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INVITED EDITORIAL COMMENTARY

Autoregulation Monitoring is Important: Even After Aneurysmal Subarachnoid Hemorrhage—Isn't it?

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Perhaps the advent of indicating the importance of autoregulation monitoring was the seminal work by Marek Czosnyka, who introduced transcranial doppler-based (TCD) Mx and intracranial pressure-based pressure reactivity index PRx as prognostically relevant after traumatic brain injury [1, 2]. Since then, a myriad of autoregulation indices and tests was described [3, 4] predominantly in traumatic brain injury victims. Loss of autoregulation is linked to less tolerance of intracranial pressure (ICP) [5]. The PRx allows calculation of an optimal cerebral perfusion pressure (CPP), and a deviation of this optimal CPP from the real CPP is related to worse long-term outcome [6]. Patients after subarachnoid hemorrhage (SAH) are less researched, but the same principles seem to apply. Autoregulation is known as predictor of delayed cerebral ischemia, as confirmed by a recent meta-analysis of seven prospective trials [7].

In this issue of Neurocritical Care, Rynkowski et al. [8] present additional prospective data on autoregulation monitoring in aneurysmal SAH. The authors investigated the *transient hyperemic response test,* THRT, which classifies the response in TCD flow velocities after a short carotid compression as either increase, indicating preserved autoregulation, or absent, meaning loss of autoregulation. THRT was performed early in the clinical course of the patients, and results were linked to outcome. Parameters used include the items recommended for outcome assessment after aneurysmal SAH [9], cerebral infarction as well as long-term clinical outcome, here performed with the modified Rankin score. In the current paper, the THRT was the only significant predictor for outcome besides the APACHE II score on admission in multivariate analysis. The APACHE II is rarely investigated in SAH research and driven much by age and Glasgow Coma Scale score. It may be reasonable to assume that a lot of collinearity between different parameters is present. Forty patients in the current study are simply too small a number to facilitate multivariate analysis beyond more than two to three independent predictors. Therefore, the multivariate significance of the THRT is to be noted, but likely to depend on the fate of one or two patients only, thus having a low fragility index, as much intensive care unit (ICU) research does [10]. Nevertheless, the authors are to be congratulated to this small, but important piece of work. It includes long-term outcome data and provides further evidence that autoregulation may have a role after SAH. Previous work using the THRT focused on predicting vasospasm and ischemia, with varying definitions [11–13]. Rynkowski et al. put the THRT, with a one-time assessment, in the league of PRx and ORx [14, 15], without requiring long-term monitoring and complex data recording.

Predicting outcome after aneurysmal SAH with reasonably accuracy is rather simple by clinical examination only, despite an ever-increasing armamentarium of additional scores and indices [16]. The question arises: what do we do with the results from additional tests like the THRT? Being *more vigilant* in the group identified by THRT as high risk for worse outcome? So far, there is little we can do specifically, besides what we would be doing for every patient—applying prophylactic nimodipine, and, in case all other factors being equal, opt for early coiling (unfortunately, due to low availability in the

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authors' hospital, the latter was performed less frequently than contemporarily used). Another option would be being less restrictive for the group with minor risk and uses the THRT as additional safeguard. It seems reasonable to discharge patients in good grade and with intact autoregulation early from the ICU to a regular ward, just using clinical surveillance without further monitoring. Even classic TCD examination was recently identified to be of questionable value in the low-risk group, due to the low prevalence of vasospasm [17].

The prognosis of a patient with aneurysmal SAH has been improving in the last three decades [18]. This was not due to major single advances in treatment, but more the tiny steps in general ICU care. So far, autoregulation monitoring and autoregulation-oriented treatment did not play a role, despite an increasing knowledge. If this is to change, we need to identify treatment options to modify the status of autoregulation. Otherwise, autoregulation monitoring in aneurysmal SAH will stay a research toy: being able to diagnose that something is wrong, but unable to change the fate.

Compliance with Ethical Standards

Conflict of interest

The author declares that he has no conflict of interest.

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