

وَقُلْ رَبِّ زِدْنِي عِلْمًا



# PERIPHERAL NERVOUS SYSTEM

SUBJECT : microbiology

LEC NO. : one

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يعطيكم العافية وريد ❤️❤️

ملاحظات بما يخص التفريغ : عملت ترتيب شوي للسلايدات و برضه ترتيب لملاحظات الدكتور و دمجت كلام و ملاحظات الدكتور مع السلايدات لتصير مادة علمية واحدة  
ضفت لكم معلومات خارجية للإحتياط حتكون باللون الأحمر و ضفت أسئلة للتدرب بالنهاية ، أي شي مهم حيكون عليه كلمة مهم أو عليه هايلايت مميز .

التفريغ قابل للطباعة للي بحب يدرس ورقي أو بصفحات قليلة ، و حأزودكم بنسخة من التفريغ على شكل سلايدات للي بحب السلايدات  
و برضه تم الاعتماد على شرح الدكتور بمحاضرة الأونلاين ❤️ فلو بتحبوا ادرسوها مع ريكورد الوجيه لتتأكدوا انه ما في أي معلومة ناقصة ، حأسمع ريكورد الوجيه بعدين و لو في أي معلومة ضافها الدكتور حأبلغكم فيها ببوست مستقل بإذن الله

موفقين يارب ولا تنسونا بصالح دعائكم ❤️

و بسم الله نبدأ...

# BACTERIAL MENINGITIS

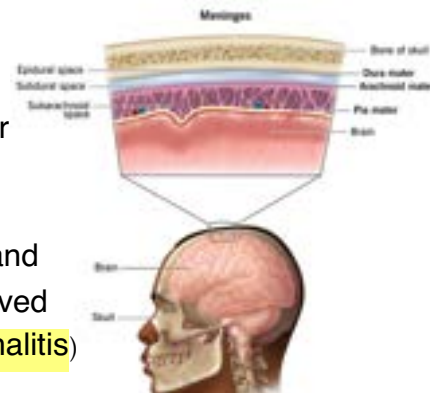
## Acute Bacterial Meningitis

### DEFINITION

■ It is an acute purulent infection (purulent = presence of pus) within the subarachnoid space (**leptomeninges** : refers to the pia mater and arachnoid mater)

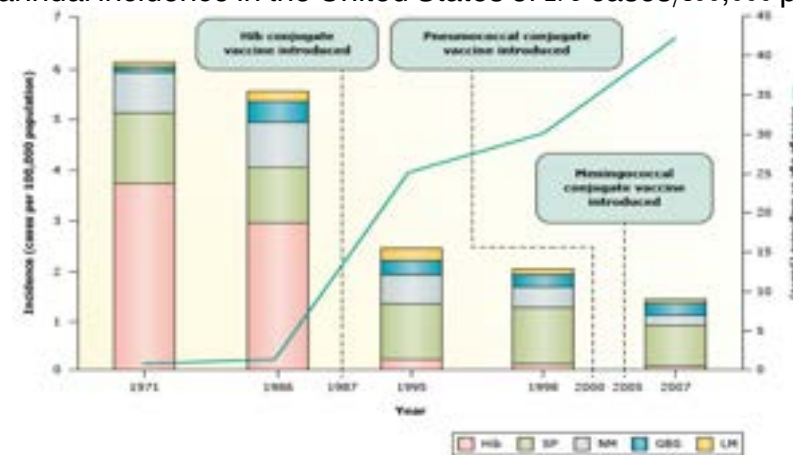
■ If the meninges, the subarachnoid space, and the brain **parenchyma** are all frequently involved in the inflammatory reaction (**meningoencephalitis**)

■ usually the illness starts with meningitis and then it involves meningoencephalitis.



### EPIDEMIOLOGY

Bacterial meningitis is the most common form of suppurative CNS infection, with an annual incidence in the United States of 2.5 cases/100,000 population.



بنلاحظ انه بال 1971 العمر السائد للحالات كان الأطفال الأقل من سنة و كان المسبب للحالات هو H. Influenzae type B لغاية سنة 1986 والي صار وقتها كان introduction of H. Influenzae type B

تذ كبير : هاد ال **conjugated vaccine** ، شو يعني ؟

The most antigenic part of this virus is the capsule (polysaccharide) and in order to protect children and make them immunogenic we conjugate it with proteins

إذا لهسا الي صار انه تغير ال age group و صار في shifting لل causative microorganism

**In 1995**

-The H. Influenzae type B is the least causative MO

-But the most is Streptococcus pneumoniae followed by Neisseria meningitidis, Group B streptococci and Listeria monocytogenes

**In 2007**

Streptococcus pneumoniae is the **most common** causative MO with Neisseria meningitidis and Group B streptococci.

**Do we expect to see a pussy CSF at the time of CSF withdrawal??**

Question

No, in the case of severe infection we might see there is a little bit turbid but with no pus.

■ **The meningitis is classified to :**

1-**Septic meningitis**: is caused by a bacterial infection, the patient is presented with pus, the CSF spiecman grows on the culture palate, it can lead to sepsis, it requires urgent antibiotic or antifungal treatment.

2-**Aseptic meningitis**: is typically caused by viruses, **negative culture**, resolves on its own with supportive care.

# BACTERIAL MENINGITIS

## Acute Bacterial Meningitis

من ضمن المفاتيح المهمة في الكيسات هي العمر ✓

### Etiology

■ The organisms most commonly responsible for **community-acquired** bacterial meningitis are **Streptococcus pneumoniae (50%)**, *N. meningitidis* (25%), group B streptococci (15%), and *Listeria monocytogenes* (10%). *H. influenzae* (10%).

■ ***P. aeruginosa*** is the most common organism responsible for **hospital-acquired** meningitis.

### Causes of Bacterial Meningitis by Patient Age

طبعاً يختلف حسب **age group** ولكن بشكل عام الـ **strep. pneumonia** هي الأشهر

#### Neonates and young infants:

- 1-Group B streptococci (*Streptococcus agalactiae*)
- 2-*Escherichia* (*E. coli*)
- 3-*Listeria monocytogenes*



#### Older infants, children, and young adults:

- 1-*Neisseria meningitidis*
- 2-*Streptococcus pneumoniae*
- 3-*Staphylococcus aureus* (it is seen in children having **anomalies** in the brain that increases the intracranial pressure, the only solution for these patients is doing a shunt (ventriculoperitoneal (VP) shunt) This shunt helps to drain excess cerebrospinal fluid from the brain's ventricles into the abdominal cavity, where it can be absorbed by the body; this shunt can be contaminated with *Staph. aureus*)
- 4-*Haemophilus influenzae*



#### Middle-aged adults

- 1-*S. pneumoniae*
- 2-*S. aureus*\*
- 3-*N. meningitidis* (less common in this age group)



#### Older adults

- 1-*S. pneumoniae*
- 2-*S. aureus*\*
- 3-*L. monocytogenes*
- 4-Gram-negative bacteria



الآن حنبداً نحكي عن كل نوع من هذول البكتيريا ♥ دمجت معلومات كل بكتيريا انحكت بالمحاضرة بالقسم الخاص فيها و حاولت ارتب الـ كم المعلومات بقدر المستطاع و حتلاحظوا انه كل بكتيريا الها لون عشان تربطوا الموضوع بمخيلتكم ♥

# *S. pneumoniae*

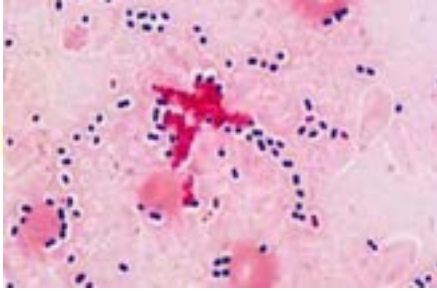
Or pneumococcal pneumonia

## Age group

The most common bacterial cause of meningitis overall

## Morphology

- It is a Gram-positive bacterium (purple-blue)
- Diplococci (spherical and appear in pairs)
- In certain views, particularly in narrow areas, it can appear lancet-shaped.



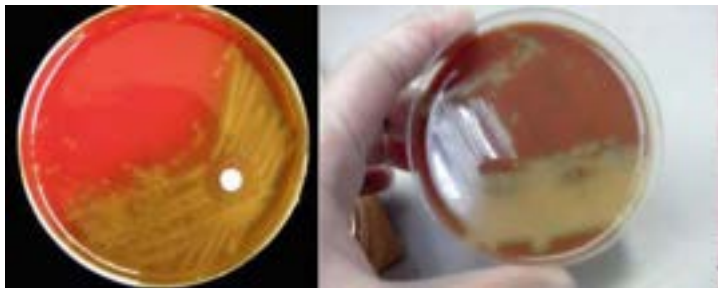
## Culture

- **Pattern of hemolysis** : alpha hemolysis (partial hemolysis)
- **Colony appearance** : round, smooth, dome-shaped and may have a central depression giving them draughtsman or umbilicated appearance.

\*\*To differentiate between streptococcus species, the **optochin disc** (known as P disc) is commonly used.

Streptococcus pneumoniae is **sensitive** to optichan.

Other alpha-hemolytic streptococci, such as viridans, are resistant to optochin.



## Biochemical tests

Bile soluble

## Predisposing factors

- acute or chronic pneumococcal sinusitis or otitis media
- Alcoholism
- diabetes
- Splenectomy
- Hypogammaglobulinemia (problem in the production of the antibodies -> increase the chance of having an infection)
- complement deficiency ( no MAC formation )
- head trauma with basilar skull fracture and CSF rhinorrhea.

## Ways of transmission

1. Hematogenous Spread (indirect)
2. Direct Extension: it can directly invade the meninges from nearby sites of infection, such as the sinuses or middle ear, through the extension of infection into the central nervous system.
3. Respiratory Tract Infections

## Vaccination

It has a vaccine ✓

## Treatment

(2 weeks)

Penicillin-sensitive Penicillin G

Penicillin-intermediate Ceftriaxone or cefotaxime

Penicillin-resistant (Ceftriaxone or cefotaxime) + vancomycin

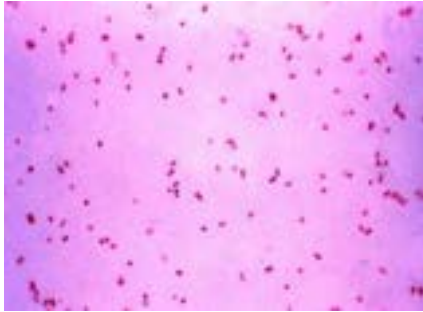
# NEISSERIA MENINGITIDIS MENINGOCOCCI

## Age group

Common in teenagers and young adults

## Morphology

- It is a gram negative bacteria (pink or red)
- Diplococci, in wide areas it appears as kidney bean or coffee bean appearance



## Culture

- 1-chocolate agar
- 2-blood agar
- 3-Thayer-Martin agar (selective)

## Biochemical tests

Oxidase +

## Pathogenesis

1. Colonization of the nasopharynx
2. Invasion to the bloodstream
3. Bloodstream Dissemination (bacteremia)
4. Crossing the Blood-Brain Barrier
5. Meningeal Inflammation

## Vaccination

بنعطي ال vaccine تبعها للي بدو يروح للحج او العمرة و للي بدو يكمل و يدرس بالجامعات الي برا و السبب هو انه ال spread تبعهم عالي هناك

## Treatment

(1 week)

Penicillin-sensitive Penicillin G or Ampicillin  
Penicillin-resistant Ceftriaxone or cefotaxime

## Notes

- **Petechial or purpuric skin** lesions are important clue for the N. meningitis.
- It is fulminant, progressing to death within hours.
- Initiated by **nasopharyngeal** colonization
- Individuals with deficiencies of any of the complement components, are highly susceptible.
- Oral sex is dangerous risk for this disease.



## Epidemic Cerebrospinal Meningitis :

- It is a highly contagious disease.
- Occurs among school children, teenagers and young adults.
- The infection is transmitted by droplets.
- 5% of people become chronic carriers (source of infection)
- High level meningococemia can be associated with fatal disseminated disease and result in petechial rash, septic shock, DIC and multiorgan failure.

\*\*Its lipopolysaccharide are responsible for endotoxic shock found in meningococcal septicemia

لو اجاك سؤال فيه rash مع meningitis symptoms مثل  
(rocky mountain spotted fever)

و برضه no neck stiffness فأول MO بدك تفكر فيه N. meningitis

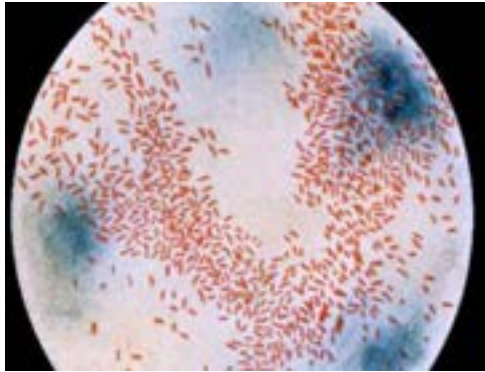
# Hemophilus influenzae

## Age group

Important cause in young children (preschool)

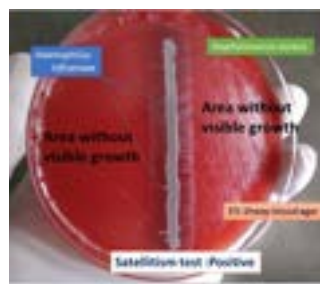
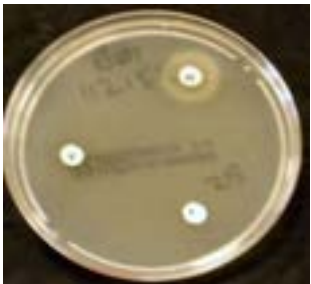
## Morphology

Gram negative bacillus (cocci bacillus)



## Culture

- It has a specific and complex growth requirements that must be met. (**fastidious**)
- It typically requires a medium supplemented with blood or hemin (**x factor**) and NAD or **V factor** (**satellitism**).
- Produces **No** hemolysis



## Vaccination

Rare in developed countries but still seen in countries where the H. influenzae type B vaccine is not widely used

ملاحظة ...

في الأردن و بسبب انه ال vaccine هو جزء من national vaccination program فال chances لاصابة المواطنين ب meningitis بسبب Haemophilus influenzae هي very minimal.



## Notes

Can cause a lobar pneumonia



## Treatment

(3 weeks) Ceftriaxone or cefotaxime

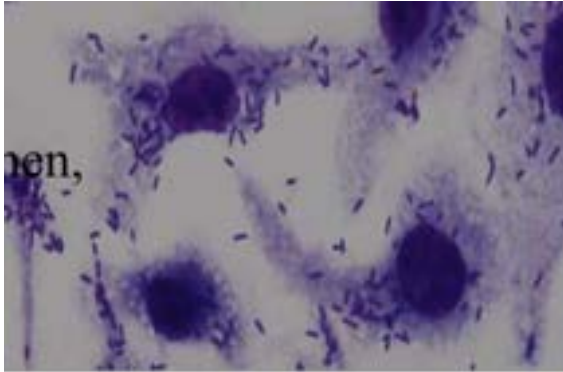
# *L. monocytogenes*

## Age group

- 1-in infants (1st month of age)
- 2-pregnant women
- 3-individuals  $\geq 60$  years of age.

## Morphology

- Gram positive short bacilli
- It is motile at 22C



## Biochemical tests

Catalase positive

## Ways of transmission

1. **Unpasteurized Dairy Products**: Raw milk, soft cheeses
2. Raw and Undercooked Meats
3. Raw or undercooked seafood, including smoked fish and shellfish.

## Treatment

(3 weeks) Ampicillin + gentamicin

# *Group B streptococcus*

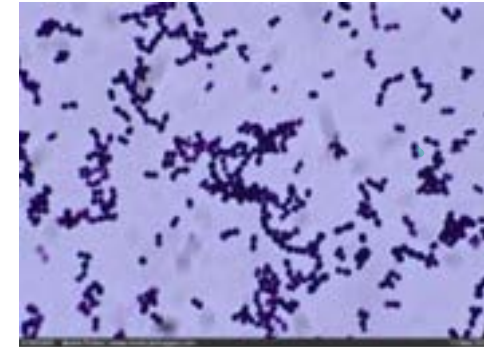
also known as *Streptococcus agalactiae*

## Age group

Neonates, individuals  $\geq 50$  years of age. .

## Morphology

Gram positive cocci arranged in chains or pairs



## Culture

- Beta hemolysis
- Positive CAMP test

## Biochemical tests

Catalase negative

## Pathogenesis

هسا هي بالوضع الطبيعي موجودة بال GI و ال genital tracts عند ال adults و لكن ممكن تسبب serious infections عند ال newborns او الي مناعتهم قليلة ، ممكن يصير الها transmission اثناء الولادة لل newborn لهيك ضروري اعطي المريض penicillin او ampicillin اثناء الولادة .

■ its infection can be classified into:

- 1- early infection: occur during the passage through birth canal, the newborn will be infected with streptococcus agalactiae which is associated with meningitis, pneumonia, sepsis and **high** mortality rate.
- 2- late infection: it starts after 2 weeks of delivery and it is associated with arthritis, pneumonia, and **low** mortality rate.



# Gram-negative

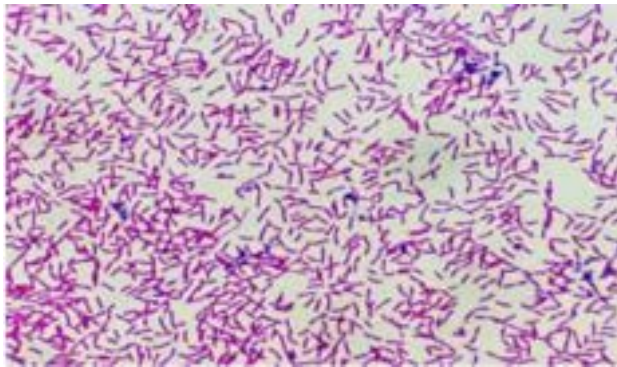
## Age group

In newborns, particularly premature infants

## Morphology

- Gram negative rod shaped organism, cylindrical, they have straight sides and rounded or slightly pointed ends

- It is motile



## Culture

1-macconky : dark pink dry

2-Eosin Methylene blue agar (EMB): green metallic sheen



## Pathogenesis

- Commonly found in the intestines
- Neonatal meningitis can occur when the bacteria spread from the mother's genital tract to the baby during childbirth or through other means of transmission after birth.

infected بصير newborn الاله بسبب احتمالية انه ال screening للحامل قبل الولاد لازم نعمل ب E-coli أو Group B strep

## Notes

- It can complicate neurosurgical procedures, particularly craniotomy.

## Treatment

(3 weeks) Ceftriaxone or cefotaxime

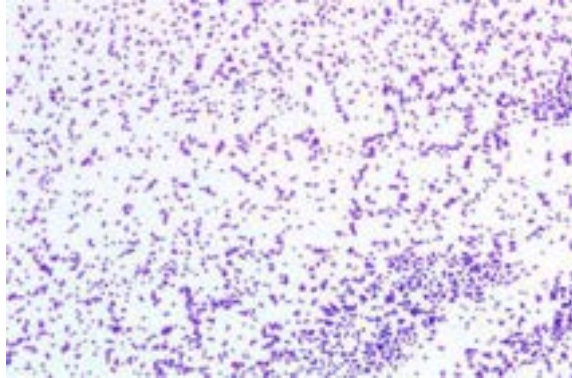
# Staphylococcus aureus

## Age group

Older infants, children, and young adults

## Morphology

Gram-positive, appears as clusters of spherical cells (grape-like)



## Culture

We use **Manitol Salt Agar** for the isolation and differentiation of staphylococcus aureus.

1- **Selective properties:** MSA contain high concentration of salt making it selective for staphylococcus aureus

2- **Differential properties:** It ferments mannitol producing acid byproducts and it decreases the PH of the agar and turn turns from red to yellow.

\*\*On agar plates, colonies appear as round, smooth, opaque, and often golden-yellow colonies.



## Notes

- It is presented in 20%–30% of population in the **oropharyngeal tract**.
- Important cause of meningitis that follows invasive neurosurgical procedures, particularly **shunting procedures** for hydrocephalus or after intrathecal chemotherapy.



### How could Staph.aureus access to meninges?

- 1-sinusitis
- 2-mastoiditis
- 3-Basal skull fracture
- 4-CSF leakage

## Ways of transmission

1-**bloodstream:** through open wounds and surgical site. Once it enters the bloodstream it can cross BBB.

2-**Direct extension:** Infections in nearby structures, such as the sinuses, middle ear, or bones of the skull, can spread directly to the meninges.

3-**Medical devices:** Staphylococcus aureus can contaminate medical devices, such as ventricular shunts or catheters, which are inserted into the body. If these devices become colonized with bacteria, they can serve as a pathway for the bacteria to reach the meninges.

## Treatment

(3 weeks)

Methicillin-sensitive : Nafcillin

Methicillin-resistant : Vancomycin

# BACTERIAL MENINGITIS

## Clinical Features

■ either an **acute** fulminant illness that progresses rapidly in a **few hours** or as a **subacute** infection that progressively worsens over **several days**.

■ The **classic clinical triad** of meningitis is fever, headache, and nuchal rigidity occurs in 90% of cases.

■ **Kernig's sign** (It involves flexing the hip and knee at 90-degree angles and then attempting to extend the knee. In cases of meningitis, this maneuver can cause resistance or pain in the neck and back due to inflammation of the meninges)

■ Alteration in mental status occurs in 75% of patients and can vary from lethargy to coma.

■ Nausea, vomiting, and photophobia.

■ Seizures occur as part of the initial presentation of bacterial meningitis or during the course of the illness in 20 to 40% of patients.

■ Raised ICP is an expected complication of bacterial meningitis and is the major cause of obtundation and coma in this disease & lead to papilledema 6th n. palsy, decerebration [and herniation (1-8%)]

### Meningitis TRIAD



## Diagnosis

■ When bacterial meningitis is suspected, **blood cultures** should be immediately obtained then empirical antimicrobial therapy initiated without delay

■ The diagnosis of bacterial meningitis is made by **examination of the CSF**.

خلي بالكم انه حنطلب 3tubes لل CSF بحيث الأول بـ **chemistry** لنشوف **WBC** و **RBC** ...  
والثاني لل **culture** لنزرع العينات على 3 انواع من ال **agars** :

1- blood agar

2- chocolate agar (enriched growth medium, it is not selective and we can use it in both gram negative and gram positive bacteria)

3- macconkey agar (selective to **gram negative** bacteria only)



how can we use the **agglutination test** in bacterial meningitis diagnosis?

1. CSF Collection via lumbar puncture.

2. Testing CSF sample using a commercial latex agglutination kit (contains latex beads coated with antibodies specific to the bacterial antigens).

3. If the targeted bacterial antigen is present in the CSF sample, it will bind to the antibodies on the latex beads, leading to visible agglutination and clumping.

4. A positive result indicates the presence of the specific bacterial antigen in the CSF, suggesting a bacterial etiology for the meningitis.

طبعاً هاد ال **test** اجراء سريع للغاية ما تطع نتائج **culture** ، حأستناها لمدة 24 ساعة لو ما طلعت النتيجة بستنى 48 ساعة لو ما طلعت النتيجة بحكي انه **negative** للبكتيريا ، و طبعاً بلجاً لل **PCR** الي نتائجه تحتاج 3-5 ساعات

### Question

#### What are the clinical presentation in children and newborns?

Fever - Irritability - Lethargy - Poor feeding - Vomiting - Rash

\*\* in some cases of meningitis, children may develop **bulging fontanelles**. If there is increased pressure within the skull due to meningitis, it can cause the fontanelles to bulge or feel tense.

# BACTERIAL MENINGITIS

## Question

**What are the types of MO we can detect through agglutination test?**

- 1-Streptococcus group B
- 2-Haemophilus influenzae type b
- 3-Streptococcus pneumoniae (pneumococcus)
- 4-Neisseria meningitidis (meningococcus) groups A, B,C,Y or W 135
- 5-Escherichia coli K1

## Cerebrospinal Fluid (CSF) Abnormalities in Bacterial Meningitis

- Appearance is purulent
- Opening pressure  $> 180$  mmH<sub>2</sub>O
- White blood cells 10/uL to 10,000/uL; neutrophils predominate
- Red blood cells Absent in nontraumatic tap
- Glucose  $< 2.2$  mmol/L (40 mg/dL) (patient fast 4 hrs before LP)
- CSF/serum glucose  $< 0.6$
- Protein  $> 0.45$  g/L (45 mg/dL)
- Gram's stain Positive in  $> 60\%$
- Culture Positive in  $> 80\%$

\*\*If there is increased neutrophils  $\rightarrow$  bacterial cause

\*\*If there is increased lymphocytes  $\rightarrow$  viral, fungal and microbacterial cause

## Indication of CT brain scan before LP

- Papilledema .
- Fit (focal or generalized)
- Known case of brain tumor or systemic cancer
- Immune deficiency
- Focal neurological signs
- Impaired consciousness

### Otherwise do LP without CT scan

If LP is delayed in order to obtain neuro-imaging studies, empirical antibiotic therapy should be initiated after blood cultures are obtained because C.S.F take 24 hr after start AB to be culture -ve &  $> 6$  weeks to return completely to the normal.

\* ضروري قبل ما نعمل lumbar puncture نشيك على ICP ؛ فلو كان عالي و عملنا puncture في خطر عالمريض انه يصير عنده cerebellar herniation و الي ممكن يؤدي للموت لهيك لازم اشيك عال ICP :

signs such as **papilledema** (swelling of the optic disc) observed during fundoscopic examination can indicate increased ICP. Imaging studies like CT scans or MRIs may also reveal features suggestive of elevated pressure within the skull. These indicators can help assess the need for further investigation, including lumbar puncture, in suspected cases of increased ICP.

\* غالباً دكاترة التخدير هم المختصين بأخذ هذه العينات

\* هسا في حال صار meningitis الطبيعي انه تزيد ال permeability تبعت BBB لنسمح لل cytokines انها recruite بس الاصل يكون slight increase فلهيك بقدر اعمل lumbar puncture

### What if we can't do lumbar puncture ?

We should look for other causes for papilledema by doing CT scan to check if there is any other problem and according to that I am going to decide if I can do lumbar puncture or not

# BACTERIAL MENINGITIS

## Differential Diagnosis

- Viral meningitis (headache is most prominent feature & C. S. F picture).
- Viral encephalitis (fit, more prominent disturb consciousness, focal signs, C. S. F picture).
- Rocky Mountain spotted fever (RMSF) -> it comes with no neck stiffness.
- Subdural and epidural empyema and brain abscess (parameningial infections)-> the patient comes with fever and headache but CT scan shows empyema.
- Subarachnoid hemorrhage (usually no fever, C. S. F & CT brain scan findings).
- Chemical meningitis, drug-induced hypersensitivity meningitis.
- Carcinomatous or lymphomatous meningitis.
- Meningitis associated with inflammatory non-infectious disorders such as sarcoid, systemic lupus erythematosus (SLE), and Behcet disease.

## Treatment

**Start** Empirical Antimicrobial Therapy according to the most probable causative agent depending on the age of patient, till the result of C. S. F culture & sensitivity obtained when we should stop the empirical treatment & shift to specific ABs regime

باختصار لو شكيت انه المريض عنده meningitis ، مجرد ما اسحب العينات بعطيه Empirical antibiotic

## Empirical Therapy (I.V)

Age group	Empirical therapy
Preterm infants & infants during 1 month of life	Ampicillin + <b>cefotaxime</b>
During 2 & 3 months	Ampicillin + <b>cefotaxime</b> or <b>ceftriaxon</b>
From [completed 3 months to 55 years] of age	<b>Cefotaxime</b> or <b>ceftriaxone</b> + vancomycin (for MRSA)
> 55 years and <b>adults</b> of any age with <u>alcoholism</u> or other <u>debilitating illnesses</u>	Ampicillin(2g x 4) + <b>cefotaxime</b> (2g x 4) or <b>ceftriaxone</b> (2g x 2) + vancomycin(1 gx2)
<b>Hospital-acquired meningitis</b> (caused by Pseudomonas aeruginosa), posttraumatic or postneurosurgery meningitis	Ampicillin + <b>ceftazidime</b> (2g x 3) + vancomycin

### N.B :

- Ampicillin -> (L. monocytogenes)
- 3rd generation cephalosporins -> (p. cocci & m. cocci)
- vancomycin -> (staphylococci)
- **ceftazidime** -> (P. aeruginosa).

بدي أراقب وضع المريض فلو ما تحسن بعد 48 و ساعات أموره بدي اعمل shift

ل more wider spectrum مثل meropenem او carbapenem ولكن المشكلة انهم بزيدوا ال convulsions






■ Meropenem, a beta lactam broad spectrum antibiotic, is very effective & should be used instead of above medications if no response to them within 48 hrs.

■ It should be used with caution in case of fit because beta lactam group lower threshold for **convulsion**.

راجعوهم

MNEMONIC

Cephalosporins Classes:

	<b>1st Gen:</b> Starts with "cefa" sounds	cefazolin, cephalexin, cefadroxil (except: cefaclor - 2nd gen)
	<b>2nd Gen:</b> 2 furry foxes tan faces like pros	Cefuroxime, Cefoxitin, Cefotetan, Cefaclor, Cefprozil
	<b>3rd Gen:</b> 3 po'docs fixing dinner got tazed for late taxes	Ceftriaxone Cefpodoxime, Cefixime, Cefdinir, Cefazidime, Cefotaxime
	<b>4th Gen:</b> root word 'pi'	Cefepime
	<b>5th Gen:</b> root word 'ol'	Ceftolozane, Ceftaroline

# BACTERIAL MENINGITIS

## Steroids

هنا نحن لما نعطي antibiotics حيموت عدد كبير من البكتيريا و هاد العدد الكبير حيضل بال CSF و بالتالي ممكن يعمل strong immune response الي ممكن يؤدي الى damage في meninges و ال subarachnoid space و لهيك بدي اعطي المريض برضه steroids لنمنع حصول هاد ال damage

**I.V Dexamethasone** 2cc x 4 (=0.15 mg/kg/day / 4 doses) 20-30 minutes **before** ABs or at the same time of ABs and continue it for 4 days. It decrease adhesion & inflammation by inhibit IL-1 & TNF.

## Complications

- Moderate or severe sequelae occur in 25% of the cases.
- Common sequelae include intellectual impairment, memory impairment, seizures, hearing loss, dizziness, and gait disturbances

## Prognosis

### **\*\*Mortality is :**

- 3% - 7% -> H. influenzae, N. meningitidis, or group B streptococci
- 15% -> L. monocytogenes
- 20% -> S. pneumoniae

سوف تكون بخير؛  
فالعواصف لا تدوم للأبد.  
*You will be okay.  
Storms don't last forever.*

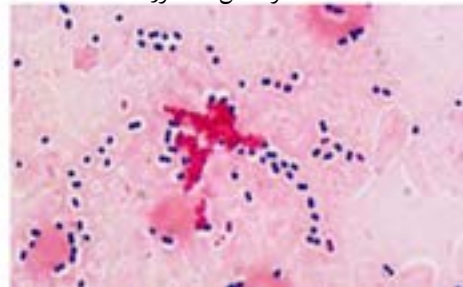
## Bad Prognostic Signs

- (1) decreased level of consciousness on admission
- (2) onset of seizures within 24 h of admission
- (3) signs of increased ICP
- (4) young age (infancy) and age 50 or more
- (5) the presence of co-morbid conditions including shock and/or the need for mechanical ventilation
- (6) delay in the initiation of treatment.
- (7) Decreased CSF glucose concentration < [2.2 mmol/L (40mg/dL)]
- (8) markedly increased SF protein concentration > [3 g/L (300 mg/dL)]

# MCQs

1. A 7-year-old child is brought to the emergency department by his parents with complaints of severe headache, fever, and vomiting for the past two days. Upon examination, the child appears lethargic and irritable, with neck stiffness noted during physical examination. Kernig's and Brudzinski's signs are positive. The parents report that the child has had a recent upper respiratory tract infection. Lumbar puncture revealed cloudy cerebrospinal fluid (CSF) with  $>100$  cells/mm<sup>3</sup> white blood cells, predominantly neutrophils. CSF protein was 110mg/dl. Gram stain of CSF showed Gram-positive cocci in pairs. Which of the following is the most likely causative agent of this patients' symptoms?

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- A) *Streptococcus pneumoniae*
- B) *Neisseria meningitidis*
- C) *Haemophilus influenzae* type b
- D) *Listeria monocytogenes*
- E) Group B *Streptococcus*
- F) *Escherichia coli*
- G) *Staphylococcus aureus*

2. Meningitis is defined as inflammation of the meninges and subarachnoid space and may be classified under several different categories. Of these categories, which of the following types is particularly serious due to the speed of its progression?

- A. Acute bacterial meningitis
- B. Aseptic meningitis
- C. Noninfectious meningitis
- D. Viral meningitis

3. When diagnosing meningitis, which of the following findings is a key indicator of meningeal irritation?

- A. Fever
- B. Headache
- C. Myalgia
- D. Nuchal rigidity

4. A 7-day-old infant presents to the emergency department with a fever, poor feeding, and a bulging fontanelle. During her physical examination, she begins to convulse. A Gram stain of the CSF reveals gram-positive rods. Which of the following organisms is the most likely causal agent?

- (A) *Escherichia coli*
- (B) *Haemophilus influenzae*
- (C) *Listeria monocytogenes*
- (D) *Neisseria meningitidis*
- (E) *Streptococcus agalactiae*

5. An infant presents with fever, convulsions, and nuchal rigidity during the first month of life. Which of the following agents is the most likely cause?

- (A) *Escherichia coli*
- (B) *Haemophilus influenzae*
- (C) *Listeria monocytogenes*
- (D) *Streptococcus agalactiae*
- (E) *Streptococcus pneumoniae*

6. Roommates of a 19-year-old college student become alarmed when he does not get up to go to swim practice in the morning and they are unable to wake him for his 11 AM class (he had complained of a headache and not feeling well the night before). The rescue squad finds a febrile, comatose young man with a petechial rash. In the emergency room, Kernig and Brudzinski signs are present. No papilledema is seen, so a spinal tap is done. Protein is high, glucose low. CSF WBC count is 9,000 (mainly PMNs) with few RBCs. The characteristics of the most likely causal agent are

- (A) An enveloped dsDNA virus
- (B) A naked (+)ssRNA virus
- (C) A Gram-negative bacillus with a polyribitol capsule
- (D) A Gram-negative, oxidase-positive diplococcus
- (E) A Gram-positive, lancet-shaped, alpha-hemolytic diplococcus

**Case F:** A family of Christian Scientists brings their youngest child to the emergency room because of fever and a stiff neck. The 18-month-old child is acutely ill with a temperature of 40.0 C (104.0 F). CSF is Gram stained, examined in a rapid test, and also cultured. A Gram stain shows pleomorphic, gram-negative rods.

A. What laboratory test could confirm the identity of the isolate?

*Answer: Meningitis screen, a series of immunologic rapid identification tests (usually EIAs using known antibodies), followed by growth of CSF sediment or filtrate on special media and drug susceptibilities.*

B. What growth factors are required to grow the isolate on blood agar?

*Answer: X = hemin and V = NAD.  
Chocolate agar provides both X and V.*

C. What is the drug of choice?

*Answer: Cefotaxime or ceftriaxone.*

D. What is the mechanism of action of the vaccine which would have prevented this condition?

*Answer: It is a conjugated vaccine containing the polyribitol phosphate capsular material of the most important serotype (the hapten) covalently coupled to the diphtheria toxoid (protein carrier). The hapten stimulates the B lymphocyte, the carrier stimulates the Th cell, and together, isotype switching becomes possible so that something other than IgM is made.*

7.

**179.** A 2-year-old child was admitted to the hospital with acute meningitis. The Gram stain revealed Gram-positive short rods, and the mother indicated that the child had received "all" of the meningitis vaccinations. What is the most likely cause of the disease?

- a. *N. meningitidis*, group A
- b. *N. meningitidis*, group C
- c. *Listeria*
- d. *S. pneumoniae*
- e. *H. influenzae*

### Questions 120–121

8. **120.** At a church supper in Nova Scotia, the following meal was served: baked beans, ham, coleslaw, eclairs, and coffee. Of the 30 people who attended, 4 senior citizens became ill in 3 days; 1 eventually died. Two weeks after attending the church supper, a 19-year-old girl gave birth to a baby who rapidly became ill with meningitis and died in 5 days. Epidemiologic investigation revealed the following percentages of people who consumed the various food items: baked beans, 30%; ham, 80%; coleslaw, 60%; eclairs, 100%; and coffee, 90%. Which of the following statements is true?

- a. This is not a case of food poisoning because only 4 people became ill
- b. A relationship between the death of the baby and the food consumed at the church supper can be ruled out
- c. Based on the epidemiologic investigation, the eclairs can be isolated as the source of the disease
- d. Based on the epidemiologic investigation, the baked beans can be ruled out as the source of the disease
- e. Additional epidemiologic data should include the percentage of those who ate a particular food item who became ill

9.

**121.** Microbiologic analysis revealed no growth in the baked beans, ham, or coffee; many Gram-positive beta-hemolytic, short, rod-shaped bacteria in the coleslaw; and rare Gram-positive cocci in the eclairs. The most likely cause of this outbreak is

- a. *Staphylococcus aureus*
- b. *Listeria*
- c. *Clostridium perfringens*
- d. *Clostridium botulinum*
- e. Nonmicrobiologic

1. a	4. c	7. c
2. a	5. d	8. e
3. d	6. d	9. b