortical hormone
  - Lessening inflammatory reaction
  - Lessening toxic symptom
  - lessening cerebral edema

General and Supportive Measures

- Treatment of hyperpyrexia and seizures
  - Pyretolysis by physiotherapy and/or drug
  - Convulsive management
    - Diazepam
    - Phenobarbital
  - Subhibernation therapy
- Treatment of increased intracranial pressure
  - Dehydration therapy
    - 20%Mannitol 5ml/kg vi q6h
    - Lasix 1-2mg/kg vi

General and Supportive Measures

- Treatment of septic shock and DIC
  - Volume expansion
  - Dopamine
  - Corticosteroids
  - Heparin
  - Fresh frozen plasma
  - Platelet transfusions

Treatment

Complication Measures

- **Subdural effusions**
  - **Subdural pricking**
    - **Draw-off effusions on one side is 20-30ml/time.**
    - **Once daily or every other day is requested.**
    - **Time cell of pricking may be prolonged after 2 weeks.**
- **Ependymitis**
  - **Ventricular puncture — drainage**
    - **Pressure in ventricle be depressed.**
    - **Ventricular puncture may give ventricle an injection of antibiotic.**

Complication Measures

- **Hydrocephalus**
  - **Operative treatment**
    - **Adhesiolysis**
    - **By-pass operation of cerebrospinal fluid**
    - **Dilatation of aqueduct**
- **SIADH (Cerebral hyponatremia)**
  - **Restriction of fluid**
  - **supplement of serum sodium**
  - **diuretic**

Prognosis

- Appropriate antibiotic therapy reduces the mortality rate for bacterial meningitis in children, but mortality remain high.
- Overall mortality in the developed countries ranges between 5% and 30%.
- 50 percent of the survivors have some sequelae of the disease.

Prognosis

- Prognosis depends upon many factors:
  - Age
  - Causative organism
  - Number of organisms and bacterial virulence
  - Duration of illness prior to effective antibiotic therapy
  - Presence of disorders that may compromise host response to infection

Aseptic Meningitis

Definition: **A syndrome characterized by acute onset of meningeal symptoms, fever, and cerebrospinal fluid pleocytosis, with bacteriologically sterile cultures.**

Laboratory criteria for diagnosis:

CSF showing ≥ 5 WBC/cu mm

No evidence of bacterial or fungal meningitis.

Case classification

***Confirmed*: a clinically compatible illness diagnosed by a physician as aseptic meningitis, with no laboratory evidence of bacterial or fungal meningitis**

Comment

Aseptic meningitis is a syndrome of multiple etiologies, but most cases are caused by a viral agent

Viral Meningitis

Etiological Agents:

Enteroviruses (Coxsackie's and echovirus): most common.
-Adenovirus
-Arbovirus
-Measles virus
-Herpes Simplex Virus
-Varicella

Reservoirs:

-Humans for Enteroviruses, Adenovirus, Measles, Herpes Simplex, and Varicella
-Natural reservoir for arbovirus birds, rodents etc.

Modes of transmission:

-Primarily person to person and arthopod vectors for Arboviruses

Incubation Period:

-Variable. For enteroviruses 3-6 days, for arboviruses 2-15 days

Treatment: *No specific treatment available*.

Most patients recover completely on their own.

Non Polio Enteroviruses

***Types*:62 different types known:**

-23 Coxsackie A viruses,
-6 Coxsackie B viruses,
-28 echoviruses, and 5 other

How common?

-90% of all viral meningitis is caused by Enteroviruses
-Second only to "common cold" viruses, the rhinoviruses.
-Estimated 10-15 million/ more symptomatic infections/yr in US

Who is at risk? Everyone.

How does infection spread?

Virus present in the respiratory secretions & stool of a patient.

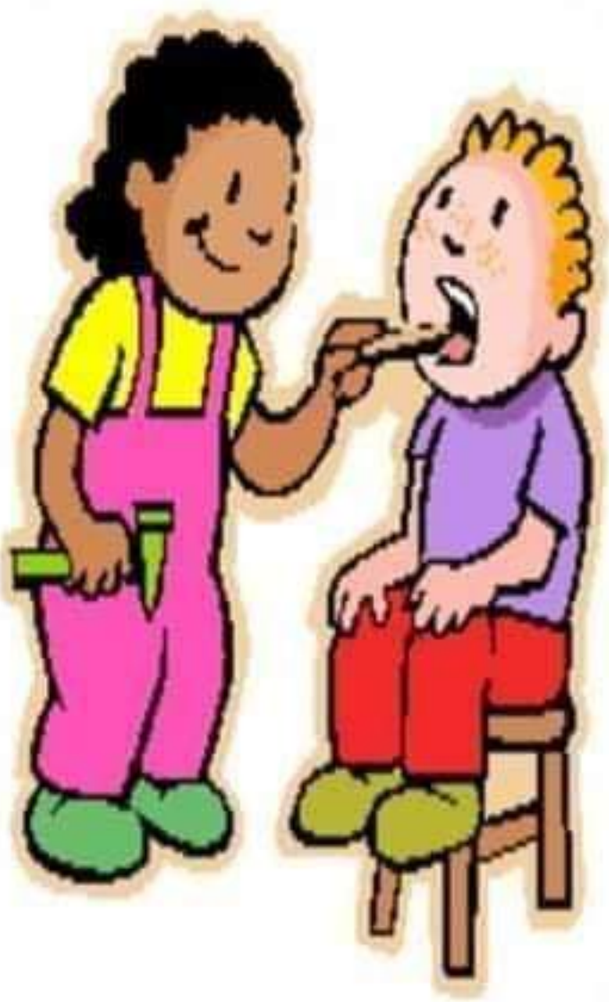
Direct contact with secretions from an infected person.

Parents, teachers, and child care center workers may also become infected by contamination of the hands with stool.

Public Health Importance

Challenges:

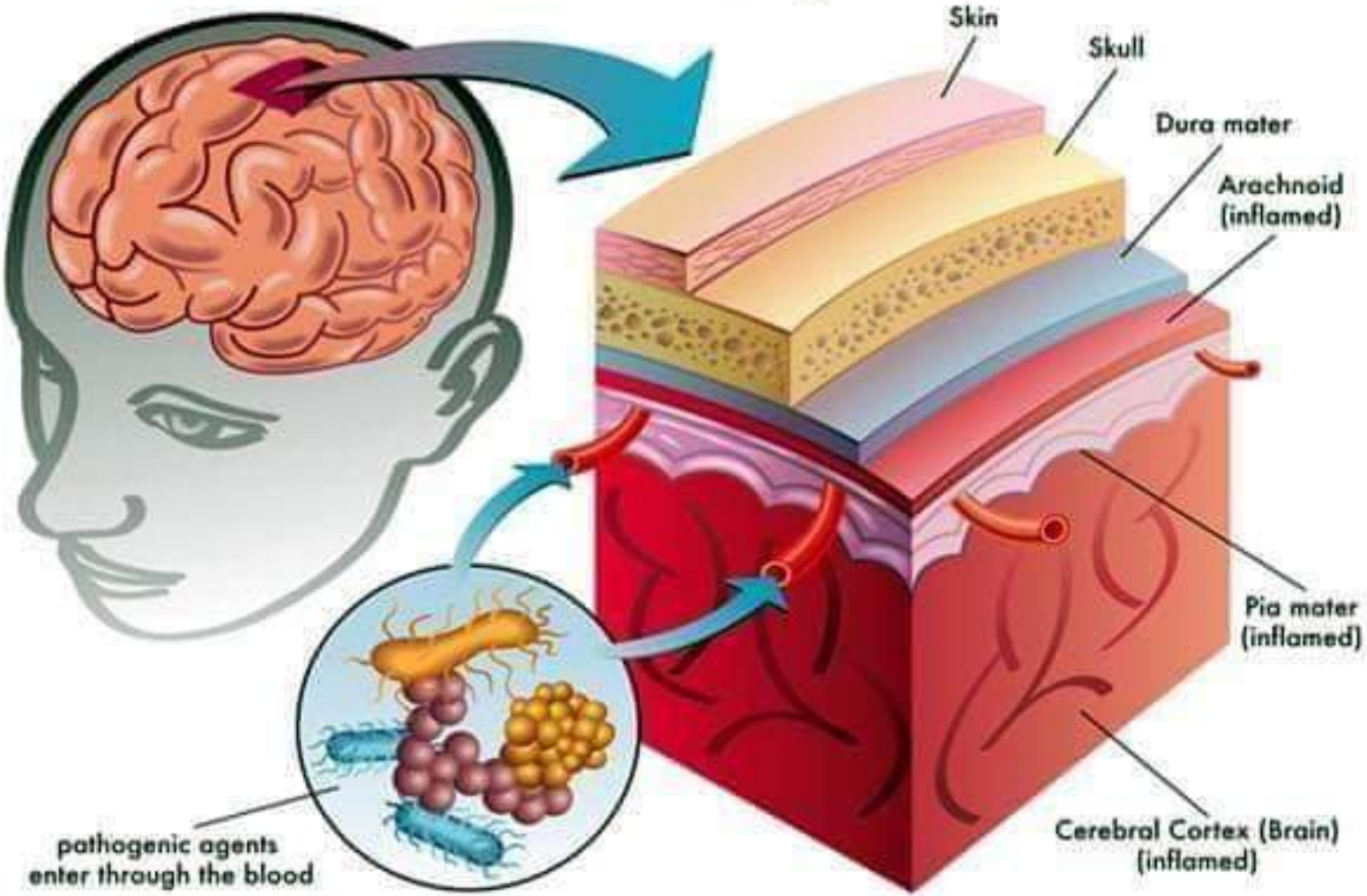
-Educating public
-Timely reporting and records keeping
-Updating information daily.
-Alleviating public anxiety and concerns
-Collaborating with health partners



Opportunities:

-Educating public
-Communication
-Strengthening partnerships

Bacterial Meningitis

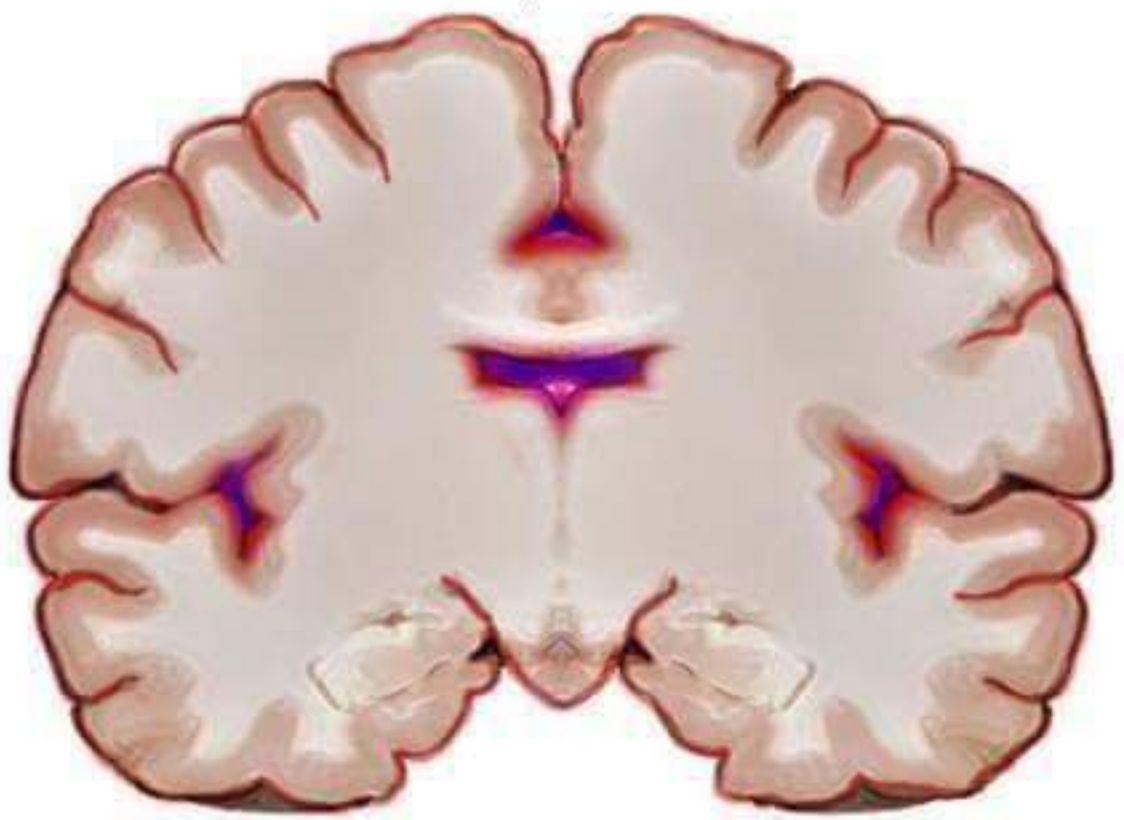


Inflammation of thin memberane of meninges and spinal cord

Brain

Vein inflammation and abnormal accumulation of cerebrospinal fluid.

Spinal cord



Cut section of brain

Spine

Bacterial Meningitis