Pediatric Infectious Diseases
Part II
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Objectives

- At the end of the presentation, the participant should be able to:
  - Know the epidemiology, clinical features and management associated with:
    - Gastrointestinal infections
    - Skin, soft tissue, bone and joint infections
    - Fungal infections
    - Selected Parasitic Infections

GASTROINTESTINAL INFECTIONS
Question # 1: Of the following, the pathogen that is least likely to be transmitted in a child care center is

- A. *Shigella sonnei*
- B. *Salmonella typhimurium*
- C. *Giardia lamblia*
- D. Rotavirus
- E. *Cryptosporidium parvum*

Non-Typhoidal Salmonella Infections: TRANSMISSION

- Ingestion of contaminated foods, milk, or water
  - Poultry, eggs and dairy products
  - Fruits, vegetables, peanut butter
  - $10^5$-$10^6$ organisms needed to cause disease
  - incubation 6 hrs-4 days
  - most common cause of food-borne outbreak of gastroenteritis in US, along with *Campylobacter*

Non-Typhoidal Salmonella Infections: TRANSMISSION

- Contact with infected animals: lizards, pet turtles, iguanas
- Person to person spread—much less common
  - Infrequently transmitted in child care centers
  - Household transmission more common
NON-TYPHOIDAL SALMONELLA INFECTIONS: CLINICAL PRESENTATIONS

- Acute asymptomatic infection
- Acute Gastroenteritis/Enterocolitis
  - abdominal pain; non-bloody diarrhea; fever
  - resolution in 2-7 days
  - most do not invade but some serotypes invade
- Bacteremia
  - Most common in infants < 1 mos.
  - Osteomyelitis-Sickle cell disease
  - Meningitis-almost exclusively in infants
  - GI symptoms may not be present

Non-typhoidal Salmonella Infections

- Asymptomatic chronic carrier state
  - Prolonged excretion common after infection
  - Carriage longer for younger children
  - Prolonged after antibiotic therapy
  - Need not exclude from school/day care

Salmonella typhi

- Found only in humans
- Infections implies direct contact with an infected person or contaminated item
- Endemic in many countries
- Acquired during international travel
TYPHOID/ENTERIC FEVER

- *S. typhi* or *S. paratyphi*
- Protracted bacteremic illness
  - Gradual onset
  - High fever
  - Constitutional symptoms—headache, malaise
  - Abdominal pain
  - HSM
  - Lymphadenopathy
  - Relative bradycardia
  - Rose spots
- Non-specific febrile illness in young infants

Question #2

- A 2-year old previously healthy boy presents with a 2-day history of low-grade fever, abdominal cramps and profuse diarrhea. A stool culture reveals *Salmonella enteritidis*. Of the following, the most appropriate management option for this child is:
  - A. Supportive care
  - B. One dose of Ceftriaxone IV or IM
  - C. Amoxicillin orally for 5 days
  - D. Clindamycin orally for 5 days
  - E. Trimethoprim-sulfamethoxasole orally for 5 days

SALMONELLA INFECTIONS: WHO NEEDS ANTIMICROBIAL THERAPY?

- Gastroenteritis in patients at high-risk for invasive disease
  - Infant < 3 months
  - Immunocompromised patients (including HIV)
  - Patients with malignancies and organ-transplants
  - Hemoglobinopathies
  - GI dysfunction (gastrectomy)
SALMONELLA INFECTIONS: WHO NEEDS ANTIMICROBIAL THERAPY?

- Bacteremia
- Meningitis
- Osteomyelitis
- Enteric Fever
- Chronic carriers of *S. typhi*
  - High recurrence rate

SALMONELLA INFECTIONS: ANTIMICROBIAL THERAPY

- Based on susceptibility patterns and severity of illness for those who need treatment
- Cefotaxime/Ceftriaxone
- Ampicillin
- Trimethoprim-sulfamethoxasole

Non-Typhoidal Salmonella: Infection Control Issues

- Infected child care center attendees can be re-admitted when asymptomatic
- Negative stool cultures NOT required for re-entry
- Contacts need not be tested unless symptomatic
Question #3: A 2 y.o. girl with crampy abdominal pain and profuse diarrhea is hospitalized for dehydration. She develops a brief generalized seizure. Of the following, the agent most likely causing this girl’s gastroenteritis is:

- A. E. coli O157:H7
- B. Campylobacter jejuni
- C. Salmonella typhimurium
- D. Shigella sonnei
- E. Yersinia enterolitica

SHIGELLA INFECTIONS: EPIDEMIOLOGY

- Person to person transmission
  - Fecal-oral spread
- Low inoculum causes disease (10-200)
- Important in child care center infections
- Less common in children < 1 year
- Chronic carrier states are rare
- 4 serotypes: S. sonnei most common in US

SHIGELLA INFECTIONS: CLINICAL PRESENTATIONS

- Gastrointestinal manifestations
  - Incubation period 1-3 days
  - Abrupt onset of high fever, crampy abdominal pain, watery diarrhea early, bloody and mucous diarrhea later, urgency, tenesmus
  - 50% have bloody stools
  - PMN’s usual
  - Symptoms last ≥ 1wk without therapy
SHIGELLA INFECTIONS: CLINICAL PRESENTATIONS

- Extraintestinal manifestations
  - Seizures
    - 10-45% of hospitalized children
    - Generalized, self-limited
    - May develop before diarrhea
  - HUS
  - Ileus and Megacolon
  - Septicemia
  - Reactive arthritis/Reiter’s syndrome

SHIGELLA INFECTIONS: ANTIMICROBIAL THERAPY

- Indicated for patients with severe symptoms, dysentery, and underlying states
  - shortens duration of diarrhea
  - stops shedding of organism w/in 1-2 days

- Third-generation cephalosporins and azithromycin effective
  - 80% resistant to Ampicillin and 40% resistant to TMP-SMX in US

- Duration: 5 days

Shigella Infections: Infection Control Issues

- Infected children attending child care centers
  - Should be treated
  - Excluded from the center until asymptomatic and until they have 2 negative stool cultures (state regulations)

- All symptomatic contacts
  - Stool cultures should be sent
  - Treated if found to be positive
  - Excluded from center until asymptomatic and have 2 negative stool cultures
Question #4: A 5 year old girl develops severe bloody diarrhea after attending a county fair. Over the next days, she is noted to be pale and to have decreased urine output. Of the following, the agent most likely to be related to her illness is

- A. *Campylobacter jejuni*
- B. *Entamoeba histolytica*
- C. Enterotoxigenic *E. coli* (ETEC)
- D. *E. coli* O157:H7
- E. *Giardia lamblia*

**E. COLI-PRODUCING DIARRHEAL ILLNESS**

- Shiga toxin-producing *E. coli* (STEC)
  - Formerly EHEC
  - O:157:H7 is prototype
  - Shiga-like toxin—invasive=bloody diarrhea
  - Food-borne
    - Contaminated undercooked beef
    - Unpasteurized milk, apple cider
    - Water and other food sources
  - Contact with animals and their environment
  - Person to person spread

**E. COLI-PRODUCING DIARRHEAL ILLNESS**

- Shiga toxin-producing *E. coli*
  - 5-10% develop Hemolytic-Uremic Syndrome
  - Antimicrobial therapy not effective/may increase risk of HUS
  - Children should be excluded from child care until asymptomatic and have had 2 negative stool cultures
E. COLI-CAUSING DIARRHEAL ILLNESS

- ETEC
  - enterotoxin-mediated disease
  - most common cause of traveler’s diarrhea
  - toxin closely related to cholera toxin
  - common sources
    - Contaminated water and food
    - Dairy, meat, seafood
  - watery diarrhea, abdominal cramps
  - self-limited

- EPEC
  - sporadic or endemic disease in 1st year of life
  - Resource-limited countries

- EIEC
  - illness resembling shigellosis

- EAEC (enteroaggressive E coli)
  - Associated with persistent diarrhea in infants

Question #5

- A 5 year old boy develops fever, crampy abdominal pain, and bloody diarrhea. The day previous to onset of symptoms, he attended a picnic where he ingested undercooked chicken. You suspect infection with Campylobacter jejuni. Which of the following is a true statement concerning this organism?
Q #5 Choices

- A. Guillain-Barré syndrome is a complication
- B. Person-to-person spread is the most common mode of transmission
- C. Transmission of the organism in child care settings is common
- D. School-aged children have the highest incidence of infection
- E. Bacteremia is a common complication

CAMPYLOBACTER INFECTIONS

- *C. jejuni* major cause of diarrhea in this country
- Ingestion of contaminated foods and water most common mode of transmission
  - Young animals, especially chickens
  - Dairy products, poultry, meat, water
- Incubation period 1-7 days
- Infants and toddlers highest incidence of infection
- Wide spectrum of clinical disease
  - from mild symptoms to severe inflammatory diarrhea

CAMPYLOBACTER INFECTIONS

- Bacteremia very rare with *C. jejuni*
  - *C fetus* associated with neonatal bacteremia and meningitis
- Immunoreactive complications
  - Guillain-Barré 6-20 days after *C. jejuni enteritis*
  - Reactive arthritis/Reiters syndrome-HLA B27
- Therapy
  - ATB’s may shorten duration of illness and prevent relapses when given early in the course
  - Erythromycin or azithromycin
Question #6: A 12 year old boy develops RLQ abdominal pain, fever, and leukocytosis. His mother reports that he ingested chitterlings (raw pork intestine) 4 days prior to the onset of his symptoms. On PE he is febrile to 38.9 and has focal tenderness in the RLQ. Of the following, the most likely cause of this patient’s illness is

• A. Vibrio cholera
• B. Giardia intestinalis
• C. Entamoeba histolytica
• D. Yersinia enterocolitica
• E. Aeromonas hydrophila

YERSINIA INFECTIONS

• Water, food, animals are primary reservoirs  
  • pork, soybean, dairy products  
  • Raw pork intestines (chitterlings)
• Wide spectrum of severity of clinical illness
• May cause intense mesenteric adenitis  
  • mimics acute appendicitis
• Important cause of reactive arthritis and Reiter syndrome; erythema nodosum
• Severe infection reported in those with iron overload states (thalassemia, hemolytic anemias)

Question #7: Which of the following is a true statement regarding Rotavirus infections?

• A. Most symptomatic illness occurs in school-aged children
• B. Fomites play an important role in transmission of the organism
• C. Zoonotic spread is a common source of infection
• D. Infection almost always leads to symptomatic illness
• E. Vomiting is a rare manifestation of illness
**ROTAVIRUS INFECTIONS**

- Fecal-oral spread
  - Fomites important in transmission
  - Zoonotic spread uncommon
- Winter and spring time
- Asymptomatic infections common
- Most symptomatic illness in 4-24 m of age
- Nearly all children infected by 3 years
- Common in child-care center outbreaks and nosocomial spread

**ROTAVIRUS INFECTIONS**

- Incubation 1-4 days
- Vomiting in more than 75% of symptomatic patients
- Watery diarrhea—rarely bloody stools
- Fever common—lasts 1-2 days
- Extraintestinal manifestations common
  - Respiratory symptoms in 20-50%
  - Encephalitis, OM also occur rarely

**Rotavirus vaccine**

- 2 vaccines licensed in US (both live and orally administered)
  - pentavalent vaccine-3-dose series
  - monovalent vaccine-2-dose series
- Routinely recommended for all infants
  - 1st dose at 6 weeks to 14 weeks, 6 days of age
  - Minimal interval between doses is 4 weeks
  - All doses administered by 8 months, 0 days
- Highly effective (98%) against severe rotaviral GE
  - 74% effective against any rotaviral GE
- No increased risk of intussusception to date
VIRAL GASTROENTERITIS

- Caliciviruses (includes Noroviurses [Norwalk-like viruses])
  - water and shellfish sources; outbreaks in childcare and on cruise ships
  - infection documented at all age groups
  - incubation usually less than 24 hrs
- Astroviruses
  - children and elderly; person-to-person and contaminated foods
  - Children less than 4 years of age mainly
- Enteric adenovirus (Group F, serotypes 40 & 41)
  - endemic diarrhea in infants year-round

Question #8: A 4 year old girl has had chronic diarrhea, weight loss and intermittent abdominal pain for the past 6 months. Stool screening test for ova and parasites reveals *Giardia* infection. Of the following, the test most likely to be abnormal in this child is

- A. CH50
- B. IgG
- C. IgM
- D. NBT
- E. IgE

GIARDIASIS

- Water source and person to person contact
- Low inoculum needed for infection
  - Frequency in child care centers
- Clinical manifestations
  - asymptomatic-20% of children may harbor this organism
  - acute illness-watery diarrhea
  - chronic diarrhea and malabsorption; FTT; Abdominal pain
- Predisposing factors for chronic infection
  - Hypogammaglobulinemia; IgA deficiency; HIV
Diagnosis of Giardiasis

- Demonstration of trophozoites or cysts in stool via direct microscopy
  - 3 stools have 95% sensitivity
- Immunofluorescent or enzyme immunoassay
  - 70-80% sensitive
- String test of duodenal aspirates
  - more sensitive than stool examination
- Duodenal biopsy

http://www.dpd.cdc.gov/dpdx/HTML/Giardiasis.htm

THERAPY FOR GIARDIASIS

- Metronidazole
  - Drug of choice
  - 80-95% cure rate with 5-7 day course
- Nitazoxanide
  - Oral suspension for 3 days
  - As effective as Metronidazole
  - Treats cryptosporidium as well
- Alternatives
  - Tinidazole
  - Furazolidine
  - Albendazole
Therapy/Control measures for Giardiasis

- Recurrence occurs in 10-20% of patients
  - Most respond to second course
- Immunocompromised patients may need prolonged or repeated courses of therapy
- Treatment of asymptomatic patients NOT recommended
- Children attending child care centers are excluded until asymptomatic
  - No need to exclude carriers or culture asymptomatic individuals

Cryptosporidiosis

- Cryptosporidium parvum
  - Infects epithelium lining of digestive tract
  - Infective form = oocyte
    - excreted in feces
- Hosts
  - Mammals, Birds, Reptiles
  - Associated with waterborne outbreaks (pools, municipal water supplies)
- Important in child-care centers—person-to-person transmission
- Highest incidence during summer and early fall

Cryptosporidiosis

- Transmission
  - Animals (petting zoos), person-to-person, contaminated water
    - Oocyte form is resistant to chlorine
    - Need appropriate water filtration
- Incubation period 7 days
- Shedding typically stops within 2 weeks
  - Up to 2 months in immunocompromised hosts
Cryptosporidiosis

- **Clinical disease**
  - May be asymptomatic
  - Diarrhea
    - Non-bloody, watery
    - Abdominal cramps, vomiting, anorexia, weight loss
    - Fever more common in children than adults
  - Illness typically lasts 1-20 days (mean 10 days)
  - Immunocompromised host
    - Chronic severe diarrhea
    - Biliary tract disease

- **Diagnosis**
  - Microscopic detection of oocytes
    - Staining with a modified Kinyoun acid-fast stain
  - Diagnostic
    - Immunofluorescent antibody testing (EIA) on stool sample
  - Screen
    - Shedding may be intermittent
    - 3 stool samples should be sent on separate days

http://www.dpd.cdc.gov/dpdx/HTML/Cryptosporidiosis.htm
Cryptosporidiosis

- **Treatment**
  - Nitazoxanide x 3 days

- **Prevention**
  - Boil water in cases of waterborne outbreaks
  - Filtration devices
  - Avoidance of public recreational water if experiencing diarrhea
  - Confirmed diagnosis
    - Should avoid recreation waters for 2 weeks after symptoms resolve

**ENTAMOEBA HISTOLYTICA**

- **Clinical spectrum**
  - Asymptomatic-10% of world’s population is infected
  - Mild non-dysenteric diarrhea
  - Invasive
    - Amebic dysentery
    - Liver abscess-occurs in 1-7% of children with invasive amebiasis

- **Diagnosis**
  - 3 stools: 60-90% for intestinal disease
  - Serology better for liver abscess
THERAPY FOR ENTAMOEBA HISTOLYTICA

- Asymptomatic disease
  - Colonic disease
    - No therapy in developing world
    - Iodoquinol or paromomycin in U.S.
- Symptomatic disease
  - Metronidazole followed by an intraluminal agent

SKIN, SOFT TISSUE, BONE, AND JOINT INFECTIONS

Question #9

- A 2-year old previously healthy boy develops redness and swelling of his right eye. There is no history of trauma. On PE he is alert, non-toxic appearing, and febrile to 38.9°C. Photo of his eye is shown. Of the following the most appropriate antibiotic regimen is
SKIN AND SOFT TISSUE INFECTIONS

<table>
<thead>
<tr>
<th>Condition</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periorbital cellulitis/Orbital Cellulitis</td>
<td>H. influenzae b, S. aureus, GAS, S. pneumoniae</td>
</tr>
<tr>
<td>Impetigo</td>
<td>S. aureus, GAS</td>
</tr>
<tr>
<td>Erysipelas</td>
<td>GAS</td>
</tr>
<tr>
<td>Non-facial cellulitis</td>
<td>GAS, S. aureus</td>
</tr>
</tbody>
</table>
### SKIN AND SOFT TISSUE INFECTIONS

<table>
<thead>
<tr>
<th>Condition</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human bites</td>
<td>Streptococci, S. aureus, Anaerobes (Eikenella)</td>
</tr>
<tr>
<td>Water contaminated wounds</td>
<td>Pseudomonas, Aeromonas</td>
</tr>
<tr>
<td>Surgical wounds</td>
<td>S. aureus, GAS</td>
</tr>
<tr>
<td>Burns</td>
<td>Pseudomonas, S. aureus, Enterobacteriaceae</td>
</tr>
<tr>
<td>Ecthyma gangrenosum</td>
<td>Pseudomonas</td>
</tr>
</tbody>
</table>

### CA-MRSA Infections

- Purulent Skin and soft tissue infections
  - Mostly skin abscesses (boils)
    - Drainage may be required
  - Some skin abscesses are locally invasive
    - Progressive necrotizing lesions occasionally seen
    - May require hospitalization and complicated debridement
    - May be confused with spider bites
  - Sepsis is atypical

### Manifestations of CA-MRSA Infections

- Mostly skin abscesses (boils)
  - Drainage may be required
  - Some skin abscesses are locally invasive
  - Progressive necrotizing lesions occasionally seen
  - May require hospitalization and complicated debridement
  - May be confused with spider bites
  - Sepsis is atypical
Manifestations of CA-MRSA Infections

- Other invasive manifestations—much less common
  - Severe pneumonia and empyema
  - Severe and fatal pneumonia associated with influenza
  - Necrotizing pneumonia
  - Osteomyelitis and septic arthritis
  - Sepsis and bacteremia
  - Toxic shock-like syndrome

Antimicrobial susceptibility patterns

- CA-MRSA remain susceptible to many non beta-lactam antibiotics
- Most are susceptible to TMP-SMX, Clindamycin, and tetracyclines
- Inducible clindamycin resistance is important with strains that are resistant to erythromycin
  - Whenever erythromycin resistant strains detected, must assure there is no inducible resistance to clindamycin
Comparing CA-MRSA and HA-MRSA susceptibilities

<table>
<thead>
<tr>
<th></th>
<th>CA-MRSA</th>
<th>HA-MRSA</th>
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</thead>
<tbody>
<tr>
<td>TMP-SMX</td>
<td>98%</td>
<td>82%</td>
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<tr>
<td>Clindamycin</td>
<td>92%</td>
<td>57%</td>
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<tr>
<td>Erythromycin</td>
<td>22%</td>
<td>34%</td>
</tr>
</tbody>
</table>

Double disk diffusion test (D test)

- Simple lab test to detect inducible clindamycin resistance in erythromycin resistant strains
- Incidence of inducible strains varies by geographic region
  - 10% in the south
  - 80-90% in Chicago and Minnesota
Interpretation of susceptibility to Clindamycin

<table>
<thead>
<tr>
<th>If the lab reports</th>
<th>Then interpret as</th>
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<tbody>
<tr>
<td>Erythromycin susceptible/Clindamycin susceptible</td>
<td>Clindamycin susceptible</td>
</tr>
<tr>
<td>Erythromycin resistant/Clindamycin resistant</td>
<td>Clindamycin resistant</td>
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<tr>
<td>Erytho R/Clinda S negative D test positive D test</td>
<td>Clindamycin susceptible Clindamycin resistant</td>
</tr>
</tbody>
</table>

Management principles

- Drainage of collections and careful follow-up are more important than choice of agent for cutaneous abscesses in healthy children
  - Studies of CA-MRSA skin infections
    - Most do very well with drainage—despite antibiotics that are not active against strain
    - Large size of skin lesion, rather than inappropriate antibiotic, predictor of hospitalization
- Large size of skin lesion, rather than inappropriate antibiotic, predictor of hospitalization

Principles of management for typical CA-MRSA infections

- Make an increased effort to obtain specimens for culture
- Drain purulent collections
- Provide thorough wound care
- Make reliable plans for reassessment after initial management
- Be familiar with local trends in susceptibility patterns
Minor skin infections

- Impetigo
- Secondarily infected excema, ulcers and lacerations
- Mupirocin 2% topical ointment

Indications for Antimicrobial Therapy after Incision and Drainage for CA-MRSA

- Severe or extensive disease
- Comorbidities or immunosuppression
- Extremes of age
- Abscess in area difficult to drain completely
- Associated septic phlebitis
- Lack of response to incision and drainage alone

Outpatient treatment of skin and soft-tissue infection without severe illness in CA-MRSA era

- Empiric
  - Conventional beta-lactam antibiotics-cover MSSA and GAS
    - Dicloxacillin, Cephalexin, Amoxicillin-clavulanate
  - TMP-SMX-for purulent SSTI
    - Does not cover GAS
  - Clindamycin
    - If the prevalent MRSA in community is clindamycin susceptible
    - If there is a significant penicillin allergy
  - Reassessment and local wound care
Outpatient treatment of CA-MRSA: Skin and soft-tissue infection without severe illness

- Culture-proven MRSA
  - Guided by susceptibility report
  - Clindamycin
    - Ensure D-test is negative
  - TMP-SMX
  - Doxycycline
    - For those 8y and older
  - Linezolid
    - Expensive
    - Toxicities

Inpatient antibiotic therapy for suspected CA-MRSA infections

- Empiric
  - Seriously ill or complicated SSTI (deep infection, cellulitis, traumatic wound infection)
    - Vancomycin
    - Clindamycin
      - Stable patient without ongoing bacteremia or intravascular infection
  - Not seriously ill
    - Clindamycin—if rate of resistance less than 10%
    - Beta-lactams—if rate of CA-MRSA is low

Inpatient antibiotic treatment for CA-MRSA infections

- Culture-proven or highly suspected MRSA
  - Skin, bone, soft tissue
    - Guided by susceptibility report
    - Clindamycin
    - Vancomycin
    - Linezolid
    - TMP-SMX
  - Pneumonia
    - Vancomycin vs Clindamycin
  - Endocarditis
    - Vancomycin or Daptomycin
    - Add Rifampin and Gentamicin for prosthetic valve
OSTEOMYELITIS

- Hematogenous
  - bacteremia
- Direct inoculation
  - trauma
  - surgery
- Local invasion
  - cellulitis

OSTEOMYELITIS: CLINICAL MANIFESTATIONS

- Fever-absent in 20%
- Limitation of involved area or limp
- Localized swelling, warmth, erythema, pain
- Neonates
  - accompanied by septic arthritis
    - epiphyseal-metaphyseal junction w/in joint capsule
  - Multiple bones may be infected
  - Pseudoparalysis
- Puncture wound osteochondritis
  - No fever; Pseudomonas sp.

Question # 10: The most common etiologic agent causing acute osteomyelitis in a healthy 2-year old child is:

- A. *S. pyogenes*
- B. *H. influenzae* type b
- C. *S. pneumoniae*
- D. *S. aureus*
- E. *Salmonella*
ACUTE OSTEOMYELITIS: MICROBIAL ETIOLOGY

<table>
<thead>
<tr>
<th>Neonate</th>
<th>Infant</th>
<th>Older child</th>
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<tbody>
<tr>
<td>S. aureus</td>
<td>S. aureus</td>
<td>S. aureus</td>
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<tr>
<td>GBS-16%</td>
<td>Group A strep</td>
<td>Group A strep</td>
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<tr>
<td>(Proclivity for right prox humerus)</td>
<td>E. coli</td>
<td>S. pneumoniae</td>
</tr>
<tr>
<td>Candida sp.</td>
<td>H. flu b</td>
<td>Salmoella (SSD)</td>
</tr>
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**Serratia, Aspergillus--CGD**

OSTEOMYELITIS: DIAGNOSIS

- **Laboratory**
  - ESR/CRP elevated in >90%
  - Blood culture-positive in 50%
  - Bone aspirate-positive in 80%
- **Radiology**
  - Plain films: 10-20 days to see periosteal elevation
  - MRI
    - Most sensitive and specific
    - 92-100% sensitive
    - Helpful for pelvic and vertebral osteomyelitis
  - Tc99m bone scan when multiple foci are suspected
- Bone biopsy and culture

OSTEOMYELITIS: MANAGEMENT

- Hematogenous
  - 4-8 weeks total ATB duration; normal ESR
- Puncture wound
  - Shorter duration if debridement performed
- Surgery
  - Drain purulent material and remove necrotic bone
- Sequential IV-Oral therapy
  - Organism isolated
  - Clear cut clinical/lab improvement
  - Reliable family and follow-up
Question # 11

- A previously healthy 18-month-old-boy is brought to the ED because of a 10-hour history of fever, irritability and refusal to walk. On physical examination, his temperature is 38.9°C and he is irritable. His right hip is held in a flexed, externally rotated and abducted position. He will not allow any movement of his right hip. Analysis of a joint aspirate performed from his left hip reveals 80,000 WBC/mm³ with 90% polymorphonuclear cells. Gram stain of the joint fluid aspirate reveals many polymorphonuclear cells but no organisms. Of the following, the test that is most likely to establish the diagnosis in this patient is a/an

Answers #11

- A. C-reactive protein
- B. Blood culture
- C. Joint aspirate culture
- D. ANA and Rheumatoid factor
- E. ASO titer

DIAGNOSIS OF SEPTIC ARTHRITIS

- Synovial fluid
  - cell count, glucose, GS, culture
  - positive in 60% (10% with GC)
- Blood culture
  - positive in 30-40% with S. aureus; much less with GC
- Genital tract cultures-if suspect GC
- Plain radiographs-nonspecific
- US hips
- MRI-if suspect osteomyelitis
MICROBIAL ETIOLOGY OF SEPTIC ARTHRITIS

<table>
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<th>Neonate</th>
<th>Infant</th>
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<tr>
<td><em>S. aureus</em></td>
<td><em>S. aureus</em></td>
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<td><em>Candida</em></td>
<td><em>Kingella kingae</em></td>
<td><em>N. gonorrhoeae</em></td>
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</tbody>
</table>

SYNOVIAL FLUID CHARACTERISTICS

<table>
<thead>
<tr>
<th></th>
<th>WBC/mm³</th>
<th>% PMN</th>
<th>Glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septic Arthritis</td>
<td>&gt; 50,000</td>
<td>90</td>
<td>Decreased</td>
</tr>
<tr>
<td>Rheumatic Disease</td>
<td>&lt; 20,000</td>
<td>60</td>
<td>Normal</td>
</tr>
</tbody>
</table>

SEPTIC ARTHRITIS: MANAGEMENT

- Duration of antibiotics
  - 3 week minimum (IV + oral)
  - same rules for PO as for osteo
- Therapy for GC septic arthritis
  - 7-10 days IV/IM Ceftriaxone if no meningitis and no SBE
- Indications for surgery
  - Hips always surgically drained
  - Foreign material; no prompt response
FUNGAL INFECTIONS

Question #12

Which of the following is a true statement concerning *Histoplasma capsulatum* infection?

A. The fungus is endemic to the Southeastern coastline of the US

B. Acute disseminated disease, manifested by high fever, hepatosplenomegaly, and pancytopenia, is a feature of infection in infants

C. 50% of infected individuals are asymptomatic

D. Serologic techniques are rarely helpful in making the diagnosis

HISTOPLASMOSIS

- Exposure to bat or bird droppings, caves, sites of excavation; Midwest (Ohio and Miss. River valleys)
- Clinical manifestations
  - Asymptomatic-95% of infections
  - Acute influenza-like pulmonary illness with hilar adenopathy
  - Erythema nodosum, migratory arthritis, HSM with more severe disease
  - Acute disseminated-children< 2 yrs; fever; HSM; pancytopenia; adenopathy
- Diagnosis-serology; culture blood and BM
- Therapy-Amphotericin B for severe disease
Question #13

A 3-year old Filipino girl living in Arizona presents with a 3-week history of headaches, increasing confusion and fever. Her PMH is unremarkable. Examination of her spinal fluid reveals 52 lymphocytes, protein 90 mg/dl, glucose 35 mg/dl. The organism most likely to cause this clinical picture is:

Question #13-Choices

A. Coccidioides immitis
B. Candida albicans
C. Cryptococcus neoformans
D. Aspergillus fumigatus
E. Blastomyces dermatitides

Coccidioidomycosis

- Endemic areas: Southwestern U.S.; San Joaquin Valley in CA; Northern Mexico
- High risk groups for disseminated disease
  - Neonates; pregnancy; immunocompromised; African Americans (14X); Filipinos (200X); Hispanics (3X)
- Clinical
  - Asymptomatic infection-most common
  - Acute pulmonary infection-resembles influenza
**Coccidioidomycosis**

- Disseminated disease
  - Bone, skin, soft tissue
  - Meningitis-15% of those with disseminated disease
    - fever, chronic headache, confusion
    - CSF: mononuclear cells (<500), low glucose, high protein
    - recurrence after antifungals stopped
- Hypersensitivity manifestations
  - M/P rash; Erythema nodosum, arthralgia
- Diagnosis-serology
- Therapy-Amphotericin B for most infections, Fluconazole for CNS infections

**Fungal Infections**

- Dimorphic pathogenic fungi
  - *Histoplasma, Coccidioides, Blastomyces, Sporothrix schenckii*
    - lymphocutaneous and cutaneous disease
    - contaminated rose bushes
- Cause localized and disseminated disease in normal and immunocompromised hosts
- Most commonly cause asymptomatic infection
Fungal Infections

- Opportunistic Fungi cause infections in immunocompromised patients
  - *Candida* species
    - premature neonates, central venous catheters
  - *Cryptococcus neoformans*
    - subacute and chronic meningitis
  - Aspergillosis
    - corticosteroid therapy, neutropenia
  - Mucormycosis
    - diabetic ketoacidosis

Selected Parasitic Infections

Q 14: Match the clinical scenario with the most likely cause of infection

14. Rectal prolapse and dysentery

- A. *Necator americanus*
- B. *Toxocara canis*
- C. *Trichuris trichuria*
- D. *Trichinella spiralis*
- E. *Toxoplasma gondii*
- F. *Ascaris lumbricoides*
Q 15: Match the clinical scenario with the most likely cause of infection

- 15. Iron deficiency anemia
  - A. Necator americanus
  - B. Toxocara canis
  - C. Trichuris trichuria
  - D. Trichinella spiralis
  - E. Toxoplasma gondii
  - F. Ascaris lumbricoides

Q 16: Match the clinical scenario with the most likely cause of infection

- 16. Wheezing, eosinophilia and hypergammaglobulinemia
  - A. Necator americanus
  - B. Toxocara canis
  - C. Trichuris trichuria
  - D. Trichinella spiralis
  - E. Toxoplasma gondii
  - F. Ascaris lumbricoides

Q 17: Match the clinical scenario with the most likely cause of infection

- 17. Acute intestinal obstruction
  - A. Necator americanus
  - B. Toxocara canis
  - C. Trichuris trichuria
  - D. Trichinella spiralis
  - E. Toxoplasma gondii
  - F. Ascaris lumbricoides
Q 18: Match the clinical scenario with the most likely cause of infection

18. Fever, myalgias, periorbital edema, conjunctival hemorrhages
   A. *Necator americanus*
   B. *Toxocara canis*
   C. *Trichuris trichuria*
   D. *Trichinella spiralis*
   E. *Toxoplasma gondii*
   F. *Ascaris lumbricoides*

Whipworm

- *Trichuris trichura*
  - Large thread-like anterior end
  - Dysentery syndrome
  - Mimics IBD
  - Growth retardation—even when asymptomatic otherwise
  - Rectal proplapse
    - Chronic infection
    - Heavy infestation

Hookworm

- *Necator americanus* — roundworm
  - Contact with contaminated soil→ skin (feet) penetration of larvae→ pruritis, papulosquamous rash (“ground itch”)
  - Cause of **hypochromic microcytic anemia** in women and children
  - Protein loss—edema from hypoalbuminemia
  - Children
    - Physical growth stunting
    - Cognitive defects and intellectual retardation
Visceral larva migrans

- *Toxocara canis* = Dog ascaris worm
- 1-3 year olds—history of pica
- Pneumonitis (wheezing)
- Hepatitis, fever
- Cerebritis
- Eosinophilia
- Hypergammaglobulinemia
- Distinct from ocular larva migrans
- Serology for diagnosis—worms do not go back into the intestines—not seen in stool
Ascaris

- *Ascaris lumbricoides* – most common roundworm worldwide
- Heavy infestation
  - Growth retardation
  - Impaired nutrition
  - Loeffler’s syndrome (eosinophilic pneumonitis)
  - Acute intestinal obstruction
  - Biliary obstruction

[Image: http://www.dpd.cdc.gov/dpdx/HTML/Ascariasis.htm]

Trichinosis

- *Trichinella spiralis* (tissue nematode)
- Ingestion of raw or undercooked pork
- Infects striated muscles
- GI illness 1-2 weeks after ingestion
- Tissue phase 2-8 weeks after ingestion
  - Fever, myalgias, bilateral periorbital edema, conjunctival and subungual hemorrhages
  - Intense eosinophilia
- Diagnosis: dietary history, clinical and lab features
  - Biopsy, serology
Trichinella Infections

http://www.dpd.cdc.gov/dpdx/HTML/Trichinosis.htm

Answers to Questions

1. B  
2. A  
3. D  
4. D  
5. A  
6. D  
7. B  
8. B  
9. E  
10. D  
11. C  
12. B  
13. A  
14. C  
15. A  
16. B  
17. F  
18. D

Children's Hospital
Cleveland Clinic