CORRESPONDENCE

Failed tracheal intubation

Sir,—I read with interest the article by Hawthorne and colleagues detailing failed intubations over 17 yr in a teaching maternity unit. One result reported was that in only one of seven failed intubations for Caesarean section for fetal distress was neonatal outcome poor. In that instance it was thought that antepartum factors rather than the delay in delivery may have been responsible. Good neonatal outcome despite the considerable delays in delivery that would have occurred in these cases raises the question of the value, if any, of providing general, rather than regional, anaesthesia to expedite Caesarean section for fetal distress.

As discussed by Hawthorne and colleagues, general anaesthesia is a potential cause of maternal morbidity and mortality. It also causes depression of maternal respiratory depression and the need for active resuscitation. Regional anaesthesia may take longer to establish, but this delay does not necessarily cause neonatal morbidity even when the indication for surgery is fetal distress. A study of 212 emergency Caesarean sections by Quinn and Kilpatrick found that the use of a regional anaesthetic technique in cases classified as urgent did not influence the incidence of admission to the special care baby unit. The authors concluded that while general anaesthesia was indicated for cord prolapse, severe sustained bradycardia and significant antepartum haemorrhage, its use for cardiotocograph diagnosed fetal distress can generally be avoided.

General anaesthesia carries considerable risk for mother and baby. Obstetric anaesthetists need to be aware that its use for Caesarean section for fetal distress is often not justified.

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Sir,—Dr Norman’s letter concerns itself with the choice of anaesthetic technique for the compromised fetus and our audit dealt specifically with intubation during general anaesthesia. Our series of failed intubations spanned 17 yr, during which time techniques and attitudes have changed. Dr Norman touches on one point in a series of complex arguments, all of which are outside the remit of our audit. While we appreciate his interest and comments on our article, it would be inappropriate to comment further.

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Sir,—I read with interest the review of the management of failed intubation in obstetric anaesthesia by Hawthorne and colleagues. In their series of 23 failed intubations, manual ventilation of the lungs was difficult or impossible in 39% of patients while the airway was maintained before patients regained spontaneous ventilation. Despite this, the authors advocate in their failed intubation drill that all patients should be managed in the left lateral head-down position during this critical period.

In my opinion there is no evidence to suggest that the traditional teaching of adopting the lateral position in such circumstances is better than leaving the patient in the supine position with left lateral tilt. Turning these patients who are often obese into the lateral position exposes them to a greater risk of failed ventilation and ineffective cricoid pressure. Unfamiliarity with the lateral position is compounded by the need for two-handed techniques both to maintain an adequate seal between face mask and patient and adequate cricoid pressure. A third pair of often unskilled hands then becomes necessary to squeeze the reservoir bag to provide ventilation. The reduced risks of aspiration of gastric contents because of preferential gravitational spill from the mouth of any regurgitated material instead of into the trachea make little sense if the risks of hypoxia and regurgitation are increased by such a manoeuvre. I believe the anaesthetist’s and anaesthetic assistant’s abilities to maintain an airway and prevent regurgitation are optimized by leaving these patients supine when a failed intubation drill is implemented. A trial of release of cricoid pressure may still necessitate a head-down tilt. In addition, the authors suggested reducing cricoid pressure earlier in their regimen to improve a grade 4 view at laryngoscopy with the patient still supine, and no advantage is gained by turning the patients at a later stage to repeat the manoeuvre.

The second reason for leaving these patients supine is that the last recourse for managing the “failure to intubate, failure to ventilate” scenario is to perform a cricothyroidotomy, which I note was attempted in one case. The authors did not state if this was performed with the patient on their side, but I would suggest this is very difficult if not impossible to do in such circumstances.

Finally, I would suggest that spinal anaesthesia is the only method of regional anaesthesia suitable in the subsequent management of such patients for Caesarean section. If an extradural or a combined spinal-extradural technique is used, as occurred in 43% and 13% of patients, respectively, in the reported series, there remains a risk of intrathecal or intravascular injection of a large quantity of local anaesthetic via the extradural catheter, despite an initial negative test dose. Failure to intubate the trachea if then required in such circumstances would no doubt be catastrophic and could be avoided by the use of a spinal anaesthetic technique.

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2. Rosen et al. Inadequate anaesthesia is a remote, but real risk, as is high spinal anaesthesia. In our series we had no problems with any regional technique, and the relative risks of one against the other are unknown.

The debate as to the best position in which to conduct the failed intubation drill is longstanding. On the one hand is the Tunstall view, and on the other is that of Rosen. Rosen did not appear to provide any data in support of his view, but in our series of 17 cases there were no instances of regurgitation or aspiration. It is only at the point where general anaesthesia is abandoned that the patient is turned. In fact, turning to the left lateral position may facilitate a view of the vocal cords. When surgery is to continue and general anaesthesia is maintained, the patient remains in the semi-prone, head-down position.

Inadvertent intrathrcal or i.v. injection with extradural anaesthesia is a remote, but real risk, as is high spinal anaesthesia. In our series we had no problems with any regional technique, and the relative risks of one against the other are unknown.

Much of the data concerning the problems with intubation in obstetric practice represent more than the opinions of the authors. We have sought publication of the only audited perform-
ance of a failed intubation drill to provide the sub-specialty with some support for clinical practice.

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Sir,—Hawthorne and colleagues’ recent review of failed obstetric intubations in their maternity unit stated that despite a decrease in obstetric general anaesthetics they have seen an increase in failed intubation from 1:300 in 1984 to 1:250 in 1994. Against a background of approximately 300 obstetric general anaesthetics per year and an incidence of failed intubation of approximately 1 per year, it is not possible to say that this change represents a real increase. Furthermore, the fact that they have seen an increase in the total number of Caesarean sections performed implies that a decrease in the use of general anaesthesia from 83% in 1981 to 23% in 1994 represented only an approximate 30% reduction in the total number of general anaesthetic Caesarean sections. Consequently, it is not surprising that they had the impression that they had not seen a reduction in the incidence of failed intubation. Fortunately, failed intubation is a rare occurrence. This implies that the effectiveness or otherwise of a difficult intubation drill is necessarily difficult to demonstrate.

In addition, the difficult intubation flow diagram described seems to suggest that in cases of fetal distress and maternal haemorrhage where direct laryngoscopy is grade 3 (Cormack and Lehane), failure to intubate should be followed by the use of the laryngeal mask but in grade 4 laryngoscopy one should institute the failed intubation drill. Precluding the use of a laryngeal mask airway in this type of emergency based on whether or not the tip of the epiglottis can be seen on direct laryngoscopy does not seem justified. Moreover, grade 2 laryngoscopy may be associated with difficult intubation, particularly in obstetric patients.

It is interesting that in the six patients who underwent indirect laryngoscopy after operation no abnormality was found. In a study nearing completion, we have found a highly significant association between difficult indirect laryngoscopy and difficult intubation. The only failed obstetric intubation that was included in our study was an easy indirect laryngoscopy. These findings support the suggestion that failure to intubate the trachea of obstetric patients is more often a result of changes caused by pregnancy and the particular problems of attempting to intubate in less that ideal circumstances than because of the anatomical features that make the intubation of non-pregnant patients difficult.

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Sir,—We thank Dr Kessell for the interest shown in our review of failed obstetric intubation in which he makes the following points. On the basis of the relative incidence of obstetric general anaesthetics and failed intubations, we would be unlikely to identify any changes, and the effectiveness of a failed intubation drill would be difficult to demonstrate. He also comments on the place of the laryngeal mask and supports our impression that the anatomical features are not the main culprit in failure to intubate in the obstetric setting.

The figures that Dr Kessell quoted are our own, and we do not wish to conceal our disappointment at our failure to reduce the incidence of failed intubation. We acknowledge that it is difficult to confirm the effectiveness of a failed intubation drill, and we wish to point out that ours is the only documented audit of its application in obstetric practice. We have not attempted to undertake a statistical analysis of this data as it would be inappropriate; none the less, we feel that our results are clinically relevant.

Dr Kessell may be correct about placement of the laryngeal mask airway (LMA). Since the publication of our article, we have become aware of a report of the use of the LMA in 224 women undergoing Caesarean section, including 49 emergencies, apparently without any significant problems and a success rate of 99%. As more information supporting the safe use of the laryngeal mask becomes available, we anticipate that it may become the first alternative when tracheal intubation fails.

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Perioperative mucosal pH in orthotopic liver transplantation

Sir,—We read with much interest the recent article by Welte and colleagues. In their study, the authors found a significant decrease in intracranial gastric pH (pHi) during the anhepatic stage of liver transplantation, even though venovenous bypass (VVB) was used. These values became normal during the reperfusion stage of the graft. In our experience, with or without the use of VVB, pHi was normal in the former group but a significant decrease was observed in the group without VVB (table 1).

As in Welte’s study, pHi values became normal after reperfusion of the graft. However, in contrast with these authors, our patients showed a higher baseline pH which could explain the differences observed during the anhepatic stage in the VVB patients. Maintaining temperature in our patients and improved global oxygenation because of vena caval preservation during the anhepatic stage may account for these differences.

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1. Liu E, Chan-Liao M. Experience of using laryngeal mask anaesthesia for Caesarean section. 11th World Congress of Anaesthesiologists, 1996; D771.

The table shows that the figures for pH

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<th>T1 GA</th>
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<tr>
<td>CI (litre m⁻² min⁻¹)</td>
<td>5.4 (1.2)</td>
<td>5.3 (2.1)</td>
<td>4.5 (1.5)</td>
<td>5.9 (2)</td>
<td>5.9 (1)</td>
<td>5.8 (1.4)</td>
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<td>Oxygen extraction (%)</td>
<td>17 (1.5)</td>
<td>13 (2)*</td>
<td>14 (3)</td>
<td>14 (6)</td>
<td>23 (5)</td>
<td>20 (3)</td>
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<td>Temp. (°C)</td>
<td>35.5 (0.6)</td>
<td>35.7 (0.7)</td>
<td>34.8 (0.7)</td>
<td>35.3 (0.3)</td>
<td>34.9 (1)</td>
<td>35.7 (0.7)*</td>
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<td>Lactate (mmol litre⁻¹)</td>
<td>2.3 (1)</td>
<td>2.6 (1.3)</td>
<td>4.5 (1)</td>
<td>4.7 (1.7)</td>
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<td>pH i</td>
<td>7.392 (0.1)</td>
<td>7.400 (0.1)</td>
<td>7.408 (0.1)</td>
<td>7.253 (0.1)*</td>
<td>7.357 (0.1)</td>
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Preliminary studies suggest that the use of venovenous bypass (VVB) during the anhepatic stage of OLT may indeed be beneficial for mucosal oxygenation: in contrast with our results, gastric pH was preserved with VVB, but decreased transiently without VVB. As pointed out in our article, we were unable to strictly test the hypothesis that VVB would maintain mucosal blood flow as VVB was used routinely at our institution. Therefore, we cannot exclude the possibility that pH values might have decreased to even lower values without VVB. The main purpose of our study was to assess the ability of tonometry to detect intraoperative mucosal hypoxia, to measure gastric and sigmoid pH, and to relate the observed changes in pH, to the occurrence of endotaxaemia and primary graft function. Although in the preliminary report of Camprubi and colleagues, important information on patient physical status and determinants of tissue oxygenation is lacking, the fact that cardiac index, oxygen extraction and lactate concentration are comparable with the values measured in our study suggests that the different results for gastric pH during the anhepatic stage may be attributed to the more severe chronic impairment of intestinal perfusion in our patients with end-stage cirrhosis. This is supported by the lower pH values measured early during hepatectomy in our study (7.28 vs 7.39). In fact, low pH values (<7.32) have been reported in patients with chronic intestinal ischaemia and portal vein obstruction. In agreement with our data, the pH values of Camprubi and colleagues patients without VVB had returned to baseline after reperfusion. However, in our patients with end-stage hepatic cirrhosis, pH did not reach normal values (> 7.32) before the second postoperative day; an observation that further supports the presence of chronic impairment of mucosal microcirculatory perfusion. Hence, pre-existing chronic mucosal hypoxia might explain why pH decreased during the anhepatic stage, although overall portal flow was maintained by the use of VVB.

It also cannot be excluded that the apparent difference in baseline pH values between our study and that of Camprubi and colleagues is a result of the use of different blood-gas analysers. Riddington and colleagues and Takala and colleagues have shown that direct comparison of pH values between our study and that of Camprubi and colleagues is not valid. Therefore, it was recommended that each institution should determine its own reference values for pH. In our article, we were unable to strictly test the hypothesis that VVB would maintain mucosal blood flow as VVB was used routinely at our institution. Therefore, we cannot exclude the possibility that pH values might have decreased to even lower values without VVB. The main purpose of our study was to assess the ability of tonometry to detect intraoperative mucosal hypoxia, to measure gastric and sigmoid pH, and to relate the observed changes in pH, to the occurrence of endotaxaemia and primary graft function.

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Sir,—Clinical interaction studies evaluating the influence of different anaesthetic techniques on the action of neuromuscular blocking agents often compare two or more groups of patients treated separately but concurrently as part of the same study. These studies are termed \textit{parallel} to emphasize their difference from other clinical studies in which patients are their own controls. Parallel comparisons include most of the usual forms of interaction studies investigating the abilities of different inhalation anaesthetics to potentiate the neuromuscular effects of neuromuscular blocking agents. However, the large between-patient variability in dose–response and dose-duration studies with neuromuscular blocking agents may preclude demonstration of subtle differences in susceptibility to these agents. Paired crossover studies can minimize the effect of inter-individual variability. However, these paired crossover studies are difficult to perform with surgical patients. Healthy ASA I or II patients that are anesthetized two or more times, receiving on each occasion a different anaesthetic technique, are rare. Therefore, these paired crossover studies have to be performed with volunteers.

Our clinical study was designed as a parallel comparison of different anaesthetic techniques, that is opioid–nitrous oxide–oxygen, opioid–nitrous oxide–isoflurane and opioid–nitrous oxide–sevoflurane, in their ability to potentiate the neuromuscular effects of the most commonly used non-depolarizing neuromuscular blocking agents in surgical patients. Using one-way analysis of variance (ANOVA) and subsequently the Ryan–Einot–Gabriel–Welsh (REGW) multiple range test to identify eventual sources of difference, there was a significant difference in magnitude and duration of neuromuscular action between the control group, receiving no volatile agent, and the groups receiving inhalation anaesthetics. We were unable to demonstrate any significant difference between opioid–nitrous oxide–oxygen–isoflurane and opioid–nitrous oxide–oxygen–sevoflurane anaesthesia on the effects of neuromuscular blocking agents. In the population investigated, the differences between opioid–nitrous oxide–oxygen–isoflurane and opioid–nitrous oxide–oxygen–sevoflurane anaesthesia on the magnitude and duration of neuromuscular blocking agents were small compared with the between-patient differences in these responses to neuromuscular blocking agents (<10% for the mean values of both magnitude and duration of action). In order to demonstrate significant differences
in the potentiating abilities of isoflurane and sevoflurane on the effects of neuromuscular blocking agents, that is a significant difference in both depth and duration, sample sizes of several hundreds of patients per neuromuscular blocking group would have been required. Such sample sizes are beyond practicable limits. We selected our population carefully, using rigid inclusion criteria, as described in the text, to reduce patient variability. This inevitably introduced constraints such as the availability of large numbers of eligible patients within a reasonable period of time. Any investigator is limited by both resources and time. Additionally, our study was intended as a phase II trial to evaluate the interaction between sevoflurane and neuromuscular blocking agents within a limited number of surgical patients.

Both the investigator and clinician should be concerned about the ability to detect an important clinical difference. Different investigators disagree on what is a clinically significant difference. They also disagree on the risk they are willing to take of missing a meaningful effect caused by drug interaction. The choice of a 20% difference in ED50 as a clinically significant value is arbitrary. Such a difference is small compared with the large inter-individual differences in the response to neuromuscular blocking agents. With the degree of variability and sample sizes used in our study, a 30% reduction in the ED50 of pancuronium and atracurium and a 45% reduction in the ED50 of vecuronium had an 80% chance of being significant at the 0.05 level.

Finally, we still feel that further interaction studies on the influence of higher concentrations of volatile anaesthetics on larger doses of neuromuscular blocking agents are warranted. To elucidate small but significant differences in the ability of isoflurane and sevoflurane to potentiate action of neuromuscular blocking agents, these interaction studies need to be performed in volunteers who are studied twice, receiving isoflurane on one occasion and sevoflurane on the other.

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Cusum: a statistical method to evaluate competence in practical procedures

Sir,—It was interesting to read the commentary by Kestin describing the use of cusum analysis to measure the competence of anaesthetic trainees at practical procedures. The cusum is a useful graphical tool for discerning trends from a series of observations. The derivation of boundary lines for sequential tests allows comparison of the observed proportions of success or failure against predetermined standard criteria. This could be developed into a continuous performance monitor in anaesthesia.

In his article, Kestin discussed the problems of keeping paper records and plotting fractions on the graphs. In response to this we set out to develop a computerized personal log book system for practical procedures to run in parallel with the electronic anaesthetic log book on the Pison 3a. However, in setting up the algorithms we have encountered a number of problems.

The values of $s$, $h$, and $b$ calculated using the formulae in the appendix do not agree with the values in table 1 of the article. On reviewing the original articles on the application of the cusum, the value of $Q$ should read $Q = \ln \left( \frac{1-p}{1-q} \right)$. The values in the table are indeed correct if this calculation is used for $Q$.

The null hypothesis in the article is stated as “the true failure rate is NOT different from the acceptable failure rate” and if the cusum exceeds $h_e$ then it is rejected. This does not imply that the true failure rate exceeds the unacceptable failure rate which is the performance indicator which interests us. Similarly the alternative hypothesis is stated as “the true failure rate is equal to or exceeds the unacceptable failure rate” and if the cusum decreases to less than $h_e$ then it is accepted. Surely this would imply that the failing cusum of registrar B in figure 1 has a true failure rate that is equal to or exceeds the unacceptable failure rate.

Furthermore, there appear to be unclear criteria in the definition of success or failure for a particular procedure. This is confusing and it is difficult to see why type 1 and 2 errors of 10% (0.1) where chosen.

For reasons of convenience for the plotting of the graph, the values of $s$, $h$, and $h_e$ multiplied by 10. It is not clear if, in the event of a success, $(1-s)$, 10 $(1-s)$ or $1-10$ was plotted.

The statistical method described by Kestin appears to be a very powerful analytical tool and may have a wide range of applications in the assessment of trainees. However, the errors and inconsistencies in the appendix are a source of confusion. It would be useful if the derivation of the definitions, variables, hypotheses and theory behind the calculations were explained more clearly.

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Sirs,—I would like to thank Drs Hammond and McIndoe for their interest, and in particular for correcting the error in the formula for $Q$ in the appendix—$p$ and $h_e$ have been transposed.

In answer to their other comments, the advantages of using $\alpha$ and $\beta$ of equal magnitude is explained in the methods section; the choice of $p = 0.1$ was a compromise between the common values for $\alpha$ of 0.05 and for $\beta$ of 0.01 or 0.2 used in clinical studies. The software on the Pison 3a can be used to record and display the cusum; in this case, it is not as helpful to have $\alpha$ and $\beta$ equal than if graphical methods are used. The graphs used by our trainees were plotted using the nearest integers of 10 and 10 $(1-s)$ as the increments.

The original article in the British Medical Journal referred to by Drs Hammond and McIndoe was the article that stimulated my interest in this topic. However, I found it difficult to understand the basic statistical concepts of cusum analysis from this article. I found it even more difficult to write an explanation myself, and this article is the only one of mine which the reviewers have ever found it even more difficult to write an explanation myself, and I still feel that further interaction studies on the influence of volatile anaesthetics on larger doses of neuromuscular blocking agents are warranted. To elucidate small but significant differences in the ability of isoflurane and sevoflurane to potentiate action of neuromuscular blocking agents, these interaction studies need to be performed in volunteers who are studied twice, receiving isoflurane on one occasion and sevoflurane on the other.

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