

Serious Pediatric Infections



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Serious Pediatric Infections

Objectives

By the end of this session you will:

- Learn special concepts pertinent to children ID
- Outline a frame work for study of infectious diseases
- Enumerate examples of serious infections
- Classify episodes of bacteremia based on the clinical pattern
- Describe how the child age and other risk factors determine etiology of certain infections in pediatrics
- Appreciate utilization of knowledge of pathogenesis of diseases in the therapeutic and preventive measures



Pediatric Infections Diseases

*SPECIAL CONSIDERATIONS

❖ First exposure

most children will encounter the organism for the first time, whereas elderly will have had previous exposure with same or similar organism, which will cross react and form AB with less intense symptoms than pediatrics.

– Children are more liable to infection than adults, particularly in regards to respiratory infection.

❖ Immature Immune System

more infection in mucosal surfaces i.e. more gastroenteritis.

IgM starts forming in utero and reaches adult number by the first year of life.

IgG is not formed until 3-4 years.

IgA by 10-14 years.



Guidelines for study of Infectious Disease

- ❖ Etiology
- ❖ Pathogenesis
- ❖ Clinical Manifestations/course
 - ✓ Immunocompetent
 - ✓ Immunocompromized

- ❖ Epidemiology
 - ✓ Mode of transmission
 - ✓ Incubation period
 - ✓ Reservoir
 - ✓ Period of communicability
 - ✓ Susceptible individuals

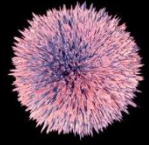


Serious Pediatric Infections

1. Bacteremias
2. Meningitis and encephalitis
3. Neonatal jaundice
4. Neonatal sepsis
5. Epiglottitis
6. Osteomyelitis
7. Septic arthritis
8. Endocarditis
9. Tuberculosis.... Etc.

Bacterial meningitis





MENINGITIS

- ❖ Etiology
- ❖ Pathogenesis
- ❖ Molecular pathophysiology
- ❖ Clinical Manifestations
- ❖ Diagnosis
- ❖ Therapy
- ❖ Complications
- ❖ Prevention
 - Chemoprophylaxis
 - Vaccination

Clinical description

- ❑ **Meningitis** is 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 can be life-threatening because of the inflammation's proximity to the brain and spinal cord; therefore the condition is classified as a medical emergency.



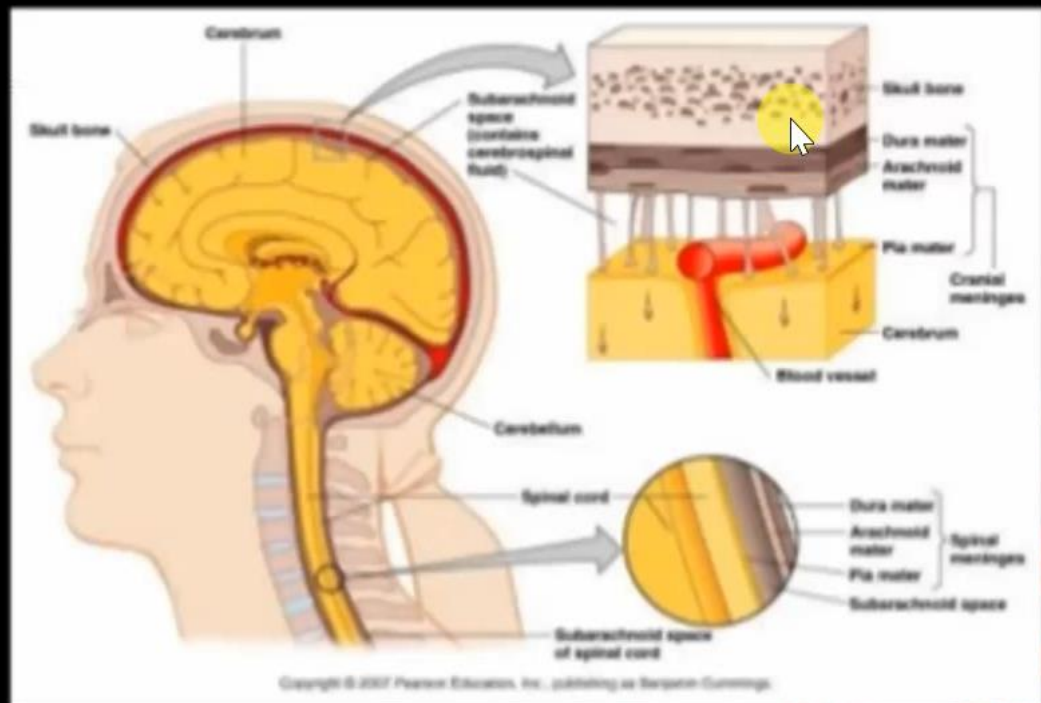
Meninges

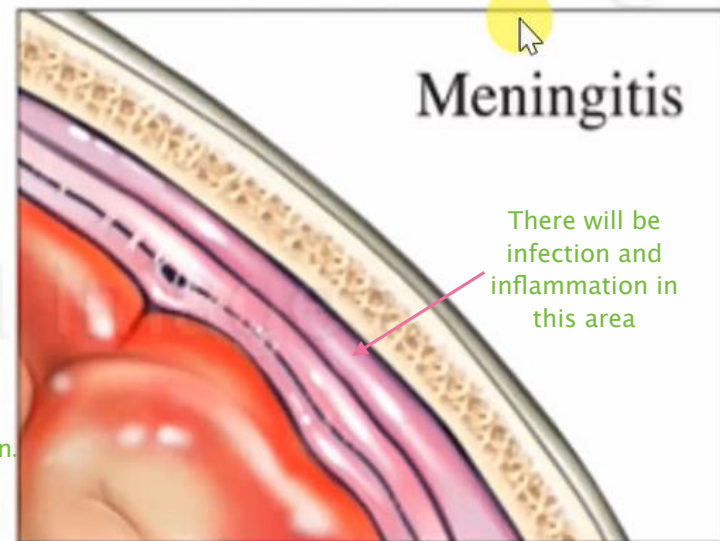
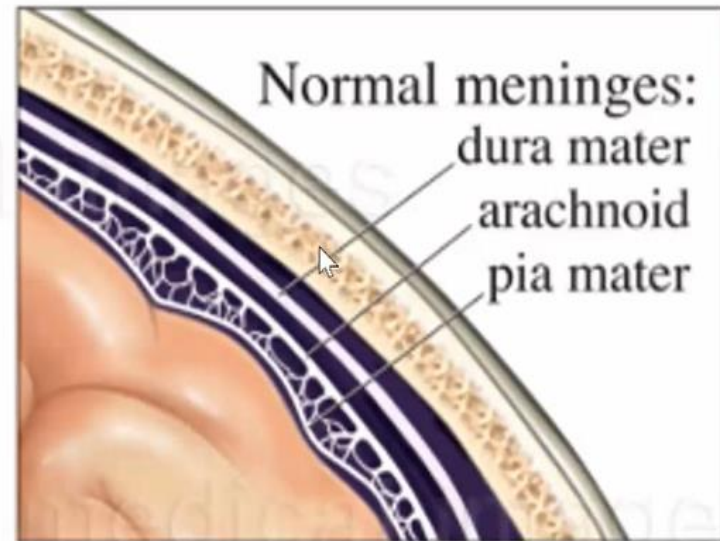
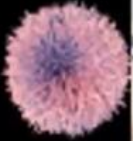
The **meninges** is the system of membranes which envelops the central nervous system.

It has 3 layers:

1. **Dura mater**
2. **Arachnoid mater**
3. **Pia mater**

Subarachnoid space - is the space which exists between the arachnoid and the pia mater, which is filled with **cerebrospinal fluid**.





Whenever we have infection or meningitis, this is what will happen. The brain will become inflamed.



it is called septic meningitis

- BACTERIAL AGENTS:

- In children, it is very important to memorize 3 bacteria: 1- streptococcus pneumoniae (the most imp.nowadays, that is why we include the vaccination) 2- niesseria meningitidis. 3-hemophilus influenzae (till the age of 4 years we consider hemophilus influenzae one of the most imporatant bacteria that can cause meningitis in children).
- niesseria meningitidis has the properties to cause infection and serious infection like meningitis, particularly in crowded situation. and whenever we have people going to hajj or omrah, people in campaign, in the military sitting, neonatal daycare.
- with the vaccine, the hemophilus influenzae are not considered anymore number one.
- number one causing meningitis in all ages after neonatal age is streptococcus pneumoniae.

It is very very important to memorize this. (all the bacterial agents). We like this question, we address it most of the time.

Neonatal: E. coli

Children get it from neonatal maternal tract. (the E.coli, Group B streptococci, hemophilus influenzae)

Group B Streptococci

Infants: Hemophilus influenzae

Adolescents and young adults:

Niesseria meningitidis(most common)

Streptococcus pneumoniae

Elderly: Listeria monocytogens

Streptococcus pneumoniae

- VIRAL AGENTS:

- it is called aseptic meningitis.

- usually it is less serious than the bacterial, except for HSVII.(very bad, it will cause meningioencephilitis or encephilitis rather than meningitis alone.

Enterovirus(most common), **Mumps virus, Coxsackie virus, HSVII, EBV**

- FUNGAL AGENTS:

- usually it will happen in the sitting of immunecompromised patient. e.g. patient with HIV.
-rare in immunecompetent patient.

Candida albicans, Cryptococcus neoformans, Blastomyces dermatidis, Coccidioidesimitis

- PARASITES:

-it will happen in immunecompromised patient, very rare in immunecompetent patient.

Protozoa, Nematodes, Cestodes



BACTERIAL MENINGITIS

ETIOLOGY

Determined by:

(I) AGE

- Neonates (< 3 months) : Group B strep > E-coli (and other gram negatives) > listeria.
- 3 months – 5 years: strep. pneumoniae > N. meningitides > HiB.
- >5 years: No HiB even in non-vaccinated children because of vaccination.

(II) SPECIAL RISK FACTORS:

The route of transmission is usually hematological, but we can have other route like:

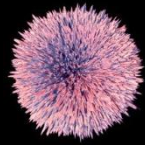
- Post-traumatic: Basal skull fractures: 80% are strep. pneumoniae.
- Post neurosurgical: staph and gram negatives
- Ventricular shunts: staph epidermidis (coagulase negative).
- Immunocompromised: depends on the organism.
- Asplenia and SCD: Salmonella and encapsulated organisms.

the patient will be prone to other bacteria than the 3 I mentioned before. very important.

it is logically understandable because staphylococcus can be a commensal flora in the skin, so once we have any communication through the skin between the skin and the meninges or the brain, staphylococcus infection can go there and can cause ventricular shunt infection

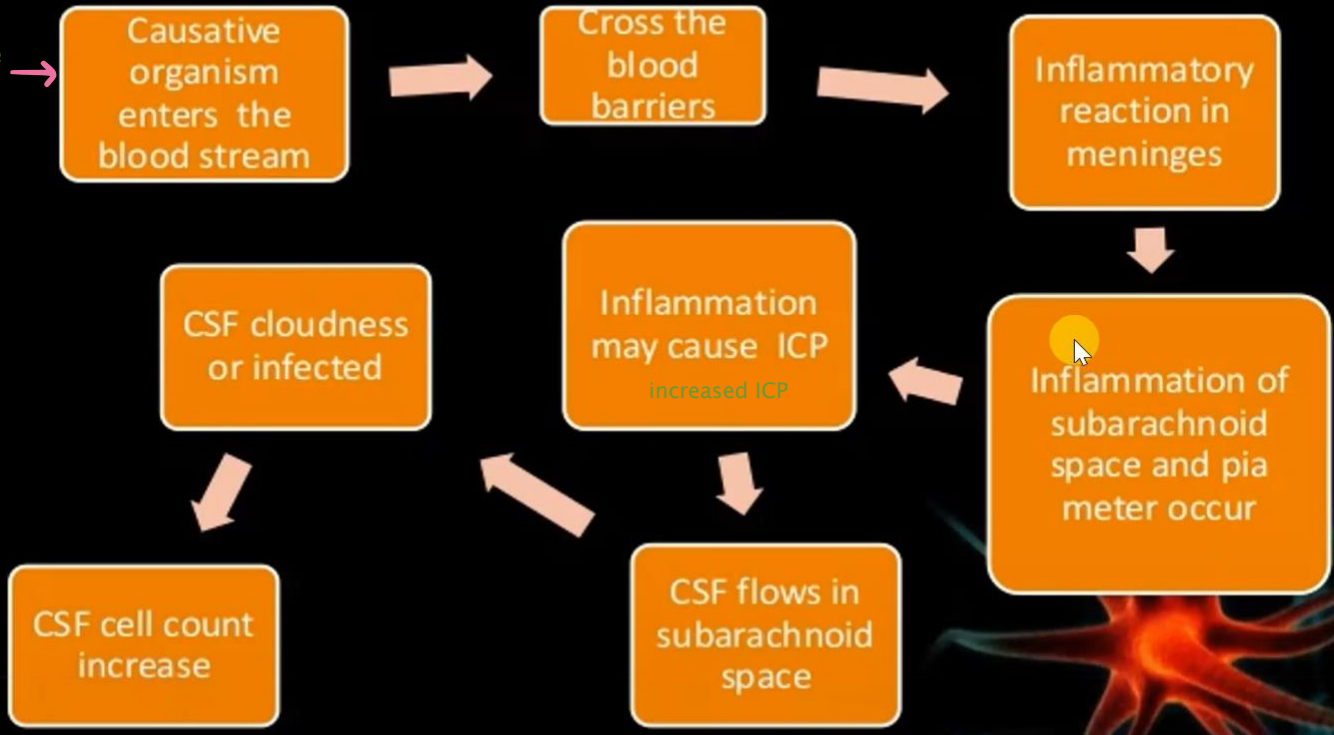
like hemophilus influenzae, streptococcus pneumoniae...etc

immune-compromised patient, in addition to the 3 bacteria I just mentioned, they can have unusual organisms such as the fungal infection, parasitic and gram negative like salmonella and brucella...etc



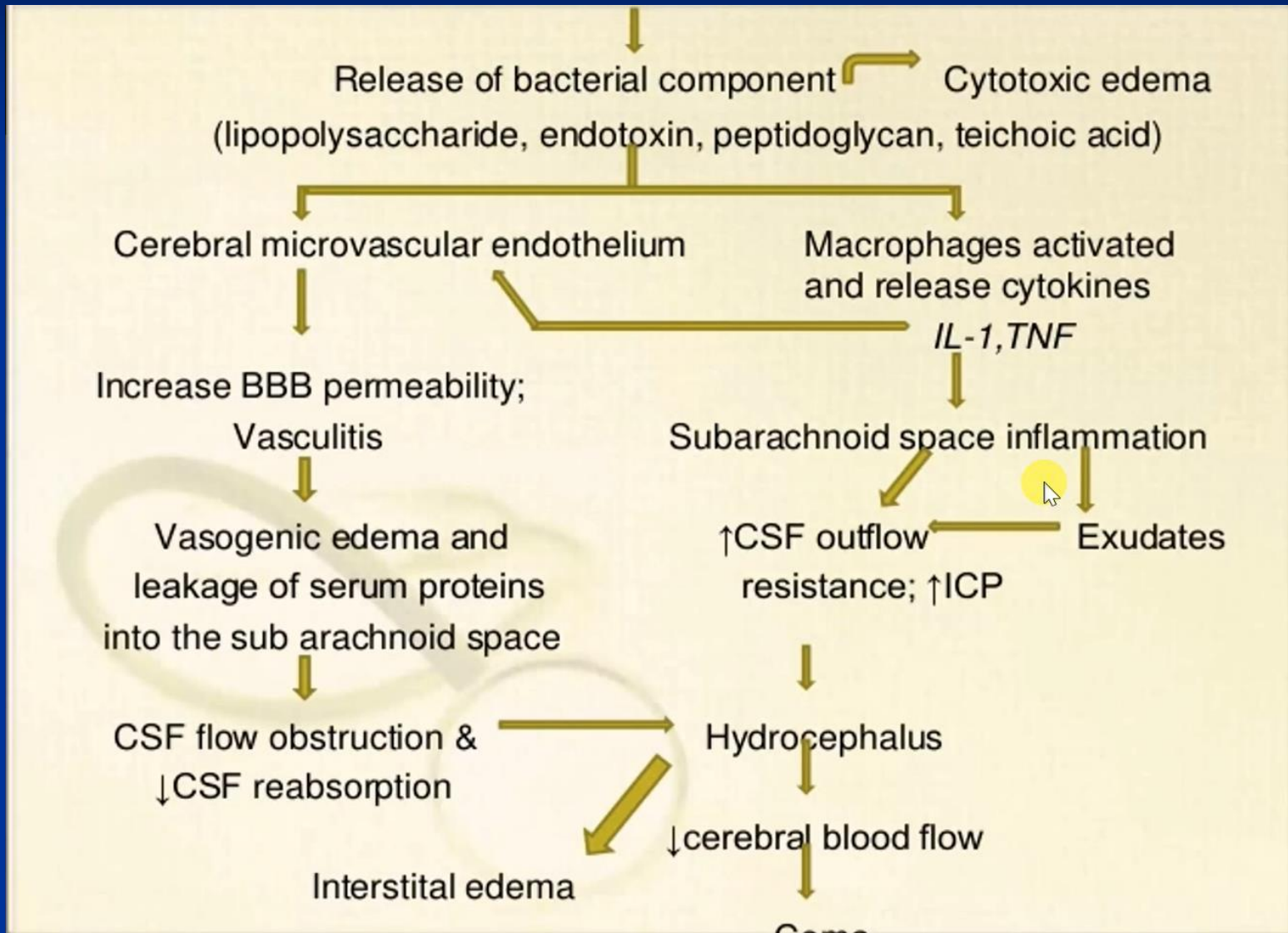
Pathophysiology

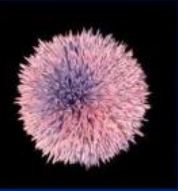
usually it will be a mucosal infection either URTI or LRTI and the patient will have the organism coming from the mucosa entering the blood stream, then





doctor went through it all.





CLINICAL PRESENTATION

- it depends whether we are dealing with a neonate or older child.

- in neonate, irritability, restlessness, hypothermia and sometimes hyperthermia, tachycardia, sleeplessness. so the mother will tell you that the baby is he is not feeding well. so I need to exclude the possibility of CNS infection.

-older children, they can manifest with these signs and symptoms.

■ IN NEONATE & IN OLDER CHILDREN

neonate: age less than 30 days.

Sign and symptoms

- Severe headache
- Irritability
- Restlessness
- Stiffness of neck
- Malaise
- Nausea/vomiting
- High grade fever
- Tachypnea
- Seizures
- Disorientation
- Tachycardia
- Coma
- Sleeplessness
- Phonophobia
- Photophobia
- Altered mental status(confusion)

to elicit this, ask the child to bend his neck, he will not be able to obey this order. and if you tried to examine him by bending his knee, you will find that he has stiffness.



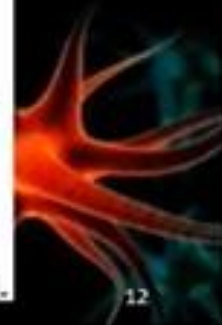
Kernig's is performed by having the supine patient, with hips and knees flexed, extend the leg passively. The test is positive if the leg extension causes pain. (leg pain)


important and comes in exams

Clinical manifestation

Confirmative sign:

- Positive kernig's sign

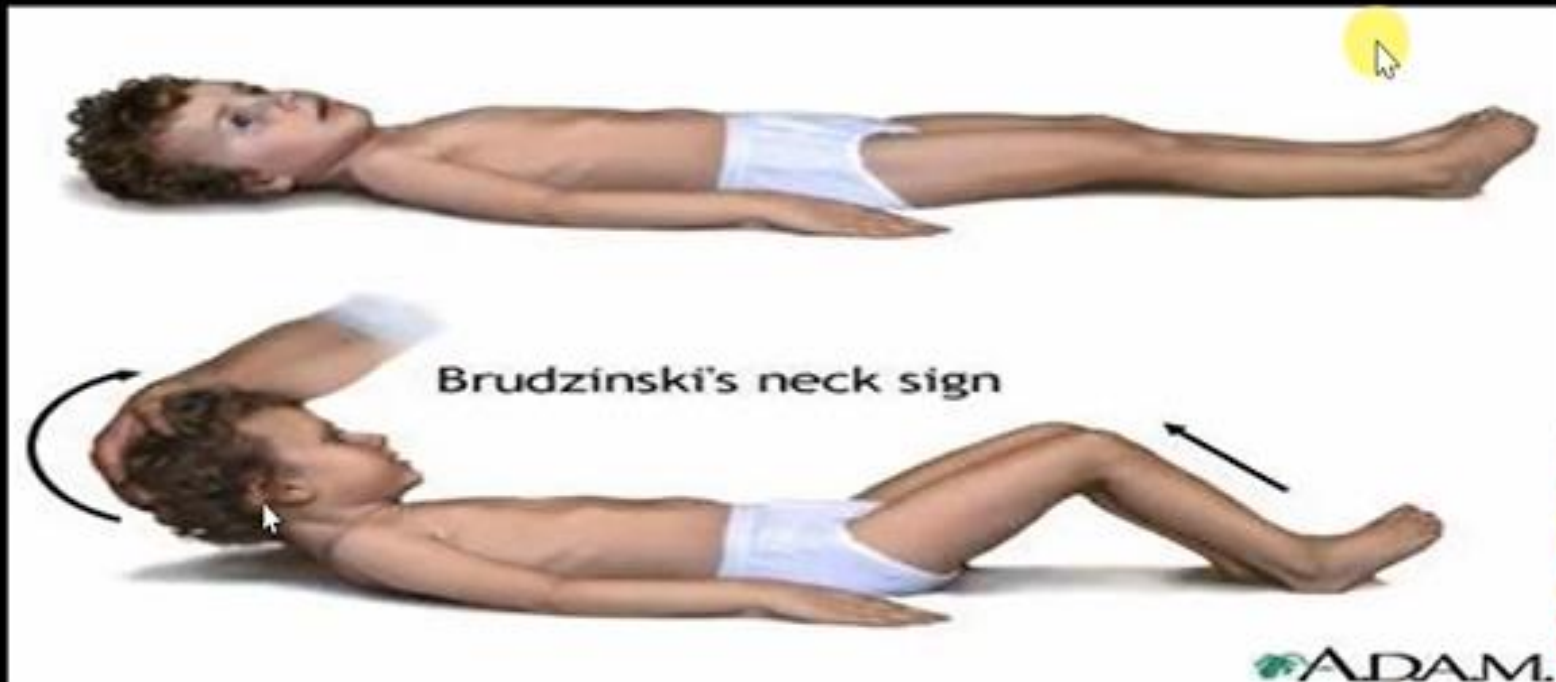


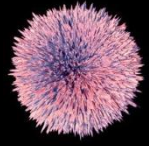


The Brudzinski's sign is positive when passive forward flexion of the neck causes the patient to involuntarily raise his knees or hips in flexion

do we need to do these tests for all patients? YES. any child more than neonatal age, it is important to try to elicit these signs.

Brudzinski's Sign





DIAGNOSIS

- **CBC** - leucocytosis or leucopenia (worst prognosis signifies meningococcal disease). Never discharge a patient with normal CBC and fitting clinical picture.
- **BLOOD CULTURE** - 60-70% specific.
- **CSF Color** *turbid or clear?*
 - Cell count and differential.
 - Chemistry: Sugar & Proteins
 - Gram stain is positive in 70-80% of the patients.
 - Latex agglutination or co-agglutination is used to detect the antigen instead of culture because the culture takes 24 hours. → not accurate if the pt on Abx
 - Culture is the gold standard

very rapid test, but can only tell me about certain bacteria like hemophilus influenzae, streptococcus pneumoniae, Meningococcal meningitis, enterobacteriaceae group



DIAGNOSIS

- we should have zero WBC in CSF.

- in infants, we can accept up to 30, sometimes 40, WBC in the CSF as normal. (important)

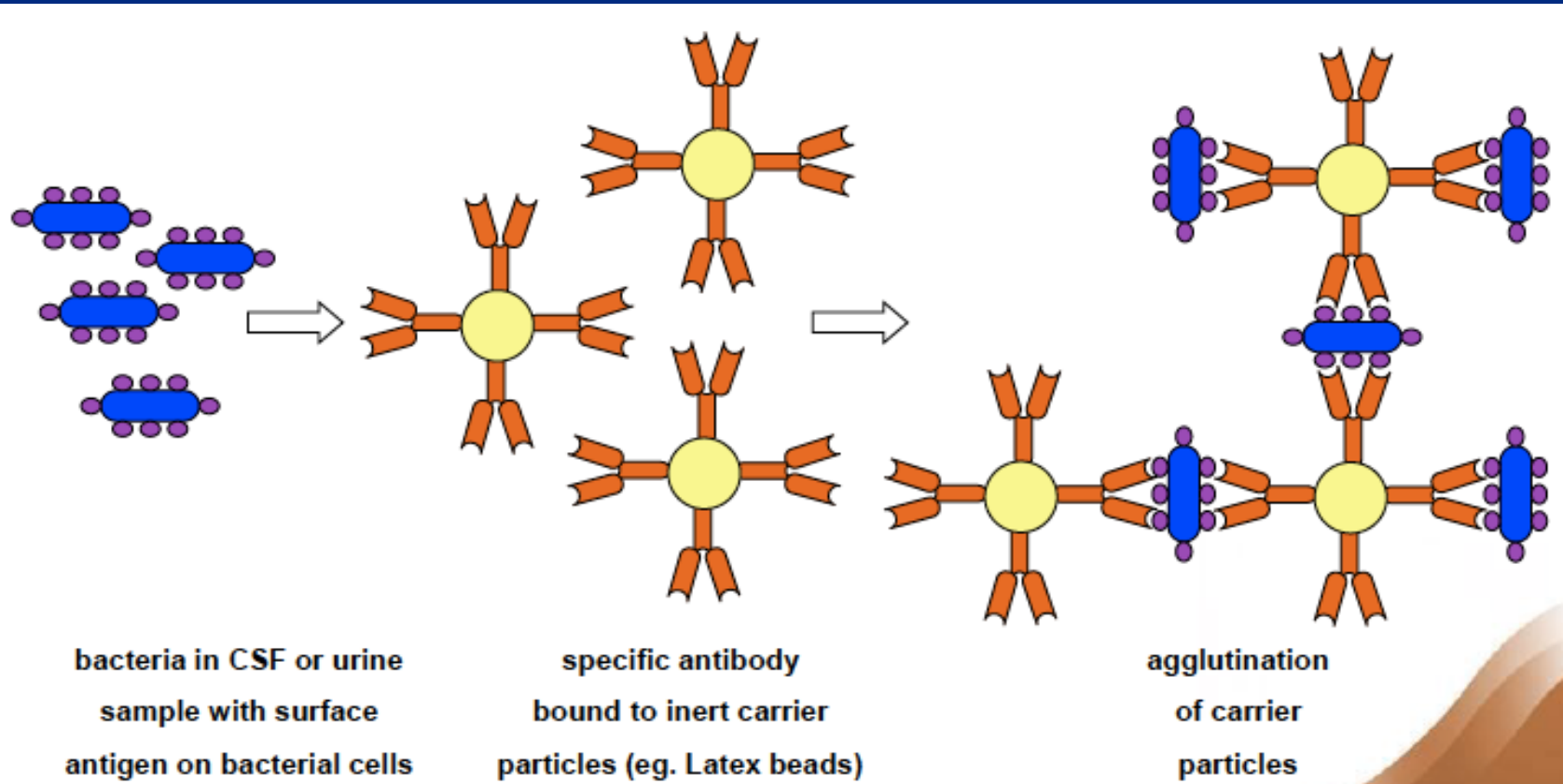
- CSF - there are three components in the CSF we should look at- WBC, glucose, and protein
- For bacterial meningitis, the WBC is mainly polymorphic and the glucose is less than 50% of serum glucose (normal is 2/3 of serum glucose). If it was partially treated bacterial meningitis the lymphocyte predominates.
- For Viral or TB, the WBC is mainly lymphocytic. Sugar is normal.
- For fungal and TB meningitis, the glucose is less than 50% the serum glucose. The protein is raised in all, but might be normal in viral.

- I have to do CT scan or MRI. why? because i do not want to preform CSF and the patient has increased ICP and he will go for coning. so important to order urgent CT or MRI in the ER before sending the patient to the word.

- the CT or MRI will show me the meningeal enhancement indicating there is inflammation.

LATEX AGGLOUTINATION OR CO-AGGLOUTINATION

the doctor went through it





MANAGEMENT

مره مهم: لو كان عندك شك ١٪ ان المريض هذا يمكن عنده meningitis
please act accordingly.

- **Supportive care** -is the most important. Careful monitoring of the patient, by checking the blood pressure for hypertension and the respiration for the RR, and pH.

- **Antibiotics**

- Which one?
- How much?
- For how long?

start empirical ABx (I do not know the organism, but i know the most likely ones): 1- hemophilus influenzae 2- streptococcus pneumoniae 3- niesseria meningitidis in children.

in neonate the spectrum of organisms will differ: i will include 1- enterobacteriaceae group 2- gram negative 3- listeria monocytogees.

- **Children**

- **Ceftriaxone + vancomycin** or gentamycin + vancomycin

- **Neonates**

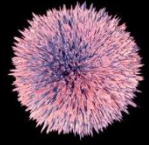
- Cefotaxime + ampicillin ampicillin is the drug of choice
- Gentamycin + ampicillin for listeria monocytogees

why cefotaxime? because the ceftriaxone might cause a problem with the gallstone formation in the bile duct

- ceftriaxone will cover hemophilus influenzae, niesseria meningitidis, and streptococcus pneumoniae.
- why vancomycin? because the patient might has streptococcus pneumoniae that is resistant to ceftriaxone.
- once the test came back from the lab and they tell me that it is streptococcus pneumoniae and it is susceptible to ceftriaxone, stop vancomycin.
- if the lab tell me it is streptococcus pneumoniae and it is susceptible to penicillin, i can stop both and continuo on penicillin.
- if resistant to ceftriaxone, continuo on vancomycin.



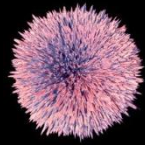
- Dexamethasone - modulates the release of inflammatory mediated factors.
- Dexamethasone with AB gave promising results with values approaching the normal. There is still a need for more data to indicate the need for dexamethasone in every case. Dexamethasone should be given at the time of AB and not after and in some cases it can be given just before (don't give dexamethasone if it's late presentation). Long-term dexamethasone decreases deafness, which is a complication of meningitis.
- Steroids are important because they decrease the level of inflammatory mediators, which are the cause of complications.



COMPLICATIONS

- **EARLY** - subdural effusion with fever resolves alone when the patient is on antibiotics. It rarely needs drainage.
- **LATE** - brain abscess is a rare complication of meningitis and is seen in a specific age group and bacterial organism.

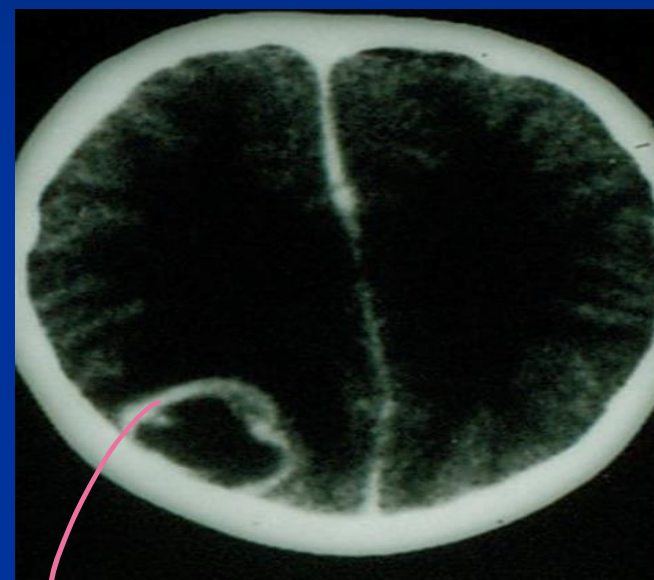
+ hearing difficulty .



subdural effusion

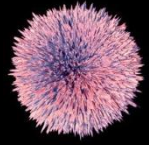


meningeal enhancement



ring enhancement

complication: brain abscess



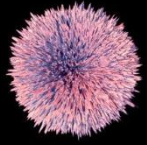
PREVENTION

❖ CHEMOPROPHYLAXIS

- ❖ Rationale - If one person is infected with meningococcal meningitis, it increases the risk by an 800 to 1000 fold of the community being affected; therefore, we treat the entire family.

❖ Protocol

- ❖ VACCINATION - HiB, meningococcal, and some require pneumococcal vaccine. the most important



ENCEPHALITIS

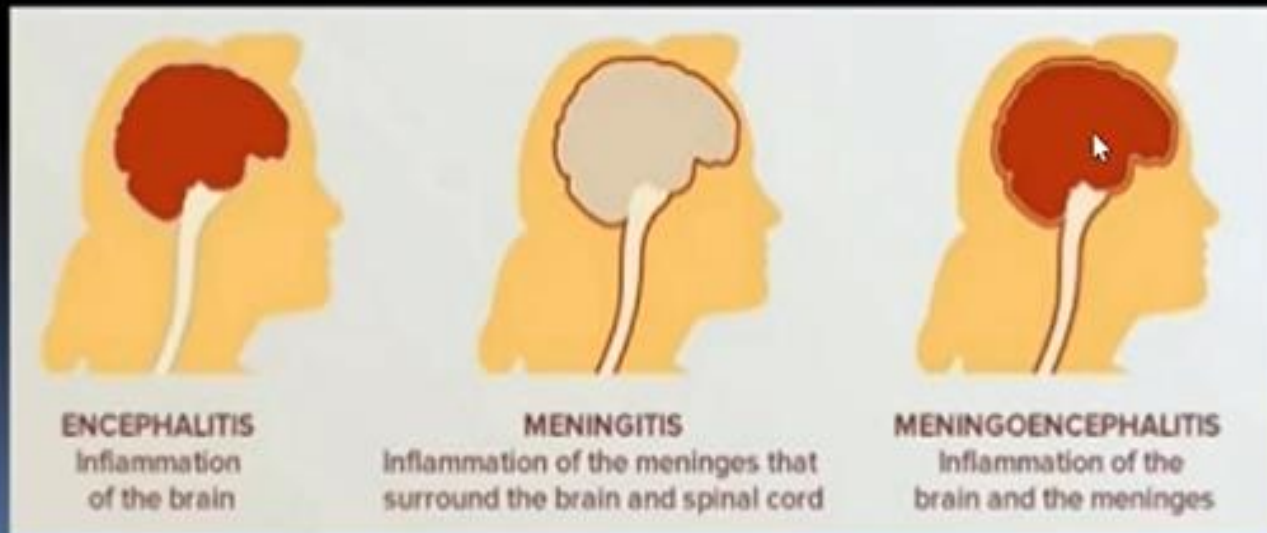
Introduction

- Encephalitis is defined as an inflammation of the brain caused either by infection, usually with a virus, or from a primary autoimmune process .
- Many patients with encephalitis also have evidence of associated meningitis (meningoencephalitis) and, in some cases, involvement of the spinal cord or nerve roots (encephalomyelitis, encephalomyeloradiculitis)

Definitions

- **Meningoencephalitis** - is an acute inflammatory process involving the meninges and to a variable degree, brain tissue. Is a common term that recognizes the overlap
- **Encephalopathy** - describes a clinical syndrome of altered mental status, manifesting as reduced consciousness or altered behaviour.

no fever, no signs of inflammation





General:

Most common pathogen in pediatrics is entero-viruses fortunately they are self-limiting, and the most serious is HSV, which increases morbidity and mortality.

Diagnosis:

CSF PCR

Previously by brain biopsy but nowadays PCR is the diagnostic tool.
MRI shows the effects early.

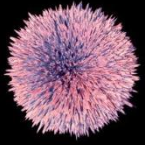
or CT

Treatment:

If HSV encephalitis is *suspected*, start acyclovir immediately even if the diagnosis was not yet confirmed because this type is very serious.

– if in addition to signs and symptoms of meningitis, the patient will have altered consciousness so I will start the empirical treatment with ceftriaxone+vancomycin+acyclovir.

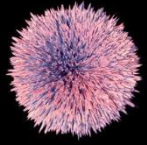
–if I suspect encephalitis, I need to add as an empirical coverage acyclovir. and send CSF PCR for HSV, if positive, continue on acyclovir. if it is negative and the assessment does not go with encephalitis, stop acyclovir.



OSTEOARTICULAR INFECTIONS

it is a serious infection, why? the child will have limping and disability for his whole life due to wrong diagnosis and management.

therefore, it is important to know how to diagnose and manage osteoarticular infections and how to approach it in pediatric age group..



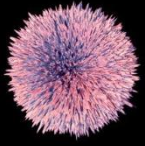
Presentation: the commonest presentation.

1. Pain.
2. Limping. or avoid using that limb.
3. Swelling.

Note: Septic arthritis of the hip is very dangerous because it is a deep-seated infection and doesn't cause any swelling. It can lead to vascular necrosis because the blood supply is from the acetabulum and goes around the joint, if there is pus it will press on the vessels therefore ER drainage is important.

4. In neonates, it is not obvious because they can't complain but it is noticed when the mother changes the diaper and the baby cries. The neonates usually maintain their hip in lateral rotation and flexion to have more space in the joint and thus relieving the pressure.

-septic arthritis of the hip is very dangerous because it is a deep infection, so it does not cause any swelling and it can lead to vascular necrosis (the pus press on the vessel so emergency drainage is very important).



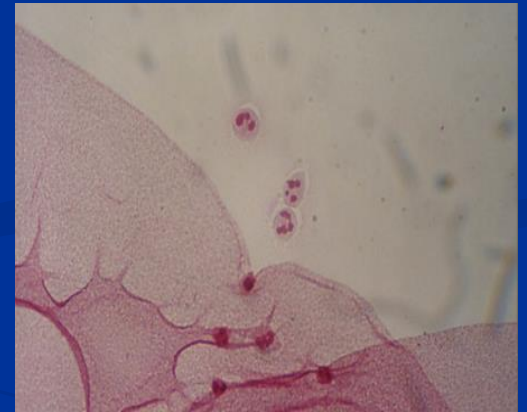
he may have septic arthritis of the knee joint with radiation to the femur, so osteomyelitis.

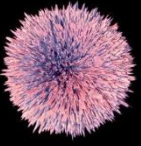


the child is keeping his leg in flexion and lateral position (comfortable position), to keep the joint open and avoid pressing on the joint vessel, so avoiding pain



swelling of the joint.



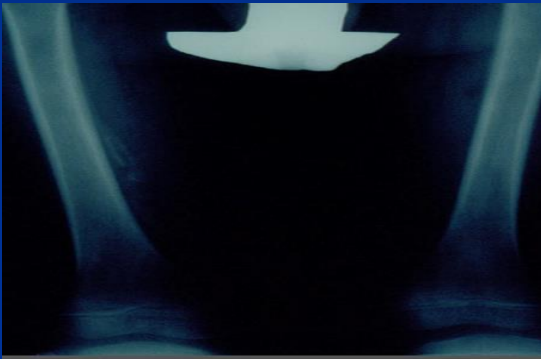


-to diagnose, we need X-ray.

-usually we do not do x-ray for suspected arthritis, but we do it for suspected osteomyelitis. we look for increased intra-articular space, periosteal reaction.

-in chronic osteomyelitis, there might be formation of dead bone, it is called sequestrum

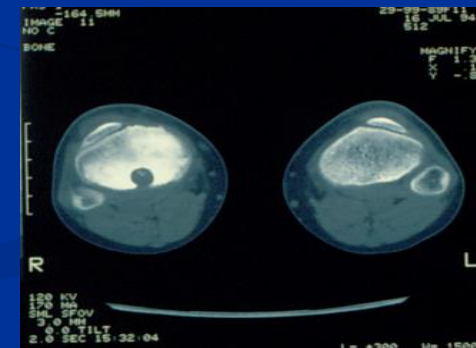
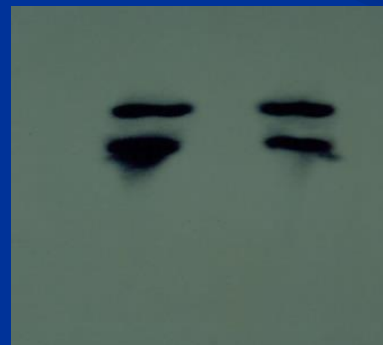
-other methods of radiology to use: bone scan, MRI (the best).



increased intra-articular space.



bone scan: there is high uptake of the dye.



MRI



do we do bone or joint aspirate to know the underlying organism? NO. unless there is a complication or if it is diagnostic-therapeutic.

Imaging

- Bone change (such as avascular necrosis or periosteal reaction) is not seen on X-ray until the 10th day, but it can be detected earlier by nuclear scan.
- The radionuclear scan will show increased uptake **sequestrum** by the osteoclasts and periosteal reaction, which indicates chronic infection.
- If there is any radiolucency, suspect malignancy.

Complications

1. Avascular necrosis.
2. Joint destruction.

start empirical treatment immediately: ceftriaxone and anti staph like vancomycin, clindamycin, cloxacillin.
and if the patient is admitted and i have the culture, I can modify the antibiotic accordingly.

Treatment

if hemophilus influenzae: ceftriaxone. | if staphylococcus aureus (which is the most common organism to cause osteomyelitis and septic arthritis in pediatric age groups): use only antistaph.

1. **Debridement** and removal of sequestrum to prevent recurrence along with
2. Long-term antibiotics. Antibiotics use in acute osteomyelitis is 4-6 weeks, and 4-6 months in chronic.
in septic arthritis: 2-4 weeks.

Case: 10 year old limping for two months

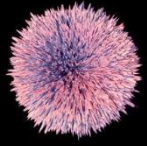


CONGENITAL INFECTIONS (TORCHS)



TORCHS and others no longer limited to TORCHS.
Certain presentation common to all

1. Hydrocephalus
2. Cerebral Calcifications (seen in toxoplasmosis and CMV)
3. Blue muffin syndrome seen in all



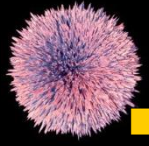
Tetanus in neonates

- Prevented by vaccination of the mother.
- Two doses if mother is not vaccinated or the doses can't be determined.
- The vaccine is safe during pregnancy but better given before.



Childhood Tuberculosis



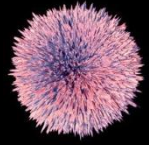


Tuberculosis is a chronic infectious disease caused by *Mycobacterium tuberculosis* characterized by vague constitutional symptoms and a protracted course of illness with remissions and exacerbations

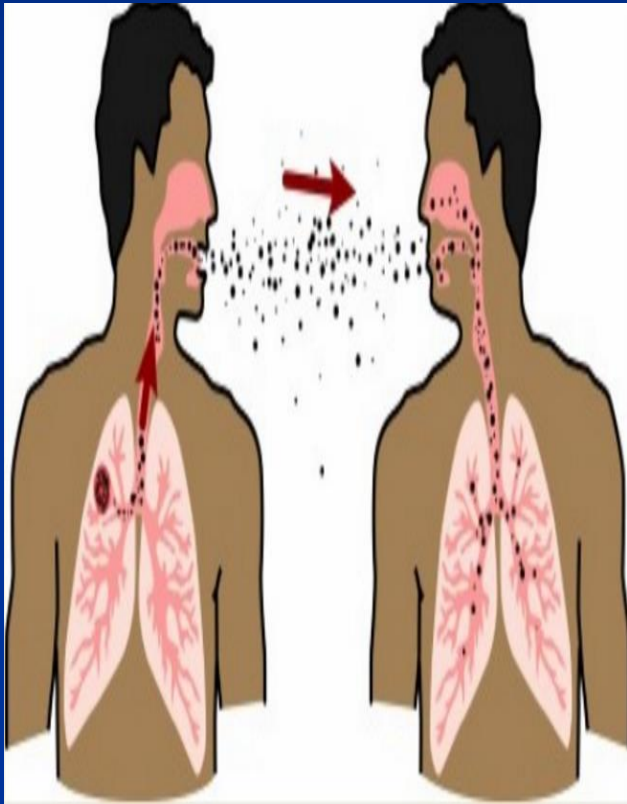


TB Diagnosis in Children

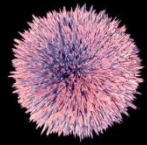
- Bacteriologic confirmation is achieved in only about 30-40% of cases
- Therefore, diagnosis often based on presence of a combination of the following characteristics:
 - History of close contact with adult with TB (especially if smear positive)
 - Triad of :
 - Signs and symptoms compatible with TB disease
 - A positive tuberculin skin test (TST)
 - Suggestive lab results or radiographic findings



How TB is Transmitted?



- Person-to-person
 - Through the air by a person with pulmonary TB disease of the lungs when he or she coughs, sneezes, or speaks
- Less frequently transmitted by ingestion of *Mycobacterium bovis*
 - Found in unpasteurized milk products
- Other modes of transmission
 - Vertical transmission (rare) – congenital TB
 - Contaminated bodily fluids (very rare)



TB: Adults vs Children

Compared to adults, children:

1. Tend to develop primary active TB more often after initial infection (0-4 years)
2. Are more likely to have extra-pulmonary disease, especially TB meningitis (0-4 years)
3. Are more likely to have extra
4. Are less contagious because their cough is not as strong as the adult's.
5. Are more difficult to diagnose because if we need a sputum for acid fast bacilli, it is difficult to tell the child to give sputum. we use other methods: nasogastric specimen, collected in 3 consecutive days in early morning.
6. A child with active TB is an indicator of unidentified contagious adult/adolescent with TB
7. A child suspected of having active TB may not yield any positive cultures/smears
8. Need the adult contact's culture results for drug sensitivities and to determine treatment regimen for the child

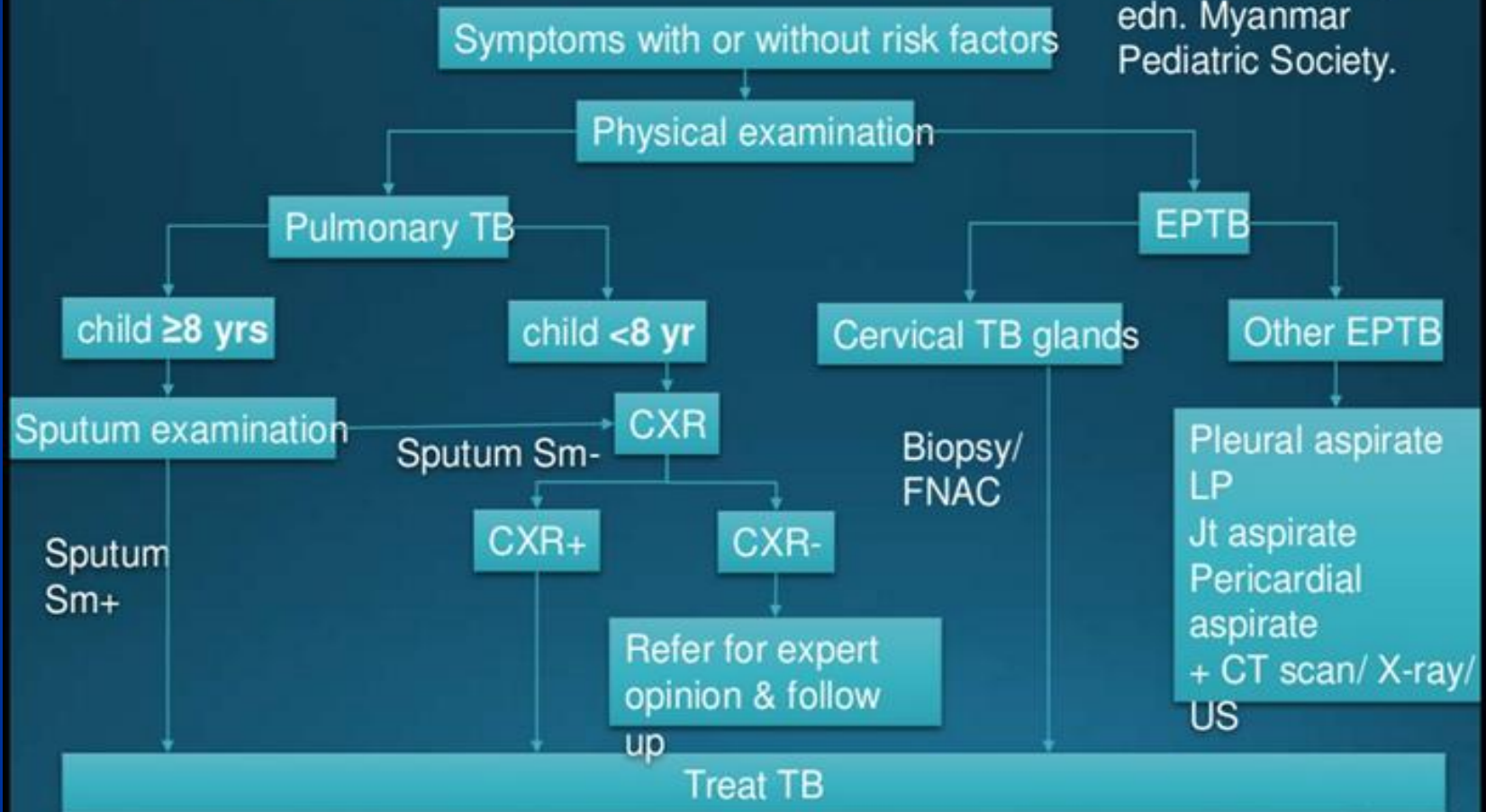


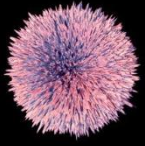
TB IN Children

- Points to remember:
 - Diagnosis may be difficult;
 - Sputum cannot often be obtained;
 - Sputum often negative for AFB even on culture;
 - Symptoms are atypical
 - Diagnosis depends on clinical history, family contact history, X-ray examination and TST.

General approach to Dx of TB in children

Pediatrics for undergraduates, 2nd edn. Myanmar Pediatric Society.





Thank you