Chapter 13

CARDIORESPIRATORY ARREST IN PREGNANT WOMEN

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Cardiorespiratory arrest (CRA) during pregnancy is a critical situation that demands immediate attention. The medical team must be familiar with the physiological changes of pregnancy and follow appropriate protocols. High-quality chest compressions and adequate oxygenation are essential. Manual displacement of the uterus to mitigate aortocaval compression should be performed promptly, and a

perimortem cesarean section may be indicated if the gestational age is greater than 20 weeks. An analysis of 462 cases of maternal CRA found that 41% of women survived to hospital discharge (Zelop *et al.*, 2018).

Cardiovascular diseases (CVDs) complicate 1-2% of pregnancies and are a significant cause of morbidity and mortality. In developed countries, CVDs are the leading cause of maternal mortality due to increased maternal age, better survival of women with congenital heart diseases, and advances in assisted reproduction. Cardiac arrhythmias are a significant complication, influenced by pre-existing conditions and pregnancy-related changes (Muñoz-Ortiz *et al.*, 2024).

The COVID-19 pandemic brought specific challenges for pregnant women, who are at higher risk of severe complications, including ICU admission and invasive ventilation. Risk factors include obesity, advanced maternal age, non-white ethnicity, pre-existing diabetes, and pre-eclampsia. Obstetric complications associated with CRA have been linked to such comorbidities, presenting numerous challenges (Allotey *et al.*, 2020).

Twin pregnancies, representing 2-4% of births, vary in prevalence in Brazil due to socioeconomic disparities. Associated with higher risks of maternal and perinatal morbidity, this condition requires specialized care to prevent maternal and fetal harm, including CRA. Dizygotic twins are more prevalent and influenced by geographic and socioeconomic factors, while monozygotic twins have a genetic basis. Maternal mortality is 2.5 times higher, and perinatal mortality is two to three times higher in twin pregnancies (Santana; Surita and Cecatti, 2018).

EPIDEMIOLOGY

Cardiorespiratory arrest in pregnant women, characterized as one of the main causes of maternal morbidity and mortality, shows significant prevalence in emergency contexts. This condition poses a simultaneous risk to both mother and fetus, exacerbated by the physiological changes of pregnancy and specific obstetric causes requiring rapid decisions and specialized protocols. The incidence distribution of cardiorespiratory arrest in pregnant women is related to various pathophysiologies, including hemorrhages, cardiovascular abnormalities, and hypertensive disorders. Risk factors such as age, maternal comorbidities, and economic and social disparities also play an important role. These trends have direct implications for the organization of emergency services and the formulation of public strategies aimed at prevention and immediate care (Muñoz-Ortiz *et al.*, 2024).

Cardiac arrest during pregnancy is a severe public and individual health situation, with the potential to lead to maternal and fetal death. Currently, it is recognized as a significant cause of maternal death worldwide, with cardiovascular diseases being a frequently involved factor (Muñoz-Ortiz *et al.*, 2024). Historically, there has been an increase in the rates of cardiac arrest in pregnant women, attributed to increased maternal comorbidities, healthcare

failures, and rising socioeconomic, racial, ethnic, and demographic inequalities, as well as improved case records and descriptions. Despite this, evidence suggests a reduction in post-cardiac arrest mortality, especially in cases of reversible etiology, highlighting the importance of post-arrest care beyond immediate treatment (Zelop *et al.*, 2018).

Cardiovascular diseases are the leading cause of indirect maternal mortality, representing one-third of deaths in pregnant women (Alkema et al., 2016). White women have a 1.4 times higher rate of cases compared to black women (Zelop *et al.*, 2018). However, if managed early, almost 70% of maternal deaths can be prevented (Zaharatos *et al.*, 2018). Comparing underdeveloped and developed countries, the incidence of cardiac arrest in pregnant women is three times higher in the former (Ford *et al.*, 2023; Nivatpumin et al., 2021). Among obstetric risk factors, hemorrhages and gestational hypertension stand out as targets for management, prevention, and follow-up (Pawar *et al.*, 2023).

Studies conducted in the United States between 2017 and 2019 observed an average of one cardiac arrest per 9,000 deliveries, with a survival rate of 70% (Ford *et al.*, 2023). In contrast, another study found an incidence rate almost three times higher, with one cardiac arrest per 3,886 deliveries (Nivatpumin *et al.*, 2021). These data emphasize the influence of environmental and socioeconomic factors on maternal and fetal morbidity and mortality.

DIAGNOSIS

Rapid diagnosis is crucial to improve the prognosis of the pregnant woman and prevent severe cardiac complications such as CRA. Most cardiac complications occur in the third trimester of pregnancy. It is important to classify the causes according to the trimester of presentation: in the first trimester, atherosclerosis is the leading cause of acute myocardial infarction, especially in the presence of risk factors. In the second trimester, the main causes include atherosclerosis and thrombosis, while in the third trimester, spontaneous coronary artery dissection is the main cause (Pfaller *et al.*, 2020).

With continuous medical advances, many congenital heart diseases (CHDs) can be detected during pregnancy. However, some CHDs may still go unnoticed. The identification of serum biomarkers can complement routine cardiac ultrasound, reducing the prevalence and mortality of CHDs. Among these biomarkers, tRFs/tiRNAs have emerged as potential diagnostic and prognostic markers. These small RNAs derived from tRNA play essential roles in various cellular functions and are involved in pathological processes. The expression of tRFs/tiRNAs in the serum of pregnant women has been examined, and biological analysis concluded that these RNAs could be used as potential biomarkers for the detection of CHDs during pregnancy, offering a new approach to improving the treatment and prognosis of fetuses with CHDs (Lu *et al.*, 2023).

The diagnosis of peripartum cardiomyopathy (PPCM) is also discussed. Checking NT-proBNP levels, which do not vary significantly during pregnancy but are elevated in

PPCM, is essential for confirming the diagnosis. Other tests, such as electrocardiograms, may be normal or show nonspecific abnormalities. Echocardiography is fundamental for diagnosis, potentially revealing systolic dysfunction, left ventricular dilation, functional mitral and/or tricuspid regurgitation, right ventricular dysfunction, pulmonary hypertension, and atrial enlargement. If echocardiography is inconclusive, magnetic resonance imaging should be considered (Carlson; Schultz; Ramu and Davis, 2023).

TREATMENT

Effective treatment of CRA in pregnant women is crucial for maintaining the well-being of both mother and fetus. A rapid, effective, and multidisciplinary approach is essential to avoid unfavorable outcomes (Enomoto *et al.*, 2022). Protocols such as BLS, ACLS, and guidelines from the American Heart Association are fundamental. The first step is to declare the CRA state and activate the multidisciplinary team. Subsequent steps involve high-quality chest compressions, left uterine displacement, ventilation, intubation, defibrillation, use of vasoactive drugs, assessment of gestational age, and surgical interventions, with treatment scaled according to the patient's response (Zelop; Einav, Mhyre and Martin, 2018).

While the focus is on maternal-fetal well-being, resuscitation aims to restore maternal spontaneous circulation. Immediately after CRA is detected, the multidisciplinary team should start high-quality chest compressions on the lower third of the sternum, at a rate of 100 to 120 beats per minute, compressing about 5 to 6 cm. Every 30 compressions are followed by two ventilations with a bag-valve-mask device and 100% oxygen. Simultaneously, the uterus should be displaced to the left and two venous accesses established. Maternal oxygenation is a priority, and an advanced airway may be used to reduce compression-free intervals. Ventilations vary from 8 to 10 per minute. The rhythm should be analyzed, and if necessary, shocks applied with the same load as non-pregnant patients. Epinephrine is the vasoactive drug of choice, used every 3-5 minutes in non-shockable rhythms, while amiodarone is indicated for non-responsive shockable rhythms. Perimortem cesarean section should be considered within 4 minutes of the onset of CRA to improve fetal and maternal survival, especially from 20 weeks of gestation (Zelop; Einav; Mhyre and Martin, 2018).

Performing uterine displacement is essential to reduce pressure on the vena cava and increase blood return. However, this maneuver can be challenging as it requires an additional professional on the team (Maurin et al., 2019). Prehospital perimortem cesarean section can increase maternal survival chances but is limited by late arrival of emergency teams and lack of training among emergency physicians (Maurin *et al.*, 2019). Pregnant women with catecholaminergic polymorphic ventricular tachycardia (CPVT) should be monitored by cardiologists and obstetricians, with the use of safe antiarrhythmic medications and the programming of implantable cardioverter-defibrillators. Labor should be monitored according to risk, with atrioventricular nodal blockers and defibrillators available (Wong *et al.*, 2021).

The number of young women with ventricular cardiac arrhythmia using implanted cardiac devices (ICDs) is increasing, with about 3% of pregnant women being ICD carriers. The implantation of these devices can be safely performed during pregnancy but requires follow-up by a specialized multidisciplinary prenatal team (Wong et al., 2021). In the acute context of CRA, the drugs needed for resuscitation are used in the same doses as the general population, despite physiological changes during pregnancy (Zelop; Einav; Mhyre and Martin, 2018). In pregnant women with heart failure, the use of ivabradine should be carefully considered due to its potential fetal toxicity and teratogenicity (Karunarathna, 2024).

The compression generated by the gravid uterus can hinder maternal circulation, making it possible to perform manual uterine displacement to the left or lateralize the pregnant woman at 27 to 30 degrees to improve circulation. Intubations are more challenging during pregnancy due to airway narrowing by edema and fluid retention, requiring smaller endotracheal tubes (Zelop; Einav; Mhyre and Martin, 2018). These practices are essential to improve the effectiveness of cardiopulmonary resuscitation in pregnant women (Enomoto *et al.*, 2022).

REFERENCES

ALLOTEY, John et al. Clinical manifestations, risk factors, and maternal and perinatal outcomes of coronavirus disease 2019 in pregnancy: living systematic review and meta-analysis. **bmj**, v. 370, 2020.

CARLSON, Selma; SCHULTZ, Jessica; RAMU, Bhavadharini; DAVIS, Melinda B. Peripartum cardiomyopathy: risks diagnosis and management. **Journal of Multidisciplinary Healthcare**, p. 1249-1258, 2023.

ENOMOTO, Naosuke et al. Effect of maternal positioning during cardiopulmonary resuscitation: a systematic review and meta-analyses. **BMC Pregnancy and Childbirth**, v. 22, n. 1, p. 159, 2022.

KARUNARATHNA, Indunil. Ivabradine Therapy in Heart Failure Management: Optimizing Outcomes Through Interprofessional Collaboration. **Uva Clinical Lab. Retrieved from Ivabradine Therapy in Heart Failure Management: Optimizing Outcomes Through Interprofessional Collaboration**, 2024.

LU, Enkang et al. Maternal serum tRNA-derived fragments (tRFs) as potential candidates for diagnosis of fetal congenital heart disease. **Journal of Cardiovascular Development and Disease**, v. 10, n. 2, p. 78, 2023.

MAURIN, Olga et al. Maternal out-of-hospital cardiac arrest: a retrospective observational study. **Resuscitation**, v. 135, p. 205-211, 2019.

MUÑOZ-ORTIZ, Edison et al. Characterization of cardiac arrhythmias and maternal–fetal outcomes in pregnant women: A prospective cohort study. **Revista Portuguesa de Cardiologia**, v. 43, n. 2, p. 67-74, 2024.

PFALLER, Birgit et al. Preventing complications in pregnant women with cardiac disease. **Journal of the American College of Cardiology**, v. 75, n. 12, p. 1443-1452, 2020.

SANTANA, Danielly Scaranello; SURITA, Fernanda Garanhani; CECATTI, José Guilherme. Multiple pregnancy: epidemiology and association with maternal and perinatal morbidity. **Revista Brasileira de Ginecologia e Obstetrícia**, v. 40, p. 554-562, 2018.

WONG, Geoffrey R. et al. Pregnancy in patients with implantable cardiac defibrillators. **Herzschrittmachertherapie+ Elektrophysiologie**, v. 32, n. 2, p. 214-220, 2021.

ZELOP, Carolyn M.; EINAV, Sharon; MHYRE, Jill M.; MARTIN, Stephanie. Cardiac arrest during pregnancy: ongoing clinical conundrum. **American journal of obstetrics and gynecology**, v. 219, n. 1, p. 52-61, 2018.

ZELOP, Carolyn M. et al. Characteristics and outcomes of maternal cardiac arrest: a descriptive analysis of Get with the guidelines data. **Resuscitation**, v. 132, p. 17-20, 2018.