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SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE

ARTICLE OF THE MONTH

Personalizing the Definition of Hypotension to Protect the Brain

Brady KM, Hudson A, Hood R, DeCaria B, Lewis C, Hogue CW

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Happy Spring and welcome to the April 2020 SNACC Article of the Month. We hope that you are all staying well during this challenging time. This month we are highlighting an article that explores a question many of us face daily in our clinical practice: can we define hypotension on an individual basis? Our commentary comes from Dr. Kyung Ji and Dr. Jacob Nadler who are both at the University of Rochester Medical Center in Rochester (URMC), New York.

Dr. Ji is currently a senior resident in anesthesiology at URMC. Dr. Ji grew up in South Korea and moved to the United States for his higher education. He has completed a residency in internal medicine and will soon be embarking on a career in anesthesiology.

Dr. Jacob Nadler is an Assistant Professor at URMC. He completed his MD and PhD in Neuroscience from Washington University and then went on to Duke for his anesthesiology residency and neuroanesthesia fellowship. Dr. Nadler is currently the Division Chief of Neuroanesthesiology at URMC. He is an active member of SNACC and is a member of the Clinical Affairs Committee. His current research interests include the impact of general anesthetics on cancer outcomes, the development of ERAS protocols for complex spine surgery, the management of OSA in parturients, and the reduction of post-operative pulmonary complications.

As always, readers are welcome to join us for further discussion and feedback on the **Twitter** feed or on **Facebook**.

~ Amie Hoefnagel, MD; Oana Maties, MD; Shilpa Rao, MD and Nina Schloemerkemper, MD

Commentary

By Kyung Ji, MD and Jacob Nadler, MD, PhD

Blood pressure measurement is something almost every clinician does during every single patient encounter. For anesthesiologists and critical care physicians, blood pressure management is our responsibility; we commonly see wide fluctuations of blood pressure and we have the necessary tools to manipulate blood pressure according to our goals. But what should those goals be? While it is generally believed that we should avoid hypotension to maintain organ perfusion, how we define hypotension is not universally agreed upon. In fact, it's rather arbitrary; a paper by Bijker et al. identified 140 different definitions of hypotension!

In this review, Brady et al. provide historic and physiologic reasoning supporting the idea that the limits of cerebral autoregulation might be appropriate definitions of hypo- and hypertension and that using those limits might protect the brain. They point out that the classical teaching of cerebral autoregulation spanning from 50 to 150 mmHg (based on Lassen's paper from 1959) has been challenged and proven to be incorrect. They further explore why this is a much more complex topic. Firstly, they report that limits of autoregulation vary significantly between individuals. Secondly, they report varying ranges of autoregulation for different organ systems in the setting of clinical complications (i.e., brain vs kidney in the setting of hemorrhage or hypercapnia). Thirdly, they report how a few previously proposed ways to empirically measure ranges of brain autoregulation have failed to show consistent results.

Brady et al. go on to suggest an innovative solution. Their proposed "signal-filtered near infrared spectroscopy method" uses arterial blood pressure signals and digital cerebral oxygen saturation signals as inputs and outputs, respectively. Applying a mathematical filter, one can determine a correlation index between these two data sets and determine the blood pressure points at which the relationship changes from pressure-passive to pressure-independent. These points define the limits of autoregulation; the lower limit defines "hypotension" that might produce insufficient cerebral perfusion.

The application of these results is limited. Studies showing benefits from using this method remain limited by the small sample size. The technology necessary to conveniently apply this method in the operating room or ICU has yet to be developed. There is still uncertainty that the lower limit of autoregulation is the blood pressure at which blood flow becomes insufficient for perfusion, especially in the setting of decreased demand, as it may occur under anesthesia. Another important consideration is that a minimal blood pressure insuring adequate perfusion to the brain may not be sufficient to satisfy the demands of other at-risk organs like the heart or kidneys, especially in patients with comorbidities.

Despite those limitations, this review is very convincing in its central thesis: while hypotension cannot be accurately determined based on population data, a tool does exist that allows for the calculation of blood pressure parameters that fall within the brain's intrinsic range of autoregulation. This realization is in line with the trajectory of current biomedical advancements where individually tailored medical assessment and therapy promise to offer significant improvement over current population-based approaches.

References:

1. Bijker, JB, van Klei, WA, Kappen, TH, van Wolfswinkel, L, Moons, KG, Kalkman, CJ . Incidence of intraoperative hypotension as a function of the chosen definition: Literature definitions applied to a retrospective cohort using automated data collection. *Anesthesiology*. 2007; *107*:213–20.
2. Lassen, NA . Cerebral blood flow and oxygen consumption in man. *Physiol Rev*. 1959; *39*:183–238.