Minimum alveolar concentration based anesthesia in high altitude and anesthetic overdose: result needs cautious acceptance

Figure 1: Images of anesthesia gas monitor displaying the variation of minimum alveolar concentration (MAC) value displayed for different ages.
Note: The age simulation was done using Mindray A7 anesthetic workstation. Consent for image: The image used does not include the patient but an image of a monitor and it is from the image bank of the author.

Dear Editor,

Maintenance of adequate depth of general anesthesia is very important as lower dose can lead to awareness in one hand, and higher dose can lead to delayed awakening[1] and increased cost in the other hand. Higher altitude affects the partial pressure of gases and, therefore, the minimum alveolar concentration (MAC) guided anesthetic depth management becomes more critical and challenging. In this line, the article[2] published in your esteemed journal, evaluating the MAC guided anesthesia in context to anesthetic overdose judged by bi-spectral index (BIS) values, has been read with great interest. At first, we should congratulate the authors for their commendable job and brilliant hypothesis. Meta-analysis does indicate that BIS can improve anesthetic delivery and recovery from anesthesia,[3] and the authors' hypothesis, comparison of MAC with BIS in higher altitude and conclusion in favor of BIS-guided anesthesia in higher altitude,[2] can be helpful. However, a few facts and methodology needs to be considered before coming to a conclusion that MAC guided anesthesia leads to overdosing in very high numbers of cases and MAC and BIS values do not have good relationships, as found in their study.

The authors clearly mention, cite the references and agree that the MAC value depends on the demographic parameters. In fact, each decade of age affects MAC by 6%.[4] Therefore, the MAC monitored is not the actual MAC for the patient until the age of the patient is taken into account, in other terms, if MACage is not monitored. As standard MAC is defined for male patients aged 40 years, all anesthesia machines display the MAC for a 40-year person, unless the age of the patient is entered in the machine/gas monitor. A study has shown that 96.67% volatile anesthetic based general anesthesia were conducted without entering the birth year/age of the patient.[5] This minor deficit led to 79.41% of the observed MACs as incorrect; 55.88% patients were potentially under-dosed whereas 23.53% were overdosed.[5] As the authors have not mentioned about the use of age-specific MAC in the study, it can be presumed that it was not done, which indicates that the MAC value noted by them was actually a MAC value of 40-year person, not for the actual age of the patient. If the age/birth year is not entered in the machine/monitor, the MAC displayed corresponds to MACage only in the age range of 36–45 years.[5] The mean age of 36.3 ± 13.5 years of the cohort studied by the authors indicates that a good number of patients were on either side of 36–45 years of age. This also explains the authors finding that all patients older than 60 years and 65% of the patients between 36–59 years had deep BIS levels in their study when anesthesia was guided by MAC.[2] The effect of MAC monitoring with the age entered in the monitor is displayed in **Figure 1**. Moreover, the MAC range (0.8–1.2) taken as adequate level/depth needs validation too, especially whether it corresponds to 40–60 BIS values before we label the range as adequate and compare.

There is no doubt that the authors have done a great job by showing the limitations of MAC guided anesthesia in high altitude, but it is clear that if the actual MAC (*i.e.* MACage) would have been monitored and compared, the results would have been different. Further study will be required taking these aspects into the account before we discard the reliability of MAC in the high altitude as a guide to depth of anesthesia as well as its relation with BIS.
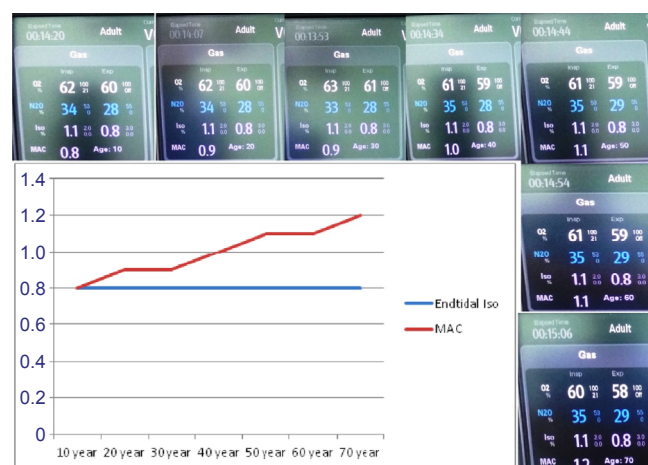
Habib Md Reazaul Karim*

Department of Anaesthesiology and Critical Care, All India Institute of Medical Sciences, Raipur, India

***Correspondence to:** Habib Md Reazaul Karim, MD, drhabibkarim@gmail.com.*
***orcid:** 0000-0002-6632-0491 (Habib Md Reazaul Karim)*

References

1. Misal US, Joshi SA, Shaikh MM. Delayed recovery from anesthesia: A postgraduate educational review. *Anesth Essays Res.* 2016;10:164-72.
2. Giraldo JC, Acosta C, Giraldo-Grueso M. Frequency of anesthetic overdose with mean alveolar concentration-guided anesthesia at high altitude. *Med Gas Res.* 2018;8:150-153.
3. Punjasawadwong Y, Phongchiewboon A, Bunchungmongkol N. Bispectral index for improving anaesthetic delivery and postoperative recovery. *Cochrane Database Syst Rev.* 2014;6:CD003843.
4. Mapleson WW. Effect of age on MAC in humans: A meta-analysis. *Br J Anaesth.* 1996;76:179-185.
5. Karim HM, Narayan A, Yunus M, Kumar S, Prakash A, Sahoo SK. An observational study on patient admission in the anaesthesia gas monitor and minimum alveolar concentration monitoring: A deficiency with huge impact. *Indian J Anaesth.* 2017;61:570-574.