4.2.4. Cardiac disease

Cardiac disease was the most common overall cause of indirect maternal death in the MBRRACE-UK report 2016,[3] being responsible for 51 maternal deaths between 2012 and 2014. The majority of deaths secondary to cardiac causes occur in women with no previous history,[2,3] and almost one in five deaths occurred in an ambulance or accident and emergency department.[2,38] Therefore, paramedics and accident and emergency staff must be familiar with the management of maternal collapse. The main cardiac causes of maternal death are ischaemia and sudden arrhythmic cardiac death with a structurally normal heart.[3] Most cardiac events have preceding signs and symptoms. Aortic root dissection, although usually associated with an inherited aortopathy e.g. Ehlers-Danlos syndrome, can present in otherwise healthy women, and signs and symptoms, such as central chest or interscapular pain, a wide pulse pressure (mainly secondary to systolic hypertension) and a new cardiac murmur, must prompt appropriate imaging and, if required, referral to a cardiologist. The incidence of congenital and rheumatic heart disease in pregnancy is increasing, secondary to increased survival rates and with improved management of congenital heart disease. In addition, women with mechanical prosthetic heart valves are at particularly increased risk of complications in pregnancy.[39] These women should be cared for by an appropriately skilled and experienced multidisciplinary team, usually in regional centres.[2] Other cardiac causes include: cardiomyopathy; dissection of the coronary artery; acute left ventricular failure; infective endocarditis; and pulmonary oedema.

Evidence level 2++

4.2.5. Sepsis

Sepsis has been recognised for centuries as a significant cause of maternal morbidity and mortality, and substandard care continues to feature in the cases that result in death.[3] Bacteraemia, which can be present in the absence of pyrexia or a raised white cell count, can progress rapidly to severe sepsis and septic shock leading to collapse.[40,41] The most common organisms implicated in obstetric sepsis are the streptococcal groups A, B and D, pneumococcus and *Escherichia coli*.

Evidence level 2–

4.2.6. Drug toxicity and overdose

Drug toxicity and overdose should be considered in all cases of collapse. Substance misuse should be remembered as a potential cause of collapse especially outside of hospital. In terms of therapeutic drug toxicity, the commonly used drugs in obstetric practice are magnesium sulphate in the presence of renal impairment and local anaesthetic agents.

Toxic effects associated with local anaesthetics usually result from excessively high plasma concentrations. This can be either as a result of inadvertent intravenous injection, or systemic absorption of toxic amounts administered via appropriate (epidural, local infiltration etc.) routes. On intravenous injection, convulsions and cardiovascular collapse may occur very rapidly. Local anaesthetic toxicity resulting from systemic absorption of the local anaesthetic may occur sometime after the initial injection. Effects initially include a feeling of inebriation and lightheadedness followed by sedation, circumoral paraesthesia and twitching; convulsions can occur in severe toxicity. Signs of severe toxicity include sudden loss of consciousness, with or without tonic-clonic convulsions, and cardiovascular collapse; sinus bradycardia, conduction blocks, asystole and ventricular tachyarrhythmias can all occur.[42]

Evidence level 4

In terms of local anaesthetics, total spinal block or high spinal/epidural block are rare. A high index of suspicion is needed in cases of maternal collapse following spinal anaesthesia or epidural top up. Appropriate training of medical and midwifery staff to recognise the signs and symptoms of high block is essential.

4.2.7. Eclampsia

Eclampsia as the cause of maternal collapse is usually obvious in the inpatient setting. Often the diagnosis of pre-eclampsia has already been made and the seizure witnessed. In the community setting, fitting after 20 weeks' gestation may be attributable to eclampsia, notably where there is no known history of epilepsy. However, epilepsy should always be considered in cases of maternal collapse associated with seizure activity.[8]

4.2.8. Intracranial haemorrhage

Intracranial haemorrhage is a significant complication of uncontrolled, particularly systolic, hypertension, but can also result from ruptured aneurysms and arteriovenous malformations. The initial presentation may be maternal collapse, but often severe headache precedes this.

4.2.9. Anaphylaxis

In cases of collapse assumed to be due to anaphylaxis mast cell tryptase levels can be useful in confirming the diagnosis. ✓

Anaphylaxis is a severe, life-threatening generalised or systemic hypersensitivity reaction,[43] resulting in respiratory, cutaneous and circulatory changes, and possibly gastrointestinal disturbance and collapse. There is significant intravascular volume redistribution, which can lead to decreased cardiac output. Acute ventricular failure and myocardial ischaemia may occur. Upper airway occlusion secondary to angioedema, bronchospasm and mucous plugging of smaller airways all contribute to significant hypoxia and difficulties with ventilation. Common triggers are a variety of drugs, latex, animal allergens and foods. The incidence of severe perioperative obstetric anaphylaxis is between 1 and 3.5 per 100 000, with a mortality rate of approximately 1%.[44] Anaphylaxis is likely when all of the following three criteria are met:

- sudden onset and rapid progression of symptoms
- life-threatening airway and/or breathing and/or circulation problems
- skin and/or mucosal changes (flushing, urticaria, angioedema).

Exposure to a known allergen for the woman supports the diagnosis, but many cases occur with no previous history. Mast cell tryptase levels can be useful in confirming the diagnosis. As a minimum, 1 sample at 1–2 hours after the start of symptoms should be taken. Ideally though 3 timed samples should be taken: as soon as possible after resuscitation has started (without delaying resuscitation); 1–2 hours after the start of symptoms; 24 hours later.[44]

Evidence level 4

4.2.10. Other causes

These include hypoglycaemia, hyponatraemia[45] and other metabolic and electrolyte disturbances. Other causes of hypoxia include airway obstruction secondary to aspiration or foreign body, air embolism, tension pneumothorax, cardiac tamponade secondary to trauma or dissection, and hypothermia. From an anaesthetic perspective, the main causes of collapse would be local anaesthetic toxicity or failed tracheal intubation. There will be other very unusual and rare causes of maternal collapse, but detailed discussion of all causes is beyond the scope of this guideline.

4.3. What are the physiological and anatomical changes in pregnancy that affect resuscitation?

It is essential that anyone involved in the resuscitation of pregnant women is aware of the physiological differences. This includes pre-hospital care clinicians, paramedics and emergency medicine department staff. ✓

Pregnant women undergo a variety of physiological changes that can accelerate the development of hypoxia and acidosis, and make ventilation more difficult.[46] These changes are listed in Appendix 3,[47] and combined with other physical changes, make resuscitation during pregnancy more challenging. It is essential that anyone involved in the resuscitation of a pregnant woman is aware of these differences. This includes paramedics, critical care staff and emergency medicine department staff.

Evidence level 2+

4.3.1. Aortocaval compression

Aortocaval compression significantly reduces cardiac output from 20 weeks of gestation onwards and the efficacy of chest compressions during resuscitation. C

From around 20 weeks of gestation onwards the gravid uterus reduces venous return in the supine position. As a consequence, cardiac output is reduced by up to 30–40%.[48] Supine hypotension itself can precipitate maternal collapse, which is usually reversed by turning the woman into the left lateral position.

Evidence level 2+

When cardiopulmonary arrest occurs, chest compressions are needed to produce a cardiac output. In the nonpregnant situation, they achieve around 30% of the normal cardiac output.[49–51] Aortocaval compression further reduces cardiac output to approximately 10% of the nonpregnant cardiac output.[52] Therefore, cardiopulmonary resuscitation (CPR) is less likely to be effective in a woman who is at 20 or more weeks of gestation.

Evidence level 2+

4.3.2. Respiratory changes

Changes in lung function, diaphragmatic splinting and increased oxygen consumption make pregnant women become hypoxic more readily and make ventilation more difficult. C

The increased progesterone level in pregnancy increases the respiratory drive,[53,54] leading to an increase in tidal volume and minute ventilation. Splinting of the diaphragm by the enlarged uterus reduces the functional residual capacity (FRC) and also makes ventilation more difficult. Reduction in FRC along with the markedly increased oxygen consumption of the fetoplacental unit, means that pregnant women become hypoxic much more rapidly during periods of hypoventilation.

Evidence level 2+

4.3.3. Intubation

Difficult intubation is more likely in pregnancy.

C

Weight gain in pregnancy, large breasts inhibiting the working space and laryngeal oedema can all contribute to making intubation more difficult.[55,56]

Evidence level 2+

4.3.4. Aspiration

Pregnant women are at an increased risk of aspiration.

C

Pregnant women are at a significantly higher risk of regurgitation and aspiration, secondary to the progesterone effect relaxing the lower oesophageal sphincter along with the raised intra-abdominal pressure secondary to the gravid uterus. During labour or following maternal opioid administration there can also be a delay in gastric emptying. Aspiration pneumonitis in pregnant women, known as Mendelsson's syndrome,[57] can be severe. The risks can be minimised by early intubation with effective cricoid pressure, and the use of H_2 antagonists and antacids prophylactically in all women considered to be at high risk of obstetric intervention during labour.

Evidence level 2+

4.3.5. Circulation

The increased cardiac output and hyperdynamic circulation of pregnancy mean that large volumes of blood can be lost rapidly, especially from the uterus which receives 10% of the cardiac output at term. Otherwise healthy women tolerate blood loss remarkably well and can lose up to 35% of their circulation before becoming symptomatic, and often maternal tachycardia may be the only sign of hypovolaemia until very late in the haemorrhage. Blood loss is tolerated less well if there is a pre-existing maternal anaemia,[58] and clotting is less efficient if there is significant anaemia. Concealed bleeding and underestimation of loss means that intervention is often delayed. Where signs of hypovolaemia have been subtle, hypovolaemia as the cause of maternal cardiopulmonary arrest may go unrecognised.

Evidence level 4

4.4. *What is the optimal initial management of maternal collapse?*

4.4.1. Resuscitation in maternal collapse

Maternal collapse resuscitation should follow the Resuscitation Council (UK) guidelines using the standard ABCDE approach, with some modifications for maternal physiology, in particular relief of aortocaval compression.

D

If maternal cardiac arrest occurs in the community setting, basic life support should be administered and rapid transfer arranged. ✓

In the UK, resuscitation is conducted according to the guidelines of the Resuscitation Council (UK). These guidelines include: Adult Basic Life Support; Adult Advanced Life Support; and Automated External Defibrillation algorithms and recommendations.[24] These guidelines were updated in 2015 by international experts under the auspices of the International Liaison Committee on Resuscitation[59] and are used in the resuscitation of a pregnant woman. Evidence level 4

Maternal collapse can occur in the community setting, and pre-hospital care of the collapsed pregnant patient should follow the same guidance from the Resuscitation Council (UK) listed above and will be delivered by ambulance paramedics and/or pre-hospital care clinicians. The care standards delivered in the pre-hospital setting have been well documented in the UK Ambulance Services Clinical Practice Guidelines Pocket Book and Emergency Birth in the Community guideline.[60,61]

In the event of maternal collapse, signs of life should be sought if the assessor is confident in this (check for breathing and carotid pulse). If the assessor is not confident or there is any doubt in the detection of signs of life, cardiopulmonary resuscitation should be commenced. However, if signs of life are detected, a standard ABCDE approach should be taken. The woman should be placed in the left lateral position, obstetric review should be sought, the need for oxygen therapy should be assessed and adequate vascular access should be gained. An alert, verbal stimulus, pain stimulus, unresponsive (AVPU) assessment should be undertaken as an alteration of consciousness can be a sign of critical illness. The cause of the maternal collapse should be rapidly identified and treated to prevent potential progression to maternal cardio-respiratory arrest. Ongoing regular ABCDE assessment should be performed as the risk of progression to cardiac arrest remains until the cause of the collapse is treated. Assessment of fetal wellbeing should be undertaken after ABCDE assessment (Appendix 4).

If signs of life are not detected in the hospital setting, a cardiac arrest should be declared and the cardiac arrest team called. An emergency call for the obstetric, obstetric anaesthetic and neonatal (if undelivered and more than 22^{+0} weeks of gestation) resuscitation teams should be made. The consultant obstetrician and consultant anaesthetist should also attend. Standard basic life support should be initiated.[62] Evidence level 4

From 20 weeks of gestation, changes in maternal physiology mean that adaptations are made to the resuscitation process. While Resuscitation Council (UK) algorithms for generic, paediatric and neonatal life support are available in standardised posters, adaptations for maternal resuscitation are addressed but are not available in algorithmic and poster form. For this reason, the Resuscitation Council (UK) algorithm for advanced life support has been modified by the authors and is included in Appendix 4 of this guideline.

4.4.2. Relieving aorto-caval compression

Manual displacement of the uterus to the left is effective in relieving aortocaval compression in women above 20 weeks' gestation or where the uterus is palpable at or above the level of the umbilicus. This permits effective chest compressions in the supine position in the event of cardiac arrest. D

