



Critical Care in Obstetrics:

***An Innovative and Integrated Model for
Learning the Essentials***

Maternal Cardiac Arrest

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Society for Maternal • Fetal Medicine

Disclaimer



- The remarks made today are not representative of the official views of the US Army or US Government
- No financial disclosures



- Learning Objectives
- Background
- Risk Factors / Etiologies
- Treatment Algorithms
 - Pregnancy specific interventions/
considerations
 - Perimortem Cesarean Section
- Summary
- Evidence

Learning Objectives



- Understand the incidence and common etiologies that lead to cardiac arrest during pregnancy
- Describe the important modifications in treatment algorithms of cardiac arrest in pregnancy



■ **AHA Guidelines 2010**

- “There are no randomized controlled trials evaluating the effect of specialized obstetric resuscitation versus standard care in pregnant patients in cardiac arrest.
- There are reports in the literature of patients not in arrest that describe the science behind important physiological changes that occur in pregnancy that may influence treatment recommendations and guidelines for resuscitation from cardiac arrest in pregnancy.”



CME The Society for Obstetric Anesthesia and Perinatology Consensus Statement on the Management of Cardiac Arrest in Pregnancy

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MAY 2014

• ***Why Was This Consensus Statement Developed?***

This consensus statement was commissioned by the Society for Obstetric Anesthesia and Perinatology to improve maternal resuscitation by providing health care providers critical information and teamwork strategies relevant to maternal cardiac arrest.

Why is this Statement Different?



- “These recommendations were designed to address the operational reality of a real event by emphasizing team and systems strategies, latent systems errors, and periodic testing of performance.”



AHA Scientific Statement

Cardiac Arrest in Pregnancy

A Scientific Statement From the American Heart Association

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Abstract—This is the first scientific statement from the American Heart Association on maternal resuscitation. This document will provide readers with up-to-date and comprehensive information, guidelines, and recommendations for all aspects of maternal resuscitation. Maternal resuscitation is an acute event that involves many subspecialties and allied health providers; this document will be relevant to all healthcare providers who are involved in resuscitation and specifically maternal resuscitation. (*Circulation*. 2015;132:00-00. DOI: 10.1161/CIR.000000000000300.)

Key Words: AHA Scientific Statements ■ cardiopulmonary resuscitation ■ heart arrest ■ pregnancy

The image features a decorative graphic consisting of two overlapping circles. The outer circle is a light purple color, and the inner circle is a teal color. The circles are positioned such that they overlap in the center, creating a white space in the middle. The word "Background" is centered within this white space.

Background

Background



- Maternal cardiac arrest (MCA) is becoming more common and is a potential morbid obstetric emergency
- Treatment algorithms are modified based on both pregnancy and gestational age
- Early consideration of how to effect cesarean delivery is an important step to optimizing outcomes

Background



- Incidence of maternal cardiac arrest is increasing
- Obstetric healthcare teams lack experience given low incidence of ~1:20,000-1:50,000 (NEW 1:1 2,000 Admissions)
- Standard ACLS courses do not dedicate significant time to teaching obstetric specific interventions

Background



- ACLS course requirements vary between institutions
- Knowledge decay shown in OB providers
- ACLS course does not address facilities issues
 - Contribute to 75% of poor outcomes

Trends in Incidence



- Increasing risk of Severe Maternal Morbidity/
Mortality

Complication

% Increase

- Acute Renal Failure 351%

- Cardiac Arrest 245%

- Shock 250%

- Sepsis 149%

- Blood Transfusion 184%

- At least one major complication **113%**



Risk Factors/
Etiologies

Case Question



- You are having your morning coffee with another OB physician and discussing cardiac arrest. Your colleague says that the majority of cases in pregnancy are related to use of crack.
- Your best reply to them is:
 - No, trauma is much more common
 - No, AFEs are now the leading cause
 - Yes, especially in women over the age of 40



- **Most common causes of MCA:**
 - **Maternal cardiac complications** **19%**
 - **Trauma** **20%**
 - **Complications of preeclampsia** **18%**
 - **Amniotic fluid embolism** **13%**
 - **Toxicity (iatrogenic/drug abuse)** **8%**

Prevention



- Awareness of patient's risk factors
 - Maternal cardiac disease
 - Risk of hemorrhage
- Aggressive treatment of conditions that may deteriorate
 - Preeclampsia/eclampsia
 - Hypertension
 - Hemorrhage/blood product replacement
- Low threshold for admission to hospital
 - Best survival rates when cardiac arrest occurs in hospital compared to outside



ROSC

- Return
- Of
- Spontaneous
- Circulation



Treatment Algorithms:

Pregnancy specific
interventions/
considerations

Pregnancy-Related Modifications to Cardiac Resuscitation



Immediate request for OB/PEDS support

- Preparation for cesarean delivery with delivery within 5 minutes

Maternal Maneuvers

- **NO- Chest compressions above center of midpoint of sternum**
- Left uterine displacement
- Removal of fetal monitors prior to defibrillation

Airway

- Early consideration for intubation
- Continuous cricoid pressure
- Use small ET tube size

Case Question



- A 38 year old G3P2002 at 32 4/7 weeks who was brought in to triage complaining of sudden onset dyspnea and chest pain that started less than an hour ago. Past medical history is unremarkable. Upon initial presentation, she appeared to be in mild discomfort and slightly short of breath. Shortly after arrival, she was observed to become more agitated and combative and while attempting to restrain the patient, she lost consciousness and could not be aroused by verbal commands. As you check the patient you are unable to identify a pulse.
- **With recognition of maternal cardiac arrest, which of the following is/are the primary responsibilities of the first responder?**
 - Activate the maternal cardiac arrest team and document time of onset of arrest
 - Start chest compressions
 - Start intravenous access and ventilation with 100% oxygen

Treatment Algorithm



■ IMMEDIATE ACTIONS:

- Call Obstetric Code
- Call for Neonatal team (if viable pregnancy)
- Begin BLS Immediately
- Get Adult code cart & Backboard
- Begin preparation for cesarean section
- Assign a staff as timekeeper/documentation

■ BEGIN ACLS ALGORITHMS- PLACE AED

Treatment Algorithm



- CIRCULATION
- AIRWAY
- BREATHING
- DEFIBRILLATE
- EXTRACT FETUS

In Hospital – BLS Steps



Unresponsive
No breathing or no normal breathing
Uterus is at or above the umbilicus

Activate emergency response system:

- BLS response: minimum 3 additional staff + code cart
- ACLS: maternal code team activation
- Second responder: get AED immediately and apply

Check pulse:
Definite pulse within 10 seconds?

Definite pulse

• Using bag-mask: give 1 breath every 5–6 seconds
• Recheck pulse every 2 minutes

No pulse or unsure

Document time
Start high-quality chest compressions*

Apply AED

Perform appropriate airway management†

Perform continuous manual LUD

Shockable

Not shockable

Give 1 shock
Resume CPR immediately for 2 minutes

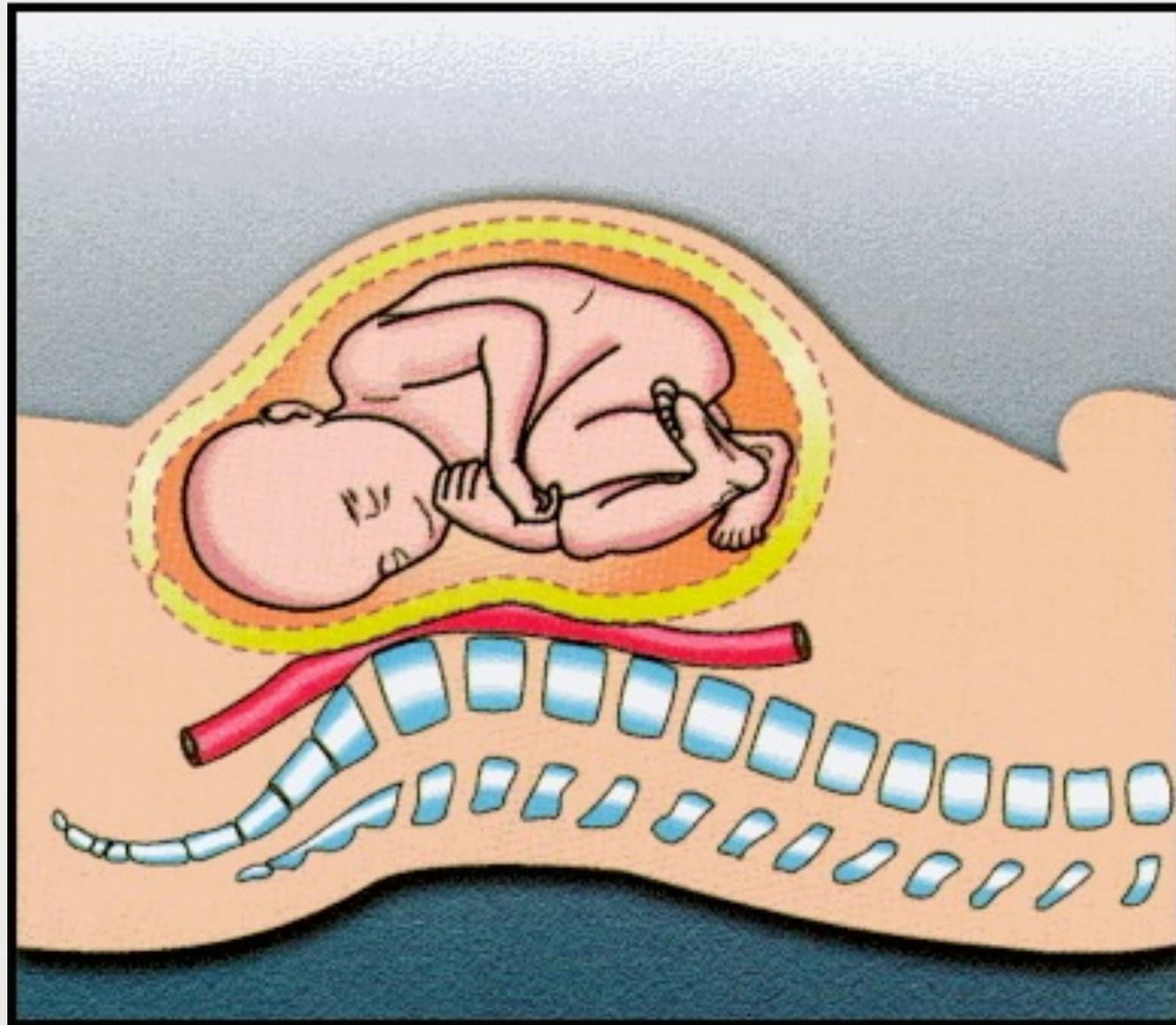
Resume CPR immediately for 2 minutes
Check rhythm every 2 minutes; if not shockable
Fluid resuscitation if PEA

Case Question

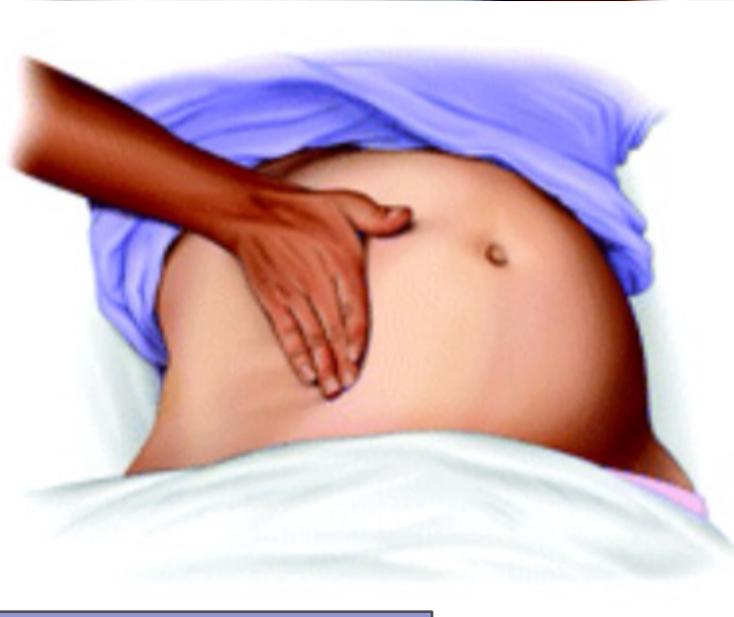


- What is the best initial patient position to decrease aortocaval compression and ensure optimal maternal hemodynamics during resuscitation efforts of maternal cardiac arrest in pregnancy?
 - With elevation of the feet above the level of the heart
 - Patient supine with manual left uterine displacement
 - Right lateral decubitus position

Aortocaval Compression



Left Uterine Displacement



2015 AHA STATEMENT

Treatment Algorithm



■ CIRCULATION

- Left uterine displacement
- Chest compressions (100/min) – 5cm depth
- IV access above diaphragm (IV or intraosseous)

■ AIRWAY

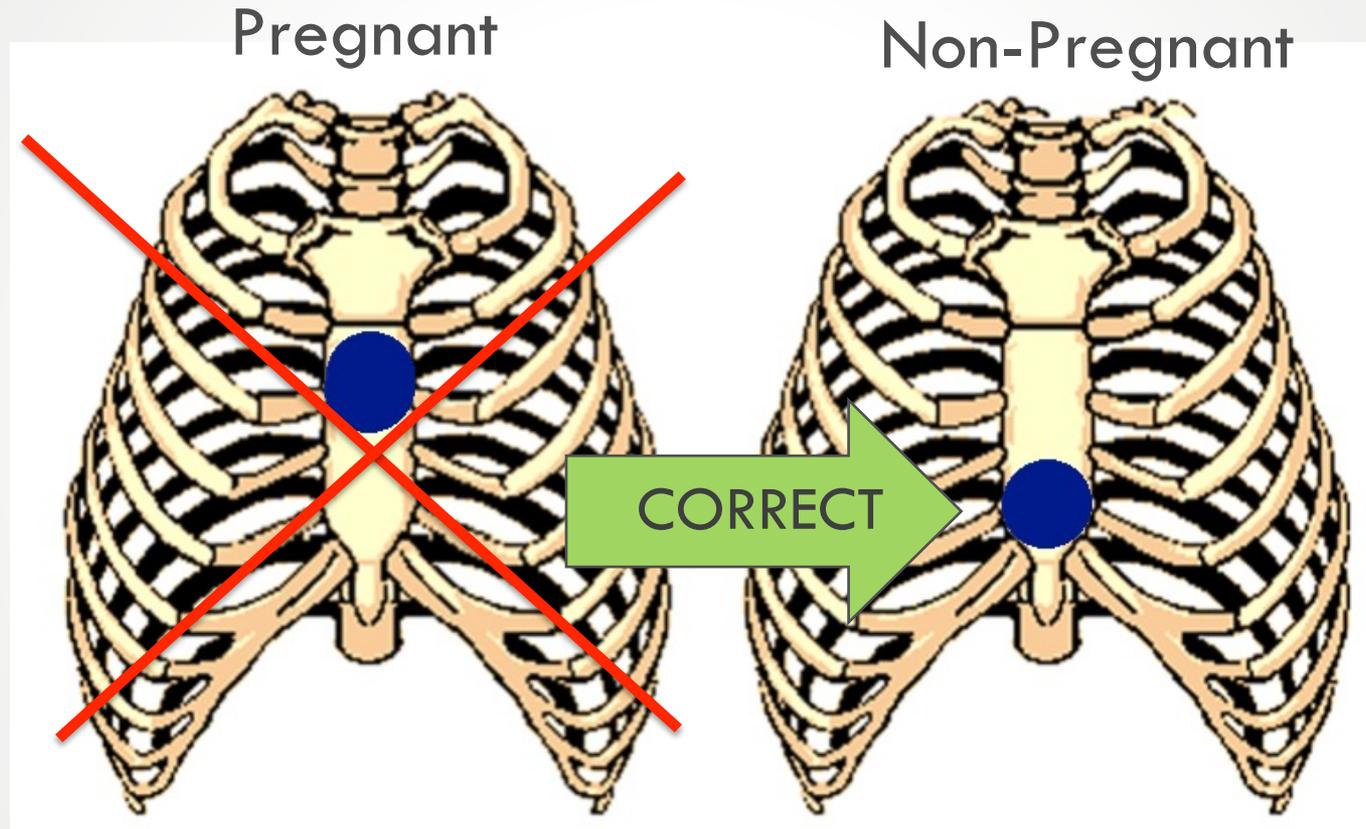
- Chin lift/jaw thrust / 100% O₂ at 10-15L/min
 - Bag/Mask ventilation
- Oral airway or Intubation (ETT vs LMA)
- **Do NOT interrupt chest compressions (if intubated)**
- Consider continuous cricoid pressure
- Small ETT size

Case Question



- You are 2 minutes into the code and you allow your intern to take over chest compressions. She is doing them correctly.
- Where is the correct placement of the hands for chest compression when performing CPR on a pregnant patient?
 - In the same position as the non-pregnant patient
 - Slightly higher than in the non-pregnant patient
 - On the lower 1/3 of the sternum

Chest Compressions



- Note higher position of hand placement in pregnancy no longer recommended by AHA

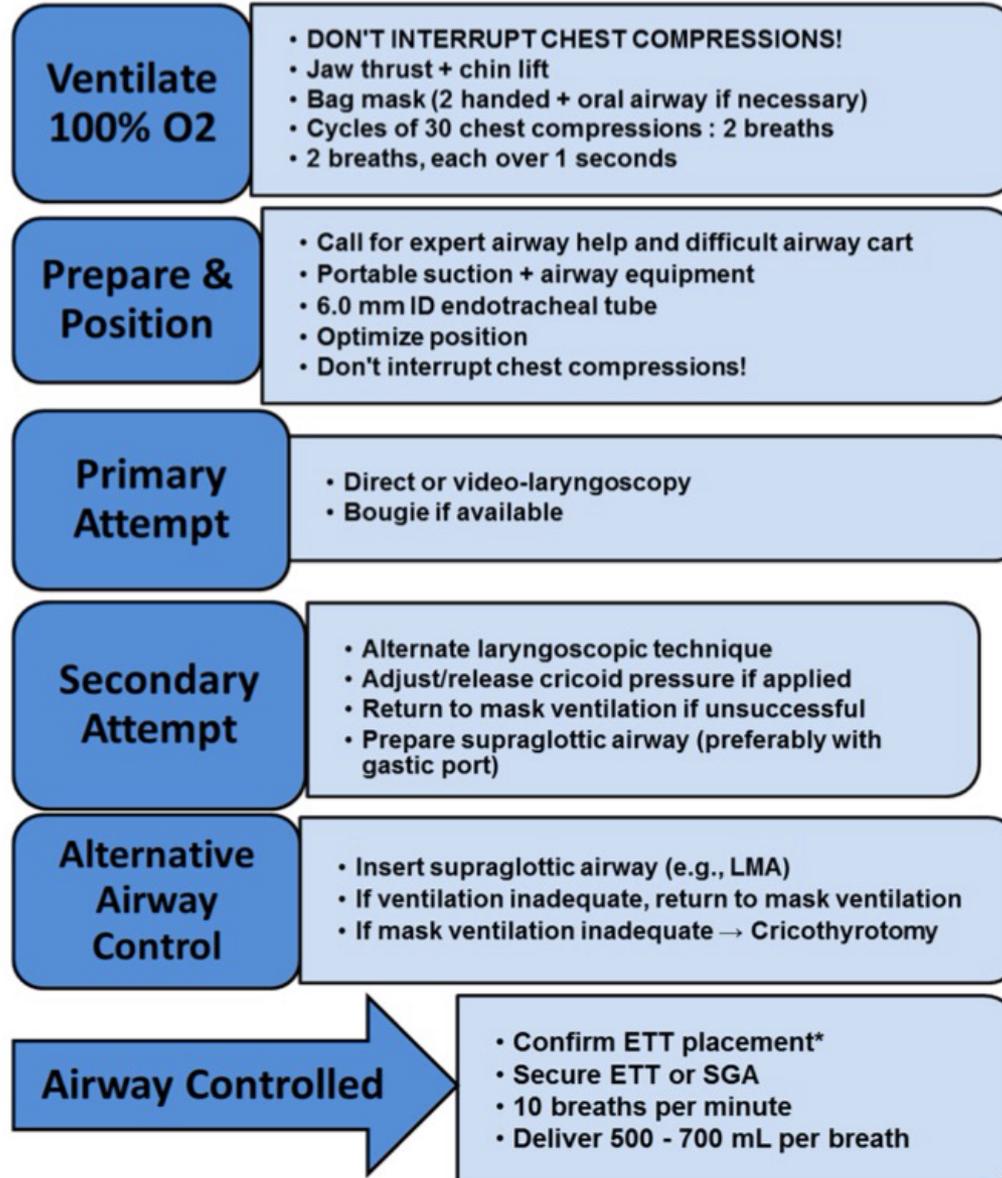


*Chest compressions in pregnancy:

- Use a firm backboard
- Place patient supine
- Place hands in center of chest (as in nonpregnant patient)
- Compress at a rate of at least 100/min
- Compress at a depth of at least 2 inches (5 cm)
- Perishock pause <10 seconds
- Allow complete chest recoil after each compression
- Minimize interruptions
- Perform continuous manual LUD



Airway Management



Case Question



- You have determined that you need to defibrillate the patient. Your nurse tells you that there is a fetal scalp electrode in place. What should you do?
- Defibrillate anyways
- Remove the FSE and then perform defibrillation
- Perform defibrillation at a lower energy level

Case Question



- The code team has arrived and taken over the code. They note that there is a shockable rhythm and ask if it is okay to defibrillate.
- You tell them:
 - No, it may cause a lethal fetal arrhythmia
 - Yes, defibrillation is considered safe in pregnancy

Treatment Algorithm



■ BREATHING

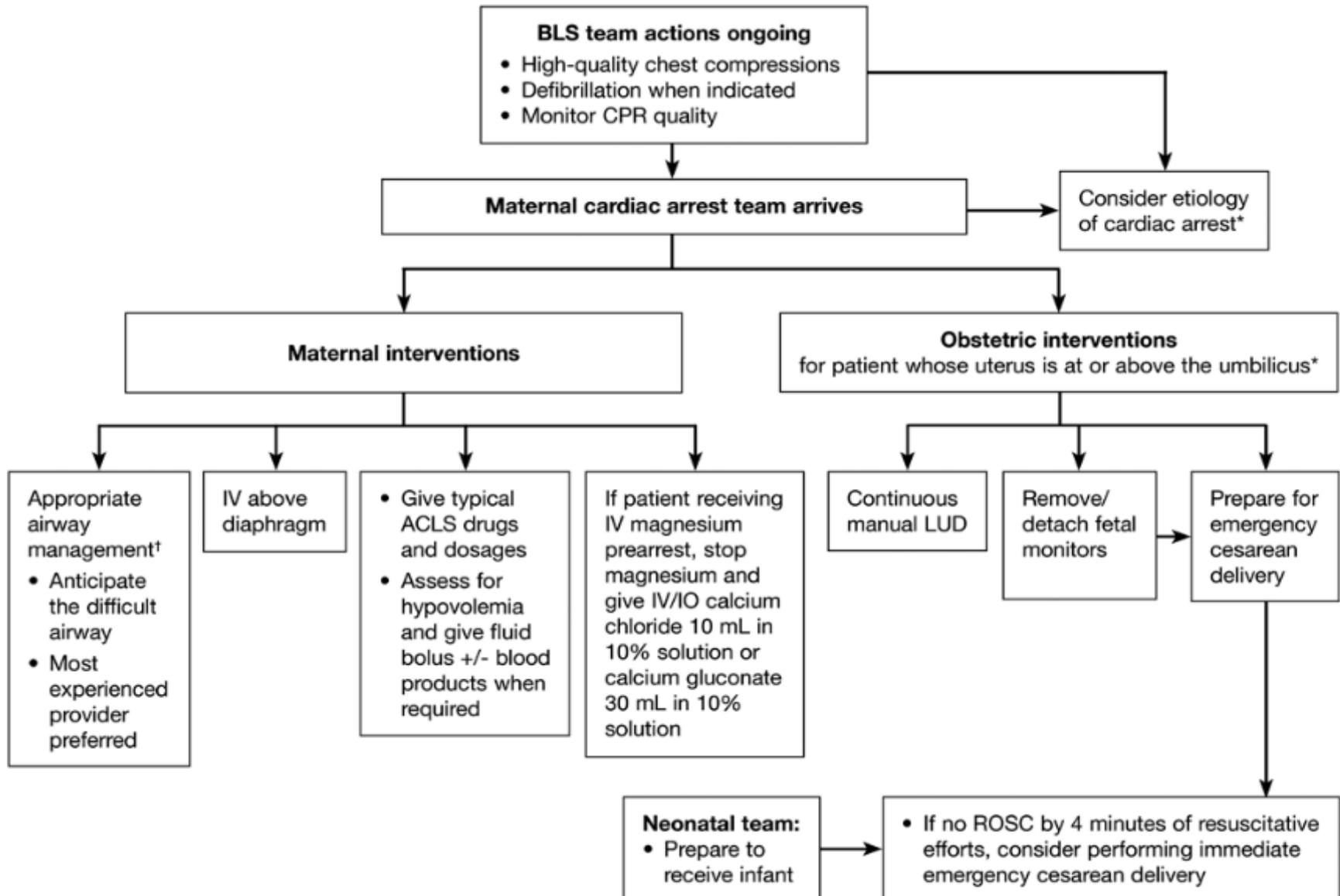
- If not intubated – 30 compressions : 2 breaths
- If intubated – 10 breaths per minute
- Administer each breath over 1 second

■ DEFIBRILLATE (*This is safe for fetus)

- Place pads (anterior & posterior)
- AED: Analyze/defibrillate every 2 min (same settings)
- Immediately resume CPR in between shocks

■ EXTRACT FETUS

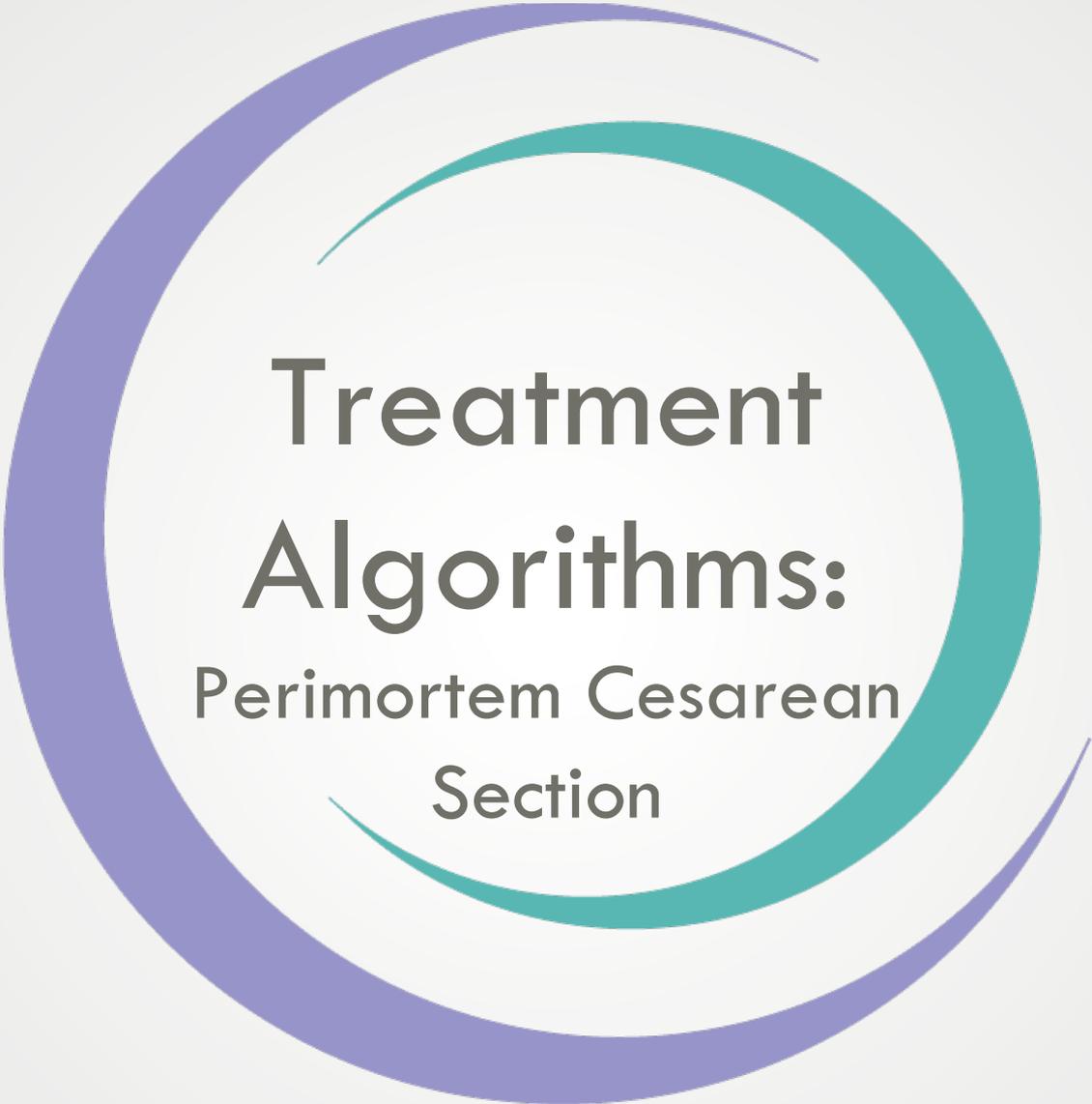
ACLS Actions During Pregnancy



Evaluate/Treat Possible Causes



- **Bleeding/DIC**
- **Embolism- coronary/pulmonary/AFE**
- **Anesthetic complications**
- **Uterine atony**
- **Cardiac disease- MI/cardiomyopathy**
- **Hypertension- preeclampsia/eclampsia**
- **Other- Differential dx of standard ACLS**
- **Placenta abruption/previa**
- **Sepsis**



**Treatment
Algorithms:
Perimortem Cesarean
Section**



Perimortem Cesarean

- Goal: Delivery within 5 min of maternal collapse after 20wks gestation.
 - Goal of improving compression of the IVC by the gravid uterus
 - Decrease O₂ demand
 - Improve pulmonary mechanics
- Practice: Of 57 cases of MCA with time from arrest to delivery recorded:
 - Only 5/57 completed within 5 minutes

Perimortem Cesarean



- Delivery within 10 minutes is likely more achievable.
- Consider creating emergency C/S kit for use in patient's room to decrease delays
 - Also considering keeping one in the ICU if pregnant patients are admitted
- Sterile abdominal prep not a priority
- "...timing of delivery remains more critical than the location of delivery."

Perimortem Cesarean



- **15 Teams randomized during drill for perimortem C/S to delivery in room or OR**
 - Significantly shorter time to delivery when done in Delivery Room than when transported to OR
 - **4:25 (3:59–4:50) vs 7:53 (7:18–8:57) minutes**
($p=0.004$)
- **When delivery accomplished in Delivery Room, following outcomes done earlier:**
 - Contacting the neonatal team
 - Placement of defibrillator
 - Resuming compressions
 - Endotracheal intubation

Perimortem Cesarean



■ AHA Scientific Statement recommends that for In-Hospital Cardiac Arrest

- a. The woman should not be transported to an operating room for PMCD during the management of an in-hospital maternal cardiac arrest (*Class IIa; Level of Evidence B*).
- b. The team should not wait for surgical equipment to begin the procedure; only a scalpel is required (*Class IIa; Level of Evidence C*).
- c. The team should not spend time on lengthy antiseptic procedures. Either a very abbreviated antiseptic pour should be performed, or the step should be eliminated entirely (*Class IIa; Level of Evidence C*).
- d. Continuous manual LUD should be performed throughout the PMCD until the fetus is delivered (*Class IIa; Level of Evidence C*). Care should be taken to avoid injury to the rescuer performing the manual LUD during PMCD.

Case Question



- A woman at 39 weeks is witnessed to collapse and have no pulse. The nurse begins CPR and the code team arrives. If no ROSC occurs, how long until you should proceed to Perimortem C/S?
 - 4 minutes after CPR started
 - 5 minutes after CPR started
 - No delay and proceed immediately

Teamwork & Communication



- **Remove physical barriers for code team access**
- **Leadership & Workload distribution**
 - Shared decision making during C/S
 - OB & Code Team (changes during code)
 - Assignment of roles
- **Communication**
 - Closed loop communication key
 - Brief “time outs” during resuscitation
- **Drills & Practice as a team**



Table 1. Checklist of Key Tasks During the First Minutes of In-House Maternal Cardiac Arrest

Call for help!	<input type="checkbox"/> Call "OB Code"
Start CPR	<input type="checkbox"/> Call neonatal team
	<input type="checkbox"/> AED/defibrillator
	<input type="checkbox"/> IMMEDIATE BLS
	<input type="checkbox"/> Adult code cart
	<input type="checkbox"/> Adult airway equipment
	<input type="checkbox"/> Backboard
	<input type="checkbox"/> Scalpel/Cesarean pack
	<input type="checkbox"/> Assign timer/documenter
C Circulation	<input type="checkbox"/> Left uterine displacement (manual)
Chest compressions	<input type="checkbox"/> Hands mid-sternum
	<input type="checkbox"/> 100 compressions/min
	<input type="checkbox"/> PUSH HARD! PUSH FAST!
	<input type="checkbox"/> Change compressors every 2 min
	<input type="checkbox"/> Obtain IV access above diaphragm
A Airway	<input type="checkbox"/> Chin lift/jaw thrust
	<input type="checkbox"/> 100% O ₂ at 10–15 L/min
	<input type="checkbox"/> Use self-inflating bag mask
	<input type="checkbox"/> Oral airway or
	<input type="checkbox"/> Experienced personnel: Intubation with 6–7.0 ETT or
	<input type="checkbox"/> Supraglottic airway (e.g., LMA)
	<input type="checkbox"/> Do not interrupt chest compressions!
B Breathing	<input type="checkbox"/> If not intubated: 30 compressions to 2 breaths
	<input type="checkbox"/> If intubated: 10 breaths per min (500–700 mL per breath)
	<input type="checkbox"/> Administer each breath over 1 s
D Defibrillate	<input type="checkbox"/> Pads front and back
	<input type="checkbox"/> Use AED or Analyze/defibrillate every 2 min
	<input type="checkbox"/> Immediately resume CPR for 2 min
	<input type="checkbox"/> Prepare for delivery
E Extract FETUS	<input type="checkbox"/> Aim for incision by 4 min
	<input type="checkbox"/> Aim for fetal delivery by 5 min



Call for help Start CPR	<ul style="list-style-type: none"><input type="checkbox"/> Call maternal code blue (Time: _____)<input type="checkbox"/> Backboard (Time: _____)<input type="checkbox"/> IMMEDIATE BLS<input type="checkbox"/> AED/defibrillator<input type="checkbox"/> Maternal airway equipment<input type="checkbox"/> Scalpel/cesarean pack<input type="checkbox"/> Assign timer/documenter<input type="checkbox"/> Document time of cardiac arrest (Time: _____)<input type="checkbox"/> Assign cognitive aid reader/recorder
C Circulation Chest Compressions	<ul style="list-style-type: none"><input type="checkbox"/> Left uterine displacement (manual) (Time: _____)<input type="checkbox"/> Hands midsternum<input type="checkbox"/> 100 compressions/min (Time: _____)<input type="checkbox"/> PUSH HARD, PUSH FAST<input type="checkbox"/> Change compressors every 2 minutes<input type="checkbox"/> Obtain IV access above diaphragm (Time: _____)
A Airway	<ul style="list-style-type: none"><input type="checkbox"/> Minimize interruptions in chest compressions<input type="checkbox"/> Chin lift/jaw thrust if not trauma victim<input type="checkbox"/> 100% O₂ at ≥15 L/min (Time: _____)<input type="checkbox"/> Use self-inflating bag-mask<input type="checkbox"/> Oral airway or<input type="checkbox"/> Experienced personnel: intubation with 6.0- to 7.0-mm inner diameter ETT or (Time: _____)<input type="checkbox"/> Supraglottic airway (eg, laryngeal mask airway with gastric port) (Time: _____)
B Breathing	<ul style="list-style-type: none"><input type="checkbox"/> If not intubated: 30 compressions to 2 breaths<input type="checkbox"/> If intubated: 8–10 breaths/min<input type="checkbox"/> Administer each breath over 1 second
D Defibrillate	<ul style="list-style-type: none"><input type="checkbox"/> Pads front and side<input type="checkbox"/> AED: analyze/defibrillate every 2 minutes (Time: _____)<input type="checkbox"/> Immediately resume CPR for 2 minutes<input type="checkbox"/> Prepare for delivery
E Extract Fetus	<ul style="list-style-type: none"><input type="checkbox"/> PMCD started (Time: _____) and<input type="checkbox"/> Fetus delivered (Time: _____)

Maternal Cardiac Arrest

First Responder

- Activate maternal cardiac arrest team
- Document time of onset of maternal cardiac arrest
- Place the patient supine
- Start chest compressions as per BLS algorithm; place hands slightly higher on sternum than usual

Subsequent Responders

Maternal Interventions

Treat per BLS and ACLS Algorithms

- Do not delay defibrillation
- Give typical ACLS drugs and doses
- Ventilate with 100% oxygen
- Monitor waveform capnography and CPR quality
- Provide post-cardiac arrest care as appropriate

Maternal Modifications

- Start IV above the diaphragm
- Assess for hypovolemia and give fluid bolus when required
- Anticipate difficult airway; experienced provider preferred for advanced airway placement
- If patient receiving IV/IO magnesium prearrest, stop magnesium and give IV/IO calcium chloride 10 mL in 10% solution, or calcium gluconate 30 mL in 10% solution
- Continue all maternal resuscitative interventions (CPR, positioning, defibrillation, drugs, and fluids) during and after cesarean section

Obstetric Interventions for Patient With an Obviously Gravid Uterus*

- Perform manual left uterine displacement (LUD)—displace uterus to the patient's left to relieve aortocaval compression
- Remove both internal and external fetal monitors if present

Obstetric and neonatal teams should immediately prepare for possible emergency cesarean section

- If no ROSC by 4 minutes of resuscitative efforts, consider performing immediate emergency cesarean section
- Aim for delivery within 5 minutes of onset of resuscitative efforts

*An obviously gravid uterus is a uterus that is deemed clinically to be sufficiently large to cause aortocaval compression



Summary

Things to Avoid



- Do NOT focus on the fetal heart rate tracing/status
 - Remove monitors during resuscitation
- Do NOT delay in moving towards perimortem cesarean section when indicated

Expected Outcomes



- Depends on the underlying etiology
- Largest study to date reports 54% survival to discharge
- Neonatal survival was most closely correlated with in hospital arrest - overall survival rate of 63%



The Joint Commission



- Recommends Obstetric Emergency Drills

- Drills should be used to:
 - train staff in the protocols,
 - refine local protocols
 - identify and fix systems problems that would prevent optimal care

Consensus Statement



“The actions of one provider or any single intervention rarely result in a positive or negative outcome in the event of maternal cardiopulmonary arrest; rather, it is the global performance of the resuscitation team and institutional preparedness for rare, critical events.”

Summary



- Knowledge of the key differences for cardiac arrest in pregnancy are important
- Practicing for obstetric emergencies with simulation improves outcomes
- Multidisciplinary simulation training should focus on both technical and teamwork skills in order to be most effective



Evidence

Evidence



- Callaghan W, Creanga A, Kuklina EV. Severe Maternal Morbidity Among Delivery and Postpartum Hospitalizations in the United States. *Obstet Gynecol* 2012; 120:120-1036.
- Einav S, Kaufman N, Sela HY. Maternal cardiac arrest and perimortem cesarean delivery: Evidence or expert-based? *Resuscitation* 2012; 83:1191-1200. **(Level III)**
- Lipman SS, Daniels KI, Carvalho B, Arafeh J, Harney K, Puck A, Cohen SE, Druzin M. Deficits in the provision of cardiopulmonary resuscitation during simulated obstetric cases. *Am J Obstet Gynecol* 2010; 203:179 e1-5. **(Level I – randomized trial)**
- Fisher N, Eisen LA, Bayya JV, Dulu A, Bernstein PS, Merkatz IR, Goffman D. Improved performance of maternal-fetal medicine staff after maternal cardiac arrest simulation-based training. *Am J Obstet Gynecol* 2011; 205:239.e1-5. **(Level II-2)**

Thank You for Your Attention!

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