Cardiac Arrest in Pregnancy

รศ. พญ. ตันหยง พิพานเมฆาภรณ์
ภาควิชาวิสัญญีวิทยา คณะแพทยศาสตร์
มหาวิทยาลัยเชียงใหม่
Overview

- Basic life support (BLS)
- Advanced Cardiovascular Life Support (ACLS)
- Causes of cardiac arrest
- Perimortem cesarean section
- Post Cardiac Arrest Care
Maternal cardiac arrest

- The overall maternal mortality was calculated at 13.95 deaths per 100,000 maternities.
- Incidence: 1:12,000 - 1:20,000
- Poor survival rate (6.9%)
- Common causes of cardiac arrest are amniotic fluid embolism, acute myocardial infarction and venous embolism.
Maternal cardiac arrest

• Resuscitation of maternal cardiac arrest:
  - The altered physiologic state induced by pregnancy
  - The requirement to consider both maternal and fetus issues during resuscitation
  - Possibility of perimortem cesarean section during resuscitation
**Validated obstetric early warning score**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Systolic BP</th>
<th>Respiratory rate</th>
<th>Heart rate</th>
<th>Fio₂ to keep Sat &gt;96%</th>
<th>Temperature</th>
<th>Consciousness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;80</td>
<td>&lt;10</td>
<td>&lt;60</td>
<td>Room air</td>
<td>&lt;34</td>
<td>Alert (GCS=15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80–89</td>
<td>10–17</td>
<td>60–110</td>
<td>24%-39%</td>
<td>34.1–35.0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>91–139</td>
<td>18–24</td>
<td>111–149</td>
<td>&gt;40%</td>
<td>35.1–37.9</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>140–149</td>
<td>25–29</td>
<td>&gt;150</td>
<td>32%–39%</td>
<td>38.0–38.9</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150–159</td>
<td>21–24</td>
<td></td>
<td>&gt;40%</td>
<td>&gt;39.0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;160</td>
<td>&gt;30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BLS Modifications
Patient positioning

- important strategy to improve the quality of CPR and resultant compression force and output

- effect of aortocaval compression of gravid uterus (↓stroke volume and cardiac output)
Basic Life Support Modifications

- Effect of left-lateral tilt
  - improved maternal hemodynamic parameters (blood pressure, stroke volume, cardiac output)
  - improved fetal parameters (oxygenation, nonstress test, and heart rate)
Aortocaval compression
Fig 2 The mean CO changes in subgroup of patients without (n = 146) and with (n = 11) severe ACC (CO change of ≥20%) at different angles of lateral tilt [mean (sd)].
Basic Life Support Modifications

- No improvement in maternal hemodynamic or fatal parameters with 10° to 20° left lateral tilt in patients without cardiac arrest

- More aortocaval compression at 15° left lateral tilt compared to full left lateral tilt

- Lateral tilt > 30° (aortocaval compression)
Basic Life Support Modifications

• A tilt ≥ 30° may not be practical during resuscitation

  - transmission forces are no longer perpendicular to thorax

• Degree of tilt is difficult to estimate (often overestimated)
Manual left uterine displacement (LUD)

• Relieve aortocaval compression

• Less hypotension and significant reduction in mean ephedrine requirement

• Allow high quality chest compression

• Easier access for defibrillation and airway management

• Left side LUD (preferable)
Recommendations

• Continuous manual LUD should be performed on all pregnant women who are in cardiac arrest in which uterus is palpated at or above the umbilicus to relieve aortocaval compression during resuscitation (Class I)

• If the uterus is difficult to assess, attempts should be made to perform manual LUD if technically feasible (Class IIb)
Left uterine displacement using 1-handed technique
Figure 3. Manual left uterine displacement by the 1-handed technique from the right of the patient during adult resuscitation.
Left uterine displacement using 2-handed technique
Patient in 30° left lateral tilt using a firm wedge
Airway

- Difficult airway
- Lateral tilt position (more difficulty)
- Increased risk of aspiration and rapid desaturation
- Cricoid pressure (no specific information to support its use) and it should be released if difficult ventilation or poor laryngoscopic view
Breathing

- Rapid desaturation
  - Decreased functional residual capacity
  - Increased oxygen demand
  - Increased intrapulmonary shunt

- Reduce of ventilation volumes
  - Elevated diaphragm

- Hyperventilation  ➔ respiratory alkalosis
- (↑uterine vasoconstriction and fetal hypoxemia)
Breathing

- Prepared to support oxygenation, ventilation, and monitor oxygenation closely
Circulation

- Chest compression: similar to nonpregnant (Class IIa)
  - Position
  - Rate
  - Depth
Circulation

- The patient should be placed supine for chest compression (Class I)

- No literature exam the use of mechanical chest compression and this is not advised at this time
Transporting pregnant women during chest compression

• An immediate cesarean delivery may be the best way to optimize the condition of the mother and fetus

  - This operation should optimally occur at the site of arrest (Class I)

  - A pregnant patient with in-hospital cardiac arrest should not be transported for cesarean delivery
Defibrillation

- The same currently recommended defibrillation protocol should be used in the pregnant patients as in the nonpregnant patients.

  - No modification of the recommended application of electric shock during the pregnancy (Class I)

  - The patient should be defibrillated with biphasic shock energy of 120 to 200 J (Class I)
Defibrillation

• Compressions should be resumed immediately delivery of the electric shock (Class IIa)

• The use of an automated external defibrillator may be considered (Class IIb)
Defibrillation

- Anterolateral defibrillator pad placement is recommended as a reasonable default (Class IIa).
- The lateral pad/paddle should be placed under the breast tissue.
- The use of adhesive shock electrodes is recommended to allow consistent electrode placement (Class IIa)
Figure 2. Cardiac arrest in pregnancy in-hospital basic life support (BLS) algorithm: simultaneous C-A-B-U (chest compressions/current-airway-breathing-uterine displacement). ACLS indicates advanced cardiovascular life support; AED, automated external defibrillator; CPR, cardiopulmonary resuscitation; LUD, left uterine displacement; and PEA, pulseless electric activity.
ACLS Modifications
Figure 5. Cardiac arrest in pregnancy in-hospital advanced cardiovascular life support (ACLS) algorithm. BLS indicates basic life support; CPR, cardiopulmonary resuscitation; ETT, endotracheal tube; IV, intravenous; IO, intraosseous; LUD, left uterine displacement; and ROSC, return of spontaneous circulation.
Search for and Treat Possible Contributing Factors (BEAU-CHOPS)

- Bleeding/DIC
- Embolism: coronary/pulmonary/amniotic fluid embolism
- Anesthetic complications
- Uterine atony
- Cardiac disease (MI/ischemia/aortic dissection/cardio-myopathy)
- Hypertension/preeclampsia/eclampsia
- Other: differential diagnosis of standard ACLS guidelines
- Placenta abruptio/previa
- Sepsis
Airway

- Changes in airway mucosa (edema, hypersecretion, friability, and hyperemia)
- Airway management is more difficult than nonpregnancy
- A major cause of maternal morbidity and mortality: failed intubation
- The most experienced person should secure and manage
Airway

- Bag-mask ventilation with 100% oxygen before intubation is important (Class IIa)

- Supraglottic airway devices are acceptable.
Recommendation

- Hypoxemia should always be considered as a cause of cardiac arrest. Oxygen reserve are lower and metabolic demand is higher.

- Early ventilatory support may be necessary (Class I)
<table>
<thead>
<tr>
<th>Equipment to Be Used by First Responders</th>
<th>Equipment to Be Used by Experts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>Laryngoscope and assorted blades</td>
</tr>
<tr>
<td>Bag-valve-mask devices (eg, Ambu Bag with disk valve as opposed to duckbill valve preferred)</td>
<td>Videolaryngoscope</td>
</tr>
<tr>
<td>Appropriate size face masks and oral airways</td>
<td>Cuffed tracheal tubes: size 6.0- to 7.0-mm inner diameter with a semirigid stylet and a range of backup sizes available</td>
</tr>
<tr>
<td>Stethoscope</td>
<td>Gum elastic bougie</td>
</tr>
<tr>
<td>Pulse oximeter</td>
<td>Airway exchange catheter</td>
</tr>
<tr>
<td>Qualitative carbon dioxide detector</td>
<td>Supraglottic airways in a range of sizes</td>
</tr>
<tr>
<td>Suction device</td>
<td>Flexible fiberoptic intubation equipment</td>
</tr>
<tr>
<td></td>
<td>Equipment suitable for emergency invasive airway access (eg, cricothyrotomy)</td>
</tr>
<tr>
<td></td>
<td>Exhaled carbon dioxide detector</td>
</tr>
</tbody>
</table>

*The items listed in this table represent suggestions. The contents should be selected to meet the specific needs, preferences, and skills of the practitioner and healthcare facility.*
Recommendation

- ET tube should be performed by experienced laryngoscopist (Class I)
  - start with an ET with ID 6.0-7.0 mm (Class I)
  - optimally no more than 2 laryngoscopy attempt should be made (Class IIa)
  - supraglottic placement is preferred  rescue strategy for failed intubation (Class I)
Recommendation

- If attempt airway control fail and mask ventilation is not possible, current guideline for emergency invasive airway access should be followed.

- Avoid prolonged intubation attempt to prevent deoxygenation, prolonged interrupted in chest compression, airway trauma, and bleeding) (Class I)
**Recommendation**

- Cricoid pressure is not routinely recommended (Class III)

- Continuous waveform capnography
  - confirming and monitoring correct placement of ET tube
  - Monitor CPR quality
  - Adequate chest compression or ROSC (PETCO2 > 10 mmHg)
Recommendation

- Interruption in chest compression should be minimized during advanced airway placement (Class I)
Circulation

- Changes in pharmacokinetics
  - Increase in glomerular filtration rate
  - Increase in plasma volume
  - Decrease in protein binding

- However, current recommended drug doses for resuscitation of pregnant patients are similar to adult cardiac arrest (Class IIb)
In the setting of cardiac arrest, no medication should be withheld because of concern of teratogenicity (Class IIb)

Current ACLS drugs at recommended doses be used without modifications (Class IIa)
Circulation

- The event of difficult peripheral IV access
  - Intraosseous access in proximal humerus
  - Ultrasound-assisted peripheral or central venous access

- Obtaining IV or intraosseous access above the diaphragm is recommended.
  - avoid the potentially deleterious effects of vena caval compression
Circulation

-Increase the time required for fluids or administered drugs to reach the heart
Defibrillation

- Defibrillation should be performed at the recommended ACLS defibrillation doses

- Potential harm to the fetus during electrical shock (arching or electrical burns)

- Risk factors for adverse fetal outcomes: current and duration of contact
Defibrillation

- The greatest predictor of risk for adverse fetal outcome if the current travels to uterus and amniotic fluid (increased risk of fetal death and burns)

- Cardioversion and defibrillation on the external chest are considered safe at all stages of pregnancy.
Defibrillation

- If shock is delivered to mother’s thorax, there is very low risk of electrical arcing to fetal monitors.

- Remove internal or external fetal monitoring is reasonable during maternal cardiac arrest (Class IIb).
Treatment of reversible causes

- Obstetric etiologies

1. Bleeding/ Disseminated Intravascular Coagulation
   - Expansion of maternal circulating blood volume can mask the sign and symptoms of hemorrhage
   - Effective quantification of blood loss and awareness of initial changes in maternal vital signs
   - Crystalloid solutions, blood or blood products or surgical interventions
Treatment of reversible causes

2. Embolism: coronary, pulmonary, amniotic fluid embolism

2.1 Amniotic fluid embolism

- Acute hypotension, cardiovascular collapse and consumptive coagulopathy

- Treatment: adequate oxygenation, aggressive restoration of cardiac output, and reverse coagulopathy
3. Anesthetic complications
   - Cardiac arrest may result from regional anesthesia
   - General anesthesia: loss of airway control or aspiration, hypoventilation or airway obstruction
   - Local anesthetic toxicity

4. Uterine atony
Treatment of reversible causes

5. Cardiac diseases

- myocardial ischemia (the most common)
- fibrinolytics drugs (relative contraindication)
- PCI is the reperfusion strategy of choices
- Other causes: congenital heart disease, pulmonary hypertension
6. Preeclampsia/eclampsia
   - severe hypertension and diffuse organ-system failure
   - Supportive treatment: magnesium sulfate, antihypertensive drugs, fluid resuscitation, fetal surveillance

7. Other: differential diagnosis of standard ACLS guideline
8. Placenta abruptio / previa

9. Sepsis
   - Decreased tissue perfusion results in multisystem organ failure
   - Pregnancy is vulnerable to infection (altered immune state)
Treatment of reversible causes

10. Magnesium sulfate toxicity
   - Effects on cardiovascular systems
     
     2.5-5 mmol/L: ECG interval changes (prolonged PR, QRS and QT intervals), AV nodal blocks, bradycardia, hypotension

     6-10 mmol/L: cardiac arrest

   Others symptoms: gastrointestinal symptoms, skin changes, and electrolytes/ fluid abnormalities
Fetal assessment during cardiac arrest

- Fetal assessment should not be performed during resuscitation (Class I)

- Fetal monitors should be removed and detached as soon as possible to facilitate PMCD without delay or hindrance (Class I)
Maternal cardiac arrest not immediately reversed by BLS and ACLS

- Activate the protocol for an emergency cesarean delivery as soon as cardiac arrest is identified

- Emergency cesarean section should be considered if maternal hemodynamic changes occur due to aortocaval compression

- Maternal aortocaval compression can occur for singleton pregnancies at >/ 20 weeks of gestational age
Timing with emergency cesarean section

- Perimortem cesarean delivery is required
  - improve the chance of ROSC
  - maternal and fetal survival
- The emergency cesarean section team should be activated at the onset of maternal cardiac arrest (Class I)
Maternal cardiac arrest team

- An adult resuscitation team
- Obstetrics
- Anesthesia care providers
- Neonatology team
Timing with emergency cesarean section

• If there is no ROSC at 4 minutes after onset of cardiac arrest, emergency cesarean section may be considered (class IIa)

• Not require to wait 5 minutes before initiating emergency hysterotomy eg. obvious nonsurvival injury
Timing with emergency cesarean section

- If maternal viability is not possible, the procedure should be started immediately, the team does not have to wait to begin the PMCD (Class I)
Vaginal delivery during maternal cardiac arrest

- Assisted vaginal delivery should be considered when the cervix is dilated and fetal head is at appropriated low station (Class IIb)
Interval between emergency hysterotomy and actual delivery of the infant

- The survival of mother has been reported with perimortem cesarean section performed up to 15 minutes after onset of maternal cardiac arrest.

- If emergency cesarean section cannot be performed by 5 – minute mark, it may be advisable to prepare to evacuate the uterus while resuscitation continues (Class IIb).

  At > 24 to 25 weeks of gestational age, the best survival for the infant when delivery no more than 5 minutes after maternal cardiac arrest.
Interval between emergency hysterotomy and actual delivery of the infant

- GA >/ 30 weeks, infant survival has been seen even after 5 minutes from onset of maternal cardiac arrest

- Neonatal survival was documented when delivery occurred within 30 minutes after onset of maternal cardiac arrest
Post-cardiac arrest care

- **Therapeutic hypothermia**
  - a comatose pregnant patient based on current recommendations for the nonpregnant patient (Class IIb)
- Post-cardiac arrest hypothermia can be used safely in early pregnancy without emergency cesarean section with favorable outcomes (case report)
- During therapeutic hypothermia
  - Continuous fetal monitoring (fetal bradycardia)
  - Obstetric and neonatal consultation (Class I)
Post-cardiac arrest care

• Caution: maternal hemorrhage or coagulopathy

- Hypothermia impair hemostasis and worsen further blood loss
Immediate postarrest care

• If the patient is still pregnant, she should be placed in full lateral decubitus position. If the patient is not in full lateral tilt, manual LUD should be maintained continuously.

• The patient should be transferred to ICU, unless an operation is required (Class I)

• Cause of arrest should be considered and treated accordingly (Class I)
Targeted temperature management

- TTM is considered should be considered in pregnancy on individual basis (Class IIb)

- TTM should be follow the same current protocol as for the nonpregnant patient (Class IIb)

- Fetal monitoring should be performed throughout TTM (Class I)
Conclusion

- Rare but devastating events
- Resuscitation requires a well coordinated, multi-team response
- Multidisciplinary team should be undertaken to optimize team preparation for resuscitation of cardiac arrest during pregnancy