Hypertension in Pregnancy and Maternal Early Warning Signs

Next Steps in Reducing Maternal Mortality

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Objectives

1. Understand the change in maternal mortality in the US and identify areas for improvement.

2. Attendees will be able to articulate the benefit of early warning tools and their benefit to maternal outcomes.

3. Utilizing that knowledge providers will identify tools and opportunities to reduce maternal risk for morbidity and mortality at their own institution.
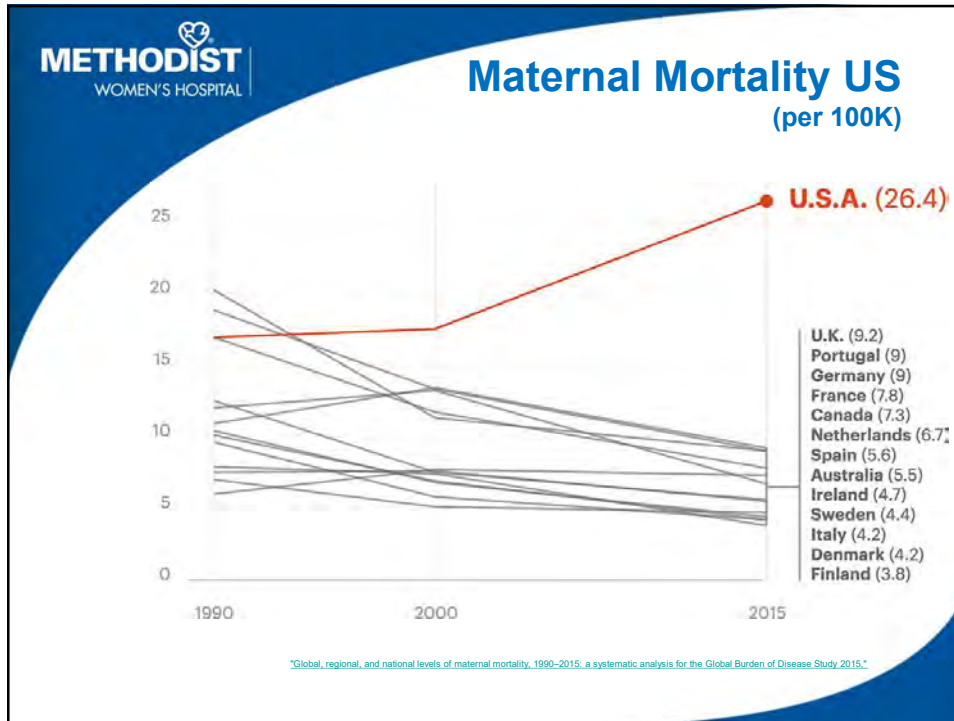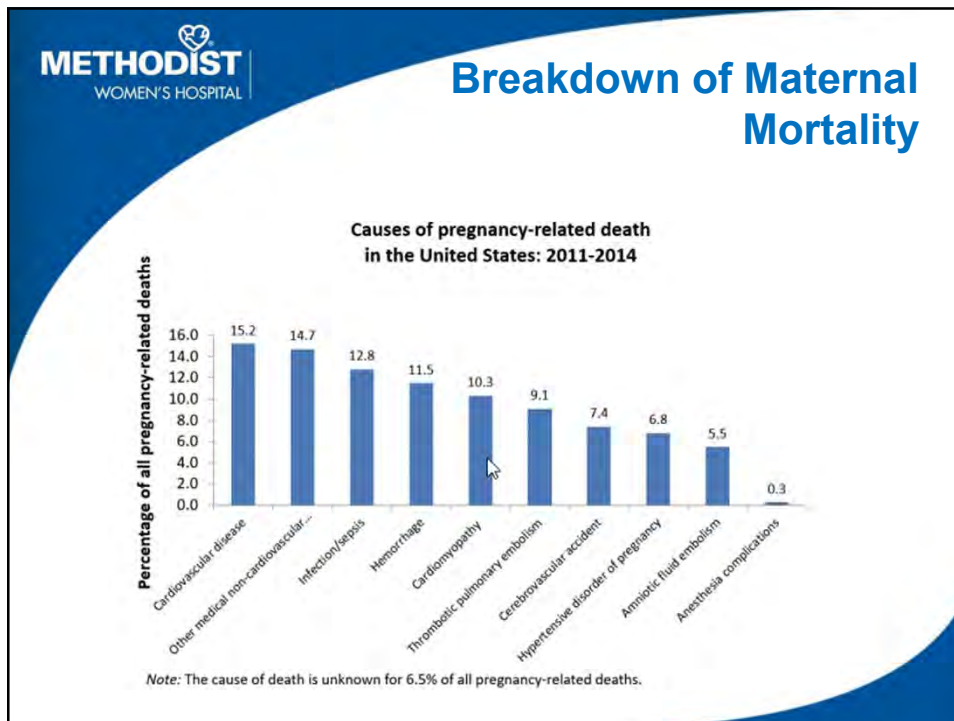
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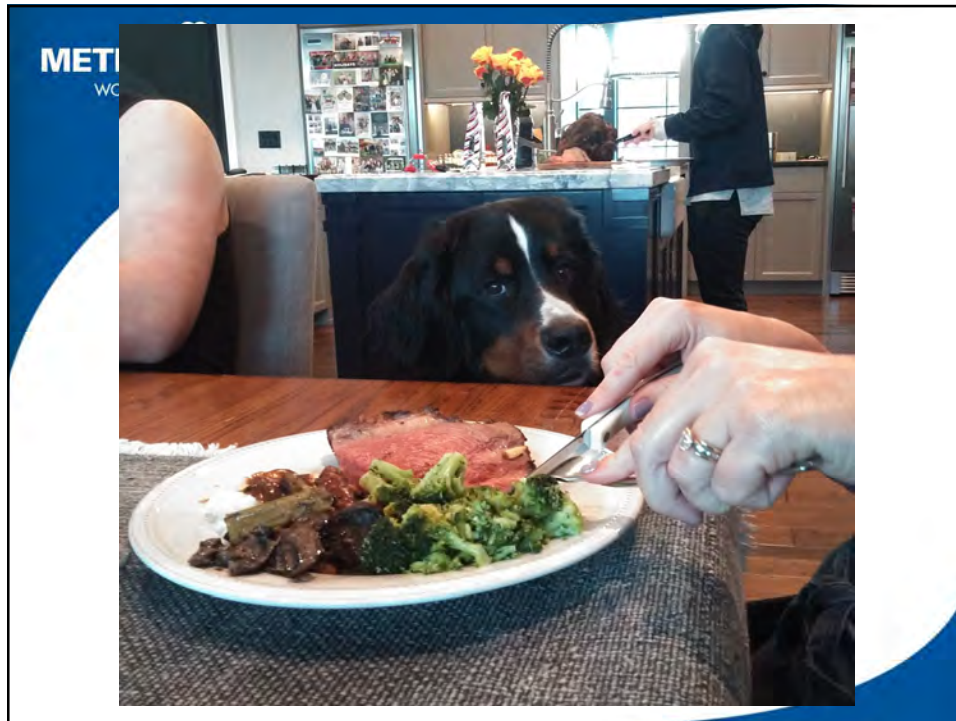
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- QI requires change in thinking

- Improvements should not be seen as PRIOR FAILURE to provide the best care but EVOLUTION in the care we provide and a badge we wear that we are willing to get better.

- Ask for evidence and validation- for both current practices and recommended changes.

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Maternal Mortality US
(per 100K)

U.S.A. (26.4)

U.K. (9.2)
Portugal (9)
Germany (9)
France (7.8)
Canada (7.3)
Netherlands (6.7)
Spain (5.6)
Australia (5.5)
Ireland (4.7)
Sweden (4.4)
Italy (4.2)
Denmark (4.2)
Finland (3.8)

"Global, regional, and national levels of maternal mortality, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015."

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Breakdown of Maternal Mortality

Causes of pregnancy-related death in the United States: 2011-2014

Note: The cause of death is unknown for 6.5% of all pregnancy-related deaths.

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How much of a difference can we make?

Depending on cause of death 60-90% of maternal deaths are **preventable.**

CDC 2019
CMQCC 2017

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How Far Have We Come

Recommendations regarding proactive measures to prevent maternal complications prior to 2010.

1. Active management of third stage of labor
2. Use of Massive Transfusion Protocols on OB units

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Current Bodies With Recommendations

1. AIM
2. ACOG
3. SMFM
4. AWHONN
5. CMQCC
6. Multiple international bodies

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Safety "Bundles"

1. Acute Hypertension
2. Hemorrhage
3. Sepsis
4. Preventing primary CD
5. Venous Thromboembolism Prevention
6. Perinatal mental health
7. Postpartum transition

*saferbirth.org (ALLIANCE FOR INNOVATION ON MATERNAL HEALTH)
*CMQCC.org

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No Bundle for MEWS

1. Maternal Early Obstetric Warning Signs, MEWS, MERC, MEWT

2. Derivative of NEWS- National Early Warning Score
   a. Designed originally to detect sepsis in the ED
   b. Extrapolated to in hospital care/screening
   c. Now expanded to try and predict morbidity and mortality in the hospital

3. If you implement the other bundles, you will have implemented MEWS

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Physiological parameter	3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO₂ Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO₂ Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

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Adaptation for Maternal Illness

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Maternal Early Obstetric Warning Signs (MEOWS)

1. First, no. We are not calling it MEOWS.
2. Developed in the UK in 2003-2005
   a. Singh S, McGlennan A, England A, Simons R. A validation study of the CEMACH recommended modified early obstetric warning system (MEOWS). Anaesthesia. 2012 Jan;67(1):12-8
   b. Similar programs adopted by Ireland, Australia and other developed countries

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Examples

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US Obstetric Care

NINE YEARS LATER WE PUBLISH THIS……

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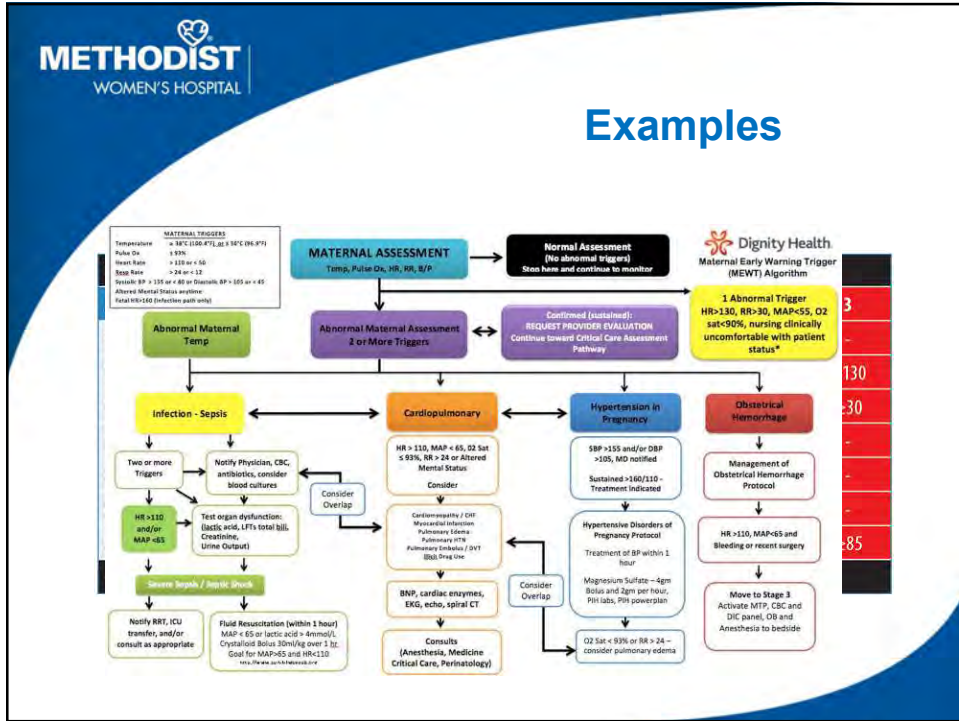
Maternal Early Obstetric Warning Signs (MEWS)

The maternal early warning criteria: a proposal from the national partnership for maternal safety

Jill M Mhyre [1], Robyn D'Oria, Afshan B Hameed, Justin R Lappen, Sharon L Holley, Stephen K Hunter, Robin L Jones, Jeffrey C King, Mary E D'Alton

Affiliations + expand
PMID: 25198266   DOI: 10.1097/AOG.0000000000000480

Abstract

Case reviews of maternal death have revealed a concerning pattern of delay in recognition of hemorrhage, hypertensive crisis, sepsis, venous thromboembolism, and heart failure. Early-warning systems have been proposed to facilitate timely recognition, diagnosis, and treatment for women developing critical illness. A multidisciplinary working group convened by the National Partnership for Maternal Safety used a consensus-based approach to define The Maternal Early Warning Criteria, a list of abnormal parameters that indicate the need for urgent bedside evaluation by a clinician with the capacity to escalate care as necessary in order to pursue diagnostic and therapeutic interventions. This commentary reviews the evidence supporting the use of early-warning systems and describes The Maternal Early Warning Criteria, along with considerations for local implementation.

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Recommended Criteria

Table 1. The Maternal Early Warning Criteria

Systolic BP (mm Hg)	<90 or >160
Diastolic BP (mm Hg)	>100
Heart rate (beats per min)	<50 or >120
Respiratory rate (breaths per min)	<10 or >30
Oxygen saturation on room air, at sea level, %	<95
Oliguria, mL/hr for ≥2 hours	<35
Maternal agitation, confusion, or unresponsiveness; Patient with preeclampsia reporting a non-remitting headache or shortness of breath	

BP, blood pressure.
These triggers cannot address every possible clinical scenario that could be faced by an obstetric clinician and must not replace clinical judgment. As a core safety principle, bedside nurses should always feel comfortable to escalate their concerns at any point.

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What's it missing?

1. Criteria crossover and serve as an umbrella for multiple disorders
   a. Sepsis
   b. Hypertensive disease of pregnancy
   c. Respiratory complications
   d. Anesthesia complications
   e. Stroke
   f. Pulmonary Embolus

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Value of MEWS

- Removes provider bias.

- "She looked fine when I saw her."

- Assists in escalating care and identifying patients in need of additional care

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Value of MEWS

- I believe there are three levels of care-
  - L and D, ICU (ICU level care, 1:1)
  - High risk obstetric/PP unit (Ratio appropriate to acuity of patients)
  - Routine Postpartum care

- Units frequently have their own policies/protocols. Changes from routine protocols often missed

- Alerts assist in justifying increased monitoring and provider awareness

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Validation

- Blumenthal EA, Hooshvar N, Tancioco V, Newman R, Senderoff D, McNulty J. Implementation and Evaluation of an Electronic Maternal Early Warning Trigger Tool to Reduce Maternal Morbidity. Am J Perinatol. 2021 Jul;38(9):869-879.
  - More rapid treatment of sepsis and severe HTN
- Shields LE, Wiesner S, Klein C, Pelletreau B, Hedriana HL. Use of Maternal Early Warning Trigger tool reduces maternal morbidity. Am J Obstet Gynecol. 2016 Apr;214(4):527.e1-527.e6. doi: 10.1016/j.ajog.2016.01.154. Epub 2016 Feb 28. PMID: 26924745.
  - Decreased incidence of severe maternal morbidity
- Paternina-Caicedo A, Miranda J, Bourjeily G, Levinson A, Dueñas C, Bello-Muñoz C, Rojas-Suarez JA. Performance of the Obstetric Early Warning Score in critically ill patients for the prediction of maternal death. Am J Obstet Gynecol. 2017 Jan;216(1):58.e1-58.e8. doi: 10.1016/j.ajog.2016.09.103. Epub 2016 Oct 15. PMID: 27751799.
  - Higher score is predictive of mortality

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What should your institution do?

- Requires adaptation to facility capabilities but almost every tool has been validated to decrease morbidity and mortality

- Many EMRs have implemented previously

- Currently implementing expanded MEWS tool at Methodist

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Early Adoption is Helpful

- Many bundles will likely be recommended or required in coming years

- Implementation of MEWS early will aid integration later

- We implemented acute HTN protocol first
  - Provider acceptance/education
  - Validate accuracy of tool
  - Quality care measure
    - Monitored and reported internally and through NPQIC

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Nebraska Methodist Health System MEWS Tool

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- SBP
- DBP
- O2 Sat
- HR
- ALT (SGPT)
- AST (SGOT)
- Platelets
- Creatinine
- BNP
- I&O Intake

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Alert Title	12/3/2021		
MEWS Alert			
Scoring	1	2	3
Systolic	>/=140		>/=160
Diastolic	>/=90		>/=110
	2 values over the last 24 hours (current encounter) at least 4 hours apart, treat as 1 data point for a max of 1 point		2 values within 1 hr (to match AHTN), treat as 1 data point for a max of 3 points
O2 Sat	<95		
	2 values over the last 24 hours (current encounter) at least 4 hours apart		
HR	>/=120		
	2 values over the last 24 hours (current encounter) at least 4 hours apart		
LFT's			
ALT (SGPT)			>/=80
AST (SGOT)			>/=70
			any single value over the last 24 hours across encounters, treat as 1 data point for a max of 3 points

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Platelets		<100	<50
		any single value over the last 24 hours across encounters	any single value over the last 24 hours across encounters
BNP			>/=500
			any single value over the last 24 hours across encounters
I&O		>4000 ml difference between intake and output on the intake side	
		calculate over the last 96 hours with the lookback starting at time of score creation	With the 96 hour lookback the I&O will start to contribute to the total score 96 hours after admission
Creatinine			>/= 1.2
Total Score to alert	2 points or greater		
Suppression criteria	Suppress for 24 hours after alert fires		

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Our Thought Process and Institution Specific Implementation

- No temperature, hypotension, or RR
  - Already have Sepsis alert that fires for hypotension, fever, elevated lactate
  - Consider future integration of sepsis criteria

- Intentionally excluded hypotensive criteria

- Alert Fatigue

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MEWS Summary

- Improves identification of at risk patients
- Helps escalate care when needed
- Predictive of morbidity and mortality
- Implementation should be institution and EMR specific
- Early implementation is beneficial for integration of future bundles
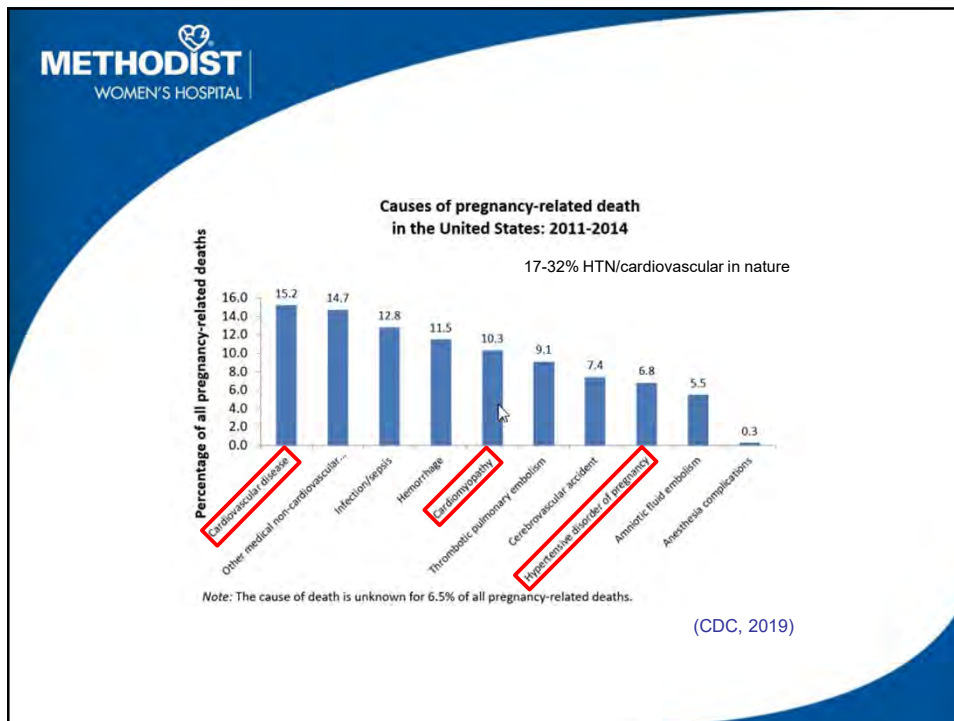- Likely to be required by certifying bodies in the future

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UPDATES IN THE PRIMARY CAUSE OF MATERNAL MORTALITY

HYPERTENSION AND ITS COMPLICATIONS

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Causes of pregnancy-related death in the United States: 2011-2014

17-32% HTN/cardiovascular in nature

Note: The cause of death is unknown for 6.5% of all pregnancy-related deaths.

(CDC, 2019)

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CMQCC
California Maternal
Quality Care Collaborative
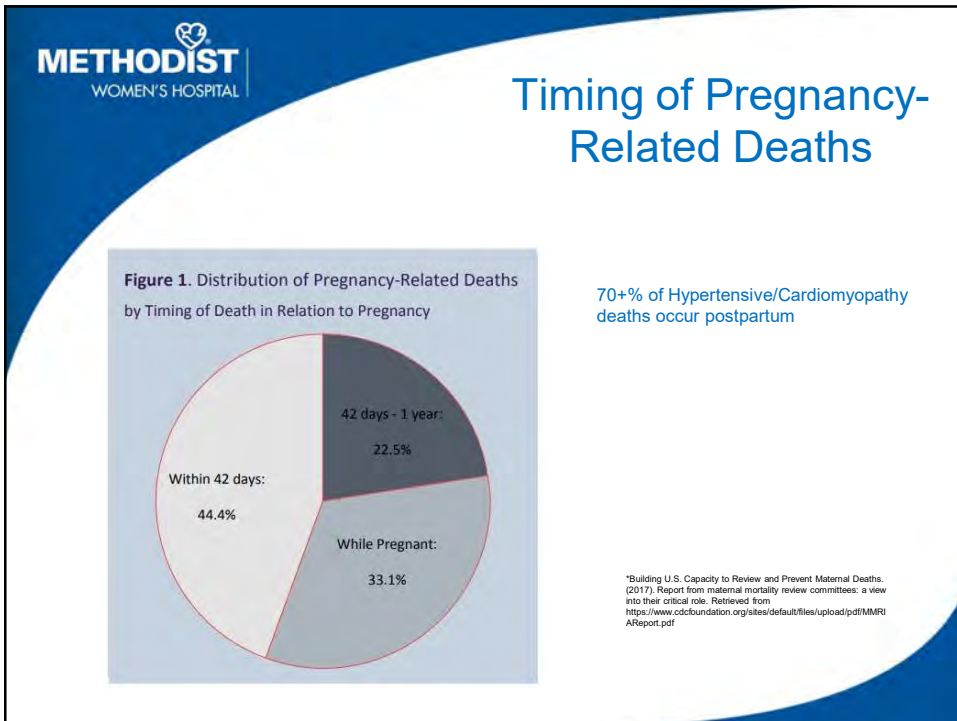
CA-PAMR Top 5 Causes of Death
2002-2006 (N=257)

Grouped Cause of Death, *per CA-PAMR Committee*	Pregnancy-Related Deaths N (%)
Cardiovascular disease	64 (25)
Cardiomyopathy	*42 (16)*
Other cardiovascular	*22 (9)*
Preeclampsia/eclampsia	45 (18)
Obstetric hemorrhage	25 (10)
Sepsis	23 (9)
Venous thromboembolism	22 (9)
TOTAL	**257**

43% of deaths were CVD related

©California Department of Public Health, 2017; supported by Title V funds. Developed in partnership with California Maternal Quality Care Collaborative Cardiovascular Disease in Pregnancy and Postpartum Taskforce. Visit: www.CMQCC.org for details

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Timing of Pregnancy-Related Deaths

Figure 1. Distribution of Pregnancy-Related Deaths by Timing of Death in Relation to Pregnancy

- 42 days - 1 year: 22.5%
- Within 42 days: 44.4%
- While Pregnant: 33.1%

70+% of Hypertensive/Cardiomyopathy deaths occur postpartum

*Building U.S. Capacity to Review and Prevent Maternal Deaths. (2017). Report from maternal mortality review committees: a view into their critical role. Retrieved from https://www.cdcfoundation.org/sites/default/files/upload/pdf/MMRIAReport.pdf

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Updates in HTN

- CHAP Trial

- Management of Acute HTN

- Postpartum Management of Pregnancy Related HTN

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Updates in HTN

- CHAP Trial
  - Tita AT, Szychowski JM, Boggess K, Dugoff L, Sibai B, Lawrence K, Hughes BL, Bell J, Aagaard K, Edwards RK, Gibson K, Haas DM, Plante L, Metz T, Casey B, Esplin S, Longo S, Hoffman M, Saade GR, Hoppe KK, Foroutan J, Tuuli M, Owens MY, Simhan HN, Frey H, Rosen T, Palatnik A, Baker S, August P, Reddy UM, Kinzler W, Su E, Krishna I, Nguyen N, Norton ME, Skupski D, El-Sayed YY, Ogunyemi D, Galis ZS, Harper L, Ambalavanan N, Geller NL, Oparil S, Cutter GR, Andrews WW; Chronic Hypertension and Pregnancy (CHAP) Trial Consortium. Treatment for Mild Chronic Hypertension during Pregnancy. N Engl J Med. 2022 May 12;386(19):1781-1792.

  Two arms
  - Goal BP </=140/90
  - Goal BP </=160/105

  Results:

  – Lower incidence of preeclampsia and PTB

  – Incidence of FGR, serious maternal or neonatal complications were not statistically significant
    - FGR was similar in both arms. RR for maternal/neonatal complications was lower in the intervention/treatment arm

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CHAP Take Home

Patients with Chronic Hypertension

Identified PRIOR to pregnancy or with HTN noted prior to 20 weeks EGA.

Treatment of BP to normotension beginning in the first/second trimester reduces risk of obstetric complications for both mother and fetus.
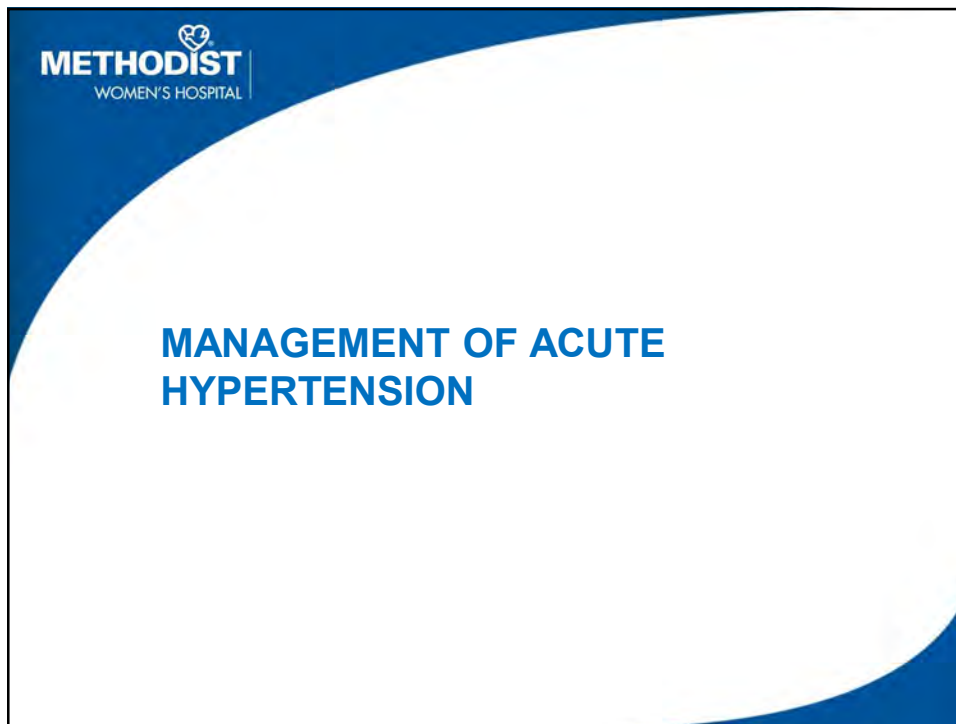
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CHAP Trial

THIS DOES NOT APPLY TO GESTATIONAL HYPERTENSION, PREECLAMPSIA or SUPERIMPOSED PREECLAMPSIA.
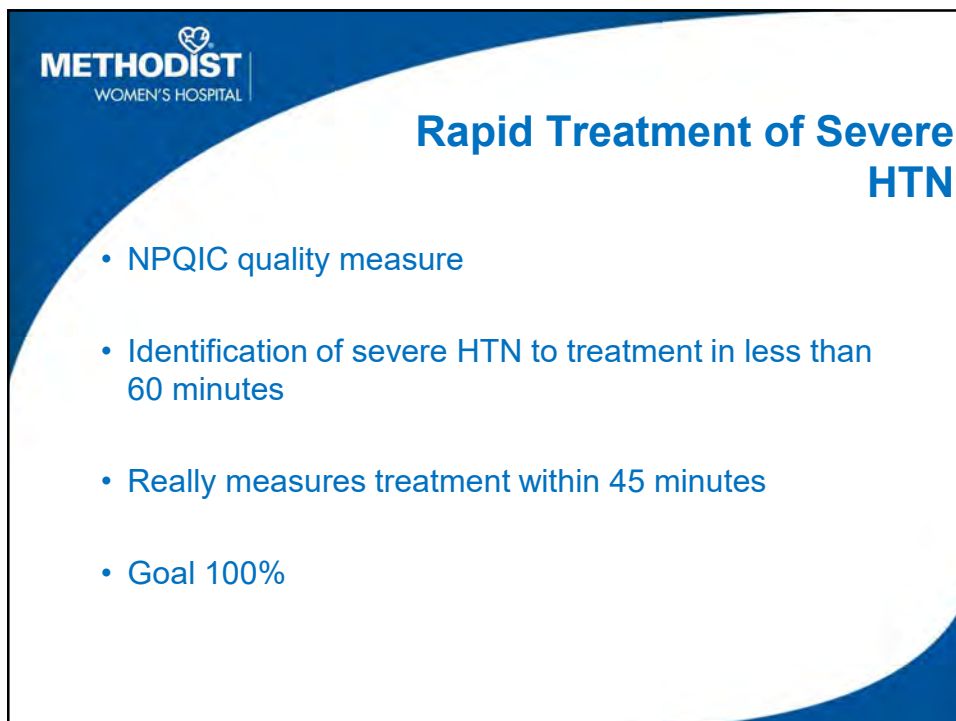
Prior ACOG recommendations still stand;

Patients with pregnancy related HTN should NOT have their HTN medically managed unless they have severe hypertension and are being managed as an INPATIENT.
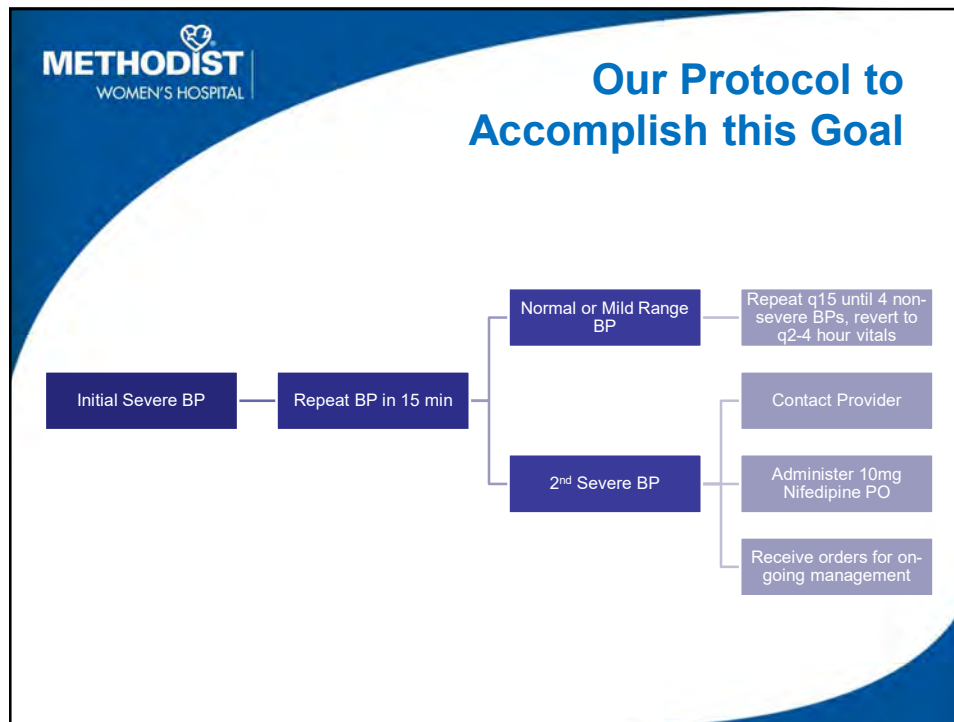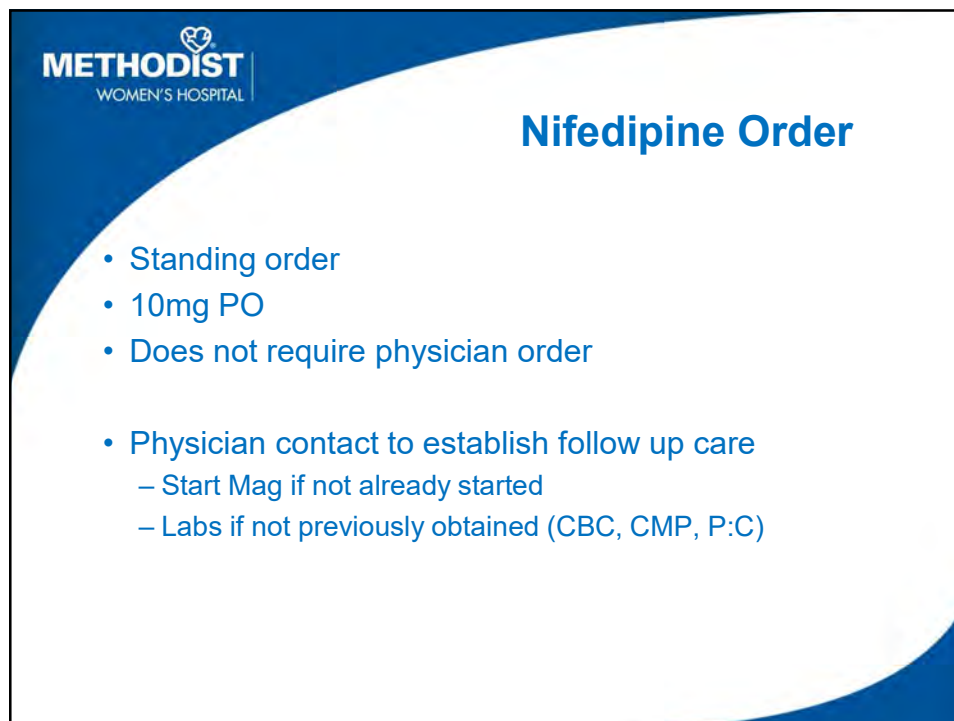
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MANAGEMENT OF ACUTE HYPERTENSION

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Rapid Treatment of Severe HTN

- NPQIC quality measure

- Identification of severe HTN to treatment in less than 60 minutes

- Really measures treatment within 45 minutes

- Goal 100%

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Our Protocol to Accomplish this Goal

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Initial Severe BP — Repeat BP in 15 min

- Normal or Mild Range BP → Repeat q15 until 4 non-severe BPs, revert to q2-4 hour vitals
- 2nd Severe BP →
  - Contact Provider
  - Administer 10mg Nifedipine PO
  - Receive orders for on-going management

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Nifedipine Order

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- Standing order
- 10mg PO
- Does not require physician order

- Physician contact to establish follow up care
  - Start Mag if not already started
  - Labs if not previously obtained (CBC, CMP, P:C)

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Evidence

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- Multiple RCTs support Nifedipine is preferred agent for *ACUTE* treatment of HTN
- All RCT trials have shown equivalency to labetalol or Nifedipine is more beneficial

- Easterling T. Oral antihypertensive regimens (nifedipine retard, labetalol, and methyldopa) for management of severe hypertension in pregnancy: an open-label, randomised controlled trial. Lancet. 2019 Sep 21;394(10203):1011-1021.
- Zulfeen M. IV labetalol and oral nifedipine in acute control of severe hypertension in pregnancy-A randomized controlled trial. Eur J Obstet Gynecol Reprod Biol. 2019 May;236:46-52.
- Tolcher MC, Fox Raheem IA, Saaid R, Omar SZ, Tan PC. Oral nifedipine versus intravenous labetalol for acute blood pressure control in hypertensive emergencies of pregnancy: a randomised trial. BJOG. 2012 Jan;119(1):78-85.
- KA, Sangi-Haghpeykar H, Clark SL, Belfort MA. Intravenous labetalol versus oral nifedipine for acute hypertension in pregnancy: effects on cerebral perfusion pressure. Am J Obstet Gynecol. 2020 Sep;223(3):441.e1-441.e8
- Shekhar S, Sharma C, Thakur S, Verma S. Oral nifedipine or intravenous labetalol for hypertensive emergency in pregnancy: a randomized controlled trial. Obstet Gynecol. 2013 Nov;122(5):1057-1063.

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Summary of Evidence

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- Fewer treatments required to obtain control

- More rapid control of blood pressure

- Lower risk of clinically significant side effects
  – Fetal distress
  – Hypotension

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Expert Opinion

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- I typically manage with short acting medication for 6-12 hours to determine # doses needed.
- I will max out Nifedipine before switching agents
  - Up to 120mg of rapid acting Nifedipine in 24 hours
    - 10, 10, 20, 20, 20, 40
- <60mg Nifedipine → Start 30mg Nifedipine BID
- >60mg Nifedipine → Start 60mg Nifedipine BID

- Reserve Labetalol for second agent
  - Reasoning to follow

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POSTPARTUM MANAGEMENT OF HYPERTENSION

Defined as any patient with 2 BPs >140 systolic or 90 diastolic during admission for delivery; includes patients with CHTN.

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Recent Publications on PP Management of HTN

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Postpartum Readmission for Hypertension After Discharge on Labetalol or Nifedipine

Adverse Outcomes during Postpartum Readmissions after Deliveries Complicated by Hypertensive

Postpartum management of hypertension and effect on readmission rates

Todd Lovgren [1], Brendan Connealy [2], Ruofan Yao [3], Joshua D Dahlke [2]

Factors associated with postpartum readmission for hypertensive disorders of pregnancy

Kelly H Bruce [1], Meredith Anderson [2], Joanna D Stark [2]

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Internal Data/Pending Publication

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Rate of readmission based on treatment and BP at Discharge

	All patients	HTN at DC	Normal BP at DC
Nifedipine	2.27%	3.24%	**0.41%**
Labetalol	10.81%	**12.63%**	5.80%
Both	2.97%	3.17%	2.50%
No Meds	4.87%	**6.15%**	3.68%

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Subjective Results

- Readmission rate has decreased 30% at Women's Hospital in hypertensive patients

- No officially adopted protocol

- Currently conducting RCT to evaluate Nifedipine/Labetalol

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Evolving Recommendations

Follow up in <72 hours after discharge

Treat to normotension prior to discharge

Nifedipine as 1st line agent

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Predictions

- Expect these recommendations will become standard of care for postpartum HTN in next 5-10 years
- Potential to be most significant "bundle" when eventually implemented

- If risk reduction for readmit translates directly to mortality:

Would reduce all cause maternal mortality up to **18%** in the US

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- Thank you to NPQIC for inviting me to speak
- Thank you to my outreach staff, clinical nurse managers and research nurses
- Thank you to Methodist leadership for helping us to champion quality care

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