

CARDIAC ARREST IN PREGNANCY: THE IMPACT ON MOTHER AND FETUS

Morgan Michael

Nursing

Pittsburg State University

INTRODUCTION

- Pregnancy is a well-researched and common medical condition. There is extensive research on prenatal care, labor, and the most common complications of pregnancy. However, in the last 25 years, maternal death rates have been on the rise in the United States from 16.9 deaths per 100,000 live births to 26.4 deaths per 100,000 live births. (Zelop... 2018). According to the American Heart Association, maternal mortality rates represent only a fraction of critical maternal events, better known as “a maternal near-miss... defined as a woman who nearly died but survived a complication that occurred during pregnancy, childbirth, or within 42 days of termination of pregnancy.” A notable maternal near-miss event is cardiac arrest and subsequent resuscitation. While rare, it is estimated one in 12,000 admissions for delivery results in cardiac arrest, with 58.9% surviving and discharged to home. This data shows that medical professionals of all disciplines, from emergency to medical-surgical to obstetrics, need to have a solid understanding and training in performing life-saving measures on a pregnant patient. (Jeejeebhoy... 2015).
- However, maternal cardiopulmonary resuscitation has many factors to consider. Anytime a pregnant patient presents in a medical situation, the providers must consider her well-being and the well-being of the fetus. One of the most challenging questions is when or if to perform a cesarean delivery, thus considering the fetus's development. The physiological changes of pregnancy must also be considered to ensure the most effective resuscitation measures. My objective is to provide concise data and techniques from multiple peer-reviewed scholarly articles to guide medical professionals during maternal cardiac arrest.

PHYSIOLOGICAL CHANGES OF PREGNANCY

- Respiratory Changes
 - Hyperemia and vocal cord edema create the need for a smaller endotracheal tube.
 - Decreased functional residual capacity increases difficulty with bag-mask ventilation
 - Increased oxygen consumption
- Gastrointestinal Changes
 - Delayed gastric emptying causes an increased risk of aspiration (Ramsay...2012)
- Cardiovascular Changes
 - Increased maternal cardiac output by 40% with up to a 20% diversion to the gravid uterus, which limits cardiac output during CPR because it is partially diverted to the uterus (Zelop...2018)
 - Aortocaval compression from the gravid uterus decreases chest compressions' effectiveness and creates a need to displace the uterus.
- Hemolytic Changes
 - Anemia creates the need for 100% oxygen (Ramsay...2012)

ABC'S OF MATERNAL CARDIAC ARREST

- **A: Anesthetic complications and Accidents**
 - Loss of airway
 - Aspiration
 - Respiratory depression
 - Trauma
 - Suicide
- **B: Bleeding**
 - Placenta accreta
 - Placental Abruptio
 - Placenta Previa
 - Uterine Rupture
 - Surgical Bleeding
 - Transfusion Reaction
- **C: Cardiovascular causes**
 - Myocardial infarction
 - Cardiomyopathy
 - Aortic dissection
 - Arrhythmias
 - Valve disease
- **D: Drugs**
 - Oxytocin
 - Magnesium
 - Drug Error
 - Opioids
 - Insulin
 - Anaphylaxis
- **E: Embolic causes**
 - Amniotic fluid embolism
 - Pulmonary fluid embolism
 - Cerebrovascular event
 - Venous air embolism
- **F: Fever**
 - Sepsis
 - Infection
- **G: General**
- **H: Hypertension**
 - Preeclampsia
 - Eclampsia
 - HELLP syndrome (Jeejeebhoy... 2015).

PREPARATIONS FOR MATERNAL CARDIAC ARREST

- While rare, hospitals and first responders must still be prepared for an incident of maternal cardiac arrest. Providers and staff of several disciplines will need to be present and prepared during the event.
- At the time of the code blue, in addition to the code team, an obstetrician, labor delivery team, neonatologist, and neonatal intensivists will need to respond as well. In a large facility, this will present no issue, but in a smaller facility, waiting for the specialized team may be detrimental to the mother and fetus.
- Any department caring for a pregnant patient must understand the procedure for basic life support (BLS) and advanced cardiac life support (ACLS) for the pregnant patient (Jeejeebhoy...2015).

RECOMMENDED GUIDELINES FOR MATERNAL RESUSCITATION

- The responding member of the healthcare team must assess the patient's pulse and breathing and call for the emergency response team (code team). They should then begin chest compressions per standard protocol, approximately 100 beats per minute.
- The responding team members should bring in the crash cart complete with a defibrillator, medications, and an intubation kit. It is also recommended that a videolaryngoscope be present as well (Jeejeebhoy...2015).
- While one person continues chest compressions, the responding staff should attach the defibrillator pads, electro-cardio monitoring, a pulsometer, and a blood pressure cuff attached to the monitor set to measure periodically. A backboard should also be placed under the patient to aid in the effectiveness of chest compressions. If appropriate, prepare the patient for cesarean delivery.
- Simultaneously, the patient should be receiving bag-mask ventilation at a rate of 2 breaths 30 compressions until intubated (Zelop... 2018).

RECOMMENDED GUIDELINES FOR MATERNAL RESUSCITATION

- Still, simultaneously, the patient's fundal height should be assessed, as well as the gestational age of the fetus. If the fundal height is above the umbilicus, left uterine displacement will need to occur to relieve the aortocaval compression and increase the effectiveness of chest compressions.
- If possible, one team member should remove fetal monitors, though it is not imperative and will not impact resuscitative measures.
- The most experienced provider should attempt intubation with a small endotracheal tube. After successful intubation, oxygenation should continue with 100% oxygen.
- If intravenous access has not been established prior to MCA, it should be done quickly to begin administering life-saving cardiac medications per protocol and physician order (Zelop...2018).

UTERINE DISPLACEMENT



Two-handed uterine displacement



One-handed uterine displacement

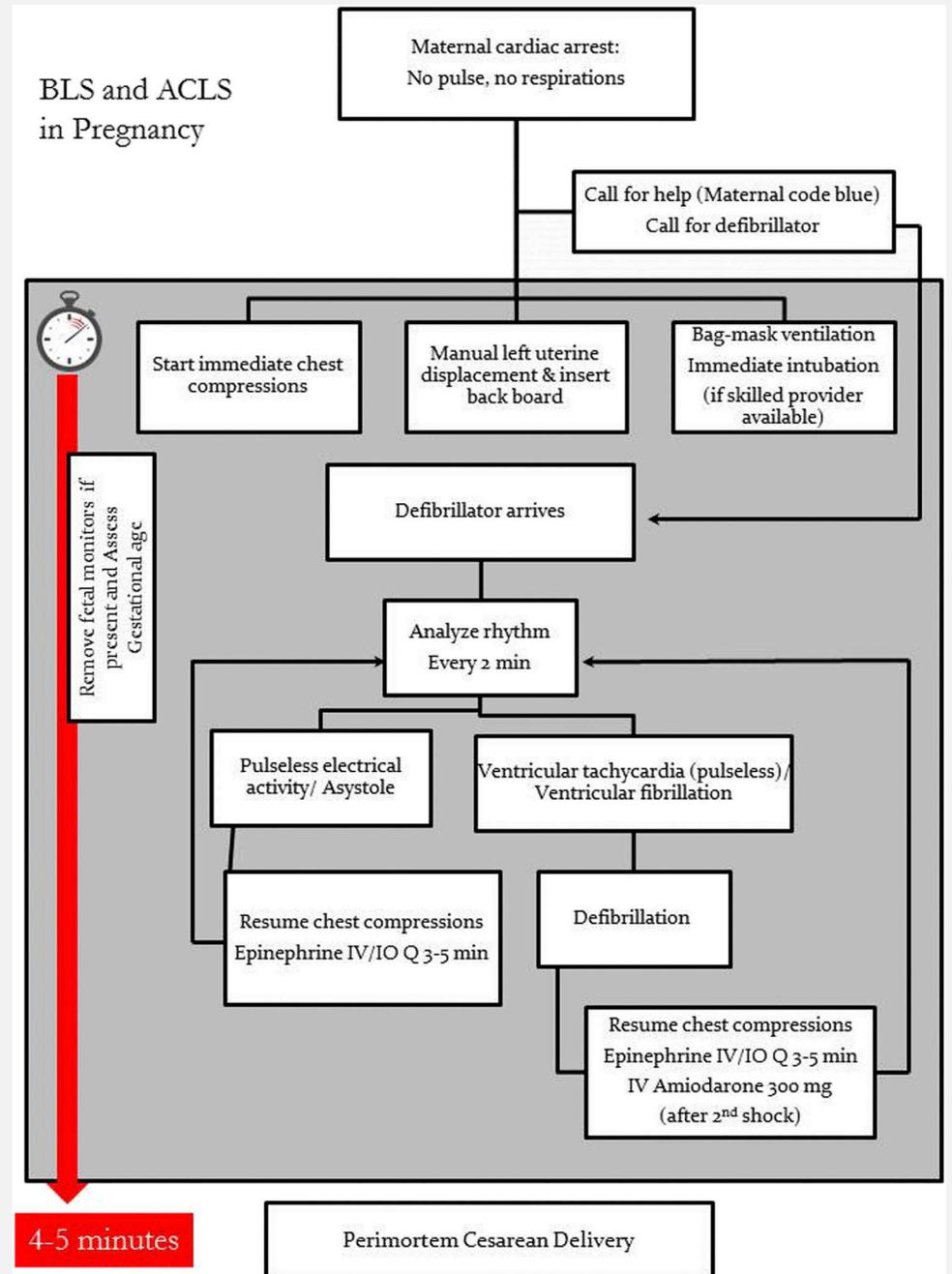
Photos from the American Heart Association

RECOMMENDED GUIDELINES FOR MATERNAL RESUSCITATION

- Following BLS and ACLS protocols, providers should perform pulse checks and determine if the patient has a shockable rhythm every two minutes.
- Shock when indicated or directed by the physician.
- After no more than four minutes, if appropriate, proceed with the perimortem cesarean delivery (PMCD).
- If the fetus is 20-24 weeks gestational age and the fundus exceeds the height of the umbilicus, PMCD should be performed immediately following the first rhythm check with an unshockable rhythm.
- During and following PMCD, continue resuscitative efforts per standard ACLS procedure.

MATERNAL RESUSCITATION FLOW SHEET

- The following flow sheet acts as a quick reference guide for the proper procedure of maternal resuscitation.
- It illustrates that most tasks are done simultaneously and within 4-5 minutes in preparation for perimortem cesarean delivery.
- Flow sheet sourced from the American Journal of Obstetrics and Gynecology (Zelop...2018)



OTHER CONSIDERATIONS FOR MATERNAL RESUSCITATION

- Alternative Airway Options:
 - Due to laryngeal edema, intubation is eight times more likely to fail in a pregnant patient than a patient from the general population. After two failed attempts, it is recommended to use a supraglottic airway device or combitube in combination with cricoid pressure. Trauma to the airway is a worst-case scenario and should only be used as a last resort. (Zelop...2018).
- Resuscitative Medication Metabolism:
 - Pregnancy increases the glomerular filtration rate and alters the pharmacokinetics of many medications. It also alters protein binding and increases renal clearance, all metabolic functions that can influence how the body metabolizes medication. However, there has been no clinical evidence to indicate that resuscitative medications may need dosage adjustments for the pregnant patient. Current research recommends following the standard ACLS guidelines (Zelop...2018).

PERIMORTEM CESARIAN DELIVERY OR RESUSCITATIVE HYSTEROTOMY

- The perimortem cesarian delivery, also known as a resuscitative hysterotomy, in combination with a timely response and effective CPR, is one of the most impactful interventions in maternal resuscitation.
- The standard for when to perform a PMCD is based on fundal height and the gestational age of the fetus. If the fetus is 20-24 weeks old or viable, and the fundal height exceeds the height of the umbilicus, it is standard to proceed with the delivery. If the fetus is under 20 weeks and the fundal height is not impacting the effectiveness of resuscitative measures, it may be more beneficial to continue with standard ACLS protocol (Jeejeebhoy...2015).
- As previously discussed, the gravid uterus can cause aortocaval compression and decrease maternal cardiac output greatly. Delivering the fetus and relieving that compression has shown a significant impact on the recovery of the patient.
- In 1986, a report described a 60% increase in maternal cardiac output after delivery.
- A 1998 report detailed the delivery of twins resulted in the immediate return of maternal cardiac rhythm (Rose...2015).

PERIMORTEM CESARIAN DELIVERY OR RESUSCITATIVE HYSTEROTOMY

- A 2010 study in The Netherlands of 12 patients described a return of cardiac output in eight patients (67%) following PMCD. (Rose...2015).
- In 18 case reports of PCMD with recorded hemodynamic parameters during the resuscitation following delivery, 12 cases described the return of maternal pulse and blood pressure (Katz...2005).
- Clinical evidence suggests that PCMD greatly increases the chances of return of spontaneous circulation, maternal hemodynamics, and overall resuscitative management (Rose...2015).

FETAL CONSIDERATIONS

- **Maternal Cardiac Arrest:**
 - Fetal death follows maternal death from hypoxia and subsequent cardiac arrest resulting from the lack of maternal blood flow to the fetus.
 - Fetal hypoxia resulting from MCA can lead to congenital abnormalities
- **Defibrillation:**
 - Defibrillation is shown to pass minimal if any energy from the mother to the fetus.
 - Removing fetal monitors will also aid in limiting fetal exposure to energy, but there is little data to support its importance.
- **Resuscitative Medications:**
 - Amiodarone: long term effects include fetal goiter and transient hypothyroidism; no known acute effects
 - Epinephrine: no known acute effects
 - Diazepam: increases risks for congenital abnormalities and floppy infant syndrome. Use with caution
 - Midazolam: less fetal effects; benzodiazepine of choice for the pregnant patient
 - Sodium Bicarbonate: increases fetal PaCO₂ and fetal acidosis. Use with caution.
 - Alpha-adrenergic agents and alpha and beta-agonists: when used in combination, may produce uteroplacental vasoconstriction leading to decreased fetal oxygenation and increased fetal hyperemia. Use with caution (Ramsay...2012).

CONCLUSION

- Maternal Cardiac Arrest is an event medical providers would prefer to never experience, but it does happen. With proper training and preparation, events of MCA can have positive outcomes. It is best to always remember that when caring for a pregnant patient, there are two patients, not just one, so decisions must be made concerning them both. While it is unethical and nearly impossible to have a clinical trial on maternal cardiac arrest, there is enough information circulating in the medical community to provide educated and quality care to mothers in these life-threatening situations. The information compiled here covers the basics of maternal resuscitation in a concise manner, hoping to aid medical professionals in preparing for the worst-case scenario of maternal cardiac arrest.

REFERENCES

References

- Jeejeebhoy, F. M., Zelop, C. M., Lipman, S., Carvalho, B., Joglar, J., Mhyre, J. M., . . . American Heart Association Emergency Cardiovascular Care Committee, Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation, Council on Cardiovascular Diseases in the Young, and Council on Clinical Cardiology. (2015). Cardiac arrest in pregnancy: A scientific statement from the American Heart Association. *Circulation (New York, N.Y.)*, *132*(18), 1747-1773. doi:10.1161/CIR.0000000000000300
- Katz, V., Balderston, K., & DeFrest, M. (2005). Perimortem cesarean delivery: Were our assumptions correct? *American Journal of Obstetrics and Gynecology*, *192*(6), 1916-1920. doi:https://doi.org/10.1016/j.ajog.2005.02.038
- Ramsay, G., Paglia, M., & Bourjeily, G. (2013). *When the heart stops: A review of cardiac arrest in pregnancy*. Los Angeles, CA: SAGE Publications. doi:10.1177/0885066611432405
- Rose, C. H., MD, Faksh, A., DO, Traynor, K. D., MD, Cabrera, D., MD, Arendt, K. W., MD, & Brost, B. C., MD. (2015). Challenging the 4-to 5-minute rule: From perimortem cesarean to resuscitative hysterotomy. *American Journal of Obstetrics and Gynecology*, *213*(5), 653-653.e1. doi:10.1016/j.ajog.2015.07.019
- Zelop, C. M., Einav, S., Mhyre, J. M., & Martin, S. (2018). Cardiac arrest during pregnancy: Ongoing clinical conundrum. *American Journal of Obstetrics and Gynecology*, *219*(1), 52-61. doi:10.1016/j.ajog.2017.12.232