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FORUM

The accuracy of visual estimation of weight and height in pre-operative supine patients

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Summary

Four observers estimated the weight and height of 38 patients who were lying covered on operating theatre trolleys. Regression analysis of the results was performed for each observer. The results showed marked variation in ability to assess these characteristics accurately.

Keywords *Measurement*; body weight, body height.

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It is important for an anaesthetist to know a patient's weight in order to give an accurate drug dosage. This is particularly important in a sick patient, when the administration of an excessive dose of induction agent might be unsafe or potentially life threatening. Similarly, an inconveniently long neuromuscular block may result if a patient is given a dose of neuromuscular blocker that is too large. Height measurement is required less frequently but will be needed for calculations involving body surface area, e.g. cardiac index and body mass index determination.

The majority of patients can be weighed and measured before anaesthesia. Alternatively, patients can be questioned, in which circumstances they tend to give reasonably accurate estimates of their own height and weight [1]. However, some patients, such as elderly trauma patients or intensive care patients, are often unable to be measured or to give estimates because of decreasing mental faculty, immobility or unconsciousness. The failure to obtain and record weight and height has been highlighted in the National Confidential Enquiry into Peri-operative Deaths (NCEPOD) reports. One report concluded that this might reflect poor quality of care [2]. It goes on to suggest that the anaesthetist's assessment of weight is reasonable. This assumption has not been questioned or quantified. This study aimed to evaluate the ability of anaesthetic staff to assess patients' weight and height.

Methods

Thirty-eight patients undergoing day case orthopaedic or urological surgery were included in this study. The Chairman of the Hospital Ethics Committee waived the need for patient consent. The patients were assessed in the anaesthetic room on identical trolleys, wearing a standard hospital gown and covered by a single blanket. The weight and height of each patient was visually assessed by the four investigators: a consultant with 18 years' anaesthetic experience, a staff grade with 9 years' anaesthetic experience, a senior house officer with 5 months' anaesthetic experience and an operating department assistant with 11 years' experience. None of the patients was seen before lying on the trolley and the actual weight and height of each patient was not made known to any estimator until the end of the study. Anaesthesia was given by target controlled infusion of propofol, the weight of the patient being entered into the pump by an independent anaesthetic assistant.

Regression analyses were performed for height and weight estimation for each observer, using the 38 observations in each case. The estimate from the member of staff is used as the explanatory variable and from this it is hoped to estimate the true weight or height. A predictive equation is therefore specific to a particular member of staff. The results are shown graphically with a plot of the regression

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Table 1 Patient characteristics. Values are given as mean (range) where appropriate.

Age; years	55.4 (15–79)
Sex ratio; M: F	19 : 19
Weight; kg	74.8 (37–105)
Height; cm	168.4 (152–185)
Body mass index	26.3 (15–37)

line together with the predictive equation and r^2 value. In the predictive equation, x is the estimated variable and y is the derived 'true' weight or height. The r^2 value shows how well the line fits the data in each case, a value of 1.0 implying a perfect fit and 0 implying no fit at all.

Results

Thirty-eight patients were assessed by all four investigators. The characteristics of the patients are summarised in Table 1.

The scatter diagrams and regression lines for each grade of observer are shown in Fig. 1 for weight and Fig. 2 for height. The lines of best fit for the consultant's and operating department assistant's estimations of weight and all but the senior house officer's height estimation pass through the origin. The best fit of the other regression lines produced lines that cross the y-axis at a negative y-value.

Testing the error in weight estimation between observers using analysis of variance showed that the senior house officer consistently overestimated, making his estimations significantly worse ($p < 0.001$) when compared with the other three estimators. Similar testing for height data showed that the errors between observers were not significantly different ($p \gg 0.05$) and that there was a tendency for all observers to overestimate. The results expressed as percentage error for each actual weight or height are shown as scatter diagrams in Figs 3 and 4.

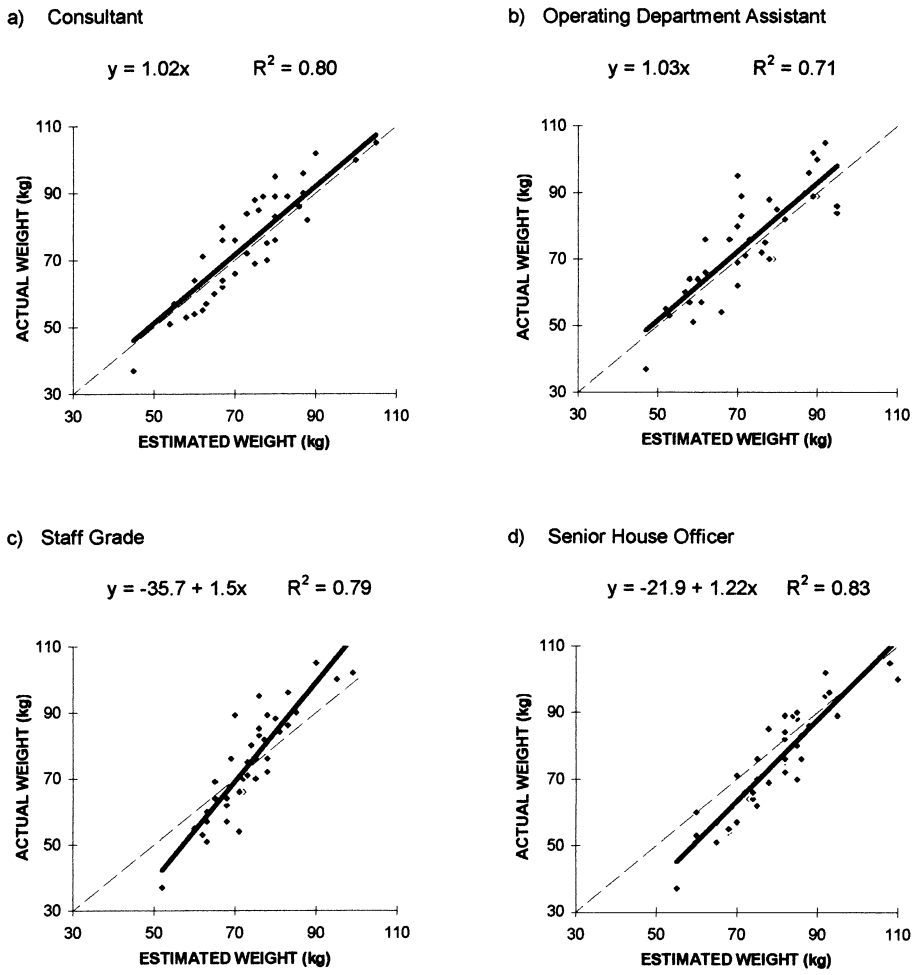


Figure 1 Scatter diagrams and regression lines (bold) for weight estimation, including the line of identity (dashed).

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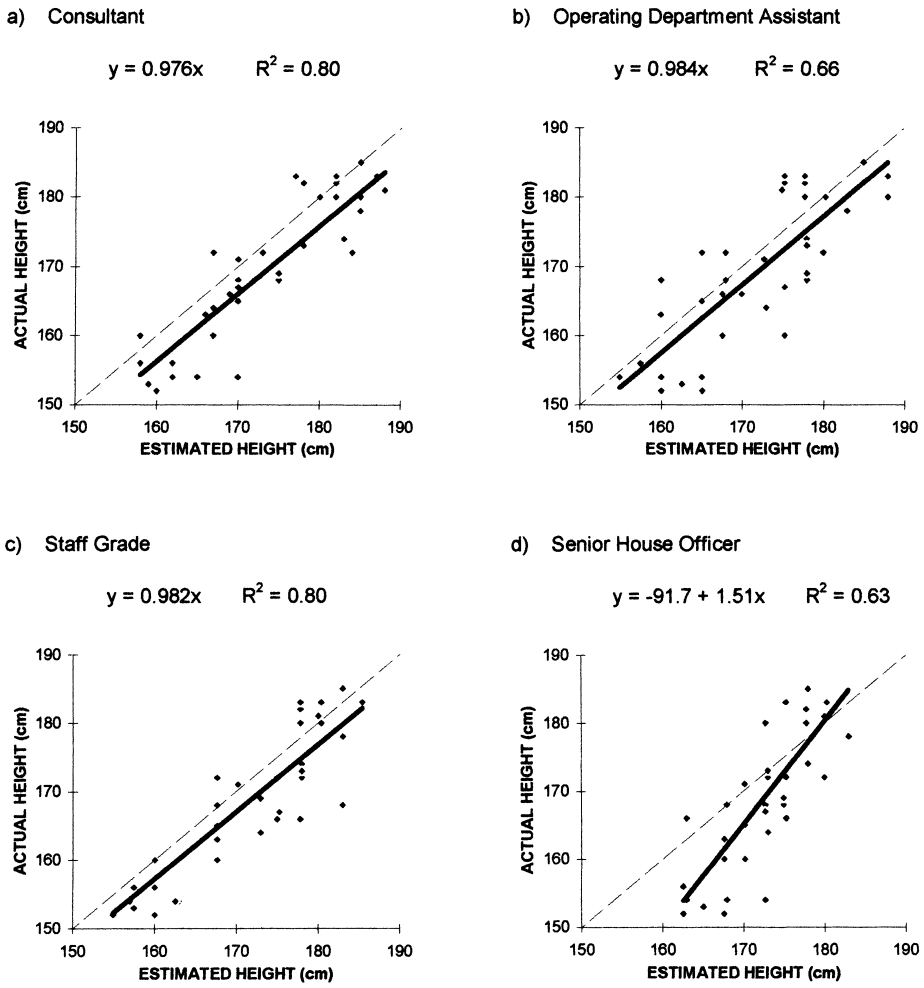


Figure 2 Scatter diagrams and regression lines (bold) for height estimation, including the line of identity (dashed).

Discussion

The results of our study show that each observer has a different ability, with specific regression lines for estimation of height and weight. The most consistently accurate estimators of weight were the consultant and operating department assistant, with regression lines reasonably close to identity. The regression lines for both the senior house officer and the staff grade have steeper gradients. The staff grade equation, nevertheless, does give useful information, showing overestimation at low weight and underestimation at high weight, with the crossover point at the approximate weight of that investigator. It is possible that one method of estimating weight is to compare the patient's physique with one's own, thereby being more accurate at similar weights but not at weights that are greatly different. However, the equation for the senior house officer shows overestimation at weights less than 100 kg, his own weight being considerably less than this.

With height estimation there was considerably more scatter in the results, particularly the estimations by the operating department assistant and senior house officer. The latter tended to overestimate smaller heights and underestimate taller heights, the crossover being about 1.79 m, somewhat taller than that author. The other three investigators all consistently tended to overestimate height.

One important factor when considering the accuracy of estimation is the amount of error that is acceptable in clinical practice. Weight is important in anaesthesia, as drugs are given on a dose per unit weight basis. However, even a 20% error in adults would probably not produce significant clinical problems, even with neuromuscular blockade. From the percentage error scatter diagrams, it can be seen that most of the estimations are within ± 20% error. Of course, actual body weight is less important than lean body mass when calculating drug doses and underestimation of weight in overweight patients may not be

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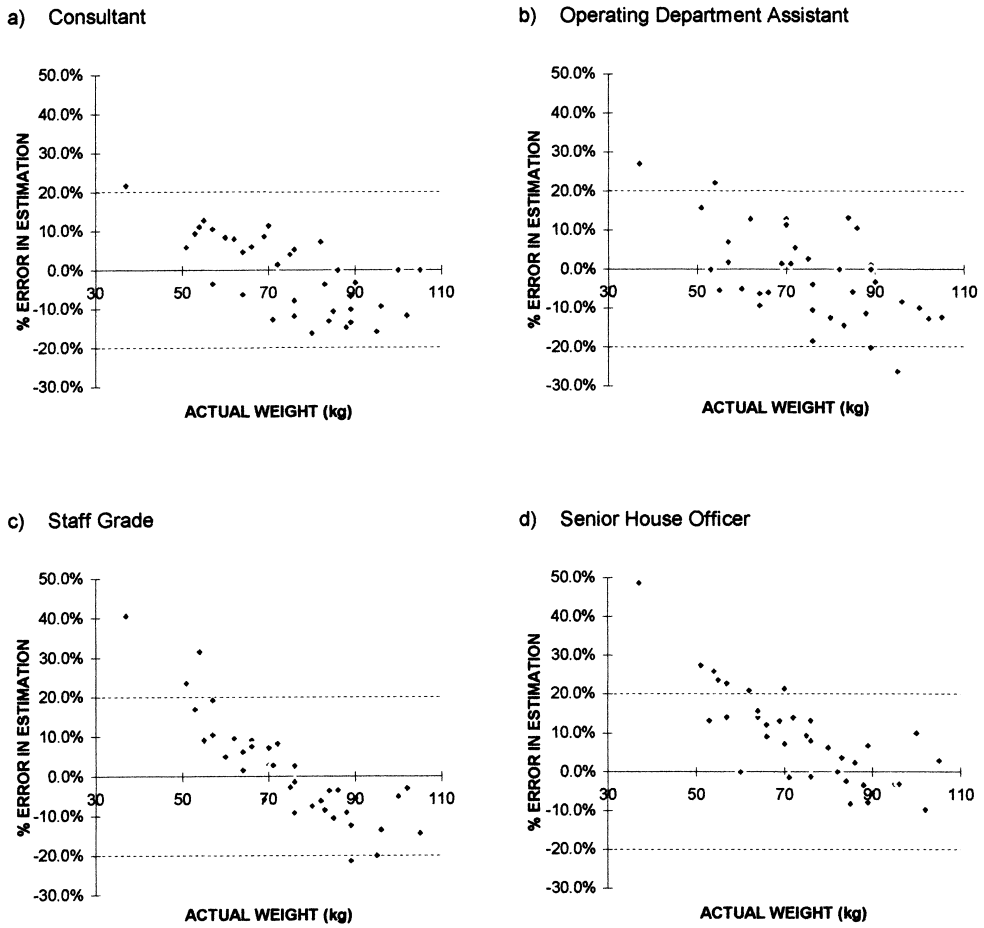


Figure 3 Scatter diagrams for percentage error in estimation of weight.

such a bad thing. However, it is important to know if one consistently overestimates at lower than normal body weight, as drug dosage in this situation may represent a significant overdose. This highlights the need for titrating dose and response, particularly at extremes of body weight. Consistent underestimation in overweight patients might suggest subconscious estimation of lean body weight rather than actual weight. However, we were consciously trying to estimate actual, rather than lean, weight. Indeed, the consistent overestimation in lean lower weight patients would bear out this fact.

Although measurement of height is widely used, it is rarely needed in the context of day care surgery. However, estimation of a patient's height is occasionally needed for cardiac output studies when the anaesthetist does not have easy access to the whole of the patient's body or does not have a tape measure. In our study, the range of heights was from 152 to 185 cm. A 20% error in estimation would give rise to clinically significant errors in the results. From the percentage error scatter diagrams, it can be seen that the majority of estimations fit within ± 5% error and this error margin would probably be acceptable. The major discrepancy appears to be overestimation of height in smaller patients.

Height estimation is more difficult in the supine than the upright position. We deliberately did not see the patients until they were lying down, as this would have biased the estimations. Supine height is probably estimated in relation to the length of the trolley and this would explain the smaller error margin at heights closer to the trolley length. If a tape measure is available and access to the whole patient is denied, as may be the case during an operation, height can be estimated from femur length [3] or lower leg length [4], assuming you have the appropriate regression equations and access to the relevant body part.

In our study, better overall accuracy of estimation of weight was achieved by the more experienced authors. This may result from more time spent assessing weights and unconsciously correlating them with the visual images of patients. Anaesthesia is probably the only speciality in

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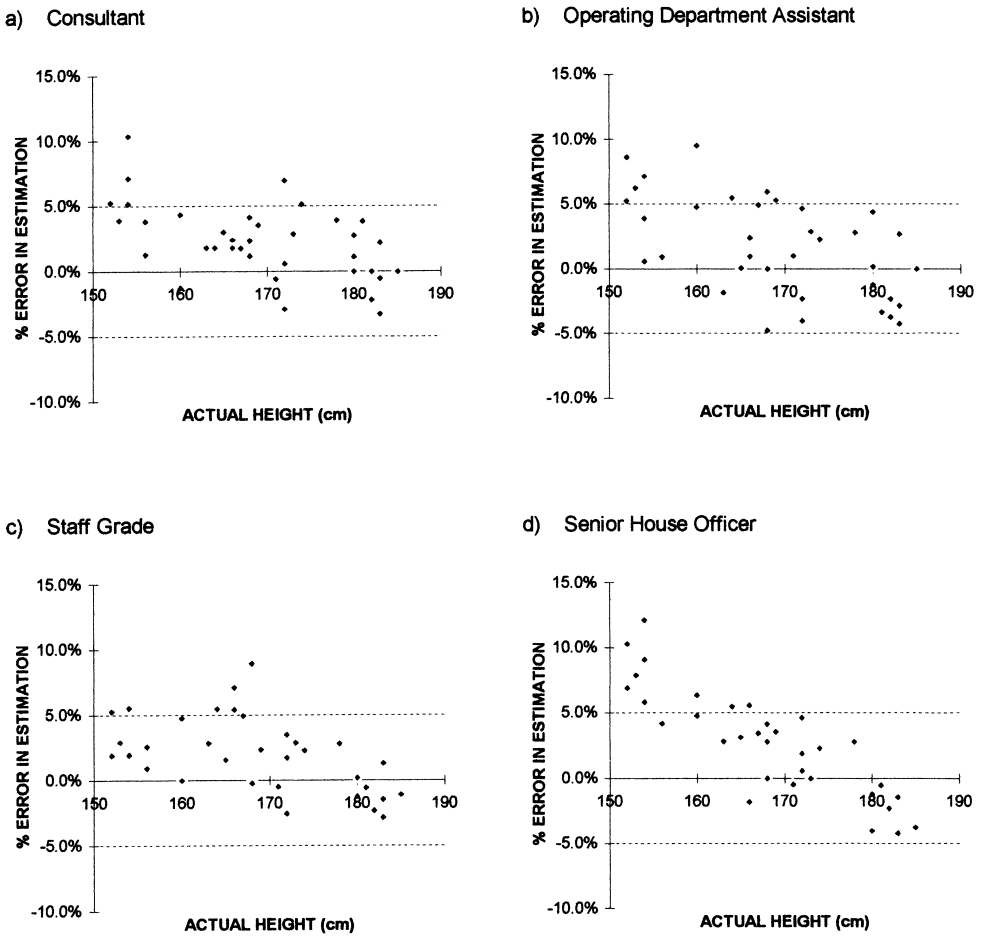


Figure 4 Scatter diagrams for percentage error in estimation of height.

which a patient's weight is noted and used frequently. The senior house officer author was significantly worse at weight estimation than the other three authors. This may be accounted for by the short exposure time to using drug doses per unit weight. However, the staff grade with 9 years' experience was also inaccurate. Size of estimator appeared to have no influence on accuracy or pattern of estimation as all the authors are of average build.

In conclusion, it would appear that the accuracy of estimation of patient weight and height varies from observer to observer, with everyone having a unique ability. It is possible that improvement in ability could be achieved after elucidating personal trends in estimation with regression analysis. The study shows that our estimations may not be as reasonable as NCEPOD suggest and caution should be exercised when using the guesses particularly at the extremes of physical size.

Acknowledgment

We thank Hilary Sanders of the University of Plymouth for help with the statistical analysis.

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FORUM

Decontamination of laryngoscopes: a survey of national practice*

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Summary

We conducted a postal questionnaire to survey methods of laryngoscope cleaning in units throughout Great Britain. We found that there was great variation in practice. Most units autoclave laryngoscope blades at some time, but less than one-quarter do so between each case. A wide range of methods is used to clean the blade in units where autoclaving was not undertaken. Most units had no guidelines relating to laryngoscope treatment between uses.

Keywords *Equipment*; laryngoscopes. *Infection*; contamination, sterilisation.

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**A summary of this work was presented at the Annual Scientific Meeting of the Association of Anaesthetists of Great Britain and Ireland, Harrogate, 10–12 September 1997*
Accepted: 6 October 1998

Laryngoscopy is an invasive procedure involving contact with mucous membranes and saliva, and sometimes with blood. Mixed cultures have been grown from laryngoscopes following routine use [1], including a wide range of potentially harmful micro-organisms [2]. Case reports of possible cross-infection from laryngoscopes have been described in a delivery suite and in neonatal intensive care units involving infection with *Listeria monocytogenes* [3] and *Pseudomonas aeruginosa* [4, 5].

Although the laryngoscope handle does not contact the patient directly, it may be contaminated by the tip of the blade, which often touches the handle when in the folded closed position, and hence the handle must also be considered a potential source of cross-infection. Residual blood contamination has been found on 40% of apparently clean laryngoscope handles awaiting re-use [6]. Another study revealed that in two units in which only obviously dirty handles were wiped clean, 50% of handles tested positive for occult blood [7]. In some cases, a plastic bag or sheath has been used to cover the handle and blade [8], but this practice has been questioned as leading to a false sense of security, and full sterilisation procedures for both handle and blade have been advocated [9].

The aim of this study was to conduct a nationwide survey of current practice, training and opinions on the cleaning of laryngoscopes both in and out of the operating theatre.

Methods

A postal questionnaire was sent to all 289 Royal College tutors in Great Britain requesting that they pass on the questionnaire to their senior operating department practitioner (ODP) or anaesthetic nurse for completion and return.

Questionnaire

We emphasised the importance of responses reflecting actual working practice, and presented a tabulated checklist of methods used to clean each component of a laryngoscope after standard use in their unit, and also for a laryngoscope used in a known 'high-risk' case. The full questionnaire is shown in Appendix A.

Results

A total of 239 units returned the questionnaire, representing a response rate of 82.7%. All responding units train ODPs and anaesthetic nurses. Most units autoclave

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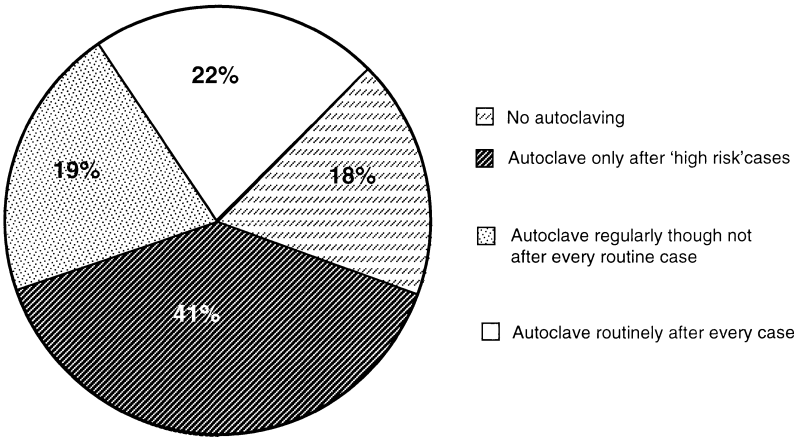


Figure 1 Laryngoscope blade sterilisation: percentage of responding units autoclaving according to perceived infection risk category.

laryngoscope blades at some time, but less than one-quarter do so between every case (Fig. 1), and few units practise 'universal precautions'. Three units send their blades to a specialist department for cleaning in a washing machine (and were included in the autoclave groups). The range of methods used to clean the blade in units not autoclaving routinely is very large (Fig. 2). In 10% of responding units, a detergent wash is the only treatment, while in others the blade is wiped, scrubbed or soaked in alcohol, Betadine™, Hibiscrub™, Cidex™, alcohol or hydrogen peroxide, with or without a specified period of active or passive drying.

Almost half of the units do not dismantle the blade before cleaning its components. The handle is not cleaned at all in one-third of units, and others only scrub with detergent or wipe with alcohol when there is gross soiling (Fig. 3). Only 5% of units routinely autoclave the handle.

There are no guidelines relating to laryngoscope care in 60% of units, while in 12% of units, 'disposable' laryngoscopes are used, but one-quarter of these units re-use the laryngoscopes. Almost two-thirds of the units use McCoy laryngoscopes, and yet less than one-tenth of these change their routine cleaning procedures for them. No units distinguish between fibrelight and electric bulb-type blades in their cleaning methods.

There were many additional points voiced, which included the following comment: 'Wouldn't touch any laryngoscopes off the crash trolley!'

Finally, we note that one-third of responders would not be prepared to put a laryngoscope, taken randomly from a trolley in their department and ready for use, into their mouth (Fig. 4). Responders from units that carried out more autoclaving were more likely to be prepared to do so, but one-fifth of responders from units autoclaving routinely would still not be prepared to put a randomly selected laryngoscope into their mouth.

Discussion

There appears to be no rationale regarding the aim of laryngoscope cleaning (social cleanliness, decontamination or sterilisation) or agreed methods to achieve that aim. The results are consistent with our impressions of current practice based on the hospitals in which we have worked.

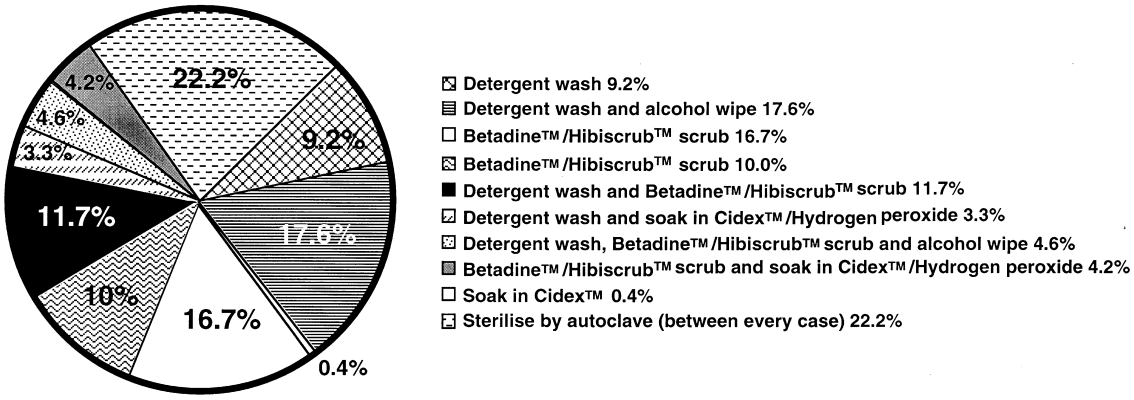


Figure 2 Laryngoscope blade cleaning methods, percentage of responding units cleaning by various methods for routine cases.

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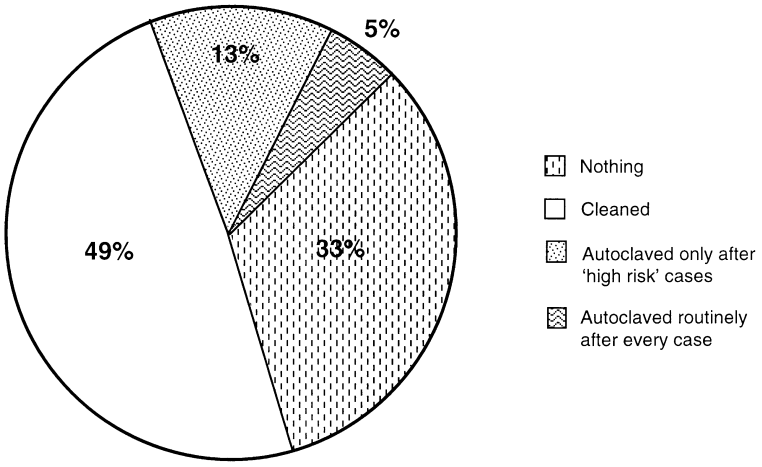


Figure 3 Laryngoscope handle cleaning: percentage of responding units cleaning the handle by various methods according to perceived infection risk category.

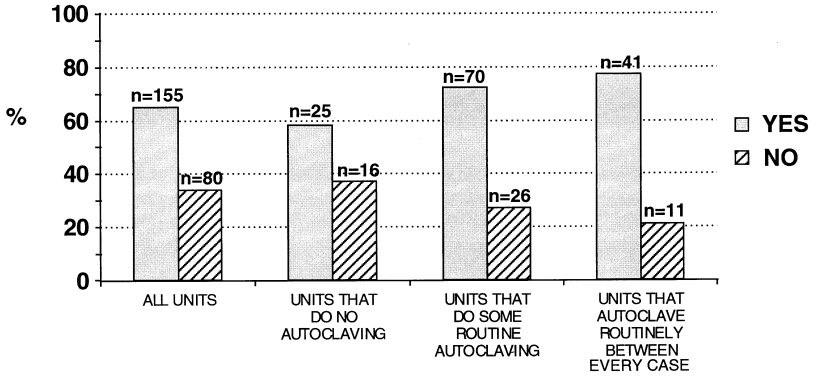


Figure 4 Responses to the question 'If you were handed a laryngoscope chosen at random in your department, would you be prepared to put it in your mouth?'.

A small number of comments suggested that some ODPs (and anaesthetists) did not believe that laryngoscope decontamination was important. Others, however, had clearly considered this problem in some depth and one-third lacked confidence in the cleanliness of their laryngoscopes.

Skilton [10], in a survey of Welsh hospitals, found that half of them autoclaved blades routinely, and asked whether the Association of Anaesthetists should consider the publication of guidelines covering the care of laryngoscopes. He suggested the following cleaning method for the blade: a detergent wash, then drying prior to a 10-min soak in 70% alcohol. In our survey, few units autoclaved routinely, and even fewer autoclaved the handle. Some suggested that while they would ideally autoclave equipment, degradation of the fibreoptic light-guide or a lack of sufficient numbers to have a 'pool' of blades restricted the practice. Few units employed more thorough techniques for McCoy laryngoscopes. Such inconsistencies between hospitals may promote complacency, and serve to reduce compliance with guidelines, particularly when staff move to a new hospital advocating more rigorous procedures. Laryngoscopes used outside the theatre suite are treated by a variety of staff, including midwives and ward nurses, and in only a minority of units are ODPs or anaesthetic nurses responsible for cleaning. Guidance needs to be given to all staff involved in laryngoscope care, particularly in light of the case reports of likely cross-infection from laryngoscopes in a delivery suite and neonatal intensive care units.

As yet, there is no universal method of choice for laryngoscope decontamination. Soap and water washing does not eliminate bacterial contaminants effectively [1, 11], and evidence for the efficacy of a water rinse followed by a 10-min soak in 3.2% glutaraldehyde (Cidexplus™) is conflicting [2, 7]. In the latter case, there are continuing concerns over risks to staff. Spot checks revealed no contamination after one unit's treatment was revised to include dismantling, washing, soaking in 70% alcohol for 10 min and drying [4]. However, alcohol, Betadine™ and Hibiscrub™ are not regarded as acceptable for disinfection of blood-borne viruses and hydrogen peroxide is potentially unreliable as it is difficult to control (D. J. Jeffries, personal communication). Wiping under water followed by autoclaving has been demonstrated to sterilise these instruments [1]. The particular problems of small neonatal laryngoscopes with grooves that may act as harbours of organic debris has been highlighted, and cleaning in a specialist department is suggested [5]. All laryngoscopes have the potential to harbour debris, particularly if the

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electric bulb or fibreoptic light-guide is not separated from the blade before cleaning. More complex designs, such as the McCoy laryngoscope with its distal hinge, may be harder to clean.

With the recent discovery of new variant Creutzfeldt–Jakob disease agent in tonsils [12], it should be noted that none of the disinfectants or standard autoclaving inactivate prions. For suspected cases, one should consider the use of disposable laryngoscopes.

We expect airways and tracheal tubes to be provided as sterile items, but have to some extent ignored the potential for cross-contamination from re-used laryngoscopes. Do we want the same level of cleanliness expected of our cutlery in a restaurant, or do we require full laryngoscope sterilisation between patients or the widespread use of single-use devices?

Acknowledgments

We gratefully acknowledge our research project grant from the Association of Anaesthetists of Great Britain and Ireland, and thank the Royal College Tutors, operating department assistants and anaesthetic nurses for responding to this survey. We also thank the Royal College of Anaesthetists for providing us with a list of the College Tutors, and Professor D. J. Jeffries for his helpful comments and advice

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Appendix A

Cleaning of laryngoscopes

This survey takes less than 5 minutes to complete and should reflect *actual* working practice

Your immediate attention would be appreciated. The results will be analysed anonymously.

No national guidelines exist for the cleaning and sterilisation of laryngoscopes and our impression is that methods used vary from no treatment through to dismantling, scrubbing and autoclaving. Although all the treatments listed below are probably used at some time in particular theatres or by particular ODAs, what we want to know are the most common methods used for the "average" laryngoscope in your unit i.e. if you pick up a laryngoscope at random from an anaesthetic room, what is most likely to have been done to it since it was last used.

1. Please complete the table below, *column by column,* detailing how your department handles each laryngoscope component, first for routine and then for known high risk cases.

Cleaning / sterilisation method	Routine			High Risk		
	Handle	Electric bulb-type blade	Fibre-optic blade	Handle	Electric bulb-type blade	Fibre-optic blade
A. Nil	❑	❑	❑	❑	❑	❑
B. Dismantle? i.e. remove bulb, light guide or battery before cleaning	❑	❑	❑	❑	❑	❑
C. i) Scrub with soap and water	❑	❑	❑	❑	❑	❑
ii) Wipe with alcohol swab	❑	❑	❑	❑	❑	❑
iii) Scrub with Hibiscrub™/Betadine™	❑	❑	❑	❑	❑	❑
iv) Soak in Cidex™/hydrogen peroxide	❑	❑	❑	❑	❑	❑
D. i) Autoclave	❑	❑	❑	❑	❑	❑
ii) between each case?	❑	❑	❑	❑	❑	❑
iii) If not, how often? (no. of times per week)	.....	.....	.....	.....	.....	.....

2) Does your department have any guidelines for the cleaning of laryngoscopes? Yes ❑ No ❑

If yes, a) please outline the guidelines over the page or enclose a copy with this form

b) if your "routine" method differs from these guidelines, why do you think this is? Please tick the table over the page.

3) Are any disposable laryngoscopes used in your unit? Yes ❑ No ❑

If yes, a) where or when are they used? .....

b) are they ever reused? Yes ❑ No ❑

If yes, please describe over the page how they are cleaned.

4) Does your department use McCoy laryngoscopes? Yes ❑ No ❑

If yes, please outline their treatment over the page.

5) Who is responsible for the cleaning of laryngoscopes used outside of the theatre suite?

a) in A&E .....

b) ward resuscitation trolley .....

c) neonatal resuscitaire .....

d) X-Ray department .....

6) Do you train ODAs / Anaesthetic Nurses in your department? Yes ❑ No ❑

7) If you were handed a laryngoscope chosen at random from an intubating trolley in your department, would you be prepared to put it in your mouth? Yes ❑ No ❑

Thank you for your help with our survey.

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Additional Notes Relating to Questions 2,3 and 4:

2) Guidelines in your unit.

a) What are they?

.....

.....

.....

.....

.....

b) Why are guidelines not followed? Please tick.

- ❑ too time consuming
- ❑ not enough laryngoscopes
- ❑ not enough autoclaves
- ❑ degrades laryngoscopes
- ❑ most of the ODAs don't know what the guidelines are
- ❑ other (please explain)

.....

.....

3) c) How are disposable laryngoscopes cleaned?

.....

.....

.....

.....

4) Are McCoy laryngoscopes treated differently? Yes ❑ No ❑
If yes, please outline how their treatment differs.

.....

.....

.....

.....

Please return to: Dr. Mark Esler,
Department of Anaesthetics,
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FORUM

The effect of cerebral palsy on the action of vecuronium with or without anticonvulsants

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Summary

Patients with cerebral palsy who are treated with anticonvulsant medication are resistant to vecuronium. We examined the contributions to vecuronium resistance made by cerebral palsy and anticonvulsants in a study of children with cerebral palsy and a control group. The acceleromyographic responses of the following three groups of children were studied: children with cerebral palsy not taking anticonvulsant medication ($n = 11$); children with cerebral palsy taking anticonvulsant medication ($n = 8$); and a control group of children who did not have cerebral palsy and were not taking anticonvulsant treatment ($n = 10$). Using a standardised technique, general anaesthesia was induced and maintained with 0.5–1.5% isoflurane in a 60/40 nitrous oxide in oxygen mixture. After a stabilisation period which was performed with supramaximal train-of-four stimuli (2 Hz every 15 s) an intubating dose of vecuronium 0.1 $mg.kg^{-1}$ was administered. The first twitch of the train-of-four response (T_1), the onset time, the times to 25, 50, 75 and 90% recovery of T_1, recovery index, and the time to 70% recovery of train-of-four ratio were recorded. Recovery times to T_1 and train-of-four responses were reduced significantly in both groups of children with cerebral palsy compared with the control group. These results suggest that children with cerebral palsy display resistance to vecuronium whether or not they are taking anticonvulsant drugs.

Keywords *Brain*; cerebral palsy. *Pharmacology*; anticonvulsants, vecuronium.

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Accepted: 8 November 1998

Patients with cerebral palsy who are taking anticonvulsant medication, have been reported to be resistant to vecuronium [1]. Similar anticonvulsant-induced resistance to nondepolarising muscle relaxants has been noted in other pathological states [2–7]. The contribution of cerebral palsy to vecuronium resistance has not been reported.

We designed a study to compare the acceleromyographic responses of children with cerebral palsy who were not taking anticonvulsant medication with similar children who were receiving an anticonvulsant, and also with a control group of children who did not have cerebral palsy and were not taking anticonvulsant treatment.

Methods

The study was approved by the hospital Ethics Committee and written, informed consent was obtained from the child's parent or guardian.

Twenty-nine children aged 4–8 years were studied in three groups as follows: children with cerebral palsy not taking anticonvulsant medication, group CP; children with cerebral palsy taking anticonvulsant medication, group CP + A; and a control group of children who did not have cerebral palsy and were not taking anticonvulsant treatment, group C. All the children studied were scheduled for elective orthopaedic or dental operations. They were free from hepatic or renal disease and, apart from anticonvulsants in group CP + A, were not taking any medication that might interfere with neuromuscular transmission. Children whose body weight was not within 20% of predicted ideal body weight were not recruited to the control group.

The children were unpremedicated. Anaesthesia was induced with a 60/40 mixture of nitrous oxide in oxygen supplemented with progressively higher concentrations of isoflurane (0.5–1.5% inspired concentration). When a sufficient depth of anaesthesia was reached, a peripheral

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venous catheter was inserted and atropine 15 $\mu g.kg^{-1}$ was administered.

Neuromuscular responses were evaluated by acceleromyography (TOF-Guard, Organon Teknika/Biometer, Denmark). The right arm was extended and the hand fixed in the supine position with the thumb free to move. Surface electrodes (Bioflex, Biometer, Denmark) were placed over the ulnar nerve on the volar side of the wrist. The acceleration transducer was connected to the thumb and the current necessary for supramaximal stimulation was determined and set automatically at the beginning of monitoring.

Following a stabilisation period, baseline measurements were performed with supramaximal train-of-four (TOF) stimuli of 0.2 ms duration at a frequency of 2 Hz every 15 s. Following this an intubating dose of vecuronium 0.1 $mg.kg^{-1}$ was injected intravenously over 10 s. When maximum twitch depression occurred, the trachea was intubated. Anaesthesia was maintained with 60% nitrous oxide in oxygen and 0.5–1.5% inspired isoflurane.

The electrocardiogram, arterial blood pressure (non-invasive), peripheral oxygen saturation, temperature and end-tidal CO_2 were monitored continuously throughout the study (Criticare 1100, Criticare Systems, Inc., WI, USA). Ventilation was controlled to maintain an end-tidal CO_2 value between 30 and 40 mmHg. Temperature was monitored using an oesophageal probe and maintained above 36°C using warming blankets when necessary during the study. The temperature thermistor was placed over the thenar eminence and maintained above 33°C.

The first twitch of the TOF response (T_1) and the TOF ratios were measured at 15 s intervals using the accelerometer. The onset of neuromuscular block was recorded as the time (s) between the initial bolus dose of vecuronium and maximal depression of T_1 from the control values. The times for the recovery of T_1 to 25 (clinical duration of action), 50, 75 and 90% (total duration of action) of control, recovery index (time to recovery of T_1 from 25 to 75%) and the time to recovery of a TOF ratio of 0.7 were determined. Maintenance doses of vecuronium were not given and none of the children required reversal of the neuromuscular block.

Analysis of variance was used for the statistical analysis of parametric data. Multiple comparisons after the analysis of variance test were performed using Scheffé's test. Gender distribution was compared using the Chi-squared test. The results are expressed as mean (SD) and $p < 0.05$ was considered statistically significant.

Results

Twenty-nine children were studied (Table 1) and the findings are given in Table 2. Although the onset of action of vecuronium tended to be delayed in the CP and CP + A group, there was no significant difference between the three groups. The mean clinical duration of action was reduced significantly in the CP + A group compared with the control children. The time to 25% recovery of T_1 was significantly shorter in both the CP ($p < 0.05$) and the CP + A group ($p < 0.01$) compared with controls. The times for the recovery of T_1 to 50, 75 and 90% of the control response were significantly shorter in the CP ($p < 0.05$) and CP + A groups ($p < 0.01$) compared with the control group (Table 2).

There was a significant difference in the mean recovery index (time to recovery of T_1 from 25 to 75%) between the control (17.7 min) and the CP + A groups (4.6 min) ($p < 0.01$). Although the recovery index was 7.1 min shorter in the CP group (10.6 min) than in the control children, this was not statistically significant. The times for the recovery of TOF ratio of 0.7 were significantly shorter in both the CP and CP + A groups compared with the control group.

There were no marked muscle relaxant-related cardiovascular, or other, side-effects in any of the groups during the study period.

Table 1 Childrens' physical characteristics. Values are mean (SD).

	Control	CP	CP + A
Age; years	6.9 (2.0)	7.5 (2.8)	8.0 (2.0)
Weight; kg	21.5 (5.4)	19.7 (5.0)	19.1 (5.6)
Girl/Boy	4/6	3/8	2/6

Discussion

Our findings confirm those of a previous study [1] which showed that children with cerebral palsy treated with

Table 2 Neuromuscular effects of an intubating dose of vecuronium 0.1 $mg.kg^{-1}$ in three groups of children. Values are mean (SD).

(*n* = 10)	Control (*n* = 11)	CP (*n* = 8)	CP + A
Onset time; s	95 (33.2)	130 (36.3)	131 (45.9)
Clinical duration of action; min	39 (16.6)	27 (7.7)*	13 (4.2)*
T_1 50% recovery; min	48 (17.3)	32 (8.5)*	15 (5.1)**
T_1 75% recovery; min	58 (17.0)	37 (8.4)*	18 (5.7)**
Total duration of action; min	65 (16.6)	41 (9.3)*	19 (6.1)**
TOF ratio 0.7; min	61 (17.9)	44 (13.1)*	18 (5.4)**
Recovery index; min	18 (6.4)	11 (4.9)	5 (1.7)**

* $p < 0.05$ when compared with control; ** $p < 0.01$ when compared with control. CP, cerebral palsy; CP + A, cerebral palsy taking anticonvulsant treatment; C, noncerebral palsy, nonanticonvulsant controls.

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anticonvulsants are resistant to vecuronium. We have also shown that there is resistance to vecuronium in the absence of anticonvulsant treatment.

The hyposensitivity (resistance) observed in the CP and CP + A groups is illustrated by the short recovery times of T_1 to 25, 50, 75 and 90% of the control response and the short recovery time of the TOF ratio to 0.7.

In the present study, a technique based on accelerometry was used to monitor the response of the adductor pollicis muscle to electrical stimulation of the ulnar nerve [8]. The single twitch response and TOF ratio of accelerography have been shown to correlate well with traditional measurements [9–12]. Moorthy *et al.* [1] using electromyography (EMG) have demonstrated that cerebral palsy patients receiving anticonvulsants may require high doses of vecuronium to produce a complete loss of the twitch response. In the present study, complete loss of twitch height occurred in all patients except in two cases in the CP + A group. In those cases depression of twitch height to more than 95% of control was observed. This may have been due to the neuromuscular monitoring technique used and may be explained by the findings of Meretoja *et al.* [13]. In their study, responses obtained with acceleromyography reflected a neuromuscular block that was 8–11% more pronounced than those obtained with simultaneous EMG.

Following the introduction of neuromuscular-blocking agents into clinical practice, it became apparent that certain pathological conditions including thermal injury [14], upper and lower motor neurone lesions [15, 16] and multiple sclerosis [17] were associated with resistance to these drugs. In addition, patients treated with anticonvulsants [2–7] and steroids [18] were shown to have decreased sensitivity to muscle relaxants. Although there are an increasing number of studies investigating pharmacokinetic and pharmacodynamic differences in these situations, the mechanism of resistance remains uncertain. However, many authors focus on the density of acetyl choline receptors at the neuromuscular junction as a major pharmacodynamic factor in their investigations [19]. Based on the view that cerebral palsy in children has been compared with adult-onset upper motor neurone syndrome, Theroux *et al.* [20] studied the dose–response of suxamethonium in patients with cerebral palsy. They were unable to detect any significant sensitivity to suxamethonium which might have been indirect evidence of resistance to nondepolarising muscle relaxants.

We cannot know whether the resistance to vecuronium in children with cerebral palsy is due to extra-junctional receptor proliferation similar to that demonstrated in multiple sclerosis [17]. This would require estimations of extra-junctional acetyl choline receptor activity which are beyond the scope of our study.

In conclusion, we have shown that vecuronium resistance occurs in children with cerebral palsy regardless of whether or not they are taking anticonvulsant medication. Careful monitoring of neuromuscular block is recommended.

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FORUM

The effects of EMLA and a topical formulation of 4% amethocaine (Ametop) on pain associated with retrobulbar injection

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Summary
Retrobulbar block is commonly performed to provide anaesthesia for cataract extraction. This technique can cause significant discomfort. A prospective, randomised, placebo-controlled trial was carried out to investigate the efficacy of a eutectic mixture of local anaesthetics (EMLA) and a 4% amethocaine topical formulation (Ametop) in reducing the pain of retrobulbar injection. Ametop and EMLA proved to be of similar efficacy, both being superior to a placebo in alleviating the discomfort of retrobulbar block. No significant side-effects were observed with the use of either formulation.

Keywords *Local anaesthetic*; amethocaine, lignocaine, prilocaine. *Ophthalmic*, retrobulbar.

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Local anaesthetic techniques are commonly used to provide anaesthesia for cataract surgery [1, 2]. Several methods can be employed, including retrobulbar, peribulbar and Van Lint injections, as well as subconjunctival and topical anaesthesia [3, 4]. Retrobulbar block is a commonly performed procedure [4, 5], which can be associated with significant pain, due both to needle insertion and to deposition of local anaesthetic solution. Strategies that have been used to reduce this pain include the application of EMLA [6] and of a 1% amethocaine cream [7], and the use of a cold spray [8]. Ametop, a topical anaesthetic formulation of 4% amethocaine, is now commercially available.

A prospective, randomised, placebo-controlled clinical trial was carried out to evaluate the use of EMLA and Ametop when used to reduce the pain of retrobulbar block.

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Methods

With institutional ethical approval and having obtained written, informed consent, 90 patients, ASA grades 1–3, who were scheduled to undergo cataract surgery using retrobulbar block, were recruited. Those with a known sensitivity to local anaesthetics or who were receiving concurrent analgesics were not studied. Patients in the Ametop group received Ametop 1.5 g, applied by an investigator, around the proposed site for retrobulbar injection for at least 1 h and secured in position with an occlusive dressing (Tegaderm, 3M). Care was taken to ensure that none of the Ametop entered the eye. Subjects in the EMLA group had EMLA 2.0 g applied in a similar manner, while a placebo gel (KY jelly, Johnson and Johnson, Dublin, Ireland) was applied to patients in the placebo group. None of the patients received premedication. On the patient's arrival in the anaesthetic room, the topical preparation was removed and the skin and eyes were inspected for evidence of irritation, e.g. conjunctival oedema or erythema. Each inspection was carried out by the investigator who was to perform the retrobulbar block.

After cleaning the skin with Bethidine (povidone iodine 10%, Seton Healthcare, Oldham, UK), retrobulbar injections were carried out with a 27-gauge 32-mm-long blunt-tipped needle (Atkinson 5109, Visitec, Warwicks., UK), introduced at the junction of the lateral one-third and the medial two-thirds of the inferior orbital margin. Four millilitres of lignocaine 2% with 1 : 200 000 adrenaline and 300 units of hyaluronidase were injected. Immediately after performing the block, the same anaesthetist assessed the pain it produced using verbal pain scores, zero representing no pain and 10 representing the worst pain imaginable.

The age and gender of the patients in the groups were compared using unpaired Student's *t*-tests and the Chi-squared test, respectively. The Kruskal–Wallis test was used to compare verbal pain scores in the three groups. A probability < 0.05 was considered significant.

Results

The results from 79 patients were analysed. The results from 11 patients were excluded from the study because of errors in application of the topical agent, i.e. inadequate duration of application or premature occlusive dressing displacement. Demographic data are summarised in Table 1. The three groups were similar with regard to age and gender. Mean (SD) verbal pain scores with both EMLA [2.48 (1.74)] and Ametop [2.56 (1.74)] were significantly lower than with the placebo [4.07 (1.48)], $p = 0.0017$ and $p = 0.008$, respectively (Fig. 1). There was no significant difference between the verbal pain scores of the EMLA group and those of the Ametop group. No evidence of irritation to the skin or eyes was observed in any patient.

Table 1 Demographic data. Values are given as mean (SD).

	Ametop ($n = 27$)	EMLA ($n = 25$)	Placebo ($n = 27$)
Age; years	75.3 (8.9)	76.8 (7.1)	75.7 (7.5)
Sex ratio; male: female	10 : 17	11 : 14	9 : 18

Discussion

Our study illustrates that EMLA and Ametop are equally effective in reducing the pain associated with retrobulbar block.

EMLA contains lignocaine 2.5%, prilocaine 2.5%, arlatone (emulsifier), carbopol (thickener), distilled water and sodium hydroxide. It is commonly used for venepuncture in children but it has been used to provide topical anaesthesia of the skin in a wide variety of clinical settings [9, 10]. In some centres, it is routinely used for all patients undergoing intraocular surgery under local anaesthesia [6]. Ametop is a gel preparation containing amethocaine 4%, methyl-*p*-hydroxybenzoate, propyl-*p*-hydroxybenzoate, water and saline. Different amethocaine formulations have been used successfully to provide topical anaesthesia for various procedures [11–14], including retrobulbar block [8].

The pain of retrobulbar block is caused by both needle insertion and the deposition of local anaesthetic solution. While a small-gauge needle is employed, the anxiety associated with having a needle inserted near the eye may alter the pain-tolerance threshold. Although topical anaesthesia does not decrease the pain associated with local

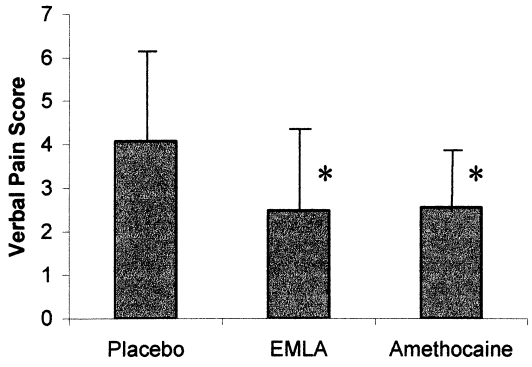


Figure 1 Verbal pain scores in the placebo, EMLA and Ametop groups. Error bars indicate SD. *Significantly different from placebo group, $p < 0.01$.

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anaesthetic deposition posterior to the globe of the eye, it can significantly reduce the discomfort of needle insertion, and hence alleviate the anxiety of retrobulbar injection. The block may be administered more easily if the patient does not react adversely to the needle puncturing the skin.

In our study, no significant side-effects were noted with any of the preparations. EMLA can produce transient stinging, conjunctival congestion and corneal epithelial denudation if it comes into contact with the conjunctival surface [6]. While it frequently causes blanching of the skin [15, 16], and has been associated with one case of methaemoglobinaemia [17], systemic toxic manifestations are very rare [18]. Amethocaine has been noted in the past for its toxicity, especially when applied to mucous membranes [19, 20]. However, various topical formulations of amethocaine have been used without any serious side-effects, with mild transient erythema being the only consequence of note [11–13]. Furthermore, it has been demonstrated that the topical application of the maximum recommended dose (100 mg) produces neither significant plasma concentrations nor clinical evidence of toxicity, and when amethocaine is applied to the skin, as opposed to mucous membranes, both the speed and degree of systemic absorption are reduced [21]. In our study, great care was taken in the application of EMLA and Ametop to ensure that neither formulation came into contact with the conjunctival surface.

In conclusion, the results of our study indicate that both EMLA and Ametop possess similar efficacy in reducing the pain of retrobulbar injection. No adverse effects were noted with either formulation.

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