# Microbiology of Acute Pyogenic Meningitis

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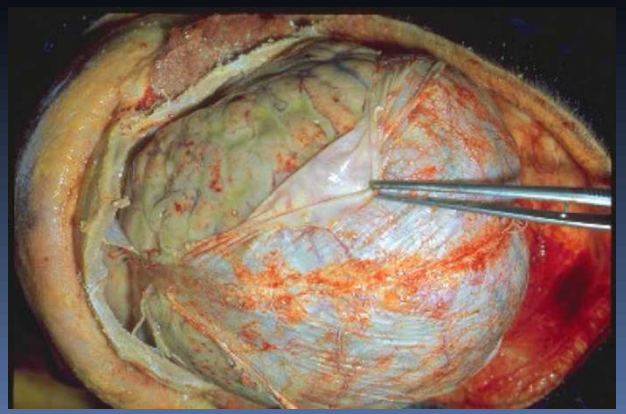
# Definition

- Pyogenic meningitis is an inflammation of the meninges affecting Pia, Arachnoid and subarachnoid space.
- Acute in onset, serious infection ,associated with marked inflammatory exudation.
- Usually caused by bacterial infections.
- May be preceded by URTI.
- Can be fatal if untreated.



# Meningitis- Epidemiology

- There are 1.2 million cases annually worldwide.
- 135,000 deaths.
- Bacterial meningitis is one of the top 10 infections causes death worldwide.
- Half of the survivals suffer neurological damage, and /or permanent side effects.

# Common Etiologic Agents

Three main capsulated bacterial species :

1. *Neisseria meningitidis*
2. *Sterptococcus pneumoniae*
3. *Hemophilus influenzae*

# Causes According to the Age

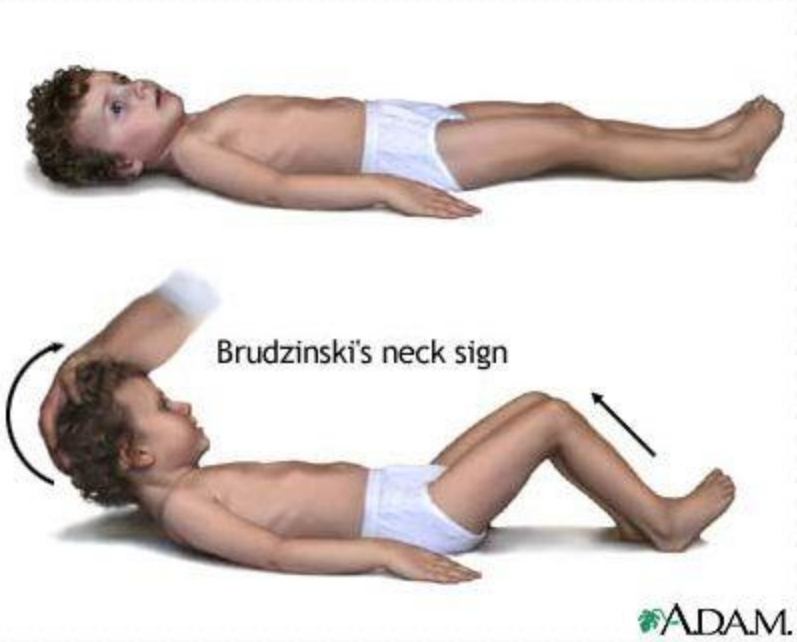
| Age Group | Common Causative Agents |
| --- | --- |
| Newborns | *Group B Streptococcus, E.coli (and other gram negative bacilli ) , Listeria monocytogenes* |
| Infants / Children | *S.pneuomiae, N.meningitidis, H.influenzae* |
| Adults | *S.pneumoniae, N.meningitidis* |
| Special circumstances | *S.Aureus (Surgery)*<br>*S.epidermidis (Shunt)*<br>*S.pneumoniae (Base of skull fracture)*<br>*anaerobes,P.aeruginosa* |

# Signs/Symptoms of Acute Meningitis

- **Most Common**
  - fever
  - Headache
  - Stiff neck
  - Nausea & vomiting
  - Sensitivity to light ,
  - Confusion
- **In infants**
  - Inactivity
  - Irritability
  - Vomiting
  - Poor feeding
- **Advanced Cases**

  bruises under skin & spread rapidly
- **Complication:**
  - Brain damage
  - Coma
  - Death

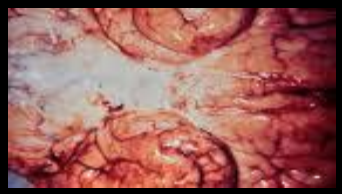
# Exam for meningitis

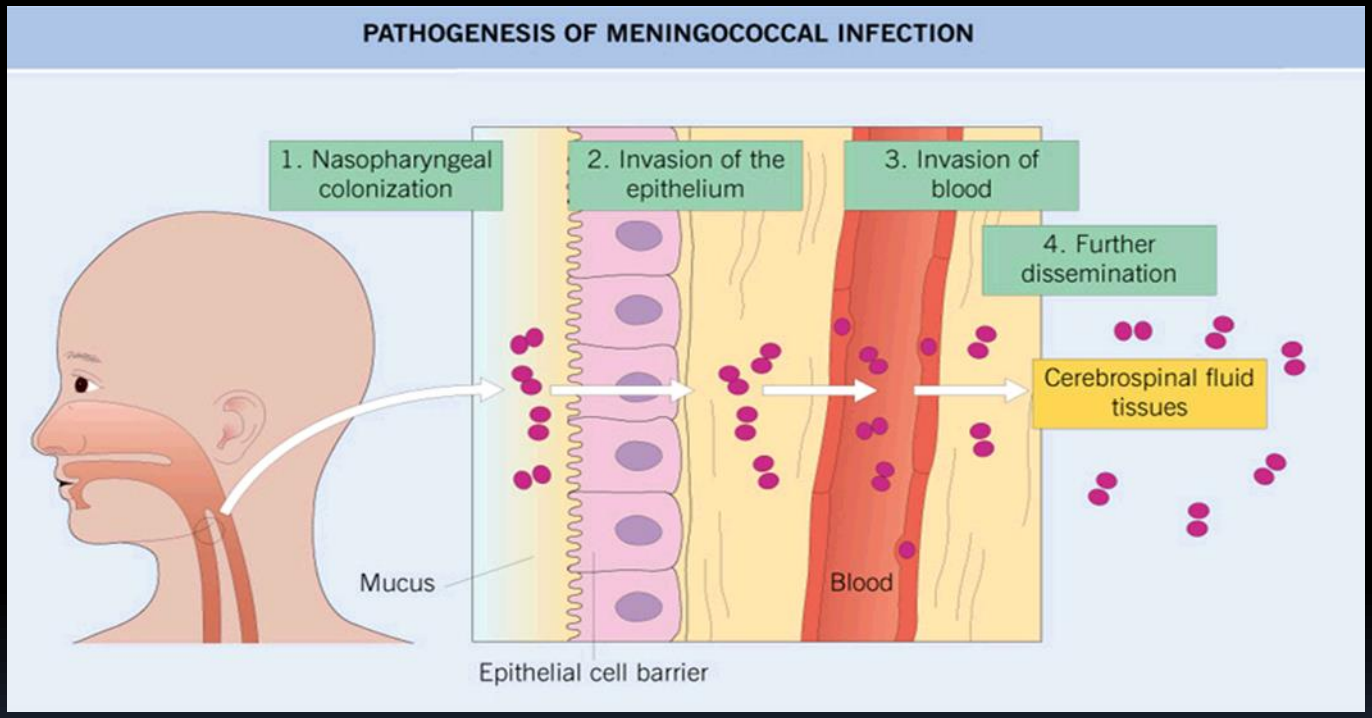

Kernig's sign

Brudzinski's sign

# Pathogenesis



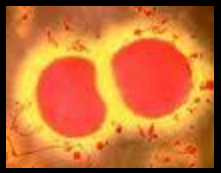
- Colonization of nasopharynx ( or from birth canal)
- Speticemia → BBB →
- Wide spread endothelia damage
- Activation of coagulation
- Thrombosis and platelets aggregation
- **Bleeding : skin rash, adrenal hemorrhage**

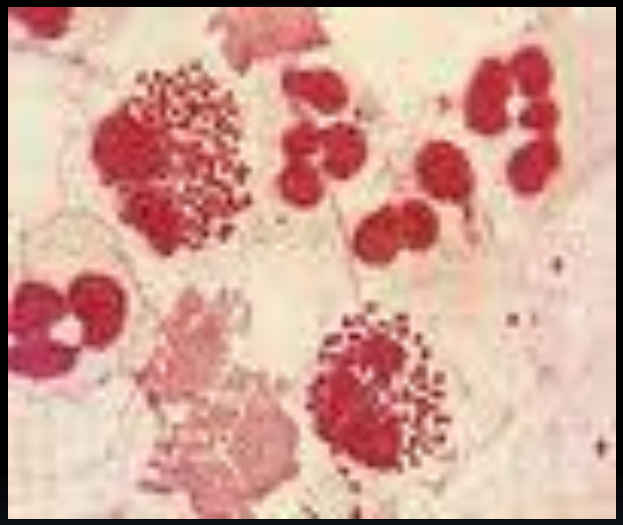

PATHOGENESIS OF MENINGOCOCCAL INFECTION
1. Nasopharyngeal colonization
2. Invasion of the epithelium
3. Invasion of blood
4. Further dissemination
Cerebrospinal fluid tissues
Mucus
Blood
Epithelial cell barrier

# *N. meningitidis*

- A Gram negative diploococci present in the nasopharynx of 10 % of people.
- Transmitted by inhalation of aerosolized droplets, close contact.
- Common in children < 6 y
- Risk factor: susceptible individuals.
- Serotypes: **B,C,Y,W135** cause isolated ,sporadic small epidemics in close population.
- Serotype **A** has an epidemic potential in sub-saharan Africa (meningitis belt).

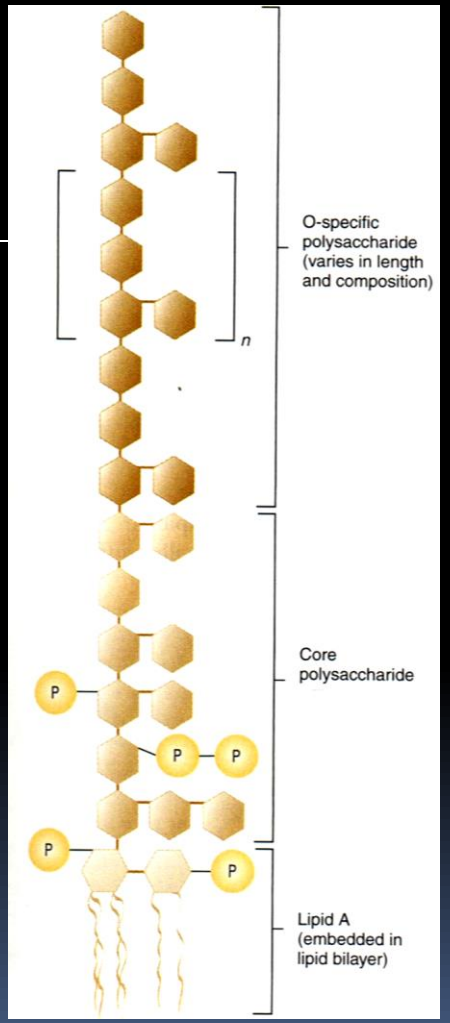
# *N.meningitidis*






# Pathogenesis –*N.meningitidis*

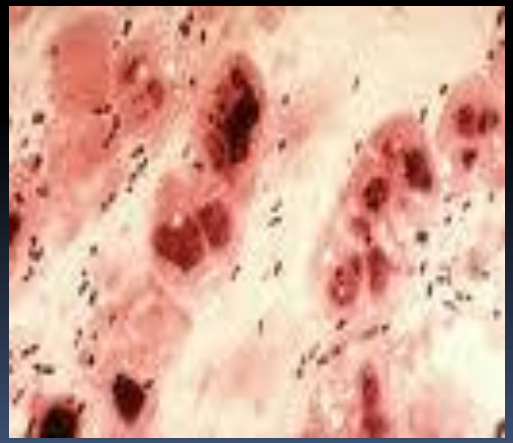
- Carriers stimulate antibody production,
- In some pili attach to microvilli of nasopharynx – invasion ⇒ bacteremia, endotoxin (LPS) produced ⇒ meninges.
- Capsule resists phagocytosis.
- 11-20 % of recovered patients suffer permanent hearing loss, mental retardation.
- 10-14% of cases are fatal.



# *S.pneumoniae*

- A Gram positive diplococci ,meningitis may follow pneumococcal pneumonia ,or other site .
- May develop after trauma to the skull.
- High mortality rate >30% due to invasive disease.
- Capsule is polysaccharide polymer
- Pneumolysin decreases inflammatory immune response ⇒ severe infection.

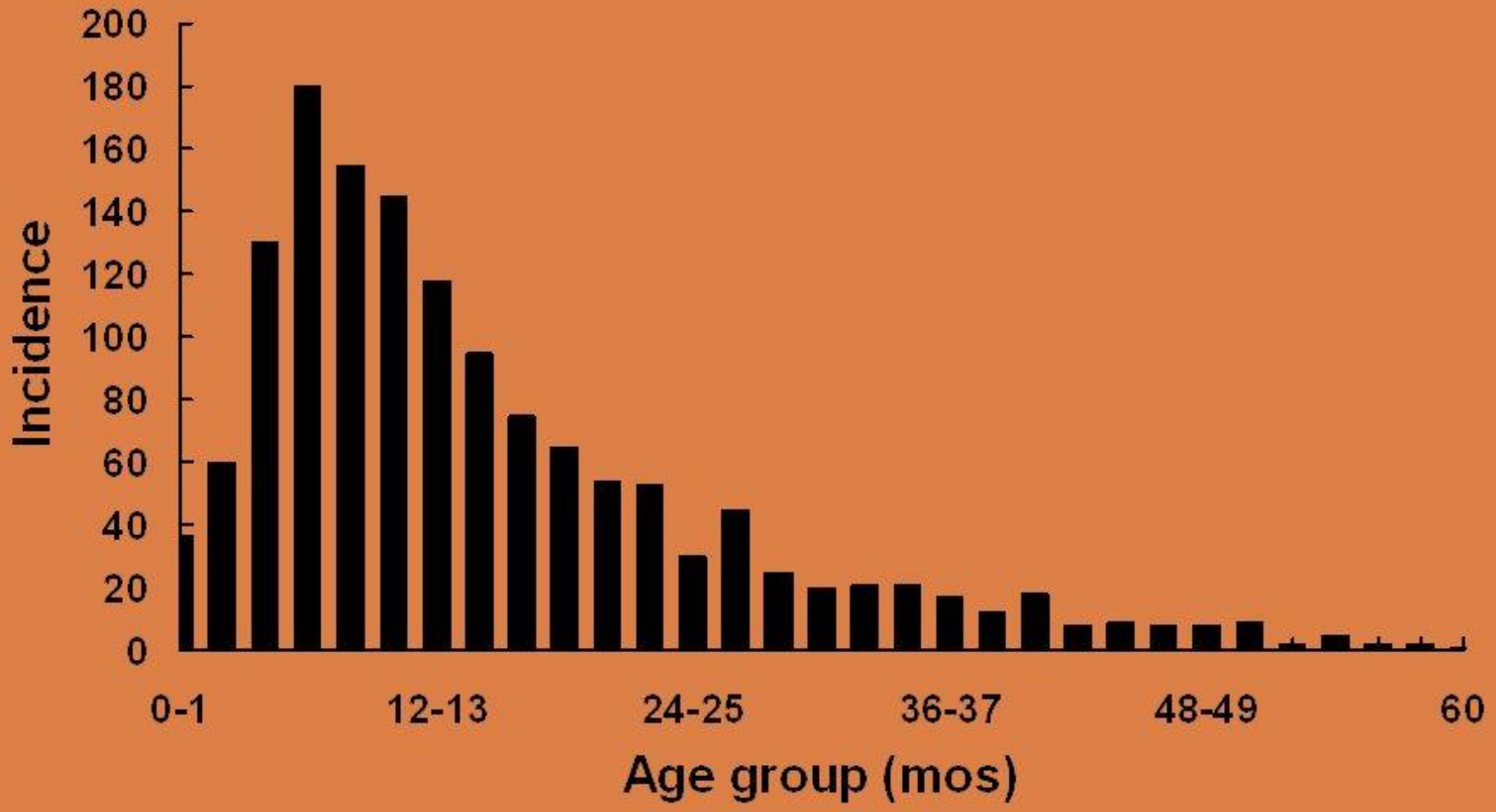
- Infection rate decreases due to vaccination .
- Recovered cases develop sustain learning disabilities .
- *S.pneumoniae*



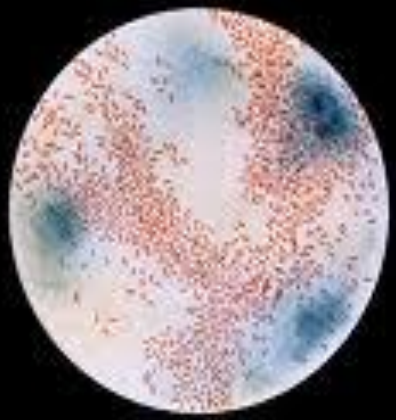
# *H.influenzae*

- A small Gram negative coccobacilli
- Has polysaccharide capsule , other species has no capsule.
- Need blood for optimal growth, Hematin (factor X) and nicotinamide adenine
- Dinucleotide NAD ( factor V)
- Many serotypes a~f ,
- *H.Influenzae* type *b* has a capsule ,a polymer of polyribosyl~ribitolphosphate(RPR) ,cause acute life threatening invasive infections .

# H.Influenzae infection by age group

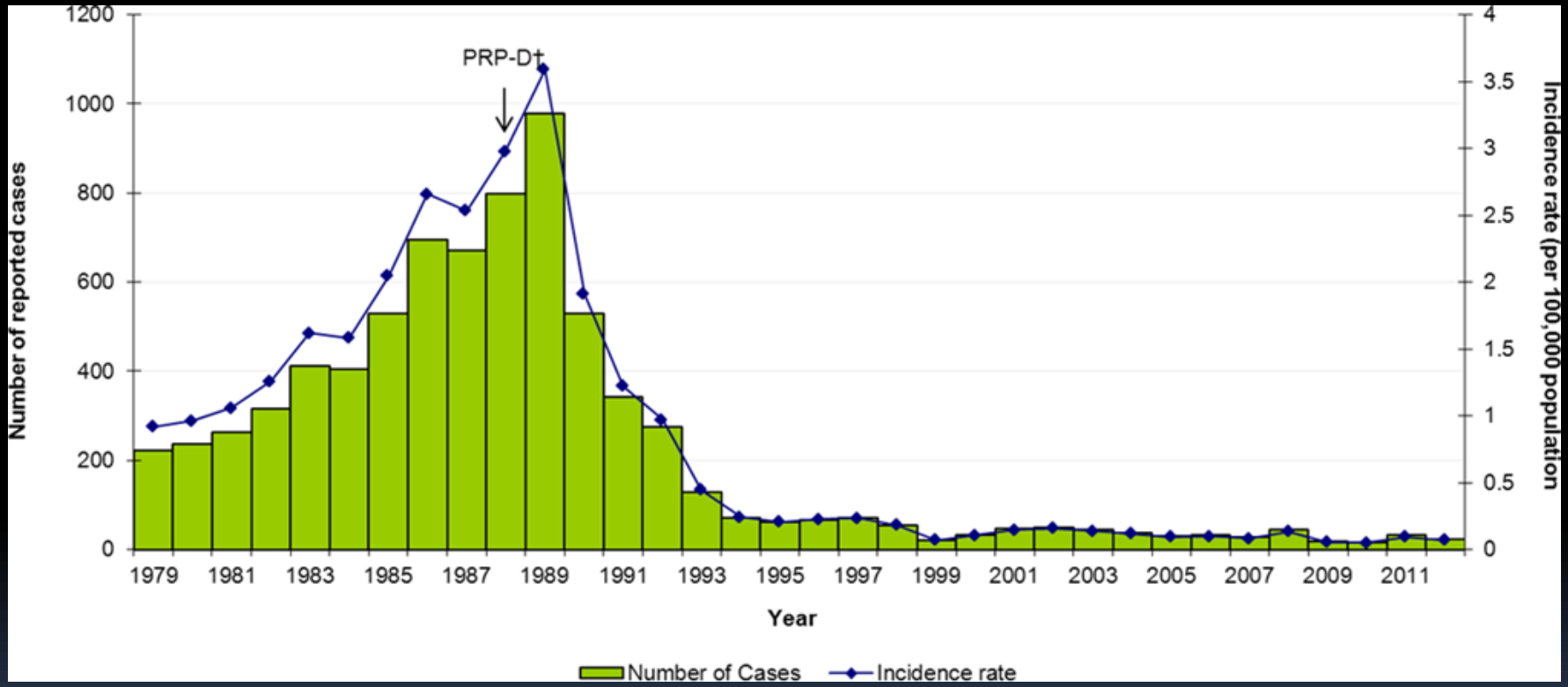


# *H.influenzae*



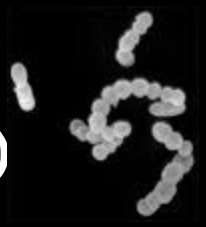
# *H.Influenzae* ~continue

- Found in the nasopharynx normal flora
- Major cause of lower RTI, occasionally invade deeper tissues and cause bacteremia.
- Bacteremia~~  CNS ,bones or other organs.
- 3~6% mortality rate
- 1/3 of survivals have significant neurological sequelae
- Infection rate decreases since the routine use of *Hib* vaccine .


PRP-D†
Number of reported cases
Incidence rate (per 100,000 population
Year
Number of Cases
Incidence rate
1200
1000
800
600
400
200
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

# Group *B Streptococcus*

- Gram positive cocci in chains



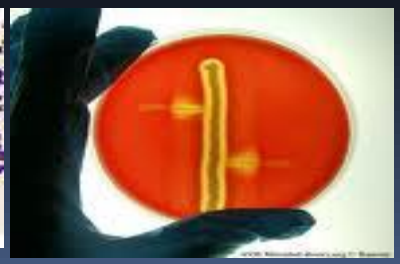
- Resident in GIT & vagina ( 10-30%)
- Gain access to aminotic fluid during delivery or colonize newborn as it passes birth canal.
- *Risk factors*: premature rupture of membrane, prematurity, low infant innate immunity
- Cause sepsis & meningitis in the first few days of life or after 4 weeks.

# *E.coli*

- A Gram negative bacilli
- Most common cause of neonatal meningitis
- Many features similar to GBS .
- Vaginal *E.coli* colonize infant via rupture of amniotic membrane or during birth.
- Failure of preterm maternal IgM to cross placenta& special susceptibility of newborn.
- K1 sialic acid capsule of some strains invade brain microvascular endothelial cells.

# *Listeria monocytogenes*

- Gram positive rods
- Wide spread among animals in nature including those associated with food supply.
- Human intestinal colonization (2~12%)
- Spread to fetus following hematogenous dissemination in mother or from birth canal
- Has tropism to CNS.



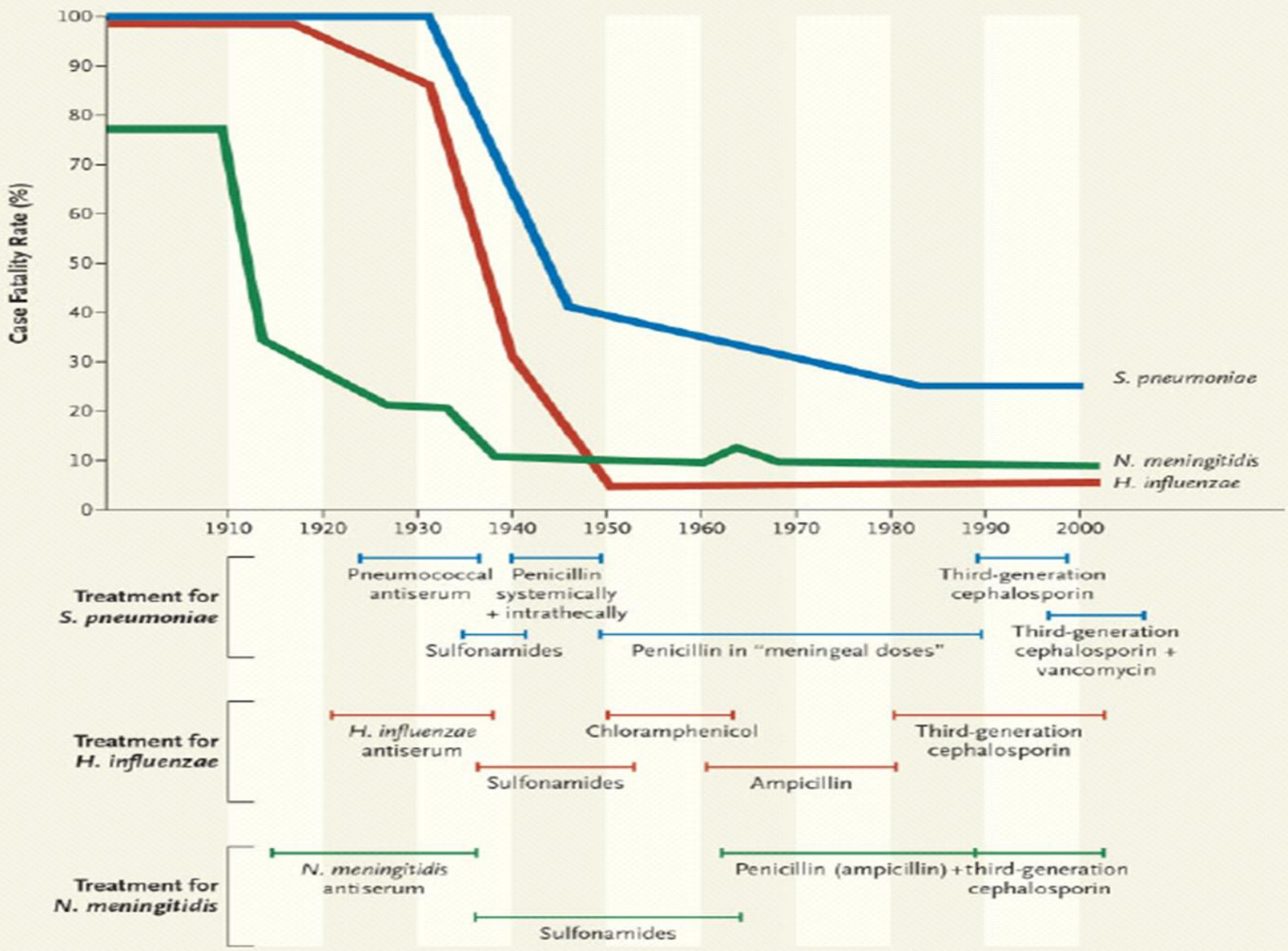
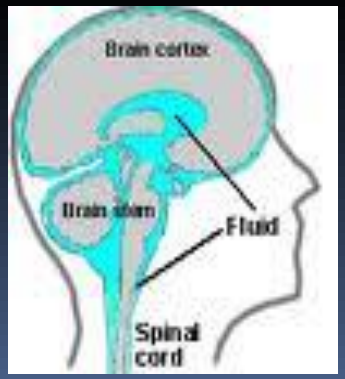



**Figure.** Mortality Rates Associated with Community-Acquired Bacterial Meningitis over the Past 90 Years.

# Diagnosis of Meningitis

- Clinically
- Specimen : **CSF** acquired through lumbar puncture and **blood** for :
- Analysis of cells, protein, glucose ,
- Culture and antimicrobial susceptibility testing.





# Findings of CNS analysis

## Normal CSF

### Adults

WBC =0-5 /cmm3,

PMN= 0 %, glucose= > 60 % of blood,

protein =< 30 mg/dl

### Neonates

*term* : WBC =0-32 /cmm3,

PMN=>60 %, glucose = >60 % of blood,

protein= **20-170 mg/dl**

*Preterm*: WBC=0-29/cmm3,

PMN= <60 %, glucose = >60 % of blood,

protein= **60-150 mg/dl**

## Pyogenic meningitis

WBC= 1000 - 5000/cmm$^3$

(range 100-10,000)

PMN= > 60%

Glucose = < 45 % of blood

Protein= >60 mg/dl

# Traumatic LP

- True WBCs in CSF= Actual WBC in CSF - $\frac{\text{WBC in blood x RBC in CSF}}{\text{RBC in Blood}}$

# Management

- **Urgent , A MEDICAL EMERGENCY**
- Antibiotics after taking specimens for lab diagnosis
- Parenteral administration of Ceftriaxone (or Cefotaxime) + Vancomycin ( *cover the main 3 pathogens*) or ,
- Amplicillin + Gentamicin or Cefotaxime ( *neonates*)
- Duration : 10-14 days according to the medical condition
- Prevention: **vaccination , prophylaxis of contacts (*Hib& N.meningitidis*)**

# CSF

| Test | Appearance | Pressure | WBC/μL | Protein mg/dL | Glucose mg/dL | Chloride |
|---|---|---|---|---|---|---|
| Normal CSF | Clear | 90 – 180 mm | 0-8 lymph. | 15-45 | 50-80 | 115-130 mEq/L |
| Acute bacterial meningitis | Turbid | Increased | 1000 -10000 | 100 – 500 | < 40 | Decreased |
| Viral meningitis | Clear | Normal to moderate increase | 5-300, rarely >1000 | Normal to mild increased | Normal | Normal |
| Tubercular meningitis | Slightly opaque cobweb formation | Increased/ decreased, spinal block | 100-600 mixed or lymph. | 50-300 due to spinal block | Decreased | Decreased |
| Fungal meningitis | Clear | Increased | 40-400 mixed | 50-300 | Decreased | Decreased |
| Acute syphilitic | Clear | Increased | About 500 lymph | Increased but <100 | Normal | normal |