

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....

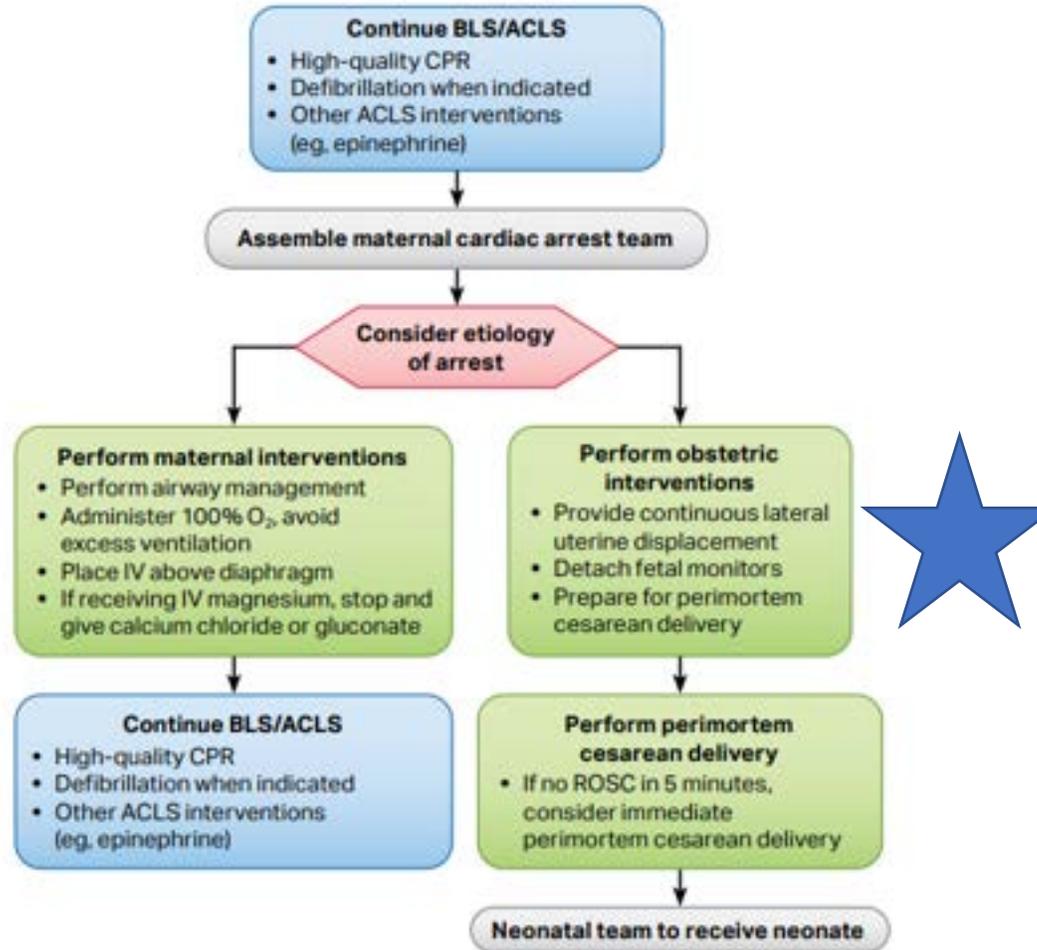
- Keep in mind the ongoing Basic Life Support (BLS) recommendations important in any Medical Emergency (actions are simultaneous, not sequential)
 - Rapid notification of response team
 - Document time of pulselessness
 - Immediate and high-quality chest compressions
 - Patient in supine position
 - 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

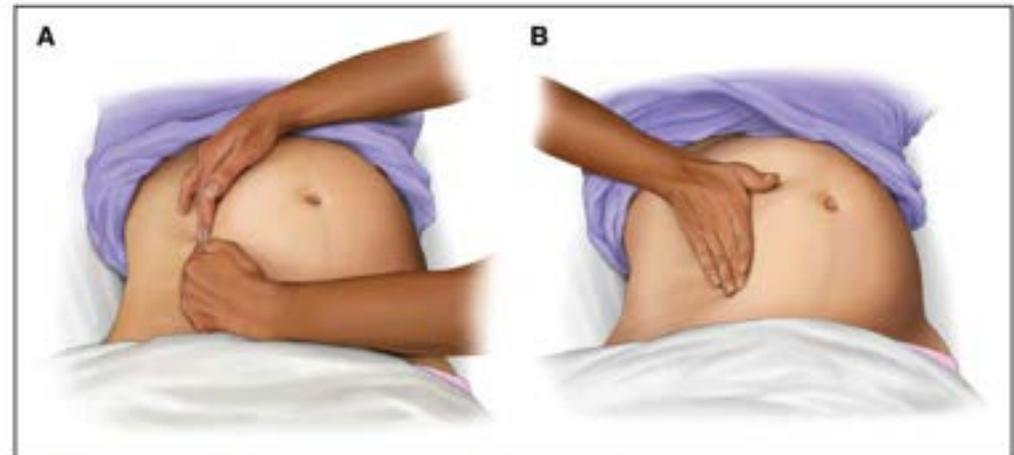


Figure 16. A, Manual left lateral uterine displacement, performed with 2-handed technique. B, 1-handed technique during resuscitation.

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,



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 \uparrow 7.40-7.45
 - **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
- Expiratory Reserve Volume
 - \downarrow 15-20%
- \uparrow in Oxygen consumption
 - Shortness of breath is a common complaint
 - \uparrow 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 **95%** in order to perfuse the fetus

• Kikuchi, J and Deering, S. (2018) pg. 34

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.



e322 Practice Bulletin *Pregnancy and Heart Disease*

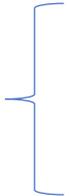
OBSTETRICS & GYNECOLOGY

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

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

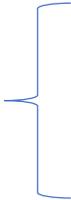
Listed Below are Normal Physiologic Changes of Pregnancy Related to the Cardiovascular System

↑ 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



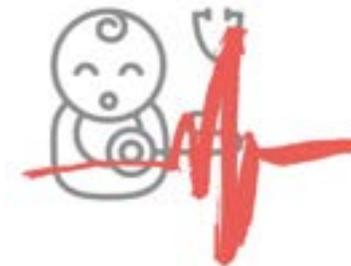
- ↑ procoagulant activity and ↓ fibrinolytic activity

Normal EKG Changes in Pregnancy

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



Interpretation		History	
SINUS RHYTHM NONSPECIFIC T-WAVE ABNORMALITY			
Vent rate	83	BPM	
PR int	143	ms	
QRS dur	98	ms	
QT/QTc	390	430	ms
P-R-T axes	25	27	24
Avg RR	719	ms	



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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

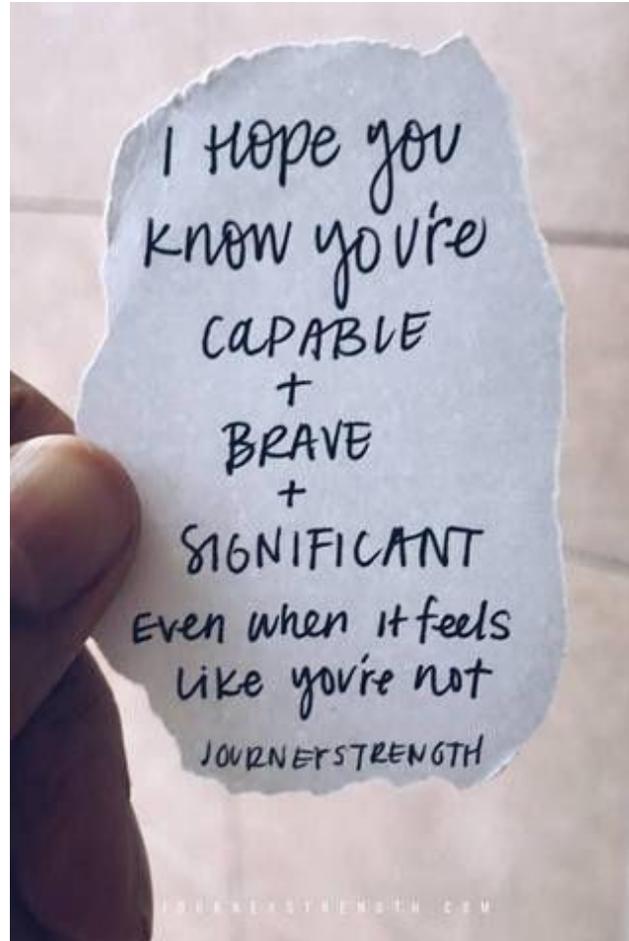
- Establish above the diaphragm to ensure administration is not obstructed by the gravid uterus
- Epinephrine is the vasopressor of choice



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

The

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; opioids; 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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