A comparison of diazepam and midazolam as endoscopy premedication assessing changes in ventilation and oxygen saturation

G. D. BELL¹, A. MORDEN¹, T. COADY², J. LEE² & R. F. A. LOGAN³

¹Department of Medicine and ² Department of Respiratory Physiology, Ipswich Hospital, Heath Road Wing, Ipswich IP4 5PD and ³Department of Community Medicine and Epidemiology, University of Nottingham, Nottingham NG7 2UH

1 One hundred and two consecutive patients undergoing upper gastrointestinal endoscopy were randomised to be sedated with either intravenous diazepam (Diazemuls—Kabi Vitrum) or intravenous midazolam (Hypnovel—Roche). It was assumed that midazolam was likely to be approximately twice as potent as diazepam on the basis of previous work.

2 All patients had an ear oximeter attached throughout the procedure to record continuously their level of oxygen saturation.

3 All 102 patients had pre-endoscopy respiratory function tests measured and 100 wore an induction plethysmograph vest to allow continuous estimation of respiratory rate and excursion. The plethysmograph was calibrated using a pneumotachygraph, so baseline, post-injection and post-endoscopy minute volumes could be estimated.

4 The age, sex ratio and pre-endoscopy respiratory function tests of the 51 patients given intravenous diazepam in a mean dose (s.d.) of 11.5 (5.8) mg over a mean of 3.4 (0.9) min were similar to that of the 51 patients sedated with intravenous midazolam (mean dose 6.0 (2.8) mg over 3.3 (0.9) min).

5 Both drugs significantly reduced minute volume ($P < 0.001$) and oxygen saturation ($P < 0.001$). Midazolam appeared to produce slightly greater hypoxaemia with 57% having falls in oxygen saturation of greater than 2.5% compared with only 35% given an equivalent dose of diazepam.

6 Ventilation was still less than baseline when re-checked some minutes after removal of the gastroscope. The speed of recovery appeared faster after diazepam sedation which is in contrast to its longer pharmacological half-life.

7 Potentially dangerous falls in oxygen saturation were observed in five cases (three following diazepam and two midazolam), necessitating supplementary oxygen administration. The implications of these findings are discussed.

Keywords diazepam midazolam endoscopy oxygen desaturation minute volume

Introduction

In the United Kingdom, patients having upper endoscopy (OGD) are usually sedated with a benzodiazepine. Until 5 years ago, intravenous diazepam (either as an aqueous preparation containing solvents such as propylene glycol and

ethanol or as an oil-in-water emulsion, such as Diazemuls—Kabi Vitrum) was used almost exclusively. More recently, the water soluble benzodiazepine midazolam (Hypnovel, Roche) has been increasingly used by endoscopists.

On a pharmacokinetic basis it was predicted that midazolam would have advantages over diazepam because it has a shorter half-life (2–3 h as opposed to approximately 20 h) and its metabolites have no intrinsic sedative effects (Dundee *et al.*, 1984). Paradoxically, in practice, recovery has been found to be more rapid after diazepam—the drug with the longer half-life (Hamdy *et al.*, 1986; Bullimore *et al.*, 1987).

Arterial hypoxaemia during OGD is well documented for both diazepam (Whorwell *et al.*, 1976; Atluri *et al.*, 1978; Rostykus *et al.*, 1980; Ona & Israel, 1981; Rosen *et al.*, 1981, 1982; Pecora *et al.*, 1984; Lieberman *et al.*, 1985) and midazolam (Bell *et al.*, 1987a). Although there have been several studies comparing midazolam and diazepam as intravenous sedation for OGD (Al-Khudhairi *et al.*, 1982; Bardhan *et al.*, 1984; Berggren *et al.*, 1983; Brophy *et al.*, 1982; Cole *et al.*, 1983; Green *et al.*, 1984; Kavar *et al.*, 1984; Magni *et al.*, 1983; Whitwam *et al.*, 1983), a comparison of their effects on ventilation and oxygen saturation has not been reported. This is of more than theoretical interest since reviews of the major complications of OGD indicate that cardiopulmonary difficulties account for 50% of the morbidity and 60% of the deaths from the procedure (Cotton & Williams, 1982; Schiller *et al.*, 1972; Taylor *et al.*, 1972; Silvis *et al.*, 1976; Davis & Graham, 1979; Katon, 1981), and that the cardiac arrhythmias seen during OGD are most commonly associated with periods of maximum oxygen desaturation (Levi & Abinader, 1977; Matthews *et al.*, 1979; Lieberman *et al.*, 1985).

There have been a number of reports of respiratory depression and occasionally death following the use of intravenous midazolam, especially in elderly patients given the drug (CSM current problems 14.7.85). It is not clear whether these adverse effects are more common than with diazepam used in comparable dosage or whether they reflect a lack of awareness that a) midazolam is approximately twice as potent a drug as diazepam (Dundee *et al.*, 1984) or that b) the dose required to produce adequate sedation for endoscopy decreases markedly with age (Bell *et al.*, 1987a, b).

We have therefore examined the effect of both drugs on ventilation and the degree of oxygen desaturation occurring before, during and following OGD.

Methods

We studied 102 consecutive patients attending for upper gastro-intestinal endoscopy on the one

day of the week when a senior respiratory physiology technician was available. The following measurements were performed:

a) in all 102 patients, ventilatory function as assessed by FEV₁ and FVC (Vitalograph Wedge Spirometer) was measured before endoscopy and recorded as a percentage of the predicted value for that patient's age and sex.

b) in all 102 patients, oxygen saturation was continuously recorded, using an ear oximeter (Hewlett Packard Co. 47201A Santiago, California).

c) in 100 of the 102 patients, a GVT induction plethysmograph (PK Morgan Limited, Chatham, Kent) was used to record simultaneously depth and rate of respiration. The instrument operates by detecting the change in inductance in a coil wound into a vest worn by the patient.

d) in 100 of the 102 patients, the induction plethysmograph deflections were calibrated against volume measurements made at the mouth using a pneumotachograph and integrator (Si-plan Electronics), so that a value was obtained for minute ventilation at each stage of the procedure (see below).

Informed consent was obtained from all patients and the study approved by the Ethics Committee of Ipswich Hospital.

A lignocaine throat spray (4%) was given to anaesthetize the back of the throat. A steady 'baseline' recording of the patient's oxygen saturation was then obtained using the ear oximeter. The induction plethysmograph recording was calibrated, using the pneumotachograph and hence a 'baseline' value for the patient's minute volume (l min⁻¹) estimated.

The patients were allocated to be sedated either with intravenous diazepam (Diazemuls—Kabi Vitrum) or intravenous midazolam (Hypnovel, Roche) by the nursing staff who drew up one or other sedative independently of the endoscopist. In the case of midazolam, a drug which we have previously studied (Bell *et al.*, 1987a, b, c) most patients received approximately 2.5 mg of the drug intravenously over 30 s, while elderly patients received only 1 mg of the drug. If, after 1–2 min, adequate sedation had not been achieved, further small increments of midazolam were given until the appropriate level of consciousness was reached (i.e. drowsy but able to swallow on command). In the case of intravenous diazepam, we gave the drug at approximately double the rate of those receiving midazolam, e.g. commence with 5 mg intravenously over 30 s in younger patients, and 2 mg of the drug over a similar time period in those over 70 years of age and then titrate as necessary with further increments. The time over which the drug was administered was marked on the paper recording.

Intubation was not attempted until any fall in oxygen saturation and ventilatory rate or excursion following the intravenous sedative had stabilised and a new baseline obtained. The time from the start of the injection of the sedative to intubation of the patient was recorded. The lowest oxygen saturation obtained during this period (i.e. 'the post injection O₂ saturation') was noted. The minute volume over the 20–30 s period prior to intubation (i.e. 'the post injection minute volume') was calculated from the already calibrated induction plethysmograph recording.

All intubations of the upper oesophagus were done under direct vision by one of us (GDB) and the oesophagus, stomach and duodenum examined in the standard way. Again, the lowest oxygen saturation obtained at any time between the insertion and removal of the gastroscope was recorded. The relatively large diameter of Pentax 34FGA endoscope was used in all 102 patients. Ventilatory minute volume was not measured during endoscopy because any tendency to cough or choke made measurement difficult and because the presence of the endoscope in the upper airways invalidated the relationship established between changes in ventilation and plethysmography.

Following removal of the endoscope, we estimated the patient's minute volume, using the tracing after the patient's breathing had settled down again—the post endoscopy minute volume. The time this estimation was made after the start of the original injection of the intravenous sedation was recorded.

We have previously shown that supplementary oxygen via nasal cannulae is an effective way of preventing hypoxaemia during endoscopy (Bell *et al.*, 1987c) and if any patients' oxygen saturation fell to potentially dangerous levels at any stage during the study, 2–4 l min⁻¹ of oxygen was administered promptly.

Statistics

Paired Student's *t*-tests have been used to assess the significance of changes in oxygen saturation and ventilation over time. Unpaired *t*-tests have been used to compare the differences in the mean changes in oxygen saturation and ventilation obtained with each drug. Figures in parentheses after mean values are standard deviations.

Results

Of the 102 patients in the study, 51 received intravenous diazepam and 51 midazolam. Table 1 shows that the two groups were similar in terms of the sex ratio and age distribution. Over 37% of both groups of patients endoscoped were over 70 years of age. The pre-endoscopy respiratory function test in both groups was also comparable.

The mean dose (s.d.) of diazepam given was 11.5 (6.7) mg which was almost double that given to the midazolam group 6.0 (2.8) mg. The mean time from the start of the injection to commencing the intubation was 3.4 min in the diazepam group and 3.3 min when midazolam was used.

Changes in ventilation (Table 2)

The baseline minute volume of the patients given diazepam (mean 8.1 (3.4) l min⁻¹) was lower than that of the patients given midazolam (mean 9.0 (3.5) l min⁻¹) but the difference was not significant at the 5% level. After intravenous sedation minute volume fell a mean of 2.6 l with the fall being almost identical after each drug.

In both groups minute volume was again measured a mean of 12 min (2.5) after intravenous sedation was given. After endoscopy

Table 1 Baseline measurements made in the 102 endoscopic patients given either intravenous diazepam or midazolam

	Diazepam	Midazolam
Number of cases	51	51
Mean age (s.d.) of subjects (% over age of 70)	62.8 (16.1) (39%)	65.8 (11.5) (37%)
Age range	21–90	35–87
Male/female ratio	20/31	24/27
FEV ₁ (s.d.)	85.0 (24.0)	79.7 (26.7)
FVC (s.d.)	83.7 (23.8)	82.7 (24.0)
FEV ₁ /FVC (s.d.)	80.3 (11.7)	75.3 (12.9)

Table 2 Mean minute volume (l min^{-1}) estimated from a calibrated induction plethysmograph worn before, during and after OGD. Measurements were taken A) before and B) after intravenous injection either diazepam ($n = 51$) or midazolam ($n = 49$). C) Measurements were repeated in both groups some minutes after endoscope removed. The mean $\pm$ s.d. and range of absolute values is shown in the upper part of the table and the changes in the lower half

Ventilation	With midazolam ($n = 49$)		With diazepam ($n = 51$)		Combined ($n = 100$)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
A Baseline minute volume (l min^{-1})	9.0	1.5	8.1	3.4	8.5	3.4
range	(3.4–16.9)		(2.6–16.3)			
B Post injection minute volume (l min^{-1})	6.3	3.3	5.6	2.4	5.9	2.9
range	(2.3–15.8)		(0.9–13.4)			
C Post endoscopy minute volume (l min^{-1})	7.2	2.4	7.4	3.3	7.3	2.9
range	(2.2–13.1)		(2.2–15.2)			
Change in ventilation 1 (A – B)	–2.6	2.6	–2.5	2.8	–2.6* (2.0–3.1) ^o	2.7
Change in ventilation 2 (B – C)	+0.9	2.6	+1.8	2.5	+1.3† (0.8–1.9) ^o	2.6
Net change in ventilation (A – C)	–1.7	3.0	–0.7	3.2	–1.2‡ (0.3–1.8) ^o	3.1

* $t = 9.6$, † $t = 5.3$, ‡ $t = 3.9$ (using paired Student's t -test).

^o 95% confidence limits.

there was an increase in minute volume that was greater in the diazepam group than the midazolam group (after diazepam 1.8 l (2.5), after midazolam 0.9 l (2.6), unpaired t -test = 1.8, $P = 0.08$).

Overall therefore the net fall in ventilation following endoscopy was 0.7 (3.2) l after diazepam and 1.7 (3.0) l after midazolam, this difference not being significant at the 5% level (unpaired t -test = 1.6, $P = 0.09$).

Changes in oxygen saturation (Table 3)

The baseline oxygen saturations were not significantly different being 94.7% and 94.9% for patients given diazepam and midazolam respectively. Following both drugs there was a 3.1% mean fall in oxygen saturation (paired t -test = 9.8, $P < 0.001$). A second similar decline in oxygen saturation (mean 3.1%) occurred during endoscopy (paired t -test = 6.7, $P < 0.001$) resulting in a mean total fall in oxygen saturation of 6.2%.

As shown in Table 3 the initial fall in oxygen saturation was 25% greater after midazolam than diazepam, although the mean difference was not significant at the 5% level. The subsequent mean changes in oxygen saturation with each drug were smaller and similar in size.

The distribution of changes in oxygen saturation is shown in Table 4. 57% (29/51) of patients

receiving midazolam had a fall in oxygen saturation of greater than 2.5% compared with 35% (18/51) of those receiving diazepam ($\chi^2 = 3.9$, $P < 0.05$).

In five of the 102 patients supplementary oxygen was given because of potentially dangerous falls in oxygen saturation. In two patients receiving midazolam oxygen saturation fell from 97% to 88% and 88% to 75% and in three patients receiving diazepam oxygen saturation fell from 95% to 73%, 97% to 86% and 95% to 86%.

Discussion

In our previous publications in which an induction plethysmograph as well as an ear oximeter was employed, we estimated that approximately 80% of patients showed some evidence of hypoventilation following intravenous midazolam (Bell *et al.*, 1987a, c). In this study, we were, for the first time, able to measure quantitative as well as qualitative ventilatory changes by calibrating the plethysmograph with a pneumotachograph. We are not aware that this technique has previously been used for patients under-going OGD. As far as we are aware, no comparisons have previously been made between the degree of respiratory depression and consequent hypoxaemia which

Table 3 Mean lowest oxygen saturation (% obtained in endoscopy patients before and after intravenous diazepam ($n = 51$) or midazolam ($n = 51$) and during OGD. The mean $\pm$ s.d. and range of absolute values is shown in the upper part of the table and the changes in the lower half

	With midazolam ($n = 51$)		With diazepam ($n = 51$)		Combined ($n = 102$)	
	%	s.d.	%	s.d.	%	s.d.
A Baseline O ₂ saturation range	94.9 (87.5–98)	(2.0)	94.7 (88–98)	(2.1)	94.8	(2.1)
B Post injection O ₂ saturation range	91.4 (82–97)	(3.2)	91.9 (84–97)	(4.2)	91.7	(3.7)
C Intubated O ₂ saturation range	88.5 (75–97)	(4.7)	88.7 (74–96)	(4.8)	88.6	(4.7)
Change in O ₂ saturation from A to B	3.5	(2.7)	2.8	(3.7)	3.1* (2.5–3.8) [°]	3.2
Change in O ₂ saturation from B to C	2.9	(3.9)	3.2	(5.3)	3.1† (2.2–4.0) [°]	4.6
Change in O ₂ saturation from A to C	6.4	(3.7)	6.0	(4.7)	6.2‡ (5.4–7.0) [°]	4.2

* $t = 9.8$, † $t = 6.7$, ‡ $t = 14.7$ (using paired Student's t -test).

[°] 95% confidence limits.

Table 4 Distribution of changes in oxygen saturation after midazolam or diazepam before intubation

Decrease or increase in O ₂ saturation	After midazolam	After diazepam
Increase of 2.5–5%	0	2
No change (< 2.5%)	22	31
Decrease of		
2.5–5%	15	10
5–7.5%	11	5
7.5–10%	2	1
10–12.5%	0	1
12.5–15%	0	0
17.5–20%	1	0
20–22.5%	0	1
	51	51

occurs when OGD is performed using diazepam or midazolam in equivalent dosage.

Our two groups of patients were well-matched in terms of age, sex ratio and pre-endoscopy respiratory function tests. Similarly, their mean baseline oxygen saturation and baseline minute volumes were similar. As we had expected the mean dose (s.d.) of diazepam used was approximately twice that of midazolam (11.5 (5.8) and 6.9 (2.8) mg respectively) with the times from the start of injection to intubation being similar.

Both drugs significantly reduced mean minute volume and oxygen saturation (Tables 2 and 3). After intubation further similar falls in oxygen saturation occurred in both groups, presumably

as a result of the endoscope partly occluding the upper airway. Following removal of the endoscope and after allowing a short period to let the patient settle minute volumes were still lower than baseline values some 12–15 min after the start of the intravenous premedication.

There was some evidence that midazolam caused greater changes in ventilation and oxygen saturation than diazepam and that the effect took longer to wear off. Had we looked at a much larger group it is possible that clearer differences between the two drugs might have emerged. However, on the basis of the present study, intravenous diazepam and midazolam in comparable doses must be considered potentially equally liable to produce respiratory depression at the time of endoscopy.

We had previously shown that supplementary oxygen was an effective means of preventing hypoxaemia when midazolam was used for upper GI endoscopy (Bell *et al.*, 1987c). It is likely that supplementary oxygen would be equally useful in patients being sedated with intravenous diazepam. The use of supplementary oxygen in elderly or at risk cardiac patients undergoing endoscopic procedures would appear to have much to commend itself irrespective of which intravenous benzodiazepine was used.

The authors would like to express their gratitude to Mrs Gail Bruhn for her skill and technical help, the Ipswich Hospital Library for finding and checking references, and finally Mrs Anne Wells for typing the manuscript.

References

- Al-Khudhairi, D., Whitwam, J. G. & McCloy, R. F. (1982). Midazolam and diazepam for gastroscopy. *Anaesthesia*, **37**, 1002–1006.
- Atluri, R. & Ravry, M. J. R. (1978). Effect of intravenous diazepam on arterial oxygen saturation levels (SAOL) during esophagogastroduodenoscopy (EGD). *Gastrointest. Endosc.*, **24**, 191 (abstract).
- Bardhan, K. D., Morris, P., Taylor, P. C., Hinchcliffe, R. F. C. & Harris, P. A. (1984). Intravenous sedation for upper gastrointestinal endoscopy: diazepam versus midazolam. *Br. med. J.*, **288**, 1046.
- Bell, G. D., Bown, S., Morden, A., Coady, T., & Logan, R. F. A. (1987c). Prevention of hypoxaemia during upper-gastrointestinal endoscopy by means of oxygen via nasal cannulae. *Lancet*, **i**, 1022–1024.
- Bell, G. D., Reeve, P. A., Moshiri, M., Morden, A., Coady, T., Stapleton, P. J. & Logan, R. F. A. (1987a). Intravenous midazolam: a study of the degree of oxygen desaturation occurring during upper gastrointestinal endoscopy. *Br. J. clin. Pharmacol.*, **23**, 703–708.
- Bell, G. D., Spickett, G. P., Reeve, P. A., Morden, A. & Logan, R. F. A. (1987b). Intravenous midazolam for upper gastrointestinal endoscopy: a study of 800 consecutive cases relating dose to age and sex of patient. *Br. J. clin. Pharmacol.*, **23**, 241–243.
- Berggren, L., Eriksson, I., Mollenholt, P. & Wickbom, G. (1983). Sedation for fibre-optic gastroscopy: a comparative study of midazolam and diazepam. *Br. J. Anaesth.*, **55**, 289–296.
- Brophy, T., Dundee, J. W., Heazelwood, V., Kavar, P., Varghese, A. & Ward, M. (1982). Midazolam, a water-soluble benzodiazepine for gastroscopy. *Anaesth. Intensive Care*, **10**, 344–347.
- Bullimore, D. W., Mulley, B. A., Cooke, P. & Miloszewski, K. J. A. (1987). Comparison of the effectiveness of midazolam and diazepam in lipid emulsion as sedation during upper gastrointestinal endoscopy. *Aliment. Pharmac. Ther.*, **1**, 409–414.
- Cole, S. G., Brozinsky, S. & Isenberg, J. I. (1983). Midazolam, a new more potent benzodiazepine, compared with diazepam: a randomized, double-blind study of preendoscopic sedatives. *Gastrointest. Endosc.*, **29**, 219–222.
- Cotton, P. B. & Williams, C. B. (1982). *Practical gastrointestinal endoscopy*, 2nd ed. Oxford: Blackwell.
- Davis, R. E. & Graham, D. Y. (1979). Endoscopic complications: the Texas experience. *Gastrointest. Endosc.*, **25**, 146–149.
- Dundee, J. W., Halliday, N. J., Harper, K. W. & Brogden, R. N. (1984). Midazolam: a review of its pharmacological properties and therapeutic use. *Drugs*, **28**, 519–543.
- Green, J. R. B., Ravenscroft, M. M. & Swan, C. H. J. (1984). Diazepam or midazolam for endoscopy. *Br. Med. J.*, **288**, 1383.
- Hamdy, N. A. T., Kennedy, H. J., Nicholl, J. & Trigger, D. R. (1986). Sedation for gastroscopy: comparative study of midazolam and diazepam in patients with and without cirrhosis. *Br. J. clin. Pharmacol.*, **22**, 643–647.
- Katon, R. M. (1981). Complications of upper gastrointestinal endoscopy in the gastrointestinal bleeder. *Dig. Dis. Sci.*, **26** Supp. 7, 47S–54S.
- Kavar, P., Porter, K. G., Hunter, E. K., McLaughlin, J., Dundee, J. W. & Brophy, T. O'R. (1984). Midazolam for upper gastrointestinal endoscopy. *Ann. R. Coll. Surg. Engl.*, **66**, 283–285.
- Levy, N. & Abinader, E. (1977). Continuous electrocardiographic monitoring with Holter electrocardiograph throughout all stages of gastroscopy. *Am. J. Dig. Dis.*, **22**, 1091–1096.
- Lieberman, D. A., Wuerker, D. K. & Katon, R. M. (1985). Cardiopulmonary risk of esophagogastroduodenoscopy: role of endoscope diameter and systemic sedation. *Gastroenterology*, **88**, 468–472.
- Magni, V. C., Frost, R. A., Leung, J. W. C. & Cotton, P. B. (1983). A randomized comparison of midazolam and diazepam for sedation in upper gastrointestinal endoscopy. *Br. J. Anaesth.*, **55**, 1095–1101.
- Matthews, P. K., Ona, F. V., Damevski, K. & Wallace, W. A. (1979). Arrhythmias during upper gastrointestinal endoscopy. *Angiology*, **30**, 834–840.
- Ona, F. V. & Israel, R. H. (1981). The effect of gastroscopy on arterial blood gases. *Am. J. Proctol. Gastroenterol. Colon Rectal Surg.*, **32**, 8–11.
- Pecora, A. A., Chiesa, J. C., Alloy, A. M., Santoro, J. & Lazarus, B. (1984). The effect of upper gastrointestinal endoscopy on arterial O₂ tension in smokers and non-smokers with and without premedication. *Gastrointest. Endosc.*, **30**, 284–288.
- Rostkyus, P. S., McDonald, G. B. & Albert, R. K. (1980). Upper intestinal endoscopy induces hypoxemia in patients with obstructive pulmonary disease. *Gastroenterology*, **78**, 488–491.
- Rozen, P., Fireman, Z. & Gilat, T. (1981). Arterial oxygen tension changes in elderly patients undergoing upper gastrointestinal endoscopy, 2: influence of the narcotic premedication and endoscope diameter. *Scand. J. Gastroenterol.*, **16**, 299–303.
- Rozen, P., Fireman, Z. & Gilat, T. (1982). The causes of hypoxemia in elderly patients during endoscopy. *Gastrointest. Endosc.*, **28**, 243–246.
- Schiller, K. F. R., Cotton, P. B. & Salmon, P. R. (1972). The hazards of digestive fibre-endoscopy: a survey of British experience. *Gut*, **13**, 1027.
- Silvis, S. E., Nebel, O., Rogers, G., Sugawa, C. & Mandelstam, P. (1979). Endoscopic complications. *J. Am. med. Ass.*, **235**, 928–930.
- Taylor, P. A., Cotton, P. B. & Towey, R. M. (1972). Pulmonary complication after oesophago-gastroscopy using diazepam. *Br. med. J.*, **i**, 666.
- Whitwam, J. G., Al-Khudhairi, D., & McCloy, R. F. (1983). Comparison of midazolam and diazepam in doses of comparable potency during gastroscopy. *Br. J. Anaesth.*, **55**, 773–777.
- Whorwell, P. J., Smith, C. L. & Foster, K. J. (1976). Arterial blood gas tensions during gastrointestinal endoscopy. *Gut*, **17**, 797–800.

(Received 7 March 1988,
accepted 28 June 1988)