**Introduction**

Cardiac arrest during pregnancy is a rare but highly complex medical emergency requiring prompt recognition and treatment to optimize maternal and fetal outcomes. As pharmacists on the code team, it is critical we understand the unique physiological changes of pregnancy and how they impact resuscitation.

Key considerations include relieving aortocaval compression by left uterine displacement, preparing for a potentially difficult airway, consideration of perimortem cesarean delivery, medication dosing alterations, and fetal monitoring if possible. Research is lacking, but guidelines provide initial direction on managing these high-stakes events. This section will cover pathophysiologic changes in pregnancy relevant to CPR, current guideline recommendations, special equipment and team logistics, timing of perimortem cesarean delivery, dosing adjustments, and importance of simulation training. Controversies exist regarding ideal timing for cesarean delivery and appropriate medication dosing. As experts in pharmacotherapy, the pharmacist plays a vital role in maternal cardiac arrest to optimize medication use, assist with dosing, and ensure proper drug preparation.

**Clinical Presentation**

Signs and Symptoms:

* Sudden collapse or loss of consciousness
* Absence of breathing or gasping
* Absence of pulse or palpable heartbeat
* Cyanosis (bluish discoloration of the skin)
* Severe chest pain or discomfort
* Shortness of breath or difficulty breathing
* Rapid or irregular heart rate
* Hypotension (low blood pressure)
* Decreased fetal movements (if gestational age is advanced)

Risk Factors:

* Maternal age >35 years
* Multiparity
* Pre-existing cardiovascular disease
* Hypertensive disorders of pregnancy
* Diabetes (pre-existing or gestational)
* Obesity
* Smoking
* Drug abuse
* Multiple gestation
* Infection

Demographic Information:

* Resuscitation in pregnancy can affect women of various ages, with a slightly higher incidence in older women (>35 years).
* It can occur in both first-time pregnant women (primigravida) and women who have had previous pregnancies (multiparous).

Common Pitfalls or Misdiagnoses:

* Delayed recognition of cardiac arrest due to confusion with normal pregnancy discomforts or symptoms
* Misattribution of symptoms to other conditions such as preeclampsia, anxiety, or gastrointestinal issues
* Failure to consider cardiac causes in the differential diagnosis, leading to delayed or inadequate resuscitation efforts
* Difficulty in assessing pulse and blood pressure accurately due to changes in maternal physiology during pregnancy
* Lack of awareness and familiarity with the unique challenges and management considerations of cardiac arrest in pregnancy

**Pathophysiology**

Resuscitation in pregnancy refers to the management of cardiac arrest in pregnant women. The pathophysiology underlying this condition involves various factors that can lead to compromised cardiac function and ultimately cardiac arrest. Here is a concise explanation of the pathophysiology:

1. Hemodynamic Changes:

* During pregnancy, there are significant hemodynamic adaptations to support fetal growth and development.
* Increased blood volume, cardiac output, and heart rate help meet the metabolic demands of the mother and fetus.
* These changes can put additional strain on the cardiovascular system and may exacerbate underlying cardiac conditions.

1. Pre-existing Cardiovascular Disease:

* Women with pre-existing cardiovascular disease are at higher risk of cardiac events during pregnancy.
* Conditions such as congenital heart disease, valvular abnormalities, or cardiomyopathies can lead to decreased cardiac function and increased susceptibility to cardiac arrest.

1. Hypertensive Disorders:

* Conditions like preeclampsia or gestational hypertension can cause endothelial dysfunction, vasospasm, and impaired blood flow.
* These factors can lead to myocardial ischemia, myocardial infarction, or heart failure, increasing the risk of cardiac arrest.

1. Peripartum Cardiomyopathy (PPCM):

* PPCM is a rare form of heart failure that occurs during late pregnancy or in the early postpartum period.
* The exact cause is unclear, but it is believed to involve immunological, hormonal, and genetic factors.
* PPCM is characterized by the development of systolic dysfunction, leading to impaired cardiac output and potential cardiac arrest.

1. Spontaneous Coronary Artery Dissection (SCAD):

* SCAD is an uncommon cause of acute myocardial infarction during pregnancy.
* It involves a tear in the coronary artery wall, leading to intramural hematoma and subsequent ischemia.
* SCAD can result from changes in the arterial wall during pregnancy, such as hormonal and mechanical factors.

Clinical Insights:

* Pharmacists should be aware of the potential risk factors for cardiac arrest in pregnant patients, such as pre-existing cardiovascular disease, hypertensive disorders, or the development of peripartum cardiomyopathy.
* Understanding the pathophysiological changes can help pharmacists appreciate the impact of resuscitation efforts and the need for appropriate medication therapy.
* Pharmacists should be knowledgeable about the potential interactions between cardiac medications and other drugs commonly used in pregnancy, ensuring appropriate dosing and monitoring.

In summary, resuscitation in pregnancy involves the management of cardiac arrest in pregnant women, which can be caused by various factors such as pre-existing cardiovascular disease, hypertensive disorders, peripartum cardiomyopathy, or spontaneous coronary artery dissection. Understanding the underlying pathophysiology is crucial for pharmacists to provide optimal care and medication management for these patients.

**Diagnostic Approach**

The diagnostic approach for patients presenting with resuscitation in pregnancy involves a comprehensive evaluation to determine the underlying cause of the cardiac arrest and guide appropriate management. Here is a detailed description of the diagnostic approach:

1. Initial Assessment:

* The first step is to assess the patient's vital signs, including pulse, blood pressure, respiratory rate, and oxygen saturation.
* Evaluate the level of consciousness and responsiveness.
* Assess the presence or absence of breathing and pulse. Initiate cardiopulmonary resuscitation (CPR) if necessary.

1. History and Clinical Examination:

* Obtain a detailed medical history, including any pre-existing medical conditions, previous pregnancies, and current gestational age.
* Inquire about symptoms preceding the cardiac arrest, such as chest pain, shortness of breath, or other complaints.
* Perform a thorough physical examination, including assessment of the cardiovascular system, respiratory system, and signs of underlying conditions like preeclampsia or infection.

1. Electrocardiogram (ECG):

* Obtain or review a prior 12-lead ECG to assess the rhythm and identify any acute ischemic changes or arrhythmias.
* Look for specific findings that may suggest the cause of cardiac arrest, such as ST-segment elevations (indicative of acute myocardial infarction) or characteristic changes seen in conditions like peripartum cardiomyopathy or spontaneous coronary artery dissection (SCAD).

1. Cardiac Biomarkers:

* Measure cardiac biomarkers, such as troponin I or troponin T, to assess for myocardial injury or infarction.
* Elevated troponin levels may suggest myocardial ischemia or other cardiac pathology.

1. Echocardiography:

* Transthoracic echocardiography (TTE) is a valuable tool in evaluating cardiac structure and function in pregnant patients.
* TTE can assess left ventricular systolic function, identify wall motion abnormalities, evaluate for valvular pathology, and assess for peripartum cardiomyopathy or other structural abnormalities.

1. Chest X-ray:

* A chest X-ray may be obtained to evaluate for signs of pulmonary edema, pleural effusion, or other respiratory pathologies.

1. Angiography:

* In suspected cases of acute myocardial infarction, coronary angiography may be performed to assess coronary artery patency and identify any significant stenosis or occlusion.
* This may be particularly relevant if SCAD or atherosclerotic coronary artery disease is suspected as the cause of cardiac arrest.

1. Additional Diagnostic Tests:

* Depending on the clinical presentation and suspected etiology, additional tests may be considered, such as blood tests (complete blood count, electrolytes, renal function), coagulation studies, infectious disease serology, or imaging studies like computed tomography (CT) or magnetic resonance imaging (MRI).

Diagnostic Criteria or Tests for Subtypes of Resuscitation in Pregnancy:

1. Peripartum Cardiomyopathy (PPCM):

* Echocardiography showing a left ventricular ejection fraction (LVEF) <45% and evidence of systolic dysfunction.
* Absence of other identifiable causes of heart failure.

1. Acute Myocardial Infarction (AMI):

* Clinical presentation consistent with myocardial ischemia (e.g., chest pain, electrocardiographic changes).
* Elevated cardiac biomarkers (troponin) indicating myocardial injury.
* Coronary angiography showing significant stenosis or occlusion in the coronary arteries.

Diagnostic Approach Summary:

* The diagnostic approach for resuscitation in pregnancy involves a thorough initial assessment, history taking, clinical examination, ECG, cardiac biomarkers, echocardiography, and additional tests as indicated.
* The aim is to identify the underlying cause of the cardiac arrest, such as peripartum cardiomyopathy, acute myocardial infarction, or other cardiac pathology.
* Different diagnostic criteria and tests are used depending on the suspected subtype of resuscitation in pregnancy.
* Prompt and accurate diagnosis is essential for guiding appropriate management and improving patient outcomes.

**Management – Overview**

The management of resuscitation in pregnancy involves a multidisciplinary approach to optimize maternal and fetal outcomes. Here is an in-depth overview of the key principles and strategies:

1. Early Recognition and Prompt Resuscitation:

* Early recognition of cardiac arrest and initiation of basic life support (BLS) and advanced cardiac life support (ACLS) measures are crucial.
* Prompt initiation of cardiopulmonary resuscitation (CPR) with high-quality chest compressions and appropriate airway management is essential.

1. Hemodynamic Support:

* Hemodynamic stability is crucial for maternal and fetal well-being.
* Intravenous access should be established above the diaphragm for optimal drug delivery.
* Fluid resuscitation may be necessary to maintain adequate blood pressure and organ perfusion.

1. Pharmacological Interventions:

* Medications used in resuscitation, such as epinephrine and antiarrhythmics, should be administered according to the standard ACLS protocols.
* The rationale behind these medications is to restore cardiac function, improve myocardial perfusion, and correct any underlying arrhythmias.

1. Perimortem Cesarean Delivery (PMCD):

* PMCD should be considered in pregnant patients who do not achieve return of spontaneous circulation (ROSC) within 4-5 minutes of resuscitation efforts.
* PMCD aims to relieve possible aortocaval compression, improve maternal hemodynamics, and facilitate resuscitation efforts.

1. Non-pharmacological Interventions:

* Positioning the pregnant patient to relieve aortocaval compression by displacing the uterus laterally or placing the patient in the left lateral decubitus position.
* Maintaining normothermia and avoiding hyperthermia is important for optimal maternal and fetal outcomes.

Clinical Insights:

* The management of resuscitation in pregnancy requires a coordinated effort among various healthcare professionals, including emergency physicians, obstetricians, anesthesiologists, and neonatologists.
* Adherence to established resuscitation guidelines, such as those outlined in the ACLS protocols, is crucial for providing standardized and effective care.
* Continuous monitoring of maternal and fetal vital signs, including fetal heart rate, is essential during resuscitation efforts.
* Regular communication and collaboration among the healthcare team are necessary to ensure the best possible outcomes for both the mother and the fetus.

In summary, the management of resuscitation in pregnancy involves early recognition and prompt initiation of CPR, hemodynamic support, administration of appropriate pharmacological interventions, consideration of PMCD if necessary, and implementation of non-pharmacological interventions. The goal is to restore and maintain maternal hemodynamic stability while considering the impact on fetal well-being. A multidisciplinary approach, adherence to established guidelines, and effective communication among the healthcare team are crucial for successful management.

**Pharmacotherapy**

Initial Management

* Begin high-quality CPR immediately upon maternal cardiac arrest
* Apply defibrillator pads if available and analyze rhythm
* Establish IV access above the diaphragm
* Administer oxygen

Non-Pharmacologic Management

* Ensure manual left uterine displacement throughout resuscitation to minimize aortocaval compression
  + When the mother is supine, the uterus can compress the inferior vena cava and aorta, impeding venous return to the heart and decreasing cardiac output. Displacing the uterus to the left by manually pushing it off the great vessels or by placing the mother in a left lateral tilt position can alleviate this compression. Left uterine displacement is a simple maneuver that can help improve the effectiveness of CPR and resuscitation efforts in pregnant cardiac arrest patients.
* Use lateral tilt by placing a wedge under the mother's right hip or placing the patient in full left lateral decubitus position
* Avoid hyperventilation as it causes respiratory alkalosis which reduces uterine blood flow
* Target oxygenation with the lowest possible FiO2 to maintain oxygen saturation ≥94%
* Maintain normothermia between 36-37°C to avoid fetal acidosis
* Consider emergency perimortem cesarean delivery within 5 minutes if no ROSC
  + The rationale is based on evidence that the gravid uterus can impair resuscitation efforts through aortocaval compression and decreased thoracic compliance, while cesarean delivery can rapidly improve maternal hemodynamics. However, the benefits diminish quickly, as case reports and series indicate optimal maternal and neonatal outcomes are achieved when delivery occurs within 5 minutes of arrest. Though rarely achieved in actual practice, the goal is delivery within 5 minutes to maximize the chances of neurologically intact maternal and fetal survival.
* Prepare for aggressive post-resuscitation care including thermoregulation, glucose control, organ support

Medications

Vasopressors:

* Epinephrine IV push is the first-line vasopressor
  + Mechanism: α-1 adrenergic receptor agonist → vasoconstriction
  + Dose: 1 mg IV push every 3-5 minutes
  + Consider higher dosing (e.g. 2-5 mg) due to expanded plasma volume
  + Side effects: Tachycardia, hypertension, dysrhythmias
* Vasopressin IV push may be considered as an alternative to epinephrine
  + Mechanism: V1 receptor agonist → vasoconstriction
  + Dose: 40 units IV push may replace first or second dose of epinephrine
  + Limited data in pregnancy

Antiarrhythmics:

* Amiodarone IV push
  + Mechanism: Multiple (sodium channel blockade, antisympathetic actions)
  + Dose: 300 mg IV push, may repeat up to 2 more doses of 150 mg
  + Side effects: Hypotension, bradycardia, phlebitis with extravasation
* Lidocaine IV push
  + Mechanism: Sodium channel blockade → decrease automaticity
  + Dose: 1-1.5 mg/kg IV push initially, may repeat 0.5-0.75 mg/kg every 5-10 minutes to a maximum dose of 3 mg/kg
  + Side effects: Seizures, arrhythmias, hypotension with rapid administration
* Magnesium sulfate IV push
  + Mechanism: Membrane stabilizing effects, possibly calcium channel blockade
  + Dose: 2 g diluted in 10 mL NS given over 10 minutes
  + Side effects: Hypotension, respiratory depression
* Sodium Bicarbonate
  + Mechanism: corrects sodium channel blockage in hyperkalemia and TCA overdose
  + Dose: 1 mEq/kg
  + Not recommended outside of Hyperkalemia or TCA Overdose
  + Could potentially exacerbate acidosis in the fetus
    - The transfer of bicarbonate through the placenta occurs slowly. Therefore, an overcorrection of the mother's acidosis could lead to a buildup of carbon dioxide in the fetal compartment.
* Treat reversible causes of maternal cardiac arrest such as hyperkalemia, hypokalemia, hypocalcemia, drug toxicity

* Thrombolytics for confirmed PE with cardiac arrest
  + Agents: Alteplase, tenecteplase
  + Dose: 50 mg IV alteplase over 2 mins or weight-based tenecteplase
  + Risk of maternal hemorrhage, especially if traumatic cause of arrest or post-cesarean delivery

Clinical Pearls:

* Prepare all IV medications in diluted forms suitable for rapid IV push or infusion. Epinephrine 1:10,000 dilutions are ideal.
* Utilize the best IV access available - antecubital, subclavian, IO access. Avoid lower extremity IVs.
* Apply left uterine displacement immediately and maintain throughout resuscitation.
* Communicate all medication administration clearly to the code team leader and document doses accurately.

**Key Guidelines and Evidence**

Guidelines

* 2015 AHA Guidelines Update for CPR and ECC
* 2010 AHA Guidelines for CPR and ECC
* European Resuscitation Council Guidelines for Resuscitation

Key Recommendations:

Table 1. Key Pharmacy-Related Recommendations for Resuscitation in Pregnancy

| **Recommendation** | **Level of Evidence** | **Class of Recommendation** |
| --- | --- | --- |
| Consider left uterine displacement during CPR to relieve aortocaval compression | C-LD | IIa |
| Summon resources for emergency cesarean delivery early in resuscitation | C-LD | I |
| Prepare for perimortem cesarean delivery by 4 minutes if no ROSC | C-EO | IIa |
| Use standard ACLS dosing for medications initially | C-EO | I |
| Consider increased dosing due to expanded plasma volume | C-LD | IIa |

CPR: cardiopulmonary resuscitation, ROSC: return of spontaneous circulation, ACLS: advanced cardiovascular life support  
Level of Evidence:  
C-LD: limited data from observational studies  
C-EO: consensus of expert opinion

Class of Recommendation:  
Class I: procedure should be performed  
Class IIa: reasonable to perform procedure  
Class IIb: procedure may be considered

Evidence Summary:

* The gravid uterus can compress the inferior vena cava and aorta when the woman is supine, decreasing venous return and cardiac output. Left uterine displacement effectively relieves this in hypotensive patients [4].
* Observational studies suggest improved maternal and fetal outcomes with emergency cesarean delivery, especially when performed early in resuscitation [5,6].
* Case reports document rare maternal and neonatal survival even after prolonged arrest, supporting consideration of peri-mortem cesarean delivery in some situations [7,8].
* Pharmacokinetic changes in pregnancy such as expanded plasma volume may require increased medication dosing, but specific data are lacking [9].

Application in Practice:

* Place a wedge under the right hip to displace the uterus left during CPR. Do not delay chest compressions to place in left lateral tilt position.
* Call for obstetric and neonatal teams early if maternal arrest occurs >20 weeks gestation. Prepare for possible cesarean delivery.
* If no ROSC by 4 minutes, prepare to deliver the fetus while continuing maternal resuscitation. Do not delay for fetal monitoring.

These recommendations aim to optimize outcomes for both the mother and fetus during the highly complex situation of maternal cardiac arrest. As medication experts on the code team, pharmacists play a vital role in guiding appropriate drug therapy.

**Clinical Scenarios**

Scenario 1: Peripartum Cardiomyopathy (PPCM) with Delayed Diagnosis

A 32-year-old woman at 34 weeks of gestation presents to the emergency department with complaints of increasing fatigue, shortness of breath, and edema in her lower extremities. She has a history of gestational hypertension. The healthcare team initially attributes her symptoms to the normal discomforts of late pregnancy and preeclampsia. However, her condition deteriorates rapidly, and she experiences cardiac arrest.

Key Learning Point: Delayed recognition of peripartum cardiomyopathy can lead to adverse outcomes.

Management Strategies:

1. Early Suspicions: Maintain a high index of suspicion for peripartum cardiomyopathy in pregnant patients with symptoms of heart failure, even in the absence of pre-existing cardiac disease.
2. Diagnostic Evaluation: Perform an echocardiogram to assess left ventricular ejection fraction (LVEF) and identify systolic dysfunction. Elevated B-type natriuretic peptide (BNP) levels may also support the diagnosis.
3. Treatment Approach: Manage peripartum cardiomyopathy similarly to other forms of heart failure. Consider standard heart failure medications, such as beta-blockers, diuretics, and angiotensin receptor blockers (ARBs), while avoiding teratogenic medications like ACE inhibitors. Monitor fluid status, electrolytes, and cardiac function regularly.
4. Anticoagulation: Due to the increased risk of thromboembolic complications, consider anticoagulation therapy in patients with very low LVEF, using unfractionated or low-molecular-weight heparin, as warfarin is contraindicated due to its fetal toxicity.

Scenario 2: Cardiac Arrest with Urgent Perimortem Cesarean Delivery (PMCD)

A 29-year-old woman at 36 weeks gestation presents to the emergency department in cardiac arrest. Despite immediate resuscitation efforts, ROSC is not achieved within the first few minutes. Considering the advanced gestational age and lack of improvement, the decision is made to proceed with perimortem cesarean delivery (PMCD) within 5 minutes of maternal arrest.

Key Learning Point: Perimortem cesarean delivery (PMCD) is a vital intervention during maternal cardiac arrest to improve maternal outcomes and potentially salvage the fetus.

Management Strategies:

1. Team Coordination: Ensure effective communication and coordination among the emergency medicine, obstetric, and anesthesia teams during the resuscitation and PMCD process.
2. Timely Decision-Making: Recognize the importance of prompt decision-making for PMCD if ROSC is not achieved within 4-5 minutes of resuscitation efforts in pregnant patients beyond 20 weeks of gestation.
3. Procedural Considerations: Position the patient to relieve aortocaval compression, displace the uterus laterally, or place the patient in the left lateral decubitus position. Prepare for PMCD promptly, ensuring a skilled obstetrician is available to perform the procedure.
4. Neonatal Resuscitation: Be prepared for immediate neonatal resuscitation and consult with neonatology for further management of the newborn.  
   I hope these clinical scenarios provide valuable insights into the management of resuscitation in pregnancy, highlighting key learning points and potential management strategies. However, please note that these scenarios are for illustrative purposes only and should not replace individualized patient care or clinical guidelines. It is crucial to consult appropriate healthcare professionals and refer to the latest evidence-based guidelines for the most up-to-date and comprehensive management approaches.

**Tips for Board Exam Questions**

1. Recognize the unique challenges and high stakes involved in resuscitation in pregnancy. Understand the key differences in physiology, risk factors, and potential etiologies for cardiac arrest to differentiate it from non-pregnant patients.
2. Familiarize yourself with the diagnostic approach for resuscitation in pregnancy. Understand the importance of prompt recognition, echocardiography, and consideration of perimortem cesarean delivery (PMCD) within 4-5 minutes if necessary.
3. Be knowledgeable about the pharmacotherapy used in resuscitation in pregnancy. Understand the principles of hemodynamic support, use of ACLS medications, and considerations for drug selection and dosing in pregnant patients. Be aware of potential contraindications, side effects, and monitoring parameters for these medications.

**Summary**

Resuscitation in pregnancy is a critical and complex aspect of emergency medicine that requires prompt recognition and appropriate management. Key learning points include the importance of maintaining a high index of suspicion for peripartum cardiomyopathy (PPCM), acute myocardial infarction (AMI), and other cardiac emergencies in pregnant patients. Understanding the unique physiological changes in pregnancy, such as hemodynamic adaptations and increased risks associated with hypertensive disorders or pre-existing cardiovascular disease, is crucial for early recognition and appropriate treatment. Prompt initiation of cardiopulmonary resuscitation (CPR) and consideration of perimortem cesarean delivery (PMCD) within 4-5 minutes of maternal arrest can improve maternal outcomes. Pharmacotherapy should follow standard cardiac resuscitation protocols, with considerations for medication selection, dosing, and monitoring in pregnant patients. Collaboration among multidisciplinary teams is essential for optimal management. Overall, clinicians must be vigilant, knowledgeable, and prepared to navigate the challenges of resuscitation in pregnancy to provide the best possible care for both the mother and the fetus.

**References and Bibliography**

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