Cardiac arrest during pregnancy: ongoing clinical conundrum

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While global maternal mortality has decreased in the last 25 years, the maternal mortality ratio in the United States has actually increased. Maternal mortality is a complex phenomenon involving multifaceted socioeconomic and clinical parameters including inequalities in access to health care, racial and ethnic disparities, maternal comorbidities, and epidemiologic ascertainment bias. Escalating maternal mortality underscores the importance of clinician preparedness to respond to maternal cardiac arrest that may occur in any maternal health care setting. Management of maternal cardiac arrest requires an interdisciplinary team familiar with the physiologic changes of pregnancy and the maternal resuscitation algorithm. Interventions intended to mitigate obstacles such as aortocaval compression, which may undermine the success of resuscitation interventions, must be performed concurrent to standard basic and advanced cardiac life support maneuvers. High-quality chest compressions and oxygenation must be performed along with manual left lateral uterine displacement when the uterine size is ≥20 weeks. While deciphering the etiology of maternal cardiac arrest, diagnoses unique to pregnancy and those of the nonpregnant state should be considered at the same time. If initial basic life support and advanced cardiac life support interventions fail to restore maternal circulation within 4 minutes of cardiac arrest, perimortem delivery is advised provided the uterus is ≥20 weeks' size. Preparations for perimortem delivery are best anticipated by the resuscitation team for the procedure to be executed opportunely. Following delivery, intraabdominal examination may reveal a vascular catastrophe, hematoma, or both. If return of spontaneous circulation has not been achieved, additional interventions may include cardiopulmonary bypass and/or extracorporeal membrane oxygenation. Simulation and team training enhance institution readiness for maternal cardiac arrest. Knowledge gaps are significant in the science of maternal resuscitation. Further research is required to fully optimize: relief of aortocaval compression during the resuscitation process, gestational age and timing of perimortem delivery, and other interventions that deviate from nonpregnant standard resuscitation protocol to achieve successful maternal resuscitation. A robust detailed national and international prospective database was recommended by the International Liaison Committee on Resuscitation in 2015 to facilitate further research unique to cardiac arrest during pregnancy that will produce optimal resuscitation techniques for maternal cardiac arrest.

Key words: basic and advanced life support during pregnancy, cardiac arrest during pregnancy, manual left lateral uterine displacement, maternal cardiac arrest, perimortem cesarean delivery, perimortem delivery

Introduction

The last decade has heralded a paradigm shift in perceptions regarding maternal collapse and cardiopulmonary resuscitation (CPR). Historically, survival was described as poor, and resuscitation futile, because "the causes of cardiac arrest are fatal."[1,2] But new evidence indicates high survival, with a significant proportion of cases attributed to a reversible etiology of arrest. This unique population of young, yet critically ill women can respond to appropriate treatment and may be more salvageable than most patients requiring CPR.[3]

While the global maternal mortality ratio (maternal deaths/100,000 live births) has decreased in the last 25 years from 281.5-195.7, the maternal mortality ratio has actually increased from 16.9-26.4 in the United States. More robust ascertainment systems likely explain some, but not the majority, of this increase. Maternal mortality is a complex multifaceted phenomenon with each etiology of maternal death influenced by population health, comorbid conditions, access to health care, and socioeconomic, racial, and ethnic inequalities. Regardless, cardiac arrest separates survival from death for many forms of maternal critical illness and comorbidities. Institutional preparation for maternal CPR represents an opportunity to optimize maternal survival in many health care settings.[4]

In this article, we aim to provide a comprehensive review of cardiac arrest in pregnancy and outline a practical management algorithm for the clinician in the trenches. Recent guidelines from the Society for Obstetric Anesthesia and Perinatology (SOAP), the American Heart Association (AHA), and the International Liaison Committee on Resuscitation (ILCOR) are reviewed.

Due to the low prevalence and the circumstances of cardiac arrest during pregnancy, randomized clinical trials do

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not exist to guide management; therefore, we have extrapolated data from simulation studies, expert opinions, small case series, and cohort studies, including new prospectively reported data on maternal cardiac arrest (MCA).[5,6] Given the low frequency of maternal resuscitation, optimal resuscitation practices are poorly described. Most recommendations are based on expert opinion, case reports, and case series. To encourage further research in maternal resuscitation science, this review also highlights existing knowledge gaps.

Recent guidelines

In the past 3 years, several organizations have published new or updated guidelines focusing on maternal resuscitation. Following the publication of several index papers suggesting that MCA is accompanied by better prognoses than believed in the past, and thus merits more focus than it had received,[3,7] SOAP released its first consensus statement on treatment of cardiac arrest in pregnancy in 2014.[8] This practical document provided several important resources to support an optimal team response, including emergency checklists and an alphabetical etiology checklist running from A-H: anesthetic complications (eg, loss of airway, inadvertent spinal injection); bleeding (intrapartum or postpartum); cardiovascular causes (eg, cardiomyopathy, exacerbation of preexisting valve disease, aortic dissection, myocardial infarction); drugs (eg, anaphylaxis, magnesium overdose); embolic events (thrombotic, amniotic fluid); febrile conditions (ie, sepsis); general causes (the regular H's and T's); and hypertension.

A year and half later, in November 2015, the AHA also published their first scientific statement on maternal resuscitation.[9] This document, written by interprofessional and multidisciplinary experts in resuscitation science and women's health care, reflects a comprehensive review of available evidence, and offers standardized recommendations for all disciplines to optimize care during MCA. The guideline also highlights the need to improve consensus regarding the optimal sequence of initial resuscitation maneuvers, and the circumstances under which perimortem delivery should be strongly considered. The AHA document also reviews the literature about the causes of MCA.

ILCOR completed another cycle of its 5-year evidence review process of cardiac arrest in 2015, and included a section on cardiac arrest during pregnancy. Following a structured search strategy, the ILCOR review of maternal CPR focused exclusively on left lateral uterine displacement and perimortem delivery. The systematic review found very low-quality evidence for specific interventions for advanced cardiac life support (ACLS) during pregnancy, but suggested perimortem delivery for women in cardiac arrest in the second half of pregnancy.[10]

Subsequently, the 2015 AHA guidelines on CPR drew from the AHA Scientific Statement on Maternal Resuscitation and the more focused results of the systematic review found in the 2015 ILCOR guideline. In summary, priorities for the management of MCA include high-quality chest compressions and manual left uterine displacement. Because evacuation of the gravid uterus relieves aortocaval compression and may improve resuscitative efforts, perimortem delivery may be considered part of standard maternal resuscitation in the second half of pregnancy regardless of the viability of the fetus.[11]

Spectrum of disease

Prevalence of MCA

Large health care utilization databases have sufficient information to describe MCA despite its low prevalence. Recent data from the US Nationwide Inpatient Sample suggest that MCA occurs in 1:12,000 admissions for delivery, based on administrative billing data for diagnostic and procedural codes consistent with cardiopulmonary arrest.[3] The United Kingdom Obstetric Surveillance System (UKOSS) reports a somewhat lower prevalence of 1:16,000 MCA per maternities based on prospectively collected nationwide surveillance data from 2011 through 2014 that relied on active clinician reporting.[5,6] Although prevalence varies by continent paralleling the observed improved global maternal mortality ratio trend cited earlier in the introduction, their respective 95% confidence intervals overlap suggesting insufficient event frequency and statistical power to distinguish these 2 rates. Another retrospective population-based study using data from the discharge abstract database of the Canadian Institute for Health Information reported a prevalence of 1:12,500 deliveries.[12] Most importantly, all of these studies concur that maternal survival after cardiac arrest is >50%.

Etiologies for MCA

Both pregnancy- and nonpregnancy-related diseases and conditions must be considered in the differential diagnosis of MCA. The AHA has proposed an alphabetical listing rather than a specific mnemonic to encourage a broader consideration of etiologies[9] (Table). Familiarity with the etiologies enables the clinician to initiate resuscitation while simultaneously looking for clues leading to a more definitive management that will improve the chance of return of spontaneous circulation (ROSC) and ultimately survival. Hemorrhage remains one of the most common causes of cardiac arrest related to pregnancy.[3] Cardiovascular conditions and sepsis should be considered early; both the Centers for Disease Control and Prevention and UKOSS noted an increase in cardiovascular and infectious etiologies leading to maternal death.[13-15] Anesthetic complications were the most prevalent etiology for MCA in the recent UKOSS Cardiac Arrest in Pregnancy Study (CAPS), accounting for 27% of the arrests, while hemorrhage was the second most common etiology.[5,6] These data confirm the need to prioritize anesthesia care for pregnant women, including airway management, safe neuraxial analgesia and anesthesia, and hemostatic and hemodynamic resuscitation for massive hemorrhage. Notably, the parturient airway is more easily managed by an anesthesiologist at the onset of arrest rather than after several failed intubation attempts. Comorbidities (eg, heart disease), which

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