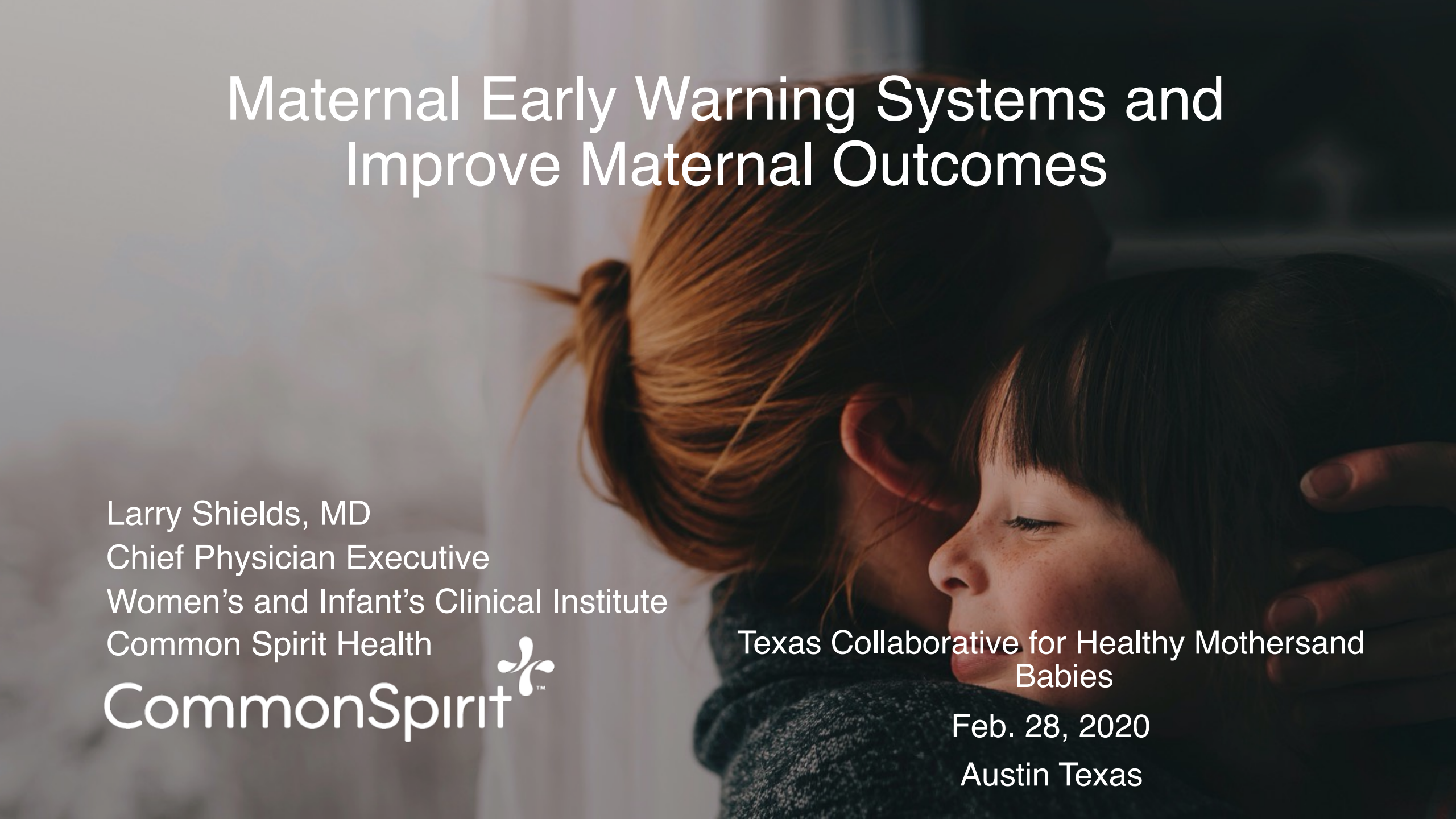
Maternal Early Warning Systems and Improve Maternal Outcomes



Larry Shields, MD
Chief Physician Executive
Women's and Infant's Clinical Institute
Common Spirit Health

CommonSpirit™

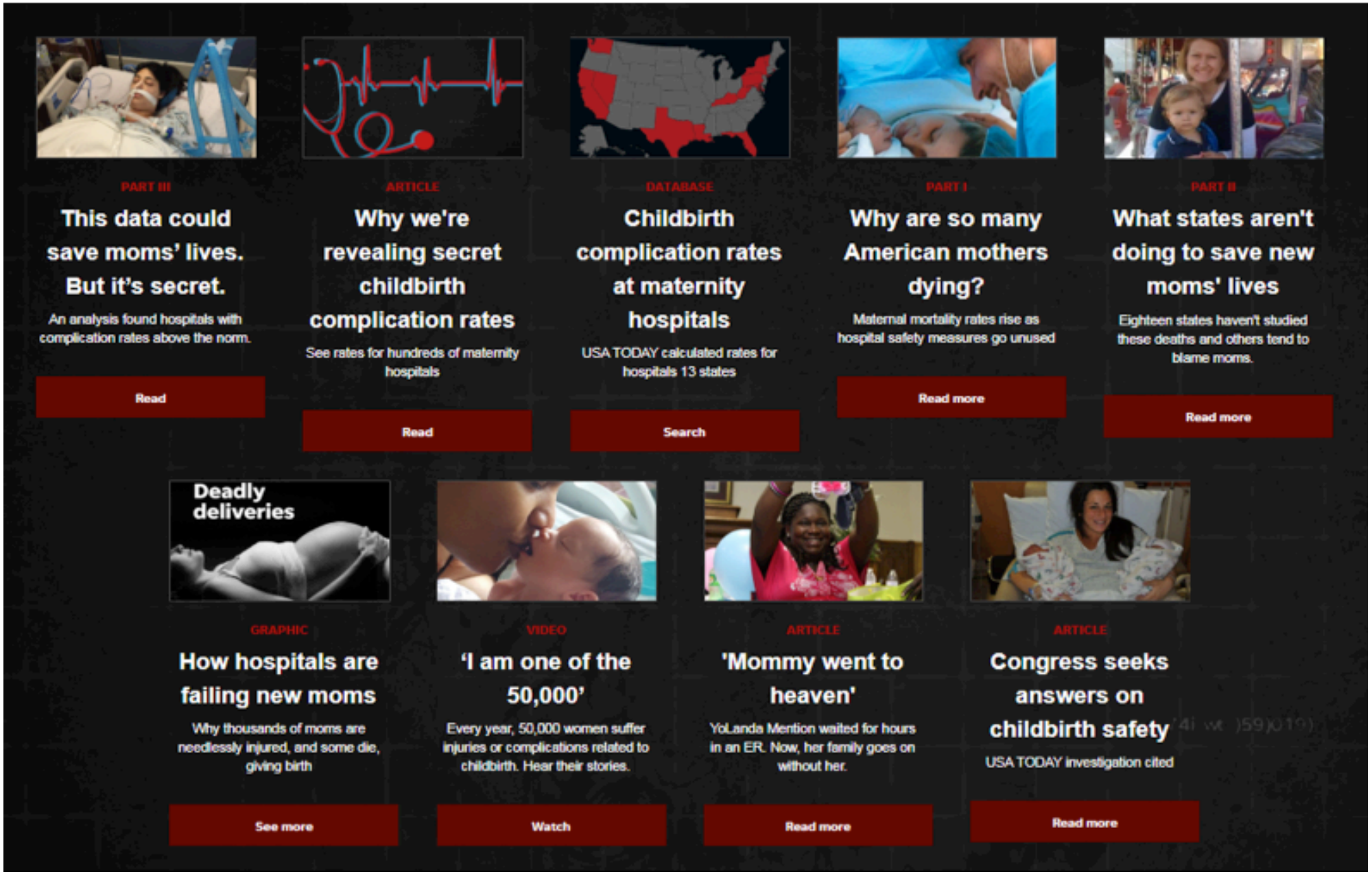
Texas Collaborative for Healthy Mothersand Babies

Feb. 28, 2020

Austin Texas

Disclosures-None
CommonSpirit

USA Today: Maternity Complications



Rural Reports

Texas is Most Dangerous State to Have a Baby

By **Rural Reports** - May 11, 2017

Critical Pathway to Poor Outcome

Maternal Death
1-3/10,000

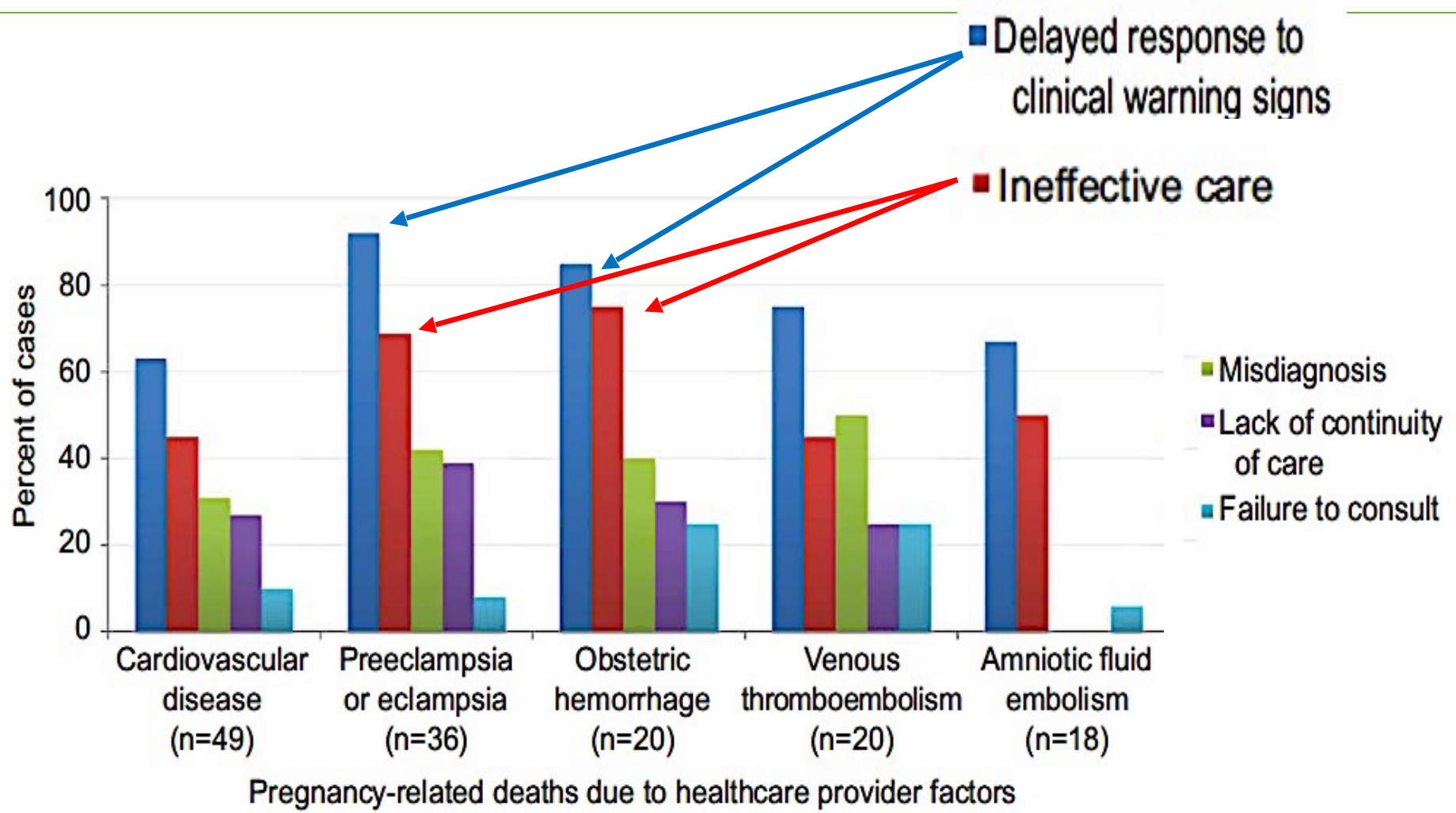
↑

Near Miss - ICU Admission
1-5/1,000

↑

Serious
Morbidity
1-4/100

California PMAR – Healthcare Providers



CMQCC
CALIFORNIA MATERNAL QUALITY CARE COLLABORATIVE

Obstet Gynecol 2015;125:938–47

Pregnancy Related Deaths 2011-15									
	During Pregnancy		During Delivery		1-6 Days PP		Total		
Hemorrhage	72	11%	123	30%	105	21%	300	19%	**19%**
Infection/Sepsis	117	19%	17	4%	83	17%	217	14%	**14%**
Thrombotic Embolism	115	18%	24	6%	41	8%	180	12%	
HTN	23	4%	41	10%	94	19%	158	10%	**10%**
CVA	68	11%	9	2%	49	10%	126	8%	**8%**
Cardomyopathy	48	8%	21	5%	25	5%	94	6%	**6%**
AFE	12	2%	114	28%	42	8%	168	11%	
Other Cardiovascular	173	28%	65	16%	61	12%	299	19%	**19%**
	628		414		500		1542		**76%**

https://www.cdc.gov/mmwr/volumes/68/wr/mm6818e1.htm?

SMM Rates

Acute Myocardial Infarction	0.15%	
Acute Renal Failure	7.12%	
Acute Respiratory Distress	4.39%	
Amniotic Fluid Embolism	0.33%	
Aneurysm	0.10%	
Cardiac Arrest	0.54%	
Eclampsia	**4.19%**	**PreE**
Pulmonary Edema	**3.30%**	
Acute Heart Failure	0.03%	
Cerebrovascular Events	1.32%	
Complications of Anesthesia	0.39%	
Sepsis	**9.14%**	**Sepsis**
Shock	4.01%	
Sickle Cell Crisis	0.23%	
VTE	**1.49%**	**VTE**
Transfusion	**67.00%**	
DIC	**11.43%**	**Hemorrhage**
Hysterectomy	**7.20%**	
Conversion of Dysrhythmia	0.52%	
Temporary Tracheostomy	0.09%	
Ventilation	2.80%	
TOTAL	**125.8 “%”**	**80%**

CA, OR, WA MDC 2018

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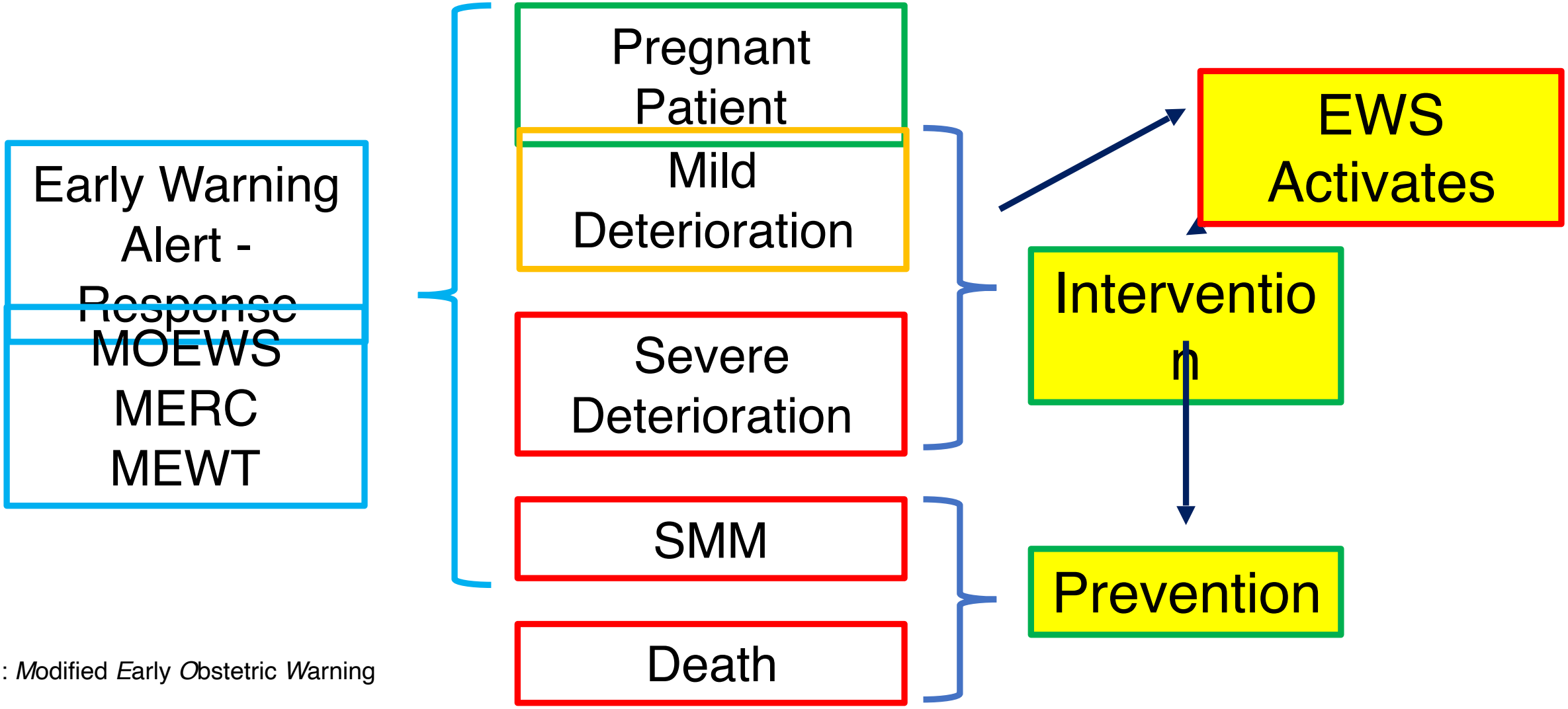
PreE + OBH = 75%

MDC 2018: CA, OR, WA: 1,079,107 birt

MEWS – *Improve Process & Outcomes*



MEOWS: *M*odified *E*arly *O*bstetric *W*arning *S*core
MERC: *M*aternal *E*arly *R*ecognition *C*riteria
MEWT tool: *M*aternal *E*arly *W*arning *T*rigger

Positive Alert Criteria

	MEOWS		MERC	MEWT	
	2 yellow	or 1 Red	Any Single	Two Needed	One Needed
Heart Rate (bpm)	>100 -120, <50	>120, <40	<50, >120	<50, >110	>130
BP systolic (mmHg)	>150-160, <90-100	<90, >160	<90, >160	<80	>160
BP Diastol. mmHg	>90-100	>100	>100	<45	>110
Respir. Rate	21-30	<10, >30	<10, >30	<12, >24	>30
MAP (mmHg)	---	---	---	<65	<55
O2 sat (%)	---	<95%	<95%	<93	<90
Temp	35-36°	<35, >38	---	<36, >38	---
Oligouria (ml/hr)	---	---	<35	---	---
Nurse	---	---	---	---	Uncomfortable
Pain Score	2-3	---	---	---	---
Neuro Response	Voice	Pain or none	---	Altered	---

Dignity Health

Maternal Early Warning Trigger (MEWT) Algorithm

MATERNAL TRIGGERS	
Temperature (96.9°F)	≥ 38°C (100.4°F) or ≤ 36°C
Pulse Ox / O2 Sat	≤ 93%
Heart Rate	> 110 or < 50 bpm
Respiratory Rate	> 24 or < 12 per minute
Systolic BP	< 80 or ≥ 155 mmHg
Diastolic BP	< 45 or ≥ 105 mmHg
Mean Art Press	< 65 mmHg
Altered Mental Status	anytime)
WBC	≥ 15,000 or ≥ 10% Bands or <4,000

SEVERE MATERNAL TRIGGERS	
Pulse Ox	≤ 90%
Heart Rate	> 130 bpm
Respiratory Rate	> 30 per minute
Systolic BP	≥ 160 mmHg
Diastolic BP	≥ 110 mmHg
Mean Art Press	< 55 mmHg
Nurse clinically uncomfortable with patient status	

Normal Assessment
(No sustained abnormal triggers)
STOP here and continue to monitor

Abnormal Assessment
(sustained abnormal triggers)
1 severe or 2 non-severe triggers
PROVIDER ASSESSMENT REQUIRED

Infection - Sepsis

Abnormal Temp ONLY or Abnormal Temp + FHR >160
SUSPECT CHORIOAMNIONITIS

Abnormal Temp and/or Suspected Infection

Notify Physician - CBC, blood cultures and antibiotics

Two or More Additional Triggers
HR > 110, MAP < 65, 02 Sat ≤ 93%, RR > 24, sBP < 80, dBP < 45
WBCs <4,000 or ≥ 15,000 or ≥ 10% Bands

Test for organ dysfunction
Lactic acid, LFTs, total bili, creatinine, urine output

Signs of acute organ dysfunction: lactic acid > 2 mmol/L, creatinine > 2.5 mg/dL, O2 Sat ≤ 93%

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Consider Overlap

Cardiopulmonary

HR > 110, MAP < 65, 02 Sat ≤ 93%, RR > 24 or Altered Mental Status
Consider Underlying Cause

Cardiomyopathy / CHF
Myocardial Infarction
Pulmonary Edema
Pulmonary HTN
Pulmonary Embolus / DVT
Pneumonia
Illicit Drug Use

BNP, cardiac enzymes, EKG, echo, spiral CT

Consults
Anesthesia, Medicine, Critical Care, Maternal-Fetal Medicine

Consider Overlap

Hypertension in Pregnancy

SBP > 155 and/or DBP > 105
Notify Provider
Consider Therapy

BP >160 and/or 110
Treatment indicated within 1 hour

Follow Severe HTN Algorithm:
IV labetalol 20, 40 80 mg q 20 min.
IV Hydralazine 5, 10 mg q 10 min
or
PO Nifedipine 10 mg PO Q10 min
And
Magnesium Sulfate – 4gm Bolus then 2gm per hour

HTN Labs (PT, PTT, fibrinogen)

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Consider
pulmonary edema, VTE, CHF

Obstetrical Hemorrhage

Designed to produce early intervention and reduction in hemorrhage severity

Most Useful Postpartum

MEWT Algorithm 2.0 (revised 9-2019)

Dignity Health.

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  Illicit Drug Use
- BNP, cardiac enzymes, EKG, echo, spiral CT
- **Consults**
  Anesthesia, Medicine, Critical Care, Maternal-Fetal Medicine

Consider Overlap

Hypertension in Pregnancy

- SBP > 155 and/or DBP > 105 Notify Provider Consider Therapy
- **And**
  Magnesium Sulfate – 4gm Bolus then 2gm per hour
- **HTN Labs (PT, PTT, fibrinogen)**
- O2 Sat < 93% or RR > 24 Consider pulmonary edema, VTE, CHF

Designed to produce early intervention and normalization of Blood Pressure

Obstetrical Hemorrhage

- Abnormal Blood Loss and/or HR > 110,), 02 Sat ≤ 93%, sBP < 80, dBP < 45, MAP < 65 Consider Underlying Cause
- OB and Anesthesia to bedside
- Concealed Hemorrhage
  Uterine Atony
  Retained Products
  Intra-abdominal bleeding
  Perineal / Cervical Trauma
- **Follow Management of Obstetrical Hemorrhage Protocol (multistage algorithm)**

MEWT Algorithm 2.0 (revised 9-2019)

Dignity Health

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N… s

HR… BP

Signs … dysfuncti… mmol/L, cre… O2… 0, o… tic a… tput… s

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…llow Management of …cal Hemorrhage Protocol …ultistage algorithm)

Designed to improve early intervention of INFECTION and Early *Identification* and *Severity* of SEPSIS

Value of Early Detection

- Sepsis:
  - Case controlled study 82 cases of sepsis v. 328 controls
  - Usual "suspects": (chorio, endometritis, pneumonia, wound, pyelo)
  - mortality 8% v. 20% based on antibiotics at < or > 1 hour

Anesthesia & Analgesia. 2019;129:1613-1620

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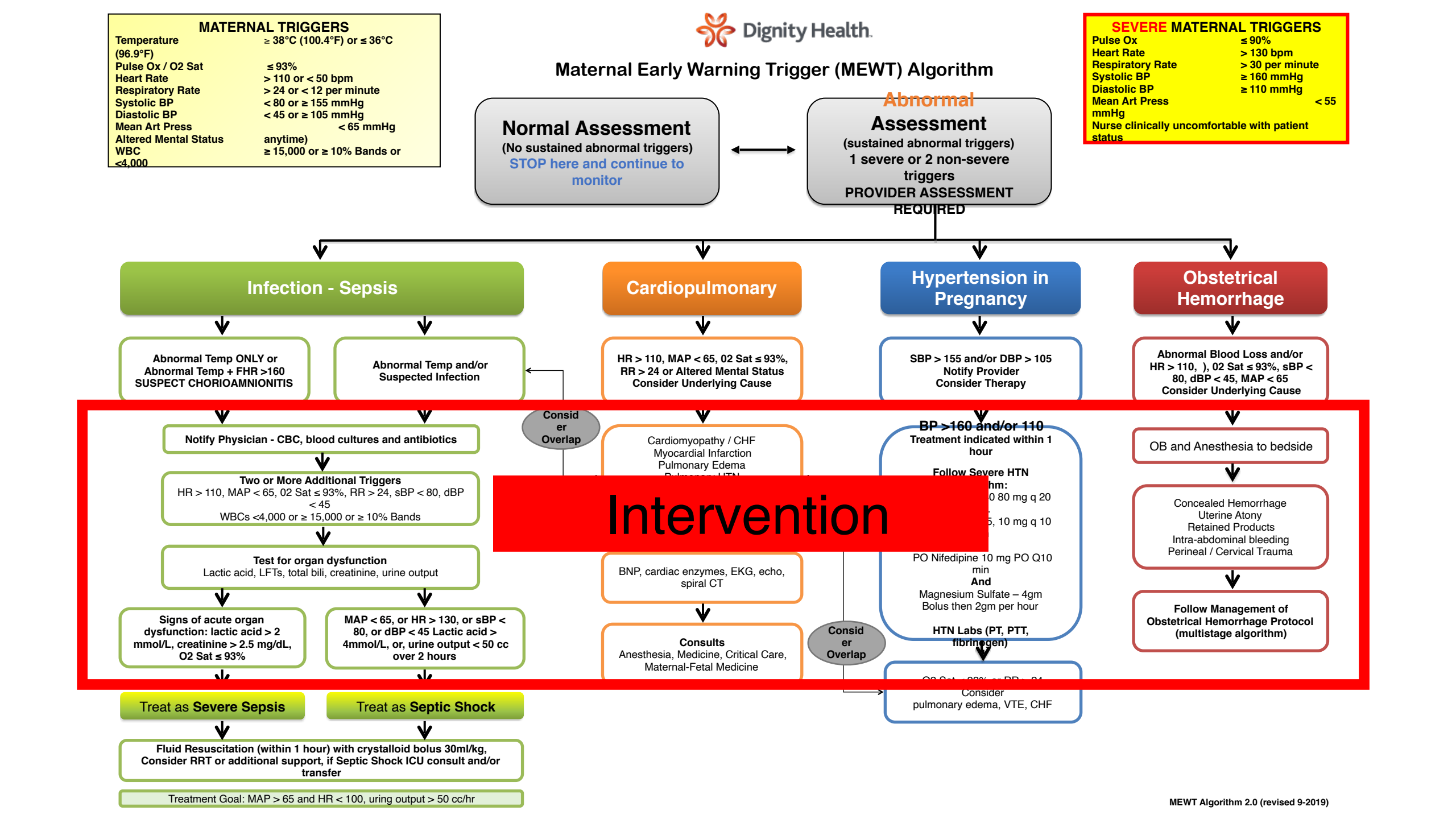

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5, 10 mg q 10

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OB and Anesthesia to bedside

Concealed Hemorrhage
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Follow Management of Obstetrical Hemorrhage Protocol (multistage algorithm)

Intervention

MEWT Algorithm 2.0 (revised 9-2019)

Recognition and Intervention

Alert: Trigger Concern for OBH
Criteria: HR 124
Activate MEWS

Order Set for MEWS with concern for PPH:

- ❑ Place peripheral IV
- ❑ Bolus 500 cc lactate ringers
- ❑ Methergine 0.2 mg IM every 2-4 hours up to 5 doses
- ❑ Hemabate 0.25 mg IM every 15 minutes up to 8 doses
- ❑ Pitocin 30 units in 500 mL infusion or 10 units IM
- ❑ Misoprostol (cytotec) 400-1000 mcg rectal ***or*** 600 mcg buccal
- ❑ Tranexamic acid 1g to be infused over 10 to 20 minutes (infusion >1 mL/minute can cause hypotension). If bleeding persists after 30 minutes, a second one gram dose can be administered
- ❑ CBC
- ❑ INR, PT, PTT
- ❑ Fibrinogen
- ❑ Thromboelastogram
- ❑ Crossmatch XX units
- ❑ Transfuse XX units of XX
- ❑ Vitals signs q5 min for XX time

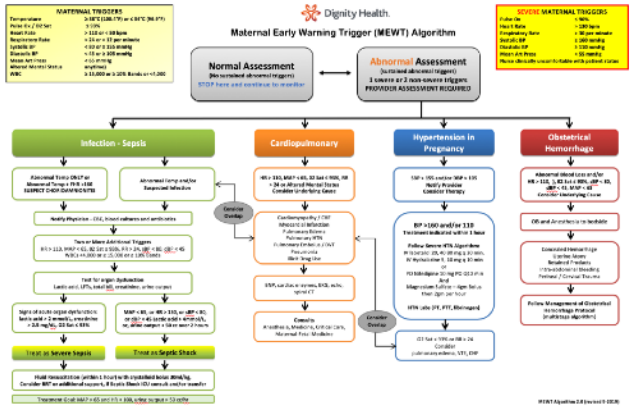
Do Maternal Warning Systems Improve Delivery of Maternal Care?

Do Maternal Warning Systems Improve Delivery of Maternal Care?

Process Measures:

1. Percent of providers that use tool
2. Time to bedside evaluation
3. Percentage that enter designated order set

MEWT Tool Process Assessment



- Reduction in timely treatment of critical BP
- Physician assessment within <1 hour after trigger alert: >80%
- Provider followed evidenced based clinical pathway: >80%

- Deficits: did not have pre and post rates

CommonSpirit

Shields 2016;214:527 e1-6

Clinical care metrics pre vs post MEWT

MEWT Trigger rate 2.3%	Pre MEWT -N (%) categorical variables -N, median hours [IQR] continuous variables	Post MEWT -N (%) categorical variables -N, median hours [IQR] continuous variables	P value[f]
Sepsis			
Time MEWT alert to antibiotics	N=17, 1.87 [1.11-2.63]	N=13, 0.75 [0.31-1.19]	**P=0.04**
Hypertension			
Care escalation within 60 minutes[g]	N=29, 18 (62.1%)	N=47, 39 (83.0%)	**P=0.04**
Cardiopulmonary			
Time MEWT alert to diagnostic study or furosemide	N=15, 3.82 [0-8.20]	N=25, 1.50 [0-3.77]	P=0.47
Hemorrhage			
Bleeding to first transfusion	N=96, 3.38 [1.56-17.68]	N=105, 3.07 [0.77-19.75]	P=0.13[g]
Bleeding to balloon placement or return to operating room	N=38, 1.23 [0.67-3.92]	N=45, 0.77 [0.32-3.38]	P=0.06[g]
MEWT vital sign abnormality to first transfusion	N=28, 1.56 [0.32-3.95]	N=24, 2 [0.84-12.05]	P=0.30[g]

IQR= interquartile range

[f]p value determined by Chi-square test for categorical values; p value determined by Cox regression log-rank test except as indicated for continuous variables

[g]Mann-Whitney U test

Three Centers: 52 wk pre/54 wks Post-20,000 births

Blumenthal AJOG 2020;s165

Do Maternal Warning Systems Improve Delivery of Maternal Care?

Outcome Measures:

1. Return to normal vital signs
2. Reduction in severe hemorrhage
3. Reduced SMM
4. Reduction in composite adverse events

OB Hemorrhage

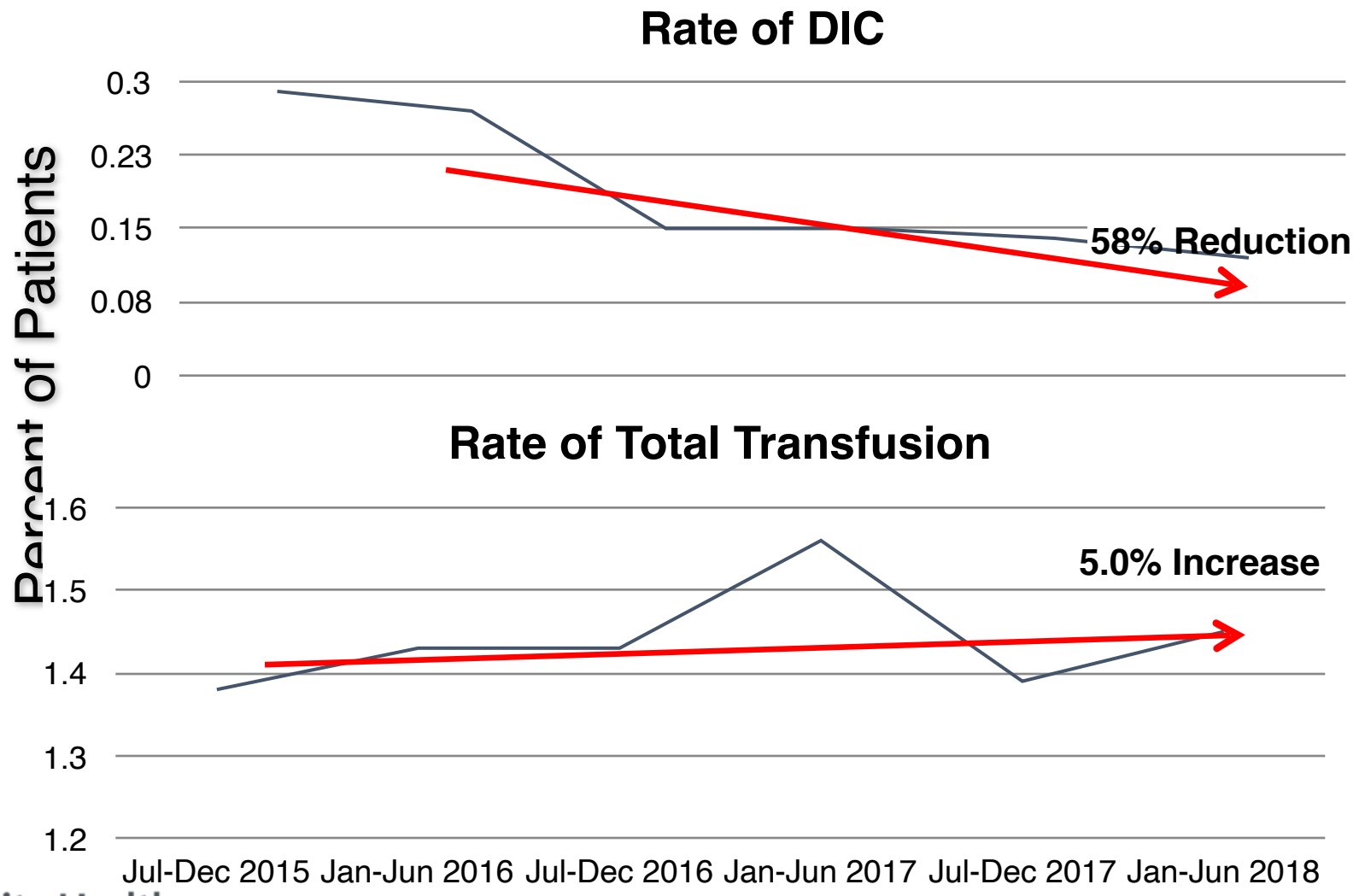


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TABLE 2
Results from pre- and post-Maternal Early Warning Trigger time periods

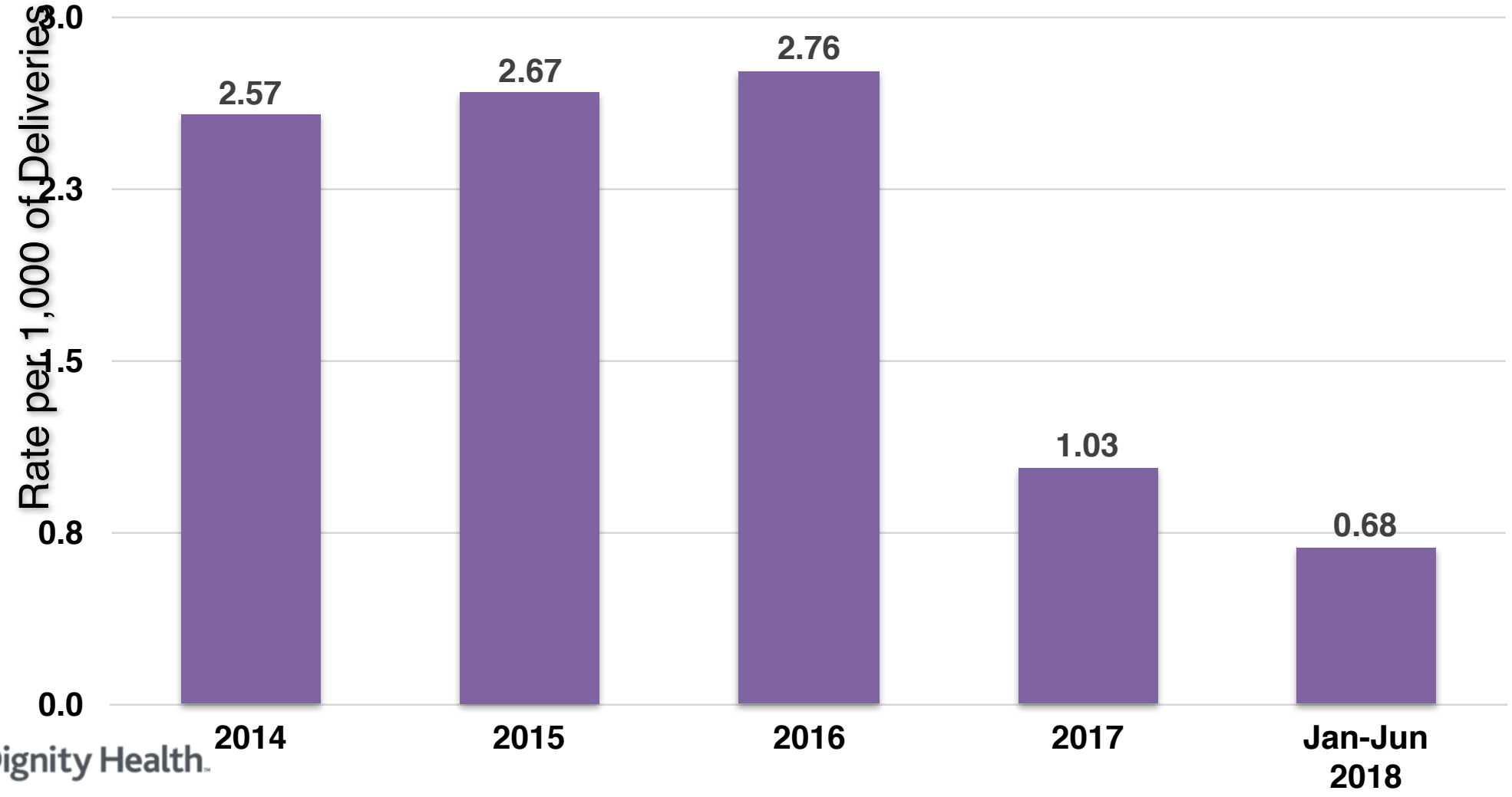
	Pre-MEWT	Post-MEWT	Trend	*P* value	Prenonpilot	Postnonpilot	Trend	*P* value	Postpilot vs postnonpilot *P* value
Deliveries	24221	12611			95,718	50,641			
CDC-SMM	2.0%	1.6%	↓	<.01	2.4%	2.4%	→	.9	<.01
Composite morbidity	5.9%	5.1%	↓	<.01	6.2%	6.2%	→	.9	<.01
Eclampsia/1000[a]	2.0	0.4	↓	<.01	1.1	1.1	→	.9	.02
Hemorrhage	2.9%	2.7%	↓	.1	3.2%	3.3%	↑	.5	<.01
Transfusion	0.7%	0.6%	↓	.5	0.7%	0.8%	↑	.01	.04
D&C/1000[a]	4.1	3.0	↓	.1	3.0	3.8	↑	.02	.2
Hysterectomy/1000[a]	0.94	0.63	↓	.3	0.95	0.95	↑	.9	.2
Sepsis/1000[a]	0.78	1.3	↑	.14	0.26	0.42	↑	.1	

CDC, Centers for Disease Control and Prevention; *D&C*, dilation and curettage; *MEWT*, Maternal Early Warning Trigger tool; *SMM*, severe maternal morbidity.

[a] Rate given per 1000 deliveries.

Shields et al. Maternal trigger tool and severe maternal morbidity. Am J Obstet Gynecol 2016.

Timely treatment of Critical BPs
SMM - PreE/Eclampsia



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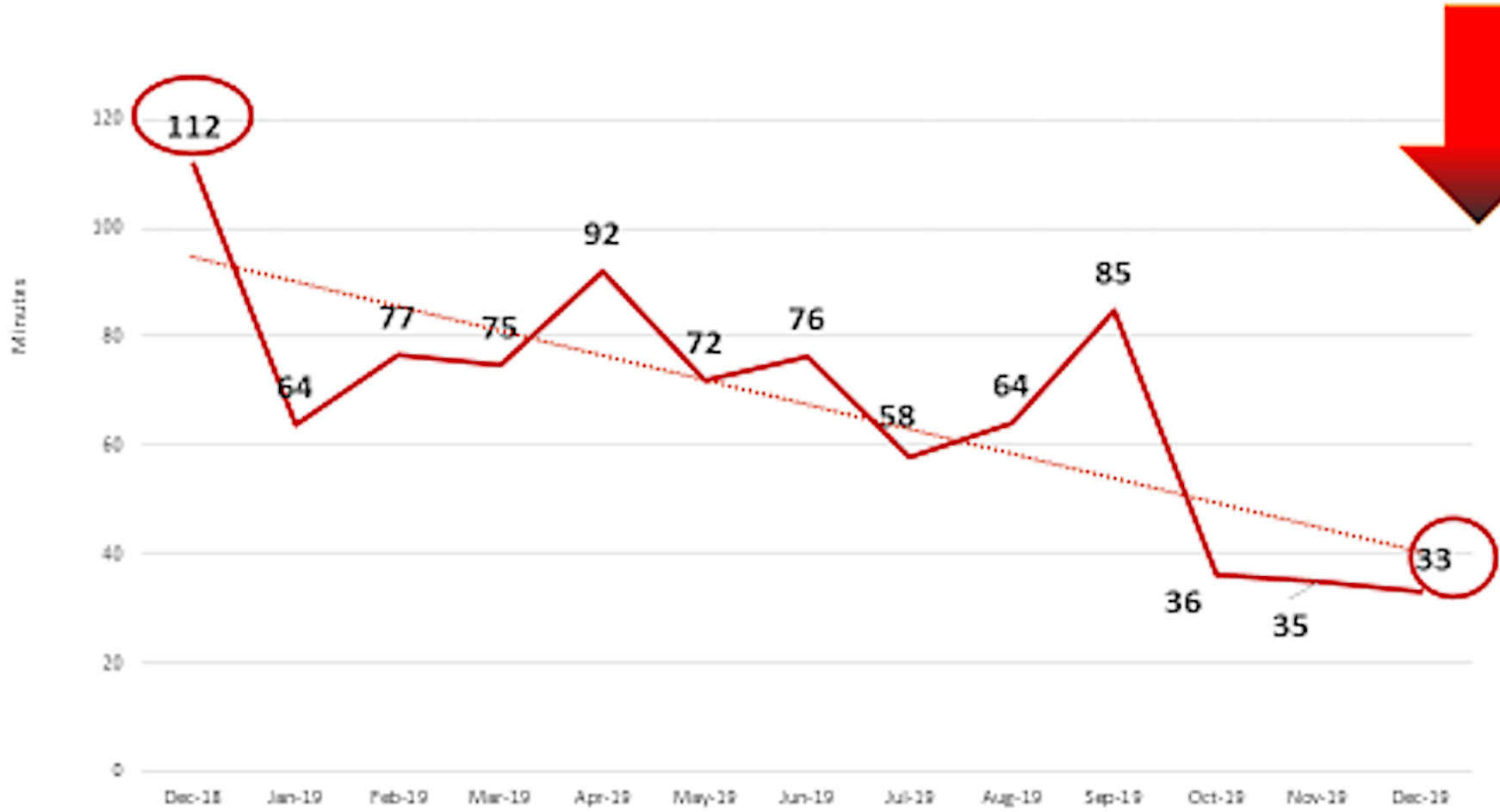
Rural Reports

Texas is Most Dangerous State to Have a Baby

By **Rural Reports** - May 11, 2017

Maternal Early Warning System: Blood Pressure Time to Resolution



71%

Reduction in the amount of time it takes for blood pressure to return to a safer range

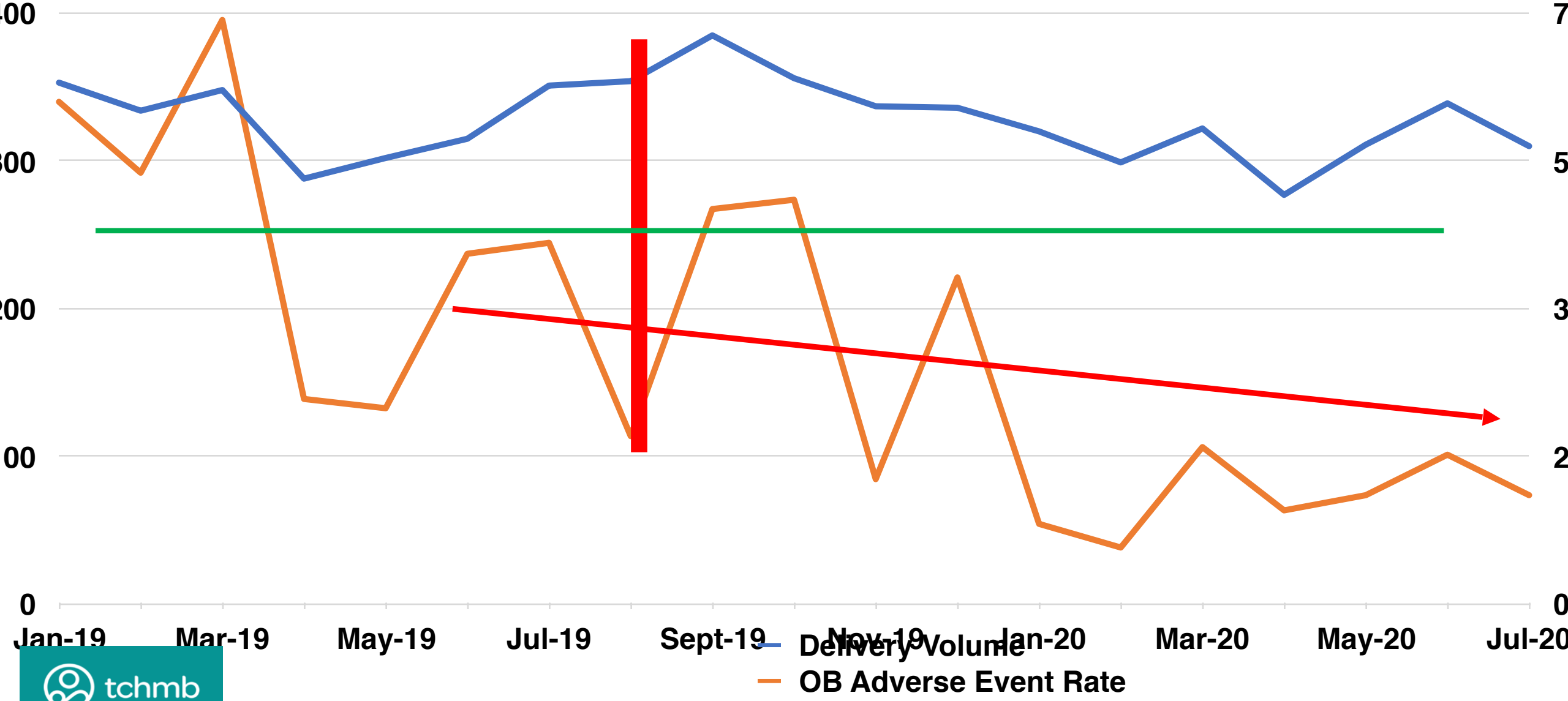
Outcomes following MEWS Implementation

	Pre-MEWS (n= 2291)	Post-MEWS (n=3946)	p value
Composite Adverse Event Rate (%)	4.5	2.2	0.006
Transfusions ≥4 units (%)	1.5	0.3	0.002

tchmb

Obstetric Adverse Event Rate

Unanticipated return to OR or ICU and Transfusion ≥ 4 units



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So Do MEWS Work?

So, Do MEWS Work?

✓ **Process Measures**:
✓ Percent of provider that use tool
✓ Time to bedside evaluation
✓ Facilitate designated order set

Outcome Measures:
✓ Return to normal vital signs
✓ Reduction in severe hemorrhage
✓ Reduced composite adverse outcomes
✓ Reduced SMM

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Logistical Issues of MEWS
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Will these Only Work in Large Centers?

Location	Del. Vol.	Location	Del. Vol.
MRMC CA	3,000	St. Joes AZ	4924
MSJ CA	2010	St. Joes. WA	4104
Mercy General CA	1260	Harrison WA	1889
French CA	706	Highline WA	838
Sierra Nevada CA	440	St Elizabeth WA	339

Same Assessment Fits All Sizes

Start Now v. No Wait for Your EMR

- Limited Resources: go “old school” i.e. paper
  - “I want to wait for the EMR”
  - Significant “build-out issues”
  - Changes to EMR can take forever

- Some systems have already started or have built system

- Larger Facilities: Cerner, Epic, Pascal Metrics, Perigen, others ….?

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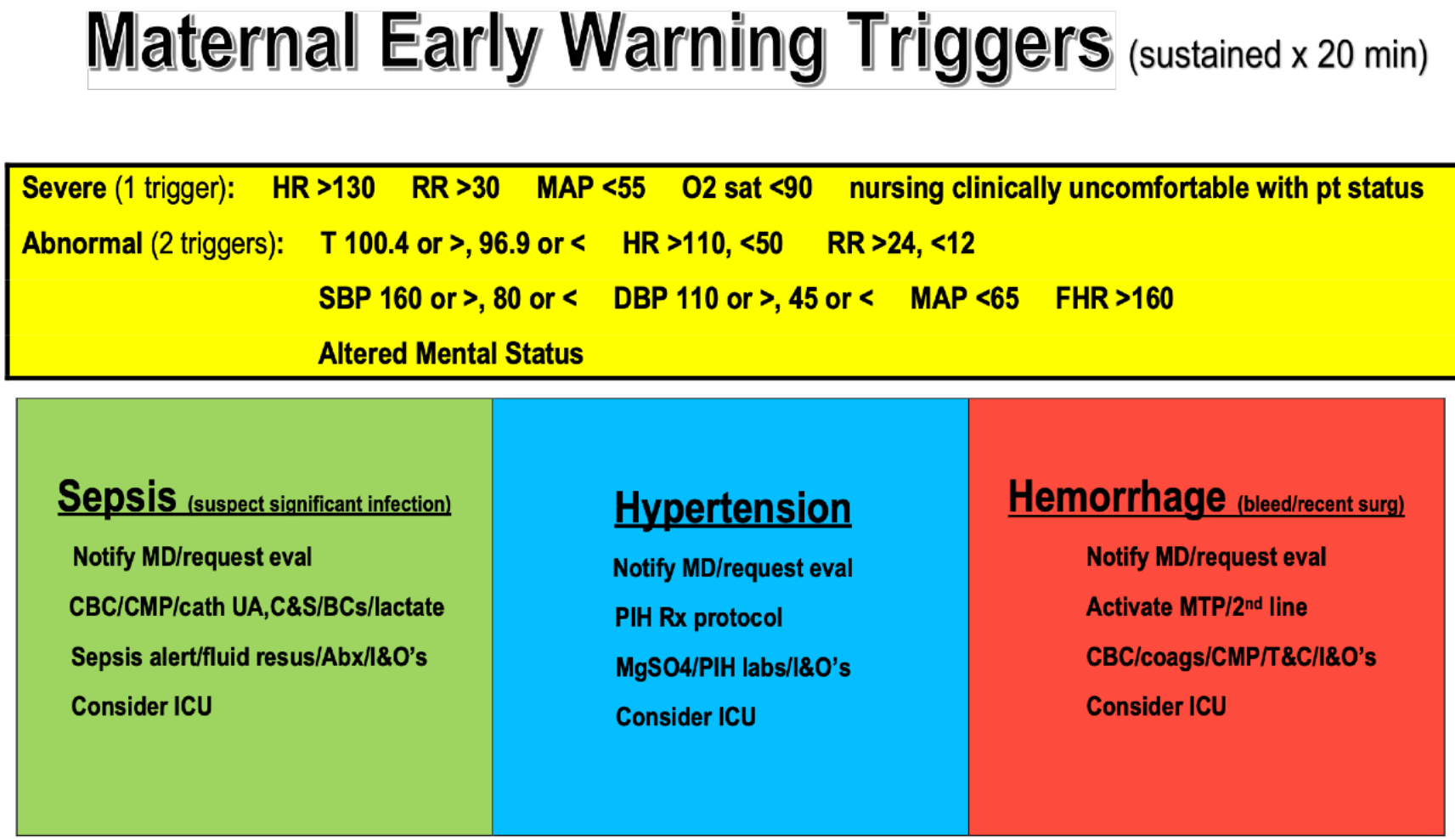
Skipped EMR for Detection but Built Order Sets



Mary Campbell, MD Eastside Medical Center, GA
Approx 1,000 birth annually

Dignity Health.

MATERNAL TRIGGERS SCREENING TOOL 6/26/14 v8

Patient Label

	Date Time						
→	Initials						

SECTION I : SCREENING CRITERIA

Severe Abnormal Trigger: If any ONE (1) of these are present greater than 20 mins CALL PROVIDER IMMEDIATELY

- ☐ Heart Rate greater than 130
- ☐ Respiratory Rate greater than 30
- ☐ Mean Arterial Pressure (MAP) less than 55
- ☐ Oxygen saturation less than 90%
- ☐ Nursing is clinically uncomfortable with patient status

Maternal Trigger	Screening Criteria	Check all that apply in the table below ↓					
1. Temperature	Greater than or equal to 38 C/100.4 F OR Less than or equal to 36 C/96.9 F	☐	☐	☐	☐	☐	☐
2. Fetal Heart Rate (sepsis path)	Greater than 160 bpm (*baseline, gestational age greater than or equal to 20 weeks)	☐	☐	☐	☐	☐	☐
3. Maternal Heart Rate *exclude during pushing	Greater than110 bpm or less than 50	☐	☐	☐	☐	☐	☐
4. Respiratory Rate	Greater than 24/min or less than 10	☐	☐	☐	☐	☐	☐
5. O2 saturation	Less than or equal to 93%	☐	☐	☐	☐	☐	☐
6. Blood Pressure	Systolic greater than 155 or less than 80 Diastolic greater than 105 or less than 45	☐	☐	☐	☐	☐	☐
7. Pain	Sudden onset, increasing, unusual for diagnosis or normal clinical course, noted in new location	☐	☐	☐	☐	☐	☐
8. Altered Mental Status	Confusion, agitation, combativeness, dizziness, shortness of breath	☐	☐	☐	☐	☐	☐
Are any two (2) of the above present? If YES repeat assessment within 20 to 30 minutes. If trigger is sustained, CONTACT PROVIDER and consider the following appropriate pathway on the back of this screening tool. Continue with screening every 20 to 30 minutes, as indicated If "NO", STOP HERE till next assessment		☐ Yes ☐ No	☐ Yes ☐ N	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

Additional Comments: **Which trigger pathway selected** _____ **Was the triggers pathway followed?** ☐ **Yes** ☐ **No**

Transferred to ICU? ☐ **Yes** ☐ **No** **LOS # Days:**_____ ****Final status of this patient: (summarize below):**

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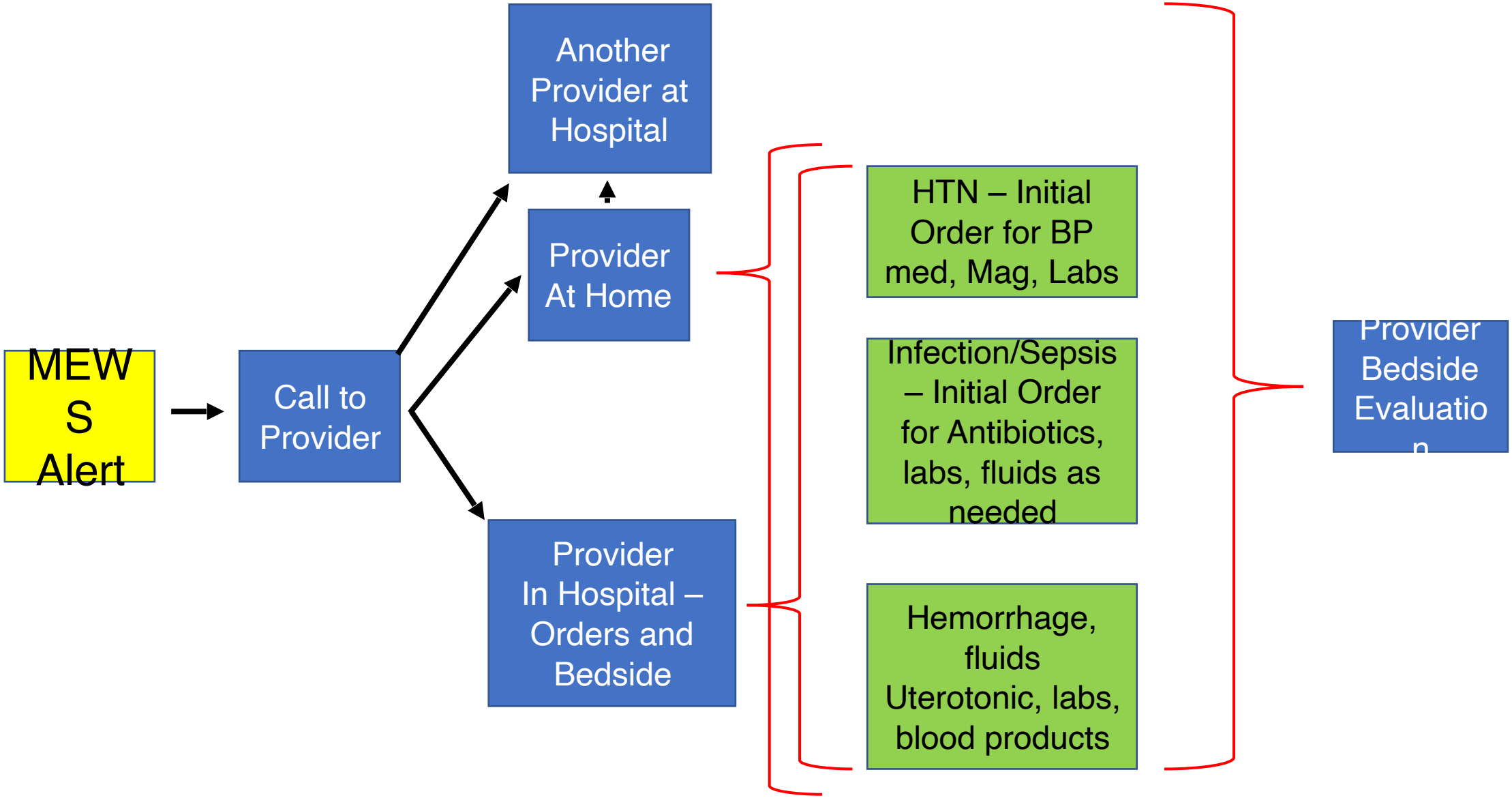
Provider Evaluation and Escalation of Care



Modification of WSHA Rural Response

Threshold of MEWS-T Alerts

- ➢ Alert Parameter are similar between the Maternal Early Warning Systems/Tools
- ➢ Sustained values:
  - ≥2 v. ≥2 sustained triggers increased probability for IUC admission for 10.2→61.7
  - Reduction in alert frequency and alarm fatigue*
  - Increase in perceived clinical relevance of alert**

*Hedriana et al. IJOG 2015; 132(3):337-41

**Blumenthal et al. AJP 2019;36:1106

Value of Alert and Frequency

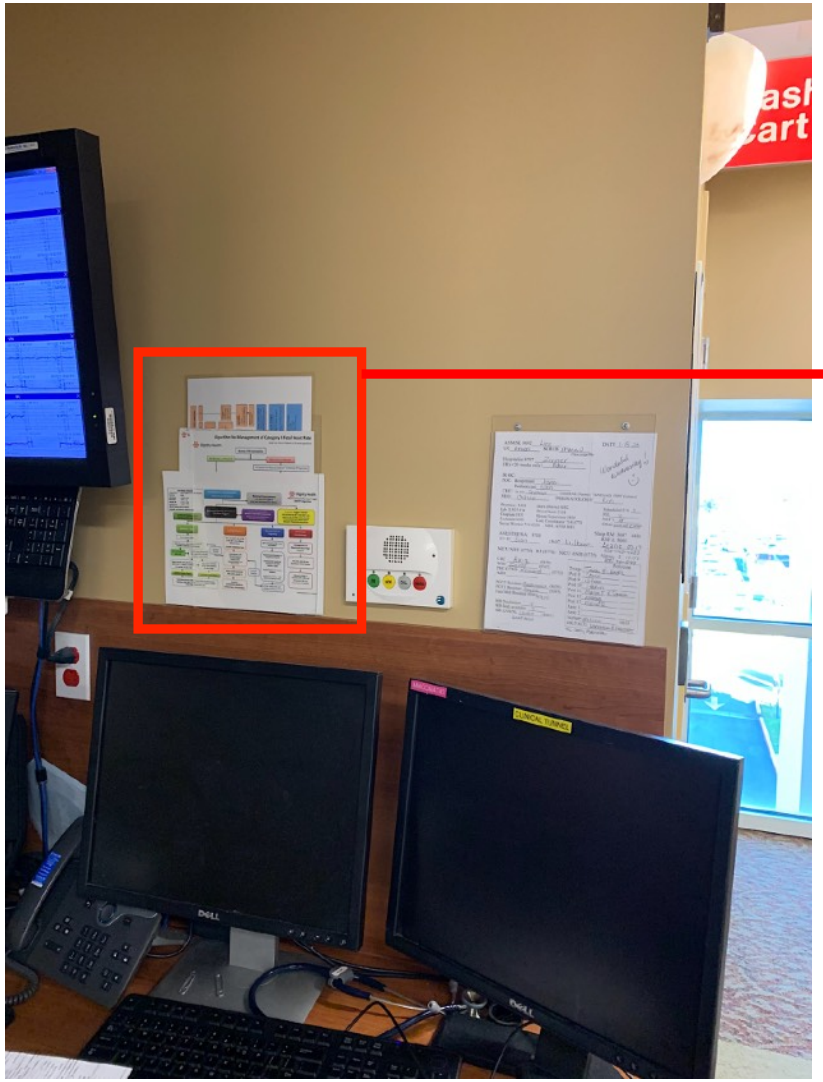
Retrospective Assessment*	**Sensitivity**	**Specificity**	**PPV**	**NPV**	**% of Control with + Alert**
MEOWS	67.1%	51.2%	46.9%	70.8%	49%
MERC	67.1%	60.2%	52.0%	74.0%	40%
MEWT	40.5%	88.6%	69.6%	69.9%	***11%***
Prospective Assessment					***% of patients with a + Alert***
MEWT**					***2.9%***
MEWT***					***2.3%***
TCHMB					***7%***

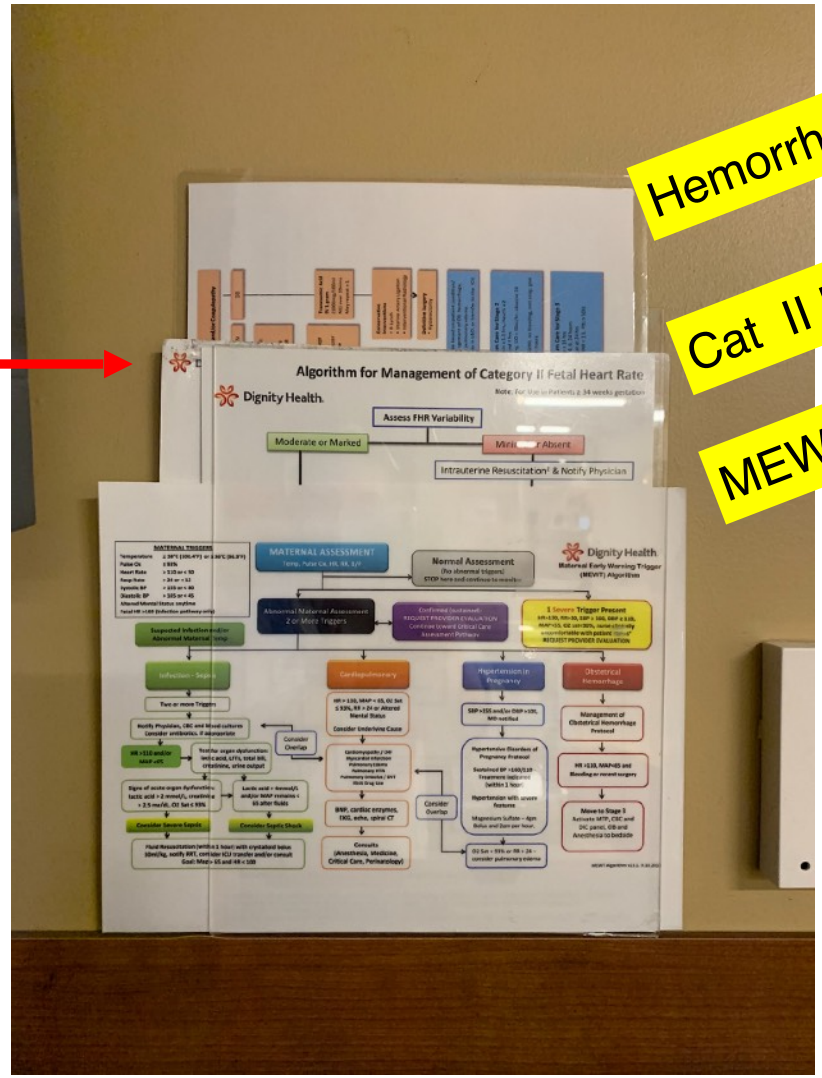
*Blumenthal et al. AJP 2019;36:1106
**Shields et al AJOG 2016;527e1-6
***Blumenthal AJOG 2020;s165

Barriers and Limitations

- ➢ Perceived value of alert: “the system fired and I don’t think anything is wrong”
- ➢ False positive alerts: “every time I get an alert the patient was fine”
- ➢ Agreeing on standard responses or order sets
    - BP, Hemorrhage, Sepsis, Cardiovascular
- ➢ Difficult in measuring value:
    - low frequency events: sepsis, DVT, cardiovascular cases
    - For systems – process and outcomes assessment
    - For *individual hospitals and providers – process measure assessment*

Post At All Charting Sites





Thank you

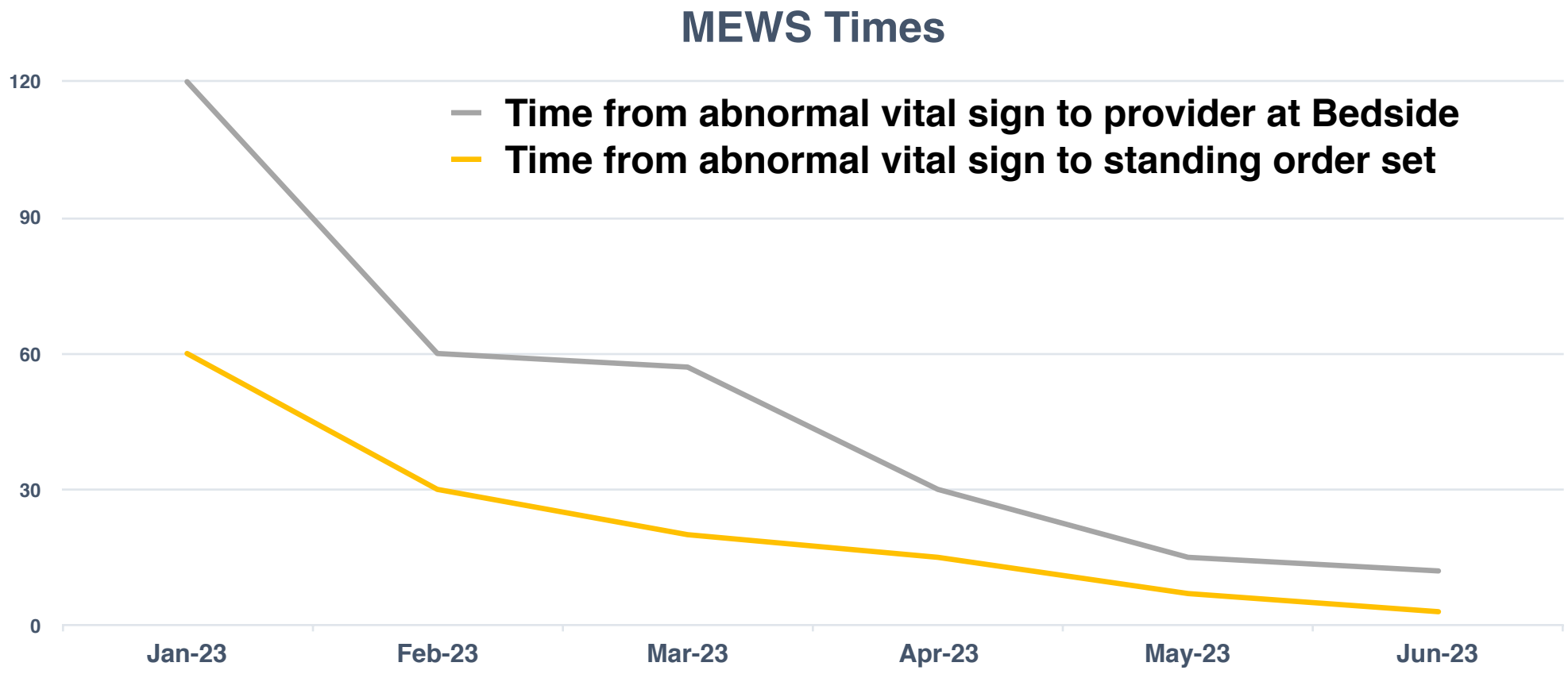
CommonSpirit

Texas Collaborative for Healthy Mothers and Babies

	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19
Cumulative % of patient that trigger MEWS – ALARM RATE	2%	4%	10%	6%	6%	7%
Time from abnormal vital sign to PROVIDER AT BEDSIDE (min)	120	60	57	30	15	12
Time from abnormal vital sign to STANDING ORDER SET (min)	60	30	20	15	7	3

tchmb

Texas Collaborative for Healthy Mothers and Babies



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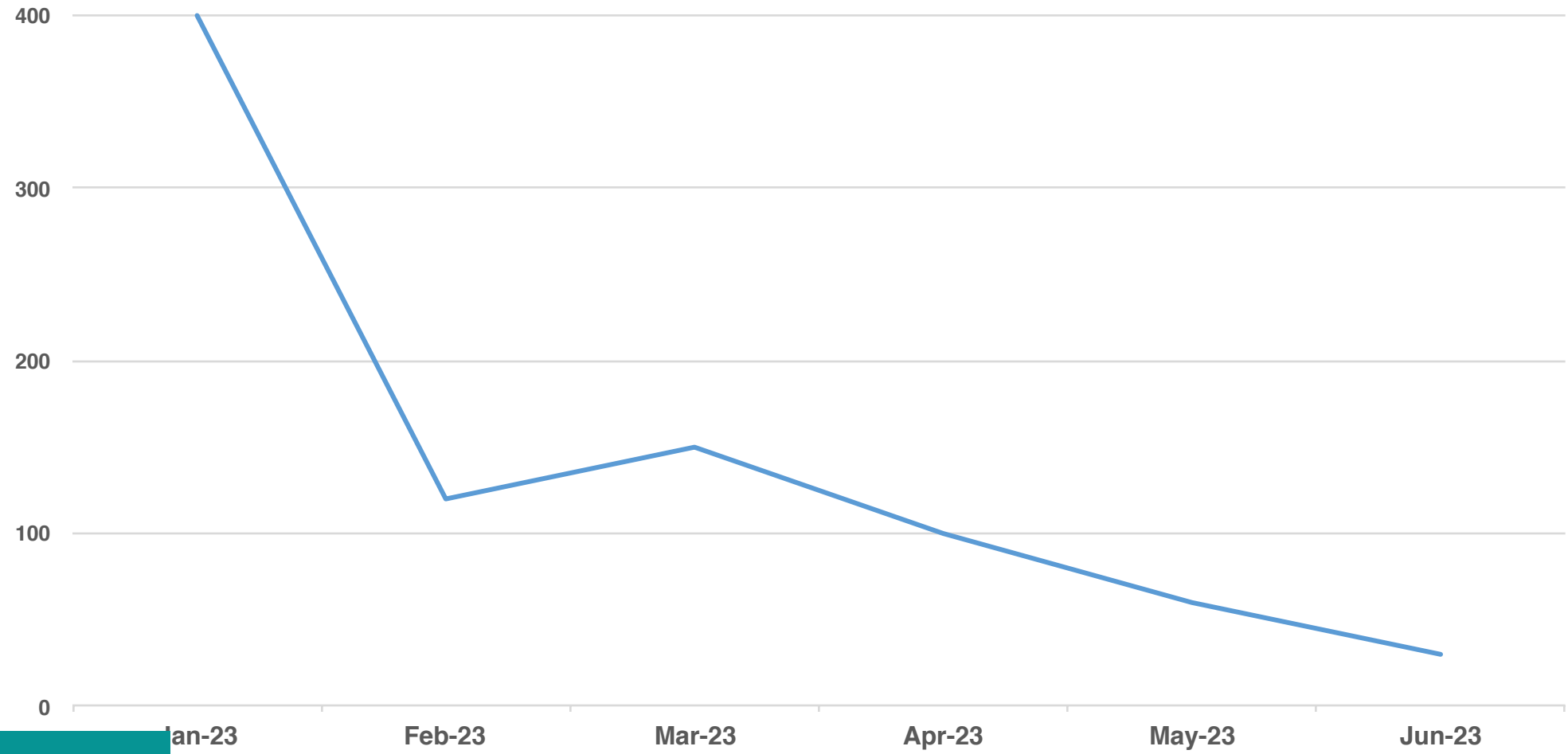
Texas Collaborative for Healthy Mothers and Babies



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