

ADULT MENINGITIS/VENTRICULITIS GUIDELINES
UC Davis Medical Center

Presentation

- Hyper-acute (hours) to acute (hours to days) onset of headache, fever, neck stiffness, or altered mental status

Laboratory Studies

Labs	When to order	Comments
CSF cell count, glucose, protein and bacterial culture with gram stain	All CSF samples	See table below for interpretation
Meningitis/Encephalitis (ME) Panel	All CSF samples EXCEPT – VPS, head trauma, brain abscesses^	Includes CMV, Enterovirus, HSV1/2, HHV6, <i>N. meningitidis</i> , Parechovirus, VZV, <i>E. coli</i> K1, <i>H. influenzae</i> , <i>L. monocytogenes</i> , <i>S. agalactiae</i> , <i>S. pneumoniae</i> , <i>C. neoformans/gattii</i>
HSV 1 and 2 DNA (CSF PCR)	High clinical suspicion for HSV	Stand alone PCR testing is more sensitive for HSV than ME panel. Recommended even if ME panel is negative.
Other work-up	e.g. EBV, West Nile, autoimmune studies, Neurologic Surveillance Testing via Public Health	Label Miscellaneous Lab as “Extra CSF for additional CSF studies,” EBV PCR, West Nile IgM

^Infectious organisms in VPS, head trauma, and brain abscesses are often not on ME panel (e.g. coagulase-negative *Staphylococci*). If ordering ME panel, be cautious of false reassurance with a negative panel.

Typical CSF Findings^{^#}

Note: LP should NOT delay initiation of antibiotics. Even if antibiotics have been started, an LP within 4 hours is still likely to be positive. LPs obtained after this window should be interpreted with caution

Test	Bacterial	Viral	Fungal
Opening pressure	Elevated (20–50 cm H ₂ O)	Usually normal	Variable
WBC count	≥ 1,000/mm ³	<100/mm ³	Variable
Cell differential	PMN predominance (80-95%)	Lymphocytic predominance	Lymphocytic predominance
Protein	Mild to marked elevation	Normal to elevated	Elevated
CSF:serum glucose	Normal (~0.6) to decreased	Usually normal	Low

^Neither normal nor abnormal CSF studies are reliable indicators for the presence of infection in patients with healthcare-associated ventriculitis and meningitis. CSF cultures are the most important test to establish the diagnosis

#Correction for traumatic tap: **True WBC in CSF = Actual WBC in CSF – $\frac{WBC \text{ in blood} \times RBC \text{ in CSF}}{RBC \text{ in blood}}$**

TREATMENT

ID consult recommended

Initial Management Checklist

- Vital signs, history, examination
- Contact and droplet precautions (until pathogen classified)
- Labs: CBC, PT/PTT, chemistries, glucose, blood cultures (2 sets prior to antibiotics), lactate
- IV fluids, treat shock
- Immediate administration of dexamethasone followed by antibiotics for presumptive bacterial meningitis
- Consider acyclovir (if concern for HSV)
- Head CT if:
 - Immunocompromised, history of mass lesion/focal infection, seizure within 1 week of presentation, papilledema, altered mental status, focal neurological deficits
 - Consider CT +/- contrast to increase sensitivity for meningeal/intra-parenchymal involvement. Look for signs of hydrocephalus/increased ICP, edema, infarcts, abnormal enhancement (abscesses, meninges) and adjacent craniofacial infections (sinuses, mastoiditis, orbits, temporal bone)
- Lumbar puncture (LP) if CT results available
- If meningococcus, remember post exposure prophylaxis for close contacts

EMPIRIC THERAPY: Community-Acquired Meningitis

Population	Common pathogens	First-line therapy	Alternative agents (Severe PCN allergy)	Therapy duration	
If bacterial meningitis suspected, dexamethasone 10mg PO/IV q6h x4 days given before/with initial dose of antibiotics [^]					
Age	< 50 years	<i>N. meningitidis</i> <i>S. pneumoniae</i>	Vancomycin + Ceftriaxone +/- acyclovir [‡]	Vancomycin + aztreonam	Based on pathogen ID: <i>N. meningitidis</i> : 7d <i>H. influenzae</i> : 7d <i>S. pneumoniae</i> : 10-14d <i>S. agalactiae</i> : 14-21d Aerobic GNR: 21d <i>L. monocytogenes</i> : ≥ 21d Duration of therapy should be individualized based on patient's clinical response
	> 50 years or immunocompromised	<i>N. meningitidis</i> <i>S. pneumoniae</i> <i>L. monocytogenes</i> Aerobic GNRs	Vancomycin + ceftriaxone + ampicillin +/- acyclovir [‡]	Vancomycin + aztreonam + TMP/SMX (replaces CTX, ampicillin)	
Head trauma	Basilar skull fracture	<i>S. pneumoniae</i> <i>H. influenzae</i> Group A <i>b</i> -hemolytic streptococci	Vancomycin + ceftriaxone +/- acyclovir [‡]	Vancomycin + aztreonam	
	Penetrating head trauma	<i>S. aureus</i> CoNS (especially <i>S. epidermidis</i>) Aerobic GNRs (including <i>P. aeruginosa</i>)	Vancomycin + cefepime +/- acyclovir [‡]		

[^]Dexamethasone should only be continued if CSF Gram stain reveals gram-positive diplococci or if blood/CSF cultures are positive for *S. pneumoniae*. It should not be given to patients who have already received antibiotics, as it is unlikely to improve patient outcomes.

EMPIRIC THERAPY: Healthcare-Associated Meningitis/Ventriculitis

Risk factors	Common pathogens	First-line therapy	Alternative agent (Severe PCN allergy)	Therapy duration	
Steroids NOT recommended for Healthcare-Associated Meningitis/Ventriculitis					
Neurosurgical	Post-neurosurgery	<i>S. aureus</i> CoNS (especially <i>S. epidermidis</i>) Aerobic GNRs (including <i>P. aeruginosa</i>)	Vancomycin + cefepime +/- acyclovir [‡]	Vancomycin + meropenem	Consult ID
	CSF shunt [#]	<i>S. aureus</i> CoNS (especially <i>S. epidermidis</i>) Aerobic GNRs (including <i>P. aeruginosa</i>) <i>P. acnes</i>			

[#]Intraventricular antimicrobial therapy should be considered for patients with healthcare-associated ventriculitis and meningitis in which the infection responds poorly to systemic antimicrobial therapy alone

[‡] If HSV suspected:

- S/sx HSV encephalitis: hemicranial headache, language/behavioral abnormalities, memory impairment, seizures
- CSF studies suggestive of viral process (see table below)
- Recommend sending ME panel +/- CSF PCR for HSV-1/2

INTRAVENTRICULAR ANTIBIOTICS

- **Indication:** Consider in patients with healthcare-associated ventriculitis and meningitis in which the infection responds poorly to systemic antimicrobial therapy alone
- **Procedure:** When antimicrobial therapy is administered via a ventricular drain, the drain should be clamped for 15–60 minutes to allow the agent to equilibrate throughout the CSF
- **Dosing:**

Antimicrobial Agent	DAILY Intraventricular Dose
Amikacin	Usual: 30 mg Range: 5-50 mg
Amphotericin B deoxycholate	0.01–0.5 mg in 2 mL of 5% dextrose in water
Colistin	10 mg
Daptomycin	2-5 mg
Gentamicin ^{^#}	4-8 mg
Polymyxin B	5 mg
Quinupristin/dalfopristin	2-5 mg
Tobramycin	5-20 mg
Vancomycin ^{^#}	5-20 mg

[^]Recommendations for frequency of administration based on external ventricular drain output over 24h as follows:

- <50 mL/24 hours: every third day
- 50–100 mL/24 hours: every second day
- 100–150 mL/24 hours: once daily
- 150–200 mL/24 hours: increase dosage by 5 mg of vancomycin/1 mg of gentamicin and give once daily
- 200–250 mL/24 hours: increase dosage

[#] Dosage recommendations in adults based on ventricle size/volume as follows:

- Slit ventricles: 5 mg vancomycin and 2 mg gentamicin
- Normal size: 10 mg vancomycin and 3 mg gentamicin
- Enlarged ventricles: 15–20 mg vancomycin and 4–5 mg gentamicin.

GENERAL ANTIBIOTIC DOSING FOR MENINGITIS

Antimicrobial Agent	CNS Penetration	Dose
Acyclovir^R	Good	10 mg/kg/ dose every 8 hours
Ampicillin	Poor to fair	2 g every 4 hours
Aztreonam^R	Fair	2 g every 6-8 hours
Cefepime^R	Fair	2 g every 8 hours EXTENDED INFUSION
Ceftazidime^R	Fair	2 g every 8 hours EXTENDED INFUSION
Ceftriaxone	Fair	2 g every 12 hours
Ciprofloxacin^R	Fair	400 mg every 8-12 hours
Daptomycin^R	Unknown	6 to 10 mg/kg once daily
Fluconazole^R	Good	400-800 mg (6-12 mg/kg) once daily
Gentamicin	Poor	<i>Enterococcus</i> : 5 mg/kg/day in 1 or 3 divided doses <i>Listeria monocytogenes</i> : 5 mg/kg/day in 3 divided doses
Linezolid	Good	600 mg every 12 hours
Liposomal amphotericin B	Poor	3-5 mg/kg daily
Meropenem^R	Fair	2 g every 8 hours EXTENDED INFUSION
Moxifloxacin	Fair	400 mg daily
Nafcillin	Poor to fair	2 g every 4 hours
Penicillin G	Poor to fair	4 million units every 4 hours
Posaconazole	Poor	IV/PO (DR tablets): 300 mg twice daily x2 doses, then 300mg daily
Rifampin	Fair	600 mg daily
Trimethoprim/sulfamethoxazole^R	Good	IV: 5 mg/kg/ dose (TMP) every 6-12 hours
Vancomycin^R	Poor to fair	**Continuous infusion preferred to optimize pharmacokinetics** Load 15 mg/kg, then a continuous infusion of 60 mg/kg/day <i>Intermittent bolus</i> : Maintain serum trough concentrations of 15–20 µg/mL
Voriconazole	Good	IV: 6 mg/kg x2 doses, then 4 mg/kg every 12 hours

^RRenal dose adjustment may be indicated

Neisseria meningitidis

- **Indication:** close contacts, defined as prolonged (8 hours or more) contact while in close proximity (3 ft is the general limit for large-droplet spread) to the patient or who have been directly exposed to the patient's oral secretions (e.g., through prolonged face-to-face contact, mouth-to-mouth resuscitation, kissing, or management of an endotracheal tube) within 1 week before the onset of the patient's symptoms until 24 hours after appropriate antimicrobial therapy has been initiated
- **Regimen:** Ciprofloxacin 500 mg PO x1 dose
- **Alternatives:** Rifampin 600 mg PO twice daily for x2 days OR ceftriaxone 250 mg IM x1
- **Refer to infection prevention team with any questions**

References

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