Exhaustion of an ABEK nitric oxide absorber

Editor,—The ABEK HgCO NO-P3 filter (Drager) has been described as an effective method of scavenging nitric oxide and nitrogen dioxide.¹ The filter contains microglass fibres coated with copper and chromium salts, and the catalysts, manganese dioxide and copper oxide. This article describes its use with an Evita 2 ventilator with a minute volume of 6.1 litre min⁻¹. Proximal nitric oxide concentrations of 55–70 ppm were maintained in 100% oxygen. Measurement of environmental nitrogen dioxide concentrations over a 170-h period peaked at 0.4 ppm. The filter became exhausted within 72 h. Helpful to include some estimate of the additional costs associated with the admission of the two patients who received nitric oxide for longer than 7 days, the filter is changed routinely. However, we would like to describe a case in which the filter became exhausted within 72 h.

A 16-yr-old was admitted to the PICU with respiratory failure after bone marrow transplantation. A presumed diagnosis of pneumocystis pneumonia was made and he was treated with oxygen via facial mask CPAP and high-dose co-trimoxazole. His condition deteriorated and an open lung biopsy was undertaken after which he required mechanical ventilation. He continued to deteriorate rapidly and nitric oxide 20 ppm was commenced. His lungs were ventilated at a minute volume of 16 litre min⁻¹, \( F_{\text{O}_2} \) 100%, tidal volume 800 ml, ventilatory frequency 20 bpm and 1:1 ratio 1:1. Airway pressures were 40/10 cm H₂O. Expired nitrogen dioxide concentrations were measured using an electrochemical sensor (with PTFE membrane). Concentrations remained less than 2 ppm at all times. After 72 h there was a sudden increase in the environmental nitrogen dioxide level. After replacement of the scavenging filter, environmental nitrogen dioxide concentrations decreased rapidly to zero.

Our report demonstrates the need to measure environmental nitrogen dioxide concentrations, particularly in the vicinity of the filter, as the filter may become exhausted more quickly than reported previously. Compared with the results of Squire, Knightley and Petros,¹ this patient was receiving a lower inspired nitric oxide concentration but had a much greater minute volume. The manufacturers estimate that the filter will take 4–5 litre of nitric oxide with a flow rate of 8 litre min⁻¹. However, our patient had twice this flow rate. We suggest that when patients have such a high minute volume while using nitric oxide, the ABEK filter should be changed at least every 72 h.

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Costs of sevoflurane and propofol anaesthesia

Editor,—We read with interest the article by Smith and colleagues on the costs of sevoflurane and propofol anaesthesia.¹ In today’s cost-conscious climate, cost analyses such as the one published recently by Smith and colleagues are worthwhile. The authors have shown that induction and maintenance of anaesthesia with propofol is more expensive than induction and maintenance with sevoflurane. However, we are concerned with some of their conclusions and would like to make a few general comments.

First, we were disappointed that, contrary to their claims, the authors had not included all direct and indirect costs. Rowe recently published a cost comparison of propofol and inhalation anaesthesia² and we were surprised that this article, which contained a more comprehensive cost analysis, was not cited. The most glaring cost that the authors ignored was that of overnight admission. We accept that their admission rate was low and unlikely to alter overall costs significantly, but it would have been helpful to include some estimate of the additional costs associated with the admission of the two patients who received inhalation anaesthesia only. Notwithstanding the costs arising from i.v. infusion pumps, other costs that should have been mentioned include the capital and maintenance costs of sevoflurane vaporizers and the scavenging apparatus.

Second, we believe that the use of nitrous oxide for all groups was a flaw in the study design. The environmental problems associated with the use of nitrous oxide were ignored completely.³ Furthermore, nitrous oxide is known to increase the incidence of nausea and vomiting,⁴ and this has made interpretation of the results more difficult. There was already a significantly lower incidence of nausea and vomiting in patients who received propofol, but omission of nitrous oxide may have resulted in an even lower incidence. Ventilation with oxygen and air would probably have increased propofol use and cost, but this has to be balanced against the benefit of emesis-free recovery. Treatment of PONV comprised only one drug administration in the propofol group, whereas 21 doses of different drugs were required to treat patients in the sevoflurane nitrous oxide group.

Third, in the discussion, the authors present their study as confirming that sevoflurane ‘is an acceptable day-case anaesthetic’. Later they assert that propofol was associated with ‘few clinical benefits in terms of speed or quality of recovery’. Sevoflurane, however, was associated with a six-fold higher incidence of nausea and a 12-fold higher incidence of vomiting than induction and maintenance of anaesthesia with propofol. Given that postoperative emesis is a concern patients have before surgery,⁶ it is difficult to see how induction and maintenance of anaesthesia with sevoflurane can be considered ‘acceptable’. Surely this markedly lower incidence of nausea and vomiting associated with propofol is ‘a significant clinical benefit’? In fact, one in 10 patients in the sevoflurane group did not wish to receive the same anaesthetic during future surgery. In the analysis of ‘cost’, should not the cost to the individual patient in terms of personal comfort also rate?

Finally, it is worth pointing out that anaesthesia where nitrous oxide is used is, by definition, not ‘total i.v. anaesthesia’, as mentioned in the last paragraph of the article.

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Editor,—Drs Absalom and Troy make some interesting comments. We attempted to include all of those direct and indirect costs which we could measure. Rowe¹ included the costs associated with nursing time, operating time and other staff costs, although these were average values for the day unit and not individually measured costs. Indeed, these costs are extremely difficult to measure objectively and there is no certainty that alterations in time actually result in increases or savings in staff costs in real life. Savings will probably only be realized if fewer staff are employed (or hours are reduced) and extra costs will only be incurred if extra staff or paid overtime are required.

Two patients in group 3 were indeed admitted overnight. The reasons for these admissions were described briefly in our article and must be considered before their inclusion in the cost analysis. The first patient (who had been recovering satisfactorily for some time) developed somnolence and respiratory depression only after administration of fentanyl to treat postoperative pain. This problem may well have been avoided by the use of an alternative form of analgesia or a lower dose of fentanyl. It did not appear to be related to the use of sevoflurane. The second patient was operated on relatively late in the day and arrived in the recovery unit shortly before the day unit was due to close. Because of the late hour, the patient was transferred to an inpatient surgical ward and admitted overnight. Performing this operation at a more appropriate hour of the day would have prevented this admission. It was therefore felt that neither of these admissions were directly attributable to the anaesthetic which the patient received and so the cost of admission was not included. Postoperative nausea and vomiting played no part in either admission.

With regard to other indirect costs, we did not include the costs of vaporizers as these items are generally supplied ‘free’ by the anaesthetic vendor. This is rarely the case with i.v. infusion pumps. While not really free, the vaporizer price is already reflected in the drug purchase cost. Modern sevoflurane vaporizers require very little servicing. In the UK, Blease recommend two service visits per year, at a total cost (including VAT) of £63.45 (Blease Medical, personal communication). This represents less than $0.5 per working day and was therefore negligible for our purposes. Scavenging is used universally in all hospitals. The best evidence for possible hazards from trace concentrations (and therefore the best justification for scavenging) comes from nitrous oxide. As nitrous oxide was common to all three groups, the cost of scavenging was a common cost to all three groups (as was the anaesthetic machine, anaesthetist, breathing circuit, etc.).

We do not consider inclusion of nitrous oxide a flaw in this study. We did discount the environmental impact of this and every other drug, technique and item of equipment used; that is a separate issue entirely. We included nitrous oxide in all groups as it is used commonly with both i.v. and inhalation anaesthesia. Either technique could have been conducted without nitrous oxide and it is pointless to speculate on the effects of this measure on nausea and vomiting, drug consumption, etc. Omission of nitrous oxide would probably have reduced PONV in all groups, although a recent meta-analysis showed the effect to be quite weak.²

In their third point, Absalom and Troy have apparently forgotten that our study involved three anaesthetic groups, the third receiving sevoflurane after propofol induction. This group had a statistically similar incidence of nausea and similar recovery times, despite significantly greater costs compared with the propofol induction and maintenance group. It was in the context of these group comparisons that we considered propofol to have ‘few clinical benefits’. The six- and 12-fold increased incidence of nausea and vomiting, respectively, were in the sevoflurane induction group. Despite this problem, 90% of these patients considered the technique ‘acceptable’, although the proportion was higher in the two other groups.

Multiple factors contribute to nausea and vomiting, and unfortunately we did not establish that all other potential causes of these unpleasant side effects were evenly distributed between groups. In addition to nitrous oxide, the use of intraoperative fentanyl may have been relevant. In my routine day-case practice, I use sevoflurane for induction and maintenance but do not administer fentanyl. To date, 342 patients having similar procedures to those in this study have received this technique: the incidence of postoperative nausea or vomiting is currently 5.6%, with only 1.2% requiring antiemetic therapy.

Naturally, patient satisfaction is important, but difficult to assign a financial value. Dissatisfaction was no more common in patients with nausea than in those without. Some element of the dissatisfaction may have been related to the relative inexperience of some investigators with inhaled induction. Again, in day-to-day practice (as opposed to the artificial environment of a randomized, controlled trial), use of sevoflurane for induction and maintenance is very well tolerated.

Finally, the last point is conceded. Total i.v. anaesthesia involves only i.v. drugs, although the term is commonly (and wrongly) used as ‘shorthand’ for anaesthesia induced and maintained with propofol. I apologize for this mistake.

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Editor,—I read with interest the report by Smith and colleagues of their multicentre comparison of sevoflurane and propofol for day-case anaesthesia.¹ I am concerned by the authors’ interpretation of some of their data. Nausea occurred significantly more frequently in patients anaesthetized with sevoflurane alone (incidence 31.9%) than in those who received propofol–sevoflurane (7.4%) or propofol–propofol (5.6%). Sevoflurane was also associated with vomiting (incidence 17.4%, 8.6% and 0%, respectively, for patients receiving sevoflurane alone, propofol–sevoflurane and propofol–propofol). In addition, patients who underwent both induction and maintenance of anaesthesia with sevoflurane were significantly less likely to agree to receive the same anaesthetic again on a future occasion than those in whom anaesthesia was induced with propofol. I find these data difficult to reconcile with the comments in the discussion that ‘sevoflurane, used either as a maintenance agent or for induction and maintenance

1 Smith I, Terhoeve PA, Hennart DA, et al. A multicentre comparison of the costs of anaesthesia with sevoflurane or propofol. Br J Anaesth 1999; 83: 564–70
4 Hartung J. Twenty four of twenty seven studies show a greater incidence of emesis associated with nitrous oxide than with alternative anesthetics. Anaesth Analg 1996: 83: 114–16
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of anaesthesia, is an acceptable day-case anaesthetic’ and later out of context. What we actually said was ‘i.v. anaesthesia with propofol was more expensive than anaesthesia induced with propofol followed by sevoflurane (group 2), but was associated with few clinical benefits in terms of speed or quality of recovery’. This statement is true; in comparing the two groups, there were no significant differences in recovery times or incidence of nausea.

We then went on to comment ‘use of sevoflurane for induction and maintenance of anaesthesia (group 3) produced a further small reduction in costs … but was associated with a significant increase in postoperative nausea and vomiting, delay in ambulation (but not discharge) and reduction in patient satisfaction’.

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Editor,—This review article was timely.¹ It emphasized that in the young adult population we should be cognizant that 10–30% of 20–30-yr-olds may have used cannabis in the week before anaesthesia. Many obstetric patients do not admit to drug use, even on direct questioning (David Birnbach, personal communication 1999), and I am sure that this would apply to a request for an illegal drug history before anaesthesia. Should we therefore be screening all patients in this age group as the list of serious complications described in association with cannabis use would appear to present major anaesthetic risk? On the other hand, why have these central nervous depressant and cardiorespiratory stimulant effects not been manifest in multiple case reports in the anaesthetic literature? There are certainly case studies in association with cocaine abuse but not cannabis, yet cannabis is traceable for a longer period in body fluids.

Apart from normal clinical anaesthesia, where there has been no systematic investigation, the issue of studies of cannabis and cannabinoids should be considered. The majority of medical studies of cannabis as distinct from cannabinoids, have used non-naïve patients, thus the records of adverse effects are often in combination with an unknown quantity of cannabinoid material in tissues. The reluctance to use non-naïve subjects opens the question as to whether or not cannabis-naïve patients should enter, for example, long-term pain studies of tetrahydrocannabinol (THC).


Conflict of interest

Dr Sneyd has received research support from Abbott Laboratories, the manufacturer of sevoflurane, and lecture fees and research support from AstraZeneca, the manufacturer of propofol.

1 Smith I, Terhoeve PA, Hennart DA, et al. A multicentre comparison of the costs of anaesthesia with sevoflurane or propofol. Br J Anaesth 1999; 83: 564–70
2 Van Wijk MGF, Smalhout B. A postoperative analysis of the patient’s view of anaesthesia in a Netherlands’ teaching hospital. Anaesthesia 1990; 45: 679–82

Out of context. What we actually said was ‘i.v. anaesthesia with propofol was …… associated with few clinical benefits in terms of speed or quality of recovery’. The authors comment at length in their discussion on both nausea and vomiting and patient preference, but appear to give these important patient-related end-points little priority in contrast with the small financial saving ($13.1 per case) associated with a sevoflurane–sevoflurane technique. Surely an equally valid interpretation of these data might reject sevoflurane as a day-case anaesthetic in favour of total i.v. anaesthesia with propofol, which in this study offered superior quality of recovery and improved patient preference at a modest additional cost.

Perhaps we should also consider what patients themselves think about postoperative nausea and vomiting (PONV). When previous investigators have done so, they reported that patients were more worried about PONV than about pain,² would tolerate some additional pain to avoid PONV² and ranked it as ‘least desirable outcome’ from a surgery/anaesthesia episode.⁴

The guide to contributors to the British Journal of Anaesthesia requires that ‘There should be clear declaration of any financial or commercial interest which any author may have in the material’. The paper acknowledges financial support from Abbott Laboratories, the manufacturer of sevoflurane. However, we are not told whether the authors have received any lecture fees or other research support from the same source. Readers might find this information useful when evaluating this report.

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Adverse effects of cannabis and cannabinoids

Out of context. What we actually said was ‘i.v. anaesthesia with propofol was more expensive than anaesthesia induced with propofol followed by sevoflurane (group 2), but was associated with few clinical benefits in terms of speed or quality of recovery’. The statement is true; in comparing the two groups, there were no significant differences in recovery times or incidence of nausea.

We then went on to comment ‘use of sevoflurane for induction and maintenance of anaesthesia (group 3) produced a further small reduction in costs … but was associated with a significant increase in postoperative nausea and vomiting, delay in ambulation (but not discharge) and reduction in patient satisfaction’.

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Editor,—I thank Dr Sneyd for his interest in our article. All three anaesthetic techniques allowed rapid, smooth induction of anaesthesia, good intraoperative conditions and rapid recovery. By these criteria they were all acceptable. The incidences of nausea and vomiting were significantly higher in the sevoflurane induction and maintenance group only, and this is a cause for concern. Nevertheless, many cases were transient, occurring early in the recovery process, and not all required treatment. Although significantly more patients in this group would have chosen a different technique in the future, 90% still found their anaesthetic ‘acceptable’. Furthermore, patients with PONV were no more likely to prefer an alternative future anaesthetic compared with those without these symptoms.

In criticizing our assertion that propofol anaesthesia was associated with few benefits, Dr Sneyd has taken our comments out of context. What we actually said was ‘i.v. anaesthesia with propofol was more expensive than anaesthesia induced with propofol followed by sevoflurane (group 2), but was associated with few clinical benefits in terms of speed or quality of recovery’. This statement is true; in comparing the two groups, there were no significant differences in recovery times or incidence of nausea. We then went on to comment ‘use of sevoflurane for induction and maintenance of anaesthesia (group 3) produced a further small reduction in costs … but was associated with a significant increase in postoperative nausea and vomiting, delay in ambulation (but not discharge) and reduction in patient satisfaction’.

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or cannabis plant material. However, THC, the main psychoactive cannabinoid in cannabis, is licensed for use in the USA and has met the requirements of the regulatory authorities. If the adverse effects of cannabis are caused by cannabinoids other than THC, these need to be identified. The warnings in the data sheet for THC include caution in patients known to have a history of substance abuse, cardiac disorders, psychiatric history and those receiving sedatives. This pales into insignificance when the list of adverse effects from commercially used drugs, such as non-steroidal analgesics, is examined in the British National Formulary.

What is required are standardized preparations of cannabinoids available for medicinal use. Then the focus can be on the adverse effects of a known amount of medicinal product rather than the broader issue of substance abuse.

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1 Ashton CH. Adverse effects of cannabis and cannabinoids. Br J Anaesth 1999; 83: 637–49

Editor,—Dr Holdcroft raises some interesting questions concerning the widespread use of cannabis in the young population. Why, she asks, have adverse effects of cannabis in anaesthetic practice been so rarely reported, and should patients in the 20–30-yr-old age group who require an anaesthetic be screened routinely for drug use?

Unfortunately, as stated in the review, there are no systematic studies of cannabis effects on anaesthesia. The theoretical potential for risks is based largely on animal data and isolated clinical reports. Until definitive studies are undertaken, we do not know if the actual risks are minimal or if they have simply been under-recognized. In the present state of knowledge, it is unlikely that routine screening for cannabis use would be very informative (except as a warning of possible but unknown complications). Because of the very slow elimination of cannabinoids and their metabolites (which are still detectable in urine up to 1 month after a single dose) and the considerable degree of pharmacokinetic and pharmacodynamic tolerance developed in chronic users, there is a poor relationship between cannabinoid concentrations in body fluids and central or systemic effects. Clearly, further research is needed. This would be difficult and should involve current cannabis users compared with non-users in the same age groups.

Dr Holdcroft also asks whether cannabis-naïve patients should enter clinical studies for therapeutic actions of cannabinoids. Her assertion that the majority of medical studies have used non-naïve patients is mistaken. In the UK, the synthetic cannabinoid nabilone has been used for many years as an antiemetic for cannabis-naïve patients undergoing cancer chemotherapy. Dronabinol, synthetic ∆9-tetrahydrocannabinol (THC) in sesame oil, has been used similarly in the USA. The therapeutic and adverse effects of these cannabinoids for this indication are well known. Nabilone and dronabinol can be prescribed legally for other indications and have been used in several clinical studies for pain relief in diverse conditions, including cancer pain and multiple sclerosis, mostly in cannabis-naïve patients (references cited in the review). These cannabinoids may have a potential in palliative care and there is nothing to prevent interested anaesthetists setting up their own studies.

The pharmacology of other cannabinoids (there are more than 60 in herbal cannabis) is little known but promising new synthetic cannabinoids are under development and a Clinical Cannabinoid Group has been set up by the Department of Health to examine the clinical use of standardized cannabinoids preparations. The medical use of raw cannabis is not recommended because of the known toxicity of the many non-cannabinoid constituents (about 340) which are broadly similar to and carry the same risks as those of smoked or ingested tobacco.

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Pulmonary aspiration of gastric contents in obstetrics

Editor,—I was most interested in the review article by Engelhardt and Webster, particularly the sections dealing with obstetric patients. While pointing out the steady decline in maternal deaths from pulmonary aspiration reported by the Confidential Enquiries into Maternal Deaths in the UK from the 1960s to the 1990s, they failed to specify concurrent relevant changes in anaesthesia practice. Over the past 11 yr, since the introduction of atraumatic pencil-point spinal needles, there has been a dramatic increase in the use of spinal anaesthesia in the UK, although this has not been well documented.2 One wonders if we would have seen the decline in mortality associated with aspiration over the past decade were it not for the concurrent reduction in the number of general anaesthetics.

The values quoted from the recent Norwegian audit are correct, but it should be mentioned that the authors declared there had been a trend for increased spinal and epidural anaesthesia for Caesarean section in that country. Furthermore, all obstetric patients who aspirated did so during airway problems under general anaesthesia and, although there were no deaths, admission to intensive care was necessary.

When commenting on the incidence of pulmonary aspiration in obstetrics, Engelhardt and Webster focused on studies from the first world. However, maternal mortality in the first world pales into insignificance compared with the staggering figures for the third world. Since the review has been published in an international journal of anaesthesia, it will be read by anaesthetists practising in the third world and I would suggest they be cautious about eschewing recommendations for reducing gastric volume and acidity. General anaesthesia is still the norm in obstetrics in many third world countries and two recent studies from Zululand and Zimbabwe have highlighted deaths caused by failures in airway management in which aspiration probably contributed to mortality. Preventive measures are particularly important in the third world because there may not be resources for adequate treatment if aspiration does occur.

One interesting South African study not mentioned in the review found that combining ranitidine and sodium citrate produced higher mean pH values from 1 h onwards compared with orogastric tube aspiration or sodium citrate, or both. This suggests that ranitidine should be administered earlier rather than later if Caesarean section is pending. A further advantage of ranitidine is that it increases lower oesophageal sphincter tone.

The reviewers are to be commended for drawing attention to
potential side effects of histamine receptor antagonists and proton pump inhibitors. A literature search on use of ranitidine in obstetrics revealed only three reports of anaphylactoid reactions to oral and i.v. doses. Symptoms resolved after oxygen and a HI blocker together with (in two cases) hydrocortisone; no patient required admission to intensive care. Given the widespread use of ranitidine in obstetrics, such reactions would seem to be extremely rare. Improved outcome through use of ranitidine and sodium citrate in obstetrics may not have been proven. To the best of my knowledge, improved outcome from the use of monitoring devices such as pulse oximetry in anaesthesia has not been proved either, but who would dare to suggest that this monitoring is unwarranted?

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Editor,—We thank Dr McKenzie for his interest in our article.1 This review encompassed aspiration during all forms of anaesthesia and was intended to highlight the lack of evidence for the increasingly widespread practice of gastric content pH-raising prophylaxis. It was not aimed specifically at obstetric anaesthesia but the point is made in the review for the continued use of such agents in this particular area. It is, however, correct to point out that obstetric anaesthesia has seen a dramatic change in practice with a shift from general to regional anaesthesia, as recent studies in the USA and Germany document.2–4 The American study4 showed a decrease in maternal mortality from 4.3 per million live births for 1979–1981 to 1.7 per million live births in 1988–1990, which was a result mainly of a decrease in mortality in patients who received regional anaesthesia from 8.6 to 1.9 per million regional anaesthetics, respectively. There was, however, an increase in mortality from 20 to 32.2 deaths per million patients receiving obstetric general anaesthesia during that period. The role of aspiration in these cases remains unknown.

Physiological changes in pregnancy may alter morbidity and mortality in the obstetric patient. We are, however, not aware of any studies which show a decrease in either morbidity or mortality after the introduction of antacid or prokinetic medication or orogastric tube aspiration. Adequate anaesthetic training and shifting the emphasis from general to regional anaesthesia rather than simply relying on these unproved preventative measures is the way forward in both first and third world countries.

Finally, surely it is necessary to regularly reassess even the most basic principles in our clinical practice and move closer to evidence-based practice.

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Acoustic monitoring for neuromuscular block

Editor,—I read with interest the study of Dascalu and colleagues on the use of acoustic monitoring for neuromuscular block. Without wanting to discuss the value of this method, I would like to bring to the readers’ attention that the authors overlooked a useful and versatile monitor of neuromuscular transmission already available for clinical use. The TOF-Guard and its successor the TOF-Watch (Organon Teknika/Biometer, Belgium) feature accelerography together with most available modes of stimulation, and display measured train-of-four (TOF) values. The TOF-Watch is no bigger than a usual nerve stimulator. The convenience and precision of these monitors have been established in several studies2–4 and in clinical practice. Studies have shown that recovery to a TOF ratio of at least 0.7 is necessary to avoid postoperative complications5 and that tactile evaluation cannot satisfactorily assess residual neuromuscular block.6 Therefore, the use of a small monitor that displays TOF values is important.

Although for scientific purposes accelerography cannot be used interchangeably with mechanomyography, the observed differences are negligible in clinical use. I agree with Dascalu and colleagues that mechanomyography, electromyography and, with the original larger monitor, accelerography, are inconvenient to use and/or costly. However, with the availability of monitors such as the TOF-Watch, introduction of a new method which differs markedly from standard monitoring, such as the reported acoustic method, is of purely scientific interest. This is emphasized even more by the fact that an ‘easy to apply, yet accurate method of quantifying the degree of neuromuscular block’ during clinical monitoring is already available.

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Editor,—Thank you for the opportunity to reply to Dr Khuenl-Brady.

The authors endorsing the use of a particular technique overlooked some of the data from our study as we compared accelerography with microphone acoustics and mechanomyography (see results). Our results are in accordance with previous data, demonstrating that acceleromyography has wide limits of agreement (−62 to +12%) and exhibits a bias of −25% relative to mechanomyography. Another well controlled study concluded that acceleromyographic and mechanomyographic recordings of neuromuscular transmission cannot be used interchangeably because of different recovery courses. Unlike the opinion expressed by Dr Khuenl-Brady, other authors have recommended that information from accelerography and mechanomyography should not be used interchangeably because of major differences between the methods. Accordingly, it was shown that accelerography had wide and unacceptable limits of agreement and was more susceptible to drift than mechanomyography. We would conclude that observed differences between mechanomyography and accelerography are far from being negligible in clinical use and that accelerography cannot be substituted for mechanical measurements, the present ‘golden standard’.

We believe that acoustic myography is a method for daily clinical use by the anaesthetist, correlating closely with mechanical measurements, and which has the potential advantage of monitoring central muscles of respiration. We conclude that it is an easy to apply and accurate method of quantifying neuromuscular block when clinical monitoring is needed.

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Bradycardia after administration of remifentanil

Editor,—Remifentanil is a recently introduced opioid with the desirable characteristics of a rapid onset and short duration of action. Its use has been recommended for controlling the cardiovascular and intraocular pressure responses to tracheal intubation. We report a case where its administration led to severe bradycardia.

An 82-year-old woman, weighing about 70 kg, was scheduled for repair of a perforating eye injury after a fall. The only past medical history of note was hypertension. Medications included atenolol 50 mg, bendrofluazide 2.5 mg and aspirin 75 mg daily. The patient had received an uneventful general anaesthetic in 1998 for a bladder repair. Preoperative investigations were normal except that the ECG showed a sinus bradycardia of 45 beat min⁻¹. She arrived in the operating room in the afternoon having taken all her medications in the morning before her fall.

After placement of non-invasive monitors (arterial pressure cuff, ECG and pulse oximeter), and siting of an i.v. infusion of Hartmann’s solution, the patient was given 100% oxygen. Anaesthesia was induced using a target-controlled infusion of propofol to a target of 2 µg ml⁻¹. A bolus dose of remifentanil 50 µg was administered over 1 min and the patient’s lungs were ventilated with 100% oxygen. Heart rate decreased to 35 beat min⁻¹ within 30 s of administration of remifentanil. Atropine 0.6 mg was administered i.v. The patient was given rocuronium 40 mg and the trachea intubated 60 s later. The patient’s heart rate remained at 35 beat min⁻¹ and another dose of atropine 0.6 mg was given i.v. An infusion of remifentanil which was intended to be commenced after the bolus was not started. Heart rate decreased further to 31 beat min⁻¹ and arterial pressure could not be recorded using the cuff. At this point, epinephrine, 0.5 ml (1:10 000) was given, resulting in a broad complex tachycardia, which was treated with lidocaine 100 mg i.v. The rhythm reverted to sinus bradycardia at a rate of 44 beat min⁻¹ with an arterial pressure of 70/30 mm Hg. An arterial line was inserted and an infusion of epinephrine was started to maintain the patient’s heart rate and arterial pressure.

A decision was made to defer surgery and transfer the patient to the ICU to be monitored, and to be reviewed by a cardiologist. The infusion of epinephrine was continued overnight. In view of a persistent bradycardia, the patient had a temporary pacing wire inserted before surgery the following day when she was anaesthetized uneventfully using propofol, rocuronium and sevoflurane. The patient was transferred to the care of the cardiologists, and was discharged after insertion of a permanent pacemaker.

The recommended bolus of remifentanil, according to the package insert, is 1.0 µg kg⁻¹ administered over 30–60 s, with a dose reduction in the elderly; our patient perhaps received a slightly large dose for her age. Laryngoscopy and intubation failed to increase heart rate. Others have also reported severe bradycardia in patients receiving beta-adrenergic receptor blocking agents and given remifentanil. In the case reported by DeSouza, Lewis and TerRiet, the patient was receiving metoprolol and nitrates, had
been premedicated heavily and had received remifentanil 1 µg kg\(^{-1}\) followed by an infusion of 0.1 µg kg\(^{-1}\) min\(^{-1}\) for 2–3 min.\(^5\) Concomitant administration of a neuromuscular blocking agent such as vecuronium with an opioid can lead to bradycardia. However, bradycardia occurred in our patient before administration of the blocker, and in any case rocuronium has a slight vagolytic action. Opioid-induced bradycardia is generally accepted to be vagally mediated.\(^6\) This effect seems to be exaggerated in the presence of beta-receptor blocking agents, and in this patient it appears that we may have unmasked a tendency to a bradyarrhythmia. This may have been the cause of the fall, which led to the initial injury to the eye.

We suggest that even a slow bolus of remifentanil may result in severe bradycardia in elderly patients receiving beta-receptor blocking drugs or with pre-existing bradycardia. A slow infusion may be preferable and result in less haemodynamic disturbances.

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5 Desouza G, Lewis MC, TerRiet MF. Severe bradycardia after remifentanil. Anesthesiology 1997; 87: 1019–20

Pulmonary haemorrhage after percutaneous paravertebral block

Editor,—With reference to the case report by Thomas, Sanders and Berrisford,\(^1\) which described pulmonary haemorrhage as a complication of percutaneous paravertebral block when a 16-gauge Tuohy needle was inserted to a depth of 6 cm in the mid-thoracic region, I would like to make the following comments.

The Tuohy needle was inserted inappropriately deep for a mid-thoracic paravertebral block; identification of the paravertebral space with the loss of resistance technique may give a false negative result; and a 22-gauge Tuohy needle is the needle of choice for single-shot percutaneous paravertebral blocks.

A full understanding of the anatomy is essential for safe use of any regional technique. When performing a paravertebral block, it is imperative to locate the transverse process of the vertebra, before advancing the needle into the paravertebral space. In the thoracic region, the spinal process of a vertebra lies in the same horizontal level as the transverse process of the vertebra below, because of the extreme angulation of the spinous processes. In adults, the transverse processes are located 2.5 cm lateral to the midpoint of the spinous processes. The skin to transverse process distance varies from 2–3 cm in the T5–6 region to 5 cm in the T1–2 region. However, there may be a small variation depending on the size of the patient. The paravertebral space lies anterior to the transverse processes and superior to the costotransverse ligaments, at a depth of 1 cm from the posterior surface of the transverse processes.

Loss of resistance with saline or air can be used to locate the space as the needle passes through the superior costotransverse ligament but may result in false negatives. Scar tissue in the paravertebral space, or a previous thoracotomy, may interfere with the loss of resistance technique.

A 22-gauge Tuohy needle (B. Braun Medical Inc, Product code E2230T) is the needle of choice for single-shot percutaneous paravertebral blocks. It has the advantage of a small diameter, 1-cm markings to a depth of 8 cm so that the precise depth of the tip of the needle is always known and a blunt tip so that a ‘pop’ may be experienced as it passes through the costotransverse ligament. Unfortunately, this needle is not available in the UK, but can be imported by special arrangement by B. Braun Medical Inc.

At Duke University Medical Center, all breast surgery is performed using percutaneous paravertebral blocks with sedation. We have performed more than 1000 percutaneous blocks with no pneumothoraces and only two epidural spreads. We would like to describe our technique. First, choose which dermatomes will be involved in the operative field. For mastectomy with axillary dissection, we routinely block T1–T6. The patient is placed in the sitting position with their neck flexed, back arched and shoulders dropped forward. The spinal process of each level is identified and a mark is placed at its most superior aspect. From the midpoint of these marks a needle entry site is marked 2.5 cm lateral to each spinal process ipsilateral to the incision. These marks should overlie the transverse process of the immediately caudad vertebra. Using an aseptic technique, a 22-gauge 8-cm Tuohy needle attached via extension tubing to a syringe is inserted through the skin and advanced anteriorly in the parasagittal plane until it contacts the transverse process, which is 2–5 cm depending on the habitus of the patient. In the T6 region, the expected depth of the transverse process is 2–3 cm. Inserting the needle 1 cm past this predicted depth is allowed. If the transverse process is not identified at the appropriate depth, it is assumed that the needle tip lies between adjacent transverse processes, and the needle should not be advanced any deeper. If bone is contacted at a point that seems too deep, this is probably a rib lying anterior to the transverse process. In both these cases, return the needle to the skin point, and search in a cephalad and then a caudal direction until the transverse process is successfully contacted. This depth is noted as the estimated distance to subsequent transverse processes. The needle is then withdrawn to the subcutaneous tissue and angled to walk onto the caudal edge of the transverse process by 1 cm. At thoracic level, it is common to appreciate a loss of resistance or a subtle ‘pop’ as the needle passes through the superior costotransverse ligament. After aspiration, 3–5 ml of local anaesthetic (0.5% bupivacaine or 0.5% ropivacaine with epinephrine 1:400 000) are injected at each level.

Percutaneous paravertebral blocks can be safe and effective when performed in good hands. The complications of the block are minimized by a full understanding of the anatomy of the paravertebral space and identification of a safe pre-end-point (i.e. the transverse process).

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Editor,—Thank you for the opportunity to respond to the points raised by Drs Hill and Greengrass regarding our recent case report describing a case of pulmonary haemorrhage after a percutaneous paravertebral block. It was not the intention of this case report to give a detailed description of how a paravertebral block should be executed correctly. This has been eloquently described in several publications, two of which were referred to in our original article. It goes without saying, however, that a sound knowledge of the relevant anatomy is a prerequisite for this and indeed any other regional or local anaesthetic technique being performed.

We would take issue with the comment made that the Tuohy needle was inserted inappropriately deep for a mid-thoracic paravertebral block. In a recently published article, the depth from skin to paravertebral space in 86 female patients ranged from 3.1 to 6.0 cm. Similarly, Richardson and colleagues reported a mean depth of the paravertebral space of 5 cm with an SD of 0.7 cm. The female patient in our case report was a relatively thick set individual, and while 6 cm is quite deep, it could not be considered to be outside the normal range.

Drs Hill and Greengrass comment that scar tissue in the paravertebral space may give a false negative result when using a loss of resistance to air technique. We agree entirely—this was exactly the point we were illustrating in our case report. To our knowledge, this complication had not been documented before, which prompted us to report it.

As the smaller 22-gauge Tuohy needle is not available in the UK, we have no personal experience in its use, although it seems a sensible option. We would advise using the size of needle to which one is most accustomed. In common with the majority of anaesthetists in this country, we use the 16-gauge needle for all of our adult epidural work and feel more comfortable with the tactile feedback from these larger needles.

We read with interest the described technique for performing breast surgery using a paravertebral block with sedation. It would appear that up to six separate injections are being made in each patient to achieve an adequate surgical block from T1 to T6. We would question the wisdom of multiple injections given that even in expert hands there is a risk of complications with each pass of the needle. It is well documented that there is a good spread across several dermatomes after a single paravertebral injection. We are currently conducting a clinical study which involves injecting methylene blue-labelled bupivacaine paravertebrally before open thoracotomy. In our experience to date, it is not uncommon to see spread over 4–6 intercostal spaces after an injected volume of 0.5% bupivacaine 20–30 ml. These as yet unpublished findings concord with previously published data, both clinically and in radiological studies. It would seem unnecessarily risky to perform multiple injections when one or perhaps two would adequately suffice.

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**Complications of paravertebral block**

Editor,—We read with interest the case report of Thomas, Sanders and Berrisford on pulmonary haemorrhage after percutaneous paravertebral block. It is well recognized that in patients who have undergone previous thoracic surgery, the paravertebral space may be fibrosed and that this can interfere with the appreciation of loss of resistance. In such cases, it is important to locate the transverse process to prevent the Tuohy needle from penetrating too deeply.

The authors do not mention whether in this patient the transverse process was identified. It is imperative that this bony landmark be located without the needle penetrating any deeper than necessary. If the transverse process is not contacted initially at a depth of approximately 3 cm, the needle should be withdrawn and reinserted in either a caudal or cephalad direction. From the displayed CT scan, the approximate position of the transverse process can be measured at a depth of 3 cm. The Tuohy needle was noted to be at a depth of 6 cm when blood was aspirated, so we assume that the authors failed to identify the transverse process. The Tuohy needle must have breached the pleura and entered the lung tissue. The most likely source of the pulmonary haemorrhage seen on bronchoscopy would be from a traumatized pulmonary vessel.

Our second point relates to the single axial CT slice of the chest. The left paravertebral space may be 5–15 mm wide in the normal subject. Using the scale displayed on the CT image, the left paravertebral space is approximately 5 mm wide and within normal limits. Further interpretation of the paravertebral region to identify abnormal tissue attenuation material within the normal fatty space is prevented by the position of the author’s marker and the window settings chosen to display the image. A paravertebral haematoma may have been visible on other slices in the examination series but in our opinion the displayed image fails to show this condition.

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1 Thomas PW, Sanders DJ, Berrisford RG. Pulmonary haemorrhage after percutaneous paravertebral block. Br J Anaesth 1999; 83: 668–9