Chapter 4

Cardiopulmonary resuscitation in the non-pregnant and pregnant patient

Objectives

On successfully completing this topic, you will be able to:

- understand and perform basic and advanced life support
- understand the importance of early defibrillation where appropriate
- understand the adaptations of CPR in the pregnant patient.

Introduction and incidence

Although cardiac arrest is fortunately a rare event in pregnancy, it is estimated to occur in every 30,000 deliveries. In the Confidential Enquiry into Maternal Deaths and Child Health (CEMACH) reports a common *Direct* cause of maternal death is thromboembolism which will present usually as a sudden collapse. It is important that the healthcare teams know the appropriate actions to take in such an event, to promote positive outcomes for both the mother and the child.

Basic life support describes the procedures which a trained lay person could be expected to provide. These include:

- recognising an absence of breathing or other signs of life,
- When obtaining help ask for automated external defibrillator,
- provision of chest compressions and mouth to mouth or pocket mask breathing.
- If rescuer not happy to perform mouth to mouth breathing can continue only chest compressions
- Minimise interruptions to chest compression whilst using AED

Advanced life support describes the procedures which a trained health care professional could be expected to provide. This includes all of the above, and in addition:

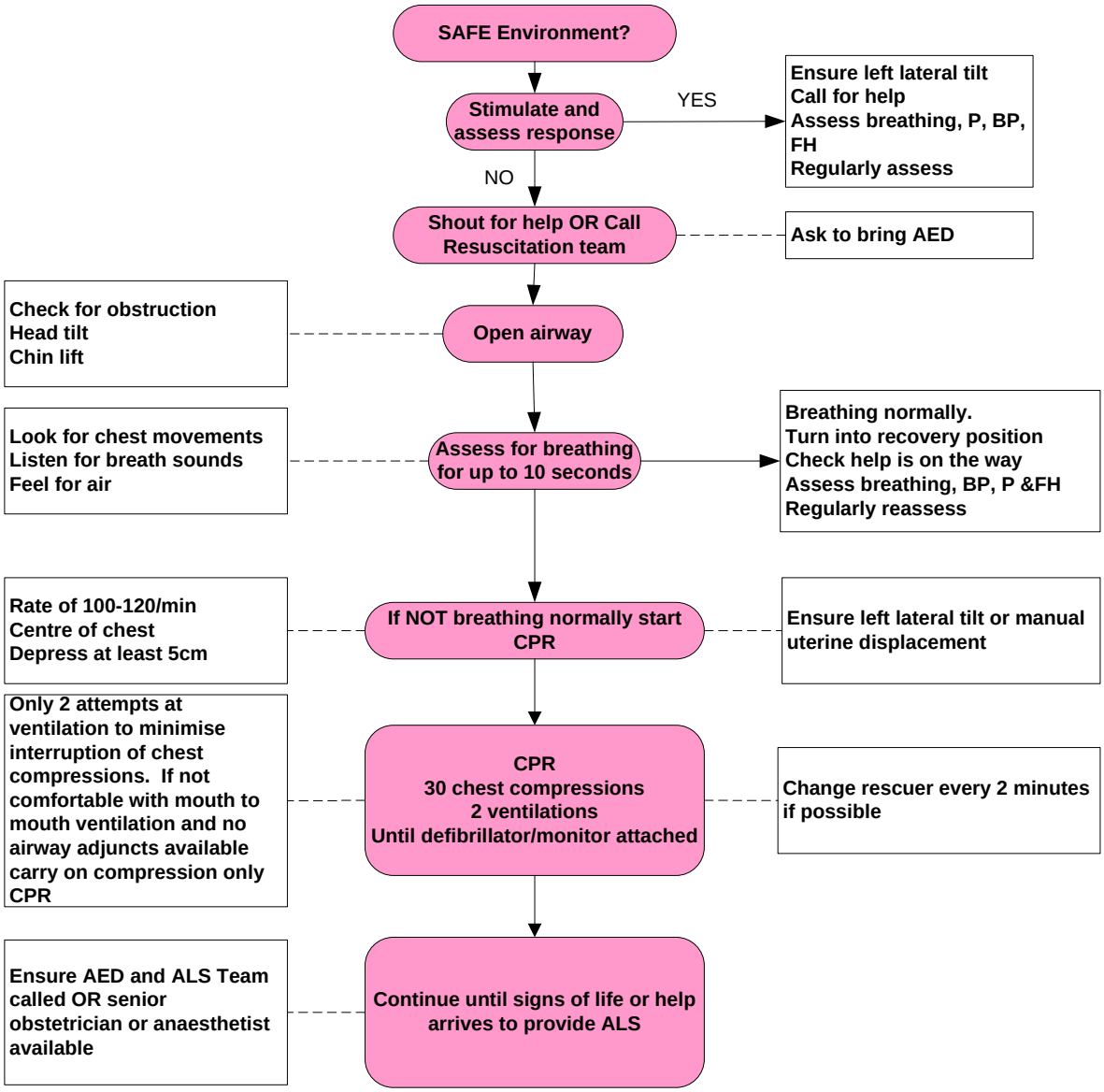
- the use of other airway adjuncts to provide more effective ventilation
- the insertion of intravenous cannulae to give drugs
- the use of semi-automated or manual defibrillators.

It should not be necessary to perform mouth to mouth ventilation in a hospital as airway adjuncts should be close to hand.

In a hospital setting the distinction between basic and advanced life support is arbitrary. The clinical team should be able to provide cardiopulmonary resuscitation, the main components of which are:

- early recognition of cardiopulmonary collapse quickly
- calling for help using a standard procedure/number
- starting cardiopulmonary resuscitation using appropriate adjuncts
- early defibrillation if possible within 3 minutes.

Recent guidelines place greater emphasis on high–quality CPR with minimal interruptions in chest compressions.



Algorithm 4.1. Basic life support

Management

The rescuer must ensure a safe environment, shake the patient and shout. If no response, call for help and then return to the patient.
If the patient appears to have collapsed but there are still signs of life then urgent medical attention should be called, and further assessment and appropriate treatment be administered.
In the event of little sign of life, the following instructions may be carried out almost simultaneously by multiple helpers but of necessity are described in an appropriate order for one person.

1. Turn the patient onto her back with left lateral tilt

In a noticeably pregnant woman i.e. one with a significant intra- abdominal mass (usually by 20 weeks) it is important to obtain a *left lateral tilt* of the pelvis at the earliest opportunity to minimise the risk of *aortocaval compression*.

Figure 4.1: Left Lateral Tilt

2. Open the airway

Check in the mouth for foreign body or material. Use suction if required or remove foreign body with care and use of forceps. To open the airway place your hand on the patient's forehead and gently tilt head back. At the same time with your fingertips under the point of the patient's chin, lift the chin to open the airway. A jaw thrust may be required to open the airway. Do this by placing fingers behind the angle of the jaw and moving jaw anteriorly to displace tongue from the pharynx.
If injury to the neck is suspected, use manual in line stabilisation, avoid head tilt and use mainly jaw thrust to open the airway.

3. Assess breathing (and circulation)

Assess breathing for no more than ten seconds by looking for chest movements, listening for breath sounds and feeling for the movement of air. Absence of breathing in the presence of a clear airway is now used as a marker of absence of circulation. Experienced staff may want to check the carotid pulse for no more than 10 seconds at the same time as assessing breathing.
Gasping or agonal breathing may be seen in the immediate time after cardiac arrest and should not be taken as a sign of life – it is a sign of dying and CPR should commence immediately.

4. Start CPR

If no circulation (or you are at all unsure)

give 30 chest compressions followed by 2 ventilations

a) The position for chest compressions should be the middle of the lower half of the sternum. Place the heel of one hand there, with the other hand on top of the first. Interlock the fingers of both hands and lift the fingers to ensure that pressure is not applied over the patient's ribs. Keep in the midline at all times. Do not apply any pressure over the top of the abdomen or bottom tip of the sternum.
b) Position yourself above the patient's chest and with your arms straight, press down on the sternum to depress —at least 5 cm at a rate of 100 to 120 beats per minute. Change the person doing chest compressions about every 2 minutes to maintain efficiency but avoid any delays in the changeover.
c) Ventilation breaths. Keep an open airway and provide ventilation with appropriate adjuncts. This might be a pocket mask, oral airway or self inflating bag with mask.

Oxygen in high flow should be added as soon as possible.

d) Each ventilatory breath should last about 1 second and should make the chest rise as if a normal breath. Tracheal intubation if experienced help available with minimal interruption to chest compression. Laryngeal mask airway as an alternative airway adjunct if intubation can't be achieved swiftly. Once the patient is intubated ventilation should continue at 10 breaths per minute but does not need to be synchronised with chest compressions. These should then be uninterrupted.
e) Mouth to mouth breathing (not usually required).
f) Ensuring head tilt and chin lift. Close the soft part of the patient's nose with your thumb and index finger. Open her mouth a little but maintain chin lift. Take a breath and place your lips around her mouth, making sure that you have a good seal. Blow steadily into her mouth over 1 second, watching for her chest to rise. Maintaining head tilt and chin lift, take your mouth away from the patient and watch for her chest to fall as the air comes out. Take another breath and repeat the sequence to give another effective breath. Return to chest compressions quickly.

If circulation present but no breathing (respiratory arrest)

continue rescue breathing at a rate of 10 breaths/minute

Recheck the circulation every ten breaths, taking no more than ten seconds each time. If the patient starts to breathe on her own but remains unconscious, turn her into the recovery position and apply oxygen 15 litres/minute. Check her condition and be ready to turn her back to start rescue breathing if she stops breathing.

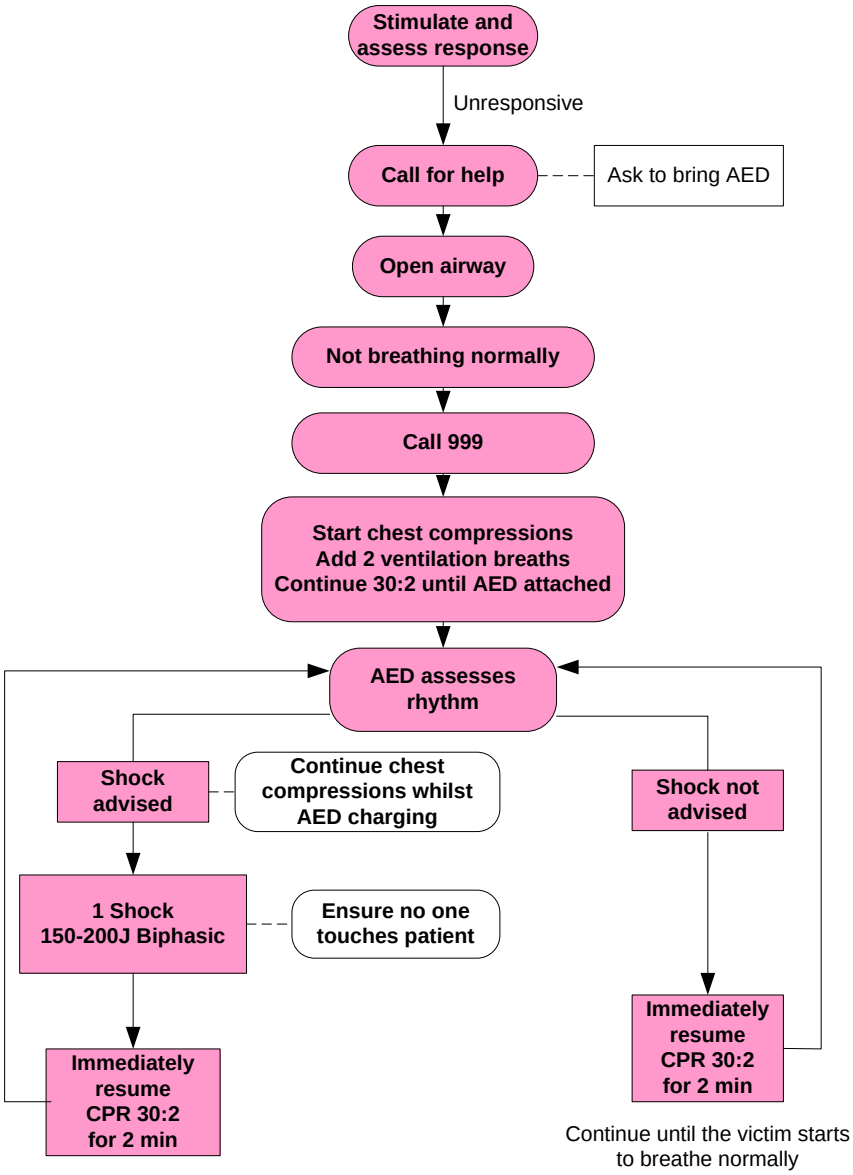
5. Use defibrillator

As soon as possible attach the defibrillator and pause briefly to assess the rhythm. The use of adhesive pads or using the paddles held over the gel pads may be quicker than attaching the ECG stickers. If shockable rythum recognised by AED then continue chest compressions whilst the AED is charging. Follow the automated external defibrillator (AED) voice prompts or use manual defibrillation as appropriate (Algorithm 4.3)

Automated external defibrillator

If automated external defibrillator (AED) is available, attach, analyse rhythm and defibrillate as indicated in Algorithm 4.2.

The most frequent initial rhythm in the context of sudden collapse (i.e. not preceded by gradual deterioration or illness) is ventricular fibrillation (VF). The chances of successful defibrillation diminishes with time. The AED allows for early defibrillation by lesser-trained personnel, as it performs rhythm analysis, gives information by voice or visual display and the delivery of the shock is then delivered automatically.



Algorithm 4.2. Automated external defibrillator

Attach AED pads (or position gel pads for manual defibrillator)

Expose the chest and place the adhesive defibrillator pads on patient's chest, one to the right of the sternum below the right clavicle and one in the midaxillary line taking care to avoid breast tissue. Keep the axillary electrode vertical to maximise efficiency.

After each shock restart CPR for two minutes when there will be a further prompt for a rhythm analysis. If defibrillation is not indicated CPR should be continued for two minutes, at which stage the AED will prompt further analysis of rhythm.

Turn immediately to advanced life support algorithm

When advanced life support arrives, the rhythm is assessed as a shockable rhythm or nonshockable rhythm and defibrillation is instituted if required. An airway is secured and intravenous access obtained.

Defibrillation sequence (Algorithm 4.2) and use of drugs (Algorithm 4.3) can be followed on the algorithms.

Shockable rhythms:

- Shockable rhythms are treated with a single shock followed by immediate continuation of CPR without stopping for a rhythm or pulse check
- Every 2 minutes the rhythm should be assessed and if necessary a further shock delivered. The pulse is not checked unless there is organised electrical activity i.e. something which looks as though it might produce an output
- The energy used for defibrillation depends on whether it is a monophasic or biphasic defibrillator. Most modern defibrillators are biphasic as this is the most efficient way of delivering energy. The charge needed is therefore lower than on the older monophasic machines.
- The initial and subsequent shocks should be 150 - 200J from a biphasic machine or 360J from a monophasic machine
- On the shockable side of the algorithm, adrenaline (epinephrine) 1mg IV is given once chest compressions are commenced after the third shock and every subsequent alternate shock i.e. approximately every 4 minutes. Amiodarone 300mg IV is given after the 3rd shock.

Non shockable rhythms:

- On the non-shockable side of the algorithm i.e. pulseless electrical activity or asystole, adrenaline (epinephrine) 1mg should be given as soon as intravenous access is available

Reversible causes of cardiac arrest are considered and treated as necessary. Those highlighted are most common causes of cardiac arrest/ collapse in pregnancy.

Four Hs:

- hypoxia
- **hypovolaemia** (haemorrhage or sepsis)
- hyperkalaemia and other metabolic disorders
- hypothermia

Four Ts:

- **thromboembolism**
- toxicity (drugs associated with regional or general anaesthesia)
- tension pneumothorax
- cardiac tamponade

Doubt about the rhythm

If there is doubt about whether the rhythm is asystole or fine VF, CPR should be maintained and treat as for asystole.

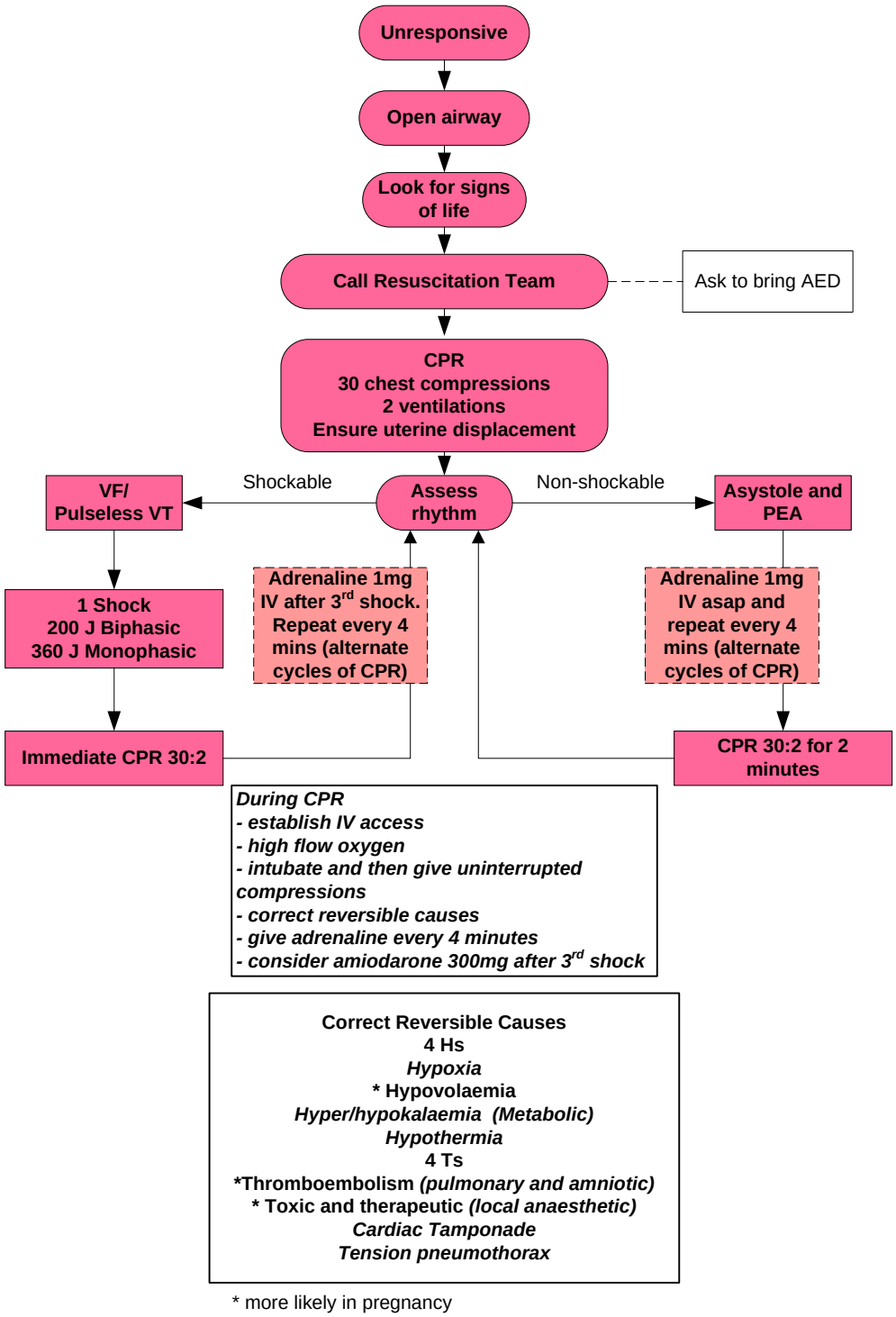
Other drugs

Sodium bicarbonate: 50mmol IV should only be given to patients if the arrest is associated with tricyclic antidepressant overdose or hyperkalaemia. Otherwise it should be given in response to the clinical condition of the patient e.g. with severe acidosis pH less than 7.1, base excess greater than -10.

Magnesium sulphate: 8mmol (4 mls of 50% solution) may be used for refractory VF. Other use may be in possible hypomagnesaemia, torsade de pointes (a persistent VF) or digoxin

toxicity. These are unlikely in pregnancy.

Calcium: 10ml 10% calcium chloride (6.8 mmol Ca^{2+}) IV can be used if it is thought that PEA is caused by hyperkalemia, hypocalcemia, overdose of calcium channel blocking drugs or *overdose of magnesium (for treatment of pre-eclampsia)***.** Calcium can be given as a bolus if the patient has no output, but not in the same line as sodium bicarbonate as this will precipitate.



Algorithm 4.3. Advanced life support

PHYSIOLOGICAL CHANGES IN PREGNANCY AFFECTING RESUSCITATION

There are a number of reasons why the processes of cardiopulmonary resuscitation are more difficult to perform and may be less effective in the pregnant than in the non- pregnant population. When these changes occur is not precise, but gradually the presence of increasing mass in the abdomen compromises resuscitative efforts. This may be the case from 20 weeks but will be more marked as the mother approaches term.

o Vena caval occlusion

At term, in a well woman, the vena cava is completely occluded in 90% of **supine** pregnant patients and the stroke volume may be only 30% of that of a non-pregnant woman. As soon as the infant is delivered, the vena cava returns towards normal and adequate venous return and consequently cardiac output is restored.

During cardiac arrest, in order to minimise the effects of the gravid uterus on venous return and cardiac output, a maternal pelvic tilt to the left of greater than 15 degrees is recommended. The tilt needs to be less than 30 degrees for effective closed chest compression to take place. An alternative, manual displacement of uterus to the left should be effective (Figure 3.2).

Delivery of the fetus during cardiac arrest will reduce the oxygen demands on the mother and also increase the venous return to the heart making it more possible that resuscitation will be successful.

o Changes in lung function

Mothers become hypoxic more readily because of a 20% decrease in their functional residual capacity due to the pressure from the gravid uterus on the diaphragm and the lungs i.e. there is less of a reservoir of oxygen in the lungs so they become hypoxic much more quickly. This is exacerbated by a 20% increase in their resting oxygen demand due to servicing the needs of the fetus and uterus. These changes make it difficult to provide enough oxygen delivery using CPR to resuscitate a near-term pregnant mother.

o Effectiveness of ventilation

In the later part of pregnancy it becomes increasingly difficult to provide effective ventilation breaths during CPR due to the increased weight of the abdominal contents and the breasts. In addition the oesophageal sphincter is more relaxed so the ease of introducing air into the stomach is increased. Passive regurgitation of stomach contents is a very real concern as these are greater in volume and more acidic in pregnancy so more likely to lead to damaging acid aspiration into the lungs. It is imperative that experienced staff provide a protected airway and adequate ventilation via an ET tube as quickly as possible following cardiac arrest.

Figure 4.2. Manual displacement of the uterus to the left

PERIARREST / PERIMORTEM CAESAREAN SECTION TO IMPROVE CHANCES OF MATERNAL SURVIVAL

The Resuscitation Council for special situations has recommended that prompt caesarean delivery should be considered as a resuscitative procedure for cardiac arrest in near-term pregnancy. Delivery of the fetus will obviate the effects of aortocaval compression and significantly improve the chance for maternal resuscitation. This will reduce maternal oxygen consumption, increase venous return, make ventilation easier and allow CPR in the supine position.

When to do it

Evidence from literature and review of maternal and fetal physiology suggests that a caesarean delivery should begin within four minutes of cardiac arrest and delivery be accomplished by five minutes. Pregnant women develop anoxia faster than non-pregnant women and can suffer irreversible brain damage within four to six minutes after cardiac arrest.

When a mother in the second half of her pregnancy suffers a cardiac arrest, immediate resuscitation should commence. Should immediate resuscitation fail, every attempt should be made to start the caesarean section by four minutes and deliver the infant by five minutes. CPR must be continued throughout the caesarean section and afterwards, as this increases the chances of a successful neonatal and maternal outcome.

Where to do it

Moving the mother to an operating theatre (e.g. from a labour room or accident and emergency department) is not necessary. Diathermy will not be needed initially, as there is little blood loss if no cardiac output. If the mother is successfully resuscitated, she can be moved to theatre to complete the operation.

How to do it

A limited amount of equipment is required in this situation. Sterile preparation and drapes are unlikely to improve survival. A surgical knife and forceps should be sufficient to effect delivery of the baby.

There are no recommendations regarding the surgical approach for caesarean section but there is no doubt that the classical approach is aided by the natural diastasis of recti abdomini that occurs in late pregnancy and a bloodless field in this clinical situation. It is accepted, however, that operators should use the technique with which they are most comfortable, and in the current context most obstetricians can deliver a baby via a routine approach in less than a minute.

Consider open cardiac massage in the context of Caesarean section when the abdomen is already open and the heart can be reached relatively easily through the diaphragm.
It is important that an anaesthetist is in attendance at the earliest opportunity. They should provide a protected airway, ensure continuity of effective chest compressions and adequate ventilation breaths as well as helping to determine and treat any underlying cause (4 H's and 4 T's)

Should resuscitation be successful and the mother regain a cardiac output, appropriate sedation/ general anaesthetic needs to be administered to provide amnesia and pain relief. If resuscitation is successful the mother should be moved to a theatre to complete the operation.

Fetal outcome

Timing of delivery is also important for the survival of the infant and its normal neurological development. From discussion so far, there is no doubt that uterine evacuation is an important step during maternal resuscitation. However, there seems to be reluctance among obstetricians to perform peri-arrest caesarean sections. Concerns include worries about neurological damage to the delivered infant. In a comprehensive review of postmortem caesarean deliveries between 1900 and 1985 by Katz *et al.*, 70% (42/61) of infants delivered within five minutes survived and all developed normally. However, only 13% (8/61) of those delivered at 10 minutes and 12% (7/61) of infants delivered at 15 minutes survived. One infant in both of these groups of later survivors had neurological sequelae.

While the optimal interval from arrest to delivery is five minutes, there are case reports of intact infant survival after more than 20 minutes of maternal cardiac arrest. Review of postmortem caesarean section, as reported in Confidential Enquiries over the past 25 years, shows that there was no reported case where survival beyond the early neonatal period was accompanied by neurological disability. Evidence suggests that if the fetus survives the neonatal period then the chances of normal development are good.

Make decision to abandon CPR if unsuccessful

Do not abandon CPR if rhythm continues as VF/VT. A decision to abandon CPR should only be made after discussion with the consultant obstetrician and senior clinicians.

Medico-legal issues

No doctor has been found liable for performing a postmortem caesarean section. Theoretically, liability may concern either criminal or civil wrongdoing. Operating without consent may be argued as battery if the mother is successfully resuscitated. However, the doctrine of emergency exception would be applied because a delay in treatment could cause harm. The second criminal offence could be 'mutilation of corpse'. An operation performed to save the infant would not be wrongful, because there would be no criminal intent. The unanimous consensus of the literature is that a civil suit for performing perimortem caesarean is very unlikely to succeed.

Communication and teamwork

Wherever possible, have senior input from the obstetric, anaesthetic and midwifery professions. Ensure that the family is looked after and kept informed. Document timings and interventions accurately. If the mother dies, you will need to inform the coroner and the GP.

Logistics

Recruit as many staff as possible. You will need an individual responsible for each of the following:

- recording events and management
- communication
- runner/porter/transport.

Suggested Further Reading

Katz VL, Dotters DJ, Droegemueller W. Perimortem cesarean delivery. *Obstet Gynecol* 1986;68:571-6

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