

# Neonatal infections

## Bacterial Infections in the Neonate

اول 28 يوم

- sepsis in the 1<sup>st</sup> month of life
  - 20% م دقوة الحلاج → **sepsis** Clinical syndrome
  - any change from normal → **sepsis**
  - 1<sup>st</sup> month with cough DDx → **Pneumonia** X  
✓ sepsis ←
  - 1<sup>st</sup> month with diarrhea DDx → **gastroenteritis** X  
✓ sepsis ←
  - 35% of early sepsis → **Complicated**  
hydroceph → **Meningitis** 1/3
  - 75% of late sepsis → **Complicated**  
(after 7 days) **Meningitis** 2/3
- No isolated infection

\* **sepsis** ✓  
\* **Meningitis** ✓  
\* **septic shock** ✓

\* Most sensitive sign & symptom for Neonatal sepsis → **hypoactive, Poor suckling**

الس (rarely) : fever  
Euthermic or hypothermic

\* 2 types early  
late

- **(GBS)** → M.C & important Microorganism
- **(GC)**
- **Listeria**
- **ureaplasma**
- **Chlamydia**
- **Gram negative sepsis**

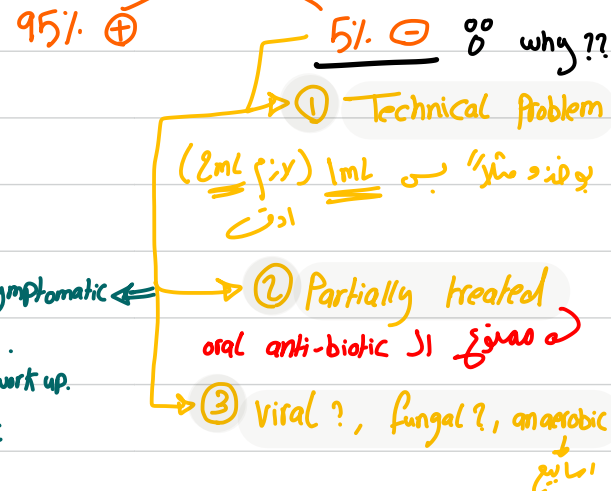
the presentation of (GBS) in neonatal sepsis is rapid & fulminant.

\* 45% of sexually active females carrier for **(GBS)**

\* 70% of early sepsis infected by **GBS**

Incidence is 1-8/1000 live births

An ill-appearing infants less than 1 month with a positive **blood culture** → **Gold standard**



\* any baby symptomatic  
1 admission.  
2. full septic work up.  
3. IV antibiotic

No need Prophylaxis # 4 doses

\* 45% colonised → should do swap at 35 w.  
(neonatal sepsis) → vaginal or caesarean

\* blindness

Gonorrhea fte :- ① (silver nitrate) new ② erythromycin eyedrop after delivery → ③ vit. K + 2 drops

## Routes of Infection

Bacteria can infect a previously sterile fetus:

- **Transplacental** (syphilis, listeria, mycobacterium)
- **Ascending** immediately before delivery, (early onset GBS)
- During passage through **birth canal** (gonococcal ophthalmia, E. coli)
- **Colonization** at time of birth, with subsequent late onset infection (GBS, listeria)

Most common cause of acquired virus

\* GBS can infect the baby up to 3 months  
old classification :

- ① early → < 7 days
- ② late → 7 - 1 month
- ③ late late → 1 month - 3 months

\* listeria can infect the baby up to 3 months , & chlamydia a.p.g.

## Classification of sepsis

\* > 6 hours viral

① early onset :-

- during 1<sup>st</sup> 7 days
- ↑ incidence during preterm infants
- M.C Microorganism **GBS**  
:  $\text{الميكروبكتريا بالهائم}$

intrapartum you have to give 4 doses of Ampicillin  
you can prevent infection (Rapid fulminant sepsis)  
(severe Respiratory)  
RDS



Risk factors interconnected with vertical transmission of causative organisms include:

- Premature → The mos imp. single RF
  - prolonged rupture of chorioamniotic membranes (PROM). 2<sup>nd</sup> > 18 hours
  - Maternal colonization with (GBS).
  - Intrapartum maternal fever. leading cause
  - Maternal UTI. → intrapartum prophylaxis
  - Preterm delivery. asymptomatic bacteriuria should be kept
  - Chorioamnionitis.
  - Meconium aspiration. Risk for sepsis + Preterm Labor
- Meconium Aspiration can cause chemical pneumonitis, leading to severe respiratory distress in newborns.



Full term  $\omega$  with RDS due to GBS

baby GA = 35w. / لا في سن 1 \*  
with RDS

→ PPHN (Primary Pulmonary HTN)

منذ فولات الحنّاج 75%  $\rightarrow$  you can prevent 75%

\* Presentation of GRS :-

✓ severe RDS after delivery  
with rapid fulminant sepsis  
(serious)

نشیبی هیپو active و و و و  
سپسید بیا می sepsis

Protocols 1 htt depends on Cause

- Risk factor 1)  $\sigma$

من الامور التي لا GRS و UTI  
sepsis

فصل ١ حالات (Congenital pneumonia)

1st: *E. coli*, 2nd: *Klebsiella*

GBS 69%  
GN bacilli 15%  
Enterococcus 3% *rare*  
Coag Neg staph 2%  
Staph Aureus 2%  
Other 8%

M.C in late

int N Risk is  
GBS → bacteremia is is  
 How to treat ???  
2 w.

اسماء

لما نجزي ما هنته ← (١) مكسنة (٢) ممكن بلن Premature يتا بها  
(٣) ممكن يولده secondary infection

**Gram-positive organisms Group B beta hemolytic streptococcus is the most common and is associated with the rapid onset of fatal respiratory disease and shock.**

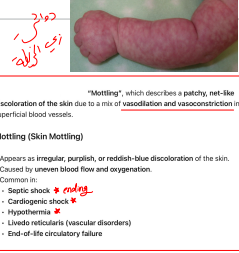


أي تغيير ← any change from Normal

## Presentation

Presentation signs are nonspecific and may include any of the following:

- Poor feeding
- Lethargy
- Temperature instability Irritability → bad sign (Mottling of skin)
- Apnea → Cessation of breathing 20 sec. associated w/ Cardiovascular Manifestation
- Respiratory distress
- Hypo/hyperglycemia
- Shock
- Metabolic acidosis → another bad (↓ Perfusion)
- Cyanosis and skin color change
- Seizures → late (Meningitis) → brain insult → SIADH → severe hyponatremia → demyelination
- Hypotonia
- Gastro intestinal symptoms such as vomiting and diarrhea
- Jaundice



"Mottling", which describes a patchy, red-blue discoloration of the skin due to a mix of vasodilation and vasoconstriction in superficial blood vessels.

Mottling (Skin Mottling)

- Appears as irregular, purplish, or reddish-blue discoloration of the skin.
- Caused by uneven blood flow and oxygenation.
- Common in:
  - Septic shock & endotoxemia
  - Cardiogenic shock
  - Hypothermia
  - Livedo reticularis (vascular disorders)
  - End-of-life circulatory failure

\* Coag Neg staph:

slow infection

gradual

Not Rapid

SD, sepsis

slow infection

G<sup>-</sup> → Rapid

Pseudomonas → Rapid

GBS → Rapid

\* Culture:  $\frac{36h}{initial} - \frac{70h}{final}$  } كم يحتاج ؟؟

anemia mask the symptoms.

50 is low 75 is normal

80-90 Polycythemia

copd...

\* Central Cyanosis: Bluish discoloration of Mucous Membrane with deoxyhemoglobin > 25% with Normal hemoglobin.

\* average deoxy Hgb in Adults = 5g

\* " " " Neonates = 25



## ② late onset

less than early onset sepsis

- ① M.C organism → Staph
- ② 8-28 days of life
- ③ invasive procedure

start early feeding

to stimulate Normal flora

Normal flora of the gut → immunity + hormonal changes

### Risk factors :

Mechanical Ventilation  
Endotracheal intubations

1. Anti-pseudomonal Beta-lactam:  
• Piperacillin-Tazobactam (preferred if stable)  
• Ceftazidime or Cefepime (3rd & 4th generation cephalosporins with Pseudomonas coverage)  
• Meropenem (preferred in critically ill neonates or if concern for ESBL-producing strains)

gradual onset

Pseudomonas

→ Rapid

إعزاني  
Pneumonia

azithromycin  
(clarithromycin)  
Pneumonia

- Indwelling urinary and vascular catheters
  - Lack of enteric feeding
  - Inborn error of metabolism
  - Exposure to broad spectrum antibiotics, which may alter normal flora and permit overgrowth and dissemination of fungal species.
- we can't differentiate btw RDS & GBS

### Causative Organisms ::

gram-positive organisms predominate most of the cases.

Coag Neg staph 43% → Preterm infants & top 10 (common skin flora)

GBS 11% → Ampicillin + gentamycin

GN Bacilli 15%

Enterococcus 5% → Ampicillin

Staph Aureus 4% → 3rd cephalosporine

MRSA 2%

Fungal 2%

\* empirical ttt :

high index of suspicion  
1 microorganism to  
choose Ab. according #

✓ Feeding intolerance

✓ Need for increased environmental oxygen

✓ Persistent tachycardia.

90% No fever  
(Not Mandatory)

Fungal infections with Candida species occur frequently in small preterm infants.

• Fever:  
- More commonly in term infants than preterm  
- A temperature of 38.0°C measured is the lowest limit of the definition of fever  
- Temperature instability is seen in only 50-60% of septic infants

slowly deteriorate ← late onset sepsis



Infant with Umbilical Catheter

Staph

→ vancomycin

Resistance ↓

amoxicillin ← Penicillin Resistance Penicillinase

20%

# Diagnosis

\* any symptomatic baby → full septic work up

\* How you will confirm the suspicious organism ??

→ Most specific (48 hours)

blood → initial culture  
urine → initial culture  
CSF (LP) → initial culture  
bubong → initial culture  
To source infection need

بنا اچي هلا → سکن به وقت → نطلب

CBC

Count

① WBCs

4,000-11,000 (adult)  
4,000-25,000 (Neonates) Normal

< 4,000 (bad prognostic sign) leukopenia

> 50,000 (leukemoid reaction) A leukemoid reaction is a reactive, excessive leukocytosis (WBC count >50,000/ $\mu$ L) that mimics leukemia but is caused by an underlying condition, such as infection, inflammation, malignancy, or severe stress.

→ septic shock

Differential

② Neutrophils > 65%

③ ITR Ratio =  $\frac{\text{immature Neutrophil}}{\text{Total}}$

> 20% (bacterial sepsis)

# 1-5 - infection

Platelets (low) (Negative acute base reactant) <sup>ESR</sup>

- pro Calcitonin

بشهر  
کوبن ادر  
late

Hgb.

سکن تپیر

↓ , Intracranial Hge.

- CRP

→ acute base reactant.

→ every 6 hours

↑ : sepsis

↓ : appropriate antibiotic choice

Titer 1/10

برق 12 لاله  
دو 1/1 Peak 48 لاله  
for follow-up

+ serial

Clinical Picture , CRP ← بآس من فلال

asL qd

## - Gram stain

(GBS or E.coli or Klebsilla) ??

(+)

GBS

(-)

E. coli

## - Lattix agglutination test

→ best organism في ساعات

- Latex particle agglutination
- Rapid antigen test

- EEG duration :

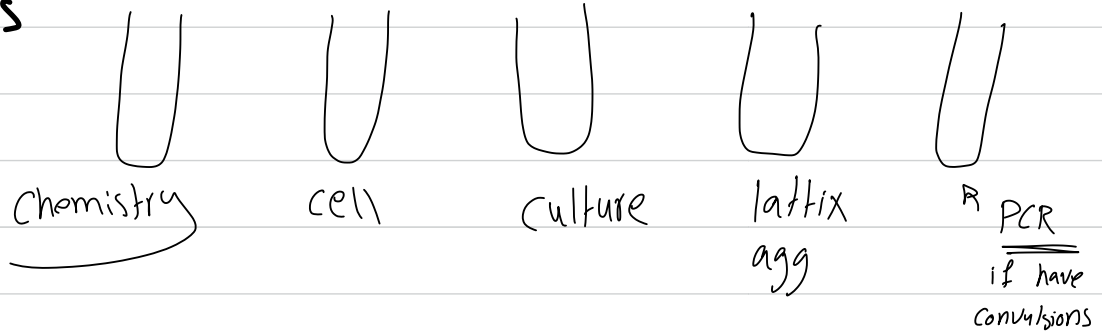
\* Meningitis → 14 days G<sup>+</sup>

Convulsion ✓ → 21 days G<sup>-</sup>

نوبت (herpes) Temporal lobe Hge (epilepsy) → resistance for EEG

\* what is interpretation of CSF analysis (من Culture)

5 tubes



- WBCs 0-5 except; Neutrophile كان & Meningitis

Neonates 0-20  
Normal بغيره

- RBCs Zero , except Neonates (shearing)

up to 100

Normal اول يومين

Sepsis + Convulsions + RBCs → acyclovir بغيره → Mortality  
→ Trauma  
→ sepsis

- **CXR** because you can't differentiate  
 ↳ if there is congenital pneumonia #

- **Respiratory distress**
  - signs of respiratory distress are **common** in infected infants and include :
    - tachypnea, grunting
    - flaring, retractions
    - rales, decreased breath sounds
  - **apnea** can occur, and is usually a **later sign**
- **Cardiovascular**
  - signs of CV effects can include :
    - Tachycardia
    - poor peripheral perfusion
    - Hypotension
- The **most reliable signs** of sepsis in infants ages 0 - 8 weeks:
  - change in **behavior, respiratory effort and peripheral perfusion**

- pleural fluid  
 - joint fluid as indicated  
 CRBS (G<sup>+</sup> on gram stain Prep.)

## Treatment

Before the specific organism is identified, and after cultures have been obtained, the antibacterial therapy is based on the **more causative agent and their anticipated susceptibilities.**

Ampicillin and amino glycoside or third generation cephalosporin are appropriate initial antibiotic therapy

Supportive therapy includes:  
 observation of vital signs  
 temporary discontinuation of oral feeding isolation

Hydration

Nutrition

oxygen

regulation of thermal environment

blood transfusion to correct anemia and shock, correction of electrolytes or acid-base imbalance.

Oral feeding isolation  
 17 منظر

Abx	
* septicemia or pneumonia (lv) early → GBS → Ampicilline → E. coli → gentamicine	supportive (24-48hr) <b>STABLE</b> → labs ↓ ↓ ↓ ↓ ↓ sugar temp. airway obs. pr. effective organ management
* Meningitis (v2) Ampicilline + 3 <sup>rd</sup> cephalosporine (cefotaxime)	Adjuvant therapy
* anaerobic infection clindamycin, metronidazole	vancomycin, trimeth

Observe for complications such as

- meningitis
- Shock
- adrenal hemorrhage
- disseminated intravascular coagulation
- Seizures
- UTI
- heart failure

# Chorioamnionitis

\* inflammation of chorioamniotic membrane

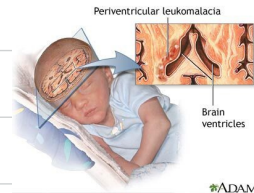
\* complication on baby ?? سبب الالتهاب

ttt for Mother :  
Ab & deliver the mum

→ sepsis  
→ preterm  
→ PVL

\* brain will be complicated by multiple cystic lesions & (Global developmental disability)

\* one of the worst types of CP



periventricular leukomalacia (PVL) is one of the worst types of brain injury associated with spastic diplegic cerebral palsy (CP), particularly in preterm infants.

→ Treatment ranges from close observation to empiric antibiotics

\* if the baby symptomatic → full set of work-up → treatment

(Pending culture results) ampicillin + aminoglycosides or 3<sup>rd</sup> cephalosporine

\* Mother w/ chorioamnionitis & baby Asymptomatic?

→ Admission

→ CBC, blood culture + observe  
≥ 48h

## Obstetrical diagnosis:

Maternal temperature > (38C)  
fetal tachycardia  
uterine irritability or tenderness  
foul smelling or cloudy amniotic fluid

### Potential Neonatal Pathogens

• Group B streptococcus (GBS)	• Escherichia coli and other gram negative enteric organisms
• Chlamydia trachomatis	• Listeria monocytogenes
• Ureaplasma urealyticum	• Trichomonas vaginalis
• Neisseria gonorrhoeae	• Bacterial vaginosis

Infection may be responsible for up to 20-40% of preterm deliveries:

Chorioamnionitis consistently increased

Increased clinical infections in preemies

Positive amniotic fluid cultures in 10-15% of preterm deliveries.

\* Protocol, if ttt depends on Risk factor

\* Mother w/ Preterm delivery <sup>①</sup>, حو بعلي ?? GBS ✓  
prophylaxis  
≥ 30 w.

with intact Membrane

swap 35 w. استعملوا الـ 35 w.

\* " " " " " ?  
with Ruptured memb.

3 Risk factors

Group B Streptococcus prophylaxis  
If between 24-32 weeks:  
Ampicillin plus erythromycin IV for 48 hours, then amoxicillin and erythromycin orally for up to 7 days  
If vaginosis is present:  
Substitute clindamycin for erythromycin  
extremely premature

## GBS

### ■ *Streptococcus agalactiae*

- Normal flora in genitourinary tract, gastrointestinal tract, and occasionally the pharynx
- Colonization of pregnant women ranges from 5-35%

- 1- 4 cases/1000 live births
- Transmission occurs in utero or shortly after delivery
- Nosocomial spread can occur via hand contamination

## Risk Factors

- Rupture of membranes > 18 hours
- Maternal chorioamnionitis
- Maternal GBS bacteruria
- Maternal age < 20 years \*
- Gestational age < 37 weeks
- Previous child with GBS
- Twin with GBS

indication for oral  
intrapartum prophylaxis



## Early Onset Infection

- Usually occurs within the 1st 24 hours
  - Range is 0-6 days
- 3/4 of all neonatal GBS infections
- Occurs in ~ 1 infant/ 100-200 colonized mothers
- Presenting symptoms:
  - Respiratory distress
  - apnea
  - shock
  - pneumonia
  - and occasionally meningitis

VS

## Late Onset Infection

- 3- 4 weeks of age
  - Range is 7 days - 3 months
- Presenting symptoms:
  - Occult bacteraemia
  - meningitis
- Rarely :
  - Cellulitis
  - osteomyelitis
  - septic arthritis

## Prepartum Chemoprophylaxis

2 different strategies :-

### option I

- Option I recommends : ALL women to have surveillance anogenital cultures at 35-37 weeks gestation

### Option I: Recommendations for Intrapartum Antibiotics

- Positive GBS colonization documented by surveillance anogenital cultures at 35-37 weeks gestation with or without risk factors
- Unknown GBS status and presence of one of the following risk factors:
  - Gestational age < 37 weeks
  - Rupture of membranes > 18 hours
  - Maternal temperature > 38

### option II

- Option II recommends : a prevention strategy based on risk factors alone and routine cultures are not obtained

### Option II: Recommendations for Intrapartum Antibiotics

- Recommendations for intrapartum antibiotics based on presence of risk factors only
  - Gestational age < 37 weeks
  - Rupture of membranes > 18 hours
  - Maternal temperature > 38
- No screening cultures are obtained

## General Considerations

- Oral antibiotics are not effective for Intrapartum prophylaxis
- Regardless of the prevention strategy adopted, the following women should be treated:
  - Any women with symptomatic or asymptomatic GBS bacteruria
  - Prior infant with GBS infection

### Drugs of Choice Intrapartum prophylaxis

- Penicillin G:
  - 5 million units IV, then 2.5 million units every 4 hours until delivery
- Ampicillin:
  - 2 grams IV, then 1 gram every 4 hours until delivery
- Clindamycin or erythromycin acceptable in penicillin allergic patients

# Management

## Asymptomatic

- Routine prophylactic antibiotics in newborns of mothers who received intrapartum antibiotics is not recommended
- Routine cultures of infants to document colonization is not recommended
- As always, strict hand washing by hospital personnel is imperative

- 1 RF < 35 weeks gestation and full maternal IAP  
CBC, blood culture  
observe at least 48 hours
- 2 RF < 35 weeks and only 1 dose of antibiotics  
CBC, blood culture  
and treat for 48h while under observation  
D/C treatment at 48h if cultures negative
- 0 RF > 35 weeks and 2 or more doses of antibiotics given to mother:  
No labs  
observe for at least 48 hours
- 1 RF > 35 weeks and only 1 dose of antibiotics:  
CBC, blood culture,  
observe for 48 hours

## Symptomatic

### Symptomatic Infants

- Full sepsis work up regardless of risk factors
- Ampicillin plus an aminoglycoside pending cultures
- May use Penicillin G alone when GBS is isolated
- GBS bacteraemia: treat for 10 days
- GBS meningitis: treat for 14-21 days
- GBS osteomyelitis: treat for 4-6 weeks

or Ampicillin + cephalo (3rd)

1 Risk → No ttt

(work-up) culture + CBC + observation

2 Risks → work-up + ttt

No Risk → No  
No

Sepsis → definitive → culture ⊕  
→ Probable → S & S (CRP, CXR pneumonia) [clinical + labs or Radio], culture ⊖  
→ Possible → just clinical (CRP ⊕, CXR ⊕)

\* ductus arteriosus

إذا كان بين 1 و 2 أسابيع

aortic stenosis

سواء كان في الفترة الأولى أو الثانية

\* in sepsis → hypothermia

Tenderness + hyperthermia

septic arthritis

# STDs

## 1 Chlamydia

### Neonatal Sepsis Chlamydia

- The presence of *Chlamydia trachomatis* in the cervix is associated with preterm deliveries
- Neonatal *chlamydial conjunctivitis*
  - 1st few days to several weeks after birth
  - Not prevented by routine eye prophylaxis
- Pneumonitis occurs between 2-19 weeks after birth

### Maternal Treatment Recommendations

- Treatment with erythromycin may prevent disease in infant
- routine screening in 1st and 3rd trimesters
- Treat partner
- screen for other sexually transmitted disease

### Infant Treatment Recommendations

- Infants born to untreated mothers should be treated with oral erythromycin for 14 days
- Neonatal *chlamydial conjunctivitis*
  - Topical therapy is ineffective
  - Oral erythromycin 50mg/kg/day in 4 divided doses for 14 days
  - ~80% effective (may need 2nd course)

## 2 Ureaplasma

### Neonatal Sepsis Ureaplasma

- Associated with lower respiratory tract infections and chronic lung disease in preemies
- Rarely causes CNS infection in newborns
- No proven benefit from prepartum or intrapartum antimicrobial therapy in colonized women

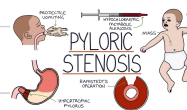
يمكن يصل Fibrosis تنس ال RDS

Adult Pneumonia - مزيج ال تنس ال Neonates Chronic lung disease

erythromycin

تنس Chlamydia

Pyloric stenosis



association Not a Cause

## 3 gonorrhea (GC)

- Preterm deliveries
- Ophthalmia neonatorum:**
  - Historically the leading cause of acquired blindness in the United States
- Less commonly:
  - Scalp abscess
  - vaginitis
  - bacteremia
  - arthritis
  - Endocarditis
  - meningitis

- All pregnant women should have routine cervical cultures for GC as part of their prenatal care
- Repeat culture in 3rd trimester for high risk women
- Positive cultures require work up for other sexually transmitted disease and work up and treatment of partner(s)

EGG:- should be treated

Asymptomatic carrier والبي

نظف البي Dose Prophylaxis 1

### Infants born to mothers with gonorrhea:

- Routine eye prophylaxis as before
- Single dose of ceftriaxone 25-50 mg/kg (125mg maximum) or cefotaxime 100mg/kg

Contraindication  
80% Neonatal Jaundice

افضل

as Prophylaxis

- ALL infants should receive routine eye prophylaxis regardless of maternal history:
  - 1% tetracycline, 0.5% erythromycin (1% silver nitrate, of historical interest only)

as Prophylaxis  
نظف العين



## Disseminated Neonatal اذا كان

### Disseminated Neonatal (GC)

- Arthritis or septicemia:
  - Ceftriaxone 25-50 mg/kg once per day for 7 days
  - Cefotaxime 50-100 mg/kg/day in two divided doses for 7 days
- Meningitis:
  - Ceftriaxone or cefotaxime for 10-14 days

# 2 weeks افضل ارجو

## اذا كان البيني حيز

### (symptomatic) eye infection

### Ophthalmia Neonatorum

- Crystalline penicillin G 50,000-75,000 units/kg/day in 2 divided doses for 7-10 days
- Alternatives include ceftriaxone or cefotaxime in a single dose
- Local saline eye washes every 1-2 hours initially, then increased to every 6-12 hours as infant improves
  - Saline washes should be followed by topical administration of chloramphenicol or tetracycline

## ④ Trichomonas

### Trichomonas

- May cause newborn vaginal discharge
- Inconsistently associated with preterm delivery
- Reasonable to screen and treat high risk or symptomatic mothers
- Treatment is with metronidazole

## ⑤ Bacterial vaginosis

### Bacterial Vaginosis

- Gardnerella vaginalis
- Clinical or laboratory confirmed bacterial vaginosis consistently associated with preterm delivery
- Pregnancy outcomes improved when treated with metronidazole (with or without erythromycin)

vaginal discharge

## ⑥ G<sup>-</sup> bacilli

its clinical picture:

Rapid fulminant sepsis

فوز بينم حيز حيز

C/P + gram stain

- Gram negative neonatal septicemia or meningitis cannot be differentiated clinically from other pathogens
- Fever
- temperature instability
- apnea
- cyanosis
- jaundice
- Hepatosplenomegaly
- lethargy, irritability, anorexia
- vomiting, abdominal distention
- Diagnosis by culture

all bad Prognostic

- Empiric therapy:
  - Ampicillin plus an aminoglycoside or cephalosporin active against gram negative bacilli (cefotaxime, ceftriaxone, ceftazidime)
- Septicemia: treat for 10-14 days
- Meningitis: treat for 21 days
- Close follow up for hearing loss or residual neurologic abnormalities

## ⑦ Listeria

very bad Microorganism → abortion, ...

- Gram positive bacilli
- Food borne transmission via contaminated dairy products, meats and unwashed vegetables
- Asymptomatic fecal and vaginal carriage can result in:
  - neonatal infection
  - preterm delivery
  - spontaneous abortion
- Nosocomial outbreaks occur

- The organism is sensitive to penicillin and ampicillin
- Combined therapy with an aminoglycoside is more effective
- Cephalosporins are not active against listeria
- Treat sepsis for 10-14 days and meningitis for 21 days

resistance is to cephalosporins

### Maternal Recommendations

- Antimicrobial therapy for known infection in pregnancy may prevent onset of neonatal disease
- Pregnant women should avoid unpasteurized dairy products and undercooked meats
- All vegetables should be thoroughly washed if eaten raw