University Hospitals Sussex
NHS Foundation Trust

Perinatal Collapse in Pregnancy & Puerperium

Maternity Protocol: MP055

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Key Principles

A protocol is a set of measurable, objective standards to determine a course of action. Professional judgement may be use in the application of a protocol.

Scope

This protocol applies to:

- All seriously ill women
- All women found collapsed in the peri-partum period

Responsibilities

Midwives & Obstetricians:

- To access, read, understand and follow this guidance
- To use their professional judgement in application of this protocol

Management:

- To ensure the protocol is reviewed as required in line with Trust and National recommendations
- To ensure the protocol is accessible to all relevant staff

1 Maternal Collapse in Pregnancy and the Puerperium

Maternal collapse is a rare but life-threatening event, with a wide ranging aetiology. The outcome primarily for the mother, but also the fetus, depends on prompt and effective resuscitation.

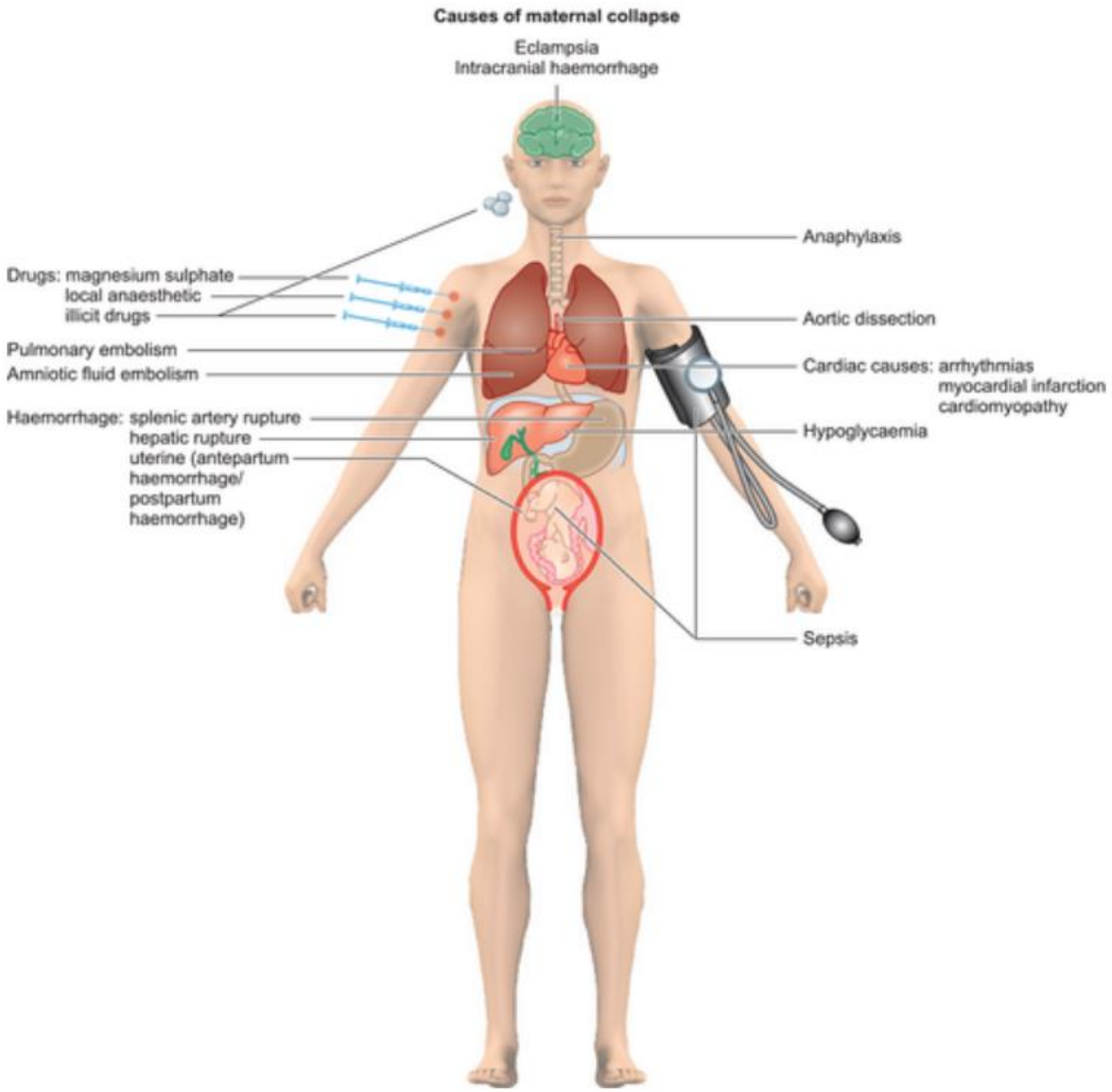
Maternal collapse is defined as an acute event involving the cardiorespiratory systems and/or central nervous systems, resulting in a reduced or absent conscious level (and potentially cardiac arrest and death), at any stage in pregnancy and up to 6 weeks after birth. Importantly, if maternal collapse which is not as the result of cardiac arrest is not treated effectively, maternal cardiac arrest can then occur.

1.1 Causes of Maternal Collapse

Maternal collapse can result from a number of causes. A systematic approach should be taken to identify the cause.

If the cause is reversible, the survival rates are greater and those for which specific treatment exists must be rapidly considered.

Reversible cause		Cause in pregnancy
4H's	Hypovolaemia	Bleeding (obstetric/other; may be concealed) or relative hypovolaemia of dense spinal block, septic or neurogenic block
	Hypoxia	Pregnant women can become hypoxic more quickly.
		Cardiac events – peripartum cardiomyopathy, myocardial infarction, aortic dissection, large vessel aneurysms
	Hypo/hyperkalaemia and Hyponatraemia	Hypo and hyperkalaemia are no more likely. Hyponatraemia may be caused by oxytocin use
	Hypothermia	No more likely
4T's	Thromboembolism	Amniotic fluid embolus, pulmonary embolus, air embolus, myocardial infarction
	Toxicity	Local anaesthetic, magnesium, other
	Tension pneumothorax	Following trauma/suicide attempts
	Tamponade	Following trauma/suicide attempts
Eclampsia and pre-eclampsia		Includes intracranial haemorrhage



N.B. The immediate resuscitative management of all conditions is the same for any woman who collapses before, during, or after labour (Appendix Immediate Resus management)

2 Immediate Emergency Resuscitative Management

2.1 Call for help via emergency bell

2.2 Check for signs of life (Open airway, check central pulse/respiration)

3 Call 2222 Ask for an Maternal Cardiac Arrest or Obstetric Emergency giving specific location

(Appendix Activation of Sudden Maternal Collapse Guideline)

3.1 Commence Basic Life support (A.B.C.)

3.2 Give oxygen via non-rebreathe reservoir face mask

3.3 Left lateral tilt with slight head down (pregnant women only)

3.4 Obtain venous access (2 large bore cannulas) Consider intra-osseous access if IV route difficult (available from ED, if not on resus trolley)

3.5 Initiate fluid resuscitation to correct shock

3.6 Institute Advanced Life Support (intubation / ventilation / inotropes) for:

- persistent hypoxia
- hypotension or
- reduced level of consciousness

3.7 Start modified early obstetric warning system chart (MEOWS)

4 Initiate Investigations to Establish a Diagnosis:

4.1 Maternal observations – temp, pulse, BP, saturations and respiratory rate

4.2 Venous blood – U&E/ FBC / Coagulation / cross-match 4 units

4.3 Arterial blood gases - lactate

4.4 ECG

4.5 CVP line – Consider taking a clotted sample for squames in relatation to diagnosis of an AFE section 7.4 AFE

N.B Inform the Obstetric and Anaesthetic Consultants on call at an early stage. ***For ANY maternal collapse Obstetric Consultants must attend in person***

5 Process for the Use of the Modified Early Obstetric Warning System (MEOWS)

5.1 Introduction

Saving Mother's Lives[2] advocates the use of a modified early warning system in maternity care settings to facilitate the prompt recognition of acute illness and/or rapid deterioration of a woman's condition. It is important to note that the system will not improve outcomes in isolation; this will only occur if interventions subsequently applied are appropriate and timely.

5.2 Use of MEOWS chart[2]

5.2.1 All antenatal patients admitted must have MEOWS commenced.

5.2.2 Postnatal women who have:

- Prior risk factors identified
- Developed complications
- Undergone surgical intervention (post-surgery MEOWS observations for the first 24 hrs)

5.3 Exceptions for use

5.3.1 If Women is in established labour document observations on the partogram, if becomes unwell to commence MEOWS

NB: It is essential that pregnant and recently delivered women with obstetric and medical complications who are admitted to all clinical areas within and outside of maternity are assessed using the MEOWS chart

5.4 Respiratory rate & MEOWS

5.4.1 Changes in the respiratory rate are often an early warning sign that the woman's condition is deteriorating.

5.4.2 It is vital to also note the regularity, pattern and description of the breathing.

5.4.3 A change in the respiratory rate is an accurate predictor of deterioration in physical condition, often before changes in any other parameters are observed.

5.5 Oxygen saturation & MEOWS

5.5.1 Sa O_2 monitoring should be available for all high risk women.

5.6 Temperature & MEOWS

5.6.1 During labour a slight transient raise in temperature is often observed and this may also be seen as a response to epidural anaesthesia.

5.6.2 However a rise in temperature observed at any other time in the pregnancy continuum must be closely observed.

5.6.3 A marked rise in temperature or a marked fall could indicate an impending risk of sepsis.

5.6.4 The early recognition and appropriate treatment for sepsis is essential

5.7 Heart rate & MEOWS

5.7.1 Most women have an increased heart rate (of about 20 bpm) in pregnancy compared to the non-pregnant state due to the associated physiological changes

5.7.2 The pulse will also increase during periods of strenuous activity and/or stress

5.7.3 A sudden rise in heart rate may be in response to labour, pain, fear, anxiety, etc and in isolation (all other parameters are normal) should be observed

5.7.4 A prolonged tachycardia, in conjunction with any other abnormal observation, must be treated as potentially very serious

5.7.5 A slow pulse may result from effective pain relief such as an epidural, especially when the woman is relaxed and possibly able to sleep

5.7.6 However, slower heart rates can also be:

- Drug induced e.g. such as local anaesthetic toxicity, refer to section 7
- present in cardiac complications
- in conjunction with a raised blood pressure and sudden loss of consciousness could indicate cerebral haemorrhage

5.8 Blood pressure & MEOWS

5.8.1 During pregnancy there are natural variations in BP due to the associated physiological changes: e.g. diastolic may fall around 20mmHg from non pregnant state in the first trimester.

5.8.2 Underlying hypertensive problems/renal disease

- With these conditions women may not exhibit a first trimester drop in blood pressure and may go on to have hypertensive problems in this or later pregnancies.

5.8.3 Pre-eclampsia

- Some women developing pre-eclampsia may be normotensive
- In the presence of proteinuria and altered blood profiles women should be closely monitored.

5.8.4 Identifying significant changes in BP

- The systolic pressure is sensitive to activity, stress and anxiety and transient rises up to 150 are considered normal
- A lower systolic reading is common in pregnancy
- A sudden decrease in blood pressure especially with a corresponding increase in pulse rate may indicate haemorrhage
- The two BP parameters (diastolic and systolic) are scored separately and so if both score in the yellow zone an obstetric referral is indicated

NB If the **pulse rate > the systolic blood pressure** this is highly significant and must be referred immediately to an obstetrician.

5.9 Urine output/testing & MEOWS

5.9.1 A fluid balance chart must be commenced for all women on a MEOWS chart

5.9.2 Other factors e.g. presence of blood (especially visible blood) may be significant especially in women labouring with previous caesarean (LSCS)

5.10 Pain scores & MEOWS

5.10.1 Pain scores should be assessed ideally with the woman resting using a verbal descriptor scale (VDS) which places a numerical value on pain, as described by the patient

5.10.2 Any pain outside that expected of normal labour is abnormal, and this should be regularly reviewed and documented, including site, type of pain (constant, intermittent, on movement only, sharp, dull, etc) as well as the intensity

5.10.3 Following surgical intervention pain is a normal physiological response to trauma but pain assessment is essential to ensure adequate analgesia is prescribed and administered.

5.10.4 Prolonged use of opioid analgesia is of concern and warrants further investigation

5.11 Observation parameters

The frequency of observations will depend on the condition of the woman**.**

6 Roles and Responsibilities of Staff Groups

6.1 **Midwives**

6.1.1 Escalate to Matron/Site manager/Manager on call to assist with ongoing emergency

6.1.2 Will provide one to one care and document observations

6.1.3 Observations and documentation are charted on:

- MEOWS Chart
- Maternity notes

6.1.4 Basic observations of the mother should be recorded regularly according to the care plan and include:

- Oxygen saturation level
- Pulse and respiratory rate
- Temperature – frequency according to clinical condition
- Blood pressure
- Hourly urine output measurement
- Level of consciousness (AVPU)
- Evaluation of pain and sensory levels
- Blood loss per vagina/wound or drain

6.1.5 Referral to the Obstetric Registrar should be made if:

- MEOWS observations trigger one red score
- MEOWS observations trigger two simultaneous yellow scores

6.1.6 Urgent referral to the Obstetric Registrar (using fast bleep system via switchboard) if:

- There is an obvious clinical deterioration or loss of consciousness of the women
- Two or more of the MEOWS cardio-respiratory parameters are recorded in the red zones

6.2 **Obstetricians**

6.2.1 Multidisciplinary plans of care should be documented and regularly updated within the maternity notes

6.2.2 There should be regular Consultant level involvement in care of severely ill patients

6.2.3 Consultant Obstetricians must attend in person all cases of maternal collapse and uterine rupture

6.3 **Anaesthetists**

6.3.1 All severely ill pregnant women should be flagged up in the multidisciplinary ward round or on admission by the midwife in charge to allow anaesthetic team involvement and review.

6.3.2 The Consultant Obstetric Anaesthetist will liaise with the ITU consultant if admission/transfer to ITU/HDU is deemed necessary.

6.3.3 All discussions and care plans should be documented in the maternal notes with planned review times

6.3.4 Appropriate cases should be reported to UK Obstetric Surveillance System (UKOSS) via the lead obstetric anaesthetist

6.4 All members of the team to consider Critical Care Outreach team for support

6.5 When to fast bleep the Obstetric Registrar

By dialling 2222 if:

- There is an obvious clinical deterioration
- Loss of consciousness of the woman

6.6 Cardiac / pulmonary arrest

If a cardiac and/or pulmonary arrest is confirmed dial 2222 and notify:

- Maternal Cardiac Arrest
- The Consultant Obstetrician and Anaesthetist should be informed about the referral as soon as possible and should review the case.

6.7 Guidance for staff on when to involve clinicians from outside the maternity service

6.7.1 Where women have complications other than common obstetric issues, specialist clinicians should be considered as a source of information and support. The Obstetrician leading the care should consider involving the following specialities if the clinical situation warrants it after discussion with the maternity team and Consultant on call (unless life threatening when direct referral can be made).

6.7.2 Specialist clinicians (usually the on call middle grade or consultant level) should be contacted via the hospital switchboard.

Specialist clinicians	Consider involvement when:
Physicians	respiratory and/or cardiovascular problems
Gastroenterologists	gastrointestinal and liver problems
Nephrologists	renal function is deteriorating
Neurologists	unexplainable CNS problems
General surgeons	surgical complication is suspected
Interventional radiologists	Haemorrhage NB only available 9-5
Haematologist	Blood related disorders
Microbiologists	Sepsis / infection / antibiotic issues

6.8 ITU admissions

The Consultant Obstetrician will liaise with the Obstetric Anaesthetic Consultant who will liaise with the ITU Consultant if admission to ITU is deemed necessary.

7 Specific Management Regimes & Guidance

7.1 **Haemorrhage**

- Major obstetric haemorrhage has an estimated incidence of 6 in 1000 maternities. This is among the most common causes of maternal collapse.
- Causes of major obstetric haemorrhage include postpartum haemorrhage, major antepartum haemorrhage from placenta praevia, placental abruption, uterine rupture and ectopic pregnancy, rarely uterine inversion. In most cases of massive haemorrhage leading to collapse, the cause is obvious, but concealed haemorrhage should not be forgotten, including following caesarean section and ruptured ectopic pregnancy.

- Other rarer causes of concealed haemorrhage include splenic artery rupture and hepatic rupture.
- Blood loss is often difficult to estimate, especially slow, steady bleeding, and fit, healthy women can tolerate significant loss prior to showing signs of decompensation.

7.1.1 Management of 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 has demised to allow rapid control of the haemorrhage.
- Intravenous tranexamic acid significantly reduces mortality due to postpartum haemorrhage.

Referred to: MP053 Obstetric Haemorrhage , MP034 Vaginal Birth after Caesarean Section VAC.

7.2 **Cardiovascular Events**

- Cardiac disease was the most common overall cause of indirect maternal death in the MBRRACE-UK report 2016.
- The majority of deaths secondary to cardiac causes occur in women with no previous history and almost one in five deaths occurred in an ambulance or accident and emergency department.
- The main cardiac causes of maternal death are ischaemia and sudden arrhythmic cardiac death with a structurally normal heart.
- 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.
- Women with mechanical prosthetic heart valves are at particularly increased risk of complications in pregnancy. These women should be cared for by an

appropriately skilled and experienced multidisciplinary team, usually in regional centres.

- Other cardiac causes include: cardiomyopathy; dissection of the coronary artery; acute left ventricular failure; infective endocarditis; and pulmonary oedema.

7.3 Management of Cardiac Diseases

- 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 non-pregnant 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. If available, percutaneous angioplasty allows accurate diagnosis and definitive therapy.

7.4 Thromboembolism

In the MBRRACE-UK report 2016 Thromboembolism was the most common cause of direct maternal death. Appropriate use of thromboprophylaxis has improved maternal morbidity and mortality, but improvements in clinical risk assessment and prophylaxis are still required.

7.4.1 Management of Thromboembolism

Refer to acute Management of Thrombosis and Embolism during Pregnancy and the Puerperium.

7.5 Amniotic fluid embolism (AFE)

- UK data published in 2016 give an incidence of AFE of 1.7 per 100 000 maternities.
- Survival rates seem to have improved significantly over time, from 14% in 1979, to approximately 30% in 2005 and 81% by 2014.
- However, neurological morbidity in survivors is well recognised.
- It presents as collapse during labour or birth, or within (usually) 30 minutes of birth, in the form of acute hypotension, respiratory distress and acute hypoxia. Seizures and cardiac arrest may occur.
- If AFE occurs prior to birth, profound fetal distress develops acutely.
- There are different phases to the disease progression, which clearly depend on maternal survival. Initially, pulmonary hypertension may develop

secondary to vascular occlusion either by debris or vasoconstriction. This often resolves and left ventricular dysfunction or failure develops.

- Coagulopathy often develops if the mother survives long enough, often giving rise to massive postpartum haemorrhage. The underlying pathophysiological process has been compared to anaphylaxis or severe sepsis, and may be due to complement activation.
- Diagnosis in nonfatal cases is clinical, as there is no established accurate diagnostic test premortem, although research continues in the area.

7.5.1 Management of amniotic fluid embolism

- 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.
- 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.
- 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.
- There is no robust evidence to support their use of steroids, heparin, plasmapheresis and haemofiltration.

7.5 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.

- 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.
- The most common organisms implicated in obstetric sepsis are the streptococcal groups A, B and D, pneumococcus and *Escherichia coli*.

7.5.1 Management of Sepsis

- **Septic shock should be managed in accordance with the Surviving Sepsis Campaign guidelines.**
- 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:

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:
    - Begin rapid administration of an initial minimum of 30 ml/kg of crystalloid to be completed within 3 hours of diagnosis.
    - 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.
5. In the event of hypotension despite fluid resuscitation (septic shock) and/or lactate more than 4 mmol/l:
    - 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

- Consider steroids if unresponsive to adequate fluid resuscitation and vasopressor therapy.
- Maintain oxygen saturation at more than 94% (88%–92% in women at risk of hypercapnic respiratory failure) with facial oxygen. Consider transfusion if haemoglobin less than 70 g/l.

6. Ongoing management involves continued supportive therapy, removing the septic focus, administration of blood products if required, and Thromboprophylaxis.

7.6 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. 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 light headedness followed by sedation, circumoral paraesthesia and twitching; convulsions can occur in severe toxicity. On intravenous injection, convulsions and cardiovascular collapse may occur very rapidly. 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.
- 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.

7.6.1 Management of Drug toxicity and overdose

- 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.

7.6.2 Management of Magnesium Sulphate toxicity

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

7.6.3 Local anaesthetic agents

- If local anaesthetic toxicity is suspected, stop injecting immediately.
- Manage arrhythmias as usual, recognising that they may be very refractory to treatment.
- Lipid rescue should be used in cases of collapse secondary to local anaesthetic toxicity. Intralipid® 20% should be available in all hospitals offering maternity services. The mechanisms by which lipids reverse local anaesthetic cardiotoxicity may be (1) increasing clearance from cardiac tissue which is termed a 'lipid sink.' (2) lipids counteract local anaesthetic inhibition of myocardial fatty acid oxidation, thereby enabling energy production and reversing cardiac depression.
- 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.
- 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 and the Lipid Rescue site. (www.nrls.npsa.nhs.uk) (www.lipidrescue.org)

8 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.

8.1 Management of Eclampsia

Refer to Hypertension in Pregnancy: Diagnosis and Management.

9 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.

9.1 Management of Intracranial haemorrhage

- Neuro-radiologists 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 non-pregnant women, although delivery may be necessary to facilitate this.

10 Anaphylaxis

- Anaphylaxis is a severe, life-threatening generalised or systemic hypersensitivity reaction, 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%.
- 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.

10.1 **Management of 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.
- The treatment for anaphylaxis is 1:1000 adrenaline 500 micrograms (0.5 ml) intramuscularly. This dose is for intramuscular use only. Adrenaline treatment can be repeated after 5 minutes if there is no effect. In experienced hands, 50 microgram bolus (0.5 ml of 1:10 000 solution) can be titrated intravenously.
- Adjuvant therapy consists of chlorphenamine 10mg and hydrocortisone 200mg. Both are given intramuscularly or by slow intravenous injection.

11 Other causes

- Hypoglycaemia, hyponatraemia 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.
- Pregnant women undergo a variety of physiological changes that can accelerate the development of hypoxia and acidosis, and make ventilation more difficult and make resuscitation during pregnancy more challenging.

11.1 **Aortocaval compression**

- 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%.Supine hypotension itself can precipitate maternal collapse, which is usually reversed by turning the woman into the left lateral position.
- When cardiopulmonary arrest occurs, chest compressions are needed to produce a cardiac output. In the non-pregnant situation, they achieve around 30% of the normal cardiac output. Aortocaval compression further reduces cardiac output to approximately 10% of the non-pregnant cardiac output. Therefore, cardiopulmonary resuscitation (CPR) is less likely to be effective in a woman who is at 20 or more weeks of gestation.

11.2 **Respiratory changes**

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

11.3 **Intubation**

- Weight gain in pregnancy, large breasts inhibiting the working space and laryngeal oedema can all contribute to making intubation more difficult

11.4 **Aspiration**

- 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, 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 tobe at high risk of obstetric intervention during labour.

11.5 **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,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.

System	Changes in pregnancy	Impact on resuscitation
Cardiovascular system		
Plasma Volume	Increased by up to 50%	Dilutional anaemia Reduced oxygen carrying capacity
Heart rate	Increased by 15–20 bpm	Increased CPR circulation demands
Cardiac output	Increased by 40% Significantly reduced by pressure of gravid uterus on IVC	Increased CPR circulation demands
Uterine blood flow	10% of cardiac output at term	Potential for rapid massive haemorrhage
Systemic vascular resistance	Decreased	Sequesters blood during CPR
Arterial blood pressure	Decreased by 10–15 mmHg	Decreased reserve
Venous return	Decreased by pressure of gravid uterus on IVC	Increased CPR circulation demands Decreased reserve
Respiratory system		
Respiratory rate	Increased	Decreased buffering capacity, acidosis more likely

12 What is the optimal initial management of maternal collapse?

12.1 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.

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

12.2 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. The technique should be performed using an 'up, off and over' method. This is achieved by placing a hand below the uterus on the maternal right and pushing the uterus slightly upwards and to the left. This maintains the woman in a supine position, allowing for continuous effective cardiac compressions if necessary.
- A left lateral tilt of the woman from head to toe at an angle of 15–30^{o} on a firm surface (a tilting operating table, with an appropriate size solid wedge and spinal board) will relieve aortocaval compression in the majority of pregnant women and still allow effective chest compressions to be performed in the event of cardiac arrest. Using soft surfaces, such as a bed, or objects, such as pillows or blankets, are not nearly as effective, compromise effective chest compressions, and should not be used. (a video of the procedure can be found at https://www.youtube.com/watch?v=2VyqGqDNlLc)
- In cases of major trauma, the spine should be protected with a spinal board before any tilt is applied. In the absence of a spinal board, manual displacement of the uterus should be used.

12.3 Airway

- Intubation in an unconscious woman with a cuffed endotracheal tube should be performed immediately by an experienced anaesthetist.
- The airway in pregnancy is more vulnerable because of the increased risk of regurgitation and aspiration. For this reason, it is important to clear and protect the airway as early as possible.
- Intubation with a cuffed endotracheal tube should then be performed. This will protect the airway, ensure good oxygen delivery and facilitate more efficient ventilation.
- Failed intubation is more common in the pregnant than nonpregnant patient and a plan for failed intubation should always be considered.

- Appendix 2 of this guideline presents suggested equipment that should be available for cases where airway management may be difficult.

12.4 Breathing

- Supplemental high flow oxygen should be administered as soon as possible to counteract rapid deoxygenation. Maternal physiological changes lead to increased oxygen requirements. Therefore, supplemental oxygen should be added with a gas flow of 10–15 l per minute to whatever method of ventilation is being employed.
- Bag and mask ventilation or insertion of a simple supraglottic airway should be undertaken until intubation can be achieved.

12.5 Circulation

- If the airway is clear and there is no breathing, chest compressions should be commenced immediately in the absence of a cardiac output. Hand position should be over the centre of the chest and it is important to ensure that the direction of compression is perpendicular to the chest wall. If a left lateral tilt is employed then the angle of tilt must be taken into account when performing chest compressions. Immediate and competent chest compressions have been found to have a direct impact on maternal outcome.
- In total, 30 chest compressions (at a rate of 100–120 per minute) should be performed for every two ventilation breaths initially. If there are two rescuers, one should be responsible for chest compressions and ventilation breaths, whilst the other should ensure aortocaval decompression with manual uterine displacement.
- Because chest compressions are not as effective after 20 weeks of gestation, there should be early recourse to delivery of the fetus and placenta if CPR is not effective. In woman with a very high BMI chest compressions can be performed over the head of the woman if there is sub-optimal rescuer positioning.
- Two wide-bore cannulae (minimum 16 gauge) should be inserted as soon as possible. If peripheral venous access is not possible, early consideration of central venous access, intraosseous access or venous cutdown should be considered.
- There should be an aggressive approach to volume replacement, although caution should be exercised in the context of pre-eclampsia or eclampsia.
- Abdominal ultrasound by a skilled operator can assist in the diagnosis of concealed haemorrhage as haemorrhage is the most common cause of maternal collapse. Laparotomy should not be delayed if the findings are negative and/or the index of suspicion is high. This, however, should not interfere with the resuscitation process.

- In the case where significant haemorrhage, and pre-eclampsia or eclampsia exist, careful fluid management is essential.
- The same defibrillation energy levels should be used as in a nonpregnant woman. Adhesive defibrillator pads are preferable to defibrillator paddles, and the left defibrillation pad should be applied lateral to the left breast. If the woman's breasts are large or engorged, defibrillator pads may need to be placed on the anterior and posterior precordium to optimise defibrillation energy transfer. The energy from the defibrillation shock is directed across the heart and there is no evidence that shocks from a direct current defibrillator have an adverse effect on the fetus. Uterine monitors should be removed before shock delivery.

12.6 Drugs

- There should be no alteration in algorithm drugs or doses used in the Resuscitation Council (UK) protocols. (Appendix- Resus Council 2021)

12.7 Other considerations

- Common, reversible causes of maternal cardiopulmonary arrest should be considered throughout the resuscitation process.
- Resuscitation efforts should be continued until a decision is taken by the consultant obstetrician and consultant anaesthetist to discontinue resuscitation efforts. This decision should be made in consensus with the cardiac arrest team.
- Throughout the resuscitation process, consideration should be given to the cause of the collapse, so that ongoing therapy can be directed towards the specific cause to optimise outcome.

12.8 When, where and how should perimortem caesarean section (PMCS) be performed?

- In women over 20 weeks of gestation, if there is no response to correctly performed CPR within 4 minutes of maternal collapse or if resuscitation is continued beyond this, then PMCS should be undertaken to assist maternal resuscitation. Ideally, this should be achieved within 5 minutes of the collapse.
- PMCS should not be delayed by moving the woman. It should be performed where maternal collapse has occurred and resuscitation is taking place. With no circulation, blood loss is minimal, and no anaesthetic is required. The doctrine of ‘best interests of the patient’ would apply to conduct of this procedure being carried out without consent.
- The operator should use the incision, which will facilitate the most rapid access. This may be a midline vertical incision or a suprapubic transverse incision.

- A scalpel and umbilical cord clamps (or alternative ligatures) should be available on the resuscitation trolley in all areas where maternal collapse may occur, including the accident and emergency department.
- Delivery of the fetus and placenta reduces oxygen consumption, improves venous return and cardiac output, facilitates chest compressions and makes ventilation easier. It also allows for internal chest compressions by inserting the hand through the open abdomen up to the diaphragm and compressing the posterior aspect of the heart against the chest wall. This improves cardiac output beyond that achieved in closed chest compressions.
- At less than 20 weeks of gestation there is no proven benefit from delivery of the fetus and placenta. PMCS should be considered a resuscitative procedure, to be performed primarily in the interests of maternal survival.
- Delivery within 5 minutes of maternal collapse improves the chances of survival for the baby. If maternal resuscitation is continuing beyond 4 minutes of the collapse, delivery of the fetus and placenta should be performed as soon as possible to aid this, even if the fetus is already dead.
- If resuscitation is successful following birth, there should be prompt transfer to an appropriate environment at that point, as well as anaesthesia and sedation, to control ensuing haemorrhage and complete the operation.
- Where the resuscitation is not successful, the case should be discussed with the coroner or procurator fiscal to determine whether a postmortem is required before any medical devices, such as lines and endotracheal tube are removed, as per the Royal College of Pathologists recommendations.

13 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.
- Time intervals between collapse and PMCS was significantly shorter in women who survived compared with those who died (median interval, 3 minutes versus 12 minutes; $P = 0.001$).
- Neonatal survival was only found in women who suffered cardiac arrest in hospital and there were reports of neonatal survival where delivery was performed 30 minutes after maternal cardiac arrest.

14 Documentation

- Accurate documentation is essential in all cases of maternal collapse, whether or not resuscitation is successful.

15 Incident reporting

- All cases of maternal collapse should generate a clinical incident form and the care should be reviewed through the clinical governance process.
- All cases of maternal death should be reported to MBRRACE-UK.

16 Training

- All generic life support training should consider the adaptation of CPR in pregnant women.
- All maternity staff should have annual formal multidisciplinary training in ABLS (Adult Basic Life Support) and the management of maternal collapse.
- Life support training improves resuscitation skills.
- Small group multidisciplinary interactive practical training is recommended to improve the management of maternal collapse.
- All front-line staff must be aware of the adaptations for CPR in pregnancy. This includes paramedics who will deal with collapse in the community setting and accident and emergency department personnel, as well as staff within a maternity unit.

17 Debriefing

- Debriefing is recommended for the woman, the family and the staff involved in the event.
- Maternal collapse can be associated with post-traumatic stress disorder (for the woman, her family and for staff involved), postnatal depression and tocophobia. Debriefing is an important part of holistic maternity care and should be offered by a competent professional to support the ongoing mental health of all concerned.

18 Auditable topics

- Proportion of staff undergoing regular training in life support (100%).
- Proportion of staff undergoing regular training in maternal collapse (100%).
- Audit of the management of maternal collapse (100%).
- Compliance with incident reporting (100%).

- Achievement of PMCS within 5 minutes of collapse on hospital premises, where there is no response to resuscitation (100% in pregnancies over 20 weeks of gestation).
- Presence of a scalpel on resuscitation trolleys (100%).

19 Useful links and support groups

- UK Obstetric Surveillance System (UKOSS) [https://www.npeu.ox.ac.uk/ukoss].
- MBRRACE-UK: Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK [https://www.npeu.ox.ac.uk/mbrrace-uk].
- Advance Life Support in Obstetrics (ALSO) [http://www.also-uk.com/].
- Practical Obstetric Multi-Professional Training (PROMPT) [http://www.promptmaternity.org/].
- Managing Medical and Obstetric Emergencies and Trauma (mMOET), Advanced Life Support Group (ALSG) [http://www.alsg.org/home/].
- The Birth Trauma Association [http://www.birthtraumaassociation.org.uk/].

20 References

Confidential Enquiry into Maternity and Child Health. (2004). Why Mothers Die 2000-2 London: RCOG Press. www.cemach.org.uk

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National Confidential Enquiry into Patient Outcome and Death. (2001). Changing the Way Operate: The 2001 Report of the National Confidential Enquiry into Peri-operative Dea London: NCEPOD. www.ncepod.org.uk

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Appendix: Activation of Sudden Maternal Collapse Guideline

Immediate management of Sudden Maternal Collapse should be the same regardless of cause.

A = Airway B = Breathing C = Circulation

Client unresponsive

Open airway and look for signs of life

No pulse or respirations

- Request a **'2222 – Maternal Cardiac Arrest'**
- Declare cardiac arrest and giving specific location
- This will activate the cardiac arrest team, including obstetric, anaesthetic & Neonatal teams for assistance

Follow cardiac arrest guidelines

The following modifications are required in pregnancy:

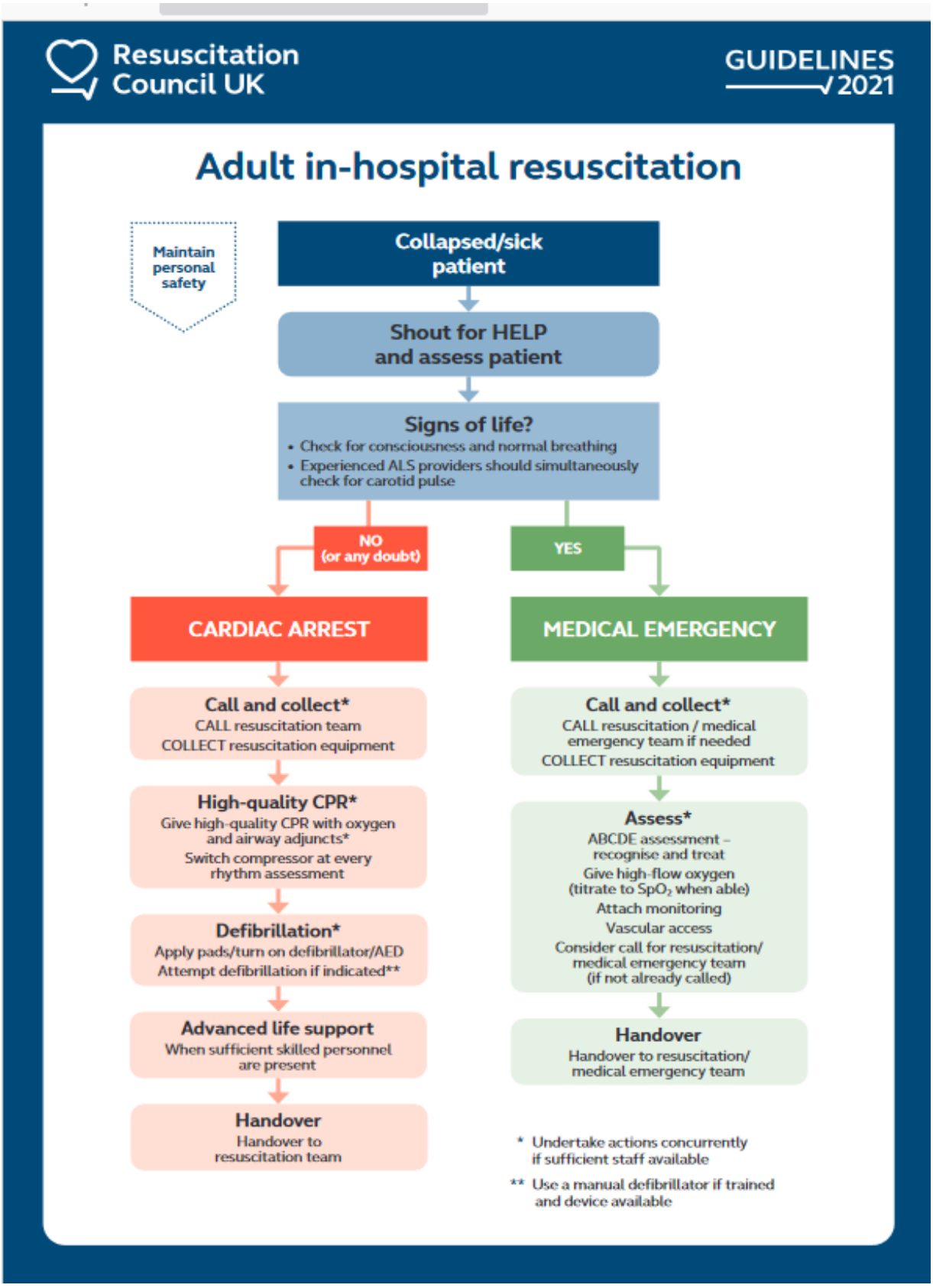
- Uterine displacement (manual or 25-30° left lateral tilt)
- Increased chest wall compression force
- Use cricoid pressure if assistance
- available
- Early tracheal intubation, consider using short laryngoscope handle and smaller endotracheal tube
- Perimortem caesarean delivery if mother fails to respond with a return of spontaneous circulation within 4 minutes
- Consider other aetiologies, e.g. Magnesium toxicity
- Consider left wide paddle, adhesive pad, or breast displacement

Pulse and respirations present

- Request a **'2222 - obstetric emergency'**
- Declare obstetric emergency giving specific location.
- This will summon the obstetric, anaesthetic and Neonatal teams for assistance

1. Administer 100% oxygen by face mask and maintain airway.
2. Put in to recovery position.
3. Insert 2 IV cannulae of not less than 14 gauge and stake blood for FBC, clotting, G&S, U&E, RBS.
4. Consider early intra-osseus access if cannulation difficult
5. Apply monitoring
   - NIBP 3min cycle
   - SpO2
   - ECG
6. If GCS < 8 or airway reflexes compromised, anaesthetic SpR should intubate and ventilate 5.
7. If systolic pressure < 90 mmHg
   - Ensure uterine displacement
   - Infuse 1 litre of colloid or crystalloid
   - Consider ephedrine 6mg boluses
8. Establish and manage specific cause of collapse but remember to regularly evaluate A,B,C for changes in maternal condition
9. Assess the fetal condition and consider urgent delivery of fetus

Appendix - Adult Resuscitation Algorithm- Resus Council 2021



Appendix- Recommended airway equipment

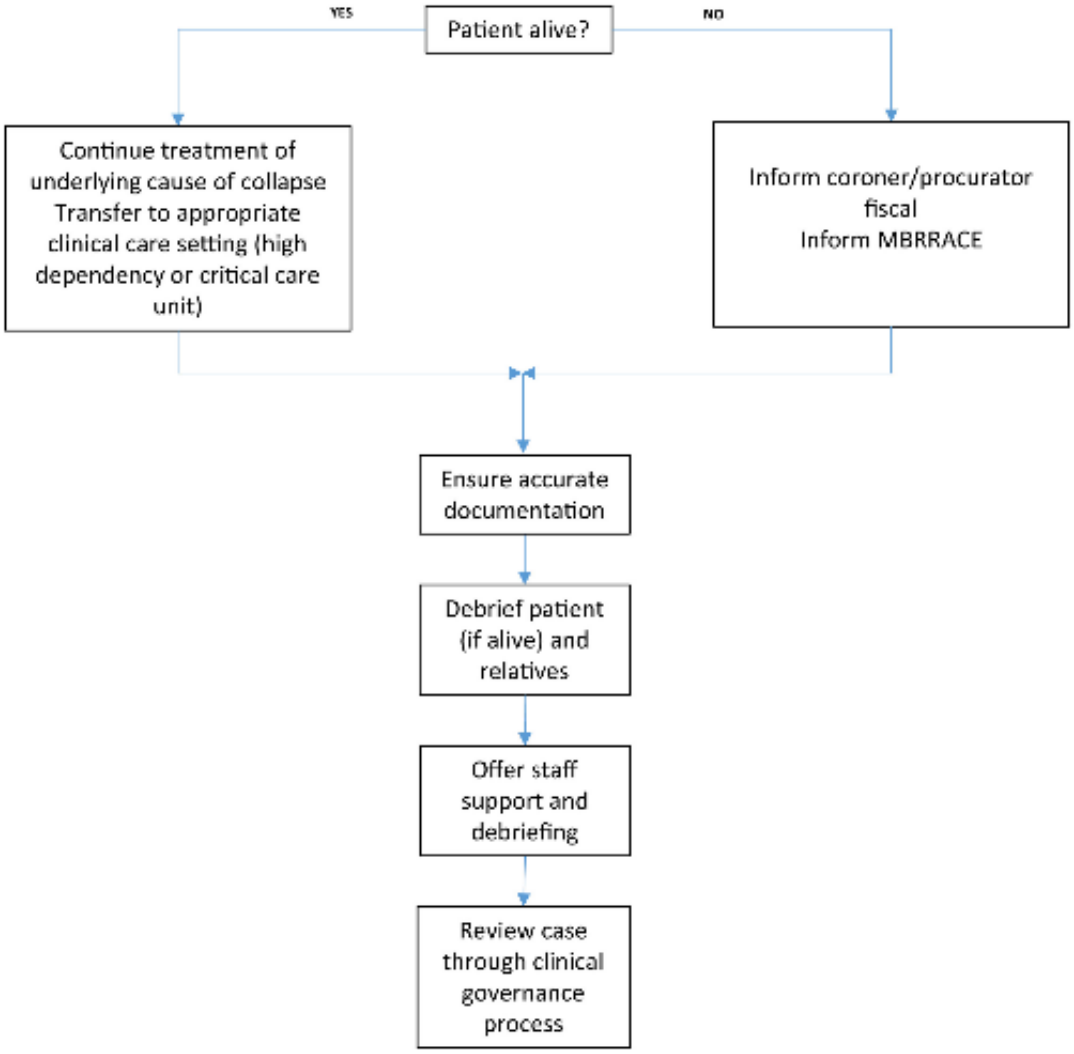
Routine airway equipment

- Face masks
- Oropharyngeal airways size 2, 3 and 4
- Endotracheal tubes in a range of sizes
- Laryngoscopes – Macintosh blades (sizes 3 and 4)
  - two working short handles
  - McCoy laryngoscopes (sizes 3 and 4 blades)
  - videolaryngoscopes (at least one type)
- Tracheal tube introducer – such as a bougie
- Malleable stylet
- Magill forceps
- Nasal cannula and oxygen tubing
- Equipment for ramping/pillows
- Monitoring equipment includin g capnography (see AAGBI guidelines- Recommendations for standards of monitoring during anaesthesia and recovery. 4th edition, 2007)

Recommended equipment for the management of unanticipated difficult intubation

- Endotracheal tubes – range of reinforced tubes, microlaryngeal tubes sizes 5.0 and 6.0 mm, LMA-Fastrach™ tracheal tubes
- Supraglottic airway devices (SAD) to include cLMA, and a second generation SAD (e.g. LMA Proseal™, LMA Supreme™ or I-gel®) - sizes 3, 4 and 5
- LMA cuff pressure manometer
- Fibreoptic scope, camera and monitor
- Aintree® intubating catheter
- Surgical cricothyroidotomy equipment for the 'can't intubate can't oxygenate' situation:
  - Scalpel with No. 10 blade
  - Bougie
  - Size 6.0 endotracheal tube
  - Tracheal hook
  - Forceps or tracheal dilator
- Equipment for awake fibreoptic intubation:
  - Equipment to deliver topical atomised local anaesthetic to the upper airway such as the Mucosal Atomization Device (MAD®) or Mackenzie technique set
  - Berman airway
  - Epidural catheter
  - Local anesthetic for topical anaesthesia (4% lidocaine, Instillagel®)
  - Vasoconstrictors for the nose – phenylephrine/lidocaine (Co-phenylcaine®) or Xylometazoline

Appendix - Post collapse management



Appendix : Prompt Card peri-partum Collapse

PERI-PARTUM COLLAPSE PROMPT CARD

NHS
Brighton and Sussex University Hospitals
NHS Trust

The immediate resuscitative management of all conditions is the same for any woman who collapses before, during or after labour.

Immediate Emergency Resuscitative Management

- Call for help → emergency bell
- Put out a 2222 → Maternal Cardiac Arrest
- Commence Basic Life support → ABC
- Oxygen via non-rebreathe mask @ 15 L/min
- Left lateral tilt with slight head down (pregnant women only)
- Venous access → x2 large bore cannulas
- Initiate fluid resuscitation → 1 litre crystalloid → Hartmann's solution

Institute Advanced Life Support for:

- Persistent hypoxia / Hypotension / Reduced level of consciousness

Initiate Investigations to Establish a Diagnosis:

- Maternal observations → T P R BP Sats
- Start MEOWS
- Venous blood → U&E / FBC / LFT's / Coagulation / x-match 4 units
- Arterial blood gases → by doctor
- ECG monitoring
- Fluid balance
- Foley catheter

Inform the Obstetric and Anaesthetic Consultants on call at an early stage.
For ANY maternal collapse Obstetric Consultants must attend in person.

Appendix : Prompt Maternal Cardiac Arrest