MAC Values of Mixtures

To the Editor—Twenty years ago Merkel and Eger introduced the term, MAC, to represent anesthetic potency. Since then, Eger has co-authored reports that nitrous oxide lowers MAC of various volatile agents. For example, page 274 of Quasha and Eger contains the following: “Similarly, 70% nitrous oxide decreases halothane MAC by 61% and enflurane MAC by 60%.” Although their reference 67 is to studies with isoflurane, not enflurane, the authors’ meaning that N₂O reduces the volatile agent required to prevent reaction to noxious stimulus is clear. It is not, however, evidence that one agent changed MAC of another. The MAC of a mixture is simply the sum of the MACs of its component parts. This is not just a semantic question, because calculations of multiples of MAC may be erroneous if this principle is not understood. A letter was sent to every tenth person on every tenth page of the 1983 ASA Directory of Members, for a total of 65 letters. The following questions were asked:

Assuming that:

- 0.8% halothane in O₂ = 1.0 MAC
- 50% N₂O in O₂ = (approximately) 0.5 MAC
- 0.4% halothane in 50% N₂O = 1.0 MAC

Then, what are the MAC values for the following mixtures?

1) 1.6% halothane in 50% N₂O
2) 1.0% halothane in 50% N₂O
3) 2.0% halothane in 50% N₂O

Of 20 replies, 10 gave correct answers and 10 gave incorrect answers. The incorrect answers were, respectively, 4, 2.5, and 5 MAC. These respondents obviously took the value of 0.4% halothane in N₂O, 1.0 MAC, and divided this into the higher halothane concentrations given in the problems. Nine of these 10 were private practitioners and eight of those nine were board certified.

The same proportions were found among the 10 who gave the correct answers of 2.5, 1.75, and 3 MAC, respectively.

Although the number queried was small and the response rate low, it appears that a significant population of practicing anesthesiologists do not understand the proper way to calculate MAC of mixtures of agents. This can be done best by regarding the MAC for each agent to be a constant concentration, rather than variable according to the presence or absence of other anesthetics. The reason 0.4% halothane in 50% N₂O is 1 MAC is that 0.5 MAC of each is being given, not that N₂O has “lowered” the MAC of halothane. If more halothane is given, more MAC units are added at the rate of 1.0 MAC per 0.8%. Nitrous oxide, 50%, will contribute about 0.5 MAC, no matter what concentration of halothane is being added to it.

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REFERENCES

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Wrestling or Resting Ventilation

To the Editor—Are pharmacologic investigations of breathing control in humans no more than tests of drug effects on the response to added CO₂?

Reports appearing in ANESTHESIOLOGY over the past 2 years describe how lumbar epidural morphine, approximately 0.10–0.15 mg/kg, depresses various indexes of the ventilatory response to rebreathing CO₂ in pain-free volunteers and in patient volunteers who have acute or chronic pain. Nowhere in these reports did I find mention of the important ventilatory information anesthesiologists are seeking, which is how epidural morphine affects resting ventilation (total and/or alveolar) and resting ṖCO₂ (end-tidal and/or arterial). The ventilatory data of these reports refer only to ventilation stimulated by added CO₂. Several other reports on this subject also focus on the response to CO₂.

The ventilatory response to added carbon dioxide frequently has been taken to be a sensitive index of drug