Normal Physiologic Changes in Pregnancy As It Relates to Maternal Resuscitation

Purpose of this presentation……..

- The intention of this education is to
  - Familiarize you with normal physiological changes in pregnancy and how they relate to maternal resuscitation
  - Identify adjustments you may need to make during a rapid response or medical emergency
- In addition, for any rapid response or medical emergency be prepared to “Respond with a Purpose”

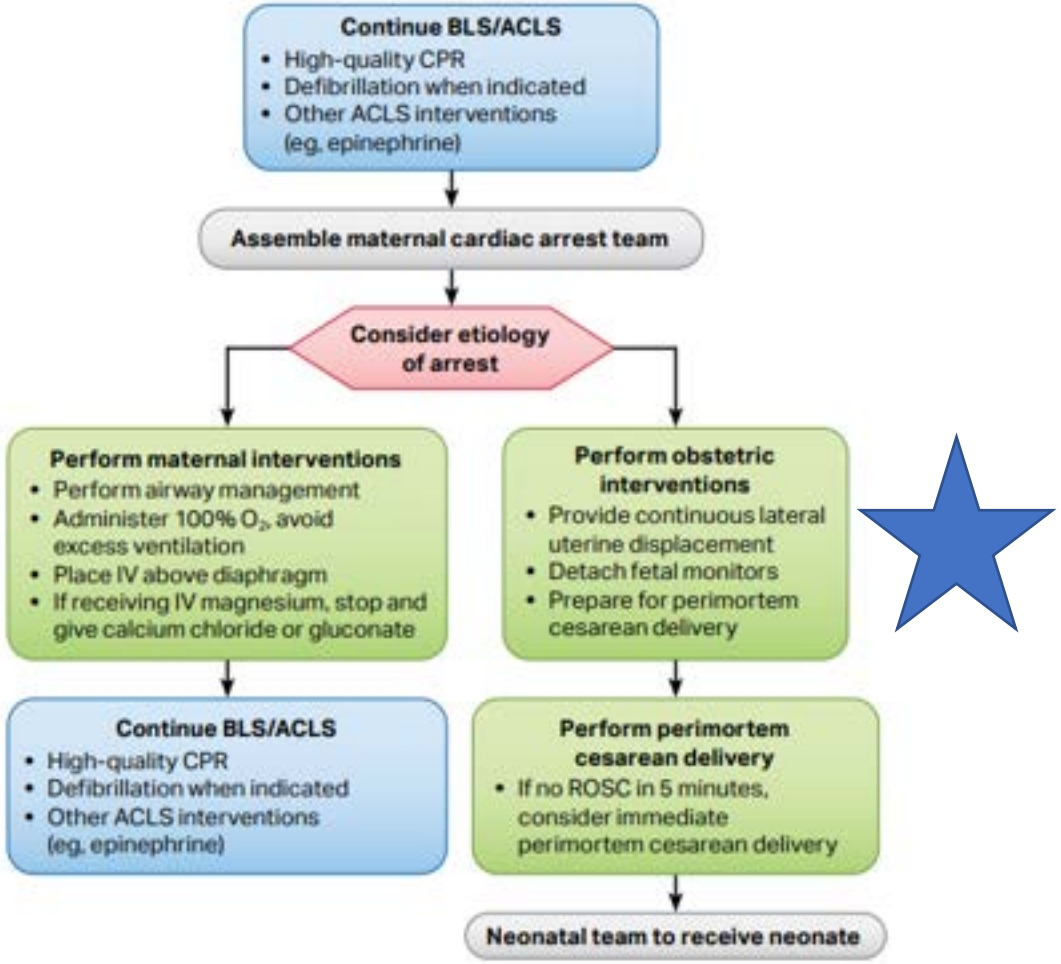
Reminder….

- Keep in mind the ongoing Basic Life Support (BLS) recommendations important in any Medical Emergency (actions are simultaneous, not sequential)
  - Rapid notification of response team
  - Document time of pulselessness
  - Immediate and high-quality chest compressions
    - Patient in supine position
    - High quality chest compressions at a rate of 100-120 per minute
    - Place hands on the center of the chest (lower half of the sternum)
    - Depress the sternum at least 5 cm (at least 2 inches) with full recoil
    - Compression-ventilation ratio of 30:2 with bag/mask
    - Minimize interruptions
    - Air-filled mattresses should be deflated when CPR is performed
  - Rapid defibrillation (when indicated)
  - Appropriate BLS airway management
  - Monitor CPR quality

Use of the Lucas Mechanical Chest Compression Device During Pregnancy

- According to the AHA (2015), “there is no literature examining the use of mechanical chest compressions in pregnancy, and this is not advised at this time.”
    - Jeejeebhoy, et al (2015), p. 1751
- However, according to the manufacturer’s 2,3 and 3.1 manual use of the Lucas during pregnancy is not listed as a contraindication.
    - Received 6-17-2020 from Jeffrey Ballentine, Associate Tech Support Specialist- Stryker Medical
- Because of the physiological changes in pregnancy, it may make it hard for the device to work/fit properly. Therefore, it would be the decision of the provider at the scene to decide the appropriateness of use.

Cardiac Arrest in Pregnancy In-Hospital ACLS Algorithm

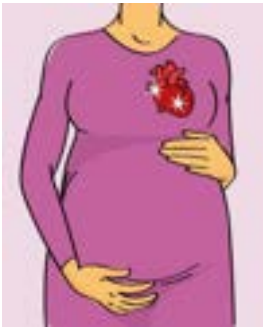


Let’s Look at the Pregnancy Physiology Behind These Modifications…

1. Why **manual** left lateral uterine displacement?
   - To generate more effective chest compressions

Manual Left Lateral Uterine Displacement

- As the uterus enlarges, it may cause aortocaval compression [ACC]
  - This can lead to decreased cardiac return and decreased cardiac output
    - Which subsequently results in maternal **hypotension and bradycardia**
    - Hypotension and bradycardia are exacerbated when the patient is in the supine position
      - This is also referred to as *supine hypotension*
- **Aortocaval compression [ACC] can interfere with maternal resuscitative efforts by diminishing the effectiveness of chest compressions**
  - Jeejeebhoy, et al. (2015) p. 1759; Kikuchi, J and Deering, S. (2018) pg. 34



Manual Left Lateral Uterine Displacement

- A uterus that extends to the umbilicus is usually large enough to cause aortocaval compression [ACC]
- The decision to use manual left lateral uterine displacement depends on whether the gravid uterus is thought to interfere with maternal hemodynamics….

Manual Left Lateral Uterine Displacement

- The American Heart Association recommends **continuous manual left lateral displacement** throughout resuscitative efforts and during perimortem cesarean section until delivery of the infant.
  - Manual left uterine displacement should be performed if uterus is palpated at or above umbilicus
    - AHA (2020) & ACOG (2019) recommends for a uterus larger than 20 weeks gestation
  - If the uterus is difficult to assess, attempts should be made to perform manual left uterine displacement if technically feasible
- **Maternal tilt** by turning the patient to her side or using a towel or hip roll **will decrease efficacy of chest compressions**

ACOG (2019), p. e337; Jeejeebhoy, et al (2015) pp. 1751-1752, 1759-1760; Kikuchi, J and Deering, S. (2018) pg. 34

Below are Examples of How to Perform Manual Left Uterine Displacement

- Effectively accomplished from the right or left side
- Care should be ensured that the uterus is not inadvertently pushed down.
  - Kikuchi, J and Deering, S. (2018) pg. 34

Figure 4. Manual left uterine displacement by the 2-handed technique from the left of the patient

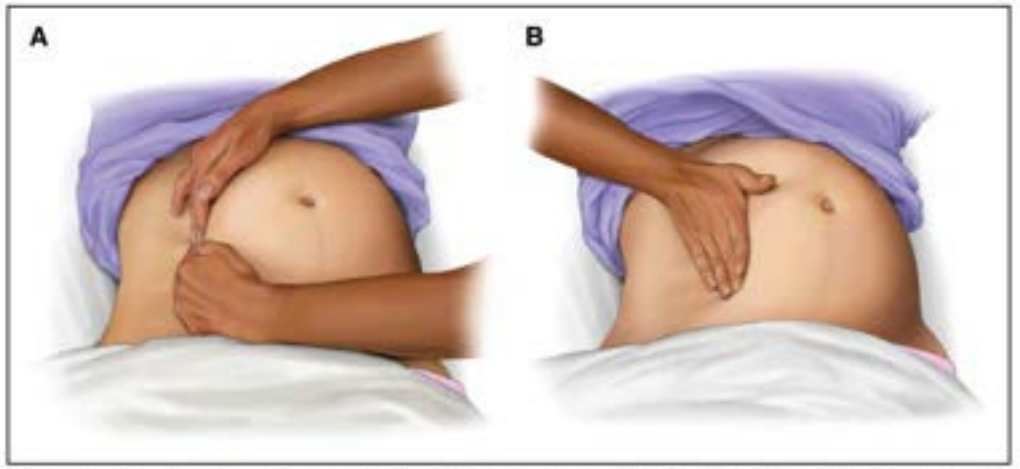


Figure 16. A, Manual left lateral uterine displacement, performed with 2-handed technique. B, 1-handed technique during resuscitation.

https://www.ahajournals.org/doi/epub/10.1161/CIR.0000000000000300 pg. 10/48

2. Remove Fetal Monitors and Assess Gestational Age….

- During active CPR the focus should remain on maternal resuscitation
- **Fetal assessment should not be performed during resuscitation**
- Fetal monitors should be **removed or detached as soon as possible to facilitate cesarean without delay or hindrance**
- Defibrillation would be unlikely to cause arcing to fetal monitors and should not deter use of rapid defibrillation when needed
  - Jeejeebhoy, et al 2015, pp. 1753, 1758
- Assess gestational age
  - May assist in management decisions
    - Example: need for cesarean delivery; need for neonatal resuscitation

3. 4 Minute Rule for Resuscitative Cesarean Delivery and Neonatal Outcome

- Neonatal survival is better if delivery occurs within 4-5 minutes of maternal cardiac arrest
    - Zelop, C.M. et al (2018) pg. 57,

https://emupdates.com/wp-content/uploads/2018/12/ReubenPeriportemCsection.jpg

Perimortem Cesarean Delivery

- Procedure should be **performed at site of the maternal resuscitation** Do Not Move to the OR
- If desired, an antiseptic solution may be poured onto the maternal abdomen

Airway and Breathing

- In addition to these three modifications, it is important to REMEMBER…
  - The incidence of failed intubation in the obstetric population is higher than the nonobstetric adult population
  - Pregnant women are at increased risk of regurgitation and aspiration
  - Maternal oxygen reserves are minimal, and hypoxemia can develop rapidly

Normal Respiratory Changes in Pregnancy

- Ph ↑7.40-7.45
  - **<u>Compensated respiratory alkalosis</u>**
    - Elevated levels of progesterone cause an increase in minute ventilation
      - Due to an increase in ventilation, pregnant patients typically experience mild respiratory alkalosis
        - Kikuchi, J and Deering, S. (2018) pg. 34
- Expiratory Reserve Volume
  - ↓ 15-20%
- ↑ in Oxygen consumption
  - Shortness of breath is a common complaint
    - ↑ in progesterone in pregnancy – Is a respiratory stimulant – this may be the reason women complain of shortness of breath and hyperventilate during labor
- However, O2 saturation should be at a minimum of **<u>95</u>**% in order to perfuse the fetus

Normal Physiologic Changes Affecting Successful Resuscitation of the Pregnant Patient

- Estrogen
  - **Hyperemia of the upper airway** results from elevated estrogen levels and increased plasma volume can cause the tissues to become more friable and prone to increased bleeding
- Progesterone
  - **Compensated respiratory alkalosis**
    - Elevated levels of progesterone cause an increase in minute ventilation
    - Due to an increase in ventilation, pregnant patients typically experience mild respiratory alkalosis
  - **Delayed gastric emptying and relaxation of the lower esophageal sphincter results in a higher risk for aspiration during resuscitation**
    - Kikuchi, J and Deering, S. (2018) pg. 34

Normal Physiologic Changes Affecting Successful Resuscitation of the Pregnant Patient (Continued)

- Both of these hormones are responsible for vascular engorgement of the upper pharynx and larynx. **The result is changes in landmarks and narrowing of the airway passages for the pregnant patient.**
- In addition, these changes magnify the **difficulty in intubation and airway management of the pregnant patient**. Anticipation of a difficult airway is advised.
- **Smaller endotracheal tube may be necessary for the pregnant patient (6-7cm).**
    - CMQCC (2021) pgs. 146-148

Normal Physiologic Changes Affecting Successful Resuscitation of the Pregnant Patient (continued)

- The pregnant patient has limited oxygen reserves and higher metabolic demands
- Functional residual capacity decreases by 10 to 25% as the uterus enlarges and elevates the diaphragm
- Oxygen consumption increases because of fetal demands and maternal metabolic processes
  - Which contributes to the rapid development of hypoxemia in response to hypoventilation or apnea in the pregnant woman
- Hypoxemia should always be considered as a cause of maternal cardiac arrest
- Early ventilatory support may be necessary
  - Bag/mask ventilation with 100% oxygen at ≥ 15 L/min and early intubation with a small endotracheal tube by experienced provider
  - Avoid excessive ventilation

Cardiovascular

Physiologic Changes in Pregnancy That Affect Cardiovascular Stress

Pregnancy is a natural stress test because the cardiovascular system undergoes structural and hemodynamic adaptations to sustain a high-volume load. An understanding of these physiologic changes is essential for health care providers.

It is important to understand these changes in order to effectively manage cardiac arrest in pregnancy

- Kikuchi, J and Deering, S. (2018) pg. 33

Listed Below are Normal Physiologic Changes of Pregnancy Related to the Cardiovascular System

↑ work on the ♥

- Heart rate ↑ 15-20 beats/minute
- Stroke volume↑25-30%
- Cardiac output ↑ 30-50%

Gestational age is important

- Blood pressure is ↓ the second trimester

Dilutional Anemia

- Blood volume 40-60%
  - Greater ↑ plasma vs. RBCs
    - Results in hemodilution
  - ↓ in Hematocrit

Pregnancy is a hypercoagulable state
↑ risk of VTE

- ↑procoagulant activity and ↓ fibrinolytic activity

Normal EKG Changes in Pregnancy

- Non specific T wave changes
- Left axis deviation
- Increased HR
- Increased QRS amplitude
- Intervals DO NOT CHANGE

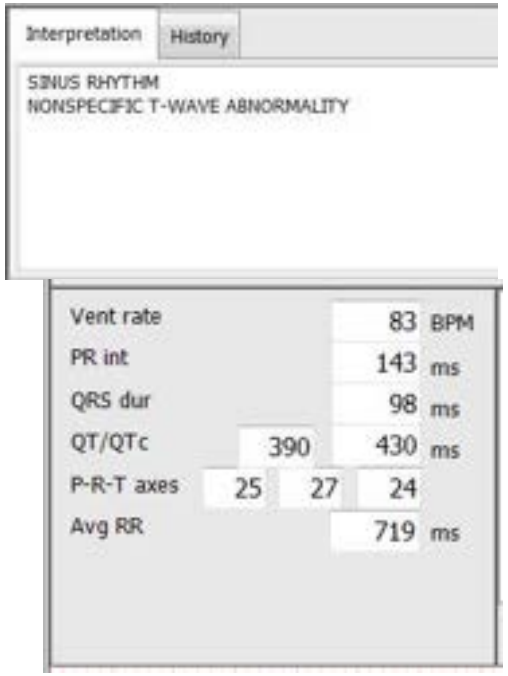


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Table 1. Cardiovascular Changes in a Normal Pregnancy*

	First Trimester	Second Trimester	Third Trimester	Stage 1 Labor	Stage 2 Labor	Early Postpartum	3–6 months Postpartum
Cardiac output	↑5–10%	↑↑35–45%		↑30%	↑↑50%	↑↑↑60–80% immediately, then rapidly decreases within the first hour	Return to prepregnancy values
Heart rate	↑3–5%	↑10–15%	↑15–20%	During uterine contractions: ↑40–50%		↓5–10% within 24 hours; continues to decrease throughout the first 6 weeks	Return to prepregnancy values
Blood pressure	↓10%	↓5%	↑5%	During uterine contractions: ↑SBP 15–25% ↑DBP 10–15%		↓SBP 5–10% within 48 hours; may increase again between days 3–6 due to fluid shifts	Return to prepregnancy values
Plasma volume	↑	↑↑40–50%		↑	↑↑	↑↑↑500 mL due to autotransfusion	Return to prepregnancy values

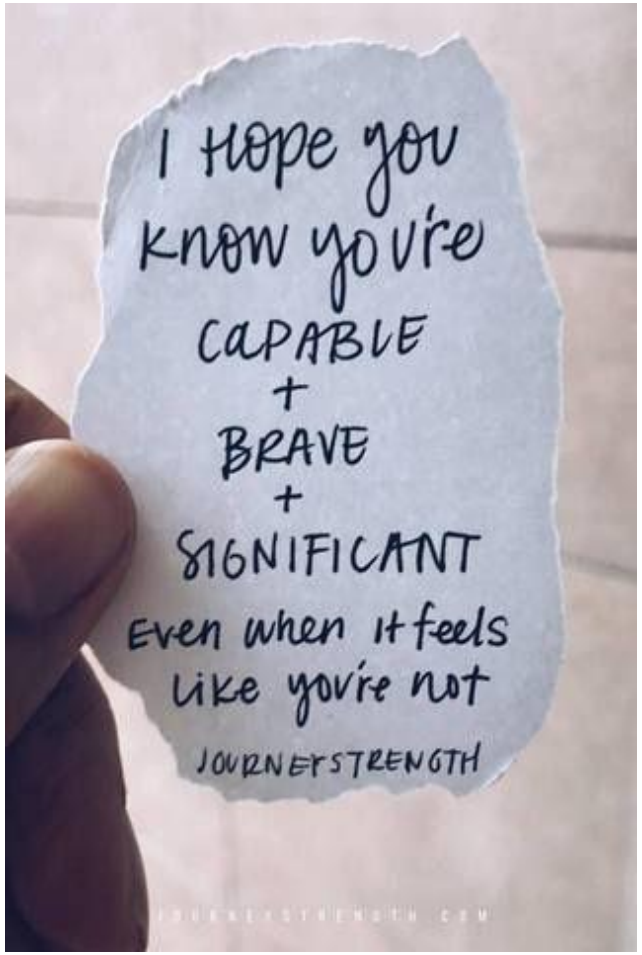
IV Access or Intra-Osseous Device

- Establish above the diaphragm to ensure administration is not obstructed by the gravid uterus
- Epinephrine is the vasopressor of choice

https://www.curpoint.com/wp-content/uploads/2020/04/ioprocedures.jpg

Keep In Mind: The Most Common Etiologies of Maternal Arrest: A B C D E F G H

A Anesthetic causes	**High spinal or epidural; intravascular injection of local anesthetic; airway complications; aspiration; respiratory depression; hypotension**
A Accidents/trauma	**Trauma; suicide**
B Bleeding	Uterine atony; coagulopathy; placenta accreta; placental abruption; placenta previa; retained placenta; uterine rupture
C Cardiovascular	Myocardial infarction; aortic dissection; cardiomyopathy; arrhythmias; valvular disease; congenital heart disease
D Drugs	Oxytocin; magnesium; drug error; illicit drugs; opiods; insulin; anaphylaxis
E Embolism	Amniotic fluid embolus; pulmonary embolus; cerebral vascular event; venous air embolism
F Fever	Sepsis; infection; viral syndromes; acute respiratory distress syndrome
G H's & T's	Hypovolemia; Hypoxia; Hydrogen ion (acidosis); Hypo-hyperkalemia; Hypothermia; Tension pneumothorax; Tamponade (cardiac); Toxins; Thrombosis (pulmonary or coronary)
H Hypertension	Preeclampsia; eclampsia; HELLP syndrome; stroke (thrombotic or hemorrhagic)



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