



Management of
Maternal Obstetric
Complications

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Critical support prior to and during
transport/transfer




Presented by:

Dr Lisa Kirkland, FACP, MSHA, FCCM
Co-Director, ANW Obstetric Critical Care Program
ANW Intensivists

Dr William Wagner, FCCM, FACOG

- Maternal Fetal/Critical Care Medicine
- Minnesota Perinatal Physicians
- *Founder and Former Co-Director of ANW OB Critical Care Program & Cardioobstetric Program*
- *Founder and Former Surgical Director of MPP Placenta Accreta Spectrum Program*

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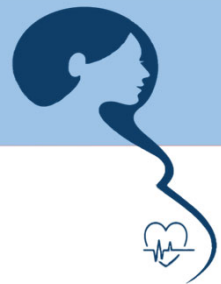
Disclosures



- Dr Kirkland – None
- Dr Wagner - None

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Objectives




- To describe recent advances in transport of critically ill patient
- To describe the unique needs for transporting critically ill pregnant patients
- To describe initial therapies indicated prior to transport

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DON'Ts



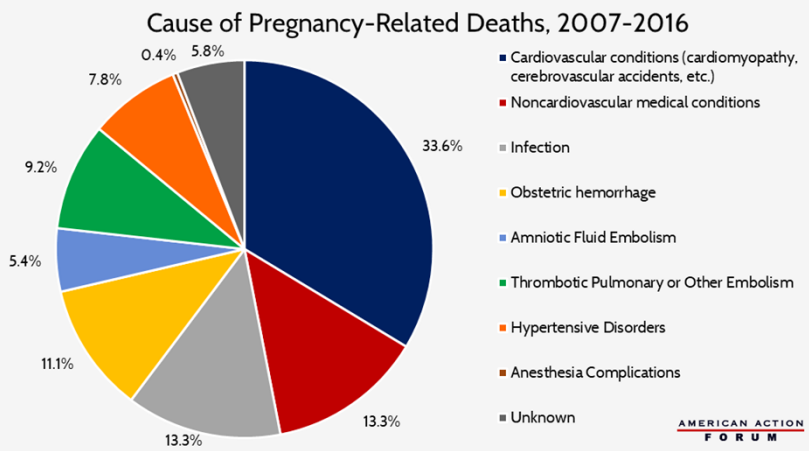
- Do not give barbiturates for seizures or intubation induction! Due to risk of difficult/unsuccessful airway
- Do not give Ondansetron for hyperemesis without knowing what the QTc is! Due to risk of undiagnosed long QT
- Do not give terbutaline in preterm labor! No longer recommended
- Don't hesitate to call a Level IV maternal care center for help with patient management! Even if they can't accept, they can still advise.

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Maternal Mortality

Cause of Pregnancy-Related Deaths, 2007-2016



Cause	Percentage
Cardiovascular conditions (cardiomyopathy, cerebrovascular accidents, etc.)	33.6%
Noncardiovascular medical conditions	13.3%
Infection	13.3%
Obstetric hemorrhage	11.1%
Amniotic Fluid Embolism	9.2%
Thrombotic Pulmonary or Other Embolism	7.8%
Hypertensive Disorders	5.8%
Anesthesia Complications	5.4%
Unknown	0.4%

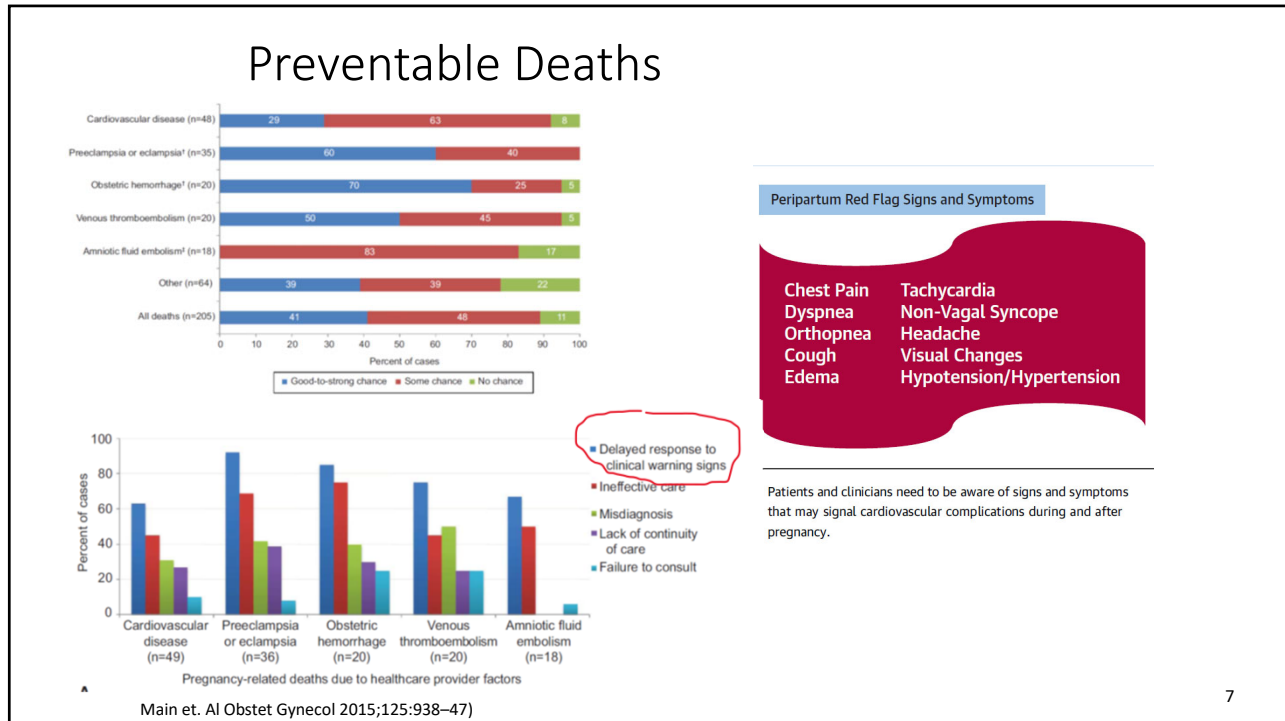
♥ the most common causes of pregnancy-related deaths were cardiovascular conditions:

- ♥ congenital heart disease,
- ♥ ischemic heart disease
- ♥ cardiac valvular disease
- ♥ hypertensive heart disease,
- ♥ congestive heart failure

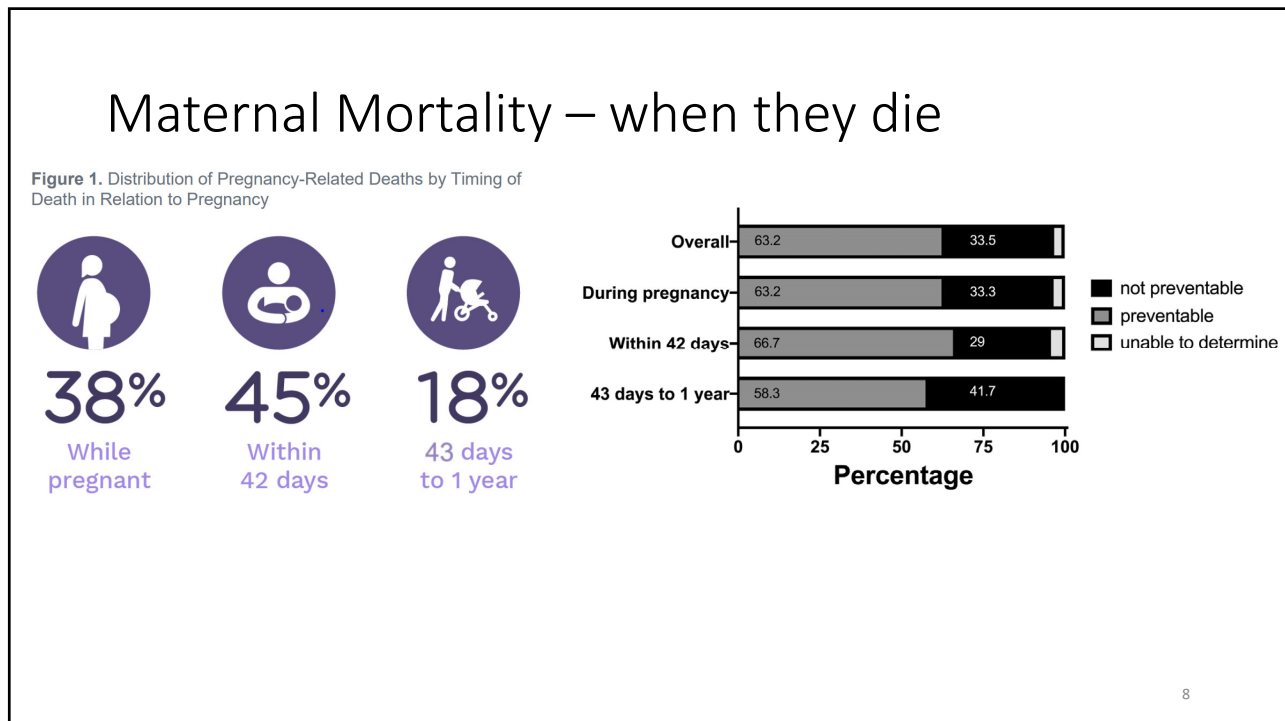
AMERICAN ACTION FORUM

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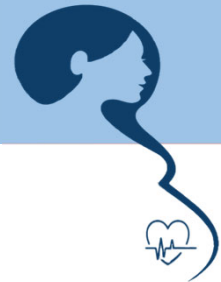
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REMEMBER...



Any patient either pregnant or within 6 weeks of delivery is at greater risk of early physiologic decline than a nonpregnant/nonpostpartum patient, based on the adaptive changes of pregnancy

When considering transport...



EMTALA ties the responsibility for patient care, interfacility transport team composition, equipment, and selection to the **sending** physician

Adverse events occur in 5–28% of critical care transports.

Transport less than 50 miles (80 km) by ground ambulance,

50–150 miles (80–240 km) by helicopter, and

greater than 150 miles (> 240 km) by fixed-wing aircraft.

Assess total transport time, particularly for time-sensitive conditions such as myocardial ischemia, intracranial hemorrhage, stroke, or severe injury in which time may be saved by using aeromedical CCT even over short geographical distances

Regionalization of Obstetric Care Examples of Appropriate Patient by Level



ACOG, SMFM, CDC, Arizona Perinatal Trust, National Perinatal Information Center developed Levels of Maternal Care verification program published in 2018.

Accredited birth Center: uncomplicated singleton vertex fetus, expected uncomplicated birth

Level 1: low risk women with uncomplicated pregnancy

higher risk: uncomplicated twin gestation, uncomplicated cesarean delivery, preeclampsia, well-controlled gestational diabetes

Level II: placenta previa with no previous uterine surgery,

maternal conditions needed monitoring: pregestational diabetes, poorly controlled asthma, poorly controlled/complicated HTN

anticipated complicated C section

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<http://dx.doi.org/10.1016/j.ajog.2014.12.030> 11

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Examples of Appropriate Patient by Level



Level III: moderate maternal cardiac disease, accreta/previa and prior uterine surgery, suspected percreta, ventilatory support, acute fatty liver of pregnancy, coagulation disorders, complex hematologic or autoimmune disease, preeclampsia with severe features remote from term

United/Mercy MBC Level III (Metro)

Level IV: severe maternal cardiac conditions, severe pulmonary HTN, neurosurgery or cardiac surgery, unstable and in need of organ transplant

Has all specialties + 24/7 Maternal Fetal Medicine specialists' availability

Abbott Northwestern Hospital is a Level IV Maternal Care Center

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<http://dx.doi.org/10.1016/j.ajog.2014.12.030> 12

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Obstetric Care Consensus: Levels of Maternal Care. OB GYN 2019 134(2)

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TABLE 2
Levels of maternal care by services

Required service	Level of maternal care				
	Birth centers	Level I	Level II	Level III	Level IV
Nursing	Adequate numbers of qualified professionals with competence in level I care criteria	Continuously available RNs with competence in level I care criteria Nursing leadership has expertise in perinatal nursing care	Continuously available RNs with competence in level II care criteria Nursing leadership has formal training and experience in perinatal nursing care and coordinates with respective neonatal care services	Continuously available nursing leaders and RNs with competence in level III care criteria and have special training and experience in the management of women with complex maternal illnesses and obstetric complications	Continuously available RNs with competence in level IV care criteria Nursing leadership has expertise in maternal intensive and critical care
Minimum primary delivery provider to be available	CNMs, CMs, CPMs, and licensed midwives	Obstetric provider with privileges to perform emergency cesarean delivery	Ob-gyns or MFMs	Ob-gyns or MFMs	Ob-gyns or MFMs
Obstetrics surgeon		Available for emergency cesarean delivery	Ob-gyn available at all times	Ob-gyn onsite at all times	Ob-gyn onsite at all times
MFMs			Available for consultation onsite, by phone, or by telemedicine, as needed	Available at all times onsite, by phone, or by telemedicine with inpatient privileges	Available at all times for onsite consultation and management
Director of obstetric services			Board-certified ob-gyn with experience and interest in obstetrics	Board-certified ob-gyn with experience and interest in obstetrics	Board-certified MFM or board-certified ob-gyn with expertise in critical care obstetrics
Anesthesia		Anesthesia services available	Anesthesia services available at all times Board-certified anesthesiologist with special training or experience in obstetrics, available for consultation	Anesthesia services available at all times Board-certified anesthesiologist with special training or experience in obstetrics is in charge of obstetric anesthesia services	Anesthesia services available at all times Board-certified anesthesiologist with special training or experience in obstetrics is in charge of obstetric anesthesia services
Consultants	Established agreement with a receiving hospital for timely transport, including determination of conditions necessitating consultation and referral	Established agreement with a higher-level receiving hospital for timely transport, including determination of conditions necessitating consultation and referral	Medical and surgical consultants available to stabilize	Full complement of subspecialists available for inpatient consultation, including critical care, general surgery, infectious disease, hematology, cardiology, nephrology, neurology, and neonatology	Adult medical and surgical specialty and subspecialty consultants available onsite at all times, including those indicated in level III and advanced neurosurgery, transplant, or cardiac surgery

ACOG. Levels of maternal care. Am J Obstet Gynecol 2015. (continued)


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Critical Care Transport Since 2004

Interventions	Examples
Substantial growth in rural based helicopters	Rapid changes in helicopter density from 545 in 2003 over 1200 in 2021 (12)
Development of national and international transport agencies	AirMed International; DOD Adult ECMO Transport Team
Increasing regionalization of healthcare	Development of high-volume centers of excellence (e.g., trauma centers, stroke centers) (3, 13)
Emphasis on interprofessional approach	Maximizing scope of practice for nonphysician teams, off-line medical direction. Examples include rapid sequence intubation (14), finger thoracostomy (15)
Telemedicine	Use of videoconferencing to allow the team to directly communicate with the receiving hospital (16)
Adaptation of military procedures	Many critical care transport services now carry packed RBCs and plasma (17, 18) Use of tranexamic acid for early hemorrhagic shock, minor traumatic brain injury (19, 20) Use of hemostatic gauze (21)
Advances in airway management	Use of videolaryngoscopy (22) Increased use of noninvasive ventilation (23)
Application of modern critical care management to transport	Use of lung-protective ventilation in transport (24) Transport on ECMO and other mechanical circulatory support devices (25–27) Enhanced strategies to manage transport of patients with highly contagious pathogens (28, 29)

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Essential Equipment for Critical Care Transport

Category	Examples
Monitoring of vital signs	Continuous rate and rhythm monitoring, O ₂ saturation, noninvasive blood pressure, and respiratory rate. Continuous or intermittent 12-lead electrocardiogram monitoring in cardiac or toxicology patients. Continuous or intermittent temperature measurement in targeted temperature management patients. Invasive hemodynamic monitoring (arterial line, pulmonary artery catheter). Quantitative end-tidal carbon dioxide monitoring for all intubated patients. Fetal heart rate checks for pregnant patients (128, 129).
O ₂ and respiratory support	Supply of O ₂ in the vehicle and in moving the patient between the vehicle and facilities. Basic airway management equipment, such as a bag-mask ventilation device and oral/nasal airways, supraglottic airways, and functioning suction. Difficult airway equipment, including video laryngoscopes and instruments for surgical airways. Critical care transport ventilators with controlled and spontaneous breathing mode options, appropriate volume and pressure alarms, and ability to deliver positive end-expiratory pressure to at least 20 cm H ₂ O.
Medications and delivery devices	Infusion pumps—types will vary depending on the scope of practice of the team. Medications, including sedation agents, analgesics, vasopressors, inotropes, neuromuscular blockers, antimicrobial agents, antiarrhythmics, bronchodilators, heparin infusions, and insulin (130).
Diagnostic equipment	Point-of-care laboratory testing (131–134). Point-of-care ultrasound for diagnostic purposes and image-guided procedures during transport (135, 136).

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Airway

- Supraglottic device converted to ETT
- ETT confirmed with EtCO₂ and CXR
- Abnormal O₂ or CO₂ addressed
- Advanced therapeutics considered*

Hemodynamics

- IV access evaluated
- CVP/resuscitation line(s) considered
- Arterial line considered
- Adequate vasopressor doses acquired

Devices and Data


- ETT, NGT, feeding tube holder(s) considered
- Vascular access and monitoring devices secured
- EHR information and imaging on portable media
- Receiving team notified

Wilcox, Susan R.; Wax, Randy S.; Meyer, Michael T.; Stocking, Jacqueline C.; Baez, Amado Alejandro; Cohen, Jason; Moss, M. Michele; Frakes, Michael A.; Scruth, Elizabeth A.; Weir, William B.; Zonies, David; Guyette, Francis X.; Kaplan, Lewis J.; Cannon, Jeremy W.

Critical Care Medicine 50(10):1461-1476, October 2022.

doi: 10.1097/CCM.0000000000005639

This graphic conveys key pretransport interventions to support optimization as well as transport safety including those related to airway security, hemodynamic performance, device security to prevent premature removal during transport, and essential data transmission. *Advanced therapeutics include pulmonary artery vasodilators, vasopressors, invasive devices such as an intra-aortic balloon pump, or ventricular assist device, or extracorporeal membrane oxygenation. CVP = central venous pressure, CXR = chest radiograph, EHR = electronic health record, Etco2 = end-tidal carbon dioxide, ETT = endotracheal tube, NGT = nasogastric tube.



Adaptive changes of pregnancy and how they can mask acute illness



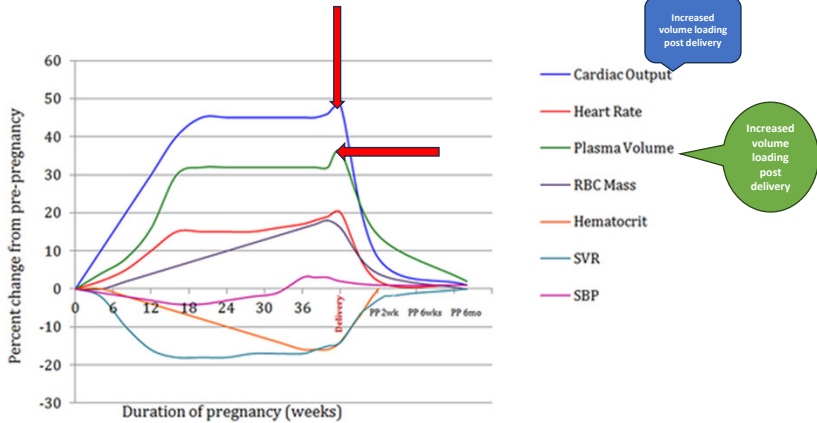
Table 1. Physiologic Changes during Pregnancy

System	Changes	Physiologic Impact
Cardiovascular	Increased heart rate and cardiac output Decreased arterial pressure	Masking signs of sepsis Increased hypoperfusion
Hematology	Increased plasma volume Increased factors VII, VIII, IX, X, XII and vWF	Physiologic anemia, less O2 supply to tissues Increased risk of DIC and DVT
Respiratory	Increased tidal volume and minute ventilation Decreased residual volume due to elevated diaphragm	Decreased PaCO2 ("normal" blood gas may be sign of impending respiratory failure) Impaired oxygenation and faster desaturation
Renal	Increased vesicoureteral reflux Increased renal plasma flow and GFR	Delayed identification of renal injury secondary to sepsis Conditions favorable to pyelonephritis
Gastrointestinal	Delayed gastric emptying	Increased risk of aspiration
GU	Decreased vaginal pH	Increased risk of chorioamnionitis

Adapted from: Cordioli. Sepsis and Pregnancy: Do We Know How to Treat This Situation? Rev Bras Ter Intensiva 2013.

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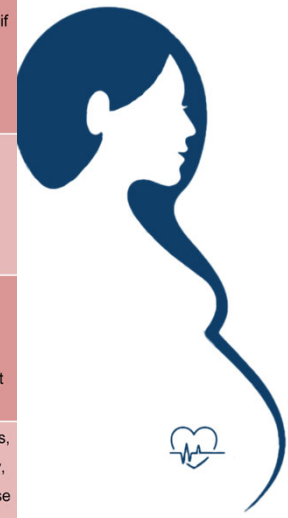
Adaptive changes in pregnancy affecting pre-transport care - Hemodynamics



Greatest risk for pulmonary edema and heart failure first 24 hours post delivery!

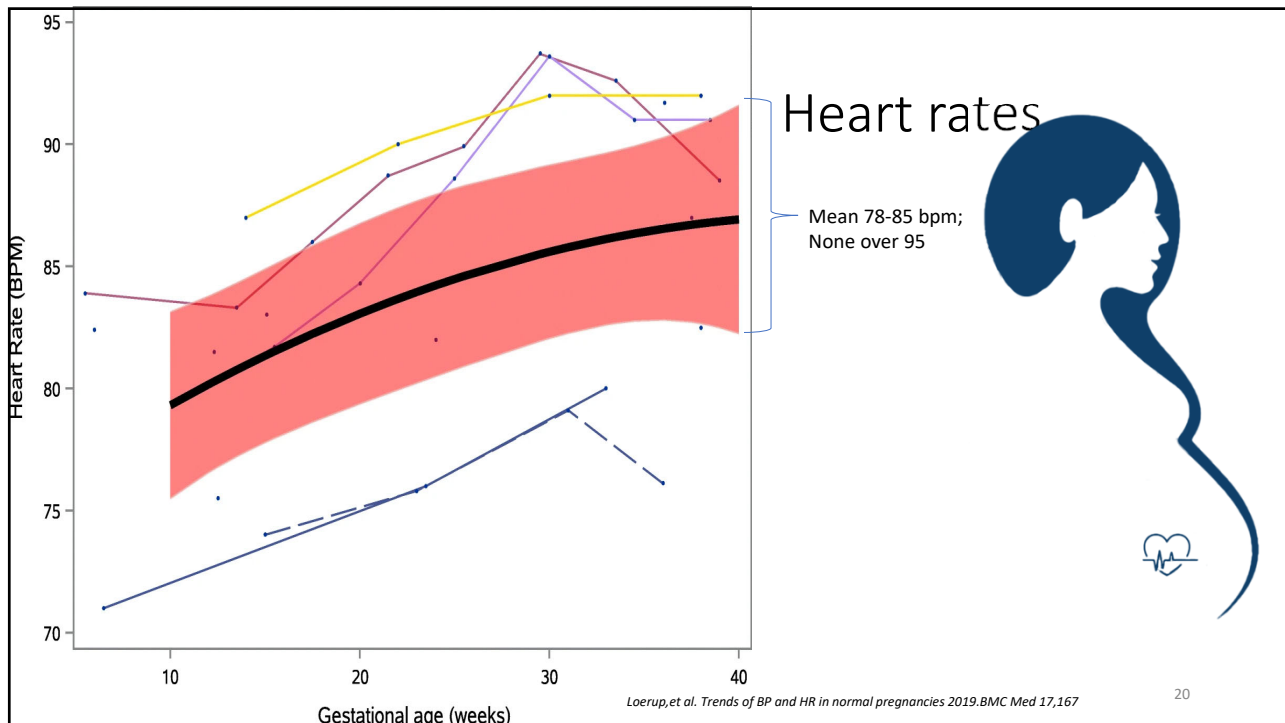
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	Normal Changes in Cardiac Exam and Testing during Pregnancy and Delivery	Abnormal Cardiac Exam and Testing during Pregnancy and Delivery
Symptoms	<ul style="list-style-type: none"> Dyspnea is reported in up to 76% by 3rd trimester Reduction in exercise tolerance, palpitations, and light-headedness are commonly reported 	<ul style="list-style-type: none"> Chest pain, pressure, or discomfort Dyspnea out of proportion to pregnancy, especially if occurs or worsens suddenly Associated pain radiating to arms, shoulder, or jaw, diaphoresis, nausea, or vomiting
Physical exam	<ul style="list-style-type: none"> Normal or mild jugular venous distension Soft, mid-systolic flow murmur Widely split S1, loud S3 Cervical venous hum 	<ul style="list-style-type: none"> Prominent jugular venous distension Holosystolic murmur at apex Diastolic murmur Fixed split S2, S4 Pulmonary rales
Electrocardiogram	<ul style="list-style-type: none"> Q waves in leads III and aVF T wave inversions in leads III, V1 – V3 Transient ST depressions with cesarean delivery 	<ul style="list-style-type: none"> ST elevations ST depressions that are persistent or occur in the setting of chest pain T wave inversions, especially if deep and/or present in leads other than V1 – V3
Cardiac Biomarkers	<ul style="list-style-type: none"> Levels generally peak at 24 hours after delivery CK and CKMB can double after delivery and may exceed ULN High sensitivity TnT can be elevated after uncomplicated deliveries in a minority of women Preeclampsia and gestational HTN can be associated with increases in TnI and TnT 	<ul style="list-style-type: none"> Elevated biomarkers in the setting of new symptoms, especially if not occurring immediately after delivery, if elevation is more than mild, or if the levels increase on serial measurements



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Tweet et al. Circulation: Cardiovascular Interventions 2020.

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Loerup, et al. Trends of BP and HR in normal pregnancies 2019. BMC Med 17,167

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