Maternal Cardiac Arrest—
Synthesis of Guidelines

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Sources

- American Heart Association (AHA) Scientific Statement
- The Society for Obstetric Anesthesia and Perinatology Consensus Statement
- ATLS Guidelines
Recognition of Risk

- Maternal History
  - Difficult to obtain with non-responsive patient
  - Essential to help guide Recognition of Etiology
- Vital Signs
- Oxygen Saturation
- Level of Consciousness
A color-coded early warning score chart developed by Carle et al. 
≥6 should trigger a call for support from the intensive care unit or rapid response team and initiation of continuous monitoring of vital signs.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Score</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80-89</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>90-139</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>140-149</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>150-159</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>&gt;160</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Respiratory rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;29</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>10-17</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>18-24</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>&gt;30</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Heart rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;90</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>80-109</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>111-149</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>&lt;100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Fio2 to keep Sat &gt;96%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypoxia</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>24%-39%</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>&gt;40%</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤34</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>34.1-35.0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>35.1-37.9</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>38.0-38.9</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>≥39.0</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Consciousness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alert (GCS≤15)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Not alert (GCS&gt;15)</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

The fetus needs oxygen!
Cardiac arrest in pregnancy out-of-hospital basic life support (BLS) algorithm for healthcare providers.

- **EMS call received**
  - Patient is identified as pregnant
  - Document time

- **Unresponsive—patient is pregnant**
  - If no breathing or no normal breathing:
  - Get AED/defibrillator or send second rescuer if available to do so

- **Check pulse:**
  - Definite pulse within 10 seconds?
    - No pulse
      - AED/defibrillator arrives
    - Definite pulse
      - Give 1 breath every 5-6 seconds
      - Recheck pulse every 2 minutes

- **AED/defibrillator arrives**
  - Check rhythm
  - Shockable
    - Give 1 shock
    - Resume CPR immediately for 2 minutes
  - Not shockable
    - Resume CPR immediately for 2 minutes, check rhythm every 2 minutes, if not shockable

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*Manual left uterine displacement by the 1-handed technique from the right of the patient during adult resuscitation.*


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Manually left uterine displacement by the 2-handed technique from the left of the patient.

Cardiac arrest in pregnancy *in-hospital* basic life support (BLS) algorithm: simultaneous C-A-B-U (chest compressions/current-airway-breathing-uterine displacement).

**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
  - **Definite pulse**
    - Man (Bag-mask): give 1 breath every 5-6 seconds
    - Recheck pulse every 2 minutes
- No pulse or unsure
  - **No pulse or unsure**

Document time
- Start high-quality chest compressions*!

Shockable
- Give 1 shock
- Resume CPR immediately for 2 minutes

Not shockable
- Resume CPR immediately for 2 minutes
- Check rhythms every 3 minutes; if not shockable

Apply AED
- Perform appropriate airway management*
- Perform continuous manual LUD

* 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)
  - Peri-shock pause <10 seconds
  - Allow complete chest recoil after each compression
  - Minimize interruptions
  - Perform continuous manual LUD

**Appropriate airway management for pregnancy:**
- Open airway by using head tilt–chin lift maneuver (if not a trauma victim)
- Administer 100% O₂ at ≥15 L/min
- When available, perform bag-mask ventilation:
  - Seal mask; ensure no leak around mask
  - 2-handed technique preferred
  - Deliver each rescue breath over 1 second
  - Give 2 breaths for every 30 compressions
  - Give a sufficient tidal volume to produce visible chest rise or log within face mask
  - If not seen, reopen airway and improve seal.
  - Consider using oral airway
  - Avoid excessive ventilation

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Cardiac arrest in pregnancy in-hospital advanced cardiovascular life support (ACLS) algorithm.

**Maternal interventions**
- Anticipate difficult airway
- Status: hypovolemic, acidotic, polyuric, septic
- Give chlorpromazine or etomidate
- Give fluid boluses

**Obstetric interventions**
- FHR below 100 bpm
- If patient receiving magnesium sulfate: magnesium sulfate 2 g IV, give 2 L of normal saline, 10% calcium gluconate 30 mL IV, 1 L of normal saline
- Continuous manual LIDM
- Remove fetal monitors
- Prepare for emergency cesarean delivery
- If no ROSC by 4 minutes of resuscitative efforts, consider performing immediate emergency cesarean delivery

**Cognitive aid checklist for cardiac arrest in pregnancy.**

### Call for help
- Call maternal code blue (Time: ________)
- Backbone (Time: ________)
- IMMEDIATE BLS
- AED/defibrillator
- Maternal airway equipment
- Subcut/cesarean pack
- Assign time/documenter
- Document time of cardiac arrest (Time: ________)
- Assign cognitive aid reader/recorder

### Circulation
- Left uterine displacement (manual) (Time: ________)
- Hands midline
- 100 compressions/min (Time: ________)
- PUSH HARD, PUSH FAST
- Change compressors every 2 minutes
- Obtain IV access above diaphragm (Time: ________)

### Airway
- Minimize interruptions in chest compressions
- Chin-lift, jaw thrust if not trauma victim
- 100% O2 at 15 L/min (Time: ________)
- Use self-inflating bag-mask
- Oral airway
- Experienced personnel: intubation with 6.0- to 7.0-mm inner diameter ET or (Time: ________)
- Sues Anastasia, eg, laryngeal mask airway with gastric port (Time: ________)

### Breathing
- If not intubated: 30 compressions to 2 breaths
- If intubated: 8-10 breaths/min
- Administer each breath over 1 second

### Defibrillate
- Pads front and side
- AED: analyze/defibrillate every 2 minutes (Time: ________)
- Immediately resume CPR for 2 minutes
- Prepare for delivery

### Extract Fetus
- PMCD started (Time: ________)
- Fetus delivered (Time: ________)

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Perimortem, NOT Postmortem, Cesarean Delivery

• The procedure should be consider both an intervention to potentially assist with maternal resuscitation and for fetal indications to potentially be life saving.
  • *CPR is rarely effective with 1/3 less Cardiac Output, for late stage pregnant uterus (Ueland et al).*
  • *CPR in a left tilt is less forceful.*
  • *Perimortem cesarean delivery is rarely done within 5 minutes.*

Jeejeebhoy et al. Resuscitation, 2011

Key Components in Resuscitation

1. Organization of the Response Team
   a. Proper personnel – **CALL OB Charge Nurse and Remember the baby!**
   b. Critical equipment – Scalpel

2. Communication
   a. Open-air commands
   b. Failure to close-the-loop

3. Workload Delegation and Assignment of Roles
   a. Standardize roles
   b. Redundant roles for familiar (prepping), lack of assignment for timer/documentation, second CPR, LUD roles

4. Assessment
   a. The individuals with the highest competency should perform assessments to the best of their ability, each in parallel for each patient (the mother and the fetus)
Key Components in Resuscitation

5. Leadership
   a. Coordinated integration given 2 patients present
   b. Shared decision-making
   c. Code leader should have a familiarity with the physiology and customary management of pregnant women

The Society for Obstetric Anesthesia and Perinatology Consensus Statement on the Management of Cardiac Arrest in Pregnancy, 2014

1. Immediate BLS – Call for help, Neonatology included
2. Compressions – Hard (5-cm Depth); Fast (100 compressions/min); Uninterrupted
3. Uterine Displacement – Left, Uterus at umbilicus or greater.
4. Defibrillation – Within 3 minutes for shockable rhythm. AED is acceptable.
   a. Ventilate with 100% O2 – Jaw thrust + chin lift, Two-hands! Bag q 6 sec
   b. Primary attempt at Intubation – Optimize, consider smaller tube 6 mm
   c. Second attempt – Laryngoscopy altered, Cricoid pressure changed
   d. Insert LMA, Bag, or Cricothyrotomy
   e. Secure – Confirm, 10 breaths per min, Tidal Volume 500-700 mls
6. IV access – Above the Diaphragm
7. Resuscitation with Drugs – No variation from other Adult Guidelines
8. Perimortem Cesarean or Operative Vaginal Delivery
Perimortem Cesarean Delivery

• Preparation of the abdomen is preferred but not required.
• Cesarean section instruments should ideally be readily available at the start of the procedure; however only a scalpel is necessary.
• The procedure should be performed by individuals experienced in the technique unless they are not available and the maternal injuries are obviously lethal to the mother.
  • Cases of out of hospital cesarean should be limited
  • Rare maternal trauma can lead to cesarean delivery at site
• The procedure should be considered promptly after initial attempts are made to regain spontaneous maternal circulation, at the 1 minute timepoint.
• The procedure can be considered at the location of the arrest if experts are available.

Improving Outcomes II: Causes of Maternal Cardiac Arrest

A  Anesthetic complications
  High neuraxial block
    • Hypotension
    • Loss of airway
    • Aspiration
    • Respiratory depression
    • Local anesthetic systemic toxicity
  Accidents/Trauma
    • Suicide
Causes of Maternal Cardiac Arrest

B  Bleeding Coagulopathy
   - Placenta accrete/percreta
   - Placental abruption
   - Placenta previa
   - Retained products of conception
   - Uterine rupture
   - Ruptured spleen
   - Uterine atony
   - Surgical-Post cesarean
   - Transfusion reaction

C  Cardiovascular causes
   - Myocardial infarction-Atherosclerosis vs coronary dissection
   - Aortic dissection
   - Cardiomyopathy
   - Arrhythmias
   - Valve disease
   - Congenital heart disease
Causes of Maternal Cardiac Arrest

D  Drugs
  • Magnesium
  • Drug error
  • Illicit drugs
    • Opioids
  • Insulin
  • Anaphylaxis

E  Embolic causes
  • Amniotic fluid embolus
  • Pulmonary embolus
  • Cerebrovascular event
  • Venous air embolism
Causes of Maternal Cardiac Arrest

F  Fever
  •  Sepsis (Infection)
  •  Prolonged Rupture of the Membranes

G  General H’s and T’s

<table>
<thead>
<tr>
<th>H</th>
<th>Hypovolemia</th>
<th>Hypoxia</th>
<th>Hydrogen Ion (acidosis)</th>
<th>Hypo/Hyperkalemia</th>
<th>Hypothermia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low circulating volume.</td>
<td>Deprivation of an adequate oxygen supply can be a significant contributing cause of cardiac arrest.</td>
<td>Obtain an arterial blood gas to determine respiratory acidosis.</td>
<td>Provide adequate ventilations.</td>
<td>If a patient has been exposed to the cold, warming measures should be taken.</td>
</tr>
<tr>
<td></td>
<td>Look for obvious blood loss.</td>
<td>Ensure that the airway is open.</td>
<td>Ensure adequate ventilation and bilateral breath sounds.</td>
<td>Use sodium bicarbonate to prevent metabolic acidosis if necessary.</td>
<td>Core temp. should be raised above 96°F (35.5°C) as soon as possible.</td>
</tr>
<tr>
<td></td>
<td>Most important intervention is to obtain IV access and administer IV fluids.</td>
<td>Ensure oxygen supply is connected properly.</td>
<td></td>
<td></td>
<td>The patient may not respond to drugs or electrical therapies if hypothermic.</td>
</tr>
<tr>
<td></td>
<td>Use a fluid challenge to determine fluid error in relation to hypovolemia.</td>
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</tbody>
</table>

- Toxins – Overdose
- Tamponade
- Tension Pneumothorax
- Thrombosis – MI or PE
Causes of Maternal Cardiac Arrest

- Hypertension Preeclampsia
  - Eclampsia
  - HELLP syndrome

What are the Mechanisms of Death related to these conditions?
- Intracranial Bleed
- Intrahepatic or intra-abdominal bleeding
Post-Arrest Management

• Correction of the underlying etiology is the **ONLY** path for a less morbid or to avoid mortality
• Attempts at correction of Mortality should be initiated promptly
  • Eg. Consider ECMO promptly for cardiogenic causes
• Consultation should be obtained immediately to define and correct etiology.
Case 1

• A 26 year yo primigravida arrives with progressive shortness of air of two days duration at 27 weeks of pregnancy
  • Past Medical History is remarkable for a history of congenital heart disease

Case 1

• Evaluation in the ER suggests volume overload with diffuse pulmonary airspace disease, hypoxemia, and progressive tachypnea.
  • A CT does not demonstrate an embolus
Case 1

- Maternal fatigue and worsening hypoxia lead to fetal status with a Category II tracing.
  - Intubation is followed by deterioration of maternal and fetal status.
  - A maternal pulse is not identified.
    - A code is called.

Case 2

- Pregnant woman 35 weeks gestation presents to the ER unresponsive after a GSW to the chest.
Case 2

• Despite volume resuscitation and perimortem cesarean delivery both mother and child are mortalities.
• Potential role for “in the field” perimortem cesarean when lethal injuries are suspected.

Quality Improvement

• Consistency of Approach plus an Etiology-specific Approach
  • ACLS vs ATLS: Does the etiology of hypovolemia mandate unique consideration of the sequence for Maternal Fetal Resuscitation? Should the literature be standardized for such a rare event? YES.
  • If the fetus is dead, who should call for the cesarean during the course of a maternal resuscitation; ER physician, Obstetrician, Trauma surgeon? Ideally, those involved should have the best understanding of maternal physiology as it is unique, and special considerations are acknowledged by each specialty organization who construct guidelines.
  • If the fetus is viable, who should call for the cesarean; Obstetrician if available
  • Who performs the assessment of fetal viability? Obstetrician or ER physician
  • Where should the cesarean delivery take place? Where needed.
  • After what time interval, should a perimortem cesarean section be considered futile for maternal or fetal benefit? 30 minutes after initiation of CPR? 45? 60 minutes? Is there literature to justify futility? There is no number.
  • Is there a value for a postmortem cesarean delivery? History of cesarean delivery provides a guide. Emotional issues involved with closure. Obtain consent.