Diagnosis and treatment of acute bacterial meningitis- ESCMID guideline

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Aim of guideline

Epidemiology

1. What are the causative microorganisms of community acquired bacterial meningitis in specific groups (neonates, children, adults and immunocompromised patients)?

Diagnosis

1. What are the clinical characteristics of community-acquired bacterial meningitis, and what is their diagnostic accuracy?
2. What is the diagnostic accuracy of algorithms in the distinction between bacterial and viral meningitis?
3. Can we use clinical characteristics to predict the absence of intracranial abnormalities associated with increased risk of lumbar puncture?
    a) If lumbar puncture is delayed, should we start treatment?

Treatment

1. What is the optimal type, duration and method of administration of antibiotic treatment when started empirically, after the pathogen has been identified or in culture-negative patients?
   a) Does the addition of vancomycin or rifampicin to a third generation cephalosporin improve outcome in pneumococcal meningitis patients in the setting of a high resistance rate of pneumococci?
2. Does dexamethasone have a beneficial effect on death, functional outcome and hearing loss in adults and children with bacterial meningitis?
   a) Up to what point in time is treatment with dexamethasone indicated if antibiotics are already provided?
   b) Should dexamethasone be stopped if pathogens other than S. pneumoniae are identified?
3. Do glycerol, mannitol, acetaminophen/paracetamol, hypothermia, antiepileptic drugs or hypertonic saline have a beneficial effect on death, functional outcome and hearing loss in adults and children with bacterial meningitis?
4. Does the use of prophylactic treatment of household contacts decrease carriage or secondary cases?
   a) Is vaccination indicated after community-acquired (pneumococcal) meningitis?
5. What complications occur during community-acquired bacterial meningitis, what ancillary investigations are warranted when complications occur and how should they be treated?

Follow-up

1. What follow-up of community-acquired bacterial meningitis patients should be provided (e.g. testing for hearing loss, neuropsychologic evaluation)?

TABLE I.1. Quality of evidence

Class	Conclusions based on:
1	Evidence from at least one properly designed randomized controlled trial.
2	Evidence from at least one well-designed clinical trial, without randomization; from cohort or case–control analytic studies (preferably from >1 centre); from multiple time series; or from dramatic results of uncontrolled experiments.
3	Evidence from opinions of respected authorities, based on clinical experience, descriptive case studies.

TABLE I.2. Strength of recommendation

Grade	Recommendation
A	ESCMID strongly supports recommendation for use.
B	ESCMID moderately supports recommendation for use.
C	ESCMID marginally supports recommendation for use.
D	ESCMID supports recommendation against use.

Aim of guideline

- **Epidemiology**
- **Diagnosis**
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Epidemiology of community-acquired bacterial meningitis in Europe

TABLE 2.3. Causative organisms of adult bacterial meningitis

Country	Denmark [25]	Turkey [26]	United Kingdom [27]	Czech Republic [28]	Netherlands [4]	Total
Observation period	1998–2012	1994–2003	1997–2002	1997–2004	2006–2012	
Neisseria meningitidis	42	251	550	75	171	1089 (27%)
Streptococcus pneumoniae	92	457	525	82	1001	2157 (53%)
Haemophilus influenzae	3	2	48	3	56	112 (3%)
Listeria monocytogenes	5	6	48	21	74	154 (4%)
Other	30	68	124	35	291	548 (13%)
Total	172	784	1295	216	1593	4060

Most common causative pathogens in adults are Streptococcus pneumoniae and Neisseria meningitidis.
Another important causative microorganism in adults is Listeria monocytogenes.

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- **Epidemiology**
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What are the clinical characteristics of community-acquired bacterial meningitis, and what is their diagnostic accuracy?

TABLE 3.2. Presenting clinical characteristics of adults with bacterial meningitis

Country	Netherlands [41]	France [42]	Spain [43]	Iceland [44]	Denmark [25]
Observation period	1998–2002	2001–2004	1996–2010	1975–1994	1989–2010
No. of patients	696	60	295	119	172
Headache	87%	87%	—	—	58%
Nausea/vomiting	74%	—	45%	—	—
Neck stiffness	83%	—	69%	82%	65%
Rash	26%	—	20%	52%	—
Fever (>38.0°C)	77%	93%	95%	97%	87%
Altered mental status	69%	30%	54%	66%	68%
Coma	14%	—	7%	13%	16%
Focal neurologic deficits	34%	23%	15%	—	21%
Triad of fever, neck stiffness and altered mental status	44%	—	41%	51%	45%

Conclusion

- The most common clinical characteristics of bacterial meningitis are fever, headache, neck stiffness and altered mental status but these characteristics can be absent. (Level 2)

- The sensitivity and negative predictive value of Kernig and Brudzinski sign is low in the diagnosis of meningitis and therefore do not contribute to the diagnosis of bacterial meningitis. (Level 2)

Recommendation

- In adults with bacterial meningitis classic clinical characteristics may be absent and therefore bacterial meningitis should not be ruled out solely on the absence of classic symptoms. (Grade A)

What is the diagnostic accuracy of algorithms in the distinction between bacterial and viral meningitis?

Score	Population	Items	Studies/level of evidence	Lowest reported sensitivity	Lowest reported specificity
Boyer [46]	Children	Score including temperature, rash, neurologic impairment/seizures or altered mental status, CSF protein, glucose and CSF WBC count, PMN count. *If >5 points = bacterial meningitis, 3–4 = unclear, <3 = no bacterial meningitis*	5/2	89%	88%
Oostenbrink [47]	Children	Score including duration of complaints, vomiting, meningeal irritation, cyanosis, petechiae or ecchymosis, disturbed consciousness, CRP, CSF PMN count, CSF to blood glucose ratio. *If score is <8.5: low risk of bacterial meningitis*	5/2	79%	50%
Bacterial Meningitis Score [48]	Children	Item list including CSF Gram stain, CSF protein, peripheral absolute neutrophil count, seizures before or at admission, CSF absolute neutrophil count. *If all items are absent low risk of meningitis*	8/2	96%	44%
Bonsu [49]	Children	Formula including CSF WBC count, CSF protein concentration and age. *If score is <0.1: low risk of bacterial meningitis*	4/2	92%	28%
Hoen [50]	All ages, except neonates	Formula including CSF PMN count, CSF protein, blood glucose and blood WBC count. *If score is <0.1: low risk of bacterial meningitis*	6/2	77%	70%
Freedman	Children	Item list including patient's age, blood WBC count, peripheral band count, CSF glucose concentration, CSF/serum glucose ratio, CSF protein concentration, and positive CSF Gram staining. *If all items are absent low risk of meningitis*	3/2	98.7%	12%
Meningitest	All ages, except neonates	Item list including WBC, CSF WBC, CSF PMN, CSF protein, and glucose CSF/blood ratio. *If all items are absent low risk of meningitis*	2/2	79%	51%
Spanos [51]	All ages, except neonates	Formula including age, time of year, glucose ratio, and total CSF PMN count. *Probability of meningitis calculated by nomogram*	6/2	89%	55%
Tokuda	Adults	Item list including disturbed consciousness, CSF gram stain, neutrophil count and percentage. *If all items are absent low risk of meningitis*	2/2	88%	88%
De Cauwer	Children	Item list including CRP, CSF neutrophil count, CSF protein and CSF glucose concentration. *If all items are absent low risk of meningitis*	2/2	99%	40%
Schmidt	All ages, except neonates	Item list including CSF WBC, CSF protein and CSF lactate. *If all items are absent low risk of meningitis*	2/2	59%	100%

CRP, C-reactive protein; CSF, cerebrospinal fluid; PMN, polymorphonuclear cells; WBC, white blood cells.

Conclusion

- None of the published diagnostic algorithms was 100% sensitive upon validation in an independent cohort, indicating that bacterial meningitis patients will potentially be missed when any of the algorithms are used (Level 2)

Recommendation

- Use of diagnostic algorithms may be helpful to guide management in individual patients with suspected acute bacterial meningitis, but clinical judgement is key when considering whether to start empiric antibiotic and adjunctive therapy (Grade C)

Diagnostic accuracy of laboratory techniques in bacterial meningitis

Conclusion

- It has been shown that in both children and adults, classic characteristics (elevated protein levels, lowered glucose levels, CSF pleocytosis) of bacterial meningitis are present in 90% of patients. A completely normal CSF occurs but is very rare. (Level 2)
- CSF culture is positive in 60–90% of bacterial meningitis patients depending on the definition of bacterial meningitis. Pretreatment with antibiotics decreases the yield of CSF culture by 10–20%. (Level 2)
- CSF Gram stain has an excellent specificity and varying sensitivity, depending on the microorganism. The yield decreases slightly if the patient has been treated with antibiotics before lumbar puncture is performed. (Level 2)

Conclusion (continue)

- Latex agglutination testing has little incremental value in the diagnosis of bacterial meningitis. (Level 2)
- In patients with a negative CSF culture and CSF Gram stain, PCR has additive value in the identification of the pathogen. (Level 2)
- It is unclear whether immunochromatographic antigen testing has incremental value in the diagnosis of bacterial meningitis. (Level 2)
- In children with meningitis, elevated CRP and pro-calcitonin levels in blood are associated with bacterial infections. The diagnosis of bacterial meningitis can, however, not be made with these tests(Level 2)
- In adults and children with bacterial meningitis, blood cultures are useful to isolate the causative microorganism. The yield of blood cultures decreases if the patient is pretreated with antibiotics. (Level 2)

Recommendation

- In patients with suspected bacterial meningitis, it is strongly recommended to determine CSF leukocyte count, protein and glucose concentration, and to perform CSF culture and Gram stain. (Grade A)
- In patients with negative CSF cultures, the causative microorganisms can be identified by PCR and potentially by immunochromatographic antigen testing. (Grade A)
- In patients with suspected bacterial meningitis, it is strongly recommended to perform blood cultures before the first dose of antibiotics is administered. (Grade A)

Can we use clinical characteristics to predict the absence of intracranial abnormalities associated with increased risk of lumbar puncture?

Conclusions

- The risk of cerebral herniation after lumbar puncture in patients with suspected bacterial meningitis is increased compared to normal individuals. (Level 2)
- Clinical characteristics can be used to identify patients with an increased risk for space-occupying lesions associated with increased risk of cerebral herniation due to lumbar puncture. (Level 3)
- A delay in antibiotic treatment administration is associated with poor outcome and should therefore be avoided. (Level 2)

Recommendation

- It is strongly recommended to perform cranial imaging before lumbar puncture in patients with:
  - Focal neurologic deficits (excluding cranial nerve palsies).
  - New-onset seizures
  - Severely altered mental status
  - Severely immunocompromised state

  In patients lacking these characteristics, cranial imaging before lumbar puncture is not recommended.
- It is strongly recommended to start antibiotic therapy as soon as possible in acute bacterial meningitis patients. The time period until antibiotics are administered should not exceed 1 hour. Whenever lumbar puncture is delayed, e.g. due to cranial CT, empiric treatment must be started immediately on clinical suspicion, even if the diagnosis has not been established.

Aim of guideline

- **Epidemiology**
- **Diagnosis**
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What is the optimal type, duration and method of administration of antibiotic treatment when started empirically, after the pathogen has been identified or in culture negative patients?

TABLE 4.1. Empiric antibiotic in-hospital treatment for community-acquired bacterial meningitis [3]

Patient group	Standard treatment: Reduced *Streptococcus pneumoniae* antimicrobial sensitivity to penicillin	Standard treatment: *S. pneumoniae* susceptible to penicillin	Intravenous dose[a]
Neonates <1 month old	Amoxicillin/ampicillin/penicillin plus cefotaxime, or amoxicillin/ampicillin plus an aminoglycoside		Age <1 week: cefotaxime 50 mg/kg q8h; ampicillin/amoxicillin 50 mg/kg q8h; gentamicin 2.5 mg/kg q12h Age 1–4 weeks: ampicillin 50 mg/kg q6h; cefotaxime 50mg/kg q6–8h; gentamicin 2.5 mg/kg q8h; tobramycin 2.5 mg/kg q8h; amikacin 10 mg/kg q8h
Age 1 month to 18 years	Cefotaxime or ceftriaxone plus vancomycin or rifampicin	Cefotaxime or ceftriaxone	Vancomycin 10–15 mg/kg q6h to achieve serum trough concentrations of 15–20 µg/mL; rifampicin 10 mg/kg q12h up to 600 mg/day; cefotaxime 75 mg/kg q6–8h; ceftriaxone 50 mg/kg q12h (maximum 2 g q12h)
Age >18 and <50 years	Cefotaxime or ceftriaxone plus vancomycin or rifampicin	Cefotaxime or ceftriaxone	Ceftriaxone 2 g q12h or 4 g q24h; cefotaxime 2 g q4–6 h; vancomycin 10–20 mg/kg q8–12h to achieve serum trough concentrations of 15–20 µg/mL; rifampicin 300 mg q12h
Age >50 years, or Age >18 and <50 years plus risk factors for *Listeria monocytogenes*[a]	Cefotaxime or ceftriaxone plus vancomycin or rifampicin plus amoxicillin/ampicillin/penicillin G	Cefotaxime or ceftriaxone plus amoxicillin/ampicillin/ penicillin G	Ceftriaxone 2 g q12h or 4 g q24h; cefotaxime 2 g q4–6h; vancomycin 10–20 mg/kg q8–12h to achieve serum trough concentrations of 15–20 µg/mL; rifampicin 300 mg q12h, amoxicillin or ampicillin 2 g q4h

[a]Diabetes mellitus, use of immunosuppressive drugs, cancer and other conditions causing immunocompromise.

TABLE 4.2. Specific antibiotic in-hospital treatment for community-acquired bacterial meningitis[a]

Microorganism	Standard treatment	Alternatives	Duration
Streptococcus pneumoniae			
Penicillin susceptible (MIC <0.1 µg/mL)	Penicillin or amoxicillin/ampicillin	Ceftriaxone, cefotaxime, chloramphenicol	10–14 days
Penicillin resistant (MIC >0.1 µg/mL), third-generation cephalosporin susceptible (MIC <2 µg/mL)	Ceftriaxone or cefotaxime	Cefepime, meropenem, moxifloxacin[b]	10–14 days
Cephalosporin resistant (MIC ≥2 µg/mL)	Vancomycin *plus* rifampicin, or vancomycin *plus* ceftriaxone or cefotaxime, or rifampicin *plus* ceftriaxone or cefotaxime[c]	Vancomycin *plus* moxifloxacin,[b] linezolid	10–14 days
Neisseria meningitidis			
Penicillin susceptible (MIC <0.1 µg/mL)	Penicillin or amoxicillin/ampicillin	Ceftriaxone, cefotaxime, chloramphenicol	7 days
Penicillin resistant (MIC ≥0.1 µg/mL)	Ceftriaxone or cefotaxime	Cefipime, meropenem, ciprofloxacin or chloramphenicol	7 days
Listeria monocytogenes	Amoxicillin or ampicillin, penicillin G[d]	trimethoprim-sulfamethoxazole, moxifloxacin,[b] meropenem, linezolid	At least 21 days
Haemophilus influenzae			
β-Lactamase negative	Amoxicillin or ampicillin	Ceftriaxone, cefotaxime or chloramphenicol	7–10 days
β-Lactamase positive	Ceftriaxone or cefotaxim	Cefepime, ciprofloxacin, chloramphenicol	7–10 days
β-Lactamase negative ampicillin resistant	Ceftriaxone or cefotaxime *plus* meropenem	Ciprofloxacin	7–10 days
Staphylococcus aureus			
Methicillin sensitive	Flucloxacillin, nafcillin, oxacillin	Vancomycin, linezolid, rifampicin,[e] fosfomycin,[e] daptomycin[b]	At least 14 days
Methicillin resistant	Vancomycin[f]	Trimethoprim/sulfamethoxazole, linezolid, rifampicin,[e] fosfomycin,[e] daptomycin	At least 14 days
Vancomycin resistant (MIC >2.0 µg/mL)	Linezolid[f]	Rifampicin,[e] fosfomycin,[e] daptomycin[b]	At least 14 days

[a]Recommendations must be in accordance with the results of the susceptibility testing.
[b]Based on case reports.
[c]Ceftriaxone dose 2 g q12h and cefotaxime 2–3g q6h.
[d]Adding an aminoglycoside can be considered.
[e]Must not be used in monotherapy.
[f]Addition of rifampicin can be considered.

Conclusion

- The empiric antibiotic treatment in bacterial meningitis patients is based on expert opinion and differentiated for demographic/ epidemiologic factors (age and rate of reduced antibiotic susceptibility). (Level 3)
- The specific antibiotic treatment in bacterial meningitis patients is based on antimicrobial susceptibility testing. (Level 3)
- There is insufficient evidence to support a short course of antibiotics in children and adults with bacterial meningitis in the European setting. (Level 2)
- There is no evidence of superiority of either continuous or bolus administration of antibiotics in bacterial meningitis patients. (Level 1)

Recommendation

- The recommended treatment for bacterial meningitis patients in whom no pathogen can be cultured should be according to the empiric regimen for a minimum duration of 2 weeks. (Grade A)
- The committee does not recommend a short course of antibiotics in children and adults with bacterial meningitis. (Grade D)
- Because of a lack of evidence, the committee does not provide a recommendation on the use of continuous or bolus administration of antibiotics in bacterial meningitis patients. (Grade C)

Does dexamethasone have a beneficial effect on death, functional outcome and hearing loss in adults and children with bacterial meningitis?

Conclusion

- Corticosteroids significantly reduced hearing loss and neurologic sequelae but did not reduce overall mortality. Data support the use of corticosteroids in patients with bacterial meningitis beyond the neonatal age in countries with a high level of medical care. No beneficial effects of adjunctive corticosteroids have been identified in studies performed in low-income countries. The use of dexamethasone for neonates is currently not recommended. (Level 1)

(The advised dexamethasone regimen in children is 0.15 mg/kg every 6 hours and in adults 10 mg every 6 hours, both for a duration of 4 days.)

Conclusion (continue)

- In the absence of scientific evidence, the committee has reached consensus that when antibiotic treatment has already been started, adjunctive dexamethasone treatment can still be started up to 4 hours after initiation of antibiotic treatment. (Level 3)
- In the absence of scientific evidence, the guideline committee concludes that dexamethasone should be stopped if the patient is discovered not to have bacterial meningitis or if the bacterium causing the meningitis is a species other than H. influenzae or S. pneumoniae, although some experts advise that adjunctive treatment should be continued irrespective of the causative bacterium. (Level 3)

Recommendation

- Empiric treatment with dexamethasone is strongly recommended for all adults (10 mg qid for 4 days) and children (0.15 mg/kg qid for 4 days) with acute bacterial meningitis in the setting of high-income countries. (Grade A)
- Treatment with dexamethasone is strongly recommended to be initiated with the first dose of antibiotic treatment. (Grade A)
- If intravenous antibiotic treatment has already been started, dexamethasone can still be administered up to 4 hours after start of the first dose of intravenous antibiotics. (Grade C)
- It is recommended to stop dexamethasone if the patient is discovered not to have bacterial meningitis or if the bacterium causing the meningitis is a species other than H. influenzae or S. pneumoniae, although some experts advise that adjunctive treatment should be continued irrespective of the causative bacterium.(Grade B)

Do glycerol, mannitol, acetaminophen/ paracetamol, hypothermia, antiepileptic drugs or hypertonic saline have a beneficial effect on death, functional outcome and hearing loss in adults and children with bacterial meningitis?

Conclusion

- The present data do not support the use of glycerol in adults with acute bacterial meningitis. Although potential beneficial effect exists in children, no recommendation can be made because strong evidence is not available. (Level 1)
- Therapeutic hypothermia is associated with a higher mortality rate in bacterial meningitis patients. (Level 1)

Conclusion (continue)

- Paracetamol (acetaminophen) use in bacterial meningitis patients did not improve outcome.(Level 1)
- Use of mannitol, antiepileptic drugs and hypertonic saline needs further evaluation to make conclusive recommendations on its routine use in bacterial meningitis patients.(Level 3)
- Use of intracranial pressure/cerebral perfusion pressure monitoring and treatment needs further evaluation to make a conclusive recommendation on its use in bacterial meningitis patients. .(Level 2)

Recommendation

- Routine adjuvant therapy with mannitol, acetaminophen, antiepileptic drugs or hypertonic saline is not recommended. Hypothermia and glycerol are contraindicated in bacterial meningitis.(Grade D)
- Use of intracranial pressure/cerebral perfusion pressure monitoring and treatment can be life-saving in selected patients but cannot be recommended as routine management because solid evidence is lacking and harm may occur. (Grade C)
- Adjuvant therapy with immunoglobulins, heparin and activated protein C is not recommended. (Grade D)

Does the use of prophylactic treatment of household contacts decrease carriage or secondary cases?

Conclusion

- Prophylactic antibiotic treatment of household contacts of meningococcal meningitis patients prevents secondary cases and eradicates meningococcal carriage. (Level 1)
  - The risk of meningococcal disease is increased 400–800-fold in individuals in close contact with meningococcal disease

Antibiotic	Dose	Duration
Rifampicin	Child <3 months of age: 5 mg/kg twice a day orally Child ≥3 months to 12 years of age: 10 mg/kg twice a day orally (max 600 mg) Child >12 years of age: 600 mg twice a day Adult: 600 mg twice a day Pregnancy: 600 mg twice a day—only after first 3 months of pregnancy	2 days
Ciprofloxacin	Adult >16 years: 500 mg oral Pregnancy: Do not use	Once
Ceftriaxone	Child <16 years: 125 mg intramuscular Adult ≥16 years: 250 mg intramuscular Pregnancy: 250 mg intramuscular (first choice during pregnancy)	Once

Conclusion (continue)

- Based on the recurrence risk of 1–5% of pneumococcal meningitis, the committee sees substantial benefits in vaccination with pneumococcal vaccines after an episode of pneumococcal meningitis.
- Vaccination with pneumococcal vaccines is deemed beneficial in bacterial meningitis patients with CSF leakage to reduce recurrences.
- Vaccination with H. influenzae type b and a meningococcal vaccine (either serogroup C, serogroup B or quadrivalent A/C/Y/W135, depending on local epidemiology) can be considered in bacterial meningitis patients with CSF leakage.(Level 3)

Recommendation

- It is strongly recommended to treat household contacts and other close contacts of meningococcal meningitis patients with antibiotic prophylaxis consisting of ceftriaxone, ciprofloxacin or rifampicin.(Grade A)
- It is recommended to vaccinate with pneumococcal vaccine patients after an episode of pneumococcal meningitis and persons with CSF leakage along with the reconstruction of the dural barrier. Additional vaccination with H. influenzae type b and N. meningitidis vaccine can be considered in patients with CSF leakage. (Grade B)

What complications occur during community-acquired bacterial meningitis, what ancillary investigations are warranted when complications occur and how should they be treated?

Complication	Frequency	Ancillary investigations	Treatment
Seizures	17%	Cranial CT or MRI; EEG if not clinically evident	Antiepileptic drugs
Hydrocephalus	3–5%	Cranial CT or MRI	External ventricular drain if clinically relevant
Ischaemic stroke	14–25%	Cranial CT or MRI	No specific treatment
Haemorrhagic stroke	3%	Cranial CT or MRI	Consider neurosurgical intervention
Subdural empyema	3%	Cranial CT or MRI	Consider neurosurgical intervention
Brain abscess	2%	Cranial CT or MRI	Consider neurosurgical intervention
Sinus thrombosis	1%	Cranial CT or MRI	No proven therapy
Severe sepsis	15%	Evaluation of other foci of infection (e.g. pneumonia, endocarditis)	According to guidelines for the management of sepsis [124] including fluid replacement, ICU admission and monitoring
Hearing loss	17–22%	Otoacoustic emission/hearing evaluation	Cochlear implant

Conclusion

- Neurologic and systemic complications occur in a large proportion of children and adults with bacterial meningitis. In patients with neurologic deterioration, cranial imaging (MRI or CT) is often indicated, and repeated lumbar puncture and EEG may be indicated in selected cases. (Level 2)
- Bacterial meningitis complicated by hydrocephalus, subdural empyema and brain abscess may require neurosurgical intervention.(Level 3)

Recommendation

- As neurologic and systemic complications frequently occur during bacterial meningitis, physicians should be alert for recognition of these complications, perform ancillary investigations upon deterioration and initiate specific treatment when required.(Grade A)

What follow-up of community-acquired bacterial meningitis patients should be provided (e.g. testing for hearing loss, neuropsychological evaluation)?

Conclusion

- Sequelae occur in a substantial proportion of children and adults with bacterial meningitis and most frequently consist of hearing loss, neuropsychologic defects and focal neurologic deficits. (Level 2)
- Hearing loss needs to be detected early during the disease course to facilitate effective cochlear implantation in the case of severe hearing loss. (Level 2)

Recommendation

- In children with bacterial meningitis, testing for hearing loss should be performed during admission (otoacoustic emission). In adults with bacterial meningitis, testing for hearing loss should be performed during admission. In the case of hearing loss, patients should be referred to an ear–nose–throat specialist in a medical centre performing cochlear implants.(Grade A)
- Routine neuropsychologic examination is not recommended. If cognitive defects occur, neuropsychologic examination should be performed, and referral to a (neuro)psychologist/rehabilitation physician may be indicated. .(Grade B)

Take home massage

1.Common Pathogens for Community-Acquired Bacterial Meningitis in Europe:

- Streptococcus pneumoniae ,Neisseria meningitidis , Listeria monocytogenes

2.Pre-treatment Considerations:

- Conduct blood cultures before initiating antibiotic therapy.

3.Initial Antibiotic Treatment Approach:

- Use Dexamethasone in conjunction with initial antibiotics.
- Discontinue Dexamethasone if H. influenzae or S. pneumoniae is not the identified pathogen.

4.Vaccination Recommendations:

- Pneumococcal vaccines are beneficial for bacterial meningitis patients with CSF leakage.
- Consider vaccination: H. influenzae type b; Meningococcal vaccine (serogroup C, serogroup B, or quadrivalent A/C/Y/W135, depending on local epidemiology.

5. Monitor neurologic and systemic complications

- Perform testing for hearing loss during admission.

Thanks for your attention