Response to APSF Updated Monitoring Recommendations – EEG to Assess Anesthetic Depth

March 12, 2023

Donald H. Lambert, PhD, MD

To the Editor:

The APSF recently published recommendations for preventing awareness during general anesthesia.[1] The recommendations include:

1. Whenever an inhaled agent is administered, its end-expired concentration shall be measured, and a low concentration alarm be activated if available.
2. Whenever a neuromuscular blocking agent is administered during inhalational anesthesia, if 0.7 MAC cannot be maintained, an EEG-based monitor of anesthetic depth should be used and an inadequate anesthetic depth alarm limit set if available.
3. Whenever a neuromuscular blocking agent is administered during total intravenous anesthesia (TIVA), an EEG-based monitor of drug effect is recommended, and alarm limits activated when available.

The article also notes,

> "In some patients, it is not possible to maintain an inhaled anesthetic concentration consistent with 0.7 MAC due to hemodynamic compromise and in those patients, monitoring for the risk of awareness is especially compelling. In those cases, an EEG-based monitor of anesthetic depth should be used to help ensure adequate depth of anesthesia."

Awareness during general anesthesia although important is an extremely rare event[2] but devastating when it occurs.[3] On the other hand, myocardial injury after non cardiac surgery (MINS) and acute kidney injury (AKI) owing to hypotension[4–6] and vasopressor administration,[7] are much more common and are most likely to occur during the induction of anesthesia to incision interval,[8] when there is little or no patient stimulation. Therefore, anesthesia providers need to strike a balance between providing enough anesthesia to ensure absence of awareness and avoid organ injury.

As recommended by the APSF, employing 0.7 MAC will prevent awareness. However, the 0.7 value was determined in the absence of intravenous medications. Utilizing a fixed 0.7 MAC to

prevent awareness, overlooks the effects of routinely administered intravenous medications on the depth of anesthesia and “hemodynamic consequences.” The combination of 0.7 MAC and intravenous medication can produce a depth of anesthesia that can result in hypotension, vasopressor use, and possibly MINS and AKI.

Is it the fixed 0.7 MAC in combination with intravenous medications (benzodiazepines, opioids, etc.) that de facto causes the hemodynamic instability, which in turn necessitates, as recommended by the APSF, decreasing the MAC, and employing an EEG-based monitor to ensure lack of awareness? If so, why not use an EEG-based monitor in all patients and allow MAC to vary according to the patient’s wakeful state, as determined by the EEG-based monitor and the mean arterial pressure? A recommendation such as this has been proposed.[9]

Unfortunately, MAC is so ingrained in our culture that not relying on it is impossible for most anesthesia providers to accept. Philips and Hendrickx propose, in an APSF Editorial, that end-tidal agent monitoring should be a "standard of care,"[10] noting that the concentration of end-tidal agent is a reliable indicator of a patient's level of consciousness, and an end-tidal agent concentration of 0.7 MAC makes it highly improbable for the patient to be aware. However, the depth of anesthesia and absence of awareness depends on many variables, including judgements on how much IV and inhaled agents to administer and their effects on awareness and hemodynamics. On the other hand, Jin, et. al., suggest that an EEG-based monitor be considered as a standard of care for monitoring the depth of anesthesia.[11]

To summarize,

1. The depth of anesthesia results from a combination of inhalational and intravenous agents
2. The combined effect is not reflected by calculating the MAC value of the inhaled agents
3. An EEG-based monitor is currently the only way to assess the combined effect of anesthetic medications on the patient
4. Maintaining a proper anesthetic depth based on EEG monitoring, can result in a MAC value < 0.7 MAC without risk of awareness and may positively impact patient outcome

Donald H. Lambert, PhD, MD
Anesthesiologist, Boston Medical Center
Professor of Anesthesiology, Boston University Chobanian & Avedisian School of Medicine

---

The author has nothing to disclose.

REFERENCES

1. APSF Committee on Technology. The APSF Committee on Technology. APSF endorsed statement on revising recommendations for patient monitoring during anesthesia. *APSF Newsletter*. 2022;37(1):7-8.
2. Pandit JJ, Andrade J, Bogod DG, et al. 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: summary of main findings and risk factors † ‡. *British Journal of Anaesthesia*. 2014;113(4):549-559. doi:10.1093/bja/aeu313
3. Domino KB, Posner KL, Caplan RA, Cheney FW. Awareness during Anesthesia. *Anesthesiology*. 1999;90(4):1053-1061. doi:10.1097/00000542-199904000-00019
4. Salmasi V, Maheshwari K, Yang D, et al. Relationship between Intraoperative Hypotension, Defined by Either Reduction from Baseline or Absolute Thresholds, and Acute Kidney and Myocardial Injury after Noncardiac Surgery. *Anesthesiology*. 2017;126(1):47-65. doi:10.1097/ALN.0000000000001432
5. Sessler, Daniel I. Perioperative Hypotension. *APSF Newsletter*. 2021;36(3):89-96.
6. Shimada T, Mascha EJ, Yang D, et al. Intra-operative hypertension and myocardial injury and/or mortality and acute kidney injury after noncardiac surgery: A retrospective cohort analysis. *European Journal of Anaesthesiology*. 2022;Publish Ahead of Print. doi:10.1097/EJA.0000000000001656
7. Ariyarathna D, Bhonsle A, Nim J, et al. Intraoperative vasopressor use and early postoperative acute kidney injury in elderly patients undergoing elective noncardiac surgery. *Renal Failure*. 2022;44(1):648-659. doi:10.1080/0886022X.2022.2061997
8. Maheshwari K, Turan A, Mao G, et al. The association of hypotension during non-cardiac surgery, before and after skin incision, with postoperative acute kidney injury: a retrospective cohort analysis. *Anaesthesia*. 2018;73(10):1223-1228. doi:10.1111/anae.14416
9. Lambert DH. A proposed method to minimize acute kidney injury by avoiding vasopressors during surgery. *Renal Failure*. 2022;44(1):1993-1995. doi:10.1080/0886022X.2022.2141647
10. Phillip J, Hendrickx J. Importance of End-Tidal Agent Monitoring as a Standard of Care. *APSF Newsletter*. 2019;34(2):45.
11. Jin Z, Feldman J, Gan, Tong J. Depth of Anesthesia Monitoring—Why Not a Standard of Care? *APSF Newsletter*. 2019;34(2):43-44.