Epochs of Clinically Relevant Disagreements in Depth of Hypnosis Monitors Observed by Replay of the Electroencephalogram

Authors: Christian L. Petersen[1], Zachary Katz[1], Matthias Görges[2], Nicholas West[1], Guy A. Dumont[3], J. Mark Ansermino[1]
[1] Dept of Anesthesiology, Pharmacology & Therapeutics, [2] Pediatric Anesthesia Research Team, Child and Family Research Institute, and [3] Dept of Electrical and Computer Engineering, University of British Columbia, Vancouver, BC, Canada

Background: Commonly used electroencephalogram (EEG) based anesthesia monitors rely on EEG measurements to determine a Depth of Hypnosis (DoH) index, a dimensionless number between 100 (awake) and 0 (comatose). The algorithms used in these monitors differ greatly and it is possible that the same EEG episodes can lead to quite different DoH values, even if the measures are otherwise statistically comparable.

Objective: We investigate whether episodes of clinically relevant deviations occur in different anesthesia EEG monitor readings, by replaying the EEG data, previously recorded from patients under general anesthesia, to multiple anesthesia monitors.

Methods: EEG data was collected from anesthetized patients with approval from the local research ethics board and written informed consent from the patients. The data was acquired with the NeuroSENSE (NeuroWave Systems Inc., Cleveland Heights, OH) monitor (WAV), and saved as a raw continuous two-channel 256 Hz 16 bit signal. It was next replayed to two other DoH monitors: BIS (Covidien, Mansfield, MA) and M-Entropy (GE Healthcare, Little Chalfont, Bucks., UK) (ENT), and visually inspected for periods of disagreement in DoH readings.

Results: Approximately 56 hours of EEG data were evaluated. Episodes were found with significant deviations between monitors. In one case, the BIS and ENT monitors registered a drop in DoH during emergence from anesthesia, while the WAV was unaffected (Fig. 1a). The BIS appears to lock onto a fixed level/state, a behavior previously predicted from procedural simulations [1]. In another instance, the WAV and ENT saw a rapid drop in DoH while the BIS was unaffected, for a divergence of approximately 20 DoH points (Fig. 1b). In cases with Burst Suppression (BS) the ENT would sometimes fail to register the BS periods, resulting in a strong divergence between ENT and WAV/BIS, reaching up to 30 DoH points (Fig. 1c).

Conclusions: The results indicate that there are sustained epochs with significant disagreement in DoH between monitor brands. When DoH is used as a guide to administer anesthesia, this could adversely affect drug dosing and outcomes. More work is needed to understand what triggers these disagreements, and if measures can be developed to warn clinicians in situations where the DoH readings become less reliable.

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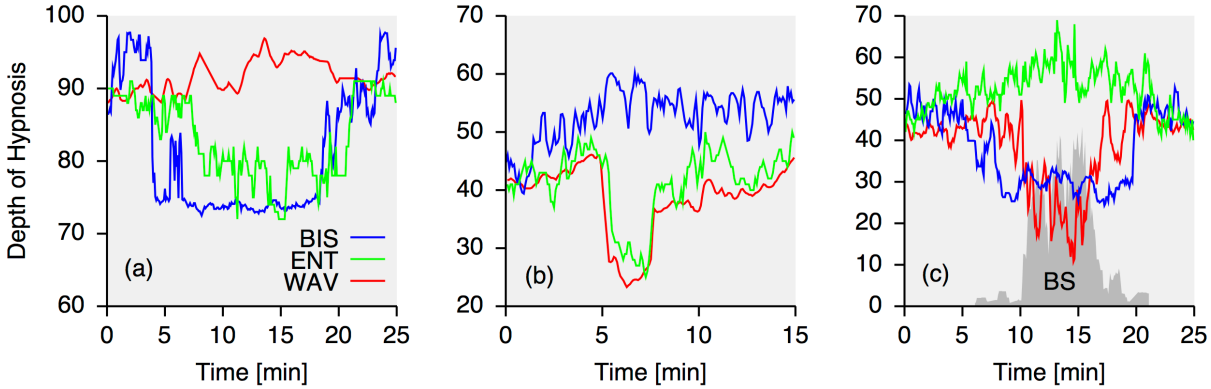

Fig 1: Comparison of DoH and the effect of BS on readings from WAV, BIS and ENT monitors.

[1]Petersen CL, Görges M, Massey R, Dumont GA, Ansermino JM. A procedural electroencephalogram simulator for evaluation of anesthesia monitors. Submitted to Anesthesia & Analgesia.