

**Commentary on:**

Cerebrospinal Fluid Output as a Risk Factor of Chronic Hydrocephalus After Aneurysmal Subarachnoid Hemorrhage by Garcia-Armengol et al. *World Neurosurg* 2022
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Cerebrospinal Fluid Drainage and Subarachnoid Hemorrhage—Proper Timing of Conversion to Ventriculoperitoneal Shunting

Victor Volovici and Ruben Dammers

Around one third of patients presenting with aneurysmal subarachnoid hemorrhage (aSAH) develop hydrocephalus¹ and require external drainage of cerebrospinal fluid (CSF), either in the form of an external ventricular drain (EVD) or an external lumbar drain. Of all aSAH patients, it is estimated that 12%–14% will eventually require permanent CSF shunting in the form of a ventriculoperitoneal shunt (VPS).² Earlier external drainage might be associated with better outcomes, likely due to the reduction of intracranial pressure and the clearance of intraventricular blood.¹ Late permanent shunting appears to be associated with poorer outcomes.^{3,4}

Within the complex process of care that is the acute phase of an aSAH, especially of a high-grade aSAH, CSF drainage plays an important role. Clinicians are confronted daily with a myriad of choices: which patients to indicate for external drainage, the level of drainage for EVDs, the proper moment to clamp, the proper moment to insert a VPS. Clamping an EVD too soon might induce disorders of consciousness and hamper the clinical progress of a patient at a time when the equilibrium is frail. Clamping too late might lead to ventriculitis. Placing a VPS too soon might be associated with more complications, such as clogging of the system with debris if intraventricular blood is still present. Some patients might be indicated for a VPS who in reality do not need one. Last but not least, “missing the signs” and placing a VPS too late might lead to poorer outcomes on the long run.

These issues are also clouded by the fact that there is no “gold standard” test to assess shunt-dependant hydrocephalus after aSAH. Furthermore, the poor overall condition of patients after aSAH, including fluctuating consciousness, might obscure the symptoms associated with hydrocephalus.

In order to aid clinicians in making these difficult choices, Garcia-Armengol et al⁴ published in **WORLD NEUROSURGERY** their

prospective study of 249 aSAH patients, of which 76 had received CSF drainage with an EVD. Their findings were that, after confounder adjustment, not the total duration of drainage, as one might expect, but the total CSF output volume and the CSF output volume after 72 hours were associated with the need for permanent shunting. A mean output of 214 mL in the first 72 hours was found to have a high specificity (94%) and reasonably high sensitivity (89%) to indicate shunt dependency.

It is worthwhile to note that the effect size is lower when EVD production at 24 hours is considered compared with the one at 72 hours. This might indicate, when corroborating other findings in the literature,³ that the first days are crucial in the later development of shunt-dependent hydrocephalus. This finding makes pathophysiologic sense, as the impaired reabsorption of CSF likely causing chronic hydrocephalus after aSAH likely occurs in the early phase after ictus. It is also important to realize that 214 mL/24 hours is less than the 10 mL/hour one would strive for after EVD placement in aSAH. This finding suggests that even an apparently “normal” daily EVD volume in the first days after aSAH might be associated with the development of shunt-dependent hydrocephalus.

The debate regarding early versus late placement of VPS after aSAH is ongoing. A Korean group of investigators reported on a cohort of 33 patients who had undergone EVD weaning and VPS placement an average of 6.4 days after EVD placement, irrespective of the amount of intraventricular blood left or of CSF protein count.⁵ Six percent of patients required a revision. Nevertheless, this strategy of early weaning, while preventing secondary meningitis and ventriculitis, likely indicates patients for VPS who would have otherwise not developed shunt-dependent hydrocephalus.

Key words

- Cerebrospinal fluid drainage
- Subarachnoid hemorrhage
- Ventriculo-peritoneal shunt

Abbreviations and Acronyms

- aSAH:** aneurysmal subarachnoid hemorrhage
- CSF:** Cerebrospinal fluid
- EVD:** External ventricular drain
- VPS:** Ventriculoperitoneal shunt

Department of Neurosurgery, Erasmus MC University Medical Center, Rotterdam, The Netherlands

To whom correspondence should be addressed: Victor Volovici, M.D., Ph.D.
 [E-mail: v.volovici@erasmusmc.nl]

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Whichever strategy would be employed, both the volume drained in the first days after ictus and the number of EVD clamp trials^{6,7} seem to be markers of the development of shunt-dependent hydrocephalus. Despite these findings, the clinically important research questions remain unanswered.

In future studies, a time series analysis of hourly EVD output, adjusted for EVD level and EVD position and CT findings, should be carried out. If the effect of the early drainage volume is as impressive as the literature findings suggest, then this would open up opportunities for other therapies in the acute phase, such as intrathecal fibrinolytics. A combination of clinical, radiologic, and EVD output factors should be combined in a prediction model, in a large database, with external validation. Results of centers with a more aggressive weaning strategy should be compared with the results of centers that choose longer drainage periods with a comparative effectiveness design (or a “target trial

emulation” design). The role of external lumbar drain should also be defined. Last but not least, the relationships between 1) early CSF drainage and outcome after aSAH and 2) placement of VPS and outcome after aSAH should be investigated.

We are witnessing steps in the right direction. The literature highlights several predictors that should be taken into account when evaluating whether a patient will develop shunt-dependent hydrocephalus. Given that the specificity of these markers is high, one can reasonably exclude patients from shunting on the basis of these criteria. Considering the prevalence of external CSF drainage after aSAH, this topic should figure largely in research agendas and a coordinated effort should aim to clarify the remaining research questions. While not as exciting as securing the aneurysm after ictus, CSF drainage is easily as important and leaves lasting, and sometimes unnecessary (VPS), scars.

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