experimental investigation performed in dogs *in vivo* has found no beneficial effect with pancuronium on pulmonary resistance,⁶ contrary to what was expected by Kuwahara and Goresky from pancuronium sympathomimetic properties. Moreover, low doses of pancuronium increased pulmonary resistance (likely by blocking prejunctional M2-muscarinic receptors) whereas vecuronium was devoid of this side effect.⁶

Frédéric J. Mercier MD
Dan Benhamou MD
Département d'Anesthésie-Réanimation
Hôpital Antoine Béchère
157 rue de la Porte de Trivaux
92141 Clamart Cedex-France

REFERENCES

- 1 Kuwahara B, Goresky GV. Anaesthetic management of an asthmatic child for appendectomy. *Can J Anaesth* 1994; 41: 523-6.
- 2 Olsson GL. Bronchospasm during anaesthesia. A computer-aided incidence study of 136,929 patients. *Acta Anaesthesiol Scand* 1987; 31: 244-52.
- 3 Mallampati SR. Bronchospasm during spinal anaesthesia. *Anesth Analg* 1981; 60: 839-40.
- 4 Wang CY, Ong GS. Severe bronchospasm during epidural anaesthesia. *Anaesthesia* 1993; 48: 514-5.
- 5 Boushey HA, Holtzman MJ, Sheller JR, Nadel JA. Bronchial hyperreactivity. *American Review of Respiratory Disease* 1980; 121: 389-413.
- 6 Vettermann J, Beck KC, Lindahl SG, Brichant JF, Rehder K. Actions of enflurane, isoflurane, vecuronium, atracurium, and pancuronium on pulmonary resistance in dogs. *Anesthesiology* 1988; 69: 688-95.

REPLY

There is a small but possible risk of increase in airway resistance with the use of an epidural anaesthetic when it extends into the high thoracic dermatomes. Accepting this small risk is justifiable, in view of the substantially higher risk of inducing bronchospasm with airway manipulation and intubation at the time of induction of anaesthesia.

The evidence provided is insufficient for us to alter our recommendation of pancuronium as a drug of first choice in patients at high risk of bronchospasm, where the use of a long-acting muscle relaxant is indicated. Although there is, based on research conducted in vagotomized dogs, a theoretical risk of marginally increasing airway resistance when low doses of pancuronium are used, the phenomenon is reduced at higher doses. We are uncomfortable directly extrapolating a physiological response in vagotomized dogs to an intact human who is undergoing treatment with beclomethasone, ipratropium, salbutamol, and methylprednisolone. Although we did not recommend use of a general anaesthetic for the patient described, we would require a higher level of evidence to change our recommendation regarding the use of pancuronium. Some other muscle relaxants, however, could safely be used.

Each clinical situation presents the anaesthetist with a unique opportunity to balance anaesthesia risks with patient benefit. The comments by Dr. Mercier and Dr. Benhamou emphasize the need, as part of good clinical judgement, to prioritize risk for each individual patient."

Brian S. Kuwahara MD
Gerald V. Goresky MD
Department of Anaesthesia
Alberta Children's Hospital at the University of Calgary

Arterial to end-tidal carbon dioxide differences during neurosurgical procedures

To the Editor:

In a recent issue of your Journal,¹ Sharma *et al.* concluded that end-tidal carbon dioxide (PETCO₂) could be used as a "reliable guide to estimate" arterial CO₂ (PaCO₂) and that Pa-PETCO₂ differences "remained stable overtime" in a group of 21 fairly healthy patients undergoing elective craniotomy.

However, the intraoperative Pa-PETCO₂ relationship is complex and dynamic.² In addition, several studies have found that Pa-PETCO₂ differences (or gradient) are often large, and not infrequently negative during anaesthesia, and that the prediction of PaCO₂ from capnography is unreliable, especially where close CO₂ control is considered to be clinically important.²⁻⁵

Indeed, in our recent study of 96 patients mainly undergoing elective craniotomy for tumour resection,⁶ we found that our patients' Pa-PETCO₂ differences had a mean of only 4 ± 4 (SD) mmHg, but a range of -6 to 15 mmHg. More than a third of patients had gradients ≥ 8 mmHg (22% of patients) or negative gradients (13% of patients). Eighteen per cent of gradients varied in the same patient by ≥ 4 mmHg, and the range of this intrapatient variation was -8 to 6 mmHg during anaesthesia.

In summary, although the importance of close CO₂ control during many neurosurgical procedures has been recently reappraised,³ we must conclude that prediction of PaCO₂ from capnography alone is clearly unreliable and may be potentially deleterious in some patient subgroups.

Peter R. Isert MB BS FANZCA
Division of Anaesthesia & Intensive Care
The Prince of Wales Hospital
Sydney, N.S.W.
Australia

REFERENCES

- 1 Sharma SK, McGuire GP, Cruise CJE. Stability of the arterial to end-tidal carbon dioxide difference during anaesthesia for prolonged neurosurgical procedures. *Can J Anaesth* 1995; 42: 498-503.
- 2 Good M. Capnography: uses, interpretation, and pitfalls. In: Barash P (Ed.). *ASA Refresher Lectures*, Vol 18. Pennsylvania: J.B. Lippincott, 1990; 175-93.
- 3 Isert P. Control of carbon dioxide levels during neuro-anaesthesia: current practice and an appraisal of our reliance upon capnography. *Anaesth Intensive Care* 1994; 22: 435-41.
- 4 Russell G, Graybeal J. End-tidal carbon dioxide as an indicator of arterial carbon dioxide in neurointensive care patients. *J Neurosurg Anesthesiol* 1992; 4: 245-9.
- 5 Engoren M. Evaluation of capnography to predict arterial CO₂ in neurosurgical patients. *J Neurosurg Anesthesiol* 1992; 4: 241-4.