Guidelines for the Evaluation and Management of Pediatric Ventriculoperitoneal (VP) Shunt Infections

This guideline was developed by the following multidisciplinary group:

Pediatric Infectious Diseases (ID): Alex Plattner, MD, MBA

Pharmacy: Christine Lockowitz, PharmD, BCIDP

Pediatric Neurosurgery: Jennifer Strahle, MD

I. Basic Principles

a. All patients with suspected or confirmed VP shunt infections should have Neurosurgery and Infectious Diseases involved in their care.

II. Inclusion/Exclusion Criteria

a. This guidance only applies to ventriculoperitoneal shunt infections, NOT other types of shunts such as ventriculopleural or ventriculoatrial shunts. Please consult Neurosurgery and ID for guidance.

III. Diagnostic Testing

a. All suspected VP shunt infections should have the following collected (ideally before antibiotics are initiated):
   i. CSF cultures are the MOST important test to establish the diagnosis of a VP shunt infection.
   ii. CSF cytochemical analysis obtained including:
      - WBC and differential
      - RBC
      - glucose
      - protein

b. The microbiology lab automatically holds CSF cultures for 5 days to ensure ability to detect and grow more indolent pathogens (e.g., *Cutibacterium acnes*).

c. In patients with confirmed shunt infections, CSF cultures should be obtained every 24 hours until at three consecutive CSF cultures are negative, at which point, CSF cytochemical analysis and cultures from EVDs are not needed to monitor response to therapy unless there is a change in clinical status (e.g., new onset fever, mental status changes).

d. The need for neuroimaging will be determined in conjunction with Neurosurgery.

IV. Interpretation of Diagnostic Testing

a. Normal CSF cell count, protein, and glucose may not reliably exclude infection in patients with ventriculitis and/or meningitis due to a VP shunt.

b. Additionally, a negative CSF gram stain does not exclude the presence of infection.

c. Findings that are consistent with VP shunt infection:
   i. CSF pleocytosis with a positive culture and signs/symptoms of infection.
   ii. Hypoglycorrhachia and elevated CSF protein concentrations.

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d. Interpreting Positive CSF cultures:
    i. Growth of a bacteria considered a contaminant (e.g., Coagulase-negative Staphylococcus) in enrichment broth only or on just 1 of multiple cultures in a patient with normal CSF and no fever is not indicative of a VP shunt infection.
    ii. CSF cultures with multiple organisms from a single sample may be contaminants in patients with no symptoms of infection or CSF pleocytosis.
    iii. CSF cultures with S. aureus, Gram-negative bacilli, or fungus are indicative of infection.

V. Therapeutic Recommendations

a. Empiric Antimicrobial Therapy:
    i. Empiric therapy for suspected VP shunt infection should be vancomycin PLUS cefepime, initiated after obtaining CSF/shunt cultures if possible.
    ii. Metronidazole is not routinely necessary as empiric therapy in the absence of a brain abscess or abscess around the peritoneal tip of the VP shunt.
b. Definitive Antimicrobial Therapy:
    i. Should be tailored based on the organism detected, susceptibility results, and other patient-specific factors, with recommendations provided by the Infectious Diseases Consult Team.
c. Duration of Antimicrobial Therapy:
    i. Methicillin-susceptible *Staphylococcus aureus* (MSSA) and methicillin-resistant *S. aureus* (MRSA):
        - 10–14 days from first negative CSF culture.
    ii. Coagulase-negative Staphylococcus species and *Cutibacterium acnes*:
        - No CSF abnormalities and negative CSF cultures for 48 hours: 10 days from first negative CSF culture.
        - Presence of CSF pleocytosis, hypoglycorrhachia, and clinical symptoms: 10–14 days from first negative CSF culture.
    iii. Gram-negative bacilli:
        - 10–14 days from first negative CSF culture (some experts recommend durations up to 21 days).
    iv. *Candida* species:
        - 4 weeks minimum from first negative CSF culture.

***Durations of therapy may vary based on patient-specific or infection-specific factors and should be decided in collaboration with the Infectious Diseases Consult Team.*

VI. VP Shunt Management

a. Complete removal of the infected shunt and replacement with an external ventricular drain (EVD) is recommended.
b. Reimplantation of the shunt can occur after at least three consecutive CSF cultures are negative, and may depend upon causative pathogen:
    i. Methicillin-susceptible *Staphylococcus aureus* (MSSA) and methicillin-resistant *S. aureus* (MRSA):
        a. After 10 days of antibiotics from first negative CSF culture.
    ii. Coagulase-negative Staphylococcus species and *Cutibacterium acnes*:
        a. No CSF abnormalities and negative CSF cultures for 48 hours: after 3 days of antibiotics from time of VP shunt removal.
        b. Presence of CSF pleocytosis, hypoglycorrhachia and clinical symptoms: after 7 days of antibiotics from first negative CSF culture.
    iii. Gram-negative bacilli:
        a. After 10 days of antibiotics from first negative CSF culture.

iv. *Candida* species:
a. 4 weeks minimum from first negative CSF culture.

c. Observation period off antimicrobial therapy to verify clearance of infection before shunt reimplantation is not recommended.

***Time to reimplantation may vary based on patient-specific or infection-specific factors and should be decided in collaboration with the Infectious Diseases Consult Team.*

VII. References

1. Allan R. Tunkel, Rodrigo Hasbun, Adarsh Bhimraj, Karin Byers, Sheldon L. Kaplan, W. Michael Scheld, Diederik van de Beek, Thomas P. Bleck, Hugh J. L. Garton, and Joseph R. Zunt. 2017 Infectious Diseases Society of America's Clinical Practice Guidelines for Healthcare-Associated Ventriculitis and Meningitis. Clin Infect Dis. 2017 Feb 14. doi: 10.1093/cid/ciw861. [Epub ahead of print]
2. Berrios-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, et. Al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg. 2017 Aug 1;152(8):784-791.