interactions have been identified.[13] These variables contribute to the poor correlation between dose and blood cyclosporin concentration,[11] making knowledge of the daily dose a poor predictor of the blood cyclosporin concentration. In our study between patient variation of cyclosporin concentrations was very large, with many measurements falling outside the target range. It is noteworthy, however, that half of the episodes of toxicity occurred within the first two weeks of transplantation, during which there was little opportunity to alter the cyclosporin dose in the light of blood concentration measurements, since a fixed dosage schedule was used for the first seven days. Possibly a more flexible dosage schedule, in association with a more rapid provision of blood cyclosporin results, would help to reduce the incidence of toxicity during this period.

Our data suggest that frequent measurements of the drug, especially during the first few weeks after transplantation, are a useful aid in planning alterations of dosage with the aim of avoiding the high mean concentrations associated with nephrotoxicity while ensuring concentrations consistent with the suppression of graft rejection; infrequent measurements, or samples collected only at the time of renal dysfunction, would be of less value. We conclude that, despite its lack of specificity for the parent compound, the radioimmunoassay used in this study produced results which were of clinical value, exposure to average predose blood concentrations outside the range of 333-666 nmol/l (400-800 ng/ml) being associated with an enhanced risk of graft rejection or nephrotoxicity.

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Prolonged pregnancy: the management debate

LINDA CARDOZO,   JOHN FYSH,   J MALCOLM PEARCE

Abstract

A prospective trial was conducted to compare the effects of conservative management of prolonged pregnancy (conservative group) with routine induction of labour at 42 weeks' gestation (active group) in otherwise uncomplicated pregnancies. Of the 402 pregnancies studied, 207 (51%) were allocated to conservative management and 195 (49%) were allocated to have labour induced. The groups were well matched for age, parity, and smoking habits. One hundred and sixty six (80%) of the patients in the conservative group went into spontaneous labour. Of the remainder, two underwent elective caesarean section, 19 had labour induced because of clinical concern, and the remaining 20 had labour induced at the patient's own request. One hundred and twenty five (64%) of the patients in the planned active group underwent induction of labour. Of the remaining 70, 49 went into spontaneous labour and 21 (11%) asked that they should not have labour induced.

Comparison of the two groups showed no difference in the length of the first stage of labour but a trend towards an increased need for intervention for fetal distress (p<0·06) in the active group. There were no differences in the length of the second stage, the need for intervention, or the mode of delivery. In terms of Apgar scores the neonatal outcome was not significantly different between the two groups, but a greater proportion of the babies (15% v 8%) in the active group required intubation. Umbilical cord venous pH estimated in the last 183 consecutive deliveries in the study showed a significantly lower mean value in the active group (p<0·05). There was no difference in birth weight between the two groups.

Two deaths occurred in the study. There was a stillbirth in the conservative group at 292 days after massive abruption, and one neonatal death in the active group owing to multiple congenital abnormalities.

The outcome for mother and baby in patients from both groups who went into spontaneous labour was generally good. The outcome for patients for whom conservative management was planned but induction became necessary was no different from that of patients who underwent planned induction at term. Thus from our results we can find no evidence to support the view that women with normal prolonged pregnancy should undergo routine induction of labour at 42 weeks' gestation.

Departments of Obstetrics and Neonatology, King's College Hospital, London SE5

LINDA CARDOZO, MD, MRCOG, senior registrar
JOHN FYSH, MRCP, DCH, lecturer
J MALCOLM PEARCE, FRCS, MRCOG, research fellow

Correspondence to: Mr J M Pearce, Department of Obstetrics and Gynaecology, St George's Hospital Medical School, London SW17 0RE.

Introduction

Now all other animals bring the time of pregnancy to an end in a uniform way; in other words, one single term of pregnancy is defined for each of them. But in the case of mankind alone of all animals the times are diverse; for pregnancy may be of 7 months' duration or of 8 months or of 9 and still more commonly of 10 (lunar) months, whilst some women go even into the eleventh month.   ARISTOTLE, *Works.* Vol II

As long ago as 399 BC Aristotle appreciated that the gestation period for human pregnancy varied considerably and that prolonged pregnancy was not uncommon. Postmaturity is now one of the commonest indications for inducing labour in many hospitals in

both the United Kingdom and the United States.[1 2] Induction of labour was first recommended as the best method of preventing postmaturity by Ballantyne and Brown.[3] In 1954 Walker showed a threefold increase in unexplained fetal death after 42 weeks' gestation, which he attributed to a progressive reduction in oxygen supply to the fetus with increasing maturity.[4] In a survey of perinatal mortality conducted in 1950 Butler and Bonham[5] showed that perinatal mortality at 43 weeks' gestation was double that at term.[5]

The advent of effective methods of induction in the 1950s allowed induction for postmaturity to become routine, but the subject was still hotly debated. In 1958 Gibberd wrote "The choice between death from post-maturity and death from induction of labour,"[6] and in 1959 Theobald replied with "The choice between death from post-maturity or prolapsed cord and life from induction of labour."[7]

Few controlled studies on prolonged pregnancy have been conducted recently, and most have studied the timing of induction rather than comparing a policy of routine induction with that of awaiting spontaneous labour.[8] A retrospective study from our unit compared outcomes from two consultant units.[9] One unit practised routine induction at 42 weeks' gestation while the other awaited spontaneous labour. Analysis showed no improvement in outcome but an increased chance of delivery by caesarean section in induced labours.

Even recent studies on prolonged pregnancy have been hampered by uncertainty over gestational age. The routine use of ultrasound examination to confirm or assign gestational age in the first half of pregnancy reduces the number of patients who exceed 42 weeks' gestation.[10-12]

In the United Kingdom women are becoming increasingly concerned by the amount of intervention to which they are being subjected.[13] It is therefore time to reconsider the benefits, if any, of routine induction of labour to prevent postmaturity.

Patients and methods

Women attending the antenatal clinic at King's College and Dulwich hospitals were admitted to the study at 40 weeks plus 10 days' gestation (290 days). All patients had booked for obstetric care before 20 weeks' gestation and had had the gestational age confirmed by routine ultrasound examination.[11] If dates were uncertain or if postmenstrual age differed by more than seven days from the mean age as assigned by ultrasound examination the gestational age obtained by ultrasound examination was used for the purposes of the study.

Patients were allocated to one of two groups according to the last digit of their case sheet number. We have no reason to believe that this introduced a bias as it is impossible to predict which pregnancies will be prolonged. For those with even numbers induction of labour was planned between 40 weeks plus 12 days' and 40 weeks plus 14 days' gestation (active group). Labour was induced with one 3 mg pessary of prostaglandin E_2 followed three hours later by amniotomy and, if necessary, oxytocin infusion. Patients with odd case sheet numbers (conservative group) underwent ultrasound examination between 40 weeks plus 12 days' and 40 weeks plus 16 days' gestation. The ratio of the head circumference to abdominal circumference[14] was derived, and amniotic fluid volume was recorded as the greatest vertical column that could be seen in any part of the uterus.[15] Patients were monitored with daily kick count charts[16] and cardiotocography on alternate days. Induction of labour was indicated in the conservative group for asymmetric intrauterine growth retardation[17] together with an abnormal cardiotocogram, premature rupture of membranes, or the onset of hypertension. The local ethical committee also insisted that patients should be allowed to request or decline induction of labour after 42 weeks' gestation. All patients gave informed consent.

Progress of labour was charted on the partogram from the onset of painful regular contractions or admission in labour. Dysfunctional labour was diagnosed by means of a nomogram[18] and was treated with an oxytocin infusion. Continuous electronic monitoring of fetal heart rate was routine during labour and fetal scalp pH was measured if there was a major abnormality on the cardiotocogram. Epidural analgesia or pethidine, or both, were available on request.

The condition of the baby at delivery was recorded. During the course of the study data from Sykes et al suggested that Apgar scores were an unsatisfactory means of determining fetal asphyxia.[19] Therefore, in the last 183 consecutive cases in this study (84 active group, 99 conservative group) umbilical cord venous pH was also measured at delivery. All babies were examined by one of us (JF) within 72 hours of delivery. Patients' satisfaction with their management was assessed by means of a simple questionnaire administered by the midwifery staff on the day after delivery.

STATISTICAL METHODS

The sample size was based on an expected 17% reduction in the caesarean section rate in the group managed conservatively ($2\alpha=0.05$, $\beta=0.10$).[9] About 350 patients were required,[20] but this number was exceeded as the number of recruits was reviewed only twice a month. Characteristics of patients and outcomes in the two groups were compared by means of the χ^2 test, Fisher's exact test, or Student's t test, as appropriate.

Results

A total of 402 consecutive, uncomplicated, prolonged pregnancies were studied over 21 months. These comprised 6·6% of the total deliveries. This figure is similar to the 6·3% of patients exceeding 42 weeks' gestation based on ultrasound findings reported from a previous study from this hospital.[11] There were 195 patients in the active group, of whom 125 (64%) had labour induced for prolonged pregnancy. The remaining 70 either went into labour spontaneously before planned induction (49) or specifically asked for induction of labour (21). Two hundred and seven patients were allocated to the conservative group, of whom 166 (80%) went into spontaneous labour on or after 40 weeks plus 12 days' gestation. Two of the remainder underwent elective caesarean section, one for severe, late onset hypertension induced by pregnancy and the other for advanced maternal age together with a long history of infertility. The remaining 39 had labour induced for the following reasons. Five patients underwent induction of labour for late onset of asymmetric intrauterine growth retardation together with an antenatal cardiotocogram which caused clinical concern, four for hypertension which developed after 40 weeks plus 12 days' gestation, and 10 for premature rupture of membranes and 20 requested induction of labour.

The two groups were well matched for maternal age, parity, and smoking habits. There was a difference in the racial distribution in that 142 (73%) of the active group and 171 (83%) of the conservative group were white ($p<0.05$). There was also a difference in height: the mean height in the active group was 161·4 cm compared with 162·4 cm ($p<0.01$) in the conservative group.

Amniotic fluid measurements were obtained from 196 (95%) of the conservative group but were not used in the clinical management of the patient. Only three patients had vertical columns of less than 3 cm. Two underwent caesarean section in the first stage of labour for fetal distress and the other had a forceps delivery in the second stage of labour for fetal distress.

Table I shows the data on admission and for the first stage of labour. As expected, the mean gestation was significantly longer ($p<0.001$) in the

TABLE I—*Details of patients on admission and during first stage of labour. Unless shown otherwise results are numbers (and percentages) of patients*

	Active group	Conservative group	Significance
No of patients	195	207	
Mean (SD) gestation (days)	294·2 (2·8)	296·4 (4·3)	p<0·001
Range	292-308	292-313	
Bishop's score (mean (SD))	6·9 (3·5)	7·9 (3·9)	p<0·01
Position of occiput:			
Occipitoanterior	19 (10)	42 (20)	p<0·01
Occipitotransverse	142 (73)	134 (65)	
Occipitoposterior	23 (12)	21 (10)	
Undefined	11 (5)	10 (5)	
Level of head (two fifths or less palpable)	87 (45)	127 (61)	p<0·001
Analgesia:			
None	73 (37)	79 (38)	NS
Epidural	68 (35)	68 (33)	NS
Pethidine	41 (21)	45 (22)	NS
Mean (SD) dose (mg)	131 (71)	109 (27)	NS
Entonox alone	13 (7)	15 (7)	NS
Mean (SD) length of first stage (hours)	7·8 (5·1)	7·9 (5·1)	NS
Intervention:			
None	176 (90)	188 (92)*	NS
No progress	11 (6)	15 (6)	NS
Fetal distress	8 (4)	2 (1)	NS
Cervimetric pattern:			
Normal	144 (74)	157 (76)*	NS
Abnormal	51 (26)	48 (23)	NS
Major abnormality on cardiotocogram	27 (14)	17 (8)	NS
pH <7·25	10 (11)	2 (5)	NS

NS=not significant.
* Two patients had elective caesarean sections.

conservative group. These women also had more favourable features at the onset of labour: they had a significantly higher mean Bishop's score (p<0·01) and significantly lower fetal head levels (p<0·001). In addition, more patients in the conservative group had an occipitoanterior position at the time of their first vaginal examination (p<0·01). There were no significant differences in the length of the first stage, the percentage of patients with cervimetric abnormalities, or the type of or need for analgesia. Although there was no difference in the prevalence of abnormal cardiotocograms, there was a trend for more patients in the active group to need intervention in the first stage for fetal distress based on fetal scalp blood gas analysis (p<0·06).

Table II shows the data for the second stage of labour. There was no difference between the two groups in the length of the second stage or in the need for intervention. The mode of delivery and the overall caesarean section rate were not significantly different between the two groups.

TABLE II—*Details of patients during second stage and delivery. Results are numbers (and percentages) of patients*

	Active group	Conservative group	Significance
No of patients	175	188	
Mean duration (minutes)	72	77	NS
Intervention:			
None	131 (75)	134 (71)	NS
No progress	25 (14)	34 (18)	NS
Fetal distress	12 (7)	14 (7)	NS
Maternal exhaustion	6 (3·5)	7 (4)	NS
Elective	1 (0·5)	0	NS
Mode of delivery:			
Spontaneous vaginal	131 (67)	133 (65)	NS
Traction forceps	29 (20)	37 (26)	NS
Rotation forceps	10	17	
Emergency LSCS	25 (13)	18 (9)	NS
Failed induction	3	4	NS
Elective LSCS	0	2	

NS=not significant.
LSCS=lower segment caesarean section.

There was no significant difference between the two groups in the mean time spent in hospital either before or after birth, but patients in the conservative group had significantly more antenatal cardiotocograms than the active group (mean 2·96, range 0-16 v mean 1·44, range 0-14, Mann-Whitney U=12017·5, p<0·0001).

Table III gives details of the babies at birth. There was no difference between the two groups in the mean Apgar scores or in the prevalence of low Apgar scores. Meconium was present in the pharynx or trachea in 29 (15%)

TABLE III—*Neonatal outcome. Unless shown otherwise results are numbers (and percentages) of patients*

	Active group	Conservative group	Significance
No of patients	195	207	
Apgar scores:			
Less than 5 at 1 minute	30 (15)	25 (12)	NS
Less than 5 at 5 minutes	2 (1·0)	4 (1·9)	NS
Meconium:			
In pharynx	21 (15)	21 (13)	NS
In trachea	8	6	
Aspiration syndrome	1	1	NS
Intubated	30 (15)	17 (8)	p<0·05
Admission to SCBU	6 (3)	3 (1·5)	NS
Mean (SD) birth weight (kg)	3·69 (0·51)	3·63 (0·43)	NS
Mean (SD) cord pH*	7·29 (0·10)	7·32 (0·08)	p<0·05

*Measured in 84 cases in active group and 99 in conservative group.
NS=not significant.
SCBU=special care baby unit.

of the babies in the active group and 27 (13%) of the babies in the conservative group; one baby from each group was admitted to the special care baby unit with meconium aspiration syndrome. A greater proportion of babies from the active group required intubation, however, and analysis of cord pH from the last 183 deliveries showed a significantly lower mean value in the active group (p<0·05).

There were no significant differences in the women's comments regarding their management, and analysis of the data showed that satisfaction was

TABLE IV—*Patients' satisfaction with their management*

	Active group		Conservative group		
	Type of delivery		Type of delivery		
	Spontaneous	Other	Spontaneous	Other	
Pleased	77 (59)	18 (28)	86 (65)	24 (32)	p<0·01
No comment	46 (35)	20 (31)	41 (31)	32 (43)	
Disappointed	5 (4)	24 (38)	4 (3)	18 (24)	p<0·01
No response	3 (2)	2 (3)	2 (1)	0	
Total	131	64	133	74	

related to the mode of delivery and outcome rather than to induced or spontaneous labour (Table IV).

Seventy (36%) of the patients in the active group went into spontaneous labour before planned induction between 40 weeks plus 12 days' and 40 weeks plus 14 days' gestation. This group of patients had the best outcome: only three (4%) required caesarean section (none for fetal distress) and only one infant had a low five minute Apgar score. This infant was the child that later died from major congenital abnormalities, which included a diaphragmatic hernia.

Of the 207 patients in the conservative group, 40 (19%) had labour induced; 20 (10%) underwent induction for medical reasons and 20 (10%) requested induction. Compared with the rest of the conservative group these 40 women had a worse outcome. Those who had labour induced had a higher prevalence of abnormal traces of fetal heart rate in labour (58% v 38%, p<0·05) and required more intervention during the first stage of labour (23·7% v 5·4%, p<0·001). In addition, fewer had spontaneous vaginal deliveries (50% v 68%, p<0·001) and significantly more required caesarean section (23% v 7%, p<0·001). Four women required caesarean section for failed induction of labour. These women also spent longer in hospital before delivery (mean 2·1 days, range 0-12 v mean 1·0 day, range 0-7, p<0·001) and after delivery (mean 6·3 days, range 2-11 v mean 4·8 days, range 1-10, p<0·001). Fewer of these patients were pleased with the outcome of their labour (30% v 59%, p<0·002). Comparison of this group, however, with the patients undergoing planned induction of labour showed no significant difference apart from the expected difference in gestation at delivery (296·5 days v 293·9 days, p<0·001) and the number of antenatal cardiotocograms that they required (1·23 v 3·15, p<0·001).

Analysis of the data according to parity showed that apart from the expected difference in gestation at delivery (mean 294·1 days v 296·5 days, p<0·0001) there was no significant difference between the two groups of primigravidas. In addition to the difference in gestation (mean 294·3 days v 296·4 days, p<0·0001), however, the multigravid patients who were managed conservatively had significantly higher Bishop's scores on admission (mean 6·8 (3·3) v 9·0 (3·5), p<0·0001), a higher prevalence of engaged heads (39% v 70%, p<0·001), and a lower prevalence of delivery by caesarean section (12 (12)% v 2 (2)%, p<0·05).

Discussion

A post-term pregnancy is one that is prolonged beyond 42 weeks (294 days).[21] Such pregnancies are associated with an increased incidence of fetal distress, oligohydramnios, fetal macrosomia, fetal dysmaturity, and perinatal mortality.[1 5 22] Many fetuses born after 294 days, however, appear to be completely normal. Routine induction to prevent prolonged pregnancy leads to an increase in the number of caesarean sections performed because of failed induction.[23 24] Prolonged pregnancy therefore remains an obstetric problem.

Prolonged pregnancy probably has three subgroups.[24] Group 1 consists of patients with incorrect dates; group 2 consists of patients with correct dates but in whom physiological maturity is not achieved until after 42 weeks' gestation—that is, normal prolonged gestation; and group 3 consists of patients with correct dates in whom maturity occurs at 40 weeks but labour fails to ensue. It is in the last group that the postmaturity syndrome occurs. The infants classically show signs of advanced maturity (hard skull bones, narrowness of sutures and fontanelles, long fingernails and toenails, and well developed nipples, ear cartilage, and genitalia) and also evidence of intrauterine malnutrition (absence of subcutaneous fat and dry skin).

The prevalence of prolonged pregnancy is about 10% when based

on the first day of the last menstrual period.[1-3] The introduction of routine ultrasound examination, however, has reduced this figure to about 6%.[10 12 22] Routine ultrasound was in use throughout our study, and we found that 6·6% of our patients exceeded 42 weeks' gestation.

Our study was too small to allow sensible comments to be made on perinatal mortality as only two babies died in the study, giving a corrected perinatal mortality of 2·5 per 1000. This, however, agrees with the Nordic studies, which showed that perinatal mortality is at its lowest from 40 to 43 weeks (280-307 days).[8]

Two German studies found the prevalence of uterine inertia in labour occurring in prolonged pregnancy to be twice that reported in labour occurring at term.[25 26] We did not show a significant difference in the prevalence of abnormal cervimetric patterns between our two groups. Overall, the prevalence of abnormal labour patterns was similar to that reported in labour occurring at term.[27 28]

There was no difference between the two groups in the prevalence of fetal distress in the first stage as diagnosed by major abnormalities in the cardiotocogram. Although the number of fetuses with low scalp pH in the first stage of labour was not significantly different between the two groups (see table I), there was a trend towards a higher rate of caesarean section for fetal distress in the active group (p<0·06). We agree with the findings of two other studies which failed to show an increased prevalence of fetal distress in labour occurring in prolonged pregnancy compared with labour occurring at term.[29 30] We did not show the 35% fetal distress rate noted by Schneider et al.[31] Meconium was present in the pharynx or trachea of the babies, and this was not significantly different between the two groups. In other studies of prolonged pregnancy meconium has been found in up to 36% of cases.[32]

Assessment of fetal wellbeing in prolonged pregnancy is difficult, but the value of ultrasonically measured amniotic fluid columns has recently been reported.[15] Such measurements were performed on 196 (95%) of the patients in the conservative group, and in only three patients (1·5%) was a column of amniotic fluid of less than 3 cm found. This group, however, contained both of the patients who required caesarean section for fetal distress in early labour.

We have suggested that the lower prevalence of fetal distress in labour together with the lower prevalence of meconium staining of the amniotic fluid may be due to our increased ability to detect pregnancies at risk before birth. The routine use of a two stage ultrasound screening procedure will detect over 80% of cases of growth retardation,[11] and these patients will therefore no longer go unrecognised beyond term.

Our study was designed to determine whether conservative management of prolonged pregnancy would reduce the prevalence of caesarean section by 17% without adversely affecting the short term neonatal outcome. Previous published work had led us to believe that the prevalence of caesarean section after induction of labour for prolonged pregnancy was about 27% compared with about 10% for the rest of the population. In our study, however, the overall prevalence of caesarean section was only 11%, with a difference between the two groups of 4% (95% confidence interval −0·02 to 0·10). A possible explanation for this may be that we now routinely induce labour with prostaglandin pessaries whereas the previous reported studies used a combination of amniotomy and oxytocin. The use of prostaglandin pessaries is known to reduce the number of failed inductions.[33] From the results of our study it has been estimated that about 2000 patients would be needed in each group to stand a 90% chance of showing that the 4% difference in caesarean section rate was significant.

Our study failed to show any difference in the neonatal outcome as judged by Apgar scores or the presence of meconium in the pharynx or trachea. Only two babies (one from each group) developed the meconium aspiration syndrome. This was diagnosed when signs of respiratory distress appeared soon after birth and lasted for more than six hours together with perihilar shadowing in a radiograph. Both babies had developed a moderate degree of the syndrome in that they required a fractional inspired oxygen of more than 0·4 and less than 0·8. It is noticeable, however, that there was a significantly increased need for intubation (p<0·05) in babies born

to mothers in the active group and this, together with measurements of the cord pH on the last 183 consecutive babies, suggests that asphyxia is more likely to result from routine planned induction of labour than conservative management.

Of the patients in the active group, 36% went into spontaneous labour within 48 hours of planned induction. A similar incidence has been noted in other studies,[33] and, as might be expected, these patients had an excellent outcome which was significantly better than that of the women who required induction of labour. This suggests that routine induction for prolonged pregnancy before 42 weeks is meddlesome. Patients in the conservative group who underwent induction of labour because of clinical concern or at their own request had a significantly worse outcome than the rest of their group, but this was no worse than the outcome for patients who were electively induced.

Analysis of the data by parity showed that the only important difference was the increased need for caesarean section in the actively managed multiparous group. Caesarean section rates were not significantly different between the two groups of primigravidas but this is because of the bias introduced by those women from the conservative group who required or requested induction of labour. Nine of these women underwent caesarean section, four for failed induction.

It is of some slight clinical interest that pregnancy does not go on for ever, and our longest recorded gestation was 44 weeks and five days.

We conclude that with the modern use of routine ultrasound to determine gestational age and detect intrauterine growth retardation fewer patients exceed 42 weeks' gestation than previously reported and their fetuses are at less risk of antenatal or intrapartum asphyxia. Routine induction of labour at about 42 weeks' gestation is associated with an increased need for caesarean section in the first stage of labour and with a higher incidence of asphyxiated infants. The outcome for conservatively managed patients who develop a need for delivery or who wish to be induced is no worse than that for patients routinely induced at 42 weeks. We are happy to concur with Aristotle in his observation 2385 years ago that prolonged pregnancy is a variant of normal and should be treated as such.

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Exposure of midwives to nitrous oxide in four hospitals

A J MUNLEY,   R RAILTON,   W M GRAY,   K B CARTER

Abstract

The exposure of midwives to nitrous oxide in four hospitals was measured with personal samplers. In three of the four hospitals the average exposure was not significantly less than 100 parts per million (ppm). In one hospital the average exposure was 360 ppm; this was reduced by a factor of about 2·5 when a trial scavenging system was used. Differences in working practices and in the layout, size, and ventilation of the labour suites contributed to the observed differences in average exposure.

Midwives and other staff working in the labour room are potentially at risk from excessive occupational exposure to nitrous oxide.

Introduction

The possibility that chronic exposure to anaesthetic agents may be harmful has been appreciated for some time. Epidemiological studies have observed an increased risk of certain disorders[1]; in particular there is evidence of an increased incidence of spontaneous abortion among female staff.[1,2]

Nitrous oxide has been implicated as a causative factor,[1,3] and possible mechanisms have been described by several authors. Sharer *et al* have suggested (from extrapolation of rat data) that harmful effects in humans may occur with continuous exposures above 450 parts per million (ppm) and propose a safe limit of the order of 200 ppm.[4] Sweeney *et al* found abnormalities in the bone marrow of certain dentists who experienced occupational exposures above 1800 ppm and suggest a limit of 400 ppm.[5]

West of Scotland Health Boards, Department of Clinical Physics and Bio-Engineering

A J MUNLEY, BSC, PHD, senior physicist, Lanarkshire Area Medical Physics Department
R RAILTON, PHD, FINSTP, area physicist, Lanarkshire Area Medical Physics Department
W M GRAY, BSC, PHD, principal physicist, university department of anaesthesia, Western Infirmary, Glasgow
K B CARTER, MSC, MIEE, principal physicist, university department of surgery, Royal Infirmary, Glasgow

Correspondence to: Dr A J Munley, Department of Medical Physics, Monklands District General Hospital, Airdrie ML6 0JS.

Sweden has adopted a legally enforceable limit for nitrous oxide exposure of 100 ppm,[6] while in the United States the recommended limit is 25 ppm.[7]

Nitrous oxide concentrations of up to a few thousand ppm have been experienced by staff working in unscavenged anaesthetic rooms, operating theatres,[1,8,9] and dental surgeries,[10] while staff in recovery rooms and other peripheral areas may experience concentrations of up to 100 ppm.

Scavenging can reduce theatre pollution to around one tenth of the unscavenged value,[8,9,11] but achievement of acceptably low pollution generally requires effective ventilation in addition to scavenging.[11]

The use of mixtures of half nitrous oxide and half oxygen (Entonox, BOC Medical Gases Ltd) for obstetric analgesia might be expected to lead to atmospheric pollution in delivery rooms. As many midwives are women of childbearing age the occupational exposure of this group to nitrous oxide is of particular interest. We conducted a survey of the exposure of midwives to nitrous oxide in four hospitals.

Subjects and methods

Personal diffusive samplers[12] were used to make 76 measurements of the exposure of midwives to nitrous oxide in four hospitals. Full details of the calibration and performance of the samplers and of the method of analysis are described elsewhere.[13] The samplers provided measurements of time integrated nitrous oxide exposure (expressed in ppm.h) with a coefficient of variation of 11%. The integrated exposure in ppm.h was divided by the duration of the subject's shift length or issue period to provide the average exposure in ppm. Unexposed control samplers that accompanied the exposed samplers during issue and collection were also analysed to check the possibility of erroneous results due to contamination or mishandling.

The table lists the number of delivery rooms, workload, midwives studied, and oxygen-nitrous oxide consumption for each hospital in the survey. A scavenging system consisting of a silenced receiving and disposal system (Ohmeda Mk 1 AGSS) and a modified anaesthetic circuit as a collecting and transfer system was in use in hospital D during part of our survey. No other hospital had any form of scavenging in the delivery rooms.

Results

The figure shows the results obtained during the survey. The results for hospital D with and without scavenging are shown separately. Control samplers exposed to a non-polluted atmosphere (normal room air) showed a background exposure of about 0·1 ppm, while others that were taken into the labour wards but left unexposed—that is, closed as for transport—provided insignificantly small measurements.