

Derleme

Management of Cardiac Arrest in Pregnancy

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ABSTRACT

Cardiopulmonary arrest, which is seemingly uncommon with an estimated incidence of 1 in 20,000 pregnant women, can occur at any time. Therefore, clinicians should be prepared to respond immediately. Maternal resuscitation is performed with only a few minor adjustments due to the anatomic and physiologic changes of pregnancy. Anesthesiologists, obstetricians and neonatologists should work as a team to ensure appropriate treatment of both mother and newborn. This review article will address the management of cardiac arrest in pregnancy and the use of perimortem cesarean delivery.

Keywords: pregnancy, cardiac arrest, cardiopulmonary resuscitation (CPR)

ÖZ

Gebelikte Kardiyak Arrest Yönetimi

Gebelerde yaklaşık 20.000'de 1 rastlanan kardiyopulmoner arrest, nadir gibi görünse de her an olabilir. Bu nedenle klinisyenler hızla cevap vermeye hazırlıklı olmalıdır. Maternal resüsitasyon, gebeliğin anatomik ve fizyolojik değişikliklerine bağlı çok küçük ayarlamalarla gerçekleştirilir. Anesteziyologlar, obstetrisyenler ve neonatologlar hem anne hem de yenidoğan için uygun tedaviyi sağlamak için takım olarak çalışmalıdırlar. Bu derleme makale, gebelikte kardiyak arrest yönetimini ve perimortem sezaryen kullanımı sunmaktadır.

Anahtar kelimeler: gebelik, kardiyak arrest, kardiyopulmoner resüsitasyon (KPR)

INTRODUCTION

The World Health Organization (WHO) has reported an overall decline in the maternal mortality rate (MMR) from 385 to 216 per 100,000 live births (1990 to 2015). Within the United States and Turkey, based on 2015 data from the WHO, UNICEF, UNFPA, World Bank Group, and the United Nations Population Division, the MMR is 16 and 14 per 100,000 live births, respectively^[1]. Although these data are promising, cardiac arrest in pregnancy occurs more frequently than previously appreciated, and are frequently poorly managed, leading to maternal and fetal morbidity and mortality.

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A number of etiologies can result in maternal cardiac arrest. Direct causes include hemorrhage, hypertensive disorders including preeclampsia, sepsis and amniotic fluid embolus, while indirect causes include cardiac disorders, new onset infections, exacerbation of preexisting chronic diseases or psychiatric disorders^[2].

Basic and advanced life support (BLS, ALS) and resuscitation can be life saving. Maternal cardiac resuscitation should include a few important alterations to accommodate the physiological and anatomical changes of pregnancy (Figure 1). Guidelines from the American Society of Anesthesiology (ASA, 2013) and the consensus statements from the Society for Obstetric Anesthesia and Perinatology (SOAP, 2014) have assessed the available evidence on the management of cardiac arrest during pregnancy^[3,4]. Since dissemination and adherence to these guidelines can be difficult, benefit to the global medical community should optimize maternal and neonatal outcomes.

In this review, we provide a brief overview of the latest evidence and guidance to improve maternal and fetal outcomes following maternal cardiac arrest.

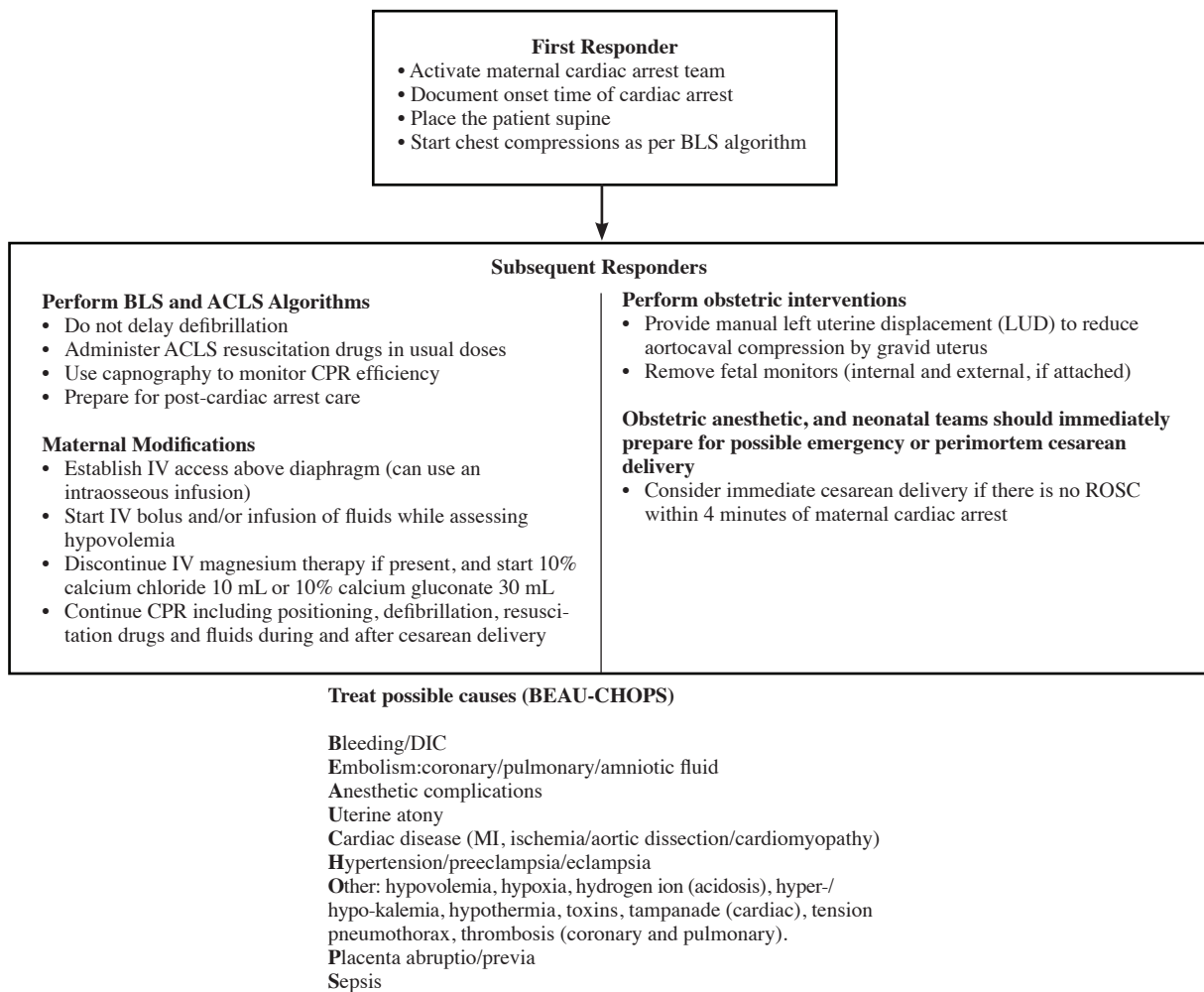


Figure 1. Maternal resuscitation algorithm in the event of cardiac arrest.

1. Basic Life Support (BLS) and Calls for Help

Immediate BLS should be started with high quality chest compressions. Meanwhile, the warning system (Code Blue at many institutions) should be immediately activated for early expert assistance including an obstetrician and neonatologist so an emergent cesarean delivery can be commenced within 4 minutes, if resuscitation has not occurred [5,6]. A defibrillator or automated external defibrillator (AED) and airway management devices should be brought to the room. Once the airway is opened, ventilation should commence with 100% oxygen, if available, or air.

2. Chest Compressions

Chest compressions with a depth of approximately 5

cm and a rate of 100 per minute should be performed with minimal interruptions and allowance of full recoil of the chest wall [7,8]. A brief (< 10 seconds) pause can be used for specific interventions (e.g., use of defibrillator, insertion of advanced airway); a period more than 10 seconds can decrease the chance for return of spontaneous circulation (ROSC) Compressions should be resumed immediately after defibrillation; waiting to perform a pulse check is no longer recommended [7,9]. Immediately prior to and after an endotracheal intubation, compressions should resumed; if intubation fails, 30 chest compressions followed by 2 breaths should be performed in continuous cycles at a rate of 100 compressions/min [8]. The ACLS providers responsible for chest compression should be changed every two minutes to allow effective cardiac compressions [8-12]; because hospital beds are typically not firm, a backboard can be placed un-

der the patient, despite insufficient evidence for their use, with proper attention to avoid delays, interruptions or displacement of lines/tubes.

In the third trimester, hand placement should be in the “normal position” (i.e., with the heel of one hand in the middle of the chest on the lower half of the sternum, and the other hand on top of the first) as with non-pregnant patients; there is currently not enough evidence to support older guidance of moving the hands 2 to 3 cm higher on the sternum during pregnancy [5].

Current guidelines recommend the use of capnography to confirm correct endotracheal tube placement and to assess the efficacy of chest compressions [8]. Capnography indirectly measures cardiac output in an intubated patient with stable ventilation [13]. During resuscitation, rising end-tidal CO₂ levels or sustained levels above 10 mmHg suggest adequacy of chest compressions and may be predictive of ROSC [14-18]. Use of continuous capnography if not readily available, should neither result in interruption of high-quality chest compressions nor delay perimortem delivery in the event of no ROSC.

3. Positioning of Parturient and Left Uterine Displacement (LUD)

Aortocaval compression by the enlarging uterus can occur as early as 12 to 14 weeks of gestation; this can result in increased afterload and decreased preload to the heart. These alterations are particularly present if the uterus is visible or palpable at or above the umbilicus (approximately 20 weeks of gestation) or even earlier if the gestation is associated with multiple fetuses, polyhydramnios, or other conditions [5,19-21].

Optimal chest compressions are provided in the supine position, and use of a firm surface (e.g., a backboard) with manual left uterine displacement (LUD) [5,22-24]. Manual LUD is performed from the left side of the patient with two hands pulling the uterus leftward and upward (toward the ceiling); any downward force can compress the vena cava, and should be avoided. If left-sided LUD is not possible, it may be applied from the right side by pushing away and toward the ceiling manually [5]. Alternatively, left lateral tilt of the patient to a full 30 degrees (i.e., pelvic tilt) can be provided with a backboard or pillow, blanket or

knees behind the lumbar/pelvic region, however, this position can make chest compressions more difficult to perform, transmit less force to the chest wall and result in less effective resuscitation [5,25-27].

4. Defibrillation

With the provision of cardiopulmonary resuscitation (CPR), prompt defibrillation in the setting of ventricular fibrillation or pulseless ventricular tachycardia is critical for successful ROSC and maternal and fetal outcomes [8]. Transthoracic impedance remains unchanged during pregnancy, thus the energy requirements and settings should not be altered (i.e., biphasic shock energy of 120 to 200 J, with subsequent energy escalation if first shock is not effective). Moreover, defibrillation is expected to pass minimal energy to the fetus or arcing through fetal monitors; as a consequence, pregnancy or the presence of fetal monitors should not delay intervention [5]. In settings of infrequent use or where staff skills of ECG rhythm recognition are limited, the use of an AED should be considered. The lateral pad/paddle should be placed under the breast tissue, and adhesive shock electrodes are recommended to allow consistent defibrillation.

5. Airway Management

With pregnancy, patients desaturate more rapidly and have airways that are more difficult to manage. During maternal cardiac arrest, the first responder unfamiliar to airway management should first oxygenate the patient using jaw thrust, oral airway and bag-mask ventilation with 100% oxygen to deliver tidal volume (500-700 mL) over one second for two seconds in total time (Table 1) [4]. In the presence of experienced provider, intubation should be attempted, with failure prompting the use of supraglottic airway devices (e.g., laryngeal mask airway). Due to the increased risk of aspiration during pregnancy, oxygenation and ventilation should not be delayed for pharmacologic precautions against aspiration; cricoid pressure can be used initially, unless laryngoscopic visualization is impaired [4].

6. Intravenous access

Establishing intravenous (IV) access is essential for

Table 1. Airway control during maternal cardiac arrest.

Ventilate with 100% oxygen	PROVIDE CHEST COMPRESSIONS CONTINUOUSLY
Preparation and positioning	Use jaw thrust + chin lift Bag mask with 2 hands + place oral airway if needed Apply 30 chest compressions:2 breaths per cycle Give 2 breaths (each over 1 second)
Primary attempt	Call expert airway assistance Have airway equipment ready (difficult airway cart + portable suction) Use endotracheal tube (ETT)-consider smallest tube (6.0 mm) Optimize airway position Continue chest compressions at all times!
Secondary attempt	Use Direct or Video laryngoscopy Apply cricoid pressure Have a bougie tube immediately available
Alternative airway control	Use an alternative laryngoscopy technique Adjust or release cricoid pressure Restart mask ventilation if intubation fails Consider a supraglottic airway (SGA; +/- gastric tube)
After airway controlled	Insert SGA (e.g. LMA) If LMA ventilation is inadequate, return to mask ventilation If mask ventilation is inadequate- consider cricothyrotomy First confirm ETT placement Then, secure ETT or SGA Provide 10 breaths/min Deliver 500-700 mL/breath

rapid administration of volume replacement and resuscitation drugs. In the event of difficult IV access, an intraosseous (IO) infusion catheter, preferentially in the proximal humerus (due to being above the diaphragm and higher fluid flow rates than tibial sites) or ultrasound guided peripheral or central access depending on the facility resources should be considered^[4].

7. Drugs used for resuscitation

Clinicians should be aware of all of the drugs are on the emergency trolley. Altered drug volume of distribution and clearance resulting from physiologic changes of pregnancy are not likely to be relevant in the setting of maternal cardiac arrest. Adrenaline (Epinephrine) 1 mg IV bolus is repeated every 3-5 minutes until ROSC^[4].

If cardiac arrest is due to local anesthetic systemic toxicity (LAST), lipid emulsion is administered in the doses used in the non-pregnant population^[28]. The practice advisory of American Society for Regional Anesthesia (ASRA, 2010) indicates using 20% lipid emulsion (for a 70-kg adult) as a therapeutic antidote for suspected LAST^[29]:

- (1) IV bolus 1.5 mL kg⁻¹ (lean body mass) over 1 min (\approx 100 ml)
- (2) Continuous IV infusion at 0.25 mL kg⁻¹ min⁻¹
- (3) Repeat bolus once or twice if persistent cardiovascular collapse
- (4) Double the infusion rate to 0.5 mL kg⁻¹ min⁻¹ if blood pressure remains low
- (5) Continue infusion for at least 10 min after attaining circulatory stability
- (6) Recommended upper limit: approximately 10 mL kg⁻¹ lipid emulsion within the first 30 min

Additionally, providers should be familiar with contraindications and side effects of uterotonic drugs (i.e., oxytocin and methylergonovine maleate available in Turkey, carboprost tromethamine). As a systemic vasodilator and negative inotropic agent, oxytocin should not be administered as a rapid (less than 30 sec), bolus dose more than 5 IU due to the risk of cardiovascular collapse^[4]. Methylergonovine can cause systemic hypertension, which increases the afterload pressure to the heart.

8. Perimortem cesarean or operative vaginal delivery

Because vaginal delivery is seldom possible in a cardiac arrest situation, perimortem cesarean delivery (PMCD) is a procedure that improves the chance of ROSC and maternal and fetal survival. Teams should continue CPR as they actively prepare to make an incision at 4 minutes following confirmed cardiac arrest, to effect fetal delivery within 5 minutes. Although an operative vaginal delivery is an option, PMCD immediately relieves maternal vena caval obstruction, improves venous return and cardiac output, decreases oxygen demand, and improves pulmonary mechanics^[4,30]. Moreover, PMCD optimizes neonatal survival (if past the age of viability of 24–25 weeks' gestation) if the fetus is delivered within 5 minutes^[5,7,31–33].

The timing of delivery is more critical than the location of delivery. PMCD or operative vaginal delivery should be performed at the site of arrest rather than moving to the nearest operating room^[4,34–37]. Patient transport during arrest creates the potential for inadequate chest compressions and delay of definitive care. If PMCD results in ROSC, the parturient can be transported to the nearest OR after delivery. If ROSC occurs prior to delivery, the parturient can be transported to the OR with the team readily available for immediate cesarean delivery. Subsequently, the mother can be transported to the ICU for postpartum care. While sterile preparation of the skin is not a priority during PMCD, early sterile preparation may be helpful to avoid delays to incision^[4].

Postcardiac arrest care

In parturients who are refractory to CPR after PMCD, the use of mechanical circulatory support [i.e., extracorporeal membrane oxygenation (ECMO)] can be considered if available^[38,39]. Therapeutic hypothermia has been used safely and effectively in early pregnancy with favorable maternal and fetal outcome after term delivery^[40]. Implantable cardioverter defibrillators (ICDs) have been used successfully during pregnancy^[41]. Due to the many possible causes of maternal cardiac arrest (Figure 1), maternal transfer to an ICU should occur promptly to continue patient treatment and stabilization^[4].

In conclusion, the main priority in the management of maternal cardiac arrest is resuscitating the mother with a good teamwork. Initiating rapid and forceful cardiac compressions, defibrillating appropriate rhythms, mitigating aortocaval compression, managing the airway, and quickly initiating a perimortem delivery are key interventions that augment maternal and fetal survival in this difficult setting.

We, the authors, declare that we do not have any conflicts of interest regarding our paper entitled “Management of cardiac arrest in pregnancy” which has been submitted to Journal of The Society of Thoracic Cardio-Vascular Anaesthesia and Intensive Care.

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