Children's Hospital
Cleveland Clinic

NEONATAL SEPSIS AND CONGENITAL INFECTIONS

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Objectives

- At the end of the presentation, the participant will be able to:
  - List the pathogens that cause neonatal sepsis
  - Discuss the epidemiology of the common pathogens of sepsis
  - Know the agents that are responsible for congenital infections
  - Discuss the clinical features of the causes of congenital infections

NEONATAL INFECTIONS

- Bacterial neonatal sepsis
- Viral infections mimicking bacterial sepsis
- In-utero infections (congenital infections)

NEONATAL SEPSIS

- **Bacterial vs viral**
- **Early-onset vs Late-onset**
- **Perinatal vs Nosocomial vs Community acquisition**
- Clinical syndromes similar regardless of etiology

BACTERIAL NEONATAL SEPSIS

- Overall incidence 1-5 per 1000 live births
- Early-onset sepsis
  - symptom onset within 6 days of life
  - maternal complications common
  - vertical transmission of organisms colonizing genital tract

BACTERIAL NEONATAL SEPSIS

- Late-onset sepsis
  - symptom onset after 6th day of life
  - 2 distinct groups of neonates
    - healthy newborns who have been discharged to home
    - high-risk hospitalized neonates who develop hospital-associated infection

QUESTION #1

- **Of the following, the organism LEAST likely to cause early-onset neonatal sepsis is:**
  - **A. *Listeria monocytogenes***
  - **B. Group B Streptococci**
  - **C. *Streptococcus pneumoniae***
  - **D. *E. coli***
  - **E. *viridans streptococci***

ETIOLOGY OF EARLY-ONSET BACTERIAL SEPSIS

- **Group B Streptococci**
  - **dramatic decline since implementation of intrapartum prophylaxis**
- ***Escherichia coli***
  - **probably most common now**
- ***Listeria monocytogenes***
- **Less Common**
  - **viridans streptococci**
  - **non-typeable *Haemophilus influenzae***

QUESTION #2

- **All of the following are important causes of late-onset neonatal sepsis, EXCEPT:**
  - **A. *Streptococcus pyogenes***
  - **B. Coagulase-negative Staphylococci**
  - **C. *Staphylococcus aureus***
  - **D. Gram-negative bacilli**
  - **E. *Candida albicans***

ETIOLOGY OF LATE-ONSET NEONATAL SEPSIS

- **Healthy newborns previously discharged from hospital**
  - **Group B Streptococci**
  - ***L. monocytogenes***
  - ***E. coli***
  - ***Salmonella* species**
- **Less frequent causes:**
  - ***H. influenzae*- nontypeable**
  - ***Neisseria meningitidis***
  - ***Streptococcus pneumoniae***

ETIOLOGY OF LATE-ONSET SEPSIS*

- **High risk newborns (VLBW infants in NICU)**
  - **Coagulase-negative Staphylococci--48%**
    - Most common cause of late-onset sepsis in hospitalized high-risk neonates
  - **Gram-negative bacilli (*E. coli*, *Klebsiella* sp, *Enterobacter* sp, *Pseudomonas* sp)—20%**
  - ***S. aureus*—8%**
  - ***Candida albicans*—12%**
  - **Enterococci—3%**

*NICHD Neonatal Network, *Pediatrics* 2002;110:285

BACTERIAL NEONATAL SEPSIS: RISK FACTORS FOR VLBW INFANTS

- **Invasive procedures**
- **Mechanical ventilation**
- **Indwelling intravascular catheters**
- **Total Parenteral Nutrition**
- **Widespread use of broad-spectrum antibiotics**
- **H_2 blockers**

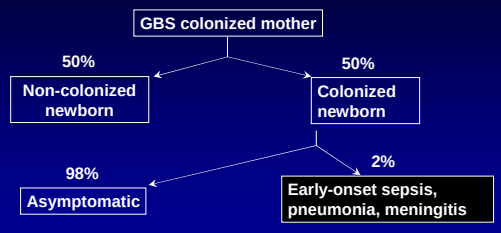
CLINICAL MANIFESTATIONS OF NEONATAL SEPSIS

- Signs and symptoms often subtle and nonspecific
- Features of neonatal meningitis often indistinguishable from sepsis
- Noninfectious illnesses have similar features
  - RDS; Congenital heart disease; Metabolic disorders
- Most neonatal pathogens produce similar symptoms

GROUP B STREPTOCOCCI: MATERNAL COLONIZATION

- 15-40% of all pregnant women are colonized with GBS
  - Genital and GI tracts
  - Highest: African-Americans, <20yo
  - Lowest: Asian, Mexican-Americans
- Colonization
  - Constant or intermittent
  - Colonization during one pregnancy does not predict colonization in subsequent pregnancy

Mother to Infant Transmission of GBS



CDC Prevention Guidelines, 2010

Additional Risk Factors for Early-onset GBS Disease

- Obstetric risk factors:
  - **Preterm delivery**
  - **Prolonged rupture of membranes**
  - **Infection of the placental tissues or amniotic fluid / fever during labor**
- GBS in the mother's urine during pregnancy (marker for heavy colonization)
- Previous infant with GBS disease
- Low maternal levels of anti-GBS antibodies
- Demographic risk factors
  - **African American**
  - **Young maternal age**

CDC Prevention Guidelines, 2010

Question #3: Which of the following is a TRUE statement concerning early-onset GBS neonatal sepsis?

- **A. Pneumonia and apnea are the most common clinical features**
- **B. Meningitis is present in 80% of cases**
- **C. The case-fatality rate is lower than with late-onset GBS infection**
- **D. Septic shock occurs in 75% of patients**
- **E. The mean age of onset is 72 hours of life**

GBS INFECTION:EARLY VS LATE ONSET

	Early-onset	Late-onset
Incidence	0.3/1000 (1-4/1000 before IAP)	0.3/1000
Mean age at onset	8 hours	27 days
Incidence of prematurity	Increased	Not increased
Obstetric complications	Common	Unusual
Manifestations	Pneumonia(40%) Meningitis(5-10%) Septic Shock(25%)	Bacteremia Meningitis Bone/joint/skin
Mortality rate	10-15%	2-6%

NEONATAL SEPSIS/MENINGITIS DUE TO *E. COLI* INFECTION

- **Incidence approx 1 per 1000 live births**
- **Most cases early-onset**
  - **Ki capsular antigen present in 80% of cases of meningitis**
- **Vertical transmission major route of transmission**
- **Infants with Galactosemia particularly susceptible to *E. coli* infection**
- **CFR high(20%) and sequelae in 30-50%**

NEONATAL LISTERIOSIS

	Early-onset	Late-onset
Age at onset	At birth	1-8 weeks
Birthweight	Often LBW	Usually term
Obstetric complications	Common (amnionitis, brown staining)	Infrequent
Source of isolate	Blood(75%)	CSF(90%)
Fatality rate	25%	5%

NEONATAL LISTERIOSIS

- **Maternal prodromal illness common-65%**
- **Elevated monocyte count present in 50% of bacteremic infants**
- **Monocytes not typically found in CSF of infants with meningitis**
- **Erythematous rash with 1-2mm pale nodules on skin and pharynx occasionally seen (granulomas on path)**
  - **granulomatosis infantisepticum**

NEONATAL BACTERIAL SEPSIS:DIAGNOSIS

- Isolation of organism from blood or CSF definitive
- Latex Particle agglutination for GBS and *E. coli* limited by poor sensitivity and specificity
- Hematologic abnormalities often accompanying sepsis
  - elevated ratio immature to total neutrophils (>0.2)
  - neutropenia
  - elevated neutrophil count
  - thrombocytopenia

EMPIRIC THERAPY FOR NEONATAL SEPSIS

- Early-onset sepsis
  - Ampicillin + Aminoglycoside
  - Cephalosporins should not be used empirically
- Late-onset sepsis
  - VLBW infants in the NICU
    - Oxacillin or Vancomycin + Aminoglycoside or 3rd gen cephalosporin
  - "Community" acquired
    - Ampicillin + 3rd gen cephalosporin

TREATMENT OF NEONATAL LISTERIOSIS

- Ampicillin and Gentamicin initially (bactericidal), then ampicillin alone
- Cephalosporins NOT active against *L. monocytogenes*
- 2-3 week duration

TREATMENT OF GRAM-NEGATIVE SEPSIS AND MENINGITIS

- Ampicillin and Gentamicin
  - initial empiric therapy
- Cefotaxime safe and effective alternative and often used in combo with aminoglycoside for meningitis
- Even with appropriate therapy, CSF cultures remain positive for at least 2-3 days after initiation of therapy
- Failure to sterilize CSF should prompt search for brain abscess or other complication
- 3-week course recommended for meningitis

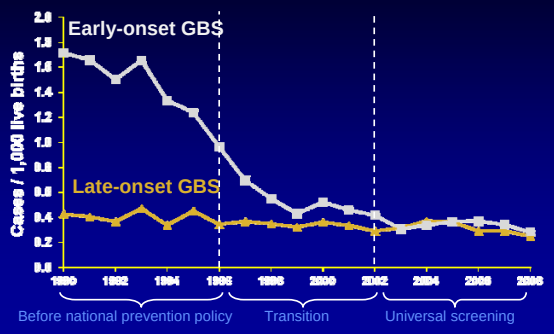
BRAIN ABSCESS AND GRAM-NEGATIVE MENINGITIS

- Propensity to cause Brain Abscess
  - *Citrobacter koseri* (formerly diversus)
  - *Enterobacter sakazakii*
  - *Serratia marcescens*

PREVENTION OF EARLY-ONSET GBS SEPSIS

- 2002 and 2010 CDC guidelines
  - Based on data showing that the screening method was >50% more effective than the risk-factor strategy

Rate of Early- and Late-Onset GBS, 1990-2008



Source: Active Bacterial Core surveillance / Emerging Infections Program

Key Prevention Strategies Remain Unchanged in 2010

- Universal screening of pregnant women for GBS at 35-37 weeks gestational age
- Intrapartum antibiotic prophylaxis for:
  - **GBS positive screening test**
  - **GBS colonization status unknown with**
    - **Delivery <37 weeks**
    - **Temperature during labor ≥100.4° F (≥38.0° C)**
    - **Rupture of membranes ≥18 hours**
  - **Previous infant with GBS disease**
  - **GBS in the mother's urine during current pregnancy**

CDC Prevention Guidelines, 2010

Key Prevention Strategies Remain Unchanged in 2010

- Penicillin preferred drug for IAP
  - **Ampicillin acceptable alternative**
  - **Cefazolin preferred for penicillin-allergic at low risk of anaphylaxis**

CDC Prevention Guidelines, 2010

Intrapartum GBS Prophylaxis Not Indicated

- Colonization with GBS during a previous pregnancy
  - Unless another indication during the current pregnancy
- GBS bacteriuria during a previous pregnancy
  - Unless another indication during the current pregnancy
- Negative vaginal and rectal GBS screening test during the current pregnancy
  - Regardless of intrapartum risk factors
- Cesarean delivery performed before labor onset on a woman with intact amniotic membranes
  - Regardless of maternal GBS test status
  - Regardless of gestational age

CDC Prevention Guidelines, 2010

QUESTION #4

Of the following, the virus *least* likely to cause symptoms at birth that mimic bacterial neonatal sepsis is:

- **A. Herpes simplex virus**
- **B. Human immunodeficiency virus (HIV)**
- **C. Cytomegalovirus**
- **D. Enterovirus**
- **E. Adenovirus**

ETIOLOGY OF NEONATAL VIRAL SEPSIS

- **Herpes simplex virus types I and II**
- **Enteroviruses**
  - **Echoviruses**
  - **Coxsackie**
- **Cytomegalovirus**
- **Respiratory viruses**
  - **RSV**
  - **Influenza**
  - **Adenovirus**

Neonatal HSV Infections

- Most occur from infected maternal genital tract at delivery
- Signs of infection by 4-5 weeks of age
- Risk largely influenced by maternal antibody status
  - 50% transmission with primary infection
  - 5% transmission with recurrent infection

Neonatal HSV Infections

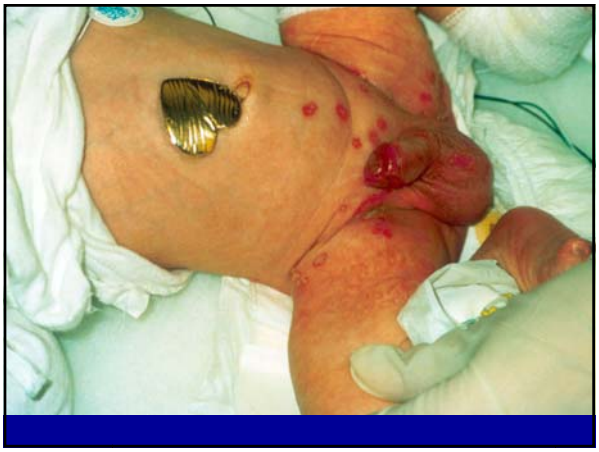
- High prevalence of asymptomatic maternal infection
- Thus, most infants (>75%) with neonatal HSV are born to asymptomatic mothers who have no past history of genital HSV infection or clinical findings during pregnancy

Neonatal HSV Infections

Type of Infection	%
Skin, Eyes, Mucus Membranes (SEM)	45%
Disseminated Infection	25%
CNS Infection	30%

NEONATAL HSV INFECTION

- Skin, eyes and/or mouth (SEM)
  - 7-14 days of life
  - Vesicles-often at sites of trauma (scalp electrode site)
  - Conjunctivitis
  - No mortality with treatment
    - 5% morbidity with treatment
  - 75% progress without treatment



Neonatal Disseminated HSV Infection

- Disseminated disease
  - 5-12 days of life
  - 58% have skin lesions
    - Lesions often absent at presentation
  - Mimics bacterial sepsis
    - DIC
    - Pneumonia
    - Hepatitis
    - CNS involvement (60-70%)
      - Seizures in 22%

Neonatal Disseminated HSV Infection

- **Disseminated disease**
  - **Rapid deterioration**
  - **Unremitting shock**
  - **Progressive liver failure**
  - **Bleeding**
  - **Respiratory failure**
  - **30% mortality with treatment**

Neonatal HSV Encephalitis

- **Encephalitis (CNS)**
  - **16-19 of life**
  - **45-63% have skin lesions**
  - **Seizures (generalized or focal)**
  - **Lethargy**
  - **Irritability**
  - **Poor feeding**
  - **Temp instability**

NEONATAL HERPES SIMPLEX INFECTIONS:DIAGNOSIS

- **Diagnosis difficult in absence of vesicular lesions- need high clinical suspicion**
- **Viral Culture**
  - cutaneous lesion
  - nasopharynx
  - CSF
  - conjunctiva
  - urine
- **Direct Fluorescent Antibody**
  - rapid diagnosis
  - requires vesicular lesions
- **Polymerase Chain Reaction-CSF**

Treatment of Neonatal HSV Infections

- Intravenous acyclovir treatment of choice
  - 20mg/kg/dose q8h IV standard dose
  - Monitor for neutropenia (20%) and nephrotoxicity (renal tubular crystalization with dehydration)
- 21-day course for disseminated or CNS infections
- 14-day course for SEM disease

Outcome of Neonatal HSV Infections

Table 3. Outcome of Neonatal Herpes.*

Site of Disease	Death		Normal Outcome†	
	No Therapy	IV Antiviral Therapy	No Therapy	IV Antiviral Therapy
	percent			
Disseminated	85	31	Rare	83
Central nervous system	50	6	Rare	31
Skin, eyes, and mucosa	0‡	0	62	100

* Data on patients who did not receive therapy are from Whitley et al.,[31] and data on patients who received intravenous (IV) antiviral therapy are from Kimberlin et al.[32]
† A normal outcome is defined as the achievement of developmental milestones within 24 months after infection.
‡ Skin, eye, and mucosal infection will progress to encephalitis or disseminated disease in the absence of antiviral therapy in a high proportion of infants.

Corey L, Wald A. NEJM 2009;361:1376

NEONATAL ENTEROVIRAL INFECTIONS

- Echoviruses 9,11,30 and Coxsackie B viruses most common today
- Most neonatal infections mild and non-specific, but 20% severe and life-threatening
- Diagnosis very difficult to distinguish from bacterial or HSV infection

NEONATAL ENTEROVIRAL INFECTIONS: CLINICAL FEATURES

- Macular or maculopapular rash-- 40%
- Hepatitis/Hepatic necrosis
- Myocarditis
- Meningoencephalitis
- Maternal history of viral illness
- Lack of obstetrical complications
- Summer and fall
- Isolation of virus from NP, throat, stool, CSF confirms Dx

IN UTERO CONGENITAL INFECTIONS

COMMON MANIFESTATIONS OF IN UTERO INFECTIONS

- General Characteristics
  - Manifestations present at birth or shortly thereafter
  - Presence of congenital defects (CHD, ocular abnormalities, calcifications, etc)

COMMON MANIFESTATIONS OF IN UTERO INFECTIONS

- Specific Features
  - Small for Gestational age
  - CNS: microcephaly, seizures, cerebral calcification
  - Skin: icterus, petechiae, purpura, vesicles
  - Eye: chorioretinitis, cataracts, microphthalmia
  - Heart: PDA, PS
  - Abdomen: HSM, hepatitis
  - Lung: pneumonitis
  - Musculoskeletel: bone lesions, limb hypoplasia

QUESTION #5

Of the following, the most common agent causing congenital infection is:

- A. *Toxoplasma gondii*
- B. Cytomegalovirus
- C. Rubella
- D. Parvovirus B 19
- E. Varicella-zoster virus

Question #6: Which is a true statement concerning congenital cytomegalovirus infection?

- A. Chorioretinitis is the most common clinical manifestation
- B. 1% of all infants born have CMV infection
- C. Fetal infection occurs only after primary maternal infection
- D. Infants with asymptomatic infection have no risk of long-term sequelae
- E. Serology represents the most reliable diagnostic test

CMV:EPIDEMIOLOGY

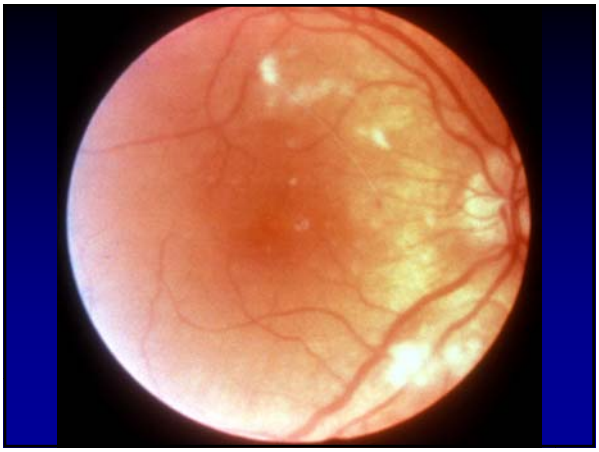
- Most common congenital infection
- 1% of all newborn infants have congenital CMV infection
- Virus transmitted from both immune mothers as well as non-immune mothers
  - Severe fetal damage occurs almost exclusively w/1° infection
- Infection can occur prenatally, natally, or postnatally

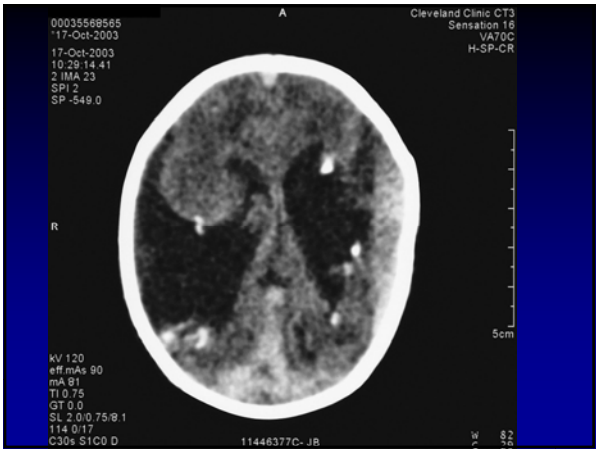
SIGNS OF PRENATAL CMV INFECTION IN THE NEWBORN

Finding	Frequency
Asymptomatic	90%
Symptomatic	10%
Petechiae	76%
Thrombocytopenia	77%
Jaundice	67%
HSM	60%
SGA	50%
CT Calcifications	50%
Microcephaly	53%
Retinitis	10%
Seizures	7%

FEATURES OF CONGENITAL CMV IN SYMPTOMATIC INFANTS

- Elevated transaminases-83%
- Thrombocytopenia (<100K)-77%
- Conjugated hyperbilirubinemia-81%
- Hemolysis-51%
- Increased CSF protein (>120mg/dL)-46%





LONG-TERM OUTCOME OF CONGENITAL CMV INFECTION

- Symptomatic infants
  - Death (30%)
  - Sensorineural hearing loss(58%)
  - IQ<70 (55%)
  - Microcephaly, seizures, paresis (52%)
  - Chorioretinitis (20%)
- Asymptomatic infants
  - Sensorineural hearing loss (7%)
  - IQ < 70 (4%)
  - Microcephaly (3%)
  - Chorioretinitis (2.5%)

LABORATORY DIAGNOSIS OF CONGENITAL CMV INFECTION

- Definitive
  - **Isolation of virus from urine or saliva by three weeks of age**
- Not Useful
  - **CMV IgG and IgM antibody**
    - **False positives and negatives common**

QUESTION #7

A newborn infant has microcephaly, is SGA, has a "blueberry muffin" rash, and bilateral cataracts. The most likely congenital heart lesion associated with this infection is:

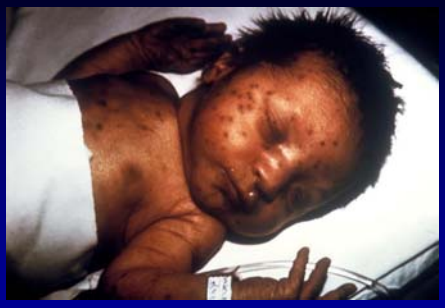
- **A. PDA**
- **B. ASD**
- **C. TGA**
- **D. Tricuspid atresia**
- **E. Coarctation of the aorta**

CONGENITAL RUBELLA INFECTION

- Almost all cases due to maternal primary infection
- Overall risk to fetus 20% (70% in first trimester)
- Imported cases from Asia and Europe
- No congenital infection seen with inadvertent maternal vaccination during pregnancy
- Diagnosis
  - Viral culture from NP, urine, cataract

CONGENITAL RUBELLA:CLINICAL MANIFESTATIONS

- Most infants asymptomatic at birth
- Cataracts
- Blueberry muffin spots (dermal erythropoesis)
- CHD (PDA, PS)
- "Salt and pepper" retinopathy
- IUGR and postnatal growth restriction
- Reticuloendothelial (HSM, jaundice)



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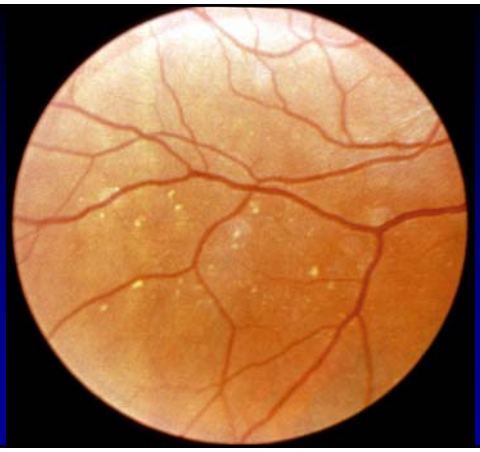


QUESTION #8

Which of the following is True regarding congenital *Toxoplasma* infection?

- **A. The incidence is constant despite geographic location**
- **B. Prenatal diagnosis is not possible**
- **C. Treatment of infected pregnant women is not recommended**
- **D. Neurological and visual problems become apparent in the majority of infected asymptomatic infants**

CONGENITAL TOXOPLASMOSIS

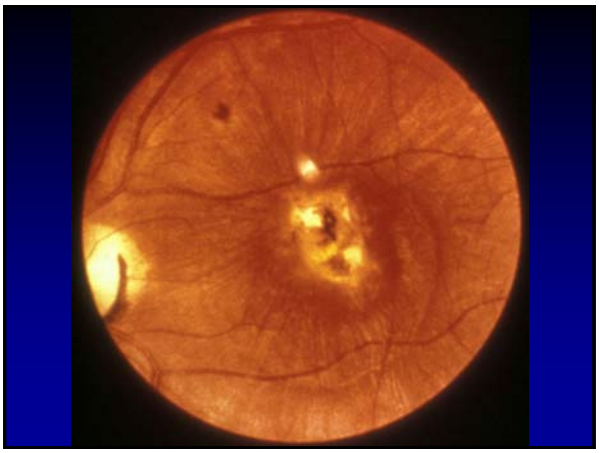
- Exposure to oocytes: cat feces and ingestion of raw beef major sources
- Fetal infection occurs only with maternal primary infection
- Incidence 1/1000-10000 live births

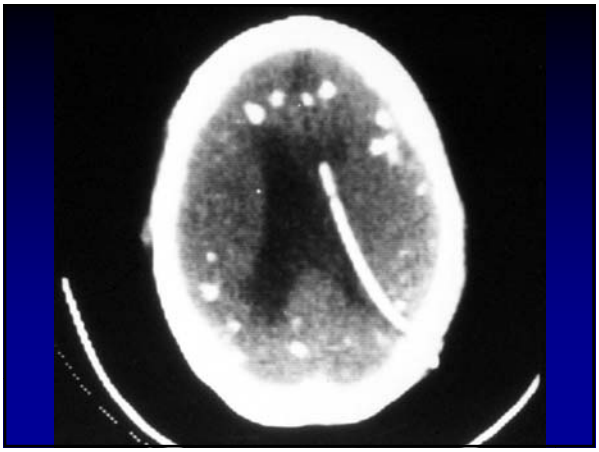
CONGENITAL TOXOPLASMOSIS: FETAL INFECTION RATES

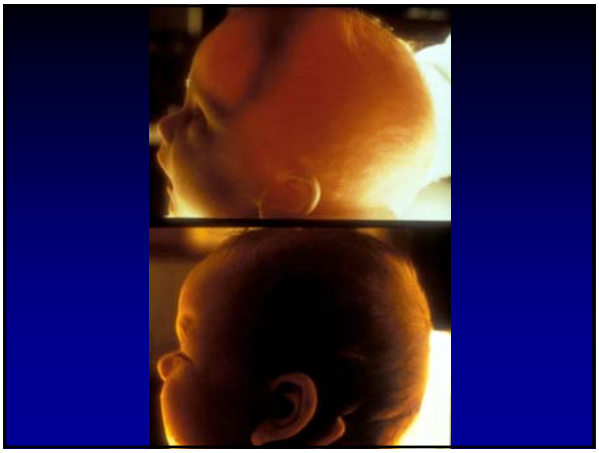
Trimester	1st	2nd	3rd
Overall rate of infection	15%	30%	60%
Subclinical disease	18%	67%	90%
Mild	6%	18%	10%
Severe	41%	8%	0
Stillborn/perinatal death	35%	7%	0

CONGENITAL TOXOPLASMOSIS: CLINICAL FEATURES

- Majority of infected neonates are asymptomatic
  - 80% Develop eye/neuro disease by adulthood
- Classic Triad
  - Chorioretinitis-86%
  - Hydrocephalus-20%
  - Cerebral Calcifications-37%
- Cerebral Calcifications
  - Distributed throughout the brain-unlike CMV
- Chorioretinitis
  - Focal necrotizing retinitis
  - Can be recurrent and progressive
  - May develop later in life without any other features of congenital infection







CONGENITAL TOXOPLASMOSIS:DIAGNOSIS

- Prenatal
  - Toxo DNA in amniotic fluid or fetal blood
  - Isolating parasite by mouse inoculation or tissue culture
  - Serial fetal US—look for increased size of lateral ventricles
- Postnatal
  - *T gondii* DNA by PCR amniotic fluid, fetal blood, blood, CSF
  - Histopathology placenta, infected organ/tissue
  - Mouse inoculation assays of infant's blood, placenta, umbilical cord
  - Serology-IgG, M, A, E on Mom and infant

CONGENITAL TOXOPLASMOSIS:TREATMENT

- Mother
  - Spiramycin to decrease transmission
  - Pyramethamine and sulfadiazine if fetal infection confirmed after 17 weeks gestation
- Infant
  - Decreases severity of disease and frequency of sequelae
  - Pyrimethamine and sulfadiazine
  - Therapy continued for 1 year

QUESTION #9

A 1-week old infant develops a copious bloody nasal discharge, lymphadenopathy, hepatomegaly and hemolytic anemia. Which of the following is the most likely additional feature in this infant?

- A. hydrocephalus
- B. periostitis
- C. limb hypoplasia
- D. seizures
- E. hydrops

CONGENITAL SYPHILIS

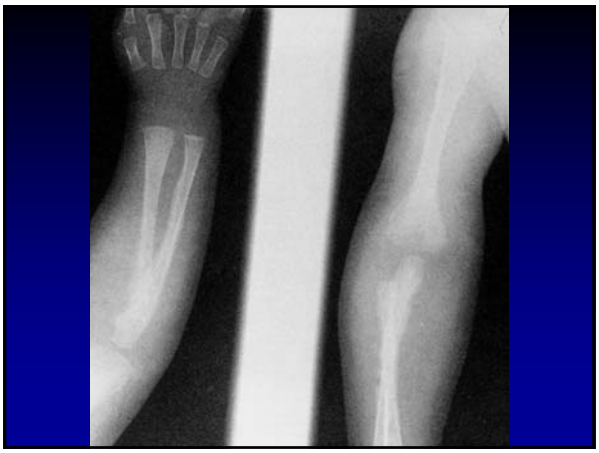
- 30-40% of infected fetuses are stillborn
- Of infected neonates who are live-born, 70% are asymptomatic at birth and are identified by prenatal maternal screening
- Because fetus acquires infection via hematogenous route, widespread involvement (rather than primary stage) is usual

UNIQUE FEATURES OF CONGENITAL SYPHILIS

- Generalized lymphadenopathy more common than other congenital infections
- Coombs-negative hemolytic anemia
- Snuffles (rhinitis)-in 25% of infants
- Exanthem
  - maculopapular rash with scaling and desquamation most common
  - vesicobullous lesions (pemphigus syphiliticus)

UNIQUE FEATURES OF CONGENITAL SYPHILIS

- Bony lesions-may be most frequently encountered manifestation
  - osteochondritis
  - osteomyelitis
  - periostitis
- CNS manifestations
  - pleocytosis; high protein, reaginic antibody
- Chorioretinitis
  - “salt & pepper”-like Rubella



INDICATIONS FOR EVALUATION OF CONGENITAL SYPHILIS

- Mother with positive non-treponemal tests confirmed by a positive treponemal test and:
  - Untreated or inadequately treated syphilis
  - Treatment in pregnancy with non-penicillin regimen
  - Lack of expected decrease in non-treponemal antibody titer after treatment
  - Treatment < 1 month before delivery
  - Treatment not documented
  - Insufficient follow-up to assess response

Evaluation for Congenital Syphilis

- PE
- Quatitative nontreponemal (RPR) and treponemal (FTA-ABS) test on infant's serum
- Antitreponemal IgM if available
- CSF for VDRL, cell count, protein
- Long-bone radiographs
- CBC, platelets
- Chest radiography, LFT's
  - as clinically indicated

Congenital Syphilis: Who needs Treatment?

- Infants with proven or probable disease
- Infants who warrant evaluation in which infection cannot be ruled out
- Infants whose follow-up cannot be assured
- Infants whose infected mothers can't be treated, treated inadequately, or treated within 1 month of delivery
- Infants of mothers not having 4-fold decrease in titer

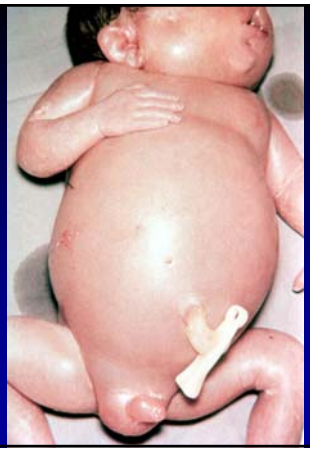
Treatment for Congenital Syphilis

- Aqueous Penicillin G for 10-14 days preferred therapy for proven or presumed infection
- Procaine penicillin (IM) may also be used
  - CSF concentrations may not be adequate
- Single dose benzathine Penicillin
  - recommended by some experts for:
    - asymptomatic infants with normal evaluation and whose follow-up can be assured, but whose mothers have not been treated adequately or do not have 4-fold decrease in titer

Question #10

Of the following, the congenital infection most associated with hydrops fetalis is:

- **A. Varicella-zoster virus**
- **B. HIV**
- **C. Human herpes virus 6 (HHV-6)**
- **D. Parvovirus B19**
- **E. *Borrelia burgdorferi***



EPIDEMIOLOGY OF PARVOVIRUS B19 INFECTIONS

- **About 50% of women are seropositive for the virus prior to pregnancy**
- **Likelihood of infection after a close exposure estimated to be 30-50%**
- **Estimates of fetal loss following infection during pregnancy range from 2-6%**
- **Thus, overall risk of fetal loss due to this virus is 1-2%**

CONGENITAL PARVOVIRUS B19 INFECTION

- Consequences of maternal parvovirus infections
  - Asymptomatic newborn
  - IUGR
  - Hydrops fetalis
    - severe anemia
    - high output cardiac failure
    - extramedullary hematopoiesis
  - Stillbirth
  - Isolated pleural or pericardial effusions

Answers to Questions

- 1. C
- 2. A
- 3. A
- 4. B
- 5. B
- 6. B
- 7. A
- 8. D
- 9. B
- 10. D

Every life deserves world class care.