

# **MENINGITIS**

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# 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).

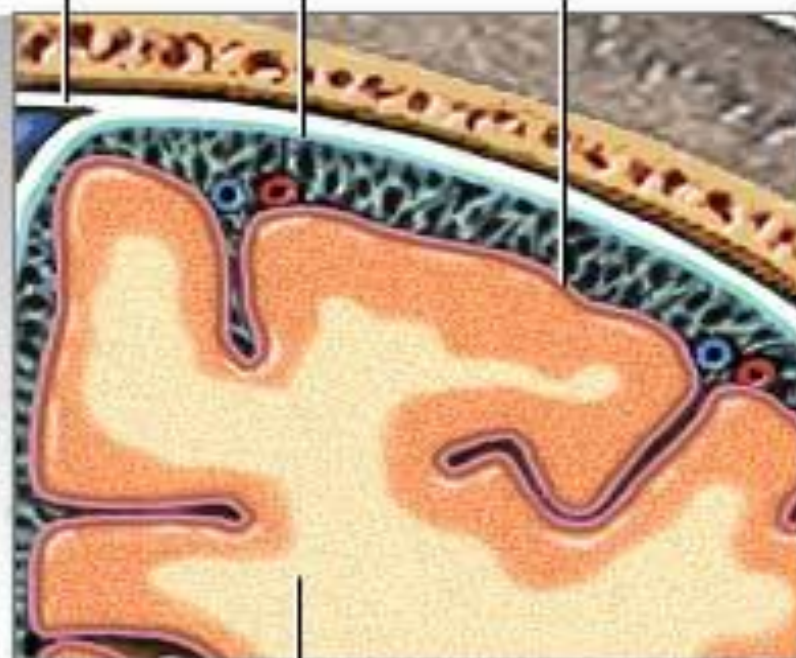
The meninges are the membranes covering the brain and spinal cord



Dura mater (2 layers)

Arachnoid

Pia mater

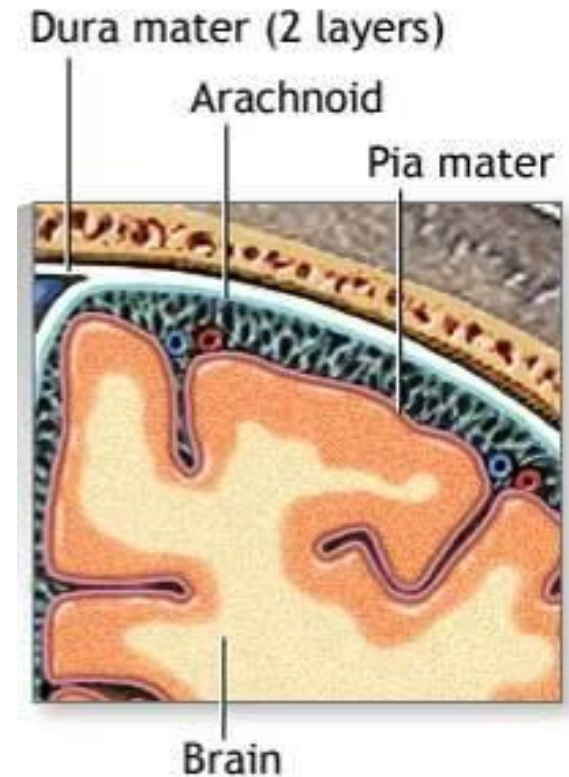


Brain

- Infection of the fluid in the spinal cord and the fluid that surrounds the brain
- Viral or Bacterial
- Etiology is important because of the seriousness of the illness and the treatment needed

# Definitions

- Meningitis – inflammation of the meninges
- Encephalitis – infection of the brain parenchyma
- Meningoencephalitis – inflammation of brain + meninges
- Aseptic meningitis – inflammation of meninges with sterile CSF



# Clinical description

Meningitis is a disease caused by the inflammation of the protective membranes covering the brain and spinal cord known as the meninges. The inflammation is usually caused by an infection of the fluid surrounding the brain and spinal cord. Meningitis is also referred to as spinal meningitis.

# History of Meningitis

- It has been recognized since as early as the 15<sup>th</sup> Century, when Hippocrates taught **“If, in a fever, the neck be turned awry on a sudden, so that the sick can hardly swallow,**
- It was first described as a specific disease entity by **British physician Thomas Willis (1621-1675) and Italian anatomist and pathologist Battista Morgagni (1682-1771)**
- The earliest suspected epidemic in the US occurred in Medfield, MA, in **1806** when on autopsy pus was noted between the patients dura and pia mater (thought to be bacterial meningitis).

# Classification

- 1. acute pyogenic (bacterial) meningitis
- 2. acute aseptic (viral) meningitis
- 3. acute focal suppurative infection (brain abscess, subdural and extradural empyema)
- 4. chronic bacterial infection (tuberculosis).



# Acute pyogenic bacterial meningitis

- Most important
- Can be fatal if untreated
- Organisms:

E.coli ----- neonates

Streptococci B ----- neonates

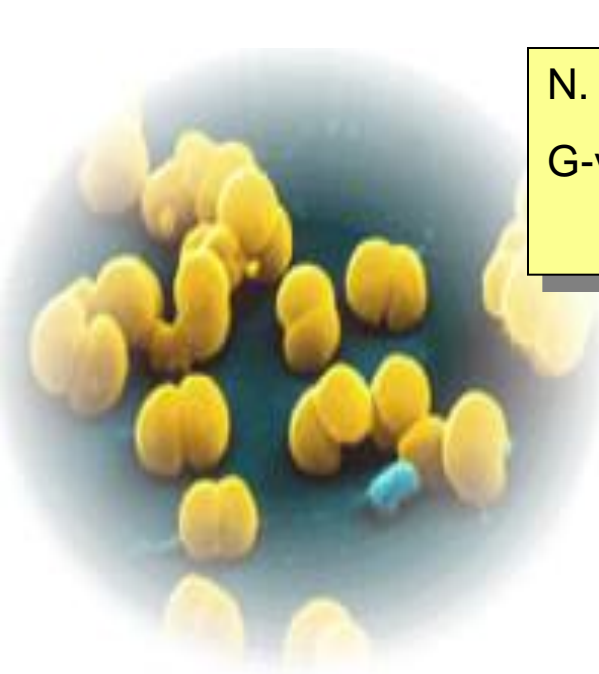
H. influenzae-----adolescents

Neisseria meningitidis----- young adults

Streptococcus pneumonia----- elderly

# Bacterial meningitis

- 3 - 8 month olds at highest risk
- 66% of cases occur in children <5 years old
- Neonates
  - Most caused by Group B *Streptococci*
  - *E coli*, enterococci, *Klebsiella*, *Enterobacter*, *Samonella*,, *Listeria*
- Older infants and children
  - *Neisseria meningitidis*, *S. pneumoniae*, *tuberculosis*, *H. influenzae*

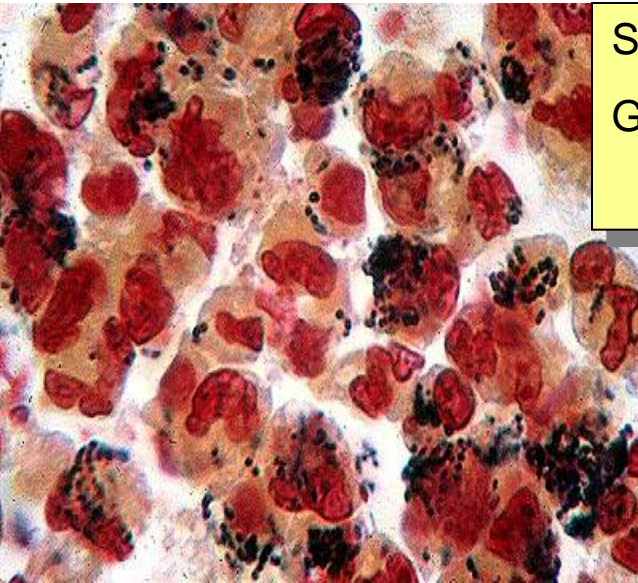


N. meningitidis  
G-ve diplococci



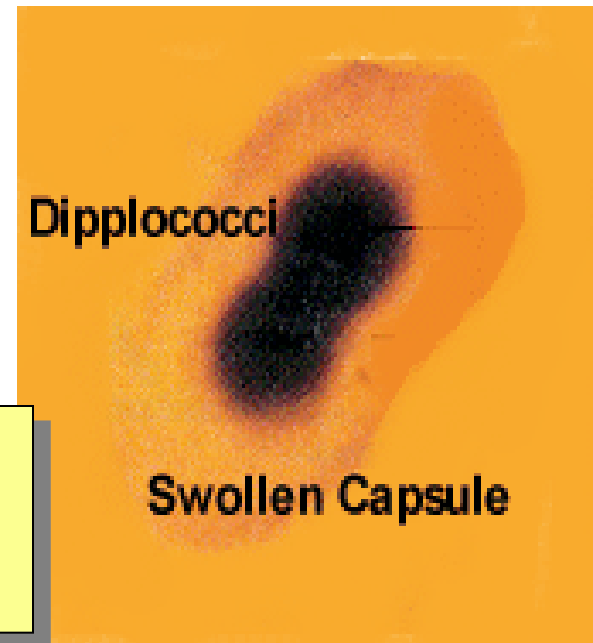
E. coli  
G-ve bacilli

Used with permission of the Natzworth Center,  
New York State Department of Health



Streptococci-GBS  
G+ve cocci

Strep. pneumoniae  
G+ve diplococci



Diplococci

Swollen Capsule

# Bacterial Meningitis - Organisms

- Birth - 4 wks: GBS, E.coli
- 4 - 12 wks: GBS, E.coli, Pneumococcus  
Salmonella, Listeria, H. Influenza
- 3 mths - 3 yrs: Pneumococcus, Meningococcus  
H. Influenza
- 3 yrs+ adult: Pneumococcus, Meningococcus

# **Bacterial Meningitis - Pathogenesis**

- Infection of upper respiratory tract
- Invasion of blood stream (bacteraemia)
- Seeding & inflammation of meninges

# How do people get Bacterial Meningitis?

- Bacteria are spread through direct contact with secretions from the nose or throat of an infected person
- None of the bacteria that cause meningitis are very contagious
- Not spread by casual contact or by simply breathing the same air where the person infected has been

# Signs and Symptoms

- Under Age 2

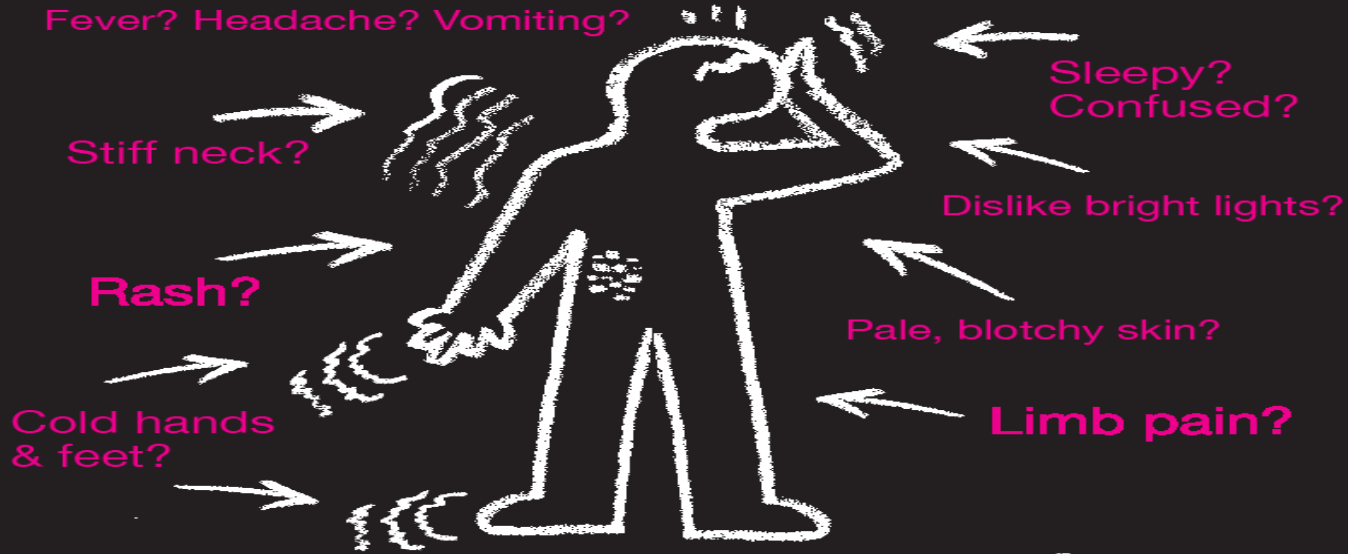
- **Fever**
- **Headache**
- **Stiff neck**
- **Inactivity**
- **Vomiting**
- **Poor feeding**
- **Seizures**
  - ❖ **May be hard to detect in infants**

- Over age 2

- **High fever**
- **Headache**
- **Stiff neck**
- **Nausea and vomiting**
- **Sensitivity to light**
- **Confusion**
- **Sleepiness**
- **Petechiae that spreads rapidly**
- **seizures**

# DON'T IGNORE

## The signs



# Meningitis

**Meningitis can kill in hours**  
**It could happen to anyone**  
**It could happen to you!**

**NHS**

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These are just some of the warning signs. If you are worried for yourself or someone else get medical help immediately. Contact   
For more information visit [www.meningitis.org](http://www.meningitis.org) or [www.meningitis-trust.org](http://www.meningitis-trust.org)



# Symptoms can be the same for Viral and Bacterial

- Fever and chills
- Mental status changes
- Nausea and vomiting
- Sensitivity to light (photophobia)
- Severe headache
- Stiff neck

# Common Symptoms

- Fever
- Headache
- Altered mental status
- Stiff neck
- Photophobia
- Nausea/vomiting

# The difference between Meningitis and Septicaemia

When bacteria cause disease i.e. **meningococcal disease** the body can be affected in different ways:

- **Meningitis** - bacteria enter the blood stream and travel to the meninges and cause inflammation.
- **Septicaemia** - when bacteria are present in the blood stream they can multiply rapidly and release toxins that poison the blood. (The rash associated with meningitis is due to septicaemia.)

Meningitis and septicaemia often occur together.

# Acute Meningococcaemia

- **Neisseria meningitidis**: serotype Grp B commonest
- Endotoxin causes vascular damage vasodilatation, severe shock
- Severe complication:  
**Waterhouse-Friderichsen syndrome**: massive haemorrhage of adrenal glands secondary to sepsis: adrenal crisis-low B.P, shock, DIC, purpura, adreno-cortical insufficiency

# Symptoms for meningitis and meningococcal septicaemia:

## :Babies and Young Children

- High temperature, fever, possibly with cold hands and feet
- Vomiting or refusing feeds
- High pitched moaning, whimpering cry
- Blank, staring expression
- Pale, blotchy complexion
- Stiff neck
- Arched back
- Baby may be floppy, may dislike being handled,
- Difficult to wake or lethargic
- The fontanelle (soft spot on babies heads) may be tense or bulging.

# INFANTS



Fever, possibly with cold hands & feet



Refusing feeds or vomiting



High pitched moaning cry or whimpering



Dislike of being handled or fretful



Neck retraction with arching of back



Blank & staring expression



Child is difficult to wake, lethargic



Pale, blotchy complexion

# Older Children and Adults

- High temperature, fever, possibly with cold hands and feet.
- Vomiting, sometimes diarrhoea.
- Severe headache.
- Joint or muscle pains, sometimes stomach cramps.
- Neck stiffness (unable to touch the chin to the chest)
- Dislike of bright lights.
- Drowsiness.

The patient may be confused or disorientated. Fitting may also be seen.

A rash may develop.

# CHILDREN/ADULTS



Stiff neck



Headache



Fever



Vomiting



Light Sensitivity



Drowsiness or  
confusion



Joint pain



Fitting



# Meningitis: older children



Severe headache



Stiff neck



Dislike of  
bright lights



Fever/vomiting



Drowsy and less  
responsive/  
vacant



Rash (develops  
anywhere on  
body)

# Septicaemia



Rash (develops anywhere on body)



Fever/vomiting



Cold hands and feet/shivering



Rapid breathing (or unusual breathing)



Stomach/joint/muscle pain



Drowsy and less responsive/vacant

- One sign of **meningococcal septicaemia** is a rash that does not fade under pressure (see 'Glass test')
- This rash is caused by **blood leaking under the skin**. It starts anywhere on the body. It can spread quickly to **look like fresh bruises**.
  - This rash is more difficult to see on darker skin. Look on the **paler areas of the skin and under the eyelids**.

## ***'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.

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# 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.**

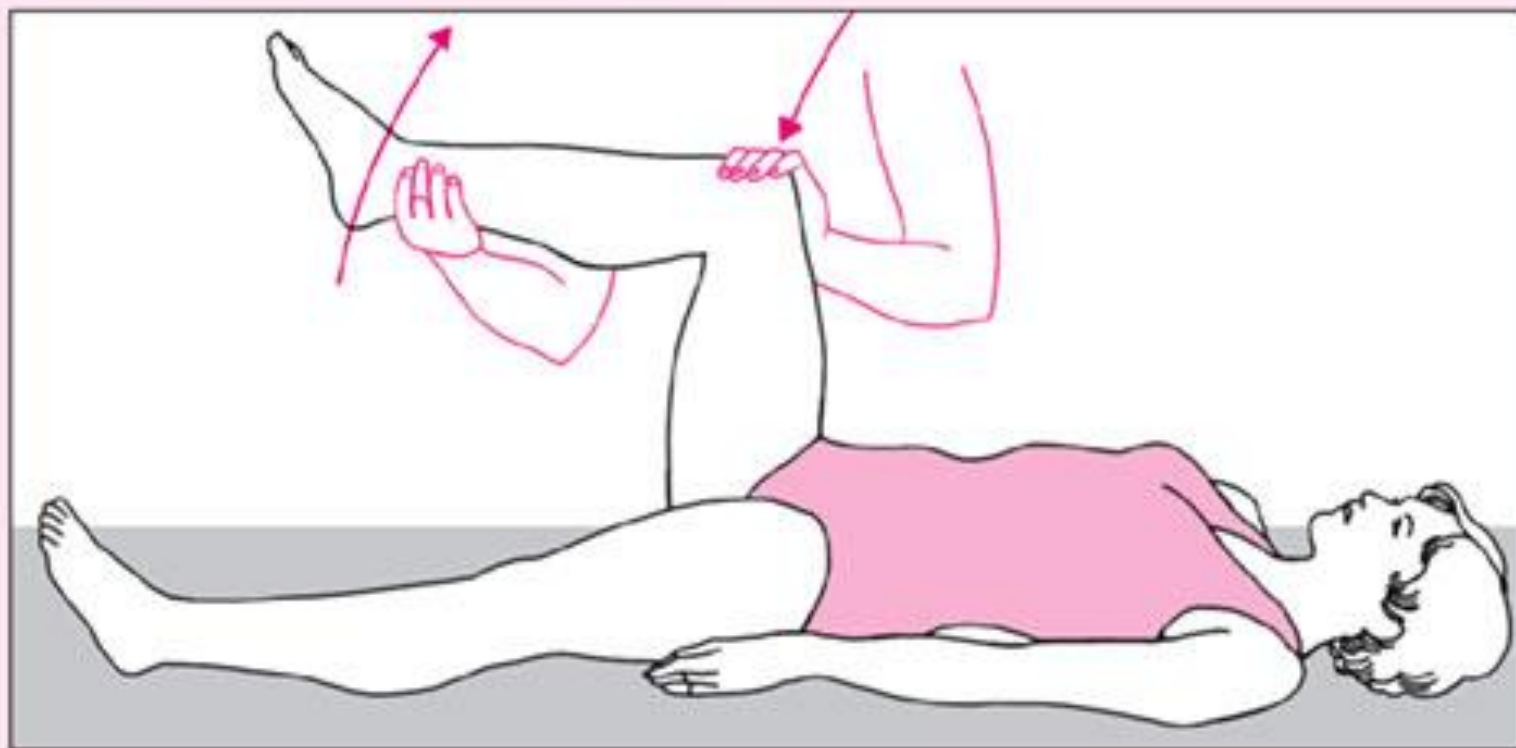


## EXAMINATION TIP



### Eliciting Kernig's sign

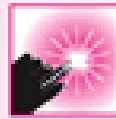
To elicit Kernig's sign, place the patient in a supine position. Flex her leg at the hip and knee, as shown here. Then try to extend the leg while you keep the hip flexed. If the patient experiences pain and possibly spasm in the hamstring muscle and resists further extension, you can assume that meningeal irritation has occurred.



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.

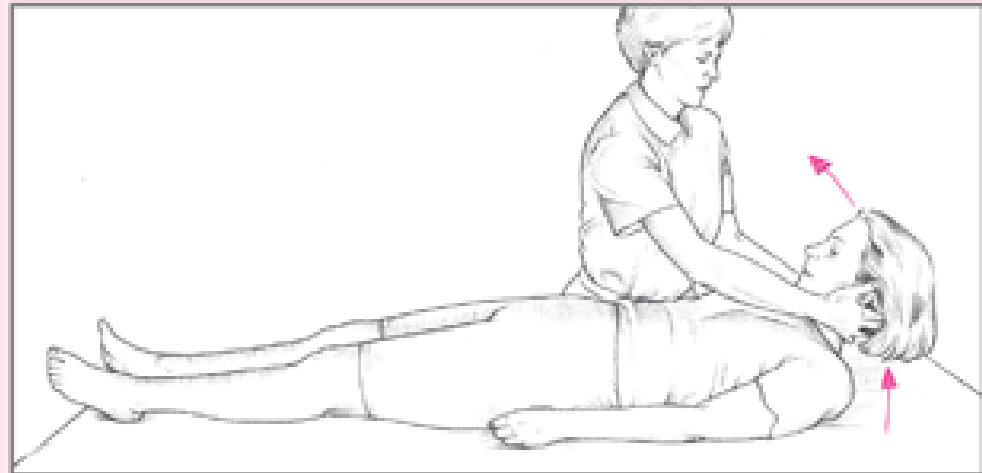




## Testing for Brudzinski's sign

Here's how to test for Brudzinski's sign when you suspect meningeal irritation:

With the patient in a supine position, place your hands behind her neck and lift her head toward her chest (as shown at right).



If your patient has meningeal irritation, she'll flex her hips and knees in response to the passive neck flexion (as shown at right).





## Children and Adults

Meningitis  and Septicaemia  often occur Together



In the early stages, signs and symptoms can be similar to many other more common illnesses, for example flu. Early symptoms can include fever, headache, nausea (feeling sick), vomiting and general tiredness.

The common signs and symptoms of meningitis and septicaemia are shown above. Others can include rapid breathing, diarrhoea and stomach cramps. In babies, check if the soft spot (fontanelle) on the top of the head is tense or bulging.

# Increased intracranial pressure (ICP)

- Papilledema
- Cushing's triad
  - Bradycardia
  - Hypertension
  - Irregular respiration
- ICP monitor (not routine)
- Changes in pupils

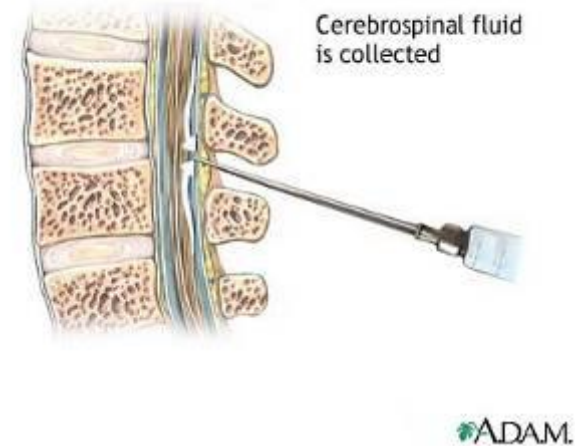


# Diagnosis



LP

# Diagnosis – lumbar puncture



- Contraindications:
  - Respiratory distress (positioning)
  - ↑ ICP reported to increase risk of herniation
  - Cellulitis at area of tap
  - Bleeding disorder

# CSF evaluation

<b>Condition</b>	<b>WBC</b>	<b>Protein (mg/dL)</b>	<b>Glucose (mg/dL)</b>
<b>Normal</b>	<b>&lt;7, lymphs mainly</b>	<b>5-45</b>	<b>&gt;50</b>
<b>Bacterial, acute</b>	<b>100 – 60K PMN's</b>	<b>100-500</b>	<b>Low</b>
<b>TB</b>	<b>10 – 500</b>	<b>100-500</b>	<b>&lt;50</b>
<b>Fungal</b>	<b>25 – 500</b>	<b>25-500</b>	<b>&lt;50</b>
<b>Viral</b>	<b>&lt;1000</b>	<b>50-100</b>	<b>Normal</b>

# Laboratory findings

- +/- Leukocytosis
- Variable CSF Findings

	Glucose		Protein		Total WBC		
	<10	10-45	>500	50-500	>1000	100-1000	5-100
<b>More common</b>	Bacterial meningitis	Bacterial meningitis	Bacterial meningitis	Viral meningitis  Lyme disease  Meningeal syphilis	Bacterial meningitis	Bacterial or viral meningitis	Early bacterial meningitis  Viral meningitis  Meningeal syphilis  TB meningitis
<b>Less common</b>	TB meningitis  Fungal meningitis	Meningeal syphilis  Some viral infections (such as mumps)	TB meningitis		Some cases of mumps	Encephalitis (including West Nile virus)	Encephalitis (including Herpes simplex virus)

**Utility of CSF analysis in infectious causes of CNS infection** Differential diagnosis of infectious causes of central nervous system (CNS) infection, according to the concentrations of glucose and protein (in mg/dL) and the total white blood cell count (WBC, per microl). Common self-limited forms of viral meningitis usually have a CSF protein concentration below 100 mg/dL and a total WBC less than 100/ $\mu$ L. In addition to the total WBC, the percent neutrophils also may be helpful: more than 50 percent suggests bacterial meningitis while a value below 10 percent is compatible with viral infection.

# Differential Diagnosis

## Differential diagnosis of Aseptic Meningitis†

	Common	Uncommon	Rare
<b>Viral</b>	Echoviruses Coxsackieviruses types A and B Herpes simplex type 2 Human immunodeficiency virus Lymphocytic choriomeningitis virus Arboviruses Mumps Poliovirus	Cytomegalovirus Epstein Barr virus Varicella zoster virus Herpes simplex type 1 Adenovirus Measles Rubella	Rotavirus Encephalomyocarditis virus Vaccinia Influenza A and B Parainfluenza
<b>Bacterial</b>	Parameningeal bacterial infection (epidural, subdural abscess) Partially treated bacterial meningitis Leptospira sp. Borrelia burgdorferi (Lyme disease) Mycobacterium tuberculosis Bacterial endocarditis	Treponema pallidum (syphilis) Mycoplasma pneumoniae Rickettsia sp. Ehrlichia sp. Brucella sp. Chlamydia sp.	Borrelia recurrentis (relapsing fever) Spirillum minor (rat bite fever) Listeria monocytogenes Mycoplasma hominis Nocardia sp. Actinomyces sp.
<b>Fungal</b>		Cryptococcus neoformans Coccidioides immitis Histoplasma capsulatum	Candida sp. Aspergillus sp. Blastomyces dermatitidis Sporothrix schenckii
<b>Parasitic</b>		Angiostrongylus cantonensis Toxoplasma gondii	Taenia solium (cysticercosis) Trichinella spiralis
<b>Drug</b>	Ibuprofen	Trimethoprim-sulfamethoxazole Other NSAIDs Pyridium (phenazopyridine) anti-CD3 monoclonal antibody Azathioprine	
<b>Malignancy</b>	Lymphoma Leukemia Metastatic carcinomas and adenocarcinomas		
<b>Autoimmune</b>		Sarcoid Behcet's disease Systemic lupus erythematosus	Vogt-Koyanagi-Harada syndrome
<b>Other</b>		Epidemioid cyst Postvaccination	

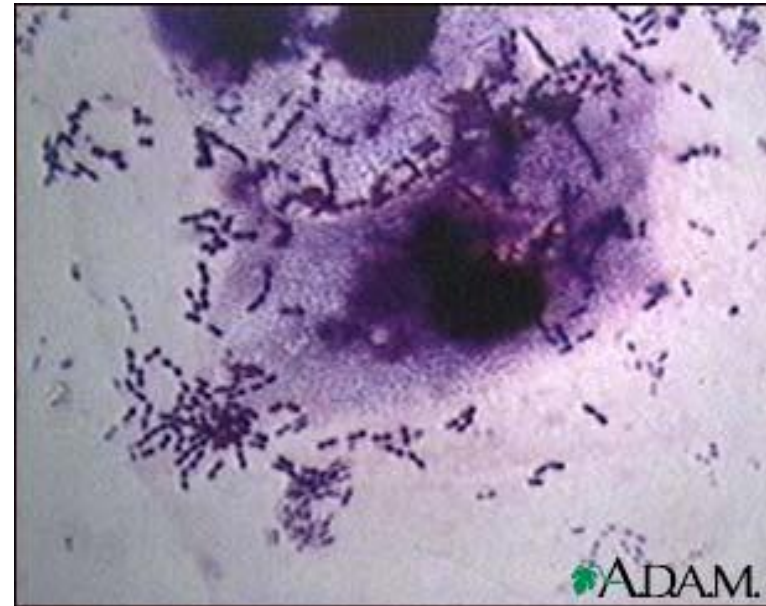
† Etiologies are classified according to their relative frequency among all causes of aseptic meningitis. Modified from Connolly, KJ, Hammer, SM. Infect Dis Clin North Am 1990; 4:599.

# CSF Gram stain

*Hemophilus influenzae*  
(H flu)



*Strep pneumoniae*





# ASSESSMENT OF MENINGITIS / ENCEPHALITIS

## History

Fever  
Headache  
Photophobia  
Lethargy  
Poor feeding/vomiting  
Irritability  
Hypotonia  
Drowsiness  
Loss of consciousness  
Seizures

## Examination

Fever  
Purpuric rash (meningococcal disease)  
Neck stiffness (not always present in infants)  
Positive Brudzinski's/Kernig's signs  
Signs of shock  
Focal neurological signs  
Altered conscious level  
Papilloedema (rare)



For optimal results, collect diagnostic samples as early as possible.

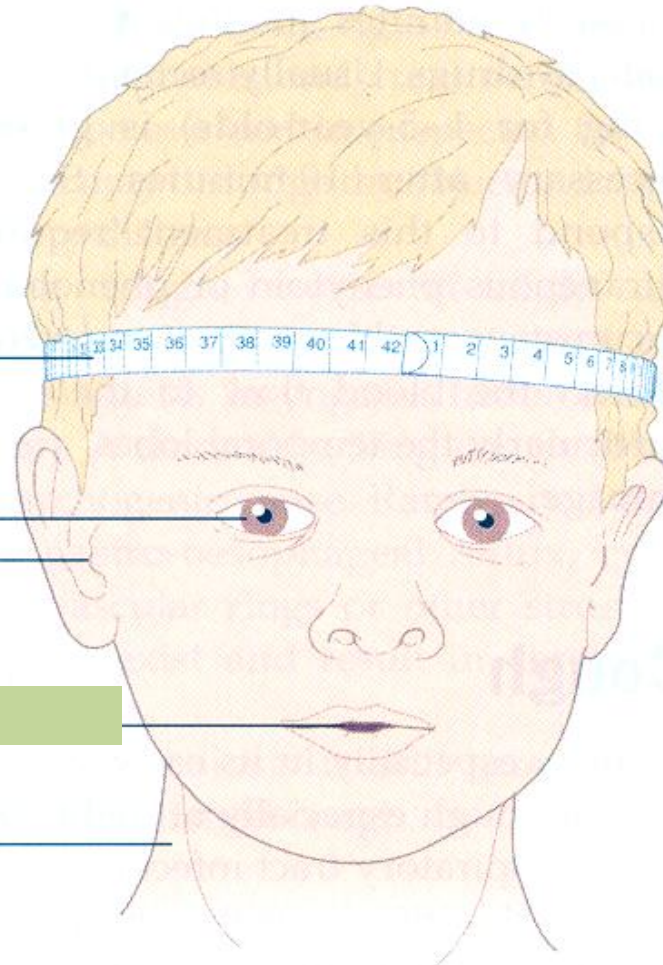
Measure occipito-  
frontal circumference

Look at optic discs

Look at eardrums

Throat examination

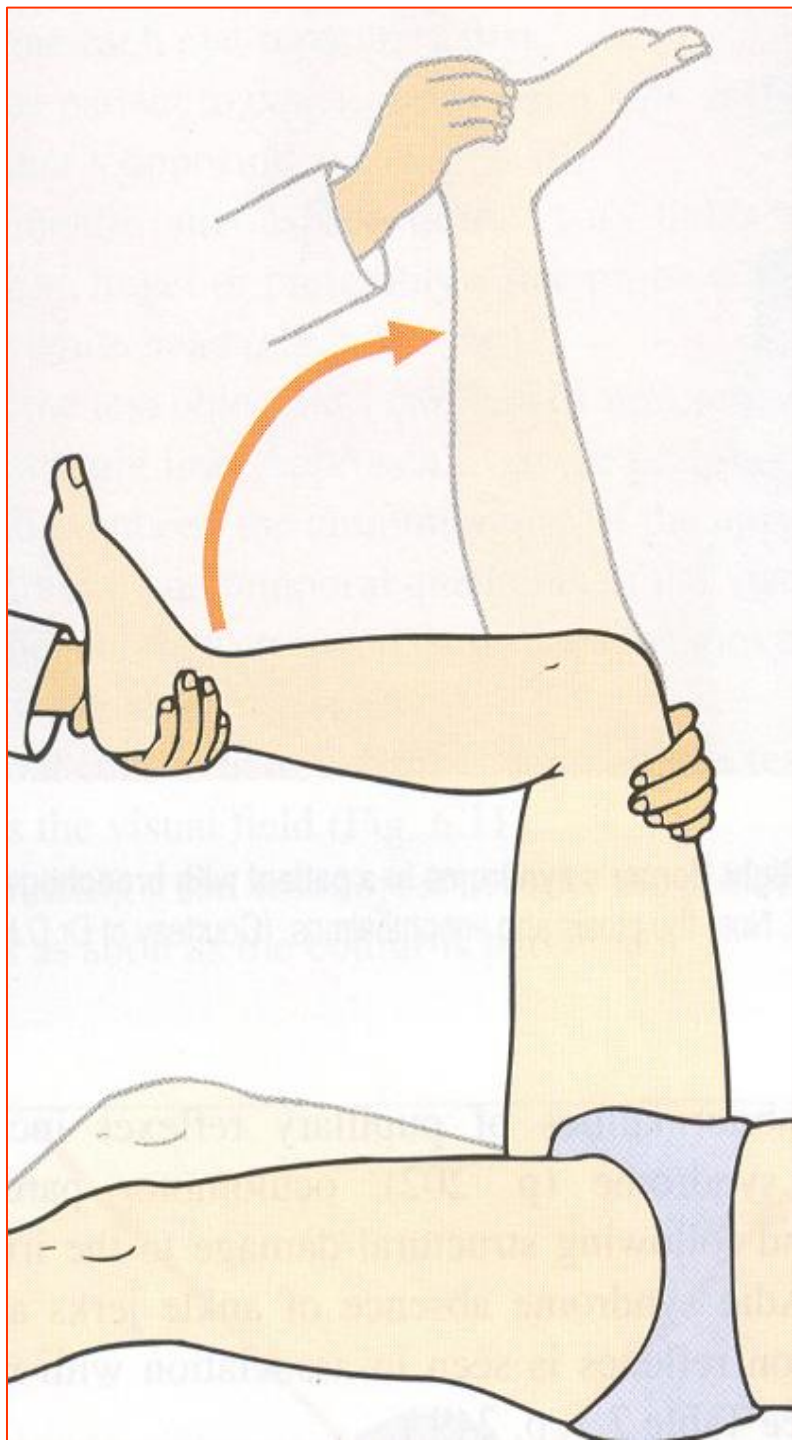
Is the neck stiff?



- Check blood pressure
- Check growth
- Does child mind light?
- Vomiting?
- Time of day of headaches

**BEWARE**

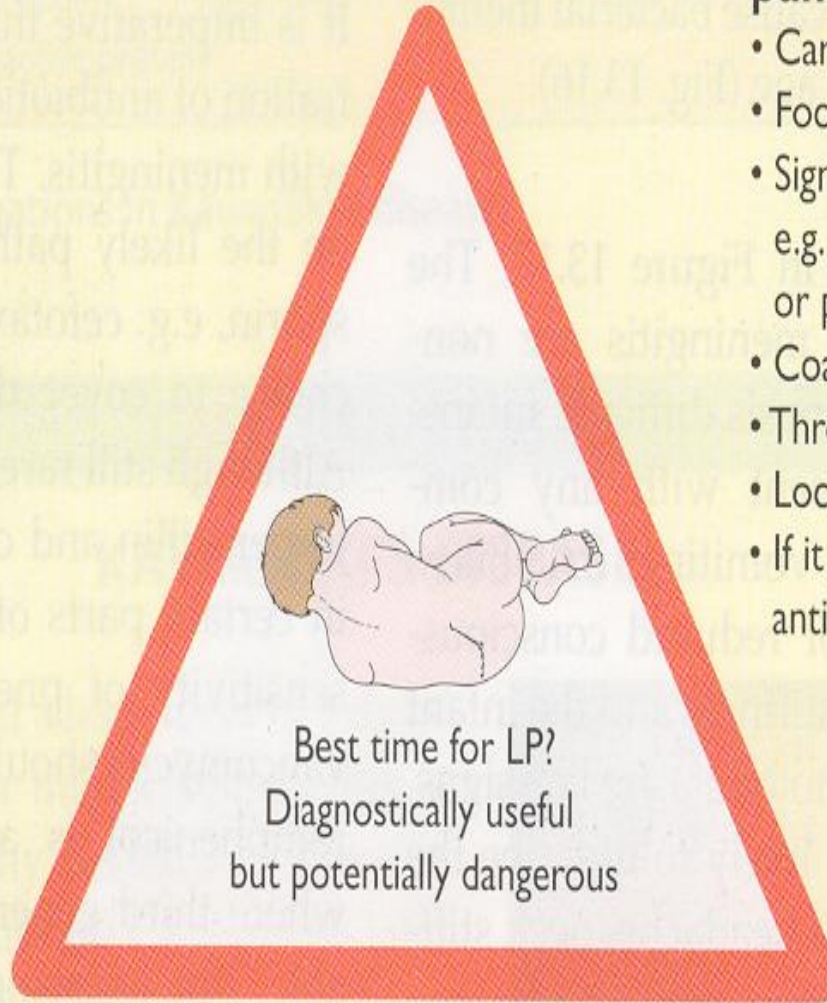
Headache every morning =  
raised intracranial pressure



## Signs associated with neck stiffness

Brudzinski's sign – flexion of the neck with the child supine causes flexion of the knees and hips

Kernig's sign – with the child lying supine and with the hips and knees flexed, there is back pain on extension of the knee



## Contraindications to lumbar puncture:

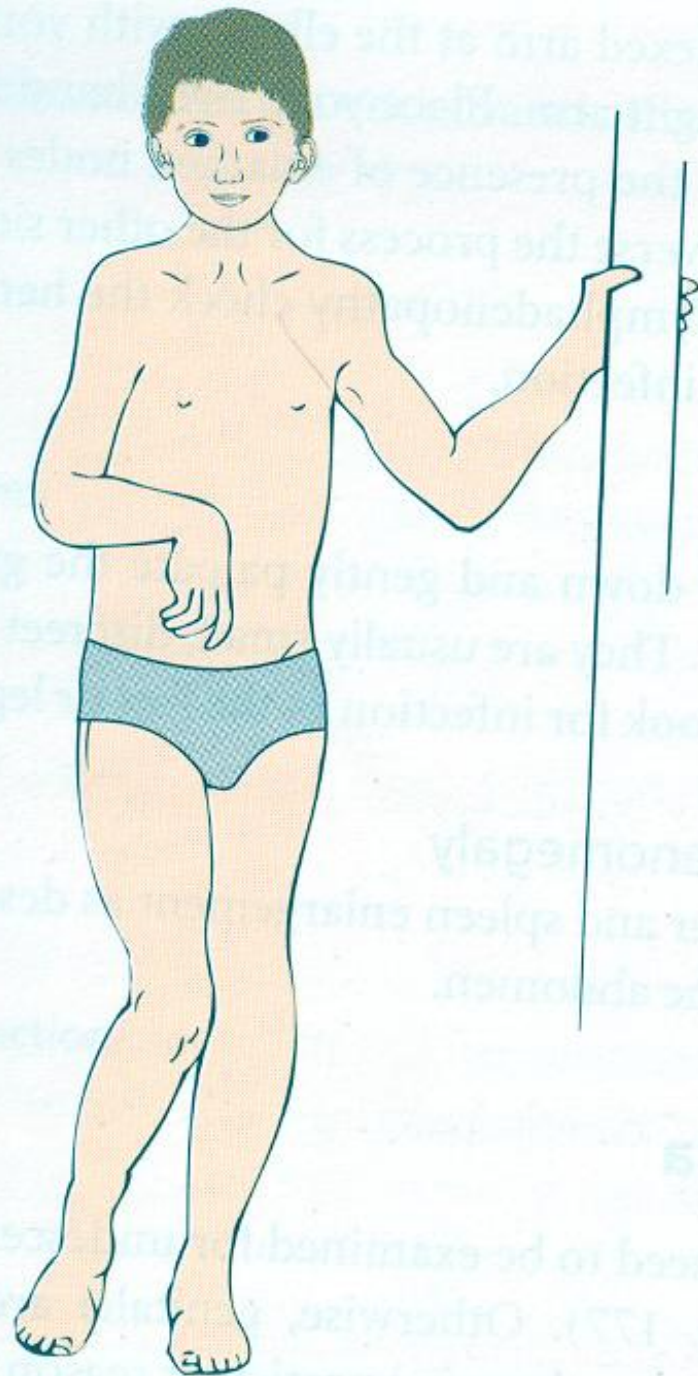
- Cardiorespiratory instability
- Focal neurological signs
- Signs of raised intracranial pressure, e.g. coma, high BP, low heart rate or papilloedema
- Coagulopathy
- Thrombocytopenia
- Local infection at the site of LP
- If it causes undue delay in starting antibiotics

# COMPLICATIONS

- Raised intracranial pressure
- SIADH
- Ventriculitis
- Neurological deficit
- Subdural effusions
- Shock (waterhouse Friedrichson syndrome)

# LONG TERM COMPLICATIONS

- ⊙Cranial nerves palsies
- ⊙Hydrocephalus
- ⊙Epilepsy
- ⊙Brain damage
- ⊙Hemiplegia
- ⊙Diabetes inspidus



**MANAGEMENT  
&  
TREATMENT**



# **Bacterial Meningitis Management**

- Medical emergency
- Early diagnosis essential
- Immediate optimum treatment
- Intensive supportive therapy
- Rehabilitation

# Meningitis - Fluid management

- Restore intravascular volume & perfusion
- Monitor serum  $\text{Na}^+$  (osmolality, urine  $\text{Na}^+$ ):
  - If serum  $\text{Na}^+ < 135$  mEq/L then fluid restrict (~2/3x), liberalize as  $\text{Na}^+$  improves
  - If severely hyponatremic, give 3% NaCl
- SIADH: presence of hyponatremia with low serum Na, low osmolality, high urine Na excretion

# Antibiotics

## Less than 2 months of age:

- **Ampicillin + Cefotaxime+/- Gentamicin**
- Treat for 3 weeks (neonate)

## Over 2 months:

- **Cefotaxime**
- Treat for 7-10 days

# Prophylaxis

- **Rifampicin:**

Children 5mg/kg bd x 2/7

Adults: 600 mg bd x 2/7

- Pregnant :

**Cefuroxime IM x 1 dose**

- All organisms that cause neonatal infection or sepsis can result in CNS disease → severe consequences to the developing brain
- Early diagnosis and therapy is mandatory → improve short and long term outcomes

# 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 arthropod 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.**

# Malignancy as a cause of meningitis

- It is also important to keep in mind that lymphoma, leukemia, and metastatic carcinomas and adenocarcinomas can occasionally present with an aseptic meningitis syndrome.

Thank you