RECENT GUIDELINES IN THE MANAGEMENT OF MATERNAL CARDIAC ARREST

Introduction

Management of cardiac arrest in pregnancy is an extremely challenging task in emergency cardiovascular care as it involves two lives, the mother and the foetus.The best hope of fetal survival is maternal survival. Out of hospital cardiac arrest management yields poor outcome[1]. The optimal management requires the participation of teams which would include the obstetrical team, the anaesthesia and the neonatal team as well as the equipment for a peri-mortem caesarean section and neonatal resuscitation.

Cardiac disease is the number one cause of maternal mortality in U.K[2]. Emergency resuscitation protocol for the pregnant patient in cardiopulmonary arrest is essential for all the emergency departments. Understanding the physiological changes of pregnancy, evidence on maternal cardiac arrest resuscitation approaches are important steps to adapt maternal cardiac arrest resuscitation protocols.

Prevention of cardiac Arrest

The following interventions are needed for treating the critically ill pregnant patient [Class I, Level C, AHA level of evidence (LOE)]:

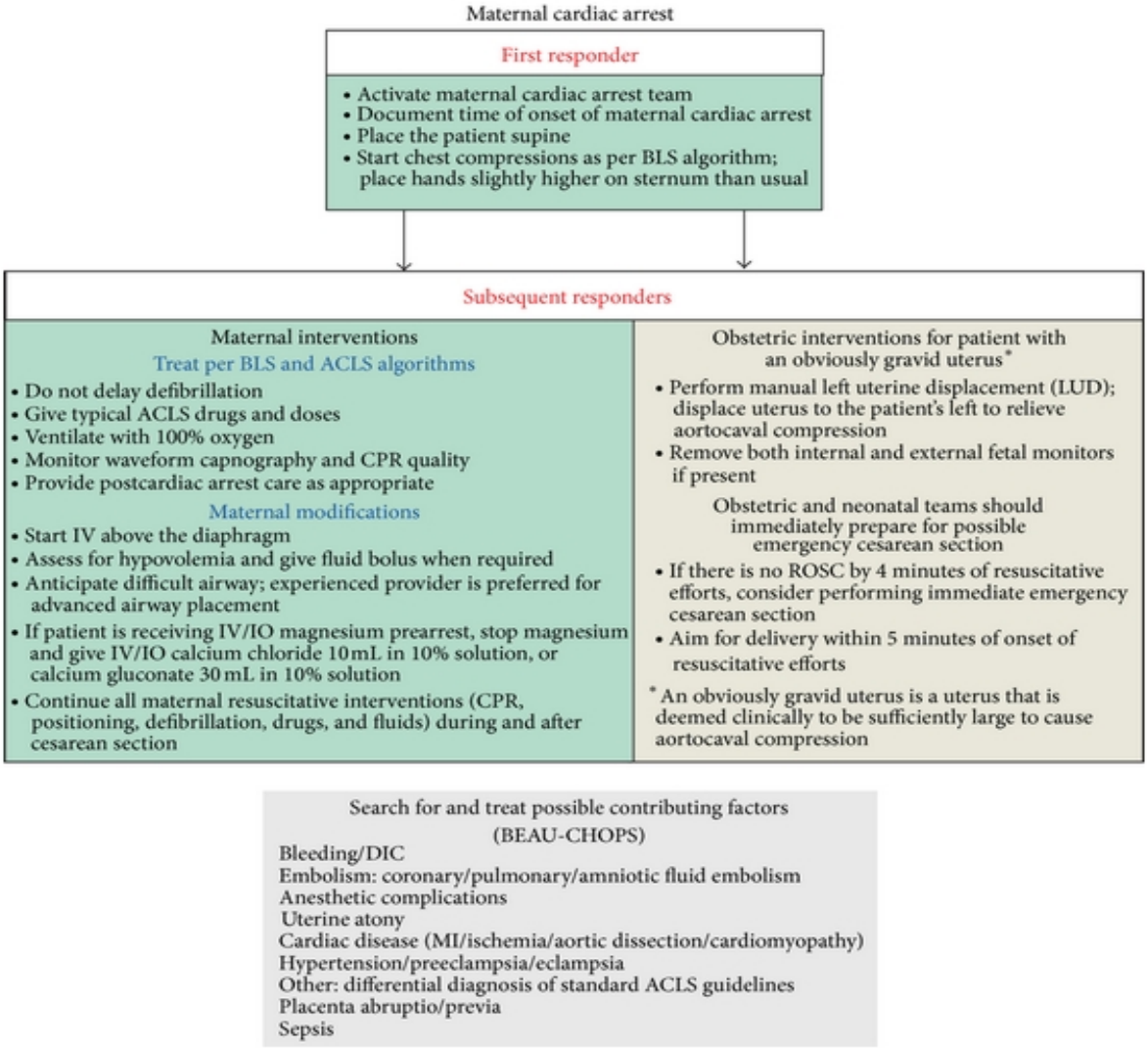
- Place the patient in full left-lateral position to relieve possible compression of the inferior vena cava, causing reduced venous return and hypotension[5,6]
- Give 100% oxygen.
- intravenous (IV) access above the diaphragm
- Assess for hypotension: Maternal hypotension can result in reduced placental perfusion[7,8,9,10] and warrants therapy when systolic blood pressure <100 mm Hg or <80% of baseline.

- Consider reversible causes of critical illness and treat conditions that may contribute to clinical deterioration as early as possible.

Treatment of Reversible Causes

The same reversible causes of cardiac arrest that occur in nonpregnant women can occur during pregnancy. Providers should be familiar to identify common and reversible causes of cardiac arrest in pregnancy. The AHA guideline algorithm on maternal cardiac arrest (Figure 1) can be useful for these additional etiologic considerations.

Figure 1.



The leading causes of death during pregnancy based onCentre for Maternal and ChildEnquiries (CMACE), include cardiac disease, sepsis, preeclampsia/ Eclampsia, thrombosis/thromboembolism and amniotic fluid embolism.

Cardiac Disease

Cardiac disease is the primary cause of maternal mortality. The number of deaths from cardiac disease was 2.27 per 100,000 pregnancies, whereas the number of deaths from thrombosis and thromboembolism was 1.94 per100, 000 pregnancies. The most common causes of maternal death from cardiac disease are myocardial infarction, followed by aortic dissection. Because fibrinolytics are relatively contraindicated in pregnancy, Percutaneous Coronary Intervention (PCI) is the reperfusion strategy of choice for ST-elevation myocardial infarction. Congenital heart disease and pulmonary hypertension are the third most common cause of maternal cardiac deaths[11].

Magnesium Sulfate Toxicity

Cardiac effects - ECG interval changes (prolonged PR, QRS and QT intervals) at magnesium levels of 2.5–5mmol/L. AV nodal conduction block, bradycardia, hypotension and cardiac arrest at levels of 6–10 mmol/L.
Neurological effects - loss of tendon reflexes, sedation, severe
Muscular weakness and respiratory depression are seen at levels of 4–5 mmol/L. Other signs of magnesium toxicity include gastrointestinal symptoms (nausea and vomiting), skin changes (flushing), and electrolyte/fluid abnormalities (hypophosphatemia, hyperosmolar dehydration). Empirical calcium administration may be lifesaving in these cases[12,13,14].

Preeclampsia/Eclampsia

Occurs after the 20th week of gestation and results in severe hypertension and subsequent diffuse organ-system failure. If untreated, maternal and fetal morbidityand mortality may result.

Pulmonary Embolism

Pregnant women in cardiac arrest with suspected Pulmonary Embolism (PE) should be treated in accordance with the ACLS guidelines (Part 12.5: “Cardiac Arrest AssociatedWith Pulmonary Embolism”).

Amniotic Fluid Embolism

Cardiopulmonary bypass may be successful in life-threatening amniotic fluid embolism during labor and delivery [15]. The use of peri-mortem cesarean section has resulted in improved maternal and neonatal survival[16].

Anesthetic Complications

During regional anesthesia, maternal morbidity and mortality results from spinal shock. During general anesthesia induction may lead to loss of airway control or pulmonary aspiration and hypoventilation or airway obstruction during emergence, leading to cardiac arrest[17-22].

Emergency Cesarean Section in maternal cardiac arrest NOT immediately reversed by BLS and ACLS

As soon as cardiac arrest is identified, resuscitation team leaders should activate the protocol for an emergency cesarean delivery. When a large gravid uterus is enough to cause maternal hemodynamic changes due to aorto-caval compression, emergency cesarean section should be considered, regardless of fetal viability.

Gravid Uterus with the Potential to Cause Aorto-caval Compression

A study found that maternal aorto-caval compression can occur for singleton pregnancies at ≥20 weeks of gestational age[23]. Fundal height is often used to estimate gestational agewhich is approximately at the level of the umbilicus by 20 weeks [24]. Fundal height may be altered by other factors such as abdominal distention and increased body mass index.Therefore fundal height may be a poor predictor of gestational age. If the fundus extends above the level of the umbilicus, aorto-caval compression can occur, and emergency cesarean section should be performed regardless of gestational age[25]. Two case reports of maternal cardiac arrest in early pregnancy of 13 to 15 weeks, resuscitation was done without an emergency cesarean section and the pregnancy continued to successful delivery of a live infant[26,27]. Thus the decision for an emergency cesarean section depends on whether or not the gravid uterus is thought to interfere with maternal hemodynamics. Education and training are essential to managing maternal cardiac arrest.Understandingthe physiological changes of pregnancy, the direct and indirect evidence on maternal cardiac arrest

resuscitation approaches and how both of them have contributed to our current resuscitation guidelines are important.

Current Science and Guidelines:

Five studies in the area of maternal cardiac arrest reported several important findings.

1. The transthoracic impedance does not change with pregnancy, and, therefore, current defibrillation energy recommendations are the same in both the pregnant and non-pregnant patient[28,29].
2. Although chest compressions are feasible in the tilted position[30], the maximum possible resuscitative force with chest compressions declines as the angle of inclination increases.

Study of case series on Peri-Mortem Caesarean sections (PMCS) reported that very few PMCS (8/38) were performed within the recommended 4-5-minute time-frame after the onset of maternal cardiac arrest; despite these timedelays for PMCS, positive neonatal and maternal outcomeswere still possible.Several women had a sudden and dramatic improvement in their hemodynamics, with a return of pulse and blood pressure immediately after PMCS & neonates had higher survival outcomes [31].

American Heart Association 2010 Guidelines:

The recent AmericanHeart Association (AHA) Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care deals a chapter specifically dedicated to maternal resuscitation [32]. First evidence-based algorithm for the management of cardiac arrest during pregnancy (Figure 1) is the basis for emergency responses during a maternal cardiac arrestfor all providers. Highlights of these guidelines include

1. Coordinate multiple teams during and after the cardiac arrest.
2. Do not delay usual measures such as defibrillation and the administration of medications.
3. Perform aorto-caval decompression manoeuvres
    a. Preferably manual leftuterine displacement (LUD)(Figures 2 and 3)

Figure 2:
Left uterine displacement using 2-handed technique

Figure 3:
Left uterine displacement using 1-handed technique

b. Human wedge: By tilting the patient on the bent knees of a kneeling rescuer, is useful in uterine displacement.

4. Consider the airway difficult, and the most experienced provider should manage the airway.
5. Intravenous access is important but should be placed above the diaphragm.
6. Dedicated timer to document when 4 minutes after the onset of a maternal cardiac arrest have elapsed, and the need for a PMCS to be performed within 5minutes of a maternal cardiac arrest if there is no return of spontaneous circulation (ROSC) by 4minutes with the usual resuscitation measures.
7. Consider an expanded aetiology list for the cause of the cardiac arrest; BEAU-CHOPS can be used as a usual mnemonic

The ABCs of Maternal Physiology during Cardiac Arrest:

The optimal management of a cardiac arrest in pregnancy depends on the physiological changes of pregnancy, airway (A), breathing (B), and circulation(C)as they relate to resuscitation[33].

1. Airway

Difficult airway to be anticipated in pregnancy and failed intubations may occur in non-arrested, undergoing general anaesthesia, with an incidence of approximately 1 : 300. During pregnancy physiological changes in the upper airway include hyperemia, hypersecretion, and edema[34].These changes increase

the friability of the mucosa and may result in impaired visualization, increased bleeding and smaller airway recommending a smaller endotracheal tube.

Airway modifications include the following

a) Good basic life support can optimize ventilations,chest excursion, and oxygenation
b) The most experienced person should secure and manage the advanced airway during a maternal cardiac arrest.

2. Breathing

During pregnancy there is an increased risk of rapid desaturation due to reduced oxygen reserve resulting from an increase in oxygen consumption[35] coupled with a reduced functional residual capacity. There is also an increased intra-pulmonary shunting leading to ventilation-perfusion mismatch which will be poorly tolerated in the pregnant patient. Thus, during a cardiac arrest, and especially prior to intubation attempts, oxygenation should be optimized in the pregnant patient. The team should also be aware of the risk of uterine vasoconstriction and foetal hypoxemia as a result of over ventilation with maternal respiratory alkalosis. During pregnancy, the elevated diaphragm may result in lower ventilation volumes and there is risk of aspiration during maternal cardiac arrest due to the reduced lower oesophageal sphincter competency[36]. The routine use of cricoid pressure is no longer recommended in the American Heart Association (AHA) Resuscitation guidelines as it may impede laryngoscopy and ventilation and may not prevent aspiration. The main points to understand about breathing modifications include the following.

1. Oxygenate well, monitor, and avoid desaturation.
2. Avoid respiratory alkalosis.
3. Consider adjusting ventilation volumes down.
4. Be aware of the risk of aspiration.

3. Circulation.

The major circulation concern during amaternal cardiac arrest is the possibility of aorto-caval compression caused by the gravid uterus resulting in a reduced preload and stroke volume. By 20 weeks of gestational age, aorto-caval compression is likely to occur. However, even at 12 weeks gestational age, mechanical venous effects of the gravid uterus can be observed. Hemodynamic

optimization during maternal cardiac arrest obviously requires effective aorto-caval decompression with a manual Left Uterine Displacement (LUD)(fig. 2&3 above). Manual LUD allows thepatient to remain supine which improves airway access, easeof defibrillation and IV access and enables high quality chest compressionsessential to maximizethe chance of a successful resuscitation.

Perimortem Caesarean Section:

Anoxic brain injury occurs within the 4 minutes after a cardiac arrest, if team members are unable to achieve Return Of Spontaneous Circulation (ROSC) by 4 minutes in a gravid patient of >20 weeks gestational age, a decision to perform a PMCS should bemade. A PMCS allows for complete aorto-caval decompression, once the uterus is evacuated. PMCS should be initiated 4 minutes after the onsetof the maternal cardiac arrest, with the aim of delivery by 5 minutes after-onset, if ROSC is not achieved. In order to achieve this goal of delivery within 5 minutes, the team should prepare for a PMCS once the arrest is documented and the PMCS should be performed at the location where the arrest occurs[37].At >24 to 25 weeks of gestation, the best survival rate for the infant occurs when the infant is delivered no more than 5 minutes after the mother's heart stops beating. At gestational ages ≥30 weeks, infant survival has been seen even when delivery occurred after 5 minutes from onset of maternal cardiac arrest. The neonatal team and neonatal resuscitationequipment are on standby to receive the infant once delivered.

Post-arrest Care:

Post–cardiac arrest care has significantly reduced early mortality caused by hemodynamic instability and later morbidity and mortality from multiorgan failure and brain injury.The post-arrest pregnant patientshould be placed at 90^0left lateral tilt to relieve possible aorto-caval compression. The use of therapeutic hypothermia during pregnancy is a relative contraindication and there have been reports of its successful use in pregnancy. The use of therapeutic hypothermia in the bleeding or post-PMCS patient relates to the risk of impairing coagulation and alert to monitor for foetal bradycardia.

Conclusion

The management of maternal cardiac arrest is very complicated and maternal resuscitation is based on its unique physiological differences, aetiology

and implementation factors. These need to be considered in advance for a better maternal and neonatal outcome.

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