

FORUM

Factors affecting the spread of bupivacaine in the adult thoracic paravertebral space

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Summary

Factors affecting the spread of bupivacaine in the paravertebral space were investigated in patients undergoing paravertebral nerve blocks for the treatment of chronically painful conditions. Injections of bupivacaine 0.5%, 10–15 ml mixed with depomedrone up to 80 mg were repeated at 2-wk intervals up to a maximum of four times. A blinded observer mapped out the subsequent distribution of sensory loss to cold on both sides of the torso at 5-min intervals after each injection. Age, sex, height and weight did not correlate with the block; nor did injectate volume, mass of bupivacaine, previous posterolateral thoractomy and spread of radiocontrast. Injections repeated at 2-wk intervals in the same patient resulted in different degrees of spread that were unrelated to one another. Time to peak onset of blockade was 40 min in 95% of patients. A single bolus of bupivacaine produces a safe but unpredictable block. Yet to be defined physical properties and anatomical factors are probably key determinants of the spread of bupivacaine in the paravertebral space. This single bolus technique may be better supplanted by a reversion to the older multiple level injection technique.

Keywords *Local anaesthetic. Bupivacaine: nerve block, intercostal nerve.*

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Two aspects of paravertebral nerve blocks that have been poorly investigated are the predictability of spread of local anaesthetic and the reliability of production of the block. To identify any involved factors, we undertook this prospective, single-blinded, longitudinal, observational study of patients undergoing therapeutic paravertebral blocks as a part of their chronic pain management.

Methods

The study was approved by the local ethics committee and written informed consent was obtained from all patients.

Patients listed for therapeutic paravertebral injections as a component of management of chronically painful conditions of the chest and abdomen were included in the study. Those with a pre-existing sensory deficit were

excluded. A single injection technique was used, as described elsewhere [1]. All blocks were performed to the satisfaction of the same experienced operator (J.R.). Correct Tuohy needle placement alongside the vertebral column superior to the transverse process in each patient was confirmed through the injection of 3 ml of radio-opaque dye (Isovist, Schering, Germany). All material was injected with the Tuohy needle opening pointing cranially and contrast medium was tracked with an image intensifier, its shape being categorised as globular or as a cranio-caudal streak. Bupivacaine 0.5%, 10–15 ml mixed with depomedrone up to 80 mg was injected over 60 s.

In the recovery room, a blinded observer mapped out the subsequent distribution of sensory loss to cold on both sides of the torso at 5-min intervals until a stable block had been established, i.e. two 5-min observations were the

same. The cold stimulus used was a mixture of ice in tap water contained in a copper test tube. Each patient also had non-invasive measurements of heart rate, systolic and diastolic blood pressures in both the supine and sitting positions, before injection and at the time of maximum distribution of the block. All the patients had their injection repeated at 2-wk intervals up to a maximum of four times.

Results were analysed with SPSS version 4.0 running in Windows on a PC. Statistical analysis included *t*-tests for comparison of independent and paired means, Mann-Whitney *U*-tests, analysis of variance (ANOVA) for repeat measures and least square regressions.

Results

Twenty-nine patients, 17 females and 12 males with a mean age of 49 yr (range 26–80), underwent a total of 73 consecutive blocks. Table 1 summarises the diagnostic categories for the cohort.

Table 1 Numbers of patients by diagnosis.

Diagnosis	Patients <i>n</i>
Post-thoracotomy neuralgia	9
Intercostal neuralgia	10
Reflex sympathetic dystrophy	4
Post-herpetic neuralgia	1
Costovertebral osteoarthritis	1
Post-nephrectomy neuralgia	1
Idiopathic hyperhydrosis	1
Chest wall pain of unknown origin	2

In nine out of 73 injections (12%) no sensory deficit developed within the observation period. In those cases where a sensory deficit was produced, the mean number of segments above the level of injection which were blocked was 2.2 (SD 2.3) and the mean number below the level of injection was 1.4 (1.1). Thus the total number of segments blocked was a mean of 4.6 (2.7). There was no significant difference in the extent of spread above and below the injection site. Maximal spread of bupivacaine occurred at 40 min following injection in 95% of cases (Fig. 1).

Age, height and weight were not significantly correlated with the maximum distribution of the block (by multiple least square regressions).

The differences in the mean distribution of the blocks between the sexes and the shape of radio-contrast prior to injection were tested by independent *t*-tests. The mean distribution of the blocks was 3.9 (SD 2.7) segments in males and 3 (SD 1.8) in females (*p* = 0.13). The spread of injected radio-contrast did not predict the maximum extent of the block; the mean distribution being 3.9 segments in cases where radiocontrast spread craniocaudally and 3.8 when it remained localised to the point of injection (*p* = 0.88).

Each patient underwent a series of up to four paravertebral injections with the same dose and volume of bupivacaine. Repeated paravertebral blocks in the same patient were analysed by one-way ANOVA for repeat measures, with no statistically significant (*p* = 0.97) differences between successive blocks. However, there was no correlation between successive blocks in the same patient, i.e. between the first and second blocks,

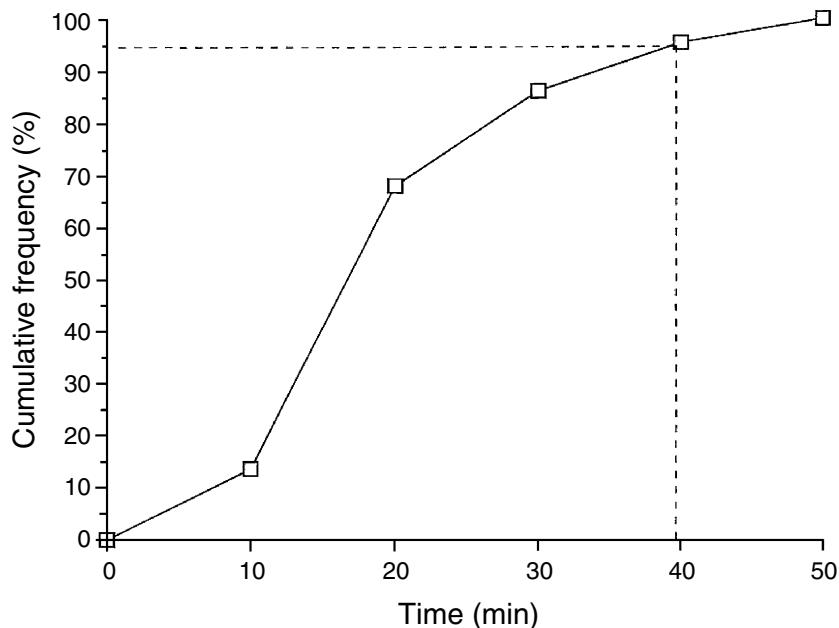


Figure 1 Cumulative frequency of number of blocked dermatomes vs time. Bupivacaine requires approximately 40 min to achieve 95% of maximal block.

second and third blocks and between the third and fourth blocks. The correlation coefficients were all low ($-0.13 < r < -0.001$) and did not reach statistical significance ($0.34 < p < 0.71$).

In nine patients who had undergone a previous posterolateral thoracotomy a mean of 3.8 (SD 3) dermatomes were blocked in contrast with 4.2 (SD 3) in a group without previous surgery. Two-tailed *t*-test for independent means showed no significant difference with a *p*-value of 0.32.

There were statistically significant changes in heart rate and blood pressure as a result of the block, although these were unrelated to posture. No patient required resuscitative measures.

No complications were generated and there was no evidence of bilateral block development.

Discussion

Thoracic paravertebral injection of between 0.15 and 0.3 ml.kg⁻¹ of 0.5% bupivacaine leads to the slow development of a unilateral block of a mean of 3.9 dermatomes (1–11) with a failure rate of 12%. The block is not reproducible in the same patient and physical characteristics, repeated injections or previous posterolateral thoractomy do not influence the spread of bupivacaine. The onset is relatively slow, approximately 40 min, and there is a lack of correlation between block distribution and injectate volume and mass (Figs 2, 3).

All patients in this study were adults. Lönnqvist & Hesser in studying paravertebral nerve blocks in children

have described a positive correlation between the X-ray appearances of the spread of contrast medium and the extent of the block, being significantly greater with longitudinal rather than globular spread [2]. Our observations failed to make that correlation. As a weak, non-statistical increase in the number of blocked segments with increasing age was observed, we suggest that there may be a loss of substance of extrapleural areolar tissue. Spread of injectate may be less contained and block distribution may be greater. Another observed difference between the child and the adult is that no spread of dye, contrast medium or block has been observed to cross the crurae of the diaphragm in the child [3], although it is known to do so in the adult [1], and indeed was seen to do so in this study.

Although extrapleural adhesions and scar tissue following a previous thoracotomy can make successful paravertebral space entry technically more challenging (personal observation, J.R.), no difference in block distribution was found in these patients. When paravertebral blocks are repeated in an individual patient, there was no tendency for the spread to alter in any predictable manner and thus there is no evidence that trauma or scarring from a previous injection had any effect on spread.

Supine heart rate, systolic and diastolic blood pressures all decreased by a clinically small but statistically significant extent, probably due to the effects of the sympathetic block, which is known to be of a greater distribution than the somatic block [4]. In contrast, postural changes in these variables were unaffected by paravertebral blockade, suggesting preservation of cardiovascular reflexes. No

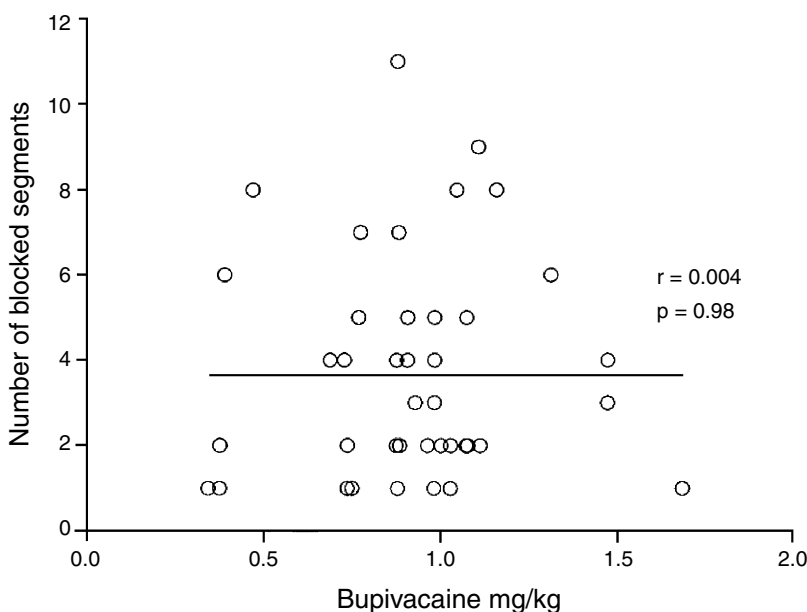


Figure 2 Scatter plot of maximum number of blocked segments against mass of bupivacaine injected into the paravertebral space. Superimposed is the line of linear least square regression.

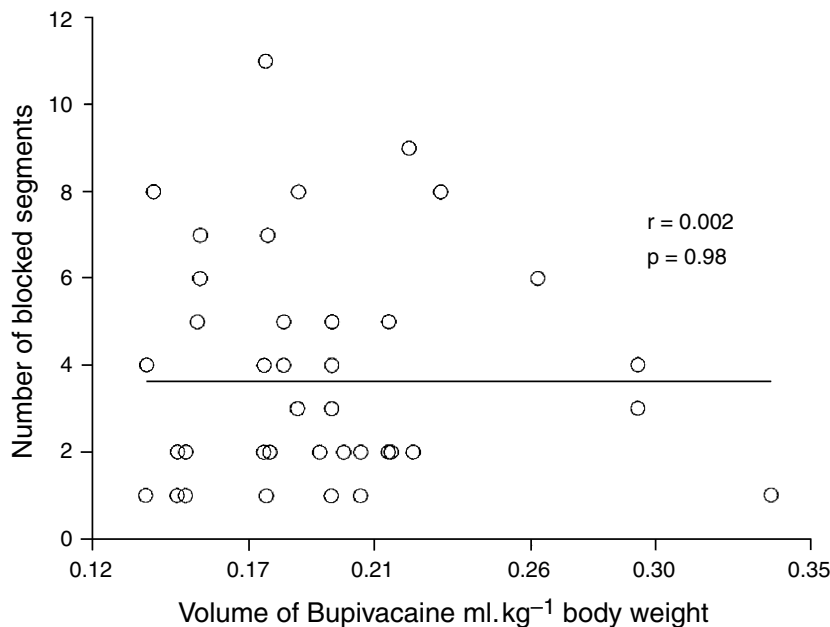


Figure 3 Scatter plot of maximum number of blocked segments against the volume of bupivacaine injected into the paravertebral space. Superimposed is the line of linear least square regression.

complications were generated other than failure to generate a somatic block.

The failure rate of detection of a block to cold by the observer (12%) is in accordance with a prospective multicentre study [5]. A number of methods of improvement of block success have been described, which include catheter insertion under direct vision at thoracotomy [1], space location with the aid of pressure monitoring [6], ultrasound [7], peripheral nerve stimulation [8] and a resurrection of the use of multiple injections at every required dorsal level [9].

The lack of an association between the distribution of the block and the factors that we have studied suggests that the paravertebral space may have additional undisclosed physical properties. With low volumes of local anaesthetic, the paravertebral space appears to behave as a collection of spaces, any one of which can be entered.

A single bolus of bupivacaine produces a safe but unpredictable block. We suggest that the older method of multiple level injection with smaller individual boluses would probably overcome the problems highlighted by this study. Further studies are required. Furthermore, the prolonged onset of the block with bupivacaine may result in an incomplete block at the start of surgery; this would have implications for studies on pre-emptive analgesia, where a nerve block should be fully established before surgical incision.

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FORUM

Variability in determination of point of needle insertion in peripheral nerve blocks: A comparison of experienced and inexperienced anaesthetists

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Summary

Accurate identification of surface landmarks is essential for the successful performance of peripheral nerve blocks. The variability between experienced and inexperienced practitioners in identifying anatomical landmarks has not been studied previously. Anaesthetists were asked to identify the point of needle insertion for posterior lumbar plexus and sciatic nerve blocks on a volunteer using a standard textbook description. The chosen point for needle insertion was described in terms of X and Y co-ordinates, measured in millimetres, from a zero reference point marked on a volunteer's back. Fifteen experienced and 22 inexperienced anaesthetists took part in the study. The lumbar plexus block mean [range] values for the X, Y co-ordinates were 80 [62–108], 66 [46–86] and 92 [49–150], 62 [0–131] in the experienced and inexperienced groups, respectively. The sciatic nerve block X, Y co-ordinates were 77 [62–99], 70 [49–89] and 68 [29–116], 62 [26–93] in the experienced and inexperienced groups, respectively. The variance for the point of needle insertion was significantly greater in the inexperienced group ($p < 0.01$) for both the lumbar plexus and sciatic nerve blocks. We conclude that with increasing experience, there is decreased variability in determining the point of needle insertion using anatomical landmarks.

Keywords *Anaesthesia:* nerve block, education. *Peripheral nerves,* sciatic nerve, lumbosacral plexus.

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Regional anaesthesia is growing in popularity, but also in terms of the complexity of the techniques performed. In a recent editorial, Vincent Chan stated: 'if regional anaesthesia is to be as popular as general anaesthesia, it must approach the same degree of simplicity and ease of success' [1]. In the editorial, he discussed techniques and research performed that have sought to increase needle accuracy and patient safety when performing peripheral nerve blocks. Before needle insertion, anaesthetists rely upon surface anatomical landmarks to predict the ideal insertion point. After needle puncture, we can use paraesthesiae or a nerve stimulator to aid successful nerve location. Accurate identification of surface landmarks is

therefore important for the performance of peripheral nerve blocks. Investigators have examined interpatient differences in surface anatomy and, in particular, differences in deep anatomical structures [2]. These anatomical differences are frequently used to explain why nerve blocks fail. Operator variability in the identification of surface landmarks may be a key factor in the success of regional anaesthesia. We hypothesise that there is a 'learning curve' in successfully identifying skin surface markings that can lead to differences in accurately identifying the correct point of needle insertion. The variability between experienced and inexperienced practitioners has not been studied. In this prospective study,

we examined the accuracy with which consultant and trainee anaesthetists identified the point of needle insertion for posterior lumbar plexus and sciatic nerve blocks.

Methods

After Local Research Ethics Committee approval and informed consent from all participants, a healthy male volunteer (weight = 90 kg, height = 178 cm) was placed in the left lateral 'knee-chest' position. His original position was marked and recorded so that it could be replicated throughout each study. All studies were performed consecutively on a single day. A large clear adhesive dressing was placed over the volunteer's back and buttock area (Fig. 1). Two 15-cm squares were drawn on the volunteer's lower back and buttock using a permanent marker. The lower left corner of both squares was used as the zero reference point for the X and Y axes. All trainee and consultant anaesthetists in the operating suite on a randomly chosen day participated in the study. Trainees and consultants in the cardiac operating theatre suite were excluded from the study for logistical reasons. Each anaesthetist was given a textbook description of how to perform a posterior lumbar plexus block using Winnie's technique [3]: 'First, the intercrystal line is drawn. Second, a line that runs parallel to the lumbar spine is drawn from the posterior superior iliac spine in a cephalad direction. The point of intersection of these two lines is the point of needle insertion'. They were also given a description of how to perform a classical (Labat)



Figure 1 Photograph of volunteer's back showing position and setup for lumbar plexus block.

sciatic nerve block [4]: 'Firstly, the greater trochanter of the femur is identified and marked. The posterior superior iliac spine is identified and marked. A line joining these two bony landmarks is made. The midpoint of the line is marked and a perpendicular line from the midpoint is drawn caudally. A line is drawn from the sacral hiatus to the greater trochanter. Where the line from the midpoint of the greater trochanter and the posterior superior iliac spine intersects the line from the sacral hiatus to the greater trochanter is the point of needle insertion'.

Both textbook descriptions were taken directly from *Raj's Textbook of Regional Anaesthesia*, published in 2002 [5]. The description was printed on a sheet of paper that was handed to every anaesthetist. They were also provided with a photograph illustrating the anatomical surface landmarks, skin markings and the ideal point of needle insertion. Each anaesthetist was asked to identify and mark, using an erasable marker, the point of needle insertion for a right posterior lumbar plexus block and a right Labat sciatic nerve block on our volunteer. They were asked to follow the textbook description provided, and were free to refer to the text or look at the images at any time during their attempt. After identification of the proposed point of needle insertion for the two blocks, the X and Y co-ordinates within each square were measured in millimetres from the zero reference point.

All skin markings were erased from the dressings after each attempt to ensure that the marks were not visible to the next anaesthetist. The level of experience of each anaesthetist and, in particular, his or her experience in performing lumbar plexus and sciatic nerve blocks was ascertained. Anaesthetists who had performed >20 posterior lumbar plexus blocks and >20 sciatic nerve blocks within the previous year were classified as experienced. The data were analysed using unpaired *t*-tests with Welch's correction, and the *F*-test for equality of variance (GraphPad Prism[®] software Version 3.02). A probability value of <0.05 was considered statistically significant.

Results

Thirty-seven anaesthetists (22 trainees, 15 consultants) took part in this study. Fifteen anaesthetists (9 trainees, 6 consultants) were classed as experienced, while 22 (13 trainees, 9 consultants) were classified as inexperienced in performing lumbar plexus and sciatic nerve blocks. The values for the X and Y co-ordinates for lumbar plexus and sciatic nerve block in the experienced and inexperienced groups are shown in Table 1.

The difference in the mean value for the X co-ordinate between the experienced and inexperienced lumbar

Table 1 X and Y co-ordinates for the point of needle insertion for lumbar plexus and sciatic nerve blocks. Values are mean (SD) [range].

	Experienced regional anaesthetists (n = 15)	Inexperienced regional anaesthetists (n = 22)
Lumbar plexus block		
X co-ordinate; mm	80 (12) [62–108]*	92 (23) [49–150]
Y co-ordinate; mm	66 (12) [46–86]	62 (26) [0–131]
Sciatic nerve block		
X co-ordinate; mm	77 (10) [62–99]	68 (21) [29–116]
Y co-ordinate; mm	70 (11) [49–89]	62 (18) [26–93]

*Significant difference between experienced and inexperienced groups, $p < 0.05$.

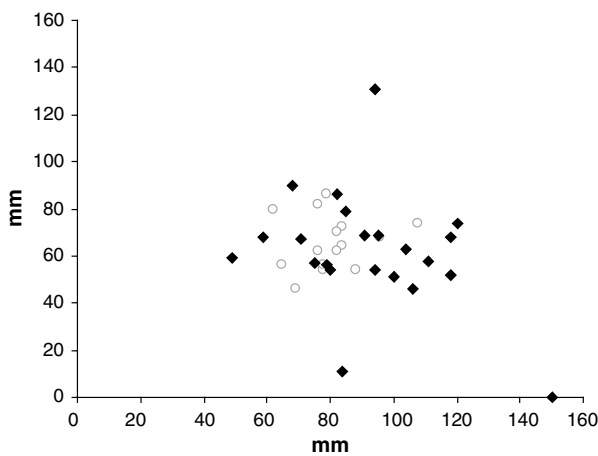


Figure 2 Scattergram of proposed point of needle insertion for lumbar plexus block in experienced (O) and inexperienced (◆) anaesthetists. There was a significant difference in variability between groups, $p < 0.01$.

plexus groups was significant ($p < 0.05$), whereas the Y-value was not significant. The mean values for the X and Y co-ordinates in the sciatic groups were not significantly different. The variance between experienced and inexperienced groups differed significantly ($p < 0.01$) for both the X and Y co-ordinates for the point of needle insertion for both the lumbar plexus and sciatic nerve block (Figs 2 and 3).

Discussion

This study shows that there is a greater variance in the ability to identify the point of needle insertion for posterior lumbar plexus and sciatic nerve blocks in inexperienced than experienced practitioners. The point of needle insertion varied widely (101, 131 mm and 85, 67 mm in the X, Y axis for lumbar plexus and sciatic

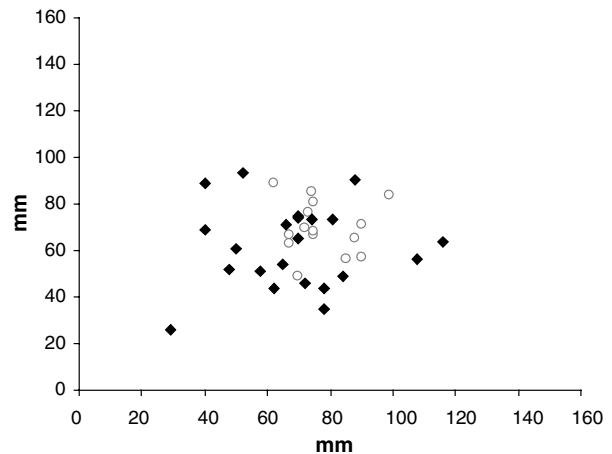


Figure 3 Scattergram of proposed point of needle insertion for sciatic nerve block in experienced (O) and inexperienced (◆) anaesthetists. There was a significant difference in variability between groups, $p < 0.01$.

nerve block, respectively) in the inexperienced group. While the variability in the experienced operator group was significantly less, there was still a broad spread of results (46, 40 mm and 37, 40 mm in the X, Y axis for lumbar plexus and sciatic nerve block, respectively). Various factors may influence this variability. Firstly, the measurements could be influenced by changes in position of the model. However, our model attempted to remain in exactly the same position during the experiment, and this was aided by his outline being marked on the examination table, and the fact that he remained on the table throughout the study period. While movement may account for small differences in accuracy between the measurements, it would have affected both groups equally. Posterior lumbar plexus block involves identifying the iliac crest and the posterior superior iliac spine, and then projecting two lines. Similarly, the classic approach to the sciatic nerve involves identifying the posterior superior iliac spine, the greater trochanter of the femur, finding the midpoint of the line joining these two structures and then dropping a perpendicular line. These projections may increase the margin for error in accurately identifying the point for needle insertion. It must be remembered also that the posterior superior iliac spine and greater trochanter are not single points but wide bony protuberances. This may also account for some variability.

Capdevila *et al.* recently published a computed tomographic (CT) scan study of the lumbar plexus [6]. The distance from the lumbar spinous process to the lumbar plexus on CT scan ranged from 24 to 65 mm in males (a difference of 41 mm in 16 patients). The range amongst 37 anaesthetists in the same vertical plane (the

Y axis) in one subject in this study was 131 mm. In the same paper, Capdevila *et al.* produced a ratio for the determination of the point of needle insertion in lumbar plexus block. This ratio was the distance from the spinous process to lumbar plexus and the distance from the spinous process to posterior superior iliac spine [6]. This ratio had a calculated value of 0.67. Although this ratio provides the clinician with important information as to the exact position of the lumbar plexus in relation to the midline, it will not increase block success if the error arises in defining the surface anatomy before needle insertion. The wide variation in results in this study could be one possible explanation for why there have now been several different published descriptions using different landmarks for both posterior lumbar plexus and sciatic nerve blocks [3,4,7–9]. Others have advocated the use of ultrasound to aid in the performance of peripheral nerve blocks [10,11]. Furthermore, this variability might explain the findings of Hadzic *et al.* who, in a nationwide survey, found that peripheral nerve blocks of the lower extremity still remain underused [12].

While the results in this study suggest that there may be a learning curve, these results might not be applicable to other peripheral nerve block approaches. In certain cases, such as axillary and femoral nerve blocks, the point of needle insertion is aided by the definitive landmark of arterial pulsation. Definitive landmarks such as this may help decrease anatomical variability with these approaches.

While there have been no previous studies using peripheral nerve block techniques that address operator variability, authors have looked at the ease of epidural space identification. Broadbent *et al.*, using a team of four experienced anaesthetists, attempted to identify interspinous spaces in the lumbar region in 100 patients [13]. In 85 instances, the anaesthetists believed they had identified the L₃₋₄ interspace, but they were correct in only 13 cases. In the remaining cases, they were one to four spaces higher than assumed. Among the four anaesthetists in Broadbent's study, experience did not improve the accuracy of identification. That no difference with experience was observed in Broadbent's paper was possibly due to the small number of anaesthetists who participated in the study and the fact that all the anaesthetists were experienced.

In our study, we chose a figure of 20 lumbar plexus and 20 sciatic nerve blocks in the previous year to differentiate between experienced and inexperienced operators. This figure was based on data published by Konrad *et al.* for learning curves in the performance of brachial plexus blocks [14]. The majority of experienced operators in our study perform many more than 20 lumbar plexus and sciatic nerve blocks in a year, and also use a variety of

other peripheral nerve block techniques. In our study, the percentage of consultants classified as experienced operators (40%) is a result of the way our practice is organised within a specific regional anaesthesia division, while the percentage of trainees classified as experienced operators (41%) is a consequence of the residency training programme and the volume and variety of regional techniques to which they are exposed at our institution [15].

In this study, we chose to use a standard textbook description of how to identify the point of needle insertion for these blocks. Newer methods of teaching, such as live demonstrations, video, and CD-ROM presentations, may help decrease the variability seen in our study.

Our study was not an attempt to assess the success rate of lumbar plexus or sciatic nerve block in the two groups, but rather to assess the influence of experience on the identification of the point of needle insertion when a standard textbook description was followed.

In conclusion, we have shown that the variability in identifying the point of needle insertion for both posterior lumbar plexus and sciatic nerve blocks varies significantly between experienced and inexperienced anaesthetists. Whether or not this variability in landmark identification is a significant factor in the time required to perform low-threshold neurostimulation of the lumbar plexus or sciatic nerve and, ultimately, the block success rate, is a question that remains to be answered.

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FORUM

Day of surgery cancellations after nurse-led pre-assessment in an elective surgical centre: the first 2 years

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Summary

We describe a nurse-led pre-assessment system at an elective surgical centre. A targeted referral system was used by trained nurses to direct referrals to a supervising consultant anaesthetist or to the surgical team. Of 2726 patients pre-assessed in the first 2 years, 105 patients (3.9%) were cancelled or postponed for medical optimisation after pre-assessment. There were 137 cancellations (5.0%) on the day of surgery, despite pre-assessment, but only 36 were for anaesthetic or medical reasons. Only eight of these 36 were considered a 'failure' of the pre-assessment system. These results are much better than the cancellation rate of about 11% in the Trust as a whole. There were 18 transfers of patients postoperatively from the elective centre to another hospital. A review suggested that four of these transfers could have been reasonably predictable from the patients' medical history. We conclude that a pre-assessment clinic has an important role to play in minimizing cancellations on the day of surgery and also in reducing the number of patients transferred to other hospitals. This last conclusion has an important implication for the planning of systems in hospitals that perform only elective surgery.

Keywords *Anaesthesia: outpatient. Pre-operative assessment.*

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A number of recent publications have suggested that pre-operative assessment of patients some weeks before surgery can potentially reduce cancellation of operations on the day of surgery [1–5]. It has also been suggested that trained nurses can undertake many aspects of the

pre-operative assessment, with overall supervision by a consultant anaesthetist [6,7]. Recently, Barnes *et al.* described a computer program (OPASS) which guided nurse decision-making in a nurse-led anaesthetic pre-admission clinic solely for orthopaedic surgery. They found that,

when used in conjunction with consultant anaesthetist supervision, pre-assessment resulted in cancellation rates falling from 5% to 2% on the day of admission [7].

We describe the use of a similar decision-making protocol but our situation has some important differences. First, the protocol is not itself computer-based (though results data are recorded on computer) and this allows for greater flexibility in nurse decision-making. Second, our case mix is wide and not confined to orthopaedic surgery. Third, our setting is a short-stay elective surgical ward (open Monday to Friday) in a hospital that has no resident anaesthetist, dedicated general surgical cover at night, or a high dependency unit or intensive care unit on site. These factors impose certain additional constraints which might not apply to a larger, acute unit.

Methods

The study analysed data over the first 2-year period (April 2000–2002) in which patients were admitted to Ward 7 at the Churchill Hospital, Oxford, for their surgery. Ward 7 is a 16-bedded, short-stay ward, open Monday to Friday (which allows for overnight stay during the week). Patients may be scheduled for all general surgical procedures (except major vascular or endocrine surgery, but including thyroid and neck surgery), maxillo-facial surgery (including mandibular and maxillary osteotomies, but excluding major head and neck cancer surgery), and all common urological procedures. The Churchill Hospital site has no resident anaesthetic or general surgical staff and it has no high dependency or intensive care facilities. It is 2 miles from the main John Radcliffe Hospital where these facilities are situated. However, the Churchill does contain medical wards (chest and infectious disease units), the breast surgery unit, all urology surgery, and the renal transplant service. Resident junior medical staff (supported by their seniors) associated with these specialties are based on-site. Other than a limited number of urgent admissions for these specialties, only elective patients are admitted to the hospital. With the exception of radiology, all support services (haematology, blood transfusion, biochemistry, microbiology) are based at the John Radcliffe site.

A nurse-led pre-operative assessment system was instituted for Ward 7 at its inception. The system consists of protocols and guidelines for a 'targeted referral system'. The initial protocols were instituted following discussions with the anaesthetists and the surgical specialities involved. Nurses involved in the pre-operative assessment initially underwent a period of training to familiarise them with the system.

Pre-assessments are performed between 2 and 4 weeks before the booked admission date. A telephone pre-assessment is carried out for patients less than 60 years of

age. If any potential problems regarding suitability for admission are identified, those patients are asked to attend a formal pre-operative assessment. Patients over 60 years of age are all given an appointment for formal pre-operative assessment. At the assessment, a trained nurse takes a full, detailed medical history. Routine examination includes: weight, body mass index, pulse, blood pressure and oxygen saturations breathing air. All the patients have a full blood count, blood urea and creatinine, serum electrolytes, ECG and urine analysis. Other investigations such as peak flow, spirometry, chest X-ray, blood cross-match, and coagulation profile are arranged according to the answers to specific questions in the history. If any aspect of the patient's history causes concern (e.g. is positive for symptoms) or if any of the test results falls outside normal values, the patient is referred by the pre-assessment nurse to the anaesthetist or surgeon as appropriate, for further advice (the 'targeted referral'). Patients are generally referred to the anaesthetist if history or tests relating to vital organ systems are abnormal (e.g. lung function or ECG). Patients are referred to the surgeon if there is a self-evident surgical issue (e.g. a surgical request for additional imaging which has not been performed).

The anaesthetist receives the patient's case notes and pre-assessment findings and the anaesthetist's role is to: a) confirm that the presumed abnormality exists (e.g. confirm that the ECG suspected by the nurse as being abnormal is indeed significant); b) decide whether, on the basis of the pre-assessment findings, further investigations or referral to another medical practitioner (e.g. a cardiologist or general practitioner) for optimisation of the medical condition is necessary; and c) make a judgement as to whether Ward 7 of the Churchill hospital is a suitable site for the operation (i.e. take into account the limited facilities available at the site).

The following data were collected in this study:

- 1 The total number of patients undergoing pre-assessment in nurse-led clinic in the 2-year period.
- 2 The number of patients subsequently referred to the anaesthetist or the surgeon.
- 3 The number of patients so referred whose admission was postponed or cancelled by the anaesthetist or surgeon. This number was taken to represent the 'success' of the system since, if these patients had been admitted, it is likely that they would have been cancelled on the day of surgery.
- 4 The number of patients who were admitted to Ward 7 after pre-assessment, but who were cancelled after admission. This number was taken to represent a 'failure' of the system since pre-assessment should have optimised the patient for surgery. The reasons for the cancellations were recorded.

5 The number of patients who required transfer from Ward 7 of the Churchill to another hospital after their operation. The reasons for the transfer were recorded. One of the aims of pre-assessment was to predict that the Churchill was an appropriate location for the patient's operation. Therefore, such transfers were recorded as a 'failure of the system' if, in retrospect, it might have been reasonably predicted that transfer to another site was likely (e.g. due to need for high dependency care).

Results

Between April 2000–2002, 2890 patients had a planned admission through Ward 7 at the Churchill Hospital. Of these, 599 patients underwent telephone assessment; 2291 appointments were made for the pre-assessment clinic, but 164 patients did not attend this or subsequent invitations to surgical clinics. These patients were eventually removed from the waiting lists. Thus, 2127 patients were seen at the pre-assessment clinic during the study period. Including the telephone assessments, a total of 2726 patients therefore underwent pre-assessment. Of these, 724 (27%) were referred to the anaesthetist and 84 (3.1%) to surgeons. No patient pre-assessed by telephone needed surgical or anaesthetic referral.

After referral, 105 patients were deemed unsuitable for immediate admission to the ward: 35 of these were cancelled outright and 70 were postponed pending further investigations and then admitted for surgery during the study period. This figure of 105 (3.9%) represented the 'success' of the system in correctly identifying those whose surgery might otherwise have been cancelled on the day of surgery.

No patient who had undergone telephone or clinic assessment failed to arrive for admission or make contact with the ward on the day of surgery. There were 137 cancellations (5.0%) on the day of the surgery. The majority of these cancellations (101, or 3.7%) were due to 'non-anaesthetic' factors (Table 1). Lack of theatre time and a decision that the operation was no longer necessary (either made by the surgeon or the patient) appeared to be the commonest reasons for cancellation (43 and 39 cancellations, respectively). Other problems with the 'general' hospital system (patients not starved or surgeon unavailable) were relatively rare (Table 1). The detailed reasons for four other surgical cancellations are listed in Table 2. In retrospect, we judged the management of two of these patients to be specific 'failures' of the pre-assessment system: the surgical decision that one patient was at high risk of pulmonary embolus might have reasonably been made earlier in the pre-assessment process; and in one patient the relevant ultrasound result should have been made available (Table 2).

Table 1 Summary of 'non-anaesthetic' reasons for patient cancellations after admission.

Reason for cancellation	Number of patients cancelled
Lack of theatre time	43
Surgery no longer needed	36
Patient no longer wanted operation	3
Patient not starved	5
Illness of patient's family member	8
Surgeon unavailable	2
Other cancellations by surgeon*	4

*See Table 2 for further details.

Case	Planned surgery	Findings at pre-assessment	Actions taken at pre-assessment	Reasons for cancellation after admission
1*	Varicose veins	Fractured pelvis and pulmonary embolus 8 months previously	Referred to surgical registrar	Cancelled by consultant surgeon, whose opinion differed from registrar's: patient felt still to be at prohibitively high risk of pulmonary embolus
2*	Epigastric hernia repair	None	None	Result of abdominal ultrasound unavailable on day of surgery
3	Varicose veins	None	None	Deep vein thrombosis in the interim period
4	Varicose veins	Previous deep vein thrombosis, on anticoagulants	Referred to surgeons	INR too high despite having stopped anticoagulants for 48 h

Table 2 Details of other cancellations by surgeons after admission.

*Represents cases judged a failure of the pre-assessment system.

Table 3 Details of cases cancelled by anaesthetists on day of admission.

Case	Planned surgery	Findings at pre-assessment	Action taken at pre-assessment	Reasons for cancellation on day of surgery
1*	Varicose veins	Long-standing heart murmur	None	Murmur found to be symptomatic by anaesthetist
2	Cystoscopy	Known carcinoma of cervix with aorto-iliac vein thrombosis	Referred to anaesthetist, whose opinion was that patient was suitably optimised	History and new ECG changes suggestive of possible recent myocardial infarction
3	Laparoscopic cholecystectomy	Stable asthma	None	Chest infection on day of admission
4	Cystolithopaxy	Diabetes, alcohol abuse	Referred to anaesthetist and then to GP, to improve glycaemic control	Blood sugar unacceptably high on admission despite changes in therapy by GP
5	Laparoscopic cholecystectomy	None	None	Serum potassium <3.0 mmol.l ⁻¹ ; new onset
6	Inguinal hernia repair	Hypertension, myocardial infarction, pacemaker	Referred to anaesthetist, whose opinion was that patient was suitably optimised	Renal dysfunction with high serum potassium; new onset
7	Umbilical hernia repair	Diabetes, mild hypertension, aortic valve replacement	Referred to anaesthetist, whose opinion was that patient was suitably optimised	Upper respiratory tract infection on day of admission
8*	Inguinal hernia repair	Chronic obstructive airways disease, mild hypertension, vocal cord leukoplakia	Referred to anaesthetist, whose opinion was that patient was suitably optimised	Opinion of anaesthetist on the day differed from pre-assessment anaesthetist
9*	Para-umbilical hernia	Obese (BMI > 35)	None	Anaesthetist felt that patient was not suitable for surgery at Churchill Hospital
10*	Haemorrhoidectomy	Multiple ectopics on ECG	None	Anaesthetist felt ECG required more investigation
11	Inguinal hernia repair	None	None	Chest infection on day of admission
12*	Trans-urethral resection of prostate	Chest pain already under investigation	None	Cancelled pending completion of cardiac investigations
13*	Varicose veins	Myocardial infarct 3 months previously	Referred to anaesthetist, whose opinion was that patient was suitably optimised	Anaesthetist on day of admission felt a 6-month interval after infarct more appropriate for elective surgery
14	Excision branchial cyst	Asthma	None	Chest infection on day of admission

*Represents cases judged to be 'failures' of the pre-assessment system.

Anaesthetists cancelled 36 (1.3%) patients on the day of admission: the majority (22) were cancelled due to hypertension on the day of surgery. All of these hypertensive patients had been referred to their general practitioner by the anaesthetist following their pre-assessment, and appropriate treatment had been commenced, but the blood pressure on the day of admission was still too high. Therefore, these cancellations were not considered 'failures' of the pre-assessment system. Details of the other 14 patients cancelled by anaesthetists are shown in Table 3. In eight patients, the clinical abnormality resulting in the cancellation on the day of admission was not present at the time of pre-assessment (e.g. a new chest infection or new cardiac problems). However, the management of six patients was considered in retrospect a 'failure' of the pre-assessment system. For example, the medical history regarding a cardiac murmur taken by the nurse at pre-assessment differed from that obtained by the anaesthetist on the day of surgery (patient 1; Table 3).

Postoperatively, there were 18 unplanned transfers to another hospital (Table 4). The transfer of four patients was considered reasonably predictable in view of their medical history, and so these cases were considered 'failures' of the pre-assessment system. Three examples of such cases are:

1 Two patients were obese and asthmatic but a failure to follow the pre-assessment protocol resulted in failure to perform lung function tests, which might have been objective predictors of a poor outcome after surgery (patients 4 and 6; Table 4).

2 Surgery in a patient with a complex blood disorder should have been performed at a site where haematology services are available on-site (patient 1; Table 4).

3 A patient needing home oxygen should have had surgery at a site where intensive care facilities were available (patient 11; Table 4).

Based on our definitions of 'failure' of the system, there were a total of just 12 failures out of 2726 pre-assessments

Table 4 Unplanned postoperative transfers from Churchill Hospital to other sites.

Case	Planned surgery	Findings at pre-assessment	Action taken at pre-assessment	Reasons for transfer to another hospital	Actions which might have prevented transfer, or reasons why operation should best have been performed elsewhere
1*	Anal sphincterotomy	Sideroblastic anaemia	Liaison with Haematology Department: 3-unit blood transfusion given	Postoperative pancytopenia	Surgery might best have been undertaken at hospital with immediate Haematology support on site
2	Inguinal hernia	None	None	Postoperative wound haematoma	
3	Laparoscopic cholecystectomy	None	None	Postoperative biliary leak	
4*	Incisional hernia	Smoker, obese (BMI > 30)	Referred to anaesthetist who considered patient optimised	Postoperative wound haematoma and chest infection	Pre-operative lung function tests might have indicated risk or need for postoperative support
5	Laparoscopic cholecystectomy	None	None	Postoperative internal haemorrhage	
6*	Wisdom teeth extraction	Smoker, asthma, obese (BMI > 30)	Referred to anaesthetist, who considered patient optimised for surgery	Postoperative chest pain and breathlessness (suspected pulmonary embolus)	Pre-operative lung function tests might have indicated risk or need for postoperative support
7¶	Inguinal hernia	None	None	Postoperative respiratory arrest	
8	Laparoscopic cholecystectomy	Asthma	None	Proceeded to open surgery and bowel repair	
9	Laparoscopic cholecystectomy	None	None	Injury to common bile duct	
10¶	Parathyroidectomy	None	None	Post-extubation stridor and vocal cord palsy	
11*¶	Neck exploration	Chronic obstructive airways disease on home oxygen	Referred to anaesthetist: local anaesthesia advised	Anaesthetist on day of admission felt patient suitable for general anaesthesia: difficult weaning from anaesthesia postoperatively and possible Addisonian crisis	Medical history seemed sufficient to indicate that operation should be performed at hospital with intensive care unit on site
12	Varicose veins	Hypertension and rheumatoid arthritis	Referred to anaesthetist, who considered patient optimised	Postoperative abdominal distension, diverticular perforation	
13	Laparoscopic cholecystectomy	None	None	Persistent postoperative nausea and vomiting	
14	Laparoscopic cholecystectomy	None	None	Postoperative pulmonary embolus	
15	Inguinal hernia repair	Hypertension	None	Postoperative wound haematoma	
16	Incisional hernia repair	None	None	Delayed wound healing	
17	Laparoscopic cholecystectomy	None	None	Suspected problems with common bile duct, resolved with observation	
18	Laparoscopic cholecystectomy	None	None	Postoperative biliary leak	

*Denotes 'failure' of pre-assessment system; all transfers were to general medical or surgical wards at the John Radcliffe Hospital, except those marked ¶ which were transfers to the intensive care unit at the John Radcliffe Hospital.

in the 2 years, amounting to a failure rate of 0.4%. Based on our definition of 'success', in terms of correctly identifying patients whose surgery might be cancelled before their admission, there were 105 cases representing 3.9% of those pre-assessed. Thus for every instance in which the pre-assessment system might have been judged to have failed, there were 10 instances in which it could be regarded as having been successful.

There was no prospective control group, nor any historical data from Ward 7 before inception of the pre-assessment system. However, comparison was made with cancellations from the Trust as a whole (excluding the figures for Ward 7). For the period in question, the Trust's average cancellation rate on day of surgery was 10.9%.

Discussion

The main finding of this study is that the nurse-led pre-assessment system resulted in a postadmission cancellation rate of 5%. Around 4% of the planned admissions to hospital were cancelled or postponed during pre-assessment. Had this group of patients not been managed at pre-assessment, it is very likely that their surgery would have been cancelled instead on the day of surgery. This would have resulted in a cancellation rate of approximately 9%. It is interesting that this figure so closely resembles the mean cancellation rate across our Trust (10.9%), where such a pre-assessment system is not in use. It is important to stress that for the Trust as a whole, other factors such as staffing shortages or emergency admissions delaying elective surgery may contribute more to the cancellation figures than they do for Ward 7.

It would have been desirable to have a control group of patients who did not undergo pre-assessment, so that direct comparison could be made. Unfortunately, we do not have such data as pre-assessment was undertaken in Ward 7 from its inception. However, the comparison with the Trust average indicates that pre-assessment has been effective and approximately halves the cancellation rate. Other groups have reported similar results. Asimakopoulos *et al.* reported a cancellation rate of around 3% on day of admission: there was no control group in their small study, but they estimated a cancellation rate of 8% without pre-assessment [8]. Barnes *et al.* obtained data from their unit before and after institution of pre-assessment; their cancellation rate fell from 5% before a consultant anaesthetist was involved in supervising the clinic to 2% after involvement started, which also represents an approximate halving of the cancellation rate [7]. However, their data were confined to a selected group of patients (orthopaedic surgery only), which

might explain their generally low cancellation rates before the pre-assessment clinic was started. Reed *et al.* reported a more dramatic cancellation rate of only 1%. Remarkably, they found that 19% of patients pre-assessed had their surgery postponed to investigate and optimise an abnormal result in the history, examination or baseline tests. If there had been no pre-assessment, therefore, their cancellation rate might have reached 20% [6].

We have assumed that *all* 105 patients whose admission was postponed following pre-assessment were 'successes' of the system. Our assumption was that, had these patients been admitted, there was sufficient evidence that an anaesthetist (or surgeon) would have cancelled the patients' surgery on the day. However, we cannot be certain of this and so our measure of 'success' might be an overestimate. Furthermore, we have no data which indicates that postponing these patients actually improved the outcome of their surgery. Balanced against this, we have assumed that the four cases transferred postoperatively *all* represent 'failures' of the system (Table 4). This must be speculative, since there is no evidence that performing these patients' surgery at another hospital site would have improved the outcome. So, to a small extent, we may have also overestimated cases of 'failure' of the system.

Table 3 reveals two instances in which the opinion of the anaesthetist on the day of surgery differed from that of the anaesthetist who had made the pre-assessment decision. Barnes *et al.* also report three such instances in their group of 463 patients [7]. Although this represents a very small number of cancellations, it would be ideal if the same anaesthetist who performed the pre-assessment also conducted the anaesthesia [9]. However, the limitations of the service probably make this impossible. It is important to emphasise that the primary function of the anaesthetist involved in pre-assessment is simply to make a judgement on the degree to which the patient is optimised for surgery (e.g. to ensure that the appropriate treatments and investigations for any medical problems have been instituted). Their function is not to specify or prescribe a specific form of anaesthesia for another colleague to follow [10].

We did not use a computer-guided referral system (such as OPASS [7]), which results in about 75% of patients being referred to the anaesthetist [7]. We anticipated therefore that our more flexible referral system would result in a larger referral rate. In fact, we found that only 34% of patients were referred. This figure is similar to referral rates of 22% quoted by others [11]. The difference with OPASS-guided systems might suggest that our protocol missed a large number of problems, but this was not the case. Table 3 indicates that nurses at

the pre-assessment clinic 'overlooked' only four problems (cases 1, 9, 10, 12; Table 3).

Finally, we did not perform a formal cost analysis. The running costs of the protocol itself are negligible (since the protocols are on photocopied sheets). The main costs are related to manpower. We estimate that 10 half-day sessions of a pre-admission nurse are necessary to staff the clinic. Barnes *et al.* estimated that, for a referral rate to the anaesthetist of 450 patients per year, about 0.5 consultant anaesthetist sessions per week would be necessary [7], and the estimate based on our figures would be similar. Added to this might be about 0.5 sessions per week for other management and audit duties involved in supervision. Balanced against these costs are the savings in cancellations on the day of surgery and, as the clinic is nurse-led, the positive impact in relation to limiting junior doctors' working hours [12].

Our methodology has some important strengths. First, we have attempted to judge whether the last-minute cancellations were preventable (i.e. whether it was a 'failure' of the pre-assessment system or not). Previous studies have not attempted analysis of this aspect of the service. We found the failure rate to be extremely low (0.4%) and, as no system can be perfect, it is probably difficult to improve upon this. Second, we documented those instances that suggest that the pre-assessment system is working well (the 'successes'). We estimated a success rate of 4%, which we regard as high. Third, we have included data concerning the unplanned transfer of patients from our unit. Some of these transfers perhaps arise largely as a result of features unique to our hospital. However, this data is important; such transfers should be kept to a minimum since they add considerably to overall costs and to patient risk. Table 4 suggests that there is some room for improvement in this regard since the incidence of *reasonably foreseeable* transfers should be zero.

The three main causes of cancellations on the day of surgery in our study were: lack of theatre time; the operation no longer judged necessary; and hypertension. If further significant reductions in cancellations are to be achieved in our unit, each of these will need to be examined in more detail.

There are many factors contributing to lack of theatre time, the majority probably related to theatre staffing issues, which are beyond the scope of a pre-assessment clinic. The possibility that over-ambitious surgical lists might contribute to the problem might be addressed by collecting data on mean operation times (including anaesthetic and turnover times) and applying this data to the planning of lists.

It was surprising that so many patients waited for operations that were not strictly necessary (Table 1: 42/132, or 32% cancellations). Koay & Marks also found

that cancellation for this reason occurred in 25% of their small study group [12] and van Klei *et al.* found it remained a major factor even after introduction of pre-assessment [13]. This problem could be addressed in a number of ways. First, surgical teams might identify particular operations for which this commonly occurs, and review this selected group before admission (though this might add to pressure on surgical clinic waiting times [14]). Second, surgeons might consider closer personal involvement in the pre-assessment clinic itself. Third, there may be an increased screening role for nurses in questioning patients about continued symptoms or need for surgery, and a telephone call to the patient the day before surgery might have an impact [15,16].

The pre-operative management of hypertension remains a difficult area. In our data, 22 patients who had been correctly managed after pre-assessment were nonetheless found to have unacceptable blood pressure levels on admission. West & Galasko also found that hypertension continued to be a reason for cancellation in 40% of their study group 4 weeks after pre-assessment and commencement of treatment [17]. These results suggest that the treatment of hypertension in the pre-operative period might need to be more 'aggressive'. It is interesting that recent guidelines advise that target pressures for long-term medical therapy should be lower than previously recommended [18]. Alternatively, it is possible that insufficient time was given to allow the medication to work, and perhaps more than 4 weeks is necessary. Some studies have shown that efficacy of antihypertensive medication increases with treatment duration for up to 3 months [19]. Unfortunately, Dix & Howell reported such great variability in individual practice among anaesthetists concerning hypertension that firm protocols may be difficult to develop or enforce [20].

Finally, it has been suggested that Trusts reconfigure their acute and elective services. Some centres may be tailored to provide only elective surgery, perhaps providing this largely in free-standing sites using short-stay beds [21]. If such a policy is implemented, it will be essential to minimise unplanned transfers from the elective centre to an acute hospital. Our results suggest that pre-assessment would have an important role helping to predict which patients might suitably have their surgery in such elective centres.

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FORUM

A comparison of intra-operative or postoperative exposure to music – a controlled trial of the effects on postoperative pain

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Summary

The effect of intra-operative compared to postoperative music on postoperative pain was evaluated in a controlled trial. In all, 151 patients undergoing day case surgery for inguinal hernia repair or varicose vein surgery under general anaesthesia were randomly allocated to three groups: group 1

listened to music intra-operatively, group 2 listened to music postoperatively and group 3, the control group, listened to 'white noise'. The anaesthetic and postoperative analgesic techniques were standardised. Pain was assessed using a numeric rating scale (0–10) and patients requirements for postoperative morphine, paracetamol and ibuprofen was recorded. The effect of music on nausea, fatigue and anxiety was also investigated. The results showed that patients exposed to music intra-operatively or postoperatively reported significantly lower pain intensity at 1 and 2 h post-operatively and patients in the postoperative music group required less morphine at 1 h compared to the control group. No differences were noted in the other variables. This study demonstrates that there is a short-term pain-reducing effect of music therapy however, the beneficial effects do not differ if the patient is exposed to music intra-operatively or postoperatively.

Keywords *Pain*: measurement, postoperative.

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An optimal postoperative pain control programme should be effective and safe, produce minimal side-effects, facilitate recovery and be easily managed by patients and staff. It should include both pharmacological and non-pharmacological methods, either used alone or in combination [1–3]. Music is a non-pharmacological technique that is inexpensive, non-invasive and has no side-effects that has been shown to reduce postoperative pain [3–7]. Interventions with music pre-operatively can modulate the patient's response to stress [8–10], music intra-operatively can also reduce sedative requirements [11], and music postoperatively has been shown to reduce fatigue [6] and can also be used to distract the from noise in the postanesthesia care unit (PACU) [1]. It has also been suggested that the use of headphones with music may reduce or eliminate awareness during anaesthesia [12]. However, other studies have failed to confirm the impressive results of music therapy [13].

Previous studies have reported the pain-reducing effects of music played intra-operatively and postoperatively [6,7]. However, it is unclear when the most effective timing for music therapy is, intra-operatively or postoperatively. Therefore, the aim of this study was to evaluate the most appropriate timing for music therapy either during surgery or during the recovery period following surgery. We also measured the duration of analgesia, nausea, fatigue and anxiety.

Methods

Sample and setting

In all, 151 consecutive ASA I–II patients, aged 21–85 yr, were included in a prospective, randomised clinical investigation. The local ethics committee approved the study and all patients gave their informed consent. The

patients were scheduled for day-case surgery of varicose veins or inguinal hernia repair under general anaesthesia. The same surgeon performed all the operations. All patients had a good understanding of Swedish and none had any hearing impairment, drug abuse or any known psychiatric or memory disorder.

Premedication was not given to patients participating in this study. Anaesthesia was induced using propofol 1–2 mg.kg⁻¹, fentanyl 1–2 µg.kg⁻¹ and was maintained using 70% nitrous oxide in oxygen and with at least 1.2 MAC end-tidal sevoflurane concentration. At the end of the operation, all inguinal hernia patients received local anaesthetic infiltration using 10 ml 0.5% bupivacaine into the surgical wound. Upon arrival in the PACU and for the first 2 h, all patients received nasal oxygen, 2 l.min⁻¹. Postoperatively, patients received 100 mg of diclofenac p.r. and on request, intravenous morphine 1–3 mg until analgesia was adequate, i.e. visual analogue scale (VAS) ≤ 3. In addition, all patients were prescribed paracetamol 4 g.day⁻¹ and ibuprofen 1.6 g.day⁻¹ orally following discharge.

Intervention

The patients were randomly allocated to three groups: two intervention groups and one control group using a computer-generated randomisation list. The patients in the IM-group were exposed to intra-operative music and a blank compact disk (CD) postoperatively. The patients in the PM-group, were exposed to a blank CD intra-operatively and postoperative music. The patients in the control group were exposed to a blank CD at both times.

The type of music played via headphones was soft instrumental with a slow, flowing rhythm [14] and included seven different melodies for 43 min of new-age synthesizer [15] using a compact disk player (Discman,

Model No D-181, Sony Corp., Tokyo, Japan). The blank CD showed numbers in the window as in regular CD's; however, there was no sound. For the observer the blank CD and regular music CD were indistinguishable. All CD players were set to the same audio settings and were not audible to anyone in the immediate area. All the patients had headphones that covered the whole ear such that no sounds from the operating theatre could leak in or out. The anaesthetist, nurse anaesthetist, surgeon and operating room (OR) nurses and PACU personal were blinded to the CD selection.

Intraoperatively, the CD was set on an auto-reverse mode and played continuously from the end of induction of anaesthesia (i.e. when the laryngeal mask was secured) until wound dressing.

Postoperatively, the CD was played from the time of arrival at the PACU and for 1 h. All CD-players were set to the same audio settings and all the patients had headphones allowing conversation between the patient and the PACU personnel. The same researcher (U.N.) supervised the research procedure.

Outcome assessment

Preoperatively, all patients were asked to evaluate their anxiety level on a numerical rating scale (NRS). The NRS contained an 11-point scale, from 0 = complete relaxation to 10 = worst feeling of anxiety possible [11]. Postoperatively, the participants rated their pain intensity on NRS from 0 = no pain to 10 = maximal possible pain, every ½ h for 2 h in the PACU. The NRS has been tested for reliability and validity in a Swedish population [16]. The total amount of postoperative morphine requirements in the PACU was calculated from the patients' records. Nausea, fatigue and anxiety were measured and assessed by a NRS from 0 = no symptoms to 10 = maximal possible symptoms.

Pain, nausea, anxiety and fatigue were also assessed after 1 h in the PACU, at discharge, at home in the evening of the day of surgery, days 1 and 2 after surgery in the morning and in the evening. However, fatigue was not assessed in the morning of days 1 and 2 following surgery. On the morning of days 1 and 2 following surgery the patients rated their experience of night sleep from 0 = not at all good to 10 = extremely good. The patient recorded those variables in a patient diary. The patient diary also included two questions, one regarding awareness under anaesthesia 'Did you hear anything whilst you were anaesthetized?' (yes, no or I don't know) and one regarding satisfaction of the peri-operative care measured by NRS (0–10) from 0 = no satisfaction with the care to 10 = maximum satisfaction with the care.

The amount of paracetamol and ibuprofen on the day of surgery and days 1 and 2 following surgery were also

recorded by the patient in the patient diary. The patients returned the diary 3 d after surgery.

Statistics

Descriptive statistics are presented as arithmetic means and standard deviation for the sake of clarity, although the questionnaire is referred to as an ordinal scale. Kruskal–Wallis ANOVA followed by Mann–Whitney *U*-test and a Bonferroni correction were used to test differences between groups. A *p*-value of <0.05 was considered statistically significant. The computer program SPSS for Windows was used for all statistical analysis.

Calculation of sample size was based on the following assumptions concerning a one-way analysis (three groups) for pain (VAS): significance level 5%, power 80%, common standard deviation 1.530 and a difference in mean characterised by a variance of means of 0.193. These assumptions suggested a sample size of 40 in each of the three groups. We therefore decided to study a sample size of 50 patients in each group.

Results

In all, 151 patients were included in this study. There were no significant differences between the three study groups regarding the demographics, pre-operative anxiety, anaesthetic and surgical factors (Table 1).

Patients who were exposed to music intra-operatively and postoperatively reported significantly lower pain scores at 1 h (*p* < 0.01) and 2 h (*p* < 0.01) compared to patients in the control group. The patients in the PM-group required less morphine after 1 h in the PACU, 1.2 mg compared with 2.5 mg in the control group, *p* ≤ 0.05. (Table 2).

Table 1 Comparison of patients' characteristics, pre-operative status, anaesthetic and surgical factors. There are no statistical differences between the groups.

	IM-group (<i>n</i> = 51) mean (SD)	PM-group (<i>n</i> = 51) mean (SD)	Control (<i>n</i> = 49) mean (SD)
Age year	54 (14.5)	53 (14.7)	54 (12.2)
Gender male/female*	39/12	35/16	33/16
ASA I/II*	43/8	39/12	37/12
Type of surgery	36/15	33/18	30/19
Hernia Inguinal/Varicose veins*			
Pre-operative anxiety 0–10	2.2 (2.2)	1.9 (2.1)	2.5 (2.6)
Duration of anaesthesia min	47 (11.1)	49 (10.8)	49 (8.6)
Duration of surgery min	23 (8.4)	23 (7.3)	24 (7.2)
Duration of intra-operative intervention min	42 (10.8)	44 (10.6)	43 (8.7)
Perioperative use of fentanyl µg	99.0 (29.6)	89.7 (32.9)	98.5 (28.6)

IM = Intra-operative music, PM = Postoperative music.

*Number of patients.

Table 2 Postoperative pain and morphine requirement at the postanaesthesia care unit following interventions with music. p-value based on Kruskal–Wallis ANOVA by ranks followed by Mann–Whitney test with Bonferroni correction. Results are expressed as mean (SD).

	IM-group (n = 51)	PM-group (n = 51)	Control (n = 49)	p-value
Pain, after 1 h 0–10	2.6 (1.5)	2.7 (1.6)	3.6 (1.7)	< 0.01 ^a
Morphine, after 1 h mg	1.6 (2.1)	1.2 (1.7)	2.5 (2.8)	< 0.05 ^b
Pain, after 2 h 0–10	1.8 (1.1)	1.7 (1.2)	2.6 (1.6)	< 0.01 ^c
Morphine, total amount mg	2.0 (2.5)	1.9 (2.8)	3.1 (3.6)	n.s.

IM = Intraoperative music, PM = Postoperative music.

^aDifference between IM and control, $p = 0.010$ and PM and control, $p = 0.034$.

^bDifference between PM and control, $p = 0.019$.

^cDifference between IM and control, $p = 0.015$ and PM and control, $p = 0.005$.

Pain scores on discharge, at home on the day of surgery and days 1 and 2 following surgery were generally low (range 1.1–2.8), and there were no significant differences between the three groups. With regard to the patient's own ratings of postoperative anxiety, fatigue, nausea and requirements of paracetamol and ibuprofen there were no significant differences between the groups. The scores for postoperative anxiety were 0.2–1.8, for fatigue 1.5–3.8 and for nausea 0.1–1.2. The result of patients' satisfaction with the peri-operative care showed high scores: IM-group 9.9, PM-group 9.9 and control group 9.8, and there were no significant differences between the groups.

No patient reported any awareness under anaesthesia and all patients in the postoperative intervention group remembered that they had been listening to music.

Discussion

The results of this study demonstrate that music may reduce the patient's perception of postoperative pain. However, we found no differences in the perception of pain between those patients exposed to music intra-operatively and those exposed postoperatively. The duration of this pain-reducing effect seems to be relatively short. In the present study it lasted for 2 h following termination of the intervention. This short-term analgesic effect of postoperative music may be due to distraction through cognitive coping strategies by competing stimuli that reduce pain perception [17]. In our earlier study, intra-operative music also had a pain-reducing effect [6]; however, the mechanism of the pain-reducing effect of music during the intra-operative compared to the postoperative period is less clear.

The pain-reducing effect of intra-operative music is unclear. Pain can be a significant problem following inguinal hernia and varicose vein surgery [18,19]. In this study, however, the pain scores were generally low. This could be an effect of the local anaesthetic wound infiltration or a positive placebo response as reflected by the high satisfaction with the peri-operative care.

In the OR and the PACU, noise levels can sometimes be as high as > 70 dB and the use of headphones for music as a distraction from this noise has been recommended [1,8]. However, it is important that the music is played to the OR patient through headphones instead of via loudspeakers, which could distract the OR staff. In one study it has been shown that 51% of the anaesthetists felt that OR music was distracting when a problem was encountered during the anaesthetic and 11.5% felt that music might distract them from alarms [20].

The efficacy of music in reducing peri-operative anxiety has been previously reported [8–10]. In this study, anxiety was not influenced, possibly because the levels of pre-operative anxiety were already low. These findings are consistent with other studies that have demonstrated relatively low levels of pre-operative anxiety in ambulatory surgery patients [7,11].

Instrumental music with slow, flowing rhythms that duplicate a pulse rate of 60–80 beats.min⁻¹ is generally thought to be relaxing [14]. Some music therapists suggest that classical music is the best music for relaxation because of its consistent tone and form [21]. Pain reduction through relaxing music has been demonstrated by using very different musical styles such as soothing music of synthesizer, harp, piano, orchestral or slow jazz [3–5], soothing synthesizer accompanied by sounds of sea waves [6] or classical music [7]. In the present study, new age music was used. However, there is no consensus regarding what type of music has the best analgesic effect.

Although it was not possible to conduct a double-blind trial due to the type of intervention, we believe that the study was well designed and controlled.

Currently, it is believed that multimodal analgesic regimens provide the best postoperative analgesic effect. Different analgesic drugs are combined to achieve additive or synergistic effects in such multimodal techniques. Music therapy could be a component of multimodal analgesia because it is simple, pleasant, inexpensive, non-pharmacological and has no side-effects.

In conclusion, to our knowledge this is the first study to compare and measure the pain-reducing effect of music therapy during or immediately following anaesthesia. Our results suggest that the analgesic effect is of short duration and this beneficial effect is similar whether the patients are exposed to music intra-operatively or postoperatively.

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FORUM

The information requested by patients prior to giving consent to anaesthesia

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Summary

Patients in a teaching hospital in Scotland were given the opportunity to ask for further information relating to their peri-operative anaesthetic management. One investigator visited all of the patients pre-operatively and asked a standard list of anaesthetic-related questions. Our objectives were to

determine what additional information patients would request before giving their consent to anaesthesia. The majority of patients ($n=469$, 67%) had no further questions at a point when so-called consent could have been obtained. Of the questions asked, 209 (66%) were related to anaesthesia and 93 (30%) to the proposed surgery. Only two patients in the group studied requested a full explanation of their peri-operative anaesthetic management. The question most commonly asked related to the duration of surgery, with less priority being given to questions relating to complications of anaesthesia.

Keywords *Anaesthesia. Medicolegal. Patient's rights: informed consent.*

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Anaesthetists, like other doctors, have a duty to obtain 'informed consent' from their patients. However, confusion still exists amongst anaesthetists as to precisely what information they are required to give and what information their patients want to receive.

Patients need to be given a clear explanation of any treatment proposed, including any risks and alternatives, before they decide whether to agree to the treatment. Although there have been many studies looking at how much information patients desired prior to anaesthesia, usually by filling in a questionnaire [1], it is not known what percentage of patients, given the opportunity to request further information, fail to request it or refuse it.

This prospective survey sought to find out what information patients actually requested before giving their consent to anaesthesia.

Methods

This survey was conducted by one of the authors (N.P.) working in a teaching hospital in Scotland. Permission was granted from the Local Regional Ethics Committee. Patients were visited pre-operatively, either on the evening before or on the day of surgery (if admitted that day). They were excluded if they were unable to give consent, had previously been anaesthetised by the above consultant at any time or by any other anaesthetist in the previous year, were aged under 16 years, or were emergency (but not urgent) cases. After exclusions, 700 consecutive patients were included in the survey.

After introducing himself to the patient, the anaesthetist asked a standard list of questions (Fig. 1). Following this, patients were offered the opportunity to ask questions or request further information concerning any aspect of their peri-operative management. The questions and comments recorded from each patient form the basis of this audit. Following this, if appropriate, further information was then given to the patient. Patient demographic data were not recorded.

Results

In all, 700 patients participated from the various surgical lists described in Fig. 2. Of these, 469 (67%) patients had no further questions to ask the anaesthetist following the questions in Fig. 1, a point when so-called consent could have been obtained. The remaining 231 (33%) patients asked or made 312 questions or statements. These were divided into those relating to the anaesthetic ($n = 209$, 66%), to the proposed surgery ($n = 93$, 30%), and unrelated to either ($n = 10$, 4%). Figure 3 lists the most commonly asked questions. Two patients wanted 'to know everything' and requested a full explanation of the peri-operative anaesthetic management. These are counted as '2' within the anaesthetic total (each of these pre-operative visits lasted over 30 min). Nine patients specifically refused to receive further information.

<p>Have you ever had an anaesthetic?</p> <p>Were there any problems related to the anaesthetic?</p> <p>Do you have any medical problems?</p> <p>Are you on any regular medicines?</p> <p>Do you have any allergies to any medications?</p> <p>Do you ever get chest pain or shortness of breath?</p> <p>Do you have any dentures or loose teeth, caps or crowns?</p> <p>When did you last have anything to eat or drink?</p> <p>Do you have any questions or would you like me to discuss any aspects of the anaesthetic?</p>

Figure 1 Pre-operative questions.

Orthopaedics 246
General surgical 68
Gynaecology 86
Renal 108
Dental surgery 18
Day case surgery 175

Figure 2 Surgical specialties.

Discussion

Valid consent can only be given after full disclosure of the proposed treatment, alternatives available and accompanying risks. There have been many studies looking at how much information a patient desires prior to anaesthesia. These have included filling in a questionnaire

pre-operatively [1], giving patients information before the pre-operative visit and asking them if they would have preferred, or not, to know about the information provided [2], testing patient responses to three different levels of information [3], or even by a telephone interview 2 weeks after a pre-operative visit to assess the degree of satisfaction with the care and information received at that visit [4].

This prospective survey sought to find out exactly what information patients requested *without prompting*, before giving their consent to anaesthesia. It showed that, contrary to the experience of virtually all previous studies, only a minority of patients requested further information. Indeed, only two of the 700 patients requested a full explanation of the peri-operative anaesthetic management sufficient to give their 'fully informed' consent for anaesthesia. A further 18 patients specifically asked about risks, three wondered if they could 'take a GA' and two more enquired what they should be asking, which led to a further discussion about the risks involved. In total, therefore, only 25 patients requested further information about risks. Some patients came armed with specific knowledge and requests, for example about the use of spinals or epidurals (six patients), or whether a tracheal tube would be passed (three patients). Seven patients wanted a guarantee that they would be asleep and not wake up during the operation.

Anaesthetic questions (66%)		Surgical questions (30%)	
How long will I take to recover?	31	How long will the operation take?	71
Will I be asleep?	31	What does the surgery involve?	17
How will the anaesthetic be given?	25	When can I go home?	3
Will I be sick afterwards?	24		
Will I be okay/ is it risky?	18	Non anaesthetic/surgical questions (4%)	
Will I get a premed?	7	What is my blood group?	5
Will I be sore after?	7	Are my test results okay?	2
Can you guarantee I'll be asleep?	7	When can I have a cigarette?	1
Can it be done under local?	7	How does cyanide work?	1
Discussion of epidural/spinal	6		
Will you be there for the operation?	5		
Will I waken up?	4		
Discussion of intubation	3		
Discuss everything	2		
What should I be asking?	2		

Figure 3 Patient questions and comments.

The most frequently asked question was the duration of surgery (71 patients). Seventeen patients requested further information regarding the surgery, such as where the incision would be, despite the fact that in most cases they had already given consent, bringing into question either their level of understanding or the amount of information provided by the doctor 'getting consent'.

It would appear therefore that the majority of patients did not request further information. Indeed, some displayed a surprising degree of lack of interest. Only 13 out of 40 patients turned the television or radio off or the volume off when the anaesthetist entered their room, introduced himself and started the discussion. Occasionally, the anaesthetist had a distinct feeling that the patient wanted him out of the room as quickly as possible to allow viewing of the latest soap opera to continue.

It is interesting to note that in one study, disclosure of 'minimal' information in a leaflet led to only 29% of patients believing the content to be too little. This increased to 63%, however, when further additional information was later provided [3]. In other words, further disclosure leads patients to require and request more information.

However, we are not suggesting that consent can be obtained by asking the questions in Fig. 1 and, if no questions are forthcoming from the patient, our duty is fulfilled. Any person such as a physician or lawyer who enters into a relationship of trust and confidence with another has an obligation to disclose all relevant facts. The essence of a professional relationship is that the professional knows more about his subject than the person who seeks help does and there is thus an affirmative duty of disclosure [5]. Furthermore, providing the patient solely with the information they would like does not necessarily constitute 'informed consent'. In the majority of cases there needs to be further discussion regarding the risks and treatment alternatives available. The Association of Anaesthetists of Great Britain and Ireland (AAGBI) has published two booklets in recent years in an attempt to help members with these issues. The first booklet provided information for patients and their relatives detailing what anaesthetists do and why [6]. It gave a clear explanation as to what the patient would experience before and after anaesthesia. Although a valuable tool, it is rarely available in the clinical setting for patients to read on the ward. The second booklet was aimed at helping the anaesthetist appreciate what was meant by the term 'informed consent' [7]. Recommendations were given regarding what information the anaesthetist should make available to the patient. Although information leaflets for surgical procedures and anaesthesia are available, these are not a substitute for the responsibility of the medical staff to ensure that the patient has been informed and has under-

stood what is to happen. It is not clear, however, what a reasonable amount of information would be. The ultimate test is the legal test and thus it is for the courts to decide what would be reasonable. Doctors, however, cannot guess what the courts will decide in particular circumstances.

Thus, despite recommendations, obtaining consent remains a difficult process to standardise and wide variations in practice will probably continue. In particular, disclosure of risk is one of the areas of uncertainty [8]. It is not clear, for example, if the nine patients who specifically refused further information should have been forced into accepting further relevant information and disclosure about risks. Is there a difference between an expressed refusal and an implied one? The majority of patients ($n = 460$) only implied they did not wish further information. Indeed, in these cases, further information was disclosed to patients. However, an expressed refusal for further information was honoured.

What is clear is that obtaining consent is a process that starts when the patient first visits the doctor. Anaesthetists are thus omitted from the start of this process but the risks inherent in the anaesthetic may be substantial and completely outweigh any introduced by the surgery. Indeed, in certain situations (such as anaesthetizing children for CT or MRI scans), the only risk is from the anaesthetic. Is the night before or the morning of theatre the appropriate time to obtain anaesthetic consent, especially if obtaining fully informed consent could take over half an hour? The recognition that consent is a 'process' leaves anaesthetists in particular difficulties.

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FORUM

A comparison of cyclizine, ondansetron and placebo as prophylaxis against postoperative nausea and vomiting in children*

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Summary

Nausea and vomiting is a relevant and common problem with unfavourable sequelae in children undergoing some plastic surgery procedures. There is a lack of anti-emetic trials performed in children, with only a few investigating the roles of the older anti-emetic agents such as cyclizine compared with newer ones such as ondansetron. This randomised, controlled, double-blind study examined the effectiveness of a single dose of ondansetron (0.1 mg.kg⁻¹), cyclizine (20 mg) and placebo (normal saline) in the prevention of postoperative nausea and vomiting in 150 children (mean age 3.6 years) undergoing plastic genitourinary procedures. Rates of previous postoperative nausea and vomiting and motion sickness were comparable across the groups. Postoperative vomiting was significantly reduced with ondansetron prophylaxis ($p = 0.006$) but there was no detectable anti-emetic effect with cyclizine. Furthermore, cyclizine caused pain on injection ($p < 0.001$).

Keywords *Imidazoles: ondansetron. Piperazines: cyclizine. Postoperative complications: postoperative nausea and vomiting. Vomiting: anti-emetics, incidence.*

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Postoperative nausea and vomiting (PONV) is a cause of misery and morbidity after surgery. In plastic surgery, bleeding of skin flaps due to postoperative vomiting is well described [1]. In children undergoing plastic surgery, the incidence of postoperative vomiting may be as high as 85% [2]. We assessed the incidence of postoperative vomiting in children undergoing genitourinary plastic surgery in a prospective, randomised, double-blind study comparing single doses of ondansetron, cyclizine or placebo (normal saline) administered at the induction of anaesthesia. The study included a calculation of sample size.

In our unit, children undergoing genitourinary plastic surgery are anaesthetised by one consultant anaesthetist

and mostly operated upon by one consultant surgeon. The anaesthetic and postoperative surgical regimens are constant for all patients. This group of children provides an ideal patient population for further investigation into the problem of postoperative vomiting.

Method

The study was undertaken at the West Midlands Regional Plastic and Jaw Surgery Unit and approved by the trust ethics committee. Informed consent by a consultant anaesthetist with the accompanying information leaflets was gained. The study included children between the ages

of 3 and 5 years, ASA grade I and II, who were undergoing elective plastic genitourinary procedures.

Fifty patients were randomly allocated to each of three groups. The sample size and power of the study were based on statistical advice and from evidence based on an audit which showed that 32% of children undergoing genitourinary surgery vomit. This was intended to give the study 80% power to detect a significant difference (5% level) between an incidence of postoperative vomiting of 32% in the placebo group and 10% in the active drug group.

Randomisation to each arm of the study was made by the hospital pharmacy who made up the study medication and held the randomisation codes for each patient. According to randomisation, patients received ondansetron 0.1 mg.kg⁻¹, cyclizine 20 mg, or normal saline. The study was double-blind and the selected drug was given intravenously before induction of anaesthesia.

The anaesthetic protocol required a minimum duration of fasting of 6 h for solids and 3 h for liquids. A premedication of oral trimeprazine 2 mg.kg⁻¹ was administered 2 h preoperatively and EMLA cream 2.5 g was applied to the dorsum of both hands. Anaesthesia was induced with intravenous thiopental 5 mg.kg⁻¹ and succinylcholine 1–2 mg.kg⁻¹. The airway was managed using a plain oral tracheal tube of appropriate size. Intermittent positive-pressure ventilation with an Ayre's T-piece and Penlon Nuffield ventilator using a Newton valve was administered. Maintenance agents included 35% oxygen, 65% nitrous oxide and 1% enflurane. Intravenous atracurium 0.5 mg.kg⁻¹ (single dose) was given after caudal anaesthesia. Caudal anaesthesia was obtained with bupivacaine 0.5% plain (1 ml per year of age) and was performed after general anaesthesia. The caudal anaesthetic aims to block lower lumbar and sacral nerve roots but in this age group it can be difficult to assess. Failure of caudal anaesthesia was judged by a rising tachycardia in response to surgical stimuli. According to this criterion, if the caudal had failed, the patient was not studied further and analgesia was provided by intravenous morphine 0.1–0.2 mg.kg⁻¹. Reversal of neuromuscular blockade was not usually required in these patients due to the length of the surgery. If the procedure took less than 30 min, residual neuromuscular blockade was reversed with atropine 20 µg.kg⁻¹ and neostigmine 50 µg.kg⁻¹ and the patient was not studied further.

Intravenous fluids were not given routinely. If required (blood pressure < 80 mmHg systolic, despite reducing enflurane concentration to < 0.6%), dextrose/saline 5 ml.kg⁻¹ was given over 20 min and the patient was not studied further.

The regimen for postoperative analgesia was oral paracetamol 15 mg.kg⁻¹ 4-hourly as required and intra-

muscular morphine 0.2 mg.kg⁻¹ 4-hourly as required. Postoperative anti-emetics were not routinely prescribed. If necessary, the nursing staff followed current practice and informed the medical staff, who prescribed anti-emetics as appropriate.

Data were recorded on a data-sheet and subsequently entered into a computer database. The outcome measures included number of vomits in the first 24 h from the time of extubation; doses of anti-emetics given because of vomiting in the first 24 h; time to first oral intake; complications (obtained retrospectively from case notes). Other postoperative variables included doses of morphine and paracetamol. Side effects such as arrhythmias and facial flushing were recorded by the anaesthetist. Any other adverse reaction in the first 24 h was also recorded.

The null hypothesis was that no difference existed for the above outcome measures between patients given prophylaxis with active agents compared with placebo. The incidence of vomiting in the three groups was compared using Chi-squared analysis or where appropriate Fisher's exact test. Duration of anaesthesia was compared using one-way analysis of variance.

Results

There were 150 patients included in the study, no patient was withdrawn and data collection was complete. Each of the three groups contained 50 patients. Mean patient age was 3.6 years and the type of surgical procedure undertaken was hypospadias repair.

Postoperative vomiting occurred in all three groups but was least in those given ondansetron ($p = 0.006$). The incidence of postoperative vomiting was 10% of patients who had received ondansetron, as opposed to 32 and 36% in those who had received normal saline and cyclizine, respectively. The total number of vomits per drug group is shown in Table 1. The incidence of history of previous PONV and motion sickness was comparable across the groups. Anti-emetics were administered to only one patient postoperatively and that child had received a preoperative study dose of normal saline (placebo).

Table 1 Number of vomits in each drug group.

Number of vomits	Ondansetron	Normal saline	Cyclizine
0	45	34	32
1	4	8	9
2	1	2	2
3			3
4		3	2
5		1	1
6		1	1
7		1	

Table 2 Side effects.

	Ondansetron	Normal saline	Cyclizine
Facial flushing	none	none	none
Dysrhythmia	none	none	none
Rhythm – nodal tachycardia	0	0	1
Rhythm – sinus	50	50	49
Pain on injection	0	0	19

Table 3 Morphine administration.

	Ondansetron	Normal saline	Cyclizine
Morphine given	9	9	12
Vomited	1 (11%)	3 (33%)	5 (41%)

For pain relief, 69% of children, regardless of drug group, required paracetamol and 17% needed morphine.

Side effects were recorded for each drug group (Table 2), but were present only following cyclizine administration. Pain on injection was recorded only in those receiving cyclizine ($p < 0.001$). No arrhythmias were recorded with ondansetron and normal saline, but one patient developed a nodal tachycardia following administration of cyclizine. This may, however, have been incidental. There were no episodes of facial flushing following administration of any of the three drugs.

Morphine is a potent emetic and was administered to some patients in all three groups at some time during the first 24 h postoperatively (Table 3). Patients in the cyclizine group received more morphine, which may be why this group vomited more. However, comparing the patients from each of the three groups who did not receive morphine, the ondansetron group vomited significantly less than the other groups ($p = 0.02$). A similar trend was observed for patients given morphine, although this was not statistically significant. In this study, the rates of vomiting for morphine and non-morphine patients were not statistically different ($p = 0.6$).

An increased duration of anaesthesia is thought to be associated with an increased incidence of nausea and vomiting. The mean duration of anaesthesia is shown in Table 4. No significant difference in the duration of anaesthesia existed between the three groups.

Table 4 Duration of anaesthesia.

	Ondansetron		Normal saline		Cyclizine	
	No vomit	Vomit	No vomit	Vomit	No vomit	Vomit
Mean duration; min	83	79	77	87	85	87
Range; min	47–155	65–90	45–135	60–148	60–135	55–135

Discussion

Postoperative vomiting is a cause of misery and morbidity after any surgery. In plastic surgery bleeding of skin flaps due to postoperative vomiting is well described [1] and in children undergoing plastic surgery the incidence of postoperative vomiting may be as high as 85% [2].

A prospective, observational study of postoperative vomiting at the West Midlands regional plastic surgery unit found the incidence of vomiting in over 200 children to be nearly 50% [OG Tittley, pers. commun.]. A large subgroup of these patients vomited significantly less than the rest of the group, i.e. children undergoing genitourinary plastic surgery in whom the incidence of vomiting was 32%. This audit also failed to show any advantage to giving traditional anti-emetics (metoclopramide and droperidol) as part of the premedication. In children given anti-emetics, the incidence of vomiting was 60%, compared with 43% in those not given anti-emetics (Chi-squared = 2.90, $p > 0.05$). Repeated vomiting was not uncommon and 26 children vomited more than five times; 3 of these children had complications related to bleeding, which may have been exacerbated by the persistent vomiting. In addition to these physical consequences, postoperative vomiting may also have metabolic and psychological sequelae in addition to resource implications for both the hospital and family.

Although traditional anti-emetics may be effective in reducing the incidence of postoperative vomiting, they are associated with significant side effects in children and the literature on their efficacy is absent or conflicting. Several anti-emetics are not recommended for children. This applies to most neuroleptics because of fear of extrapyramidal effects.

Ondansetron (Zofran), a 5HT₃ receptor antagonist, is a newer drug used successfully in the management of nausea and vomiting in children undergoing chemotherapy [3]. Extrapyramidal reactions are extremely rare, if they occur at all, with ondansetron [4]. Clinical experience in the oncology setting showed the principal side effects of ondansetron to be constipation and headache, and an elevation of liver enzymes (perhaps due to metastases) [5]. Ondansetron has been used for prophylaxis of postoperative vomiting in children. In controlled, randomised, double-blind studies, it has been shown to reduce the incidence of postoperative vomiting in children undergoing tonsillectomy [6], strabismus repair [7] and inguinal hernia repair/orchidopexy [8].

In plastic surgery, only one study has been published; this reported an incidence of vomiting of 15% with ondansetron prophylaxis, compared with 40% with droperidol and 60% with placebo in children undergoing otoplasty [9]. Three patients in the ondansetron group

developed a self-terminating nodal rhythm without haemodynamic disturbance – this may have been related to the use of halothane.

Ondansetron is perhaps a better drug than its predecessors for the prophylaxis and treatment of postoperative vomiting [10]. Unfortunately, some studies, in particular for treatment of postoperative nausea and vomiting, have been subject to criticism for failure to include an active agent in comparison [11].

In this study, ondansetron was found to significantly reduce postoperative vomiting in children undergoing genitourinary surgery when compared with saline and cyclizine. It demonstrated a lack of adverse effects and no facial flushing, arrhythmias, nodal tachycardias or pain on injection were seen.

Cyclizine is an antihistamine, which has been used widely in the treatment of motion sickness [12]. Its use in anaesthetic practice for control of postoperative vomiting was popularised in the 1950s [13]. Unfortunately, despite large patient numbers, most studies have poor methodology. One placebo-controlled, double-blind study found cyclizine treatment provided complete or partial relief of postoperative nausea and vomiting in 93% of patients [14]. With regard to prophylaxis, ondansetron and cyclizine were compared in a double-blind, placebo-controlled study undertaken on a group of adult patients undergoing day-case gynaecological laparoscopy [15]. Both were shown to be better than placebo. In one of the subgroups (diagnostic laparoscopy), cyclizine fared better in reducing the need for escape anti-emetic. This is not our experience.

Cyclizine has previously been noted to have few significant side effects; it is not associated with extrapyramidal reactions, although repeated doses can lead to restlessness and sedation [12]. It is inexpensive and readily available. In view of its relative lack of side effects and a lack of up-to-date information, it has been suggested that the place of cyclizine in the modern anaesthetic setting should be reappraised [13]. This study, however, showed a significant incidence of pain on injection, whereas none was reported in the ondansetron or control groups. There was one case of nodal tachycardia following cyclizine, which may have been incidental, although there was no other evidence of facial flushing or dysrhythmias. The incidence of postoperative vomiting was highest in this group.

It is important to note that the groups did not exhibit any difference in previous history of postoperative vomiting or motion sickness and the duration of surgery.

In conclusion, the major findings of this double-blind, prospective, randomised, placebo-controlled trial are that ondansetron significantly reduces postoperative vomiting

in children undergoing genitourinary surgery when compared with cyclizine and placebo. There was a significant increased incidence of pain on injection with cyclizine compared with ondansetron and placebo. There was no significant difference in the duration of anaesthesia or past history of motion sickness and postoperative vomiting between the groups.

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