Disclosures

• I have no financial relationships to disclose

• I will not discuss off-label use and/or investigational use in my presentation

• Slides provided by various sources including IDSA and Mandell Textbook of Infectious Diseases
Learning Objectives

1. Describe 3 common syndromes associated with infections of the Central Nervous System (CNS)

2. Discuss the clinical presentations, diagnosis including Cerebrospinal Fluid (CSF) analysis, and management of common CNS infections

3. Identify risk factors associated with the development of invasive fungal infections of the CNS
Infections of the CNS

• The central nervous system (CNS) may be infected by viruses, bacteria, fungi, protozoa, and helminths.

• The clinical presentation of a CNS infection may be acute, subacute, or chronic, depending on the virulence of the infecting agent and the location of the infection.
Clinical Presentation

• Key Factors
  – Pathogenesis of spread of the infection to the CNS
  – Virulence of the etiologic agent
  – Area of CNS involvement

• Common manifestations
  – Fever
  – Headache
  – Altered mental status
  – Focal neurologic deficits
Syndromes

- Meningitis
  - Acute
  - Subacute/Chronic

- Encephalitis

- Focal CNS Infections
  - Brain abscess
  - Subdural empyema
  - Epidural abscess
“My Head is About to Explode”

- A 35 year old healthy woman c/o severe headache for 3 days, associated with fever, nausea, and vomiting

- Self-diagnosed “sinus infection” but did NOT take any antibiotics

- Her family called EMS when she became disoriented
Meningitis
A continuum of syndromes

• Meningitis
  – Acute: Fever, headache, +/- altered mental status
  – Chronic: More gradual, less severe

• Encephalitis
  – Mental status change may occur early and may progress to obtundation or coma
  – Behavioral and speech disturbances
<table>
<thead>
<tr>
<th>Predisposing factor</th>
<th>Common bacterial pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>&lt;1 month</td>
<td><em>Streptococcus agalactiae</em>, <em>Escherichia coli</em>, <em>Listeria monocytogenes</em>, <em>Klebsiella species</em></td>
</tr>
<tr>
<td>1–23 months</td>
<td><em>Streptococcus pneumoniae</em>, <em>Neisseria meningitidis</em>, <em>S. agalactiae</em>, <em>Haemophilus influenzae</em>, <em>E. coli</em></td>
</tr>
<tr>
<td>2–50 years</td>
<td><em>N. meningitidis</em>, <em>S. pneumoniae</em></td>
</tr>
<tr>
<td>&gt;50 years</td>
<td><em>S. pneumoniae</em>, <em>N. meningitidis</em>, <em>L. monocytogenes</em>, aerobic gram-negative bacilli</td>
</tr>
<tr>
<td>Head trauma</td>
<td></td>
</tr>
<tr>
<td>Basilar skull fracture</td>
<td><em>S. pneumoniae</em>, <em>H. influenzae</em>, group A β-hemolytic streptococci</td>
</tr>
<tr>
<td>Penetrating trauma</td>
<td><em>Staphylococcus aureus</em>, coagulate-negative staphylococci (especially <em>Staphylococcus epidermidis</em>), aerobic gram-negative bacilli (including <em>Pseudomonas aeruginosa</em>)</td>
</tr>
<tr>
<td>Postneurosurgery</td>
<td>Aerobic gram-negative bacilli (including <em>P. aeruginosa</em>), <em>S. aureus</em>, coagulate-negative staphylococci (especially <em>S. epidermidis</em>)</td>
</tr>
<tr>
<td>CSF shunt</td>
<td>Coagulate-negative staphylococci (especially <em>S. epidermidis</em>), <em>S. aureus</em>, aerobic gram-negative bacilli (including <em>P. aeruginosa</em>), <em>Propionibacterium acnes</em></td>
</tr>
</tbody>
</table>
**Chronic Meningitis**

**Mycoses**
- Cryptococcus (cryptococcosis)
- Coccidioides (coccidioidomycosis)
- Histoplasma (histoplasmosis)
- Candida (candidiasis)
- Sporothrix (sporotrichosis [rare])
- Blastomyces (blastomycosis [rare])
- Other molds (rare): *Scedosporium*, *Aspergillus*, *Cladophialophora* and other dark-walled molds

**Bacteria**
- *Mycobacterium tuberculosis* (tuberculosis)
- *Treponema pallidum* (syphilis)
- *Borrelia burgdorferi* (Lyme disease)
- *Tropheryma whippelii* (Whipple’s disease)
- *Actinomyces* (actinomycosis [parameningeal, rare])
- *Nocardia* (nocardioides [with brain abscess])
- *Brucella* (brucellosis [rare])

**Parasites**
- *Acanthamoeba* (acanthamebiasis)
- *Taenia solium* (cysticercosis)
- *Angiostrongylus cantonensis* (angiostrongyliasis)
<table>
<thead>
<tr>
<th>WBC Count</th>
<th>Mononuclear Percentage</th>
<th>Glucose</th>
<th>Protein</th>
<th>Diagnosis</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-100</td>
<td>90%</td>
<td>Normal</td>
<td>Mildly elevated</td>
<td>Viral or “Aseptic” Neurosyphilis</td>
<td>Enteroviral PCR, West Nile IgM, HSV PCR, VDRL</td>
</tr>
<tr>
<td>1000+</td>
<td>90%</td>
<td>&lt;10</td>
<td>Elevated</td>
<td>Bacterial</td>
<td>Gram stain and culture, Blood cultures, DNA testing</td>
</tr>
<tr>
<td>20-200</td>
<td>90%</td>
<td>&lt;40</td>
<td>Elevated</td>
<td>Fungal Tuberculosis</td>
<td>Fungal culture, Cryptococcal Ag, Coccidioides CF, Coccidioides Ag, AFB culture/PCR</td>
</tr>
</tbody>
</table>
Management

Suspicion for bacterial meningitis

- Yes
  - Immunocompromise, history of CNS disease, new onset seizure, papilledema, altered consciousness, or focal neurologic deficit;
  - or delay in performance of diagnostic lumbar puncture

  - No
    - Blood cultures and lumbar puncture STAT
      - Dexamethasone + empirical antimicrobial therapy
        - Yes
          - CSF findings c/w bacterial meningitis
            - Positive CSF Gram stain
              - No
                - Dexamethasone + empirical antimicrobial therapy
              - Yes
                - Dexamethasone + targeted antimicrobial therapy

  - Yes
    - Blood cultures STAT
      - Dexamethasone + empirical antimicrobial therapy
        - Negative CT scan of the head
          - Perform lumbar puncture
Streptococcus pneumoniae

- Increased risk with HIV/AIDS,
  Sickle Cell Disease,
  Transplantation,
  Hypogammaglobulinemia

- Concurrent bacteremia,
  pneumonia (20%), otitis (30%).
  Mortality up to 30%
Treatment of S. pneumoniae

• Treatment includes a combination of Ceftriaxone and Vancomycin initially

• Antibiotic levels in CSF reach only 2-10% of serum levels

• PCN CSF breakpoints:
  – < 0.1 ug/ml
  – 0.1 – 1.0 ug/ml
  – ≥ 2.0 ug/ml

IDSA Guidelines 2005
**Neisseria meningitidis**

- 10% case-fatality
- Host Risk factors:
  - Asplenia
  - Complement deficiency
  - Hypogammaglobulinemia
- Sequelae in 11-19% of cases
- Asymptomatic colonization

Treatment of *N. meningitidis*

- Most strains are penicillin-susceptible but reduced susceptibility is common in Africa, Europe, regional in U.S.
- Susceptible to 3rd generation cephalosporins
- Droplet Transmission: Up to 24 hours after antibiotic therapy is started
- Chemoprophylaxis: Rifampin, ceftriaxone, and ciprofloxacin
A 70 year old man is brought in by EMS with fever, headache, vomiting, and diarrhea lasting about 4 days.

This was followed by the abrupt onset of asymmetrical cranial nerve deficits, cerebellar signs, and hemiparesis.

Nuchal rigidity is present and CSF findings are only mildly abnormal with a positive CSF culture.
Which bacteria is most likely causing this infection?

A. *Strep pneumoniae*

B. *Neisseria meningitidis*

C. *Haemophilus influenzae*

D. *L. monocytogenes*

E. *Treponema pallidum*
Which bacteria is most likely causing this infection?

A. *Strep pneumoniae*

B. *Neisseria meningitidis*

C. *Haemophilus influenzae*

D. *L. monocytogenes*

E. *Treponema pallidum*
Listeria monocytogenes

- Foodborne
- Highest risk in infants, adults > 50 years, pregnancy, HIV/AIDS, hematologic malignancy, transplantation
- Brainstem Encephalitis (Rhombencephalitis)
- Meningoencephalitis
- Parenchymal infection
### Treatment

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Recommended therapy</th>
<th>Alternative therapies</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Streptococcus pneumoniae</em></td>
<td>Vancomycin plus a third-generation cephalosporin&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>Meropenem (C-III), fluoroquinolone&lt;sup&gt;c&lt;/sup&gt; (B-II)</td>
</tr>
<tr>
<td><em>Neisseria meningitidis</em></td>
<td>Third-generation cephalosporin&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Penicillin G, ampicillin, chloramphenicol, fluoroquinolone, aztreonam</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>Ampicillin&lt;sup&gt;d&lt;/sup&gt; or penicillin G&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Trimethoprim-sulfamethoxazole, meropenem (B-III)</td>
</tr>
<tr>
<td><em>Streptococcus agalactiae</em></td>
<td>Ampicillin&lt;sup&gt;d&lt;/sup&gt; or penicillin G&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Third-generation cephalosporin&lt;sup&gt;a&lt;/sup&gt; (B-III)</td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td>Third-generation cephalosporin&lt;sup&gt;a&lt;/sup&gt; (A-I)</td>
<td>Chloramphenicol, cefepime (A-I), meropenem (A-I), fluoroquinolone</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>Third-generation cephalosporin&lt;sup&gt;a&lt;/sup&gt; (A-II)</td>
<td>Cefepime, meropenem, aztreonam, fluoroquinolone, trimethoprim-sulfamethoxazole</td>
</tr>
</tbody>
</table>
### Treatment

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Duration of therapy, days</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Neisseria meningitidis</em></td>
<td>7</td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td>7</td>
</tr>
<tr>
<td><em>Streptococcus pneumoniae</em></td>
<td>10–14</td>
</tr>
<tr>
<td><em>Streptococcus agalactiae</em></td>
<td>14–21</td>
</tr>
<tr>
<td>Aerobic gram-negative bacilli&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>≥21</td>
</tr>
</tbody>
</table>
Red Herring

• An 82 year old man presented to the clinic with fever, fatigue, urinary incontinence, confusion, and was reported to have been walking naked in the house.

• Urinalysis showed bacteriuria and pyuria.

• He was diagnosed with a urinary tract infection and was prescribed Levofloxacin.
Red Herring

- The following day he continued to have fever and worsening confusion

- He was transferred to the ED that evening with reports of having developed aphasia, ataxia, and an episode of seizure
HSV Encephalitis

- Pathogenesis: Reactivation of virus in cranial nerve ganglia and retrograde spread along axons

- Focal involvement of temporal lobe

- Personality changes, obtundation, seizures, focal neurologic findings
Herpes simplex in the CNS

**Meningitis**
- HSV 2 >> 1
- Associated with primary infection
- Normal mental status
- Can be recurrent (Mollaret)
- Usually benign

**Encephalitis**
- HSV 1 >> 2
- Usually not primary in adults
- Abnormal mental status, seizures
- Usually no oral lesions
- Acyclovir decreases mortality

Whitley et al JAMA 1982:247:317
Encephalitis: Epidemiology and Risk Factors

- Travel
- Insect Contact
- Animal Contact
- Human Contact
- Season
- Recreational Activities/Ingestions
- Occupation
- Age and Immune Status
# Infectious Causes of Encephalitis

<table>
<thead>
<tr>
<th>Viral</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV</td>
<td>ADEM</td>
</tr>
<tr>
<td>Influenza</td>
<td>Mycoplasma</td>
</tr>
<tr>
<td>Herpes</td>
<td>Coxiella burnetii</td>
</tr>
<tr>
<td>Rabies</td>
<td>Bartonella henselae</td>
</tr>
<tr>
<td>Tick borne encephalitis</td>
<td>Listeria</td>
</tr>
<tr>
<td>Arboviruses</td>
<td>Syphilis</td>
</tr>
<tr>
<td>Herpes B (monkeys)</td>
<td>Toxoplasmosis</td>
</tr>
<tr>
<td>West Nile Virus</td>
<td>R. rickettsii</td>
</tr>
</tbody>
</table>

PPID 7th Ed Table 87-3

ADEM: Acute Disseminated Encephalomyelitis
Viral meningoencephalitis: Diagnosis

- **Enteroviral**
  - PCR: best, 94-96% sensitive
  - Viral culture: 60-70% sensitive, takes 4-8 days

- **West Nile**
  - IgM in CSF most sensitive
  - Can cross react with other flaviviruses

- **HSV1/2, other herpes viruses (3 – 8)**
  - PCR in CSF
  - Serum antibodies not useful
Therapy of viral CNS infection

• Few specific antiviral medications exist

• Acyclovir for herpes encephalitis

• Supportive: Treat fever, headaches, seizures
Fungal Meningitis

• *Coccidioides* spp: Everyone in the endemic region

• *Cryptococcus neoformans*: Deficiencies in cell mediated immunity and normal hosts

• *Histoplasma capsulatum*: Ohio and Mississippi river valleys

• *Aspergillus*, *Candida*, and *Mucor* (Immunosuppressed)
Coccidioidomycosis of the CNS

- Dimorphic fungi, *Coccidioidomycosis immitis* (California) and *posadasii*, also known as the *San Joaquin Valley fever*

- During 1998–2011, a total of 111,717 cases were reported: 66% from Arizona, 31% from California, 1% from other endemic states, and <1% from non-endemic states

- Coccidioidomycosis involving the CNS was initially reported in the early 1900s and is one of the most devastating forms of dissemination, reported in 1/3 to 1/2 of patients
Clinical Manifestations

• Headache (77%)

• Nuchal rigidity (23%)

• Mental status changes (39%) including confusion, lethargy, memory loss, general malaise, and poor recognition

• Focal neurologic manifestations (33%) including ataxia due to hydrocephalus
CNS Dissemination

- The main areas of involvement are the basilar meninges
- Hydrocephalus the most common complication (49%)
- Vasculitis and focal intracerebral coccidioidal abscesses as less frequent complications

Coccidioidal meningitis and brain abscesses

Analysis of 71 cases at a referral center

Neurology® 2009;73:1780-1786

Kendra W. Drake, MD
Rodney D. Adam, MD
Coccidioidal meningitis and brain abscesses
Analysis of 71 cases at a referral center

Kendra W. Drake, MD
Rodney D. Adam, MD

Neurology® 2009;73:1780-1786
Vasculitis Secondary to Coccidioidal Meningitis
Diagnostics

- Detected by hematoxylin and eosin (H&E) stains, silver (GMS) and/or by culture in serum/blood, cerebrospinal fluid, or other body fluids/tissues

- Immunodiffusion: Tube precipitin (IDTP) and complement-fixing tests (IDCF) and titers

- Enzyme-Linked Immunoassays (EIA): Specific detection of IgM or IgG antibodies

- Antigen is detected in serum, urine, or CSF

Galgiani J., Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases, 8th Edition, 2014
Diagnostics

- CSF Coccidioides antigen (CAg) has a sensitivity and specificity of 93% and 100%

- Binnicker *et al.* applied real-time PCR to 266 respiratory specimens

- Analysis demonstrated 100% sensitivity and 98% specificity for Coccidioides when compared with culture
Management

- Treatment with intrathecal amphotericin B was the standard of care until the availability of azoles in the 1980s

- Fluconazole replaced amphotericin after its efficacy was reported in a retrospective study in 1988 and a prospective study in 1993

- Other antifungal agents used successfully in CNS infections include, voriconazole, posaconazole, isavuconazole, and intravenous liposomal amphotericin B

- Hydrocephalus nearly always requires a shunt for decompression
2016 Infectious Diseases Society of America (IDSA) Clinical Practice Guideline for the Treatment of Coccidioidomycosis

John N. Galgiani,¹ Neil M. Ampel,² Janis E. Blair,³ Antonino Catanzaro,⁴ Francesca Geertsma,⁵ Susan E. Hoover,⁶ Royce H. Johnson,⁷ Shimon Kusne,³ Jeffrey Lisse,⁸ Joel D. MacDonald,⁹ Shari L. Meyerson,¹⁰ Patricia B. Raksin,¹¹ John Siever,¹² David A. Stevens,¹³ Rebecca Sunenshine,¹⁴,¹⁵ and Nicholas Theodore¹⁶
<table>
<thead>
<tr>
<th>PREDISPOISING CONDITION</th>
<th>USUAL MICROBIAL ISOLATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otitis media or mastoiditis</td>
<td>Streptococci (anaerobic or aerobic), Bacteroides and Prevotella spp., Enterobacteriaceae</td>
</tr>
<tr>
<td>Sinusitis (frontoethmoid or sphenoid)</td>
<td>Streptococci, Bacteroides spp., Enterobacteriaceae, Staphylococcus aureus, Haemophilus spp.</td>
</tr>
<tr>
<td>Dental infection</td>
<td>Mixed Fusobacterium, Prevotella, Actinomyces, and Bacteroides spp., streptococci</td>
</tr>
<tr>
<td>Penetrating trauma or postneurosurgical</td>
<td>S. aureus, streptococci, Enterobacteriaceae, Clostridium spp.</td>
</tr>
<tr>
<td>Lung abscess, empyema, bronchiectasis</td>
<td>Fusobacterium, Actinomyces, Bacteroides, and Prevotella spp., streptococci, Nocardia spp.</td>
</tr>
<tr>
<td>Bacterial endocarditis</td>
<td>S. aureus, streptococci</td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td>Streptococci, Haemophilus spp.</td>
</tr>
<tr>
<td>Transplantation</td>
<td>Aspergillus spp., Candida spp., Mucorales, Scedosporium spp., Enterobacteriaceae, Nocardia spp., Toxoplasma gondii, Mycobacterium tuberculosis</td>
</tr>
<tr>
<td>Human immunodeficiency virus infection</td>
<td>T. gondii, Nocardia spp., Mycobacterium spp., Listeria monocytogenes, Cryptococcus neoformans</td>
</tr>
</tbody>
</table>
Brain Abscess:
Clinical Presentation

<table>
<thead>
<tr>
<th>SYMPTOM OR SIGN</th>
<th>FREQUENCY (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>49-97</td>
</tr>
<tr>
<td>Mental status changes</td>
<td>28-91</td>
</tr>
<tr>
<td>Focal neurologic deficits</td>
<td>20-66</td>
</tr>
<tr>
<td>Fever</td>
<td>32-79</td>
</tr>
<tr>
<td>Triad of headache, fever, and focal deficit</td>
<td>&lt;50</td>
</tr>
<tr>
<td>Seizures</td>
<td>13-35</td>
</tr>
<tr>
<td>Nausea and vomiting</td>
<td>27-85</td>
</tr>
<tr>
<td>Nuchal rigidity</td>
<td>5-52</td>
</tr>
<tr>
<td>Papilledema</td>
<td>9-51</td>
</tr>
</tbody>
</table>
Polymicrobial Pituitary Abscess Predominately Involving *Escherichia coli* in the Setting of an Apoplectic Pituitary Prolactinoma

Norman Beatty, Luis Medina-Garcia, Mayar Al Mohajer, and Tirdad T. Zangeneh

*Division of Infectious Diseases, Department of Medicine, University of Arizona College of Medicine, Banner-University Medical Center, 1501 N. Campbell Avenue, Tucson, AZ 85724, USA*
Disseminated Infection Caused by *Eggerthella lenta* in a Previously Healthy Young Man: A Case Report

Ahmad Salameh,1 Stephen A. Klotz,2 and Tirdad T. Zangeneh2

1 Department of Medicine, The University of Arizona Medical Center, University of Arizona, Tucson, AZ 85724, USA
2 Division of Infectious Diseases, Department of Medicine, The University of Arizona Medical Center, University of Arizona, Tucson, AZ 85724, USA
Fatal Granulomatous Amoebic Encephalitis Caused by *Acanthamoeba* in a Patient With Kidney Transplant: A Case Report
Fatal *Aspergillus fumisynneamatus* Sinusitis with CNS invasion in a healthy 36 year old man
Fatal Invasive Orbitorhinocerebral Mucormycosis in a 54 year old woman with uncontrolled diabetes
Mucormycosis

- *Rhizopus* species are the most common genera followed by:
  - *Mucor* species (19%)
  - *Rhizomucor* species (7%)
  - *Cunninghamamella* species (9%)

- Ubiquitous in nature and can be found on decaying vegetation and in the soil
- Mortality rate ranging from 68 to 100%
Pathogenesis

Role in Diabetic Ketoacidosis: Diminished capacity of transferrin to bind to and sequester free iron at a pH of <7.4
**Table 2** Factors predisposing patients to zygomycosis

<table>
<thead>
<tr>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diabetes mellitus</strong></td>
</tr>
<tr>
<td>Diabetic ketoacidosis</td>
</tr>
<tr>
<td>Poorly controlled diabetes mellitus</td>
</tr>
<tr>
<td>Chronic metabolic acidosis</td>
</tr>
<tr>
<td>Renal failure</td>
</tr>
<tr>
<td>Chronic salicylate poisoning</td>
</tr>
<tr>
<td>Deferoxamine therapy</td>
</tr>
<tr>
<td><strong>Iron overload</strong></td>
</tr>
<tr>
<td><strong>Immunosuppression</strong></td>
</tr>
<tr>
<td>Neutropenia (due to malignancies or chemotherapy)</td>
</tr>
<tr>
<td>Corticosteroid therapy</td>
</tr>
<tr>
<td>Organ or hematopoietic cell transplantation</td>
</tr>
<tr>
<td>HIV infection</td>
</tr>
<tr>
<td>Skin or soft tissue breakdown</td>
</tr>
<tr>
<td>Burn</td>
</tr>
<tr>
<td><strong>Trauma</strong></td>
</tr>
<tr>
<td>Surgical wound</td>
</tr>
<tr>
<td>Miscellaneous</td>
</tr>
<tr>
<td>Intravenous illicit drug use</td>
</tr>
<tr>
<td>Neonatal prematurity</td>
</tr>
<tr>
<td>Malnourishment</td>
</tr>
<tr>
<td>Prolonged use of broad-spectrum antimicrobial agents</td>
</tr>
</tbody>
</table>
**Decision Making and Problem Solving**

**Diagnosis and treatment of mucormycosis in patients with hematological malignancies: guidelines from the 3rd European Conference on Infections in Leukemia (ECIL 3)**

Anna Skiada, Fanny Lanterner, Andreas H. Groll, Livio Pagano, Stephan Zimmerli, Raoul Herbrecht, Olivier Lortholary, and George L. Petrikkos on behalf of the third European Conference on Infections in Leukemia.

<table>
<thead>
<tr>
<th>Management should include antifungal therapy, control of underlying conditions and surgery</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antifungal therapy</strong></td>
<td></td>
</tr>
<tr>
<td>AmB deoxycholate</td>
<td>CII</td>
</tr>
<tr>
<td>Liposomal AmB, 5-10 mg/kg</td>
<td>BII</td>
</tr>
<tr>
<td>ABLC, 5-7.5 mg/kg</td>
<td>BIII</td>
</tr>
<tr>
<td>ABCD</td>
<td>CII</td>
</tr>
<tr>
<td>Posaconazole, 400 mg bid</td>
<td>CIII</td>
</tr>
<tr>
<td>Combination therapy</td>
<td>CIII</td>
</tr>
<tr>
<td>Control of underlying condition</td>
<td>ALL</td>
</tr>
<tr>
<td><strong>Surgery</strong></td>
<td></td>
</tr>
<tr>
<td>-rhino-orbito-cerebral</td>
<td>ALL</td>
</tr>
<tr>
<td>-soft tissue</td>
<td>ALL</td>
</tr>
<tr>
<td>-localized pulmonary lesion</td>
<td>BII</td>
</tr>
<tr>
<td>-disseminated</td>
<td>CIII</td>
</tr>
<tr>
<td>Hyperbaric oxygen</td>
<td>CIII</td>
</tr>
</tbody>
</table>

*Haematologica. 2013 Apr;98(4):492-504*
Subdural Empyema
Subdural Empyema

- Subdural empyema refers to a collection of pus between the dura and arachnoid

- Predisposing factors include otorhinologic infections which are affected in 40% to 80% of cases

- Caused by aerobic streptococci, staphylococci, aerobic gram-negative bacilli, and anaerobic streptococci, and other anaerobes
Subdural Empyema

• Magnetic resonance imaging (MRI) is the diagnostic procedure of choice in patients with subdural empyema

• Subdural empyema is a medical and surgical emergency

• The goals of surgery are to achieve adequate decompression and evacuation of empyema with craniotomy being the surgical procedure of choice
“My back is killing me”

- A 24 y/o man presents to the ED with c/o fever, severe back pain described as “shooting” and stabbing in nature, lower extremity weakness with decreased sensation, difficulty walking, and bladder dysfunction.

- He reports injecting heroin for the past 3 months.
Imaging

- Epidural abscess extending from the L4-S1 levels causing severe thecal sac stenosis with cauda equina impingement
Microbiology

• *S. aureus* (Over 60% of cases)
• Gram-negative bacilli
• Streptococci
• Coagulase-negative staphylococci
• Anaerobes
• Others (fungi, tuberculosis, parasites)
Abscesses are more likely to develop in larger epidural spaces that contain infection-prone fat.
Management of Spinal Epidural Abscess

Suspected spinal epidural abscess

Do any of these conditions exist?
- Patient refuses surgery
- Patient with high operative risk
- Paralysis for more than 24–36 hr
- Panspinal infection

No

Emergency decompressive laminectomy plus antibiotic therapy

Yes

Have blood cultures identified the infecting pathogen?

No

Culture abscess by CT-guided needle aspiration to navigate definitive antibiotic therapy

Yes

Antibiotic therapy guided by blood cultures
Infective Endocarditis (IE)

- Infection of the endocardium that involves the cardiac valves and adjacent structures

- Bacterial (most common), fungal, rickettsia

- Acute and subacute course
Microbiology

- **S. aureus** — 31 percent
- **Viridans group streptococci** — 17 percent
- **Enterococci** — 11 percent
- **Coagulase-negative staphylococci** — 11 percent
- **Streptococcus bovis** — 7 percent
- **Non-HACEK gram-negative bacteria** — 2 percent
- **Fungi** — 2 percent
- **HACEK** — 2 percent

*Haemophilus spp*
*Aggregatibacter* [formerly *Actinobacillus* spp.]
*Cardiobacterium hominis*
*Eikenella corrodens*
*Kingella kingae*
Consequences of Septic Emboli

- Mitral or aortic valve
- Left ventricle
- Aorta

Large vessel

Small vessel (Janeway lesions)
CNS Involvement

- Patients with left-sided IE were prospectively evaluated with cerebral MRI regardless of neurologic symptoms.

- The total cerebrovascular complication rate was 65%, including 35% (symptomatic) and 30% (clinically silent).

- Middle cerebral artery and its branches are involved commonly.

- Hemorrhagic transformation of septic emboli commonly results in fatal intracerebral hemorrhage.

Conclusion

• Infections involving the CNS are caused by a variety of organisms.

• The clinical presentations depend on the virulence of the organism, host immunity, and the involved location.

• A delay in diagnosis is often associated with a high morbidity and mortality.