



Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive



INSTITUTE OF OBSTETRICIANS
& GYNAECOLOGISTS
ROYAL COLLEGE OF PHYSICIANS OF IRELAND

CLINICAL PRACTICE GUIDELINE

Resuscitation for the Pregnant Woman

**Institute of Obstetricians and Gynaecologists
Royal College of Physicians of Ireland
and
Health Service Executive**

Version 1.0

Date of publication: October 2014

Guideline No. 32

Revision date: October 2017

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1. Revision History

Version No.	Date	Modified By	Description
1.0	September 2014	Dr Larry Crowley	Version 1.0 Draft for review

2. Key Recommendations

1. Each obstetric unit should have a designated lead person for maternal resuscitation.
2. All healthcare providers within the unit should have adequate and up to date resuscitation skills.
3. Standard adult resuscitation guidelines (with the addition of left uterine displacement) are applicable to the pregnant woman.
4. In the setting of likely aorto-caval compression, perimortem caesarean delivery should be performed as soon as possible (ideally within 5 minutes) if there is no response to adequate resuscitation manoeuvres including left uterine displacement.
5. For a maternal cardiac arrest emergency, we recommend that the emergency team comprises the locally agreed adult emergency team as well as an obstetrician capable of performing caesarean delivery. The neonatal team should be called early if delivery is likely.
6. For third trimester parturients, during resuscitation it is recommended to place the hand 2-3 cms higher on the sternum than in non-pregnant individuals.
7. If maternal CPR is ongoing and a fetal scalp electrode or external fetal monitor is in place to monitor the fetal heart rate, it should be disconnected from its power source prior to shock and in preparation for caesarean delivery.
8. Obtaining intravenous or intra-osseous access above the diaphragm is preferable in order to avoid the potentially deleterious effects of vena caval compression.
9. All cases of maternal collapse should generate a clinical incident report and the care should be reviewed through the clinical governance process.

10. The two most important intervals affecting patient survival are the collapse-to-first CPR attempt interval and collapse-to-first defibrillatory shock interval.

3. Purpose and Scope

The purpose of this document is to provide evidence-based guidance to healthcare professionals involved in the management of the pregnant woman who had a cardiac arrest.

These guidelines are intended for all healthcare professionals who care for the pregnant woman. They are designed to guide clinical judgement but not replace it. In individual cases a healthcare professional may, after careful consideration, decide not to follow a guideline if it is deemed to be in the best interests of the woman.

4. Methodology

Medline, EMBASE and Cochrane Database of Systematic Reviews were searched using terms relating to cardiac arrest in pregnancy, peri-partum haemorrhage, hypotension, maternal collapse, amniotic fluid embolus, eclampsia, hypertensive disease, and cardiac arrhythmia in pregnancy, drug toxicity, maternal resuscitation and resuscitation algorithms during pregnancy. Searches were limited to humans and restricted to the titles of English language articles published between 1960-2014. Relevant meta-analyses, systematic reviews, intervention and observational studies were reviewed.

Guidelines reviewed included the American Heart Association 2010 ACLS guidelines for cardiopulmonary resuscitation in special situations (pregnancy), The Society for Obstetric Anaesthesia and Perinatology 2014 consensus statement on the management of cardiac arrest in pregnancy, the Royal College of Obstetrics and Gynaecology 2011 Maternal Collapse in Pregnancy and the Puerperium guideline and the European Resuscitation Council 2010 guidelines on cardiac arrest in special circumstances (pregnancy). (Venden Hoek *et al.*, 2010; Society for Obstetric Anaesthesia and Perinatology, 2014; RCOG, 2011; European Resuscitation Council, 2010)

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5. Background and Introduction

Maternal collapse is defined as an acute event involving the cardiorespiratory and cerebrovascular systems, resulting in reduced or absent conscious levels at any stage in pregnancy and up to six weeks after delivery. Determining the true incidence of a rare event is difficult but the best data we have suggests that the incidence of cardiac arrest in the pregnant woman is in the range of 1: 20,000 to 1: 30,000 pregnancies in the United Kingdom. (Lennon *et al.*, 2013; Cantwell *et al.*, 2011; Cemach, 2011; Hogan *et al.*, 2010) In recent data from the United States, there were 4843 cases of cardiopulmonary arrest in 56,900,512 (or 1 in 12,000) hospitalisations for delivery between 1998 – 2011 in a database designed to capture a representative sample of approximately 20% of all U.S. hospital admissions. (Mhyre *et al.*, 2014) In this U.S. data, 58.9% of those who suffered maternal cardiopulmonary arrest survived to hospital discharge.

Effective and prompt resuscitation not only improves the primary outcome for the mother but also of the fetus. It is important for the teams involved to understand the physiological changes that occur during pregnancy to make key adjustments during resuscitation.

Physiological changes during pregnancy

Cardiovascular: There is an increase in maternal heart rate and stroke volume which results in an increased cardiac output. There is an increase in blood volume by 30-50%, whilst there is only a 20% increase in red blood cell volume resulting in physiological anaemia. This increased plasma volume significantly compensates for blood volume loss before abnormal clinical signs are detected. Supine hypotension occurs after 20 weeks of gestation due to aorto-caval compression by the gravid uterus.

Respiratory: Maternal respiratory rate and tidal volume increase leading to increased minute ventilation to compensate for increased oxygen demand. This increased oxygen demand is due to the growing needs of the uterus, placenta and the fetus. During pregnancy the combination of reduced oxygen reserves (via reduction in the functional residual capacity) and increased oxygen demand means that parturients blood oxygen levels deteriorate more rapidly than in non-pregnant patients.

Abdominal/Pelvic: During pregnancy, lower oesophageal sphincter tone decreases and the intra-gastric pressure increases resulting in an increased risk of gastric aspiration.

Causes of and contributing factors for cardiac arrest in a pregnant woman:

(BEAU-CHOPS)

- **B**leeding/ Disseminated Intravascular Coagulation (DIC)
- **E**mbolism: pulmonary/coronary/amniotic fluid embolism
- **A**naesthetic complications
- **U**terine atony
- **C**ardiac disease :myocardial ischaemia/infarction, aortic dissection, cardiomyopathy
- **H**ypertension, preeclampsia, eclampsia
- **O**ther: differential diagnosis of cardiac arrest e.g. The **H's** and **T's**: Hypoxia, Hyper/Hypokalaemia, Hypo/Hyperthermia, Hydrogen ions (acidosis), Hypoglycaemia, and Tension pneumothorax, Tamponade, Toxins, Trauma.
- **P**lacental abruption/praevia
- **S**epsis

6. Clinical Guidelines

When a pregnant woman is found collapsed and unresponsive

I. Start Basic Life Support (BLS) immediately and call for help.

Start high quality chest compressions immediately to optimise maternal and fetal outcomes. A defibrillator or Automatic External Defibrillator (AED) should be connected to the parturient. A clear airway must be established with simple airway manoeuvres, such as a head tilt, chin lift and a jaw thrust. Ventilation with bag and mask should be commenced (a pocket mask is recommended for a lone rescuer). All of these procedures should be performed with the pregnant woman placed in a lateral tilted position or supine with left uterine displacement (LUD) achieved manually or with the help of a wedge.

A 'maternal cardiac arrest emergency' should be declared and activated immediately. Appropriate members of the resuscitation team should be decided locally. For a maternal cardiac arrest emergency, we recommend that the emergency team comprises the locally agreed adult emergency team, as well as an obstetrician capable of performing caesarean delivery. The neonatal team should be called early if delivery is likely. In some hospitals it may be necessary to create a specific emergency code for maternal cardiac arrest so that an obstetrician and neonatologist are alerted along with the general adult emergency team.

II. Chest Compressions

Continuous uninterrupted chest compressions should be started at a rate of 100/min with a depth of 5-6 cms. Minimising interruptions to chest

compressions are key to a better outcome in resuscitation of a parturient. The 'peri-shock pause' (to check for a shockable rhythm immediately pre-shock) should be limited to < 5 seconds; as even brief pauses decrease the chance for return of spontaneous circulation (ROSC). (American Heart Association, 2011; Cheskes *et al.*, 2011) To minimise interruptions in compressions, pulse checks performed immediately post-shock are discouraged.

If the parturients' trachea is intubated, chest compressions should be performed without any interruption. If the airway has not been secured with an endotracheal tube, chest compressions should be continued at a rate of 30 compressions to 2 breaths. The resuscitation team should rotate its team members every two minutes because compressions are physically rigorous and provider fatigue develops rapidly (Hightower *et al.*, 1995; Sugarman *et al.*, 2009; McDonald *et al.*, 2009). For third trimester parturients, during resuscitation it is recommended to place the hand 2-3 cms higher on the sternum than in non-pregnant individuals.

Measurement of expiratory carbon dioxide during resuscitation with continuous capnography measures the partial pressure of carbon dioxide (CO₂). The current Adult Cardiac Life Support (ACLS) guidelines recommend capnography as mandatory to confirm endotracheal tube placement. Capnography also serves to assess the quality and effectiveness of chest compressions. Capnography reflects the quality of chest compressions because it indirectly measures cardiac output in an intubated patient under stable ventilation conditions. (Pernat *et al.*, 2003) During resuscitation, end-tidal CO₂ levels above 10 mmHg and/or rising end-tidal CO₂ levels suggest good quality of chest compressions and return of spontaneous cardiac output. (Wayen *et al.*, 1969; Eckstein *et al.*, 2011; Einav *et al.*, 2011; Kolar *et al.*, 2008; Pokorna *et al.*, 2010)

III. Patient Position and Left Uterine Displacement (LUD)

In order to minimise the adverse effects of vena caval compression by the gravid uterus on venous return and cardiac output, the collapsed parturient should be immediately placed in a left lateral position after 20 weeks of gestation or if the uterus is palpable or visible at or above the umbilicus. (Venden Hoek *et al.*, 2010) Vena-caval compression may occur earlier during pregnancy and the need for LUD should be based on individual circumstances such as multiple gestation, polyhydramnios, or any other conditions where vena caval obstruction may be a relevant concern, even if the gestational age is <20 weeks (Veland *et al.*, 1969).

The cardiac output produced from chest compressions is optimised when the arrested parturient is placed on a firm surface (e.g. a backboard) in the supine position with manual left uterine displacement. (Venden Hoek *et al.*, 2010; Noordercraaf *et al.*, 2009; Nishisaki *et al.*, 2012; Kundra *et al.*, 2007) Manual left uterine displacement is optimally performed using two hands from the left side of the patient (see Appendix 1). The designated provider must pull leftward and upward, because if downward force is inadvertently applied, inferior vena caval compression may worsen. If it is not possible to perform manual LUD from the left, it may be applied from the right side of the patient by pushing with

one or both hands, although this approach may be technically more difficult to perform adequately. Left lateral tilt of the patient to a full 30 degrees (i.e. pelvic tilt) can also be used to provide LUD, but this position may make the provision of adequate chest compressions more challenging as the force transmitted to the chest wall is reduced.

Further diagrams & the ACLS Maternal cardiac arrest algorithm may be accessed via this link:

http://circ.ahajournals.org/content/122/18_suppl_3/S829.figures-only

IV. Defibrillation

Cardio-pulmonary resuscitation should not be interrupted whilst a defibrillator or AED is attached (American Heart Association, 2011). In sudden cardiac arrest with ventricular fibrillation, early defibrillation improves the chance of successful return of spontaneous circulation (ROSC) with continuous chest compressions. Defibrillation is safe for the fetus in the setting of maternal cardiac arrest. (Venden Hoek *et al.*, 2010)

The defibrillation energy requirements for a pregnant woman are the same as for a non-pregnant adult. (Venden Hoek *et al.*, 2010) Despite limited evidence, AEDs may be considered for the hospital setting as a way to facilitate early defibrillation (a goal of shock delivery < 3 minutes from collapse) especially in areas where staff have no rhythm recognition skills or defibrillators are used infrequently. (Chan *et al.*, 2010; American Heart Association, 2011) If maternal CPR is ongoing and a fetal scalp electrode or external fetal monitor is in place to monitor the fetal heart rate, it should be disconnected from its power source prior to shock and in preparation for caesarean delivery. The key point to remember in the setting of maternal cardiac arrest is that fetal monitoring is not necessary to guide management and may distract staff from or delay the provision of maternal CPR and fetal delivery.

V. Airway Management and Ventilation

Initial responders without advanced airway experience should use simple airway techniques to oxygenate the patient (e.g. head tilt, chin lift, jaw thrust, oral airway and bag-mask ventilation). Oral airways are preferred over nasal airways in a pregnant patient because of the potential risk of epistaxis. Repeated airway manipulations should be minimised to avoid airway trauma and interruptions to chest compressions.

Only personnel with experience in advanced airway management should perform laryngoscopy. Care must be taken to avoid fixation errors associated with one specific technique of airway management (e.g. 'must intubate') (Berkenstadt *et al.*, 2012) and alternative airway control strategies such as supra-glottic airway control devices (e.g. laryngeal mask airways) should be considered.

Although pregnant women are at risk of aspiration (Chiloiro *et al.*, 2001; O'Sullivan, 1993), oxygenation and ventilation must always remain the primary

objective and take priority over aspiration prevention strategies. Manual cricoid pressure may be employed to prevent aspiration (Fenton *et al.*, 2009; Boet *et al.*, 2012, Smith *et al.*, 2003) although evidence suggests that cricoid pressure may not be effective at preventing aspiration and it can impede ventilation and laryngoscopy. If cricoid pressure is utilised, it should be released or adjusted if intubation is challenging or the view during laryngoscopy is poor.

VI. Perimortem Caesarean or Operative Vaginal Delivery

The current ACLS guidelines support rapid delivery of the fetus. (Venden Hoek *et al.*, 2010) In the setting of maternal cardiac arrest where the gravid uterus is felt to be causing aorto-caval compression and when vaginal delivery is not immediately possible, if there is no response to advanced life support (including adequate left uterine displacement), then perimortem caesarean delivery (PMCD) is required in order to improve the chance of ROSC and survival. Delivery should be performed as soon as possible if ROSC has not occurred within four minutes of the start of the cardiac arrest. Teams should continue CPR throughout and strive to effect fetal delivery at 5 minutes after the onset of maternal cardiac arrest. Proposed mechanisms for the efficacy of PMCD include immediate relief of vena caval obstruction with improved venous return and cardiac output, decreased oxygen demand and improved pulmonary mechanics. Although definitive evidence is lacking, numerous reports describe ROSC or improvements in haemodynamics after delivery (Marx, 1982; Katz *et al.*, 1986; Katz *et al.*, 2005; Katz, 2012; Einva *et al.*, 2012; Araibi *et al.*, 2007). Achieving delivery of the fetus within five minutes may be difficult to achieve but PMCD should be performed as soon as possible if there is no response to adequate resuscitation efforts. Neonatal survival may also be greatest if viability is past 24-25 weeks and when the fetus is delivered within 5 minutes (Katz *et al.*, 1986; Einva *et al.*, 2012), although maternal and neonatal survival have been reported when even longer intervals from arrest until ROSC have occurred.

When maternal cardiac arrest occurs elsewhere outside the operating theatre complex, transporting the arrested patient to the operating theatre for delivery is not recommended. Patient transport distracts rescuers from the core tasks of resuscitation, interferes with high quality continuous chest compressions and delays delivery. Based on simulation studies, anecdotal reports and reviews of maternal arrests in the literature, it is strongly recommended to perform a perimortem caesarean delivery at the site of maternal arrest (Lipman S *et al.*, 2007). Ideally, fully equipped caesarean section packs should therefore be located on the resuscitation trolley.

There should be a defined pathway for transfer of a successfully resuscitated patient to the Intensive Care Unit (ICU). Recommendations for care of the critically ill pregnant woman are available via this link:

<http://hse.ie/eng/about/Who/clinical/natclinprog/criticalcareprogramme/publications/guidelines.pdf>

Post-resuscitation measures (e.g. therapeutic hypothermia) are outside the scope of this document.

VII. Intravenous Access

Intravenous (IV) access is essential for rapid intravascular volume replacement and administration of resuscitation drugs. In the setting of massive obstetric haemorrhage, life-saving interventions include multiple sites of large gauge vascular access and a massive transfusion protocol. A device to rapidly infuse and warm fluids and blood products must be available. In the event of difficult peripheral IV access, alternative options include intra-osseous access in the proximal humerus, proximal tibia or ultrasound-assisted central venous access. Obtaining intravenous or intra-osseous access above the diaphragm is preferable in order to avoid the potentially deleterious effects of vena caval compression, which would increase the time required for fluids or administered drugs to reach the heart or even prevent their circulation altogether. (Venden Hoek *et al.*, 2010; American Heart Association, 2005)

VIII. Resuscitation and other Drugs

Resuscitation drugs should be administered as per current ACLS guidelines. None of these drugs (e.g. adrenaline, amiodarone etc) are contraindicated during maternal cardiac arrest (1). If local anaesthetic-induced cardiac arrest is suspected, lipid emulsion may be administered as an adjunctive therapy as in the non-pregnant patient. (41, 42). In addition to its uterotonic effect, oxytocin is a systemic vasodilator and a negative inotrope and therefore may precipitate cardiovascular collapse if administered in a large (> 5 international units) bolus.

7. Hospital Equipment and Facilities

All departments that may receive pregnant women should be supplied with or have access to mobile trolleys containing equipment for maternal and neonatal resuscitation. The resuscitation trolley should contain emergency airway equipment, a defibrillator, all resuscitation drugs (including lipid emulsion), devices for vascular access e.g. IV cannula and interosseous needle kits along with a surgical kit comprising a caesarean delivery pack.

8. Quality Improvement

All cases of maternal collapse should generate a clinical incident report and the care should be reviewed through the clinical governance process. Each unit should have a designated lead person for resuscitation.

All healthcare providers within the unit should maintain adequate and up to date resuscitation skills. Basic Life Support training is mandatory for all hospital clinical staff; BLS certification lasts for two years.

We support recommendations by the Confidential Enquiries into Maternal and Child Health of the United Kingdom and others emphasising the provision of periodic emergency drills, including drills that involve both the obstetric and neonatal teams. Unannounced drills may be appropriate for more experienced teams in order to practice the co-ordination and performance of a series of complex tasks under pressure. Ideally, drills should be timed and followed by a debriefing session to collectively analyse behavioural, cognitive, and technical skill-sets, as well as to identify and develop strategies to mitigate systems issues in all departments that may receive obstetric patients (Labour and Delivery, Emergency Department, Intensive Care Unit, Radiology etc).

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10. Implementation Strategy

- Distribution of guideline to all members of the Institute and to all maternity units.
- Implementation through HSE Obstetrics and Gynaecology Programme local implementation boards.
- Distribution to the Director of the Acute Hospital Services for dissemination through line management in all acute hospitals.
- Distribution to other interested parties and professional bodies.

11. Key Metrics

In order to determine how an obstetric unit is performing in its management of a clinical scenario, it is necessary to evaluate the multitude of contributing factors and interventions relevant to that scenario. The outcome of cardiac arrest and cardiopulmonary resuscitation (CPR) is dependent on critical interventions, particularly early defibrillation, effective chest compressions, and adequate oxygenation.

Those bodies involved in developing resuscitation guidelines (including The American Heart Association and European Resuscitation Council) recommend the use of Utstein reporting templates to gather information on key events which occur during a cardiac arrest situation. These templates require the collection of a multitude of data but the two most important intervals affecting patient survival are the collapse-to-first CPR attempt interval and collapse-to-first defibrillatory shock interval. Perhaps one could also add the interval to perimortem caesarean delivery (where indicated) to these key performance indicators.

12. Qualifying Statement

These guidelines have been prepared to promote and facilitate standardisation and consistency of practice, using a multidisciplinary approach. Clinical material offered in this guideline does not replace or remove clinical judgement or the professional care and duty necessary for each pregnant woman. Clinical care carried out in accordance with this guideline should be provided within the context of locally available resources and expertise.

This Guideline does not address all elements of standard practice and assumes that individual clinicians are responsible for:

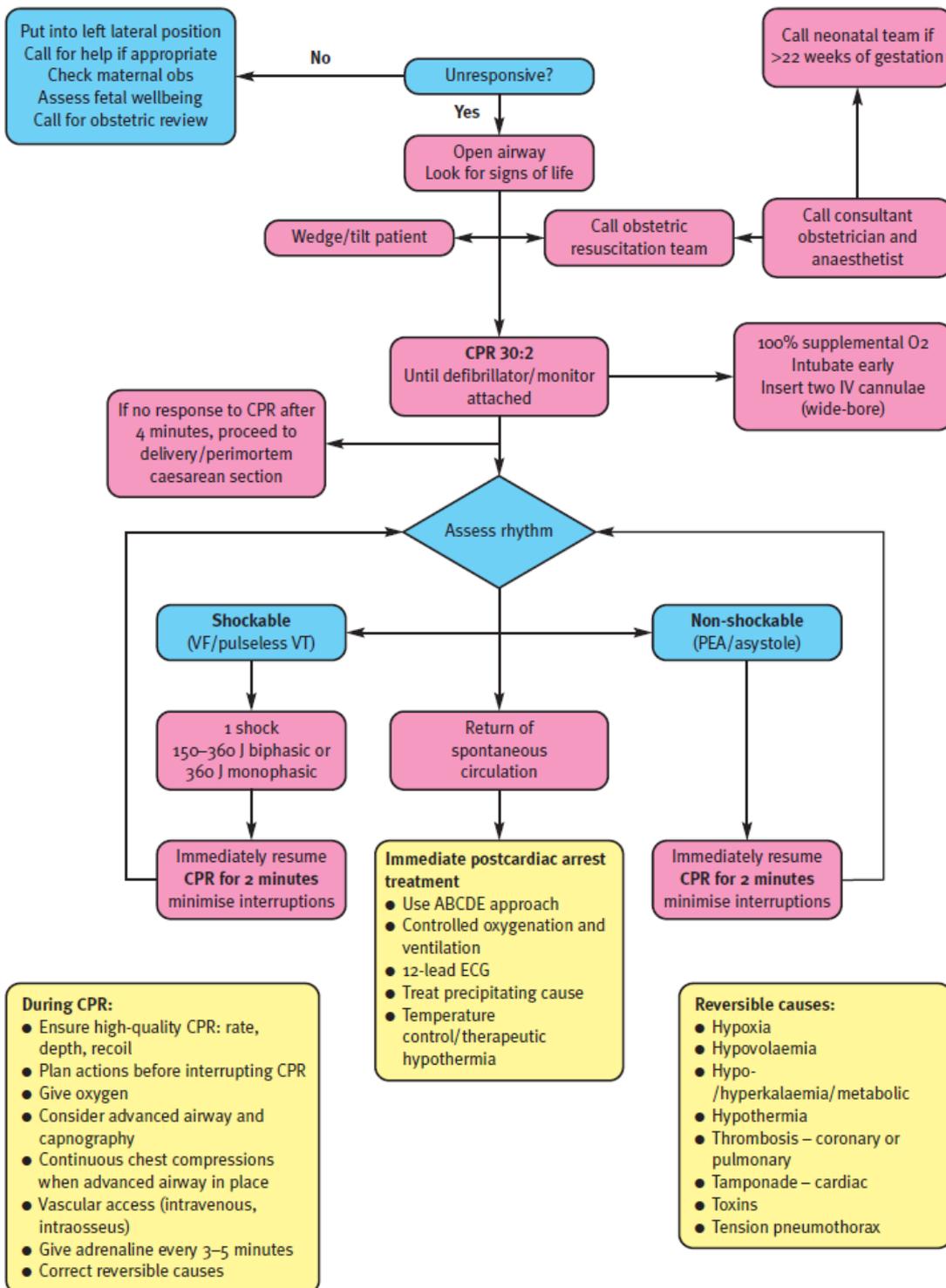
- Discussing care with women in an environment that is appropriate and which enables respectful confidential discussion.
- Advising women of their choices and ensuring that informed consent is obtained.
- Meeting all legislative requirements and maintaining standards of professional conduct.
- Applying standard precautions and additional precautions, as necessary, when delivering care.
- Documenting all care in accordance with local and mandatory requirements.

13. Appendices



Appendix 1: Left uterine displacement using two-handed technique.

APPENDIX 2 Maternal collapse algorithm



KEY

ABCDE = airway, breathing, circulation, disability, exposure; CPR = cardiopulmonary resuscitation; RCG = electrocardiogram; PEA = pulseless electrical activity; VF = ventricular fibrillation; VT = ventricular tachycardia

Appendix 2: RCOG Maternal collapse algorithm.