Trends in Utilization of Temporary and Permanent Cerebrospinal Fluid Diversion and Catheter Cerebral Angiography for Patients with Aneurysmal Subarachnoid Hemorrhage in the United States

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Abstract

Introduction
Aneurysmal subarachnoid hemorrhage (aSAH) pools blood into the subarachnoid space and may extend into the cerebrospinal fluid (CSF) ventricles, elevating intracranial pressure. This requires permanent CSF diversion achieved by external ventricular drainage (EVD) and sometimes followed by a ventriculoperitoneal shunt (VPS) if the patient develops hydrocephalus. Although predictors of EVD failure requiring VPS shunting are well-established, we sought to analyze the relationship in the utilization of the two in a nationally representative cohort.

Methods
The Nationwide Inpatient Sample database was queried from 2006 to 2018 for patients with aSAH who underwent clipping or coiling. Patients who received EVD and VPSs were also identified. Cochrane Armitage test was conducted to assess the linear trend of proportions of EVDs and VPSs per year.

Results
A total of 133,566 admissions were identified from 2006 to 2018 involving aSAH. Of these, 55,859 (41.82%) received EVDs, and 14,125 (10.58%) with VPSs. There was an average upward trend of 1.57% in EVD utilization; There was no trend seen in VPS utilization (trend: -0.06%; p=0.44).

Conclusion
Although there was an increase in the utilization of EVDs for aSAH over the years, there was an underutilization of VPSs. Previous literature demonstrates that VP shunts have higher rates of complications, and shunt dependency after aSAH raises the likelihood of morbidity and mortality. The underutilization of VPS needs to be explored further, but this phenomenon may be due to the improvement in CSF diversion management.
Background

Hyperviscosity is a common complication from intracranial subarachnoid hemorrhage (SAH). Typically, the reduction of cerebrospinal fluid (CSF) viscosity is achieved by external ventricular drainage (EVD) or lumbar drainage, sometimes followed by a ventriculoperitoneal shunt (VPS). After aneurysm treatment, repeat catheter cerebral angiography can be used for diagnosis of neovasospasm and for intra-arterial injection of vasodilators for its treatment. We sought to analyze the rate of utilization of methods of cerebrospinal fluid drainage and catheter cerebral angiography for patients with SAH treated at a representative center of patients admitted with SAH.

Methods

The Nationwide Inpatient Sample database was queried from 2006 to 2016 for patients with SAH who underwent EVD (n=1,056) or lumbar drainage (n=456) and who underwent repeat catheter cerebral angiography (n=1,056). The primary outcome was to assess the linear trend of proportions of EVD, lumbar drainage, VPS, and repeat catheter cerebral angiography per admission per year. Four regression analyses were conducted to infer the association of baseline variables to EVD, lumbar drainage, VPS, and mean number of repeat catheter cerebral angiographies.

Results

Demographics

A total of 15,846 admissions were identified from 2006 to 2016. Of these, 54.8% received EVD, 4.3% received lumbar drainage, 10.5% received VPS, and 35.8% had cerebral angiography.

Trend Analysis

There was an average upward trend of 3.5% in annual EVD utilization, an average downward trend of -0.09% in utilization of lumbar drainage, no change in VPS utilization, and an average upward trend of 0.04 angiograms per year (p<0.001)(Figures 1 & 3).

Patient & Hospital Profile

EVD use was greater in smaller hospitals and a higher proportion of Black patients treated with EVD and VPS (p<0.001). Twelve patients (0.7%) had higher odds of being treated with EVD or VPS compared to White patients (Table 1). There was a higher proportion of Black patients treated with VPS in urban teaching hospitals and large hospitals.

Conclusions

Our results show the temporal trends in utilization of temporary and permanent methods of cerebrospinal fluid diversion and repeat catheter cerebral angiography among patients with SAH. The outcomes of EVD and VPS utilization are associated with differences in EVD and VPS utilization depending on race and hospital size. Further exploration is needed.