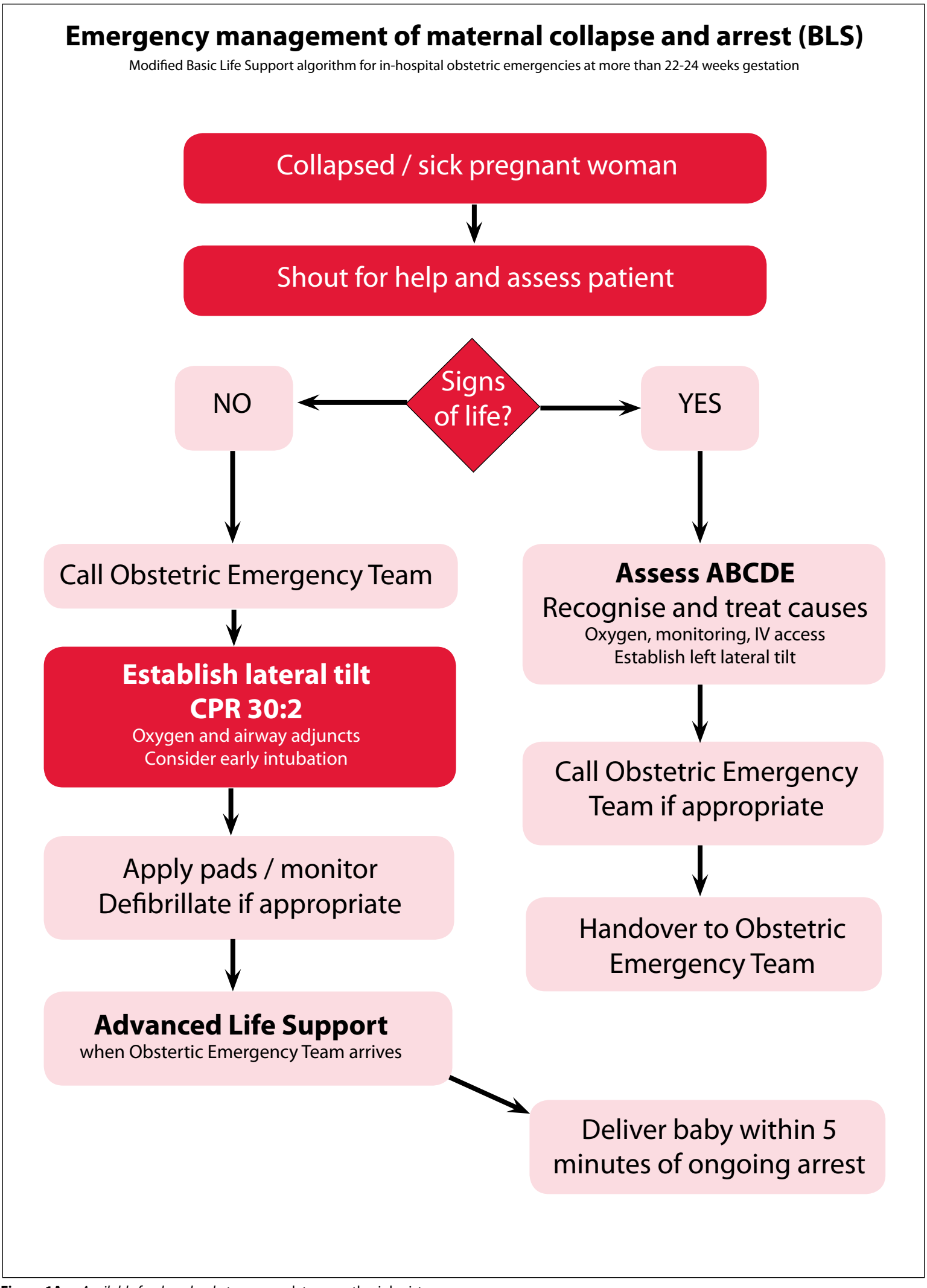

Figure 1A. *Available for download at*: www.update.anaesthesiologists.org

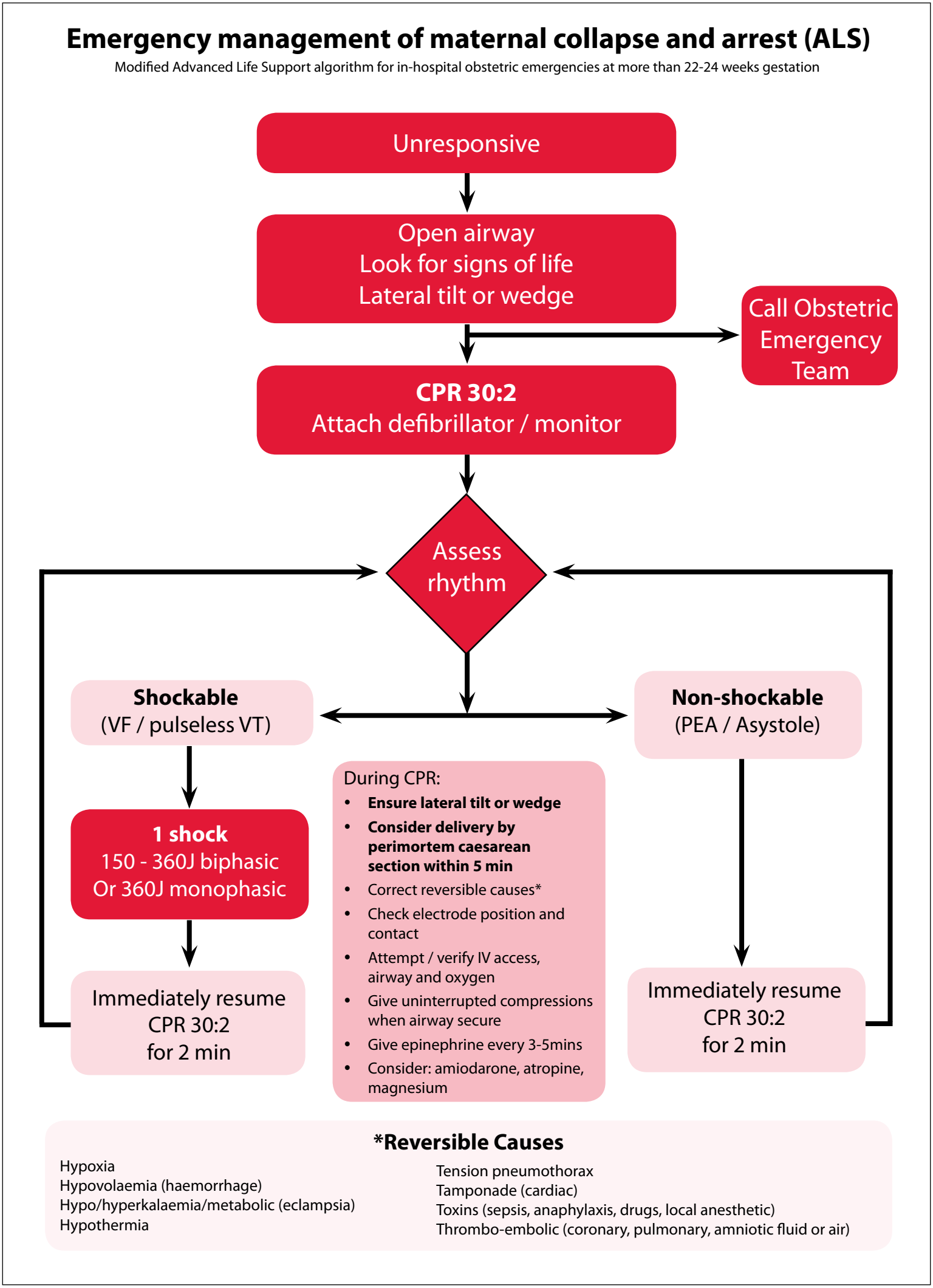

Figure 1B. *Available for download at*: www.update.anaesthesiologists.org

Update in
Anaesthesia

Emergency management of maternal collapse and arrest

Richard Kaye
Correspondence Email: richardkaye@nhs.net

Summary

The cause of maternal collapse and arrest is not always immediately apparent.

A generic approach based on Basic and Advanced Adult Life Support is recommended.

Key modifications to these algorithms are required in pregnancy. These include early intubation and the use of lateral tilt or uterine displacement.

If cardiopulmonary resuscitation is unsuccessful, delivery of the baby by perimortem caesarean section should be accomplished within 5 minutes.

Senior multidisciplinary help should be summoned immediately by defined emergency pathways.

INTRODUCTION

Maternal collapse is a spectrum of clinical presentations from an uncomplicated faint to sudden unexpected cardiac arrest in a term mother.

Around two-thirds of pregnancy-related deaths occur during childbirth or in the immediate postpartum period.[1] The commonest causes of worldwide maternal mortality are shown in Table 1, although it should be noted that there is widespread regional variation.

Less common causes include pulmonary or amniotic fluid embolism, cardiovascular disease, trauma and problems related to anaesthesia. Importantly the reason for the collapse may not initially be obvious, therefore a generic approach to resuscitation may be helpful, and this can be augmented by specific treatments as the diagnosis becomes apparent.

RESUSCITATION DURING PREGNANCY

Prior to 22-24 weeks gestation, resuscitation of a collapsed pregnant woman follows the European Resuscitation Council Basic and Advanced Life Support algorithms (BLS and ALS, see *Update* 22, 2007). After this gestation, resuscitation is complicated by the progressively significant maternal anatomical and physiological changes discussed in this article.

Whilst the algorithms and the ABC (airway, breathing, circulation) approach remain the basis of cardiopulmonary resuscitation, modifications are required in this group. Sample obstetric arrest algorithms are shown in Figures 1 and 2.

COMMENTARY ON ALGORITHMS

A - Airway

Prompt and effective airway management is critical to successful resuscitation. Efforts are directed at early intubation of the trachea, as it protects from aspiration of stomach contents and facilitates effective ventilation of the mother. Tracheal intubation should be considered early in resuscitation, although attempts must not be at the expense of oxygen delivery. In the face of respiratory arrest, simple airway manoeuvres and positive pressure mask ventilation with cricoid pressure should be started until intubation can be achieved. Repeated attempts at intubation may lead to trauma and hypoxia, worsening an already grave situation.

The increased rate of difficult or failed intubation in obstetric patients is multi-factorial. Proposed factors include a reduction in training and expertise due to the increasing use of regional techniques and situational stress. The presence of large breasts, obesity and oedema of the soft tissues and airway may further complicate airway management.

Difficult airway equipment, in a well-organised trolley, should be available in clinical areas and staff should be trained in its use. Gum elastic bougies, alternative laryngoscopes such as the 'polio blade' (Figure 3), intubating laryngeal mask airways (ILMAs) and advanced fibre-optic devices may improve success, but should not delay ventilation by other means. In a 'cannot intubate, cannot ventilate' situation, emergency cricothyroidotomy may be required (see page 39).

Table 1. *Leading global causes of direct maternal death (2000)*[1]

Cause	Number of maternal deaths	% of all direct deaths
Haemorrhage	132 000	28
Infection	79 000	16
Unsafe abortion	69 000	15
Eclampsia / HELLP syndrome	63 000	13
Obstructed labour	42 000	9

Richard Kaye
Specialist Registrar in Anaesthesia
South West Peninsula Deanery
UK

Table 2. *Factors affecting airway management*[1,2]

High reported difficult intubation rate (1:250)
Worsened by obesity and oedema (including larynx)
Increased aspiration risk
Increased intragastric pressure, reduced oesophageal tone and gastric motility delayed

Figure 3. *Polio laryngoscope blade and short laryngoscope handle*

B - Breathing

Table 3. *Factors affecting breathing (ventilatory) management*[3]

Higher ventilatory requirements
Decreased functional residual capacity (FRC) by 10-15%
Increase in basal oxygen requirements by 20-30%
Decreased chest compliance due to raised abdominal pressure

A combination of increased oxygen requirements and reduced ventilatory capacity results in rapid hypoxia once normal breathing ceases. The diaphragm is displaced upwards by the gravid uterus and exacerbates the difficulties in achieving effective positive pressure ventilation. Whilst an endotracheal tube allows high positive pressures to be employed, this may have a further deleterious effect on the cardiac output from chest compressions. This is improved following perimortem caesarean section (see below).

Ventilation should follow Adult Life Support guidelines, with 100% oxygen if available, and become uninterrupted following intubation.

C - Circulation

Both blood volume and basal cardiac output increase dramatically from the first trimester, with around 25% of cardiac output supplying the utero-placental circulation at term. During cardiac arrest, in non-pregnant subjects, closed chest compressions provide up to 30% of normal cardiac output.[1] In pregnancy, the effect of aorto-caval compression by the bulky uterus in the supine position is likely to worsen this considerably. For this reason, it is imperative to mechanically displace the uterus leftwards from the midline to reduce this effect. The ideal full left lateral position is not compatible with cardiopulmonary resuscitation and so a compromise must be reached. Many authorities advocate a tilt of up to 30° by rolling the patient or placing a wedge under the right side. Beyond this, chest compressions are not effective.[1] Alternatively, manual leftwards displacement of the uterus using external pressure can be employed.

Table 4. *Factors affecting circulatory management*[3]

Anatomical
Mediastinum displaced upwards in chest
Aortocaval compression by gravid uterus when supine
Physiological
Increased cardiac output at rest (around 40-50%)
Increased blood volume (up to 60%)

Circulatory life support should generally follow standard guidelines, with large bore IV access, use of epinephrine, atropine, defibrillation as appropriate and identification and treatment of the underlying cause. Exclusion of the four 'H's and the four 'T's in the ALS algorithm may help (Figure 2).

Perimortem caesarean section

It has become clear that cardio-pulmonary resuscitation remains significantly impaired by the gravid uterus after 22-24 weeks gestation, despite the above management. Accordingly, surgical evacuation of the uterus has preceded many successful resuscitation attempts. Therefore immediate delivery by perimortem caesarean section is strongly recommended to begin within 4 minutes of cardiac arrest if no spontaneous circulation has been restored, aiming for delivery within 60 seconds. The indications for this are shown in Table 5. The logistics of this are challenging, although arguably it is unjustifiable to move the patient to an operating theatre prior to the procedure. A simple kit of gloves, scalpel and swabs is potentially life saving and should form part of a readily accessible emergency obstetric trolley.

If unknown, estimation of gestational age should be made clinically by observation and palpation. Intervention should not be delayed for formal uterine or foetal assessment.

Table 5. *Indications for perimortem caesarean section*

- No spontaneous maternal circulation at 4 minutes despite ongoing cardiopulmonary resuscitation
- Estimated gestational age > 22 weeks
- Skilled person available to perform procedure
- Resources to allow post-operative care of mother (and ideally child, although of secondary importance)

Whilst primarily a life-saving procedure for the mother, infants appear to have the best chance of survival when delivered within 5 minutes of maternal arrest (although some reports show survival up to 30 minutes[1] and perimortem caesarean section should still be considered after prolonged resuscitative efforts). The recommendation for performing perimortem caesarean section within 4 minutes of arrest was made by the American Heart Association in 1986. Following this, a review of cases to 2004 suggests that early delivery of the infant in cardiac arrest is associated with much improved outcomes for both mother and child (including neurologically), and certainly does not worsen the situation.[1]

Multidisciplinary team involvement

Effective management of obstetric emergencies relies heavily on the skills and support of several individuals and services (Table 6).

Table 6. *Services involved in effective obstetric emergency plan*

- Obstetricians
- Midwives
- Anaesthetist
- Critical care
- Haematology
- Ancillary (theatre staff, porters etc.)

Adequate planning, preparation and rehearsal of emergency drills are crucial to this process. Many hospitals will have protocols and activation pathways to ensure that these services are rapidly engaged in the event of an emergency. Daily tasks involve checking of equipment, drugs and communication systems. Long term tasks involve training, audit, service development, case review and risk management.

Thorough records should be kept throughout and following the resuscitation, noting times of drugs, decisions, interventions and transfers.

Post resuscitation care

Following successful resuscitation, meticulous attention must be paid to ongoing support and treatment of the mother, ideally in a high dependency or intensive care environment. Less immediate complications of obstetric emergencies, such as myocardial damage from post-partum haemorrhage,[1] renal failure and pulmonary thrombo-embolic disease,[2] may be underestimated contributors to mortality and morbidity.

It is good practice that senior staff members take responsibility for informing the family of key progress and outcomes throughout. Additionally, a team debrief should be carried out whether the resuscitation is successful or not.

REFERENCES AND FURTHER READING

1. The World Health Report 2005: Make every mother and child count. World Health Organisation. Geneva.
2. Barnardo P, Jenkins J. Failed tracheal intubation in obstetrics: a 6-year review in a UK region. *Anaesthesia* 2000; **55**: 685 - 94.
3. The Merck Manual for healthcare professionals. Accessed 20 Feb 2010. Available at www.merck.com/mmpe
4. Sanders A, Meislin H, Ewy G. The physiology of cardiopulmonary resuscitation. *JAMA* 1984; **252**: 3283-6.
5. Rees , Willis B. Resuscitation in late pregnancy. *Anaesthesia* 1988; **43**: 347-9.
6. Capobianco G, Balata A, Mannazzu M, et al. Perimortem cesarean delivery 30 minutes after a laboring patient jumped from a fourth-floor window: baby survives and is normal at age 4 years. *Am J Obstet Gynecol* 2008; **198**: e15-6.
7. Katz V, Balderston M, DeFreest M. Perimortem cesarian delivery: Were our assumptions correct? *Am J Obstet Gynecol* 2005; **192**: 1916-21.
8. Karpati P, Rossignol M, Pirot M, Cholley B, et al. High incidence of myocardial ischaemia during postpartum haemorrhage. *Anesthesiology* 2004; **100**: 30-6.
9. Kuklina E, Meikle S, Jamieson D, et al. Severe obstetric morbidity in the United States: 1998-2005. *Obstet Gynecol* 2009; **113**: 293-9.