Kentucky Antimicrobial Stewardship Innovation Consortium

# Educational Pearl

## Understanding a Cerebrospinal Fluid Analysis

A cerebrospinal fluid (CSF) analysis is a routine test used to determine the etiology of central nervous system (CNS) disorders including bacterial meningitis. Antibiotics should be initiated as soon as possible when clinical suspicion for bacterial meningitis is high regardless of whether a lumbar puncture (LP) and CSF analysis are able to be collected.[1,2] How should a CSF analysis be interpreted?

**What is in a CSF analysis?**

The CSF collected from a LP is assessed by several tests including Gram stain, culture, polymerase chain reactions (PCR), and fluid analysis. Unlike the other tests, a fluid analysis is unable to identify pathogens. However, differences in analysis components can be used by clinicians alongside other diagnostic tools to differentiate between infectious (e.g., bacterial, viral, or fungal meningitis) and non-infectious CNS disorders (e.g., subarachnoid hemorrhage or malignancy).[3] Fluid analysis components that may suggest bacterial infection are described below.

**Table 1: Components of a CSF Analysis[3-8]**

| Test | Usual Range | Comments |
|---|---|---|
| **WBC** | 0 – 5 cells/µL | Elevated in bacterial meningitis (≥ 100 cells/µL); lower WBC counts may be seen in viral meningitis. Traumatic LPs contaminates CSF with peripheral blood; use correction calculations to adjust. |
| **WBC Differential** | Lymphocyte predominance | Bacterial meningitis is often associated with neutrophil predominance but this may also be seen in early viral, fungal, and tuberculosis meningitis; eosinophilia may be seen in parasitic infections |
| **CSF/Plasma Glucose Ratio** | 0.44 – 0.90 | Reduced in bacterial meningitis. Comparing ratio of CSF to plasma glucose is important in patients with peripheral hyperglycemia. |
| **Protein** | < 50 mg/dL | Elevated in bacterial meningitis (21 – 2220 mg/dL) |
| **Color** | Clear | Turbid CSF is suggestive of bacterial meningitis. Red color can indicate a traumatic tap and therefore analysis should be interpreted with caution (see WBC) |

**Should antibiotics be continued if a CSF analysis is "negative"?**

While several components of a CSF analysis may indicate infection and/or inflammation, the CSF analysis should not be used in isolation to adjust antibiotic therapy. Specific pathogens (e.g., *Listeria monocytogenes*) or septic shock may lead to CSF findings not classically suggestive of bacterial meningitis.[8] However, CSF analysis not suggestive of bacterial meningitis in addition to a negative Gram stain, culture, and PCR should prompt re-evaluation of antimicrobial regimens.

**Key Takeaway**: A CSF analysis allows clinicians to evaluate for multiple competing etiologies prior to culture results being available. Empiric antibiotics should be evaluated for discontinuation if a CSF analysis and other tests are not consistent with bacterial meningitis.

**References:**


1. Tunkel AR, Hartman BJ, Kaplan SL, et al. Practice guidelines for the management of bacterial meningitis. Clin Infect Dis. 2004;39(9):1267-1284. doi:10.1086/425368
2. van de Beek D, Cabellos C, Dzupova O, et al. ESCMID guideline: diagnosis and treatment of acute bacterial meningitis. Clin Microbiol Infect. 2016;22 Suppl 3:S37-S62. doi:10.1016/j.cmi.2016.01.007
3. Shahan B, Choi EY, Nieves G. Cerebrospinal Fluid Analysis [published correction appears in Am Fam Physician. 2021 Jun 15;103(12):713.]. Am Fam Physician. 2021;103(7):422-428.
4. Mazor SS, McNulty JE, Roosevelt GE. Interpretation of traumatic lumbar punctures: who can go home? [published correction appears in Pediatrics. 2003;111(5):1127]. Pediatrics. 2003;111(3):525-528.
5. Seehusen DA, Reeves MM, Fomin DA. Cerebrospinal fluid analysis. Am Fam Physician. 2003;68(6):1103-1108.
6. Leen WG, Willemsen MA, Wevers RA, Verbeek MM. Cerebrospinal fluid glucose and lactate: age-specific reference values and implications for clinical practice. PLoS One. 2012;7(8):e42745. doi:10.1371/journal.pone.0042745
7. Hrishi AP, Sethuraman M. Cerebrospinal Fluid (CSF) Analysis and Interpretation in Neurocritical Care for Acute Neurological Conditions. Indian J Crit Care Med. 2019;23(Suppl 2):S115-S119. doi:10.5005/jp-journals-10071-23187
8. Brouwer MC, Tunkel AR, van de Beek D. Epidemiology, diagnosis, and antimicrobial treatment of acute bacterial meningitis. Clin Microbiol Rev. 2010;23(3):467-492. doi:10.1128/CMR.00070-09


Created 7.9.25