REFERENCES

- 1 *Thornhill ML, Camann WR.* Cardiovascular disease. In: Chestnut DH (Ed.). *Obstetric Anesthesia*. St. Louis: Mosby, 1994: 746–79.
- 2 *American Heart Association.* Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Special resuscitation situations. *JAMA* 1992; 268: 2242–50.
- 3 *Lopez-Zeno JA, Carlo WA, O'Grady JP, Fanaroff AA.* Infant survival following delayed postmortem cesarean delivery. *Obstet Gynecol* 1990; 76: 991–2.
- 4 *Carp HC, Chestnut DH.* Fever and infection. In: Chestnut DH (Ed.). *Obstetric Anesthesia*. St. Louis: Mosby, 1994: 686–98.

Calculation of dead space volume

To the Editor:

We read with interest the article by Mora *et al.*¹ regarding sedative and ventilatory effects of midazolam. They used the following equation for the calculation of dead space volume:

$$V_d = (EPaCO_2 - PETCO_2) \times (V_t - \text{Valve dead space}) / EPaCO_2$$

The use of end-tidal partial pressure of CO₂ (PETCO₂) is questionable. It seems to us that the *mixed expired*, rather than end-tidal PCO₂, should be used.

The volume of CO₂ eliminated in the expired gas each minute (CO₂ production, V̇CO₂) equals the product of minute ventilation (V̇E) and mixed expired CO₂ concentration (F̄ECO₂):

$$\dot{V}CO_2 = (\bar{F}ECO_2) \times (\dot{V}E) \quad (\text{Eq. 1})$$

The volume of CO₂ eliminated from the body is also equal to the sum total of CO₂ volume in the alveoli and in the dead space:

$$\dot{V}CO_2 = (\dot{V}A) \times (FACO_2) + (\dot{V}D) \times (FDCO_2) \quad (\text{Eq. 2})$$

where FACO₂ is the CO₂ concentration in the alveoli, FDCO₂ is the CO₂ concentration in the dead space (which equals inspired CO₂ concentration, FICO₂), and V̇A and V̇D are alveolar and dead space ventilation, respectively.

Setting equation 1 against equation 2, and using the relationship between V̇E, V̇A and V̇D (V̇E = V̇A + V̇D), and substituting FICO₂ for FDCO₂, results in the equation

$$(\bar{F}ECO_2) \times (\dot{V}E) = (\dot{V}E - \dot{V}D) \times (FACO_2) + (\dot{V}D) \times (FICO_2) \quad (\text{Eq. 3})$$

Since FICO₂ is approximately zero, and since FACO₂ approximates arterial CO₂ (FaCO₂), and since ventilation (V̇) is the product of volume (V) and respiratory rate, further algebraic manipulation yields the equation:

$$V_D = (FaCO_2 - \bar{F}ECO_2 \times (V_T) / FaCO_2 \quad (\text{Eq. 4})$$

which is known as the Bohr equation.²

Ze'ev Sherkman MD

Ioan Mircea Crisnic MD

Alexander Avidan MD

Department of Anesthesiology and Critical Care Medicine

Hadassah University Hospital

Hebrew University, Hadassah Medical School

P.O. Box 12000

Jerusalem 91120

Israel

REFERENCES

- 1 *Mora TC, Torjman M, White PF.* Sedative and ventilatory effects of midazolam infusion: effect of flumazenil reversal. *Can J Anaesth* 1995; 42: 677–84.
- 2 *Benumof JL.* Respiratory physiology and respiratory function during anesthesia. In: Miller RD (Ed.). *Anesthesia*. 3rd ed. New York: Churchill Livingstone Inc., 1990: 505–49.

REPLY

We appreciate the comments of Drs. Sherkman, Crisnic and Avidan regarding the calculation of physiologic dead space.¹ We apologize for the typographical error in expressing the Bohr equation. Indeed mixed expired values (P̄ECO₂) were used for the calculation of physiologic dead space rather than PETCO₂ values.

Our instrumentation consisted of a metabolic cart (MGC 2001) which is primarily designed to measure V̇E, V̇O₂ and V̇CO₂ and, therefore, provides an F̄ECO₂ measurement from the waveform analyzer trace. Had we used PETCO₂ values for our calculations, we would have obtained measurements well below the normal physiological range since PaCO₂ and PETCO₂ values are similar in patients with normal lung physiology.

Marc Torjman MD

Thomas Jefferson University

Philadelphia

Christina T. Mora MD

Stanford University

Paul F. White PhD MD FANZCA

University of Texas Southwestern Medical Center

Dallas

REFERENCE

- 1 *Mora CT, Torjman M, White PF.* Sedative and ventilatory effects of midazolam infusion: effect of flumazenil reversal. *Can J Anaesth* 1995; 42: 677–84.

Erratum

Orser BA. Medication labels: for whose benefit? (Correspondence). *Can J Anaesth* 1996; 43: 194.

Please note that in the above Letter to the Editor, Dr. R. Chen, the primary author, was inadvertently omitted. It should read:

Chen R, Orser BA.