

# Cardiac arrest in pregnancy: best practices are needed

## Paragem cardíaca na gravidez: a importância das boas práticas

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### Abstract

Cardiac arrest in pregnancy is uncommon and carries a high morbidity and mortality for the mother and the fetus. This article provides an updated review on the causes of cardiac arrest and the physiologic changes that occur during pregnancy. A number of modifications to standard cardiopulmonary resuscitation are presented as well as the relevance of emergency drills to improve the staff's clinical skills when managing these situations.

**Keywords:** Cardiac arrest; Pregnancy; Cardiopulmonary resuscitation; Emergency skills training.

### INTRODUCTION

Cardiac arrest in pregnancy is a rare event, occurring in 1:30,000 births<sup>1</sup>. Although uncommon, it is associated with a high maternal and fetal mortality rate. A multicenter study<sup>2</sup> reported the outcomes of 55 women who experienced cardiac arrest during pregnancy, including 12 who underwent perimortem cesarean delivery: only 15% (8/55) survived. Therefore, although pregnant women are younger than the usual cardiac arrest patient, their survival rates are the poorest. Furthermore, during an attempt to resuscitate a pregnant woman, providers have 2 potential patients: the mother and the fetus to whom the best hope is maternal recovery. During a time-period of five minutes, caregivers are expected to diagnose a maternal cardiac arrest, initiate cardiopulmonary resuscitation (CPR) and deliver the fetus by cesarean section if the maternal cardiac output is not immediately restored. So, providing high quality medical care quickly and efficiently to the pregnant patient who suffers cardiac arrest is a complex process, which requires previous awareness and training. This review is intended to update the readers' knowledge regarding cardiac arrest in pregnancy, and includes a brief comment on its etiology

and pathophysiology, followed by the specifications of advanced cardiac life support during pregnancy and the importance of implementing emergency drills in order to prepare doctors for this emergency.

### WHAT CAUSES CARDIAC ARREST IN PREGNANCY?

There is a wide list regarding the causes of cardiac arrest during pregnancy (Table I). In the United States and the United Kingdom the most common causes include pulmonary embolism (29%), hemorrhage (17%), sepsis (13%), peripartum cardiomyopathy (8%), stroke (5%), preeclampsia-eclampsia (2,8%) and complications related to anesthesia (eg, difficult intubation, local anesthetic toxicity, aspiration) (2%)<sup>3</sup>. In Portugal, the causes for cardiac arrest are similar and hemorrhage and pregnancy-induced hypertension were responsible for 50% of maternal deaths of known cause<sup>4</sup>. Therefore, in order to provide an adequate treatment, it is crucial to recognize the reversible causes (Table II). Occasionally, the etiology of cardiac arrest during pregnancy may be multifactorial making the diagnosis and management more difficult.

### PATHOPHYSIOLOGY OF CARDIAC ARREST IN PREGNANCY AND MANAGEMENT IMPLICATIONS

During pregnancy there are physiologic changes that

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**TABLE I. CAUSES OF CARDIAC ARREST IN PREGNANCY<sup>4</sup>**

**Obstetric causes**

Hemorrhage  
 Pregnancy induced hypertension  
 Idiopathic peripartum cardiomyopathy  
 Anesthetic complications (airway related catastrophes, local anesthetic toxicity)  
 Amniotic fluid embolism

**Nonobstetric causes**

Pulmonary embolism  
 Infection/sepsis  
 Stroke  
 Myocardial infarction

can complicate cardiac arrest, mostly aortocaval compression. CPR with closed chest massage in non-pregnant patients results in a maximal cardiac output of approximately 30% of the normal cardiac output<sup>5</sup>. In patients with more than 20 weeks of gestation lying in supine position, the cardiac output is decreased, meaning that despite a well-performed CPR there will be practically no cardiac output.

Women with an advanced pregnancy are also more prone to hypoxemia and acidosis, and have a higher risk of pulmonary aspiration compared to the non-pregnant population. Also a short obese neck and full breasts due to pregnancy may make it difficult to intubate. These risks are increased in multiple gestations and obese women making resuscitation more challenging.

**ADVANCED CARDIAC LIFE SUPPORT GUIDELINES: WHAT IS DIFFERENT IN PREGNANCY?**

The following updated guidelines include several adjustments for pregnant women and take into account the lives of both mother and fetus (Figure 1)<sup>5</sup>.

**Key interventions during pregnancy**

- Call for help;
- Secure the airway;
- If the uterus is above the umbilicus, displace the uterus laterally and to the left;
- Start CPR with chest compression using pregnancy modifications;

**TABLE II. POTENTIALLY TREATABLE CONDITIONS ASSOCIATED WITH CARDIAC ARREST<sup>5</sup>**

**Obstetric causes**

Acidosis  
 Cardiac tamponade  
 Hypothermia  
 Hypovolemia, hemorrhage, anemia  
 Hypoxia  
 Hypomagnesemia

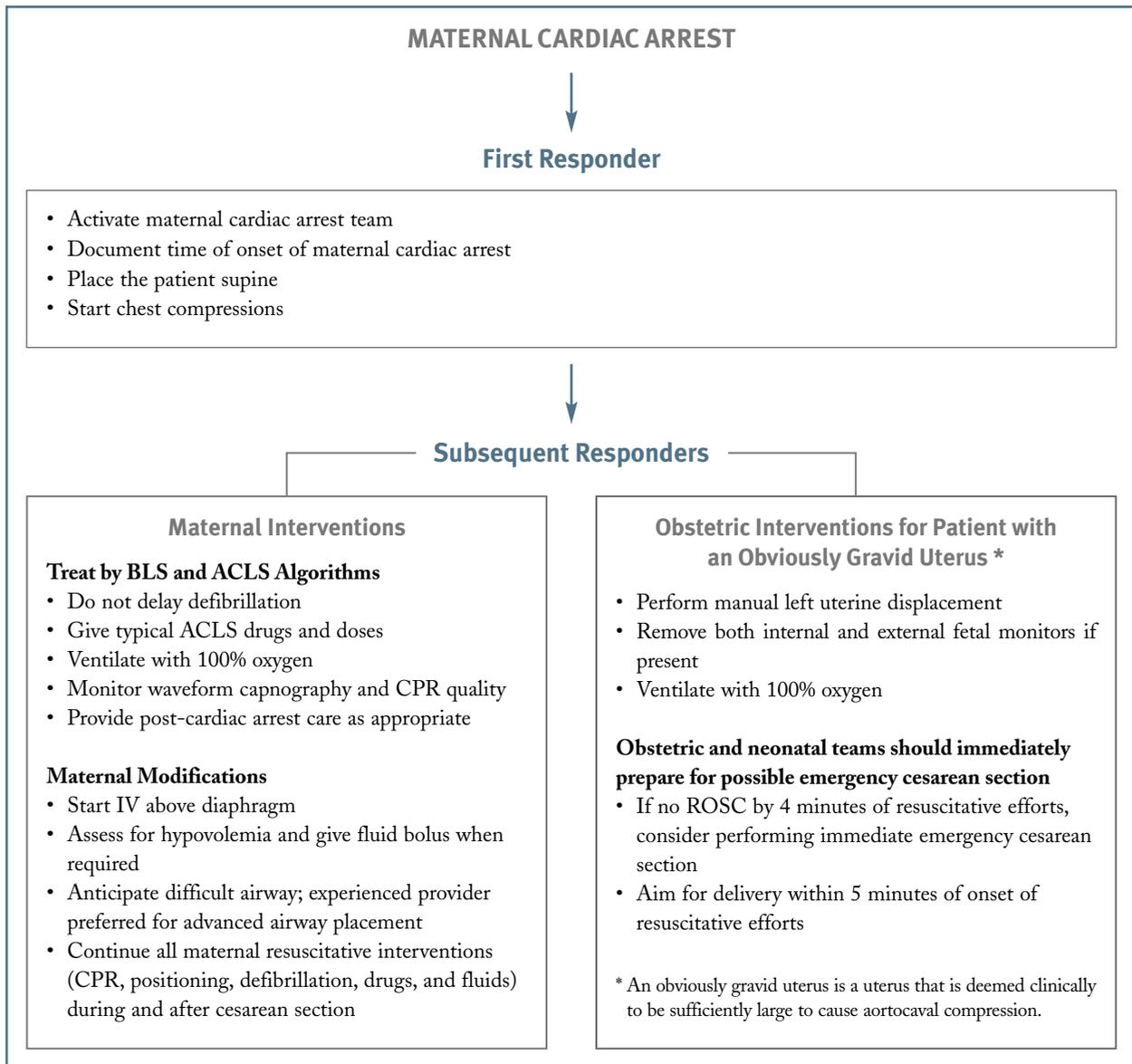
- Consider possible causes of cardiac arrest to ease targeted management;
- Estimate the gestational age of the fetus;
- If the uterus fundus is  $\geq 4$  fingerbreadths above the umbilicus begin perimortem cesarean delivery at the 4<sup>th</sup> minute and complete delivery by the 5<sup>th</sup> minute following cardiac arrest;
- If resuscitation remains unsuccessful at the 15<sup>th</sup> minute initiate direct cardiac massage when appropriate resources and personnel are available.

**Left lateral position**

In the non-pregnant patient the supine position increases the effectiveness of chest compressions. However, in the pregnant patient with a fundal height at or above the umbilicus a left lateral uterine displacement is needed to minimize aortocaval compression, optimize venous return and engender cardiac output during CPR. This can be best achieved by manual uterine displacement to the left by an assistant, by tilting the operating room table or by placing a resuscitation wedge (or rolled towels or blankets) underneath the right hip and lumbar area.

**Airway and breathing**

One of the most important interventions during cardiac arrest includes securing the airway. The pregnant patient is more prone to develop rapid hypoxemia because of decreased functional residual capacity and increased oxygen consumption<sup>3</sup>. Both intubation and bag mask ventilation can be more difficult, since estrogen acts on the connective tissue leading to an increase in interstitial water which results in edema of the respiratory tract, including oral and nasal pharynx, larynx and trachea. Patients with pre-eclampsia/eclampsia have a higher risk due to reduced plasma proteins and marked fluid retention, which worsens the head and neck ede-



**FIGURE 1.** Maternal cardiac arrest algorithm (adapted from 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care). BLS basic life support, ACLS advanced cardiovascular life support, CPR cardiopulmonary resuscitation, ROSC return of spontaneous circulation.

ma. Therefore, some back-up airway procedures such as cricothyrotomy may be required. During the 3<sup>rd</sup> trimester, there is an increased risk of aspiration of the gastric content and the application of continuous cricoid pressure during ventilation and a fast intubation reduce the risk of regurgitation.

### Circulation

Chest compressions are performed in a higher location than in non-pregnant patients, slightly above the

center of the sternum due to elevated diaphragm and abdominal contents<sup>6</sup>. Chest compression should be performed with the patient lying on a hard surface. A compression-ventilation ratio of 30:2 is recommended, including 2 compressions per second, with a minimum of 100 per minute. If incorrectly applied, chest compressions may result in liver laceration, uterine rupture, hemothorax and hemopericardium. Circulation should be evaluated after 2 minutes of chest compressions.

## Defibrillation

Defibrillation may be needed for management of pulseless ventricular tachycardia or fibrillation. In pregnancy, standard defibrillation doses should be used<sup>7</sup>. Fetal monitoring equipment (including internal fetal monitoring equipment) must be removed before delivering the counter shock to prevent electrocution injury to the patient or the caregivers.

## Fetal monitoring

Fetal monitoring is not recommended during resuscitation maneuvers. The status of the mother should always guide the decision making in the resuscitation process. Once the mother becomes hemodynamically stable, fetal monitors can be applied if/when the fetus is viable.

## Delivery

The resuscitation team should consider the need for an emergency hysterotomy (cesarean delivery) as soon as a pregnant woman at > 20 weeks of gestation develops cardiac arrest. The recommendation to perform a perimortem cesarean delivery within 4 minutes of maternal cardiac arrest was introduced in 1986, based on the assumptions that cardiopulmonary resuscitation is ineffective in the 3<sup>rd</sup> trimester due to aortocaval compression, and that fetal and maternal outcomes would be optimized by timely delivery<sup>8</sup>. The best survival rates are achieved when a viable fetus is delivered in less than 5 minutes after the onset of cardiac arrest. Neurologic injury to the mother occurs after the 6<sup>th</sup> minute as a result of cessation of cerebral blood flow. Therefore, if cardiac arrest is not immediately (4-5 minutes) reversed by basic and advanced life support, an emergent cesarean delivery should be performed. However, a recent review by Einav<sup>9</sup> showed a good overall performance of resuscitation and delivery within 10 minutes of arrest concerning maternal and neonatal survival. Either way by delivering the fetus, the uterus is emptied and the venous return and aortic flow are restored. In addition, this allows neonatal resuscitation. Nonetheless, cesarean section might still be necessary if fetal death has occurred.

From a practical point of view, the procedure should be performed by the most skilled obstetrician/doctor<sup>5</sup>. There should be a staff member monitoring time, and reinforcing each 30 seconds. Moving the patient to the operation room should not be attempted, if one hopes to achieve the best outcome. Given the time taken to prepare theatre packs, a cesarean section is probably

best carried out with just a scalpel, with minimal asepsis, and without anesthesia. Broad-spectrum antibiotics should be administered to decrease the risk of postpartum infection. Minimal bleeding is expected due to hypoperfusion. However, extraction of the placenta and closure of the hysterotomy are critical to avoid subsequent hemorrhage once hemodynamic stability is restored. Cardiopulmonary resuscitation, including chest compressions, must be prolonged throughout the operation without interruption until the return of spontaneous circulation, to improve the prognosis for the mother and child<sup>10</sup>. If necessary, transabdominal open cardiac massage can be performed and extracorporeal circulation may be required. Consideration must be given to the availability of appropriate staff and facilities for neonatal care as the neonate (especially if premature) may require extensive resuscitation. As soon as clinical conditions allow, both mother and neonate should be transferred to their respective intensive care units.

## THE IMPORTANCE OF KNOWLEDGE AND EMERGENCY SKILLS TRAINING

The Centre for Maternal and Child Enquiries (CMACE) reports, referring to 2006-2008, have revealed that care was substandard in more than 50% of maternal deaths due to cardiac arrest and that resuscitation skills were “considered poor in an unacceptably high number of cases”<sup>11</sup>. Several studies published on this matter<sup>12,13</sup> have shown a significant lack of knowledge among obstetric care providers about differences in the resuscitation of the pregnant patient. A variety of medical professionals are involved in the resuscitation of these patients and, as cardiac arrest is such a rare occurrence on labor and delivery units, staff members are often unprepared to address this unexpected event. A diminished maternal physiologic reserve usually leads to rapid deterioration of the mother’s condition, while concern for the fetus may distract the caregivers’ attention from the mother.

In 2010, the Joint Commission has transitioned their patient safety goal of recognizing and responding to changes in a patient’s condition to the level of a standard, meaning that hospitals must have a written protocol/process that describes early warning signs of a change or deterioration in a patient’s condition and when to seek assistance<sup>14</sup>. Still, guidelines are readily forgotten. Therefore, assistance to maternal cardiac ar-

rest and perimortem cesarean should be practiced periodically, specifically addressing the guidelines as they stand, and emphasizing the modifications for pregnant patients<sup>12</sup>. The initiation and periodic incorporation of obstetric life support training would allow to debrief staff's approach to the patient, assess occult system errors, offering the opportunity to discuss the logistics and the time required for patient transfer. Through maternal arrest simulations, the obstetrical staff may be able to develop better practices, and hopefully improve the outcomes at the time of maternal cardiac arrest<sup>15</sup>.

## CONCLUSIONS

Cardiac arrest during pregnancy is a rare event. Despite its rarity the management of these situations should not be substandard. Optimal outcomes are dependent on the cause of the arrest, the prompt understanding of the physiological effects of pregnancy on the resuscitative efforts and the application of the latest principles of advanced life support. Beyond 20 weeks of gestation, the standard ABC's of CPR should also include "D" for delivery, when the initial resuscitation is unsuccessful. Hospitals should develop a multidisciplinary team of obstetricians, anesthetists and nursing staff specialized in the care of pregnant patients to respond quickly to cardiac arrest. This requires simulation training, to improve and retain knowledge and skills, and ultimately meliorate maternal and neonatal outcomes.

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