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SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE

ARTICLE OF THE MONTH

Optimal Hemodynamic Parameters for Brain-Injured Patients in the Clinical Setting: A Narrative Review of the Evidence

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Oh how time flies! It's hard to believe that summer is over. Our September AOTM explores optimal hemodynamic parameters for patients with brain injury. Our commentary comes from Dr. Michaela Randall and Dr. Joseph Pawlowski, from the University of Nebraska Medical Center.

Dr. Joe Pawlowski is an assistant professor at the University of Nebraska Medical Center. He is section head of neuroanesthesiology and the associate program director of the residency program. He has subspecialty certification in critical care medicine and attends the surgical and cardiovascular ICUs at UNMC, as well as serving as staff anesthesiologist in the multispecialty division. His passions include improving resident feedback and evaluation. Dr. Michaela Randall is currently a CA2 at UNMC and plans on pursuing a fellowship in critical care medicine.

As always, we encourage our readers' input on this topic on the SNACC Twitter feed, or on Facebook.
Amie Hoefnagel, MD, Oana Maties, MD, Shilpa Rao, MD

Commentary:

Drs. Ma and Bebawy's narrative review[1] evaluates the complex mechanisms by which cerebral autoregulation is maintained in varying types of brain injuries. The authors approach this undertaking with the understanding that hemodynamic goals change depending on the underlying pathology of the disease, thus making it challenging to generalize specific goals. This review specifically discusses TBI, intracerebral hemorrhage, aneurysmal SAH, and acute ischemic stroke.

The paper helpfully reviews the common misconceptions associated with cerebral autoregulation, which in our experience remain widespread and tend to oversimplify the involved physiology. Ma and Bebawy explain that a cerebral autoregulation curve as understood by the sharp-angled, flat-plateaued schema described by Lassen in 1959[2] is incomplete in many cases. As examples, they cite research that demonstrates: 1) the lower- and upper-limits of autoregulation have more gradual, "rounded" transitions into the pressure-passive ranges, 2) cerebral blood flow remains responsive to blood pressure changes even within the range of autoregulated flow, 3) anesthetics, vasoactive medications, and acute and chronic cerebral pathologies can have dramatic effects on the autoregulatory curve, 4) the lower limit of autoregulation is variable between individuals and in many cases is probably greater than the historically understood 50 mmHg, and 5) healthy and diseased regions of brain may have autoregulatory capacity that is variably intact or compromised.

The review then delves into a description of the various types of brain injuries previously mentioned, and guidelines on hemodynamic management. In the case of TBI, decades of experience teaches us that the relationship between SBP and mortality is U-shaped, with extremes of hypo- and hypertension being particularly harmful. Recent guidelines from the Brain Trauma Foundation recommend SBP ≥ 100 mmHg for patients 50-69 years old and SBP ≥ 110 mm Hg for ages 15-49 and over 70 years. Data regarding the ideal upper limit for blood pressure have not been as specific, and we're left with the general understanding that avoiding hypertension improves outcomes. Importantly, Ma and Bebawy point out that CPP targets should be individualized and can be determined by continuous measurement of ICP, CPP, and MAP, especially when used as a way to calculate Pressure Reactivity Index, which they describe.

The authors move on to spontaneous intracerebral hemorrhage, with concomitant hypertension being a common presentation. Current guidelines recommend maintaining SBP < 140 mm Hg or within the range of 110-140 mm Hg, with avoidance of large drops in SBP (> 90 mm Hg) being critical to avoiding kidney injury. Ma and Bebawy discuss two RCTs with seemingly conflicting results: the INTERACT-2 trial, upon which the above guidelines were partially based, and the ATACH-II trial. The differences in these studies were attributed to duration of therapy and alternate design which was thought to be the cause of the different outcomes.

For aneurysmal subarachnoid hemorrhage, the AHA/ASA guideline for management includes a SBP <160 mmHg to prevent rebleeding. Ma and Bebawy highlight the relevant studies and wisely caution against targeting a fixed SBP in isolation, without considering the effects of elevated ICP which can contribute to secondary injury. The review goes on to describe the management of delayed cerebral ischemia in SAH, especially induced hypertension as the gold standard. The authors of this review point out that there are no quality controlled studies that support this practice, and hint at the possibility of future studies focusing on autoregulatory-based approaches.

Acute ischemic stroke in the last injury described, with hypertension thought to be a protective response. Current recommendations vary between societies but generally recommend permissive (or even induced) hypertension to perfuse ischemic penumbra, with reduced BP goals after tPA or mechanical thrombectomy.

In summation, one single approach has not proven effective for all patients regarding hemodynamic management after brain injury. The review notes that many of the trials surrounding blood pressure management in this patient population have had negative or insignificant results. The authors conclude that we should treat patients on a case-by-case basis, taking into account the hemodynamic pathophysiology likely to be present, with special awareness for cerebral disautoregulation.

1. Ma, Kan MD*; Bebawy, John F. MD†. Optimal Hemodynamic Parameters for Brain-injured Patients in the Clinical Setting: A Narrative Review of the Evidence. Journal of Neurosurgical Anesthesiology: July 2022 - Volume 34 - Issue 3 - p 288-299 doi: 10.1097/ANA.0000000000000752

2. Carney N, Totten AM, O'Reilly C, et al. Guidelines for the management of severe traumatic brain injury, Fourth Edition. Neurosurgery. 2017;80:6–15. doi: 10.1227/NEU.0000000000001432