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SPECIAL ARTICLE

Anaesthesia chapter from *Saving Mothers' Lives; reviewing maternal deaths to make pregnancy safer*

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This chapter concerning maternal mortality due to anaesthesia, reprinted with permission from *Saving Mothers' Lives*, is the 18th in a series of reports within the Confidential Enquiries into Maternal and Child Health (CEMACH) in the UK. In the years 2003–05 there were six women who died from problems directly related to anaesthesia, which is the same as the 2000–02 triennium. Obesity was a factor in four of these women who died. Two of these deaths were in women in early pregnancy, who received general anaesthesia for gynaecological surgery by inexperienced anaesthetists who failed to manage the airway and ventilation adequately. When trainee anaesthetists are relatively inexperienced their consultants must know the limits of their competence and when close supervision and help may be needed. One death was due to bupivacaine toxicity due to a drug administration error when a bag of dilute local anaesthetic was thought to be intravenous fluid. In a further 31 cases poor perioperative management may have contributed to death. Obesity was again a relevant factor. Other cases could be categorized into poor recognition of women being sick and poor clinical management of haemorrhage, sepsis and of pre-eclampsia. Early warning scores of vital signs may help identify the mother who is seriously ill. Learning points are highlighted in relation to the clinical management of these obstetric complications.

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Anaesthesia: specific recommendations

All patients, including women in early pregnancy whose treatment is generally managed by gynaecological services, require the same high standard of anaesthetic care. This includes early recovery from anaesthesia for which anaesthetic services have full responsibility. Recovery staff must be able to receive immediate effective assistance from an anaesthetist until the woman is fully conscious and has stable vital signs.

Trainee anaesthetists must be able to obtain prompt advice and help from a designated consultant anaesthetist at all times. They and their consultants must know the limits of their competence and when close supervision and help are needed. Morbidly obese women should not be anaesthetized by trainees without direct supervision.

Trainees across all specialties may not have the experience or skill to recognize a seriously ill woman. Referral to a consultant or senior trainee should occur if there is any doubt about a woman's condition. Early warning scores may help identify the mother who is seriously ill. Bedside estimation of haemoglobin concentration is valuable. Many of these points are reiterated in the 'top-ten' Recommendations of this Report.

Summary of key findings for 2003–05

The central assessors in anaesthesia reviewed 150 cases where a woman who died from either a *Direct* or *Indirect* cause of maternal death was also known to have had an anaesthetic. These comprise around half of the maternal deaths this triennium. From these cases the assessors identified six women who died from problems directly associated with anaesthesia and whose deaths are counted in this Chapter. This is the same number and a similar rate to 2000–02. The overall mortality rates from deaths from anaesthesia over the past seven triennia are shown in Table 1.

In addition to the six women who died from *Direct* anaesthetic causes, the assessors considered that in a further 31 cases poor perioperative anaesthetic management may have contributed to the outcome. These deaths are counted in the relevant Chapters of this Report, but the lessons for anaesthetists to be learnt from them are included here.

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Table 1 *Direct* deaths attributed to anaesthesia and rate per 100 000 maternities; United Kingdom: 1985–2005

Triennium	Number	Percentage of *Direct* maternal deaths	Rate per 100 000 maternities	95% CI	
1985–87	6	4.3	0.26	0.12	0.58
1988–90	4	2.8	0.17	0.07	0.44
1991–93	8	6.3	0.35	0.18	0.68
1994–96	1	0.7	0.05	0.01	0.26
1997–99	3	2.8	0.14	0.05	0.42
2000–02	6	5.7	0.30	0.14	0.66
2003–05	6	4.5	0.28	0.13	0.62

It is clear that the workload and challenges presented to the obstetric anaesthetist are increasing in number, complexity and severity because of increasing interventions, maternal age, obesity and other co-morbidities.

Deaths directly due to anaesthesia

The women who died

The ages of the women who died ranged between 23 and 33 yr, with a median age of 30. All but one were White and, where relevant, all attended for regular antenatal care. Four were obese, two morbidly so with a body mass index (BMI) greater than 35. Two, whose care was managed by the gynaecological services, died in early pregnancy.

Postoperative respiratory failure

> An obese asthmatic woman died as a result of failed re-intubation during the recovery phase after anaesthesia for laparoscopic surgery for an ectopic pregnancy. She developed acute respiratory distress due to severe bronchospasm on extubation. A senior anaesthetist was called but by then she had suffered an irreversible cardiac arrest.

As highlighted in the previous Report there is great concern that trainees in anaesthesia now take longer to become experienced in laryngoscopy, intubation and other advanced airway techniques. Fortunately there have been no deaths this triennium from unrecognized oesophageal intubation at caesarean section but this case reiterates the need for intubation skills throughout anaesthetic practice. Better training in tracheal intubation and dealing with consequent problems is still required. Undoubtedly this can only be gained outside obstetric practice and is a departmental responsibility. Tracheal extubation has been added as a specific skill to the Initial Test of Competence in the CCT syllabus.[1]

> Another obese woman, also in early pregnancy, was anaesthetized by a trainee. A second, relatively large dose of fentanyl was given at the end of the procedure and the woman was then transferred to recovery and left with the recovery nurse. Within five minutes she developed breathing difficulties and the anaesthetist was called back after having left the unit. The immediate efforts of the nursing staff to support ventilation were not adequate and the woman became bradycardic and then suffered a fatal cardiac arrest.

The anaesthetist did not appreciate the profound ventilatory depression caused by the opioid. Anaesthetists are fully responsible for their patients until full consciousness has returned, with stable cardiovascular and respiratory systems. They may delegate immediate supervision to a trained recovery nurse, but must stay close by and be able to attend immediately in case problems arise.

In these two cases, trainees without immediate senior backup, administered the anaesthetics. Their relative inexperience was relevant because, in both cases, the problems were avoidable and once they had happened should have been retrievable. The close proximity of additional skilled help may have been able to avert these deaths.

The third case also highlights the problems in caring for a morbidly obese woman with asthma where her compromised breathing should have received attention and treatment:

> A morbidly obese asthmatic woman had an elective caesarean section for which a consultant anaesthetist administered spinal anaesthesia. She became agitated and short of breath after surgery but she was sent to the postnatal ward a few hours later. She received oxygen but remained agitated and short of breath. She was reviewed by an anaesthetist but had a fatal cardiac arrest a few hours later. There were additional problems with the ready availability of resuscitation equipment on the postnatal ward.

The anaesthetist failed to recognize postoperative respiratory failure and did not monitor her appropriately, which should have included arterial blood gases. Appropriate treatment (bronchodilators, optimal positioning, early assisted ventilation) was not given. Asthma which does not respond to bronchodilators constitutes a medical emergency, particularly if associated with obesity, agitation and tachycardia.

Drug administration error

> A woman of slight build had a low dose infusion epidural during labour and was delivered by forceps. She had some bleeding and intravenous fluid and syntocinon infusions were started. Shortly after she had a grand mal convulsion followed by ventricular fibrillation from which she could not be resuscitated. She had received 150 ml of a 500 ml bag of 0.1% bupivacaine in saline intravenously in error. Blood samples taken after the arrest showed serum bupivacaine concentrations of 2.1 and 4.2 mg litre^{-1}.

It is unclear why 500 ml bags of plain 0.1% bupivacaine were in use and why they were stored in an area where the

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bags could be confused with conventional i.v. fluids. Epidural infusion analgesia has been in common use for 30 yr but, in spite of great advances in pump technology, the disposable equipment is basically the same as that used for intravenous infusion. This was a systems error and until such time as specific equipment and connectors are used for central neural drug administration these errors will recur. Strategies to avoid such errors have now been described in a National Patient Safety Agency (NPSA) patient safety alert.[2]

Lipid emulsion has been used to end otherwise refractory cardiac arrest in patients apparently intoxicated with local anaesthetics, including bupivacaine. As a result of these successes many departments have decided to stock a 'lipid rescue' pack in their theatres and labour wards.[3] Although the cases are anecdotal the authors[3] have volunteered to establish an educational website, www.lipidrescue.org, in order to collect and disseminate information that can only be assimilated through such case reports as clinical trials would clearly be unethical. We encourage anaesthetists to contribute to this.

Anatomical compromise

> A woman with pectus excavatum presented in mid pregnancy with reduced fetal movements, fulminant pre-eclampsia and HELLP syndrome. She was severely hypertensive, hyperreflexic with clonus, oliguric and had abnormal liver function tests. She was given oral labetalol, magnesium and hydralazine to little effect. An urgent caesarean section was planned with prior insertion of arterial and central venous pressure monitoring. Right internal jugular cannulation was unsuccessful but the consultant anaesthetist was able to cannulate the subclavian vein at the second attempt. Shortly after she had a cardiac arrest from which she could not be resuscitated. At autopsy a large right haemothorax was found.

There were good indications for invasive monitoring techniques in this woman with severe hypertension and oliguria. The difficulties with central venous placement were probably caused by abnormal great vessel anatomy because of her pectus excavatum. The haemothorax was secondary to trauma of the proximal part of the intrathoracic internal jugular vein. Such trauma may have been caused by a rigid vein dilator. Care should be taken not to advance a rigid dilator too far into the vein. It is unlikely that ultrasound guidance would have avoided this complication.

In the final *Direct* death from anaesthesia the cause of death was difficult to ascertain:

> Another obese woman had longstanding renal problems necessitating nephrectomy. She became pregnant and had a premature labour and delivery. A few weeks later she was admitted with fever, loin pain and an ileofemoral venous thrombosis. It was planned to drain a suspected septic focus from her remaining kidney under ultrasound guidance. The woman did not want local anaesthesia and during the subsequent general anaesthesia she suffered a cardiac arrest from which she could not be resuscitated.

The cause of her death was unascertained but pulmonary embolus and anaphylaxis were excluded. Although the details are incomplete the assessors consider her death was likely to be due to a cardiac arrhythmia, presumed to be secondary to an electrolyte disturbance.

Deaths to which anaesthesia contributed

There were 31 further *Direct* or *Indirect* maternal deaths in which perioperative/anaesthesia management contributed and from which lessons can be learned. These deaths are counted in the relevant Chapters in this Report and discussed here in the following categories:

- Failure to recognize serious illness.
- Poor management of
  - haemorrhage (including the use of syntocinon),
  - sepsis, and
  - pre-eclampsia/eclampsia.
- The management of obese pregnant women.
- The quality of in-house hospital Trust enquiries into serious untoward incidents including maternal deaths.

Failure to recognize serious illness

As highlighted in almost every Chapter of this Report, and one of its 'top ten' Key Recommendations, the early recognition and management of severe illness in pregnant or recently delivered women remains a challenge for everyone involved in their care. The relative rarity of such events, combined with the normal changes in physiology associated with pregnancy and childbirth, compounds the problem. As discussed in Chapter 19, Critical Care, modified early warning scoring systems have been successfully introduced into hospital practice which could be adapted and introduced for use in maternity units.

Haemorrhage

Less than optimal anaesthetic management was considered to have contributed to many of the 17 maternal deaths from haemorrhage or ruptured uterus counted in Chapter 4. Twelve of these women died from postpartum haemorrhage. Although some women with obstetric haemorrhage were clearly managed very well with excellent team debriefing afterwards there are still areas of concern which have also been highlighted in Chapter 4. The following is representative of a typical case:

> A woman suffered a concealed haemorrhage after a caesarean section for pre-eclampsia. The team of

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obstetrician, anaesthetist and midwives failed to interpret the classical signs of peripheral shutdown and tachycardia and misdiagnosed her abnormal twitching movements as incipient eclampsia. Ischaemic findings on an electrocardiograph (ECG) were interpreted as primary cardiac disease, rather than being due to severe anaemia. Once the correct diagnosis was made further delays occurred in obtaining her blood results and cross-matched blood. She died shortly afterwards, just as consultant help arrived.

Here there was a failure to interpret the vital signs and to consider concealed haemorrhage as a possibility. There was also failure to realize that cardiac ischaemia may be caused by severe anaemia and a further failure to estimate her haemoglobin level either urgently in the laboratory or at the bedside.

The remediable factors also illustrated in the other cases of obstetric haemorrhage include:

- Poor recognition of concealed intra-abdominal bleeding.
- The classical signs related to intra-abdominal haemorrhage of peripheral shutdown, tachycardia and tachypnoea, are still being ignored. Hypotension is often a late sign in young fit adults.
- A reluctance to believe low blood pressure recordings recorded by non-invasive devices.
- Inconsistent use of invasive monitoring.
- The wrong administration of large volumes of cold clear fluid and unwarmed blood products.
- Poor postoperative care and observations in recovery, postnatal or gynaecological wards where continuing haemorrhage may go unnoticed.
- Poor management of women with placenta accreta, as also discussed in Chapter 4.
- Recognizing that women who decline blood and blood products require consultant anaesthetic and obstetric care and, where possible, access to cell salvage facilities.

Learning points are highlighted in Box 1.

Box 1 Management of obstetric haemorrhage: anaesthetic and other learning points

Women with placenta praevia, who have had a previous caesarean section are at risk of massive haemorrhage and should be managed in units with direct access to blood transfusion and Critical Care. These cases require consultant obstetrician and consultant anaesthetist involvement with additional obstetric and anaesthetic help. Balloon tamponade by iliac artery catheters may be helpful in the planned and emergency management of these patients

The earlier recognition of hypovolaemia would be helped by the routine use of an early warning score system as advocated in the Key Recommendations

Blood pressure parameters may need adjusting in patients with pregnancy-induced hypertension

Where there is a possibility of bleeding, a near-patient method of haemoglobin estimation may be life-saving. Such a device should be available in all obstetric units

High volume infusions of intravenous fluid must be warmed beforehand. Women who are being resuscitated should be insulated and actively warmed. Hypothermia at temperatures below 33°C produces a coagulopathy that is functionally equivalent to significant (<50% of normal activity) factor-deficiency states under normothermic conditions, despite the presence of normal clotting factor levels.[4] In the situation of hypothermia and dilutional coagulopathy, both rewarming and administration of coagulation factors are required[5]

Where tachycardia persists after intraoperative haemorrhage, the woman must remain in theatre until both surgeon and anaesthetist are satisfied that her condition is stable

Invasive monitoring via appropriate routes should be used particularly when the cardiovascular system is compromised by haemorrhage or disease

Hands on help from other anaesthetists, and, in particular the consultant anaesthetist, should be present for these cases

Syntocinon

The majority of anaesthetists have changed from using a single intravenous bolus injection of 10 units of syntocinon to using the recommended dose of 5 units[6] after the 1997–99 Confidential Enquiry Report. It was disappointing to see in a number of cases that the larger bolus dose was still being given. It may be that a perceived conflict of interest arises between obstetricians and anaesthetists, the former wishing to maintain tone in the uterus and the latter trying to maintain cardiovascular stability. These two aims are not incompatible. Uterine tone should initially be stimulated by slow administration of intravenous syntocinon five units, maintaining cardiovascular stability[7] (Box 2) and thereafter maintained by an infusion of syntocinon, intramuscular or slow intravenous administration of ergometrine and intramuscular carboprost as recommended in Chapter 4.

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Box 2 Learning point: uterine atony
Uterine atony may be prevented by slow intravenous administration of syntocinon. Syntocinon causes hypotension when given intravenously by bolus dose in the hypovolaemic woman. It may be given slowly in the presence of hypovolaemia. Uterine atony should be treated by giving a continuous infusion of syntocinon as a first measure

Sepsis

Poor anaesthetic or resuscitation management were considered to have contributed to 10 maternal deaths from sepsis. Regardless of the woman's gestation, early or late in pregnancy, there were common themes in the cases reviewed (Box 3). The failure of trainee medical staff to appreciate the seriousness of the woman's condition was frequent, yet again suggesting that an early warning score system would be valuable. When cardiac arrest occurred there were some problems with the availability of resuscitation equipment and suction and difficulty in resuscitating obese women.

One woman, septic and tachycardic after a midtrimester fetal loss, collapsed immediately after an epidural test dose. There was no evidence that the local anaesthetic was given intrathecally or intravenously or that an incorrect drug was given. It is unlikely that a small dose of epidural local anaesthetic precipitated her collapse. However epidural anaesthesia is contraindicated in patients who have obvious septicaemia or those who are tachycardic secondary to the cardiovascular response to systemic infection.

Another woman who had a medical termination of pregnancy delayed seeking care afterwards when she was continuing to bleed and developing an infection secondary to retained products of conception. Having finally sought medical care her condition rapidly deteriorated in a gynaecology ward under the care of trainee medical staff. She was both severely anaemic and septic and the rapid resuscitation with intravenous fluid she was eventually given suddenly resulted in pulmonary oedema. Here early diagnosis and careful resuscitation with blood and inotropes guided by invasive monitoring in a Critical Care unit was indicated.

Box 3 Learning point: anaesthesia and sepsis
Cardiovascular collapse can happen suddenly in sepsis. Circulatory support requires invasive monitoring and careful fluid resuscitation in a Critical Care unit or operating theatre environment

Pre-eclampsia/eclampsia

Four women died from pre-eclampsia/eclampsia to which poor anaesthetic management contributed. In all cases there was inadequate control of their high systolic blood pressure either at the time of caesarean section or in the postoperative period. The importance of ameliorating the hypertensive response to laryngoscopy should be remembered. The immediate postoperative management of women with pre-eclampsia/eclampsia is the responsibility of both the consultant obstetrician and the consultant anaesthetist. It should be a joint decision whether care, treatment and monitoring are provided in a Critical Care unit, high dependency unit or the postnatal ward.

Obesity

The problems that morbid obesity pose for pregnant women are numerous and have been mentioned throughout this Report. They have also been recently reviewed in relation to anaesthetic practice.[8] It was pleasing to note that there were many good aspects of both anaesthetic and surgical management of women with morbid obesity even up to a BMI of 66. However these women present many challenges and this Report makes a recommendation that the management of obese pregnant women, especially the morbidly obese, is an important area requiring an evidence-based clinical guideline (Box 4).

Box 4 Learning points: anaesthesia and obesity
All obstetric units should develop protocols for the management of morbidly obese women. These should include pre-assessment procedures, special community, ward and theatre equipment such as large sphygmomanometer cuffs, hoists, beds and operating tables and long regional block needles

Morbidly obese women should be referred for anaesthetic assessment and advice as part of their antenatal care

Management by consultant anaesthetists is essential and difficulties with airway management and intubation should be anticipated

Positioning the women requires skill and sufficient manpower in the event of a requirement for induction of general anaesthesia

Direct arterial pressure measurement may be useful in the morbidly obese women where sphygmomanometry is often inaccurate

All morbidly obese women in childbirth should be given prophylactic low molecular weight heparin and the duration of therapy needs to be determined in view of likely immobility. Thromboembolic stockings of appropriate size need to be available

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Hospital enquiries

A new but recurring feature in many of the cases reviewed in this Report is that it is the first triennium where there have been a substantial number of reports of internal hospital enquiries related to the maternal death included in the documentation sent to CEMACH. These have been welcome in that that they reveal clinical reflections and also aspects of the culture of working in specific institutions. Whilst some of these reports have been insightful, it is fair to say that others have not been. In some cases the hospital enquiries were improperly conducted: investigatory panels did not include clinicians from relevant disciplines (including anaesthesia) and therefore lacked clinical insight and relevance, or included clinicians who were directly involved in the death and were therefore potentially biased in their assessments. Hospital managers should consider for each case whether unbiased external input would assist real learning from individual deaths: it is often after this has been received that the benefit is realized.

What the practitioners learnt

A new feature of completing the case details on the CEMACH form is an invitation for the practitioner to reflect on the case. Some of the comments are poignant and insightful whereas others are disappointing (Box 5).

Box 5 What did you learn from this case and how has it changed your practice?

'After the death of a woman who refused blood transfusion I no longer treat such patients for elective surgery and have reservations about continuing on-call because of the ethical concerns about being forced to accept treating those who refuse blood transfusion'. (Consultant anaesthetist)

'The relatives want Dr X to know that they bear no grudge, and hope that Dr X will not give up anaesthesia as a result of this case'

'No lessons to be learned'. (Consultant anaesthetist, although in the opinion of the assessors there clearly were)

'Should I have done a pre-op ECG? Would there have been a case for an echo? In future I would not rely on non-invasive blood pressure monitoring but would insert an arterial line, or at least try'. (Reflections from a consultant anaesthetist who had realized the problems of an obese hypertensive woman with pre-eclampsia)

'I am even more keen to obtain consultant advice and participation early with such patients'. (Lesson from staff grade about a woman with HELLP syndrome and bleeding)

'There was an emphasis on urgency because of possible abruption, such that the warning bells about pre-eclampsia may not have registered. It is disappointing that the anaesthetist did not reflect on the need for ameliorating the pressor response to intubation when writing his/her report'. (Central assessor)

Acknowledgement

This Chapter has been seen and discussed with the National and Regional Assessors in Anaesthesia.

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