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SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE

ARTICLE OF THE MONTH

Monitoring Depth of Anesthesia Utilizing a Combination of Electroencephalographic and Standard Measures

Schneider G, Jordan D, Schwarz G, Bischoff P, Kalkman CJ, Kuppe H, Rundshagen I, Omerovic A, Kreuzer M, Stockmanns G, Kochs EF; European Multicenter EEGAEP Anesthesia Monitoring Study Group and Research Group Knowledge-based Signal Processing.

Anesthesiology. 2014 Apr;120(4):819-28. PMID: 24694845.

In our third installment of the SNACC Article of the Month, we visit an article just recently published in *Anesthesiology* by Gerhard Schneider *et al*. as part of a multicenter European consortium. Broadly, the article examines the concept and measurement of "depth of anesthesia", which is a topic of great interest to all anesthesiologists, and is especially dear to us in the neuroanesthesia community. Specifically, the article delves into a comparison between standard vital sign and anesthetic concentration monitoring of depth during general anesthesia *versus* the "AMIC" (Anesthesia Multimodal Index of Consciousness), which is first described by the authors of this study and incorporates EEG parameters into the "depth equation". What the authors conclude is that the combination of standard measures and EEG data, *via* their method of integration, is superior to either method alone. To provide expert insight and commentary on this article, please find below an editorial written by Dr. Zirka Anastasian and Dr. Eric Heyer, both of Columbia University Medical Center in New York. Dr. Anastasian is an Assistant Professor of Clinical Anesthesiology with a primary interest in clinical neurocognitive outcomes, while Professor Heyer's primary research focus (there are many) relates to mechanisms and prevention of cerebral injury in high-neurologic risk surgeries. Thank you for your continued support of this SNACC initiative. We hope you will chime in on this and previous topics by joining in on the conversation by following the ***SNACC LinkedIn Group***.

~John F. Bebawy, MD

Commentary

Reviewers: Eric J Heyer, MD, PhD and Zirka H Anastasian, MD

Schneider et al. hypothesized that monitoring the "depth of anesthesia" can be improved by including processed electroencephalograpy (EEG) in addition to standard clinical parameters (heart rate, blood pressure, change of heart rate and blood pressure), values of anesthetic concentration (end tidal gas, propofol concentration), and patient demographics. They use this combination of factors to derive an index, called anesthesia multimodal index of consciousness (AMIC). To study if the inclusion of EEG to standard parameters can improve the prediction of "depth", the authors looked at clinically defined hypnotic states: loss of consciousness (LOC), and return of consciousness (ROC) after an anesthetic that was titrated from burst suppression for at least one second (BS) to a maintenance according to "standard practice."

The authors of this article studied 263 patients at six different European centers undergoing elective surgery under general anesthesia with ten different combinations of medications for induction and maintenance of anesthesia, but without nitrous oxide. Induction agents included thiopental, etomidate and propofol, and maintenance agents included propofol or volatiles (isoflurane, sevoflurane or desflurane). A variety of opioids were also used during induction and maintenance. They calculated the probability of predicting (P_k) LOC at the start of the case and ROC after an anesthetic. Data was acquired using either standard monitors of hemodynamic and anesthetic values and/or EEG based on two EEG channels. The EEG was recorded and stored continuously, and then played back through the bispectral index (BIS) monitor to generate their processed values and also used in their own EEG analysis. Three different analyses were performed to calculated P_k based on data from standard monitors, standard monitors plus EEG in their algorithm AMIC, or the BIS monitor.

The authors demonstrate that AMIC, which incorporates both standard monitoring plus EEG monitoring, predicts the clinical transition states more accurately then either only using standard monitoring alone or monitoring with the BIS.

The definition of “depth of anesthesia” as it relates to clinically identified endpoints LOC and ROC gives the index, AMIC, a relevant and practical use. It makes clinical sense that having data from an EEG in clinical context of hemodynamic parameters, concentration of agents and patient demographics should be able to improve prediction of “depth” as defined by LOC and ROC. However, “depth of anesthesia” is not universally represented by EEG across all anesthetic agents. Nitrous and ketamine both have sympathomimetic properties and increase EEG wave frequencies. The BIS algorithm does not account for either of these medications. AMIC is likely not helpful with the use of these two agents. With the decreased use of nitrous oxide in Europe, the effect of nitrous on the EEG component of AMIC may not be an issue. However, in cases such as carotid endarterectomies under general anesthesia, nitrous oxide is useful because it increases the baseline frequencies and therefore makes slowing of these frequencies, a sign of cerebral ischemia, easier to see.

Overall, the use of EEG in addition to the clinical parameters, change of clinical parameters, demographic history with the knowledge of the concentration of agents is logically more likely to give you a complete clinical picture of the patient’s “depth”. The exceptions, though, must be remembered, just like the processed EEG values from our current monitors must be taken with a “grain of salt”.