Meningitis aguda en adultos

Dr. Luis Ernesto González Sánchez
Neurólogo-Neurofisiólogo-Internista
RESUMEN
La meningitis es una emergencia médica
Paso: 1 Si existe el diagnóstico debe hacerse
a. RMI o TAC con contraste en tiempo de fase retardada
b. Punción lumbar según el contexto clínico e imágenes
c. Tratamiento empírico inmediato según los factores clínicos datos de riesgo
A 20-year-old man presents to the emergency department in early June complaining of 6 hours of fever, headache, and pain on flexion of his neck. He underwent renal transplantation 1 year ago. On examination he is febrile and has meningismus. There is a slight erythematous maculopapular rash on his chest. The neurological examination is normal with the exception of meningismus. Blood cultures are obtained. The patient is treated with dexamethasone 10 mg intravenously followed by cefepime 2 grams intravenously, vancomycin 1 gram intravenously, and ampicillin 3 grams intravenously. Over the course of an hour, he becomes increasingly lethargic and has a focal motor seizure with secondary generalization. Acyclovir 10 mg/kg and doxycycline 100 mg are added to the empiric regimen. Head computed tomographic (CT) scan is normal. Spinal fluid analysis demonstrates an opening pressure of 320 mm H2O, 1000 white blood cells per mm3 with a predominance of polymorphonuclear leukocytes, a glucose concentration of 10 mg/dL, and a protein concentration of 100 mg/dL. Gram’s stain of CSF demonstrates gram-positive lancet-shaped diplococci in pairs. Ampicillin, acyclovir, and doxycycline are discontinued.
Comment. Empiric therapy of bacterial meningitis is based on the possibility that a penicillin- and cephalosporin-resistant strain of S. pneumoniae is the causative organism of the meningitis and should include a combination of either a third- or fourth-generation cephalosporin plus vancomycin. The patient is an organ transplant recipient and thus is at risk for L. monocytogenes meningitis. Ampicillin is added to the empiric regimen until the results of the Gram’s stain are known. When the patient has a focal seizure, empiric therapy for HSV encephalitis is added. As it is June, the possibility of a tick-borne bacterial infection, either Rocky Mountain spotted fever or an ehrlichia infection, should be considered in the differential diagnosis and empiric therapy with doxycycline initiated until another diagnosis is made. Once the antimicrobial sensitivities of the organism are available, the antibiotic regimen is modified.
Meningitis aguda en adultos, vista global
edad: >1m, Dur: <4 semanas

ASEPTICA
Tx: HSV
NoTX: Entero-V, Arbo-V.Mumps-V, LCM-Virus, WNV

BACTERIANA
T °, Rig Cuello,
LCR: Pleocitosis
>15-≤50
SP Pneumonie (SPN)
N Meningitidis
≥50:
SPN, G-
L. Monocytogenes,
Hi-b

VIRAL
CXK-A, CXK-B
ECHO-V,Entero-V 68-71
Artropo-Borne-V
HSV-2, EB-Virus,HIV-1
Varicela-Z, LCM-Virus
Mump-Virus
Adenovirus

HONGO
CRYPTOCOCO

TRAUMA PENETRANTE O NO PENETRANTE,
POST-OP, VALVULA V-P
Fx BASE CONTINUIDAD

INMUNOCOMPETENCIA
VACUNACIÓN
ALERGIAS A ATB
RESISTENCIAS
ATB:PNC,C3,4G
TX PREVIOS
EDAD: <1m,
>1m<50y
≥ 50y
Fuentes de meningitis

- LEPTOMENINGITIS
- DEFECTO DE LA LAMINA CRIBOSA ETMOIDITIS NASOFARINGITIS
- ETMOIDITIS
- NASOFARINGITIS
- NEUMONIAS
- FRACTURA DE LA BASE DEL CRANEÓ
- FURUNCULOSIS
- CELULITIS
- LEPTOMENINGITIS
- OTITIS MEDIA
- SENO DERMÓIDE CONGENITO
- MASTOIDITIS
- SENO DERMÓIDE CONGENITO
Fuentes de meningitis
S. Pneumonia y N. Menigitidis

LEPTOMENINGITIS

FRACTURA DE LA BASE DEL CRANEO
SP PNEUMONIA

MASTOIDITIS
N. MENINGITIDIS

OTITIS MEDIA
N. MENINGITIDIS

DEFECTO DE LA LAMINA CRIBOSA
ETMOIDITIS
NASOFARINGITIS
N. MENINGITIDIS

NEUMONIAS

FURUNCULOSIS
CELULITIS

SENO
DERMOIDE
CONGENITO
Otras fuentes de meningitis Pneumoccócica

- Deficiencia de Complemento
- Talasemia Mayor
- Anemia celulas falciformes
- Mieloma
- Pneumonía
- Diabetes
- Pneumonía
- Alcoholismo
- Esplenectomía
- Trauma craneano
- Rinorrea de LCR
Meningitis infrecuentes

- *Listeria monocytogenes*
  - Cococo bacteriofilo • Gram +
  -токсигенные серотипы
  - Продуцент Listeriolysin O
  - Проникают в клетки посредством F-пил
  - Проявляется менингит, энцефалит

- *Haemophilus influenzae*
  - Cococo bacteriofilo • Gram -
  -Токсигенные серотипы
  - Проявляется менингит

- *Pseudomonas aeruginosa*
  - Cococo bacteriofilo • Gram -
  - Проявляется менингит

- *E. coli*
  - Bacilo bacteriofilo • Gram -
  - Проявляется менингит

- *Klebsiella*
  - Bacilo bacteriofilo • Gram -
  - Проявляется менингит

- *Enterobacter*
  - Cococo o Bacilo bacteriofilo • Gram -
  - Проявляется менингит

- *Streptococci* • Gram +
  - Проявляется менингит

- *Staphylococci* • Gram +
  - Проявляется менингит

- *Klebsiella*
  - Bacilo bacteriofilo • Gram -
  - Проявляется менингит

Look for antibody and complement deficiencies in every patient with bacterial meningitis, even those who have no known predisposing immunodeficiency.

### Table 2. Congenital immunodeficiencies that may predispose persons to acquire bacterial meningitis and other invasive bacterial infections.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mode of inheritance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibody (B cell) immunodeficiency</td>
<td>X-linked; autosomal recessive and/or dominant</td>
</tr>
<tr>
<td>X-linked (Bruton) agammaglobulinemia</td>
<td></td>
</tr>
<tr>
<td>Common variable immunodeficiency</td>
<td></td>
</tr>
<tr>
<td>X-linked hypogammaglobulinemia with increased IgM level</td>
<td></td>
</tr>
<tr>
<td>Combined antibody and cellular immunodeficiency</td>
<td>Variable</td>
</tr>
<tr>
<td>Severe combined immunodeficiency</td>
<td>Autosomal recessive or dominant</td>
</tr>
<tr>
<td>Immunodeficiency with adenosine deaminase or nucleoside phosphorylase deficiency</td>
<td>Autosomal recessive</td>
</tr>
<tr>
<td>Immunodeficiency with ataxia telangiectasia</td>
<td>Autosomal recessive</td>
</tr>
<tr>
<td>Wiskott-Aldrich syndrome</td>
<td>X-linked</td>
</tr>
<tr>
<td>Complement deficiencies</td>
<td>Variable</td>
</tr>
<tr>
<td>C1, C2, and C3 (early complement) deficiencies</td>
<td>Autosomal recessive or unknown</td>
</tr>
<tr>
<td>C4, C5, C6, C7, and C8 deficiencies</td>
<td>Autosomal recessive or unknown</td>
</tr>
<tr>
<td>Defects in alternate pathway, properdin</td>
<td>X-linked; sickle-cell disease</td>
</tr>
<tr>
<td>Splenic dysfunction</td>
<td>Variable</td>
</tr>
<tr>
<td>Sickle-cell disease</td>
<td></td>
</tr>
<tr>
<td>Congenital acquired (elective or traumatic) dysfunction</td>
<td></td>
</tr>
<tr>
<td>Splenectomy</td>
<td></td>
</tr>
</tbody>
</table>

---

**Indications for the Immunological Evaluation of Patients with Meningitis**

Gary D. Overturf  
Department of Pediatrics and Pathology, Division of Pediatric Infectious Diseases, University of New Mexico Health Sciences Center, Albuquerque
FACTORES QUE PREDISPONEN A MENINGITIS

Properdina o factor P

Table 2. Relation of Underlying Illness to Concentrations of Complement Proteins in 19 Patients with Initial Nonepidemic Meningococcal Disease.

<table>
<thead>
<tr>
<th>UNDERLYING ILLNESS (NO. OF PATIENTS)</th>
<th>DECREASED COMPLEMENT PROTEINS *</th>
<th>MEASURED CONCENTRATION † (% OF NORMAL MEAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with normal complement ‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (7)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>None (1)</td>
<td>Clq</td>
<td>43</td>
</tr>
<tr>
<td>None (1)</td>
<td>Clq, C4</td>
<td>45, 35</td>
</tr>
<tr>
<td>Hodgkin's disease (1)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>Systemic lupus erythematosus (1)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>Recent head trauma (1)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>Remote varicella encephalitis (1)</td>
<td>None</td>
<td>—</td>
</tr>
<tr>
<td>Patients with low complement ‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None (2)</td>
<td>C6</td>
<td>0</td>
</tr>
<tr>
<td>None (1)</td>
<td>C8</td>
<td>8</td>
</tr>
<tr>
<td>Systemic lupus erythematosus (1)</td>
<td>Clq, C3, C4, C5</td>
<td>0, 39, 0, 38</td>
</tr>
<tr>
<td>Systemic lupus erythematosus (1)</td>
<td>C3, C4</td>
<td>38, 45</td>
</tr>
<tr>
<td>Multiple myeloma (1)</td>
<td>Clq, C4</td>
<td>0, 0</td>
</tr>
</tbody>
</table>

*All alternative-pathway and classical-pathway complement proteins not listed were present in normal concentrations.
†Measured by radial immunodiffusion assay for individual complement proteins.
‡Complement activity was measured by the CH₅₀ assay.
Huesped/Agente en meningitis

Neurocirugia
Bacilos Gram negativos
Estafilococos

Valvula de Ommaya
Rieszgo de adquirir
Estafilococo Coagulasa neg
Estafilococo Aureus
Variedad de deficiencia inmune y duración

Parasitos Intracelulares

- Inmunidad celular

Macrófago

FAGOCITOSIS
(célula infectada + protozoo)

CITOTOXICIDAD DIRECTA
Variedad de deficiencia inmune celular
Variedad de deficiencia inmune humoral

INMUNIDAD HUMORAL Y CELULAR

INMUNIDAD HUMORAL
- Proliferación, maduración, células plasmáticas
- Producción de anticuerpos

INMUNIDAD CELULAR
- Receptor, microorganismo, destrucción
- Linfocito B, IgM, IgG, IgA
- Linfocito T, células supresoras

N. meningitidis
FACTORES DE VIRULENCIA
- Adhesión
- Diapedesis
- Flagelación
- Invasión
- Virulencia

MAYORES DE 1 AÑO
- Fiebre que no cede con antipsicóticos
- Cefalea
- Rígidez cervical
- Signos de irritación meníngea
  - Presentes en el 60-80% de niños con MMA al momento de la admisión
  - Vómitos
  - Convulsiones

VIH y SIDA
- Signos de neuropatía espinales: positivo/negativo
Case 1-2

A 46-year-old man presents for evaluation of recurrent bacterial meningitis. He is presently not symptomatic, but on three occasions over the past year he has had fever, headache, stiff neck, and lethargy. He has no history of head trauma except for being hit in the head with a baseball during a Little League game as a child. He has no history of surgery and no chronic medical conditions, nor is he an alcoholic. Spinal Fluid analysis each time has demonstrated an increased opening pressure, a polymorphonuclear pleocytosis, a decreased glucose concentration in the range of 0 mg/dL to 20 mg/dL, and an increased protein concentration. Prior to each episode of meningitis he has been treated with oral antibiotics for a sinusitis.

The CSF Gram’s stain and bacterial culture have always been negative. A broad-range polymerase chain reaction (PCR) has not been available in the hospitals where he has been hospitalized. On examination, he is awake and alert. No evidence of rhinorrhea is present. There is a mild left sixth nerve palsy, but findings from the neurological examination are otherwise normal. An isotope cisternogram, obtained to determine if there is a dural sinus fistula, is normal. Laboratory testing demonstrates a C2 deficiency and hypogammaglobulinemia.

Comment. Complement levels and immunoglobulin levels should be part of the evaluation of every patient with bacterial meningitis. These patients should also be vaccinated with both the pneumococcal and meningococcal vaccines, and their antibody levels should be monitored.
CLÍNICA

**Symptoms of Meningitis**

- **Central**
  - Headache
  - Altered mental status

- **Ears**
  - Phonophobia

- **Eyes**
  - Photophobia

- **Neck**
  - Stiffness

- **Systemic**
  - High fever

- **Trunk, mucus membranes, extremities**
  (if meningococcal infection)
  - Petechiae

---

**Clínica: Síntomas/Signos clásicos (MBA)**

- Fiebre y escalofríos.
- Vómitos.
- Síntomas neurológicos focales:
  - NC III, IV, VI, VII: 10-20%
- Convulsiones.
- Sensorio alterado.
- Signos de HEC:
  - Papiledema (1/3 de las meningitis con aumento PIC)
  - Síntomas de infección respiratoria superior.

**TRIADA:**

FIEBRE
CEFALEA
RIGIDEZ DE CUELLO
Criterios DSM-5

DELIRIO

- A) Disturbio en la atención (por ejemplo reducción de la habilidad para mantener, focalizar o enforzar la atención o cambios patológicos de atención) y del estado de alerta o del conocimiento

- B) El disturbio se desarrolla en periodos cortos de tiempo (horas o días no semanas ni meses), que representa la cambios de la atención y del conocimiento y tienden a fluctuar en severidad durante el transcurso del día

- C) Un trastorno de cognición se agrega (Deficit de memoria, desorientación, lenguaje, déficit de habilidad visuoespacial, o de percepción)

- Los disturbios A y C no son explicados por otro trastorno preexistente, establecido, y desorden neurocognitivo envolucrado y no ocurre en el contexto de una reducción severa del despertar tal como el cuadro de coma.
DELIRIO

• El delirio sino se trata la cusa suele progresar desde la desorientación en tempo luego de lugar y finalmente en cuanto a persona.

• Causas múltiples.
  – Vasculitis
  – Encefalitis
  – Porfiria intermitente aguda, IRC, Hepática.
  – Infartos hemisféricos derechos
  – Toxico-metabólicos: Abstinencia alcohólica, Atropínicos,
  – Medicaciones: BZP
obnubilación

• Del latín: "Golpear contra algo o embotar"
• Significa: torpeza mental
• Menos interés por el medio que lo rodea, y responde lentamente a los estímulos externos pero correctamente
• Puede haber mayor somnolencia
estupor

• Del latín: aturdido:
• Es un estado de sueño profundo y persistente, el paciente no puede ser despertado, solo a estímulos enérgicos
• Diferencias:
  – Mutismo psiquiátrico catatonia
  – Trastorno somatoforme
• Definición: Del griego: “trance”, o sueño profundo,
• Es un estado en la cual el paciente no puede ser despertado incluso con estímulos intensos o dolorosos, las puesta puede ser de defensa pero no localiza el punto de estimulo.
• Es importante recordar que la respuesta motora es la conciencia y puede haber conciencia sin respuesta motora.
Case 1-3
A 52-year-old woman 1 year after diagnosis with breast cancer complains of headache, fever, and stiff neck. She lives on a farm in the Midwest, and her husband complains there are far too many animals in the house. She has been taking nonsteroidal anti-inflammatory agents to treat her headaches and tamoxifen for breast cancer. Therapy is initiated with dexamethasone, cefepime, vancomycin, ampicillin, and acyclovir. Spinal fluid analysis demonstrates a normal opening pressure, a lymphocytic pleocytosis of 340 cells/mm³, a normal glucose concentration, and an increased protein concentration of 100 mg/dL. Gram’s stain and bacterial culture are negative. Dexamethasone and the antibiotics are discontinued. Acyclovir is continued pending the results of CSF varicella-zoster virus IgM and PCR. India ink and fungal culture are negative. CSF smear for acid-fast bacilli is negative. Mycobacterium tuberculosis culture is pending. CSF broad-range PCR for bacterial nucleic acid is negative. CSF RT-PCR for enteroviruses is negative as is viral culture. No varicella-zoster virus antibodies are detected in CSF. PCR for varicella-zoster virus nucleic acid is negative. CSF cytology is negative. Serology for lymphocytic choriomeningitis virus is positive, and the patient admits to recently acquiring a hamster.
Comment. The clinical presentation and the CSF formula suggest that this is a viral meningitis, although in a patient with a history of breast cancer, carcinomatous meningitis is also a possibility. In carcinomatous meningitis, the opening pressure is typically elevated, the protein concentration is moderately to markedly increased, and the glucose concentration is either normal or decreased. *L. monocytogenes* and varicella-zoster virus meningitis may have a CSF formula as above, and both may occur in a patient with defective cell-mediated immunity. T-cell subsets should be evaluated in all patients with a recent history of cancer for the possibility of a defect in T-cell mediated immunity. Nonsteroidal anti-inflammatory agents, intravenous immunoglobulin, trimethoprim, sulfonamides, and OKT3 monoclonal antibodies can all cause a drug-induced hypersensitivity meningitis. Spinal fluid analysis usually shows a pleocytosis of several hundred to several thousand cells/mm³, a normal glucose concentration, and an increased protein concentration. If there is no other explanation for the meningitis, the patient should discontinue the drug, and the symptoms should resolve. CSF white blood cell count may be abnormal for months in the patient with meningitis due to lymphocytic choriomeningitis virus.
A 16-year-old girl presents with complaints of sore throat, painful nodes in her neck, headache, and fever. Therapy is initiated with dexamethasone, cefepime, vancomycin, and acyclovir. Examination of the CSF demonstrates a lymphocytic pleocytosis, a normal glucose concentration, and a normal protein concentration. Gram’s stain is negative. Dexamethasone, cefepime and vancomycin are discontinued. CSF RT-PCR for enteroviruses is negative. CSF-PCR for HSV DNA is negative. HIV serology is negative. Antiviral capsid antigen (VCA) IgG titers are 1:320, and Epstein-Barr virus VCA IgM antibody is positive. Anti–Epstein-Barr (virus) nuclear antigen (EBNA) IgG is negative. EBV DNA is detected in CSF by PCR assay. The diagnosis is meningitis due to acute EBV infection.

Comment. Acute EBV infection is confirmed by the detection of VCA IgG titers of 1:320 or higher, positive IgM antibody titers to the VCA (EBV VCA IgM antibody), and the absence of antibodies to virus-associated nuclear antigen (anti-EBNA IgG). In subsequent serum specimens a fourfold decrease should occur in the IgG antibody titer to VCA and a 16-fold increase in anti-EBNA IgG (Connelly and DeWitt, 1994).
### TABLE 1-1
**Recommended Cerebrospinal Fluid Routine Studies for Acute Meningitis**

- Opening pressure
- Cell count and chemistries
  - Cell count with differential
  - Glucose and protein concentration
- Stain and culture
  - Gram's stain and bacterial culture
  - India ink and fungal culture
  - Viral culture
  - Acid fast smear and *Mycobacterium tuberculosis* culture
- Antigens
  - Cryptococcal polysaccharide antigen
  - Histoplasma polysaccharide antigen
- Antibodies
  - Complement fixation antibody titers for *Coccidioides immitis*
  - Viral-specific IgM antibodies
- Polymerase chain reaction
  - Broad range PCR for bacterial nucleic acid
  - Bacterial-specific PCR
  - Reverse transcriptase PCR for enteroviruses
  - PCR for West Nile virus RNA
  - PCR for herpes simplex virus type 2 DNA
  - PCR for Epstein-Barr virus DNA
- PCR for human immunodeficiency virus type 1 RNA

IgM = immunoglobulin M; PCR = polymerase chain reaction.

### TABLE 1-2
**Diagnostic Studies in Addition to Cerebrospinal Fluid for Acute Meningitis**

- C-reactive protein
- Plasma procalcitonin
- Cultures
  - Blood cultures
  - Throat and stool cultures for enteroviruses
- Serology
  - Paired acute and convalescent sera for IgG antibodies
  - Enteroviruses
  - Arthropod-borne viruses
  - Virus-specific IgM antibodies
  - Human immunodeficiency virus serology
  - Antiviral capsid antigen (VCA) titer (Epstein-Barr virus acute infection)
  - Epstein-Barr virus VCA IgM antibodies
  - Anti-Epstein-Barr virus nuclear antigen IgG antibodies (past infection or latent infection)

IgG = immunoglobulin G; IgM = immunoglobulin M.
TRATAMIENTO EMPÍRICO
INMUNOCOMPETENTE MAYOR MENOR DE 1 MES

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial meningitis</td>
<td>≤1 month of age</td>
</tr>
<tr>
<td></td>
<td>1 month and &lt;50 years of age</td>
</tr>
<tr>
<td></td>
<td>≥50 years of age</td>
</tr>
</tbody>
</table>

Presumptive

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>immunocompetent</td>
<td></td>
</tr>
<tr>
<td>immunocompromised</td>
<td></td>
</tr>
</tbody>
</table>

Acute

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>confirmed infection: Escherichia coli and other gram-negative Enterobacteriaceae</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Listeria monocytogenes</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Staphylococcus aureus</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Staphylococcus epidermidis</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Pseudomonas aeruginosa</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Enterococcus species</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Acinetobacter species</td>
<td></td>
</tr>
<tr>
<td>confirmed infection: Neisseria meningitidis</td>
<td></td>
</tr>
</tbody>
</table>
TRATAMIENTO EMPIRICO
INMUNOCOMPETENTE MAYOR MENOR DE 1 MES

Bacterial meningitis

Immunocompetent

≤1 month of age

1st empiric antibiotic therapy

plus supportive therapy

>1 month and <50 years of age

Primary Options
- ampicillin: consult specialist for guidance on dose and cefotaxime: consult specialist for guidance on dose

Secondary Options
- ampicillin: consult specialist for guidance on dose and gentamicin: consult specialist for guidance on dose

Comments
- Until the causative organism and its sensitivities have been identified, broad-spectrum antimicrobials should be given parenterally.[6] [23] [33]
- Choice of empiric antibiotic depends on patient's age and conditions that may have predisposed the patient to meningitis.[23]
- The regimen chosen must be broad enough to cover the potential organisms for the age group affected.
- For initial therapy, likely antimicrobial resistance should be assumed.[23]
- If a cephalosporin cannot be administered (e.g., with an allergy), an alternative antibiotic for neonates is an aminoglycoside (e.g., gentamicin).
TRATAMIENTO EMPIRICO
INMUNOCOMPETENTE ≥ 1 mes y ≥ 50 años

Bacterial meningitis
empiric antibiotic therapy

Primary Options
• vancomycin: children: 60 mg/kg/day intravenously given in divided doses every 6 hours; adults: 500-750 mg intravenously every 6 hours
  -- AND --
• ceftriaxone: children: 100 mg/kg/day intravenously given in divided doses every 12-24 hours; adults: 2 g intravenously every 12 hours or
• cefotaxime: children: 200 mg/kg/day intravenously given in divided doses every 6 hours; adults: 2 g intravenously every 4 hours

Secondary Options
• vancomycin: children: 60 mg/kg/day intravenously given in divided doses every 6 hours; adults: 500-750 mg intravenously every 6 hours
  -- AND --
  -- AND --
• meropenem: children: 120 mg/kg/day intravenously given in divided doses every 8 hours; adults: 1-2 g intravenously every 8 hours or
• chloramphenicol: children and adults: 50-100 mg/kg/day intravenously given in divided doses every 6 hours, maximum 4000 mg/day

Comments
• Until the causative organism and its sensitivities have been identified, broad-spectrum antimicrobials should be given parenterally.[6] [23] [33]
• The regimen chosen must be broad enough to cover the potential organisms for the age group affected.
• For initial therapy, likely antimicrobial resistance should be assumed.[23]
Bacterial meningitis

≥50 years of age

1st empiric antibiotic therapy

plus supportive therapy

adj. dexamethasone

Primary Options
- *ampicillin*: 2 g intravenously every 4 hours
  and
- *vancomycin*: 500-750 mg intravenously every 6 hours

--- AND ---
- *ceftriaxone*: 2 g intravenously every 12 hours
  or
- *cefotaxime*: 2 g intravenously every 4 hours

Secondary Options
- *trimethoprim/sulfamethoxazole*: 8-10 mg/kg/day intravenously given in divided doses every 6-12 hours
  and
- *vancomycin*: 500-750 mg intravenously every 6 hours

--- AND ---
empiric antibiotic therapy

- *meropenem*: 1-2 g intravenously every 8 hours
  or
- *chloramphenicol*: 50-100 mg/kg/day intravenously given in divided doses every 6 hours, maximum 4000 mg/day

Comments
- Until the causative organism and antibiotic sensitivities have been identified, broad-spectrum antimicrobials should be given parenterally.
  [6] [23] [33]
TRATAMIENTO EMPIRICO
INMUNOCOMPETENTE ≥ 50 años

Primary Options
- ampicillin: 2 g intravenously every 4 hours and
  vancomycin: 500-750 mg intravenously every 6 hours
-- AND --
- ceftriaxone: 2 g intravenously every 12 hours or
- cefotaxime: 2 g intravenously every 4 hours

Secondary Options
- trimethoprim/sulfamethoxazole: 8-10 mg/kg/day intravenously given in divided doses every 6-12 hours and
  vancomycin: 500-750 mg intravenously every 6 hours
-- AND --

empiric antibiotic therapy
- meropenem: 1-2 g intravenously every 8 hours or
- chloramphenicol: 50-100 mg/kg/day intravenously given in divided doses every 6 hours, maximum 4000 mg/day

Comments
- Until the causative organism and antibiotic sensitivities have been identified, broad-spectrum antimicrobials should be given parenterally. [6] [23] [33]
empirc antibiotic therapy

**Primary Options**
- **ampicillin**: neonates: consult specialist for guidance on dose; children: 100-200 mg/kg/day intravenously given in divided doses every 6 hours; adults: 2 g intravenously every 4 hours and **vancomycin**: neonates: consult specialist for guidance on dose; children: 60 mg/kg/day intravenously given in divided doses every 6 hours; adults: 500-750 mg intravenously every 6 hours
  -- AND --
- **ceftriaxone**: neonates: consult specialist for guidance on dose; children: 100 mg/kg/day intravenously given in divided doses every 12-24 hours; adults: 2 g intravenously every 12 hours or
- **cefotaxime**: neonates: consult specialist for guidance on dose; children: 200 mg/kg/day intravenously given in divided doses every
### Recommendations for Specific Antibiotic Therapy in Bacterial Meningitis

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Antibiotic</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Streptococcus pneumoniae</em></td>
<td>Penicillin G or ceftriaxone (or cefotaxime or cefepime)</td>
</tr>
<tr>
<td>Penicillin susceptible</td>
<td>Ceftriaxone (or cefotaxime or cefepime) or meropenem</td>
</tr>
<tr>
<td>Penicillin tolerant (MIC 0.1 µg/mL to 1.0 µg/mL)</td>
<td>Cefepime* (or ceftriaxone or cefotaxime) plus vancomycin</td>
</tr>
<tr>
<td>Penicillin resistant (MIC greater than 1 µg/mL)</td>
<td></td>
</tr>
<tr>
<td><em>Neisseria meningitidis</em></td>
<td>Penicillin G* or ampicillin*</td>
</tr>
<tr>
<td></td>
<td>Ceftriaxone or cefotaxime for penicillin-resistant strains</td>
</tr>
<tr>
<td><em>Listeria monocytogenes</em></td>
<td>Ampicillin*</td>
</tr>
<tr>
<td></td>
<td>Ampicillin plus gentamicin for critically ill patient</td>
</tr>
<tr>
<td><em>Streptococcus agalactiae</em> (group B streptococci)</td>
<td>Ampicillin* or penicillin G or cefotaxime</td>
</tr>
<tr>
<td>Gram-negative Enterobacteriaceae</td>
<td>Ceftriaxone* or cefotaxime* or cefepime*</td>
</tr>
<tr>
<td>(ie, <em>Klebsiella, Escherichia coli, Proteus</em>)</td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>Meropenem* or cefepime</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>Nafcillin* or oxacillin*</td>
</tr>
<tr>
<td>Methicillin susceptible</td>
<td>Vancomycin*</td>
</tr>
<tr>
<td>Methicillin resistant</td>
<td>Vancomycin* or Linezolid</td>
</tr>
<tr>
<td><em>Staphylococcus epidermidis</em></td>
<td>Ceftriaxone* or cefotaxime* or cefepime*</td>
</tr>
<tr>
<td><em>Haemophilus influenzae</em></td>
<td></td>
</tr>
</tbody>
</table>

*Recommended antibiotic. MIC = minimum inhibitory concentration.*
# Recommended Doses for the Antibiotics Commonly Used in the Treatment of Bacterial Meningitis

<table>
<thead>
<tr>
<th>Antibiotic Agent</th>
<th>Total Daily Dosage (Dosing Interval in Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ampicillin</strong></td>
<td>Neonate: 150 mg/kg/d (every 8 hours)</td>
</tr>
<tr>
<td></td>
<td>Infants and children: 300 mg/kg/d (every 6 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 12 g/d (every 4 to 6 hours)</td>
</tr>
<tr>
<td><strong>Cefepime</strong></td>
<td>Infants and children: 150 mg/kg/d (every 8 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 6 g/d (every 8 hours)</td>
</tr>
<tr>
<td><strong>Cefotaxime</strong></td>
<td>Neonate: 100 mg/kg/d to 150 mg/kg/d (every 8 to 12 hours)</td>
</tr>
<tr>
<td></td>
<td>Infants and children: 225 mg/kg/d to 300 mg/kg/d (every 6 to 8 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 8 g/d to 12 g/d (every 4 to 6 hours)</td>
</tr>
<tr>
<td><strong>Ceftriaxone</strong></td>
<td>Infants and children: 80 mg/kg/d to 100 mg/kg/d (every 12 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 4 g/d (every 12 hours)</td>
</tr>
<tr>
<td><strong>Gentamicin</strong></td>
<td>Neonate: 5 mg/kg/d (every 12 hours)</td>
</tr>
<tr>
<td></td>
<td>Infants and children: 7.5 mg/kg/d (every 8 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 5 mg/kg/d (every 8 hours)</td>
</tr>
<tr>
<td><strong>Meropenem</strong></td>
<td>Infants and children: 120 mg/kg/d (every 8 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 6 g/d (every 8 hours)</td>
</tr>
<tr>
<td><strong>Nafcillin</strong></td>
<td>Neonates: 75 mg/kg/d (every 8 to 12 hours)</td>
</tr>
<tr>
<td></td>
<td>Infants and children: 200 mg/kg/d (every 6 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 9 g/d to 12 g/d (every 4 hours)</td>
</tr>
<tr>
<td><strong>Penicillin G</strong></td>
<td>Neonates: 0.15 mU/kg/d to 0.2 mU/kg/d (every 8 to 12 hours)</td>
</tr>
<tr>
<td></td>
<td>Infants and children: 0.3 mU/kg/d (every 4 to 6 hours)</td>
</tr>
<tr>
<td></td>
<td>Adult: 24 mU/d (every 4 to 6 hours)</td>
</tr>
<tr>
<td><strong>Rifampin</strong></td>
<td>Infants and children: 10 mg/kg/d to 20 mg/kg/d (every 12 to 24 hours)</td>
</tr>
<tr>
<td></td>
<td>Adults: 600 mg/d to 1200 mg/d (every 12 hours)</td>
</tr>
<tr>
<td><strong>Vancomycin</strong></td>
<td>Neonates: 20 mg/kg/d to 30 mg/kg/d (every 8 to 12 hours)</td>
</tr>
<tr>
<td></td>
<td>Infants and children: 60 mg/kg/d (every 6 hours)</td>
</tr>
<tr>
<td></td>
<td>Adults: 2 g/d to 3 g/d (every 6 to 12 hours)</td>
</tr>
</tbody>
</table>

*For intravenous vancomycin therapy, maintain serum trough concentrations of 15 µg/mL to 20 µg/mL. Recommended peak levels 1 hour after intravenous administration, vancomycin 25 µg/mL.

†Intraventricular vancomycin administration: children 1 mg/d to 2 mg/d, adults 10 mg/d to 20 mg/d.
GRACIAS
Dr. Luis Ernesto González Sánchez
Neurologo