Central Nervous System Device Infections

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KEYWORDS

• Ventriculostomy • Deep brain stimulator • Infection
• Meningitis • Ventriculitis

CEREBROSPINAL FLUID DIVERSION WITH VENTRICULOSTOMIES: VENTRICULOSTOMY-RELATED INFECTIONS

The first operative procedure for hydrocephalus was recorded in the medical literature by Dandy[1] in 1922. Since then, cerebrospinal fluid (CSF) diversion techniques have become common neurosurgical procedures. Ventriculostomy catheters (also known as external ventricular drains or EVDs) serve an increasingly important role in the neurosurgical intensive care unit (ICU). These temporary devices, which permit therapeutic CSF drainage while monitoring intracranial pressure, are used broadly; after closed head injuries, intracranial hemorrhage including subarachnoid hemorrhage (SAH), intracerebral hemorrhage (ICH), and intraventricular hemorrhage (IVH), or for hydrocephalus due to obstructing mass lesions. As with any device, however, EVDs carry a risk of infection, in this case ventriculomeningitis, in an often critically ill and complex patient population.

Ventriculomeningitis may result from contamination of the drain during insertion, contamination of the drain system during routine care and manipulation, colonization of the drain at the insertion site by skin flora, or infection of the drain and CSF as a result of a surgical-site infection. Prevention efforts can be targeted to these potential routes of infection.

Incidence

The incidence of ventriculomeningitis due to EVD catheters is estimated to range from 0% to greater than 20%, but varies widely depending on the definition of infection used and the clinical characteristics of the study population. A large meta-analysis evaluated 23 major studies of ventriculostomy use and encompassed 5733 EVD

The authors have nothing to disclose.
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Infect Dis Clin N Am 26 (2012) 89–110
doi:10.1016/j.idc.2011.09.006 **id.theclinics.com**
0891-5520/12/$ – see front matter

insertions among 5261 patients. This study found the cumulative rate of positive CSF cultures was 8.80% per patient or 8.08% per EVD placement.[2] As was noted in other reports, studies that defined infection with clinical indicators in addition to a positive CSF culture showed a lower risk of infection of 6.62% per patient or 6.10% per EVD.

Risk Factors

Understanding the risk factors for infection can help guide prevention efforts (**Box 1**). Factors studied include the indication for catheter placement, duration of catheterization, difference in placement technique, antimicrobial use, and frequency of manipulation and sampling. Early in the use of ventriculostomy catheters, IVH and SAH were associated with a higher risk of infection than were other indications. In 1988, Sundbarg and colleagues[3] reported on 648 patients who were subject to prolonged ventricular fluid pressure recording, and found an infection rate of 10% among those with SAH and 13.2% among "other spontaneous hemorrhage." By contrast, the investigators reported a rate of 0% to 2.6% for all other diagnosis, which included tumors, trauma, nonhemorrhage-related hydrocephalus, and miscellaneous indications. Multiple other reports have shown a similar association with hemorrhagic parameters in the CSF and an elevated risk of infection.[4,5] By contrast, in 2008 Hoefnagel and colleagues[6] reported on a retrospective study of 228 patients requiring EVD placement and found no association with infection and IVH. This trend has been duplicated in other retrospective reviews.[7,8] An expanded focus on infection control and sterile manipulation may be contributing to this discrepancy. A heightened suspicion for CSF infection is still warranted among patients with SAH or IVH.

Duration

A lengthy debate regarding the duration of EVD placement and risk of infection has been ongoing since Mayhall and colleagues[5] published their work in 1984. In this prospective study the investigators found a significant increase in ventriculostomy-related infections (VRI) after 5 days of catheterization. Based on these data, the investigators recommended prophylactic removal and reinsertion at day 5 if continued monitoring was needed. Multiple studies have subsequently evaluated duration as a risk factor for infection, with conflicting results,[6–15] and prophylactic removal and reinsertion has proved not to be beneficial.[4,11,16]

Box 1
Risk factors for ventriculostomy-related infections

- Intraventricular hemorrhage
- Subarachnoid hemorrhage
- Depressed cranial fracture
- CSF leak from fracture or ventriculostomy site
- Neurosurgical operation
- Duration of catheterization
- Severity of underlying illness
- Systemic infection
- Frequent manipulation and sampling of drainage system
- Catheter irrigation