4.6.1. Haemorrhage

In the case of maternal collapse secondary to antepartum haemorrhage, the fetus and placenta should be delivered promptly to allow control of the haemorrhage. ✓

In the case of massive placental abruption, caesarean section may occasionally be indicated even if the fetus is dead to allow rapid control of the haemorrhage. ✓

Intravenous tranexamic acid significantly reduces mortality due to postpartum haemorrhage. A

The ongoing management of major antepartum haemorrhage is comprehensively covered in the RCOG Green-top Guideline No. 63 *Antepartum Haemorrhage*.[89]

Management of collapse secondary to massive haemorrhage as a result of placenta praevia should be managed in accordance with the RCOG Green-top Guideline Nos. 27a and 27b *Placenta Praevia and Placenta Praevia Accreta: Diagnosis and Management* and *Vasa Praevia: Diagnosis and Management*.[90,91] Evidence level 4

The ongoing management of major postpartum haemorrhage is comprehensively covered in the RCOG Green-top Guideline No. 52 *Postpartum Haemorrhage: Prevention and Management*.[92]

A large randomised controlled study[93] including more than 20 000 women comparing 1 g intravenous tranexamic acid with placebo in cases of postpartum haemorrhage demonstrated a significant reduction in death from haemorrhage, particularly if given within 3 hours. Evidence level 1++

4.6.2. Venous thromboembolism

Massive pulmonary embolism should be treated according to RCOG Green-top Guideline No. 37b *Acute Management of Thrombosis and Embolism during Pregnancy and the Puerperium*. D

The specific management of massive pulmonary embolism is covered in the RCOG Green-top Guideline No. 37b *Acute Management of Thrombosis and Embolism during Pregnancy and the Puerperium*.[94] This includes the use of thrombolysis. Evidence level 4

4.6.3. Amniotic fluid embolism (AFE)

The management of AFE is supportive rather than specific, as there is no proven effective therapy. ✓

Early involvement of senior experienced staff, including obstetricians, anaesthetists, haematologists and intensivists, is essential to optimise outcome. ✓

Coagulopathy needs early, aggressive treatment, including the use of fresh frozen plasma. ✓

Recombinant factor VII should only be used if coagulopathy cannot be corrected by massive blood component replacement as it has been associated with poorer outcome in women with AFE. C

There is no proven effective therapy for the management of AFE. It is therefore supportive rather than specific.[3,95] Evidence level 2++

In addition to resuscitation and supportive measures, arrhythmias may develop and will require standard treatment. Inotropic support is likely to be needed and measurement of cardiac output may help direct therapy and avoid fluid overload; fluid overload will exacerbate pulmonary oedema and increase the risk of acute respiratory distress syndrome. High filling pressures are indicative of a failing left ventricle.

In women with AFE, those treated with recombinant factor VII were found to have worse outcomes than in those not treated with recombinant factor VII. Therefore, recombinant factor VII should only be used in patients with AFE when haemorrhage cannot be stopped by massive blood component replacement.[29,96]

If undelivered, delivery of the fetus and placenta should be performed as soon as possible. The incidence of uterine atony is increased in this condition and contributes to the postpartum haemorrhage. This should be managed as described in the RCOG Green-top Guideline on postpartum haemorrhage.[92] Evidence level 2+

Various other therapies have been tried, including steroids, heparin, plasmapheresis and haemofiltration, usually in single cases. As such, there is no robust evidence to support their use.[29]

4.6.4. Cardiac disease

After successful resuscitation, cardiac cases should be managed by an expert cardiology team. ✓

After initial resuscitation, the ongoing management of cardiac disease is similar to that in the nonpregnant state, although in many cases, delivery will be necessary to facilitate this.

Although thrombolysis can be associated with significant bleeding from the placental site, it should be given to women with acute coronary insufficiency, although caution should be exercised in the perioperative period.[97] If available, percutaneous angioplasty allows accurate diagnosis and definitive therapy. Evidence level 4

4.6.5. Sepsis

Septic shock should be managed in accordance with the Surviving Sepsis Campaign guidelines. D

The Surviving Sepsis Campaign has updated the management of sepsis and septic shock.[98] The speed and appropriateness of therapy administered in the initial hours after severe sepsis develops are likely to influence outcome with early resuscitation improving survival rates. A multidisciplinary team approach is required, including midwives, consultant obstetricians, anaesthetists, haematologists, intensivists and microbiologists. The following 'Care

Bundle' should be applied immediately or within 6 hours, and has been shown to significantly improve survival rates:[99,100]

1. Measure serum lactate.
2. Obtain blood cultures and culture swabs prior to antibiotic administration.
3. Administer broad spectrum antibiotic(s) within the first hour of recognition of severe sepsis and septic shock according to local protocol.
4. In the event of hypotension and/or lactate more than 4 mmol/l:
   a. Begin rapid administration of an initial minimum of 30 ml/kg of crystalloid to be completed within 3 hours of diagnosis.
   b. once adequate volume replacement has been achieved, a vasopressor (noradrenaline, with vasopressin or adrenaline in addition, if required) and/or an inotrope (for example, dobutamine) may be used to maintain mean arterial pressure more than 65 mmHg.

Further management consists of:

5. In the event of hypotension despite fluid resuscitation (septic shock) and/or lactate more than 4 mmol/l:
   a. dynamic variables of fluid status such as transoesophageal Doppler and lithium dilution cardiac output (LiDCO) are preferred to static variables like central venous pressure or pulmonary artery occlusion pressure and the use of central venous pressure alone to guide fluid resuscitation can no longer be justified
   b. consider steroids if unresponsive to adequate fluid resuscitation and vasopressor therapy.
   c. Maintain oxygen saturation at more than 94% (88%–92% in women at risk of hypercapnic respiratory failure) with facial oxygen.[94] Consider transfusion if haemoglobin less than 70 g/l.

Ongoing management involves continued supportive therapy, removing the septic focus, administration of blood products if required, and thromboprophylaxis.[99] Evidence level 1+

4.6.6. Drug overdose and toxicity

Many drug overdoses have treatments specific to the drug in question and appropriate help should be sought in the management of such cases, including liaising with Toxbase and speaking to GP/local pharmacist. In obstetric practice, the two main drugs that can give rise to overdose or toxic problems are magnesium sulphate and local anaesthetic agents.

4.6.6.1. Magnesium sulphate

The antidote to magnesium toxicity is 10 ml 10% calcium gluconate or 10 ml 10% calcium chloride given by slow intravenous injection. ✓

Magnesium sulphate toxicity should be managed by slow intravenous injection of 10 ml 10% calcium gluconate or 10 ml 10% calcium chloride.[101]

4.6.6.2. *Local anaesthetic agents*

If local anaesthetic toxicity is suspected, stop injecting immediately. ✓

Lipid rescue should be used in cases of collapse secondary to local anaesthetic toxicity. C

Intralipid® 20% should be available in all hospitals offering maternity services. ✓

Manage arrhythmias as usual, recognising that they may be very refractory to treatment. ✓

All cases of lipid rescue should be reported to NHS Improvement and the Lipid Rescue site. ✓

The mechanism by which lipids reverse local anesthetic cardiotoxicity may be increasing clearance from cardiac tissue. This nonspecific, observed extraction of local anesthetics from aqueous plasma or cardiac tissues is termed a 'lipid sink.' Another proposed mechanism is that lipids counteract local anesthetic inhibition of myocardial fatty acid oxidation, thereby enabling energy production and reversing cardiac depression.

Treatment of cardiac arrest with lipid emulsion[42,102] consists of an intravenous bolus injection of Intralipid® (Baxter Healthcare Corporation, Deerfield, Illinois, USA) 20% 1.5 ml/kg over 1 min (100 ml for a woman weighing 70 kg) followed by an intravenous infusion of Intralipid® 20% 15 ml/kg/h (1000 ml.h^{-1} for a woman weighing 70 kg). The bolus injection can be repeated twice at 5-minute intervals if an adequate circulation has not been restored (a further two 100 ml boluses at 5-minute intervals for a woman weighing 70 kg). After another 5 minutes, the infusion rate should be increased to 30 ml/kg/hr if an adequate circulation has not been restored. Do not exceed a maximum cumulative dose of 12 ml/kg (840 ml for a woman weighing 70 kg). CPR should be continued throughout this process until an adequate circulation has been restored. This may take over 1 hour.[103] Evidence level 2+

Prolonged resuscitation may be necessary, and it may be appropriate to consider other options. The first-line treatment should be lipid emulsion, but if the facilities are available, some may consider the use of cardiopulmonary bypass.

All cases of lipid rescue should be reported to NHS Improvement (www.nrls.npsa.nhs.uk) and to the Lipid Rescue site (www.lipidrescue.org). The Association of Anaesthetists of Great Britain & Ireland provides guidance on the management of severe local anaesthetic toxicity, which can be used locally.[103]

4.6.7. Eclampsia

Eclampsia should be managed in accordance with the NICE Clinical Guideline 107 *Hypertension in Pregnancy: Diagnosis and Management*. D

Guidance regarding the management of eclampsia can be found in the NICE guideline on hypertension in pregnancy.[104]

4.6.8. Intracranial haemorrhage

Neuroradiologists and neurosurgeons should be involved in the care of pregnant women with intracranial haemorrhage at the earliest opportunity. ✓

Expert neuroradiology is required to establish an accurate diagnosis, and management is the same as in nonpregnant women, although delivery may be necessary to facilitate this.[105] Evidence level 4

4.6.9. Anaphylaxis

In cases of anaphylaxis, all potential causative agents should be removed, and the ABCDE approach to assessment and resuscitation followed. ✓

If the anaphylactic reaction occurs in the community, the woman should have basic life support and be transferred to a hospital setting as quickly as possible, unless a suitably trained healthcare professional is present with appropriate equipment and drugs in which case definitive resuscitation and treatment should be commenced. ✓

The treatment for anaphylaxis is 1:1000 adrenaline 500 micrograms (0.5 ml) intramuscularly. This dose is for intramuscular use only. ✓

In cases of anaphylaxis, all potential causative agents should be removed, and the ABCDE approach followed.[44,106] Evidence level 4

Adrenaline treatment can be repeated after 5 minutes if there is no effect.[44,106] In experienced hands, 50 microgram bolus (0.5 ml of 1:10 000 solution) can be titrated intravenously. Adjuvant therapy consists of chlorphenamine 10 mg and hydrocortisone 200 mg. Both are given intramuscularly or by slow intravenous injection.[44,106] Evidence level 4

4.7. What are the outcomes for mother and baby?

Outcomes for mothers and babies depend on the cause of collapse, gestational age and access to emergency care, with survival rates being poorer if the collapse occurs out of hospital. In maternal cardiac arrest maternal survival rates of over 50% have been reported. C

Due to the lack of robust population data, it is not possible to be accurate regarding maternal and neonatal outcomes of maternal collapse. There remains a significant reporter bias in publications relating to the topic. The MBRRACE-UK Saving Lives and Improving Mothers' Care report and UK Obstetric Surveillance System studies provide robust data for maternal survival for individual conditions, such as AFE and sepsis. The general trend of reducing numbers of maternal deaths despite a plateau in the number of maternities demonstrated by MBRRACE-UK suggests that survival from maternal collapse is improving.[2,3]

A UKOSS prospective cohort study identified 66 cardiac arrests between July 2011 and June 2014 resulting in an incidence of 2.78 per 100 000 maternities.[39] In all, 28 women died (case fatality rate 42%). Basic and Evidence level 2+

