

Most cases of childhood meningitis are caused by an enterovirus. Bacterial meningitis is less common, with 90% of cases occurring in children less than 5 years of age. Bacterial meningitis has a mortality rate of 20% in infants and 2% in children; neurologic sequelae occur in approximately one-third of children who survive their infection. Early diagnosis and treatment of bacterial meningitis is associated with better outcomes. Viral meningitis is a diagnosis of exclusion.

- » If vaccinations are incomplete, children are at higher risk of *N. meningitidis*, *S. pneumoniae* and *H. influenzae*.
- » Consider Lyme meningitis (in an endemic area) if there is a history of tick exposure, erythema migrans or a facial palsy, though these symptoms are not always present.
- » Parechovirus, herpes simplex, varicella-zoster and arboviruses are more frequently associated with encephalitis.

Clinical Features



Making the diagnosis of meningitis can be difficult, especially in infants. The symptoms of meningitis can look similar to those of viral illnesses.

- » **Infants:** Fever or hypothermia may be the only symptoms in neonates, progressive lethargy, irritability (often worse with handling), inconsolable crying, bulging fontanelle, poor feeding, hyper/hypotonia, vomiting, diarrhea, and/or seizures.
- » **Children/Adolescents:** The classic triad of fever, neck stiffness and headache is found in **less than half of meningitis cases** in children/adolescents.
 - » Non-specific symptoms as in infants (above), headache, altered LOC, photophobia, and/or nausea.
 - » Signs include neck stiffness (likelihood ratio (LR) for confirmed meningitis 4.00 [2.6–6.3]), Kernig's sign (LR 3.50 [2.1–5.7]) and Brudzinski's sign (LR 2.50 [1.8 –3.6]).² The absence of meningeal signs **does not** exclude meningitis.
 - » The presentation of bacterial meningitis may occur over hours or may be insidious over a few days. Lyme meningitis often has a more indolent course.
 - » A spreading petechial rash or purpura is associated with meningococcal or pneumococcal meningitis but is not reliably present.
 - » Concurrent oral antibiotic or steroid administration may alter presentation.^{2,3,4}

Stabilization and Initial Management

- » Assess ABCDs. If concern for hemodynamic compromise, refer to [TREKK Pediatric Severe Sepsis Algorithm](#).
- » Assess neurological status. If concern for raised ICP:
 - » Elevate head of bed to 30°, keep head midline.
 - » Monitor BP and perfusion closely to avoid hypotension and maintain cerebral perfusion pressure.
 - » Administer 3% NaCl 5 mL/kg (MAX 250 mL) IV over 10 min OR mannitol 0.5-1 g/kg (MAX 100 g) IV over 15 min.
 - » If seizure activity, refer to [TREKK Pediatric Status Epilepticus Algorithm](#).
- » Administer antibiotics within 60 min of concern for meningitis.
- » Contact Pediatrics/Pediatric Referral Centre/Transport Team.

Initial Workup

- » **Investigations:** CBC with differential, blood culture, CRP, glucose, electrolytes, urea, creatinine, blood gas, lactate, PTT, INR and procalcitonin (if available). Urinalysis and urine culture via clean catch, catheter, or suprapubic aspirate in infants⁴. Serology for Lyme only if high index of suspicion in consultation with Pediatrics/Pediatric Infectious Disease/Pediatric Referral Centre.
- » **Neuroimaging:** Never delay antibiotics while waiting for head CT. Head CT required if:
 - 1) suspicion of space occupying lesion (focal seizure, focal neurological deficit, underlying immunodeficiency predisposing to opportunistic infections) OR
 - 2) raised intracranial pressure (Cushing's triad, focal seizures, focal neurological deficit, irregular breathing, papilledema, persistently reduced level of consciousness, refractory seizures).
- » **Cerebral Spinal Fluid (CSF):** CSF cell count, Gram stain, culture, protein, glucose, PCR for enterovirus, pneumococcus, meningococcus, or other bacteria (if available), and parechovirus in infants less than 3 months,⁴ PCR for HSV-1/2 in infants less than 6 weeks with compatible CSF cell count. Local anesthesia doubles the chance of a successful LP. Refer to [TREKK Recommendations for Procedural Pain](#) and/or [Procedural Sedation](#) in stable patients older than 1 year.
- » **Contraindications to Lumbar Puncture:** respiratory or cardiovascular compromise, skin infection at LP site or coagulopathy/severe thrombocytopenia.

Meningitis

DO NOT DELAY ANTIBIOTICS IF PATIENT IS NOT STABLE FOR LP

- » **Practical Interpretation of the CSF Cell Count:** Interpretation varies by age. Neutrophils are not normal in the CSF in any age group. If there is a traumatic tap, the safest option is to count the total number of white cells and disregard the red cell count or accept one more WBC to the total for each 1000 RBC.

	Normal	Viral meningitis	Bacterial meningitis
White blood cells (x 10 ⁹ cells/L or x 10 ⁶ cells/mL)	Less than 1 month of age: < 15 Between 1-2 months of age: < 9 Older than 2 months of age: < 5	Typically 10 to 500 Mean of 400 Lymphocytes or neutrophils	Usually > 1000 Typically > 90% neutrophils
Glucose (mmol/L)	> 50-60% of concomitant glycemia	> 50-60% of concomitant glycemia	< 50-60% of concomitant glycemia or < 2.7
Protein (g/L)	Less than 1 month of age: < 1.7 Greater than or equal to 1 month of age: < 0.45	Slightly elevated Mean of 0.6	Less than 1 month of age: > 1.7 Greater than or equal to 1 month of age: > 0.45

Caution: Cell counts **do not reliably distinguish** between viral and bacterial meningitis. Normal CSF WBC counts can be seen in parechovirus, enterovirus, herpes simplex and early bacterial meningitis.

Treatment

Meningitis Treatment for full-term neonates, infants, children, adolescents*		
Age	Antibiotic	Steroid
0 – 7 days old	Ampicillin 225 mg/kg/day IV divided q8h AND Cefotaxime 100 – 150 mg/kg/day IV divided q8h	Not recommended
8 – 28 days old	Ampicillin 300 mg/kg/day IV divided q6h AND Cefotaxime 150 - 200 mg/kg/day IV divided q6h	
29 days or older	Ceftriaxone 100 mg/kg/dose (MAX 2000 mg/dose) IV x 1 then 12 hours later start 50 mg/kg/dose (MAX 2000 mg/dose) IV q12h AND Vancomycin 60 mg/kg/day (MAX 1000 mg/dose) IV q6h prior to levels If immunocompromised, add Ampicillin 300 mg/kg/day (MAX 3000 mg/dose) IV divided q6h	≥2 months , consider dexamethasone 0.15 mg/kg/dose (MAX 10 mg/dose) IV q6h x 4 days. Give 20 minutes prior to or at the same time as first dose of antibiotics. Steroids have been shown to ↓hearing loss & neurologic sequelae but do not change survival rates in high-income countries. ⁷
Additional Treatment Considerations		
Consult Infectious Disease specialist if gram negative bacteria identified on Gram stain		
HSV Encephalitis suspected	Acyclovir** ≤ 3 months of age give 60 mg/kg/day IV divided q8h > 3 months to less than 12 years of age give 45 mg/kg/day (MAX 1000 mg/dose) IV divided q8h ≥ 12 years of age give 30 mg/kg/day (MAX 1000 mg/dose) IV divided q8h	
Lyme disease suspected	Ceftriaxone 75 mg/kg/day (MAX 2000 mg/dose) IV q24h OR Doxycycline 2.2 mg/kg/dose (MAX 100 mg/dose) PO BID	

*Please contact Pediatric Referral Centre for pre-term neonates born under 37 weeks gestational age.

**Ensure adequate hydration with at least maintenance IV fluids to minimize risk of nephrotoxicity.

Potential Complications

- » Monitor closely for signs of potential complications important to identify and treat early:
 - » Sepsis, shock, hypoglycemia, anemia, raised ICP, SIADH, seizures.

Disposition

- » All patients with suspected or proven meningitis are admitted to hospital.
- » Contact PICU/Transport Team if hemodynamic instability, altered LOC, airway compromise needing critical care.

For a full list of references and development team members, please see the following page.

The purpose of this document is to provide healthcare professionals with key facts and recommendations for the diagnosis and treatment of meningitis in children in the emergency department. This summary uses the best available knowledge at the time of publication. However, healthcare professionals should continue to use their own judgment and take into consideration context, resources and other relevant factors. The TREKK Network is not liable for any damages, claims, liabilities, costs or obligations arising from the use of this document including loss or damages arising from any claims made by a third party. The TREKK Network also assumes no responsibility or liability for changes made to this document without its consent.

Bottom Line Recommendations

Bottom Line Recommendations are short summaries for healthcare providers of the latest knowledge related to the diagnosis and management of pediatric emergency conditions. This resource is not intended to be used as a step-by-step guide. It is ideal for educational purposes and to summarize existing evidence on meningitis exacerbations in pediatric emergency care. Development of this resource involved a rigorous and iterative process, bringing together experts from a variety of specialties (nursing, simulation, emergency medicine, intensive care, and pharmacy). To learn more about the development, see the References & Development Team section below.

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Development Team

Thank you to the following **content experts** who led the development of the Meningitis Bottom Line Recommendations:

Shannon MacPhee, MD, FRCPC Medical Director, Patient Safety Program, IWK Health Atlantic Nodal Leader, [TREKK](#), Associate Professor, Department of Emergency Medicine, [Dalhousie University](#).

Christian Renaud, MD MSc FRCPC Medical Microbiology & Pediatric ID CHU Sainte-Justine, Associate professor of clinic Department of Microbiology, Infectiology and Immunology & Pediatrics, [Université de Montréal](#).

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To see our resource development process please visit our website [here](#).



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