REFERENCE

1 *Naguib M, Mohamed G.* Atropine-neostigmine mixture: a dose–response study. Can J Anaesth 1989; 36: 412–7.

REPLY

We welcome the opportunity to respond to the letter from Dr. Kopman, which expressed some concerns regarding our recent study.[1] We feel that his comments were based on a misunderstanding of the intent of our work. We would like to annotate his points of dispute.

First, we did not *advocate the definition of bradycardia, as stated by Dr. Kopman in his letter but used reduction in heart rate from control value as an end-point to evaluate the effect of different doses of atropine when administered with neostigmine. This approach is not unique and has been used before by different investigators.[2,3] In addition, the administration of neostigmine is associated with more profound bradycardia when given during halothane anaesthesia than, for example, during enflurane anaesthesia.[4] Halothane was used in our study as the background anaesthetic for the first ten minutes after the administration of the atropine-neostigmine mixture. Halothane is known to have negative chronotropic effects and to prolong A-V nodal conduction.[5] The magnitude of halothane interaction in our study was not known and was beyond the scope of the experiment. Therefore, we treated our data as dicotomous variables.*

Second, we did not suggest or imply that doses of atropine 0.05 to 0.06 mg · kg^{-1} should be employed clinically.

The calculated ED_{95} doses of atropine in our study were high. One of the reasons for this was related to the concomitant administration of halothane (as discussed before). In addition, one should keep in mind that the 95 per cent response falls on an almost horizontal portion of the curve, hence the precision with which one can express the ED_{95} is considerably less than that of the ED_{50}. Nevertheless, one of the advantages of the ED_{95} over the ED_{50} is its clinical utility – even though its uncertainty range is quite large.

We agree with Dr. Kopman's sensible statement regarding the central nervous system effects of 4 mg atropine in a 70 kg adult. However, we did not advocate or imply that such high doses be employed routinely in clinical practice in our study.

In conclusion, absence of evidence is not evidence of absence. As we explained in our report,[1] bradycardia was (and still is)[6] frequently observed with the commonly used neostigmine to atropine dose ratios and we maintain that a greater dose of atropine should be used in order to prevent the late bradycardic effect of neostigmine.

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Hyperbaric oxygen and CO_2 embolism

To the Editor:

I read with interest the case report by McGrath *et al.* which described the treatment of massive carbon dioxide venous embolism with hyperbaric oxygen.[1] While I must compliment the authors on their prompt diagnosis and successful treatment, I question whether hyperbaric oxygen has a role in this situation.

The authors state that hyperbaric oxygen therapy (HBO) is the treatment of choice for cerebral gas embolism. This is true when the gas involved is nitrogen and may be the preferred treatment for air embolism, another situation in which the gas is comprised primarily of nitrogen. The rationale for HBO in these situations is threefold: to decrease bubble size as a direct effect of pressure, to improve tissue oxygenation in marginally perfused tissues, and to hasten the absorption of nitrogen bubbles into the blood.[2]

Under normal physiological circumstances nitrogen bubbles are poorly absorbed from tissues or blood vessels because of nitrogen's low solubility coefficient (approximately 0.013 in blood at 37 degrees)[3] and because of the low partial pressure gradient between the bubble (maximum PN_2 = 713 mmHg) and venous blood ($P\bar{v}N_2$ = 570 mmHg).[4] With HBO at three atmospheres, dissolved nitrogen is eliminated rapidly from the blood via the lungs with a corresponding decrease in the PvN_2, and at the same time the PN_2 of any gas bubbles is tripled. This greatly increased partial pressure gradient favouring bubble absorption is responsible for the rapid disappearance of nitrogen bubbles from the circulation during HBO.

In contrast carbon dioxide is highly soluble in the blood (solubility coefficient approximately 0.49),[3] and the partial pressure gradient between the blood and any CO_2 bubble will be in the order of 660 mmHg. (The PCO_2 of the bubble is approximately 713 and the $P\bar{v}CO_2$ is 46

mmHg.) In addition, dissolved carbon dioxide accounts for only about five per cent of the total carbon dioxide in the venous blood.[5] Therefore it seems unlikely that any carbon dioxide bubbles would remain in the circulation more than two hours after the embolism occurred, the time when the patient described underwent HBO.

On balance I feel that the hazards associated with the transport of a critically ill patient outweigh the questionable benefits of HBO following carbon dioxide gas embolism.

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REPLY

We appreciate Dr. Etches' comments regarding our case of carbon dioxide embolism. We agree with his comments regarding the differences in solubility between nitrogen and carbon dioxide, but not with his conclusion that carbon dioxide is unlikely to be present in the circulation more than two hours after embolization. While there are no prospective studies examining this issue, we believe that a sufficiently large volume of embolized carbon dioxide can persist in the vascular system despite its high solubility. The report by Root et al. *which we referred to in our article describes a patient who sustained a cardiac arrest 35 min after instillation of carbon dioxide.[1] According to their report, resuscitative efforts were continued for at least 45 min after the arrest, a time lapse of 75 min from the time of gas insufflation. Despite the interval from carbon dioxide instillation to death, a large quantity of gas was found in the heart, pulmonary arteries, cerebral vessels, peritoneal cavity and portal venous system at post mortem examination. Trapping of gas in the portal venous system was the proposed reason for the delay in onset of cardiac arrest. The report of Vourc'h* et al. *describes a case of dramatic reversal of coma and myocardial ischaemia by hyperbaric oxygen therapy initiated two hours after carbon dioxide embolism.[2] They attributed this response to hyperbaric oxygen's effect on residual gas in the body. While we cannot prove that our patient's improvement was due to hyperbaric therapy, we believe that it has a role in cases of massive carbon dioxide embolism.*

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Airway obstruction during anaesthesia in a child with a mediastinal mass

To the Editor:

A 12-year-old 30 kg girl was admitted with a cervicomediastinal tumour. On admission, she was not dyspnoeic or cyanosed. Multiple bilateral cervical nodes were palpable. Cardiac examination and ECG were normal. Breath sounds were coarse in both lung fields. Chest *x*-ray showed a right lobular mass and tracheal deviation to the left. A right supraclavicular lymph node biopsy was planned to make a definitive diagnosis. Diazepam 10 mg and atropine 0.25 mg were given intramuscularly one hour before induction. After preoxygenation general anaesthesia was induced with fentanyl 50 μg, thiopentone 250 mg and vecuronium 3 mg. The trachea was intubated with a 5.5 mm cuffed tube and ventilation was mechanically controlled (VT = 10 ml · kg^{-1}, Freq: 14). Anaesthesia was maintained with enflurane 0.8 per cent and nitrous oxide 50 per cent in oxygen. After 20 minutes, the biopsy had been performed and the child was turned to the left lateral position to allow a right iliac bone crest marrow biopsy. Inspiratory pressures increased from 30 to 40 cm H_2O. When the biopsy was performed it was decided to allow her to breathe spontaneously but she developed severe respiratory distress with laboured inspirations. Breath sounds were inaudible in both lung fields. It was possible to maintain ventilation only with very high inflation pressures and manual ventilation. Superficial neck veins appeared distended. Chest *x*-ray showed atelectasis of the right upper lobe and widening of the mediastinum. Treatment with hydrocortisone hemisuccinate 100 mg and erythromycin was started. A fibreoptic tracheoscopy through the tracheal tube revealed a