FOCUS ON: OBSTETRICS

Life-threatening complications of pregnancy: Key issues for anaesthetists

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Summary
Acute life-threatening complications can arise during both pregnancy and the early postpartum period and result in maternal and fetal morbidity and mortality. Substandard care and poor communication have been identified repeatedly as contributory factors to adverse outcomes from obstetric emergencies. Prompt recognition of life-threatening conditions and early effective multidisciplinary management are essential to ensure optimal maternal and fetal outcome.

This article considers both generic and specific concepts of emergency management in the peripartum period. It examines the causes, differential diagnosis and management of major acute life-threatening complications of pregnancy.

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Introduction
Improvements in antenatal and peripartum care have resulted in significant reductions in maternal mortality and morbidity over the course of the 20th century.1 However, life-threatening emergencies still arise and mandate involvement of the obstetric anaesthetist. Many of these emergency situations are specific to pregnancy. Management in the antenatal situation is complicated by the need to consider both maternal and fetal well-being.

Substandard care, poor interdisciplinary communication and lack of appropriate early senior involvement have been repeatedly cited as contributing to adverse maternal outcome. Some degree of substandard care has been identified in two thirds of direct maternal deaths.1

Generic principles of emergency management
The principles underlying the management of acute emergencies in the peripartum period are the same as those engendered by the advanced life support courses. The courses, which include Advanced Life Support®, Advanced Trauma Life Support® and Management of Obstetric Emergencies and Trauma®, teach systematic approaches to emergencies. Regular multidisciplinary emergency 'fire drills' provide an opportunity for staff to practise emer-
ency management. Simulator centres can offer an alternative environment for rehearsing emergency scenarios.

It is vital to ensure that a patent airway is maintained as maternal hypoxia develops rapidly due to the increased oxygen demands of the fetoplacental unit and decreased maternal functional residual capacity (FRC). One hundred percent oxygen should be administered via facemask with non-rebreathing reservoir bag. The airway may be difficult to maintain and intubation of the trachea rendered more difficult by oedematous tissues, breast enlargement and the need to maintain left lateral tilt to avoid aortocaval compression.

At term the vena cava is completely occluded in 90% of women when supine, leading to decreased venous return and a fall in stroke volume and cardiac output. Aortocaval compression and consequent supine hypotension must be avoided during the management of antenatal emergencies. Aortocaval compression can be avoided by use of left lateral tilt, manual uterine displacement, a Cardiff (wooden) wedge, or a ‘human wedge’ (thighs of kneeling healthcare worker).

Cardiopulmonary resuscitation in the gravid patient

One in 30,000 pregnant women will require cardiopulmonary resuscitation (CPR). The causes of maternal cardiovascular collapse are summarized in Table 1. Successful outcome from cardiac arrest in the pregnant woman will almost certainly involve Caesarean section (CS). The anatomical and physiological changes of pregnancy make effective CPR difficult (Table 2).

CPR should be carried out with 15° left lateral tilt. If defibrillation is required, adhesive rather than conventional paddles should be employed as breast enlargement and the gravid uterus may make paddle placement difficult and pose potential electrical hazard to staff. The maternal airway should be secured early to provide adequate oxygenation, and cricoid pressure maintained until the trachea is intubated. Rapid delivery should be the aim to optimize maternal and fetal outcome.

The presence of a fetus prevents effective CPR. A decision to proceed to emergency CS should be made if cardiac output has not been restored after 4 min advanced life support. Recent evidence supports this time frame. Before 24 weeks gestation the physiological benefits to the mother conferred by delivery of the fetus are minimal and the chance of a successful fetal outcome are small. However, at more advanced gestational age there are many reports of favourable maternal and fetal outcome. Early senior input with appropriate experience is ideal but management decisions should not be delayed whilst waiting for help to arrive. Only delivery will completely relieve occlusion of the vena cava and improve thoracic compliance—thereby improving the effectiveness of CPR. The gestation of the fetus will influence the decision to perform perimortem CS. Perimortem CS is conventionally performed via a classical approach as this produces a relatively bloodless field due to diastasis of the recti muscles towards the end of pregnancy. However, the surgical approach will depend on the expertise of the operating surgeon. CPR must be continued throughout surgery and recourse to internal chest compressions should be considered. If resuscitation attempts are successful it is vital that meticulous haemostasis is secured to avoid major haemorrhage as arterial pressure increases.

Anaphylaxis

The prevalence of latex allergy seems to be increasing, although succinylcholine is the most likely cause of anaphylaxis at induction of general anaesthesia for CS. The management of anaphylaxis in the parturient is the same as in the non-pregnant patient. There has previously been a

| Table 1 Causes of cardiovascular collapse in the obstetric population. |
|--------------------------|------------------|
| Hypovolaemia             | Obstetric haemorrhage |
|                         | Non-obstetric haemorrhage |
| Hypoxia                  | Convulsions—eclamptic or other aetiology |
|                         | Other neurological events |
|                         | Total spinal anaesthesia |
| Thromboembolic           | Pulmonary thromboembolism |
|                         | Amniotic fluid embolism |
|                         | Air embolism |
| Toxic                    | Magnesium sulphate overdose |
|                         | Local anaesthetic toxicity |
|                         | Overdose of antihypertensive agents |
| Other                    | Tension pneumothorax |
|                         | Cardiac tamponade |
|                         | Myocardial infarction |
|                         | Sudden adult death syndrome |
reluctance to administer epinephrine on the basis of concerns that placental perfusion might be compromised by the alpha adrenergic activity. However, epinephrine should not be withheld, as in low cardiac output states its use is likely to improve rather than decrease uteroplacental blood flow. Should anaphylaxis complicate induction of general anaesthesia for CS, surgery should be expedited to relieve aortocaval compression and help improve maternal cardiac output.

Hypertensive disorders of pregnancy

The hypertensive disorders of pregnancy are a heterogeneous group of diseases of incompletely understood aetiology. They result in increased maternal and fetal mortality and morbidity. They include pregnancy-induced hypertension, pre-eclampsia, eclampsia, and the syndrome of Haemolysis Elevated Liver enzymes and Low Platelets (HELLP). Delivery of the placenta is the only definitive treatment.

Pre-eclampsia

Pre-eclampsia appears to result from an abnormal vascular response to placentation. It results in increased systemic vascular resistance, enhanced platelet aggregation, activation of the coagulation cascade and endothelial dysfunction. Pre-eclampsia complicates around 5% of pregnancies in nulliparous women and remains a leading cause of maternal mortality and morbidity around the world. Severe pre-eclampsia and eclampsia have associated co-morbidities that are associated with maternal and fetal mortality and morbidity (Table 3). 

Management

The treatment of hypertensive disorders in pregnancy should be multidisciplinary. Early diagnosis is vital to ensure the best outcome for mother and baby. The definitive treatment is delivery of the placenta but the actual management plan will be determined by maternal and fetal assessment. Delivery versus expectant management is determined by the severity of maternal condition, gestation of the fetus and fetal surveillance by sequential Doppler ultrasound studies and cardiotocograms.

The treatment of acute hypertension is key to reducing maternal mortality and morbidity from cerebrovascular and cardiovascular complications. There should be prompt and effective management of hypertension according to local departmental guidelines. The diagnosis and treatment of pre-eclampsia has tended to focus on diastolic arterial pressure. However, severe systolic hypertension is no less indicative of the threat of intracerebral haemorrhage. The mainstays of hypertension management are intravenous (i.v.) boluses of hydralazine (2.5–5 mg) or labetalol (10–20 mg) every 10–20 min. Nifedipine (5 mg) is effective by the sublingual route. The aim of treatment should be to keep arterial pressure below 170/110 mm Hg.
yet above 130/90 mm Hg in order that maternal cerebral, renal, and uteroplacental circulations are not compromised.8,9

Central invasive monitoring is only rarely needed to guide therapy. In pre-eclampsia there is poor correlation between central venous and pulmonary artery wedge pressures. However, central venous monitoring might be helpful when arterial pressure interpretation is further complicated by sepsis or haemorrhage.9 In the presence of coagulopathy central venous catheterization should ideally be undertaken via a peripheral site, i.e. antecubital fossa. Jugular venous cannulation should only be undertaken with ultrasound guidance. Intra-arterial monitoring can be very helpful for assessing the acute response to antihypertensive therapy and for repeated blood sampling.

Imminent eclampsia (see later), multi-organ dysfunction, suspected placental abruption, or non-reassuring fetal assessment will signal the need for delivery.7 The mother’s clinical condition can continue to deteriorate for 48 h postdelivery. Close monitoring is required in a critical care area. Oliguria (< 30 ml/h) is common in the hours after delivery and does not necessarily imply volume depletion. Acute tubular necrosis is exceptionally rare in the absence of a compounding factor such as major haemorrhage.

Eclampsia

The term eclampsia describes convulsions (where there is no other aetiology) in usually the 2nd and 3rd trimesters of pregnancy, or postpartum, in women with symptoms or signs and of pre-eclampsia.8 Eclampsia complicates about 1 in 2000 deliveries in Europe and developed countries.10 It is important to bear in mind that eclamptic seizures can be unheralded—the first manifestation of a hypertensive disorder of pregnancy, in the absence of hypertension and proteinuria.8 Symptoms and signs of imminent eclampsia include persistent occipital or frontal headache, blurred vision, photophobia, epigastric and/or right upper quadrant pain, and altered mental status.8,9 Seizures can be antepartum, intrapartum or postpartum.

The principles of management of eclamptic seizures are support of maternal respiratory and cardiovascular systems and prevention of maternal injury. The basic principles of emergency management, i.e. Airway, Breathing, Circulation, should be followed. A patent airway must be maintained and attempts made to prevent aspiration of gastric contents. Oxygen at high fractional inspired concentration should be administered via facemask. To minimize the risk of aspiration and to avoid aortocaval compression the patient should be nursed in the lateral decubitus position.

Magnesium and the anaesthetist

Magnesium (Mg) is the agent of choice for primary and secondary prevention of eclamptic seizures. Phenytoin is obsolete.11,12 Mg reduces cerebral and systemic vasospasm, and is administered as an initial i.v. bolus dose of 5 g over no less than 10 min, followed by a maintenance infusion of 1 g h⁻¹. Women receiving Mg infusions must be regularly assessed for Mg toxicity. Nausea, vomiting are early symptoms, and flushing an early sign. Arterial blood pressure, pulse, respiratory rate and patellar reflexes should be assessed hourly. Regular laboratory measurement of serum Mg concentration (therapeutic range 2–3 mmol l⁻¹) is useful but not mandatory. In the event of Mg toxicity the infusion must be stopped. One hundred percent oxygen should be administered via a facemask and cardiovascular and ventilatory support given as required. Ten to twenty milliliters of 10% calcium chloride or gluconate should be administered i.v. over 5–10 min.

Administration of Mg prior to general anaesthesia helps to obviate the pressor response that occurs during tracheal intubation. Therapeutic serum Mg concentrations potentiate the action of non-depolarizing muscle relaxants (but not succinylcholine). Doses of non-depolarizing muscle relaxants must be reduced and monitoring of neuromuscular function during general anaesthesia is mandatory.

Anaesthesia in severe pre-eclampsia and eclampsia

Should operative delivery be required regional techniques confer advantages such as avoidance of the pressor response to tracheal intubation and failed intubation secondary to laryngeal oedema. The use of a regional technique also facilitates continued monitoring of neurological status. Epidural and combined spinal–epidural anaesthesia facilitate postoperative analgesia by infusion. The hypertension of pre-eclampsia is not sympathetically mediated and spinal anaesthesia is not associated with excessive hypotension.13 Both phenylephrine and ephedrine can be used in standard doses without causing an exaggerated hypertensive response.

General anaesthesia is preferable in the presence of coagulopathy or symptoms and signs of impend-
ing eclampsia. An eclamptic seizure is not necessarily a contraindication to regional anaesthesia. Regional anaesthesia may be appropriate after a single seizure if consciousness has been fully regained, the platelet count is greater than 100 000 mm$^{-3}$ and serum Mg concentration is within the therapeutic range.$^{14,15}$

General anaesthesia for operative delivery requires special consideration. The risk of difficult intubation is increased due to laryngeal oedema and the presence of a hoarse voice should alert the anaesthetist to this potential problem. The pressor response to intubation will be exaggerated and must be obtunded to reduce the risk of intracerebral haemorrhage. i.v. alfentanil (10 μg kg$^{-1}$) or remifentanil (2 μg kg$^{-1}$) are effective. The paediatrician attending the delivery should be alerted to the fact that an opioid has been given and may be the cause of neonatal respiratory depression. Direct arterial pressure monitoring should be considered prior to induction of general anaesthesia if time permits. Before extubation, consider specific therapy (e.g. labetalol in 10–20 mg increments) to avert a dangerous pressor response. If a swollen larynx was evident at laryngoscopy, or intubation was traumatic, postextubation stridor is a possibility and a period of postoperative ventilation may be prudent.

Adequate analgesia is important to reduce hypertension in the postoperative period and a generous dose of morphine (10–20 mg) should be given i.v. intra-operatively. Non-steroidal anti-inflammatory analgesics (NSAIDs) should be avoided for at least the first 24 h postpartum as renal function may be impaired and coagulation indices deranged. Introduction of an NSAID can be considered later in the postpartum period provided that the general condition is improving and urine output is satisfactory.

Differential diagnosis of acute neurological emergencies in pregnancy and the puerperium

Although eclampsia is one of the most common causes of convulsions during pregnancy and the puerperium other causes should be considered if the presentation is atypical or there are focal neurological signs. Clinical symptoms and signs are frequently non-specific and there should be early recourse to neuroradiological studies in cases where the diagnosis is in doubt. The differential diagnosis of convulsions in pregnancy and the puerperium include epilepsy, primary and secondary cerebral tumours, cerebral venous thrombosis, intracranial haemorrhage, and infection.$^8$

It is the remit of the obstetric anaesthetist to manage transfer of these women for radiological investigations. Women should be monitored throughout their transfer and investigations. The importance of avoiding aortocaval compression during both the transfer and the study cannot be understated and the woman should have a wedge inserted under her right hip. Continuous fetal monitoring during investigations may be desirable but practically limited during magnetic resonance imaging scans due to equipment incompatibility. Accompanying midwives may be unaware of these issues and should be alerted.

Thromboembolic disease

Thromboembolic disease remains the leading direct cause of maternal death despite increased awareness and utilization of thromboprophylaxis.$^1$ Prompt detection and treatment of thromboembolic disease is vital to reduce maternal mortality and morbidity. Conscientious attempts should be made to prevent the development of thromboembolic disease by identification of those at risk and institution of appropriate prophylaxis.

Risk factors and presentation

Pregnancy per se results in a hypercoaguable state that is enhanced by additional risk factors including obesity, operative delivery, pre-eclampsia, excessive blood loss and immobility. The symptoms and signs of pulmonary thromboembolism are often non-specific but include dyspnoea, collapse, chest pain, haemoptysis, tachycardia, cough, apprehension, faintness and raised jugular venous pressure. There may also be symptoms and signs of deep vein thrombosis. The onset of symptoms can be rapid and dramatic—most deaths from pulmonary embolism occur within 6 h of the onset of symptoms.

Acute management

The treatment of acute thromboembolic disease is dependent upon the severity of the clinical situation and the local availability of resources and expertise. Anticoagulation provides the mainstay of management of acute thromboembolic events but early supportive therapy should be instituted, including high fractional inspired oxygen, fluids, inotropes and CPR if required. i.v. unfractionated heparin by infusion remains the preferred
treatment in massive pulmonary embolism but low molecular weight heparin regimens have gained acceptance. Thrombolysis can be considered but obstetric delivery and major surgery are contraindications to its use. Thrombolysis has been used successfully in obstetric patients following CS but at the risk of massive haemorrhage. It should be reserved for cases where other strategies have failed. Interventional radiology can enable targeted administration of thrombolytic agents into the pulmonary vasculature. Pulmonary embolectomy in a regional cardiothoracic centre should be considered in cases of massive pulmonary embolus.

Amniotic fluid embolism

Amniotic fluid embolism (AFE) is a rare complication of pregnancy occurring with an incidence between 1 in 8000 and 1 in 80 000. Its aetiology remains poorly understood; it is now considered to encapsulate a spectrum of disease ranging from a subclinical entity to a severe and rapidly fatal event. AFE can arise before, during or after delivery, although 70% of cases present during labour. The effects of AFE were thought for decades to be due to a direct mechanical effect of amniotic fluid in the maternal pulmonary circulation. However, AFE shares many similarities with both sepsis and anaphylaxis. In both there is release of prostaglandins, histamine, leukotrienes, thromboxane and bradykinin that mediate systemic effects. These primary and secondary mediators can cause profound myocardial depression, pulmonary hypertension and coagulopathy. This has led to adoption of the term ‘anaphylactoid syndrome of pregnancy’.

AFE was previously thought to be universally fatal and associated with older multiparous women and hyperstimulated labour. These associations have now been refuted and no identifiable maternal risk factors have been found. More recently mortality rates of 16–30% have been noted, probably due to improved intensive care and the recognition of ’milder’ cases.

Clinical presentation

The classic presentation described for AFE was sudden, profound unexpected cardiovascular collapse and coagulopathy. It is now accepted that the presentation can be variable (Table 4). A consumptive coagulopathy of varying severity is almost universal in and isolated unexplained coagulopathy can be the first clinical sign.

Management

The mainstay of treatment is supportive as there is no specific treatment for AFE. Early and close liaison with intensivists is vital as most patients will require level 3 critical care support for the ensuing multiple organ dysfunction. Ventilatory, cardiovascular and renal support may all be required in addition to the correction of the consumptive coagulopathy. In addition there are case reports of survival where high dose steroids, inhaled nitric oxide or prostacyclin and cardiopulmonary bypass have been used. Antepartum AFE warrants prompt CS but blood loss can be massive as the coagulopathy develops rapidly.

Massive obstetric haemorrhage

Massive haemorrhage remains a leading cause of maternal mortality and morbidity. Severe obstetric haemorrhage is defined as estimated blood loss greater than 1500 ml, peripartum fall in haemoglobin concentration of greater than 4 g dl$^{-1}$ or an acute transfusion of more than 4 units of blood. Haemorrhage (Table 5) can be antepartum (APH) or postpartum (PPH), is frequently unexpected and can rapidly become catastrophic. The bleeding may be concealed (intraperitoneal) making accurate assessment of blood loss difficult. Disseminated intravascular coagulopathy (DIC) can complicate and contribute to massive obstetric haemorrhage. There are several causes of DIC specific to obstetrics: placental abruption, AFE, severe pre-eclampsia and prolonged intra-uterine fetal death.

Management of massive obstetric haemorrhage

All obstetric units must have a protocol in place for the management of massive obstetric haemor-
rhage. There should be regular ‘fire drills’ to ensure staff familiarity with the protocols. Women at high risk of haemorrhage must be identified early, delivered in a centre with appropriate facilities and have a multidisciplinary management plan.

Primary management should be resuscitation with ongoing diagnosis and treatment of the cause. Two large bore i.v. cannulae should be sited and volume resuscitation commenced. Initial volume replacement should consist of 2 l of 0.9% saline or Hartmann’s solution followed by colloid until blood is available. Blood product replacement should commence early. Group O, rhesus negative blood must be available on all obstetric units and given until type-specific or fully crossmatched blood becomes available.

There is no place for embarking upon regional anaesthesia when haemorrhage has resulted in maternal cardiovascular instability. Remember that physiological compensation for haemorrhage can mask the magnitude of the loss. Rapid sequence induction of general anaesthesia is required and left lateral tilt should be used in cases of APH. Etomidate (0.3 mg kg\(^{-1}\)) or ketamine (1.5–2 mg kg\(^{-1}\)) are preferable to thiopental if there is cardiovascular instability. Invasive monitoring of arterial and central venous pressure should be considered but insertion of lines must not delay resuscitation. As in pre-eclampsia, coagulopathy will dictate avoidance of jugular venous cannulation without ultrasound guidance.

Uterine atony is initially treated pharmacologically. The first line treatment is oxytocin administered as a 5 unit i.v. bolus of Syntocinon\(^{10}\). This drug causes vasodilatation and hypotension especially in a cardiovascularly unstable patient. Ergometrine is the second-line agent. It causes uterine and vascular smooth muscle contraction and is administered as an intramuscular dose of 500 μg repeated after 2–4 h. It can cause hypertension due to action at alpha and beta-adrenergic receptors and should be avoided in pre-eclampsia. The i.v. route is no longer recom-
mended in the British National Formulary owing to its intense cardiovascular effects. However, absorption of an intramuscular dose is unpredictable and slow i.v. administration is a reasonable option. The third-line drug is Prostaglandin F\(_{2\alpha}\), administered by deep intramuscular injection (250 μg repeated at an interval not less than 15 min to maximum dose 2 mg). However, it can cause intrapulmonary shunting and maternal hypoxaemia. Prostaglandin F\(_{2}\) can cause nausea and vomiting and bronchoconstriction and should not be used in patients with asthma.

The options for surgical intervention will depend on the clinical situation, and include bimanual compression, balloon tamponade, B-Lynch suture, ligation of uterine or hypogastric arteries, and hysterectomy.\(^{21}\) There may be a reluctance to undertake hysterectomy in a woman whose family is not complete, but it should be performed before irreversible deterioration in the patient’s condition. The input of a vascular surgeon may be required. Selective embolization of uterine and hypogastric arteries by interventional radiologists can be life-saving.

Early liaison with a haematologist is vital in the management of massive obstetric haemorrhage. There should be regular assessment of haemoglobin concentration, platelet count and coagulation status, including fibrinogen concentration, in order to ensure appropriate administration of blood, platelets, fresh frozen plasma and cryoprecipitate. Near-patient testing using thromboelastography can be a helpful adjunct. A standing order with blood bank for blood products for use in massive obstetric haemorrhage can help to expedite their delivery. Recombinant factor VIIa, given as an initial i.v. bolus dose of 60 μg kg\(^{-1}\), has been used successfully in refractory obstetric haemorrhage.\(^{22}\) This drug works by activation of the coagulation cascades.\(^{23}\) Activation of Factor X on the surface of locally activated platelets will initiate a ‘thrombin burst’, leading to the formation of a stable fibrin clot.

Red cell salvage can help to avoid or reduce the requirement for donated red cell transfusions. Concerns have been raised about the potential for infusion of amniotic fluid and the risk of AFE. However, there is an increasing body of evidence to support the safe use of cell salvage in the obstetric setting both in elective and emergency situations.\(^{24}\) A leucocyte depletion filter should be used during the transfusion of the salvaged blood.

**Conclusion**

Effective communication amongst obstetricians, anaesthetists, midwives, haematologists and inten-
sivists is integral to optimal maternal and fetal outcome. It is vital that there is early identification of women at high risk of obstetric complications. The obstetric anaesthetic team should be made aware of these women and there should be an agreed multidisciplinary management plan. Effective communication is also vital in emergency situations, when there should be early recourse to multidisciplinary senior involvement. Team debriefing following an obstetric emergency can be helpful to identifying strengths and weaknesses in protocols and systems.

Obstetric units should have protocols in place for the management of emergencies. However, most life threatening obstetric emergencies are rare and staff may be inexperienced in the management of these conditions. Since emergency systems are largely untested, ‘fire drills’ for a range of emergencies on obstetric units have been recommended as a means to familiarize staff, test systems and identify deficiencies. Implementation of drills is a requirement for level 2 accreditation by the Clinical Negligence Scheme for Trusts and will result in decreased premiums.

References