Obstetric Sepsis and Pneumonia: Early Recognition, Evidence-Based Management, and Prevention of Maternal Morbidity and Mortality

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Financial disclosures

- None

Objectives

Upon completion of this course, the participant will be able to

- **Recognize early clinical signs and risk factors** for obstetric sepsis and pneumonia in pregnant and postpartum patients, including physiologic changes of pregnancy that may mask severity.
- **Apply evidence-based management strategies** for maternal sepsis and pneumonia, including timely antibiotic initiation, fluid resuscitation, respiratory support, and multidisciplinary escalation of care.

RESEARCH LETTER

Incidence of Maternal Sepsis and Sepsis-Related Maternal Deaths in the United States

Table 2. Nationwide Estimates of Maternal Sepsis Incidence, Maternal Deaths, and Sepsis-Related Maternal Deaths

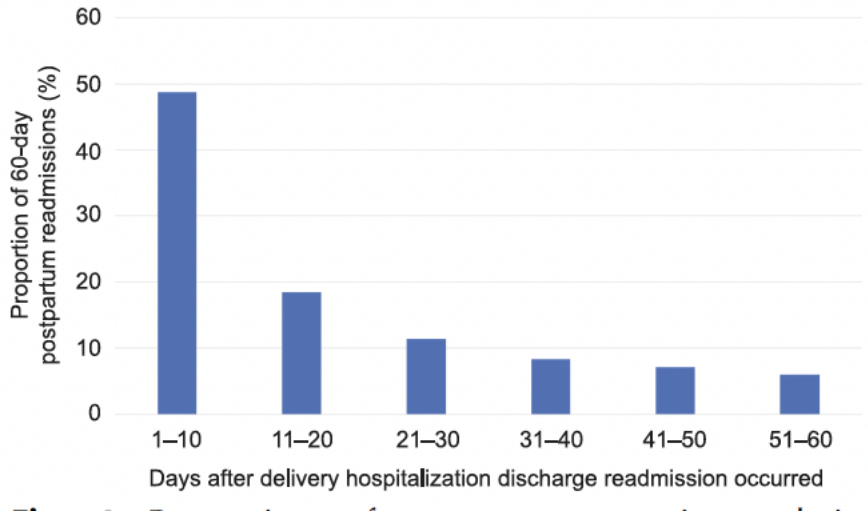
Outcome	No. in National Readmissions Database (2013-2016)	Weighted Incidence per 100 000 Deliveries in the United States (95% CI)	Weighted Percentage of Delivery Hospitalizations With the Outcome (95% CI)
Maternal Sepsis Episodes			
Total	2905	38.3 (36.6-40.2)	0.038 (0.037-0.040)
During delivery hospitalization	1463	19.0 (17.8-20.4)	0.019 (0.018-0.020)
After delivery discharge	1442	19.3 (18.2-20.4)	0.019 (0.018-0.020)
Maternal Deaths			
Total	408	6.6 (5.9-7.4)	0.007 (0.006-0.007)
During delivery hospitalization	300	4.9 (4.4-5.6)	0.005 (0.004-0.006)
After delivery discharge	108	1.7 (1.4-2.1)	0.002 (0.001-0.002)
Sepsis-Related Maternal Deaths			
Total	95	1.5 (1.2-1.9)	0.002 (0.001-0.002)
During delivery hospitalization	52	0.8 (0.6-1.1)	0.001 (0.001-0.001)
After delivery discharge	43	0.7 (0.5-0.9)	0.001 (0.001-0.001)

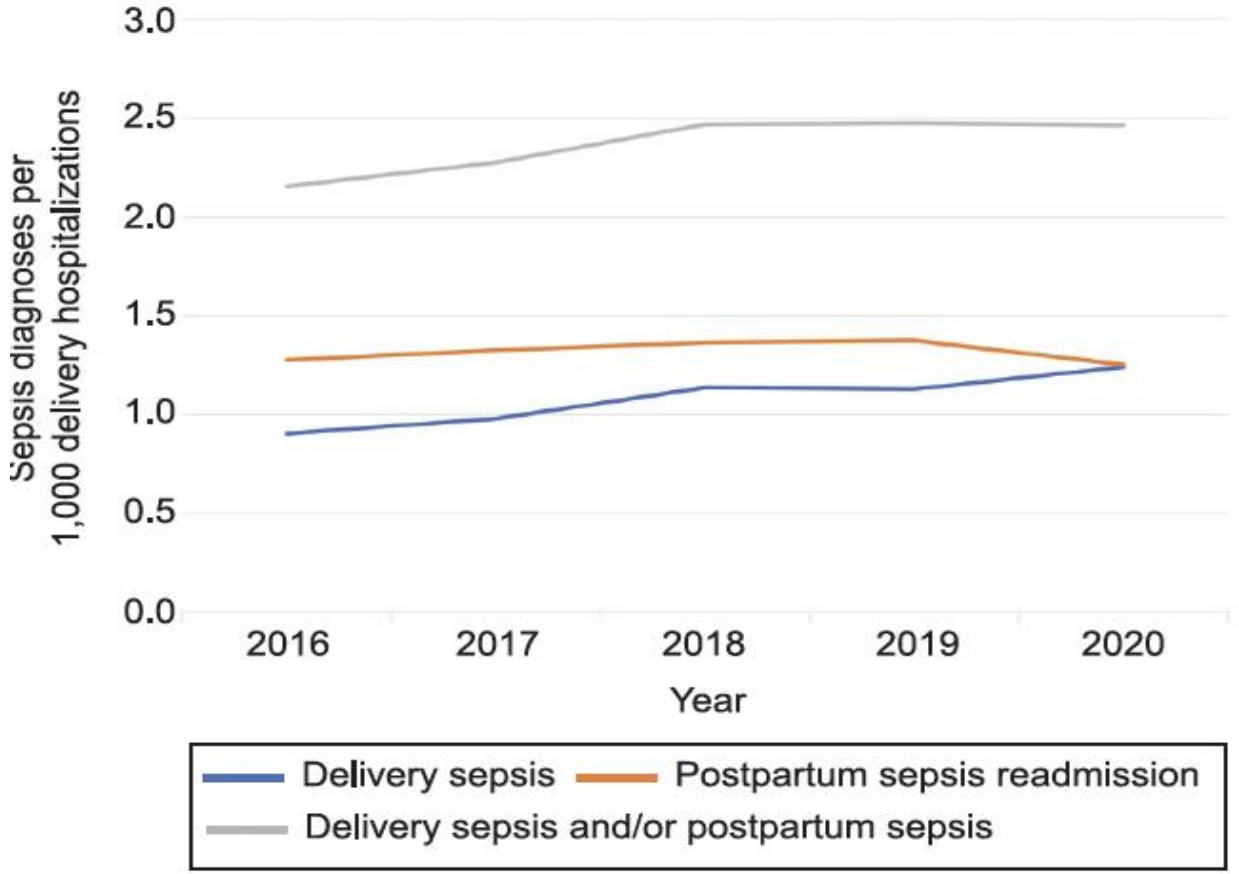
23% (95/408) of all maternal deaths were sepsis related.

Hensley, JAMA 2019

Trends in obstetric sepsis have not reversed

- Associated with:
  - Underinsurance / Medicaid
  - Lower income quartiles
  - Obesity, chronic diseases (DM, HTN)
  - Intra-amniotic infection / endometritis
  - Primary cesarean





Liu 2024

Texas Maternal Mortality and Morbidity Review Committee and DSHS Joint Biennial Report 2024

- Pregnancy-associated death: during pregnancy or within 1 year of end of pregnancy
- “If she had not been pregnant, would she have died? (No=pregnancy-related)
- In 2020: 85/203 (42%) of pregnancy-associated deaths were pregnancy-related
  - Infection was the most frequently observed underlying cause of pregnancy-related death among 21/85 (25%)
  - COVID: 14 (67%)
  - septic shock: 5 (24%)
  - postpartum genital tract infection: 1 (5%)
  - non-pelvic infections: 1 (5%)

Pregnancy

Cardiovascular:
- ↓ Systemic vascular resistance (25–30%)
- ↓ Blood pressure
- ↑ Blood volume (40–45%)
- ↑ Heart rate (10–20 bpm)
- ↑ Cardiac output (40%)

Aorto-caval compression

Respiratory:
- ↓ Pulmonary vascular resistance and plasma colloid pressure
- ↓ Residual volume
- ↓ Functional residual capacity
- ↑ Tidal volume
- ↑ Minute ventilation

Compensated respiratory alkalosis

Renal:
- ↑ Renal plasma flow
- ↑ Glomerular filtration rate

Renal collecting system dilatation

Coagulation
- ↑ Factors I, II, VII, VIII, IX, XII
- ↑ (x5) plasminogen activator inhibitors (PAI) I & II
- ↓ Protein S
- ←→ Anti-thrombin and Protein C

Sepsis

Cardiovascular:
- ↓ Systemic vascular resistance
- ↓ Blood pressure
- ↑ Heart rate

Vasodilatation
Myocardial depression

Respiratory:
- ↑ Pulmonary microvascular pressure and permeability

Acute lung injury

Renal:
Ischaemia
Vasoconstriction
Cytokine-mediated renal cell injury

Coagulation
- ↑ Procoagulant effects
- ↑ Thrombin production
- ↓ Activated Protein C

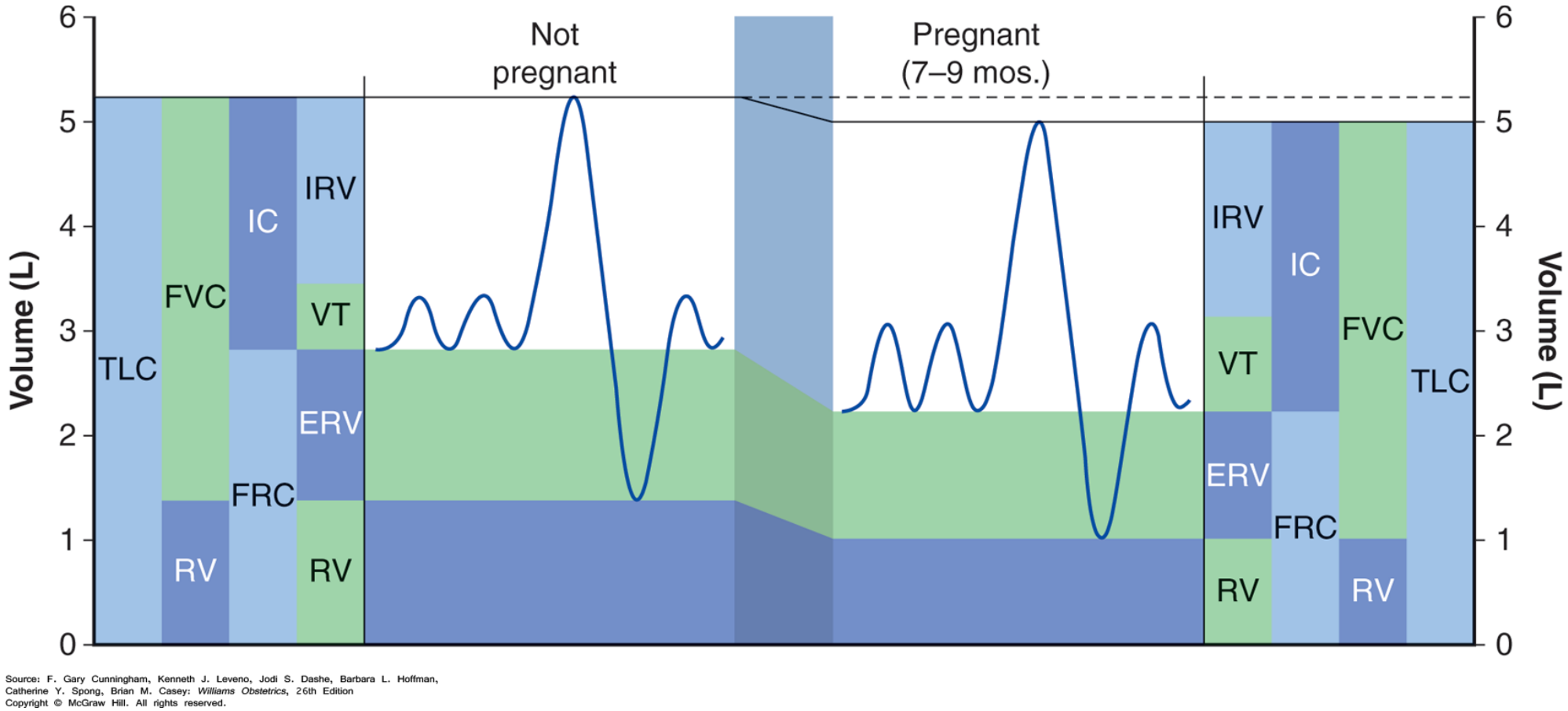
Fibrinolysis (increased PAI I)

Cumulative effect

Cardiovascular	Respiratory	Renal	Coagulation
Rapid haemodynamic collapse	• Susceptibility to pulmonary oedema • Rapid decrease in oxygenation • Adult respiratory distress syndrome • Decreased ability to compensate for metabolic acidosis	Acute kidney injury	• Increased microvascular thrombus formation • Microcirculation dysregulation • Tissue hypoperfusion • End-organ dysfunction

Greer, et al.

Decreased functional residual capacity (FRC) and its subcomponents (ERV and RV)
Increased inspiratory capacity (IC) and tidal volume (VT).



Source: F. Gary Cunningham, Kenneth J. Leveno, Jodi S. Dashe, Barbara L. Hoffman, Catherine Y. Spong, Brian M. Casey: *Williams Obstetrics*, 26th Edition

(Reproduced with permission from Hegewald MJ, Crapo RO. Respiratory physiology in pregnancy, Clin Chest Med 2011 Mar;32(1):1–13.)
Citation: CHAPTER 4 Maternal Physiology, F. Gary Cunningham, Kenneth J. Leveno, Jodi S. Dashe, Barbara L. Hoffman, Catherine Y. Spong, Brian M. Casey. *Williams Obstetrics, 26e;* 2022. Available at: https://obgyn.mhmedical.com/content.aspx?bookid=2977&sectionid=254987027 Accessed: March 22, 2026

Acid Base equilibrium in pregnancy

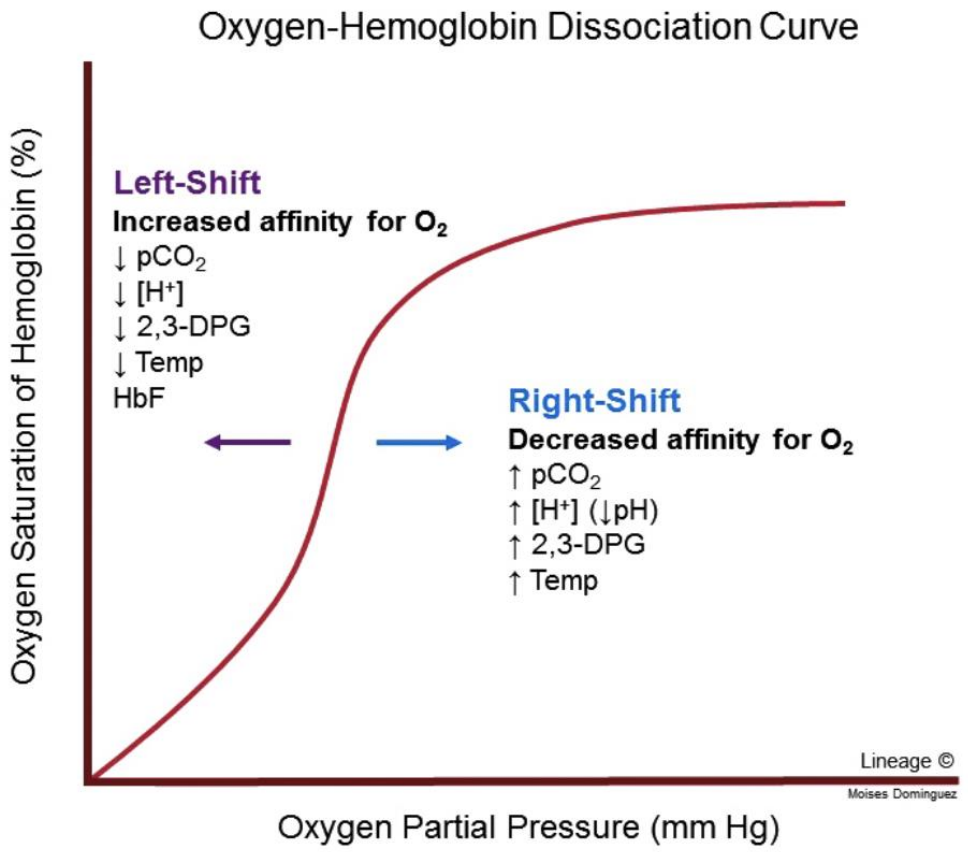
Progesterone acts centrally, increasing brain's sensitivity to CO2

- Result: higher tidal volume, bronchodilation

- PaCO2: 27-32 mmHg
- Decreased HCO3: 18-22 mmol/L
- pH minimally increases but there is slight Bohr effect
- pH increase stimulates 2,3 DPG in maternal RBCs

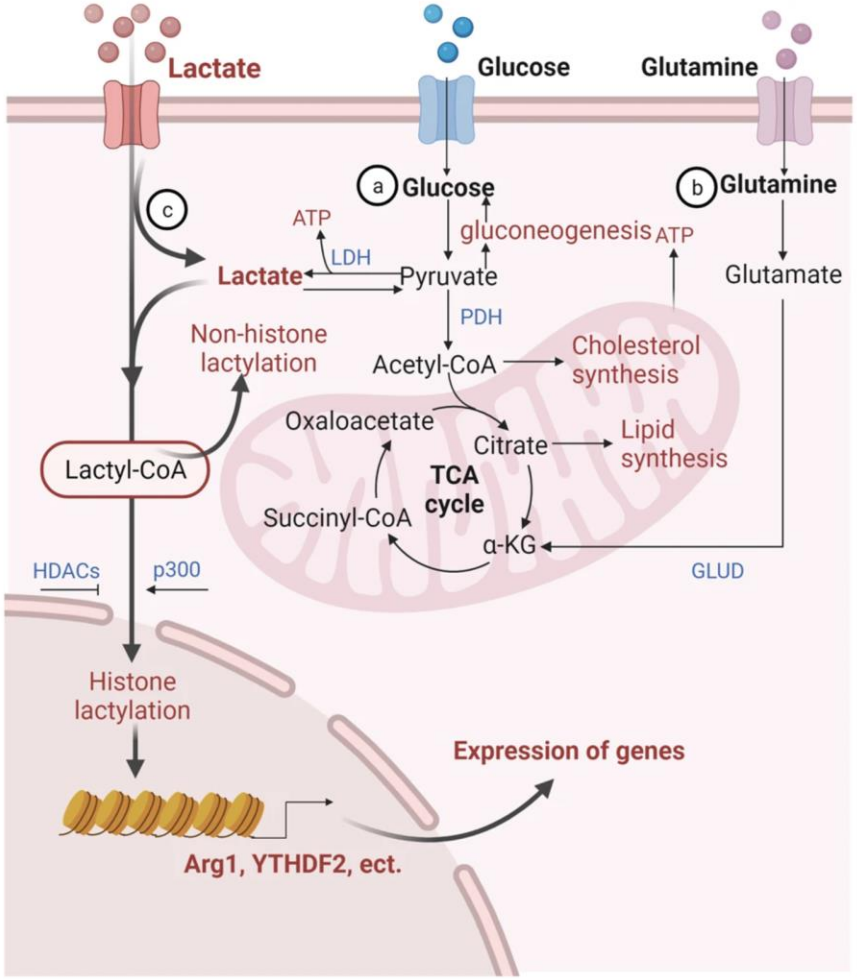
Double Bohr effect: concurrent but opposite shifts in maternal and fetal oxygen-hemoglobin dissociation curves

- Fetal CO2 -> placenta -> HbF increased affinity for O2 (left shift)
- Maternal blood acidified by fetal CO2 -> right shift



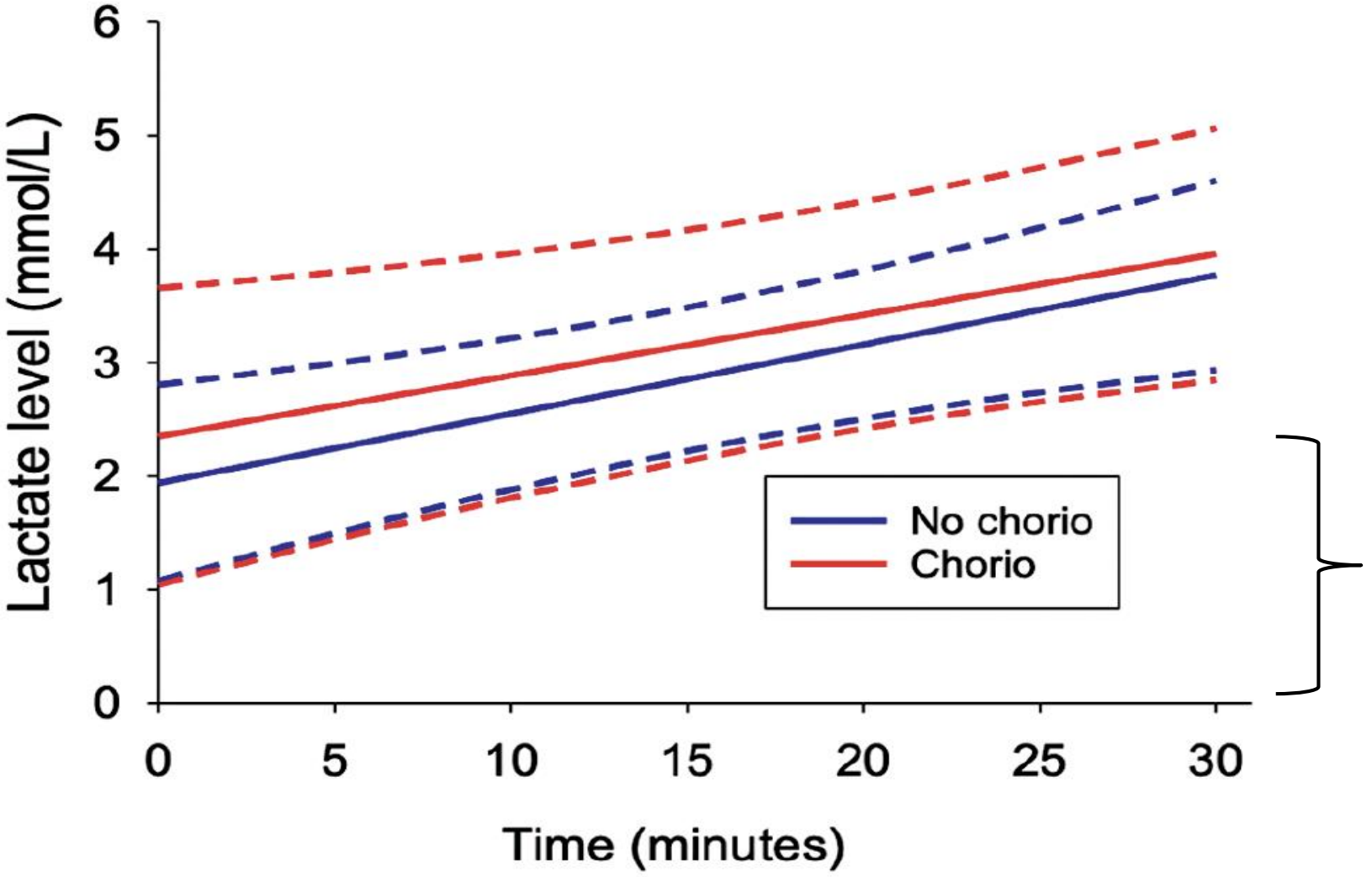
Lactate: energy and oxygen

- Lactate is not just a byproduct, but is actively produced by cells through glycolysis to regenerate make ATP particularly when hypoxia inhibits the TCA cycle in mitochondria
- Accumulation = imbalance
- *Elevated lactate suggests imbalance in energy demand vs production and decreased oxygen availability to tissues that need energy*



Li, 2022

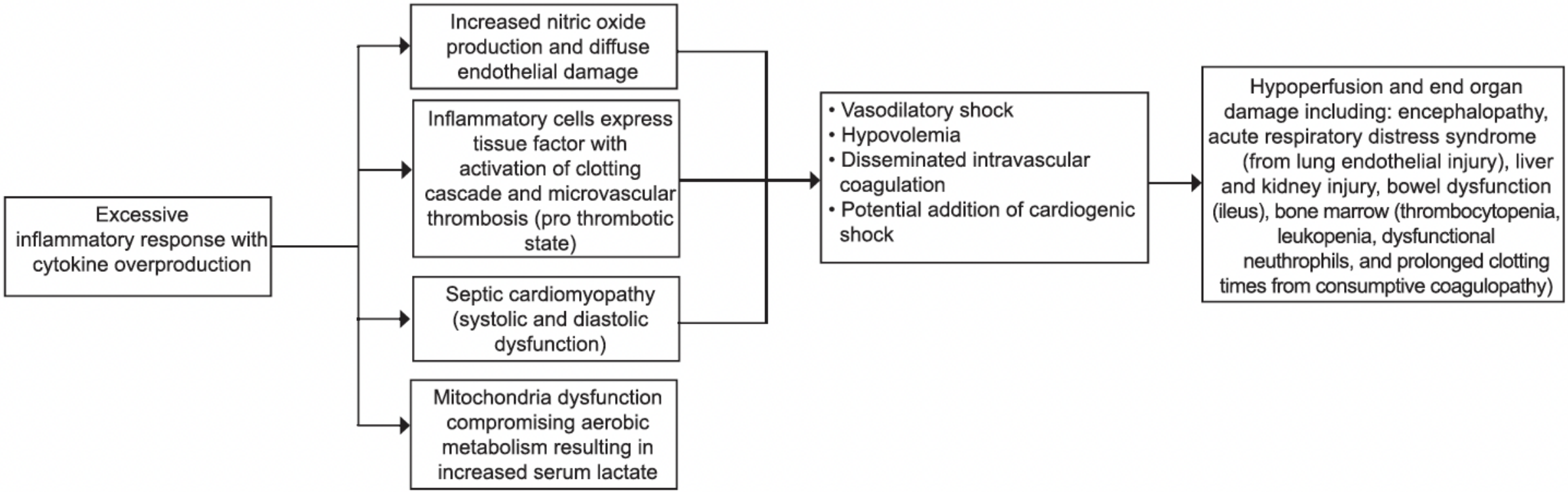
What does lactate do in the second stage of labor?



Normal lactate:
0.5 – 2.2 mmol/L

Kleinmann, 2024

Pathophysiology of sepsis



Bauer, Pacheco 2025

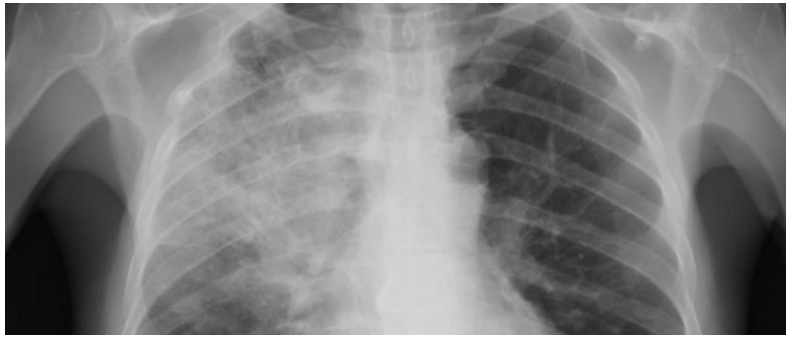
Acute Pyelonephritis (1-2%): a leading cause of ICU admission

- 80-90% in second, third trimesters or postpartum
- Up to 20% have bacteremia, ARDS in up to 10%
- Common pathogens: *E. coli* (70-80%), *Klebsiella pneumoniae* (3-5%), *Enterobacter* or *proteus* (3-5%), gram positives (10%)
- Key: Intravenous hydration, with close monitoring of oxygen saturation
- Source control: broad spectrum antibiotics
  - Ampicillin + gentamicin
  - Cefazolin or ceftriaxone
- Low threshold for evaluation with renal sonography
  - *Severe infection with significant obstruction is an emergency*

Pneumonia / Influenza

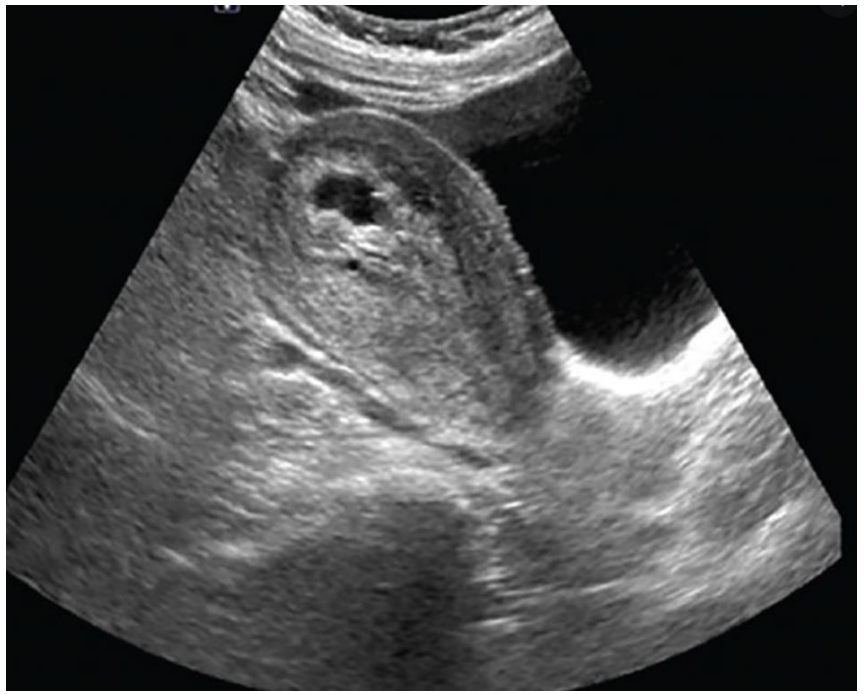
- 10-12% of pregnant women with influenza may develop pneumonia or pneumonitis
- Common etiologies:
  - *S. pneumoniae, S. aureus, H. influenzae, Mycoplasma pneumoniae*

  - Uncomplicated viral influenza: supportive care, oseltamivir
  - Suspected bacterial pneumonia: ceftriaxone or ampicillin-sulbactam plus azithromycin



Septic abortion, endometritis

- Diagnosed by clinical exam and ultrasound
- Etiologies:
  - Normal vaginal flora
  - Group A streptococcus
  - *Clostridium perfringens* and *sordelii*
- Broad spectrum antibiotics:
  - Clindamycin plus gentamicin
  - OR
  - Cefoxitin or cefotetan PLUS doxycycline



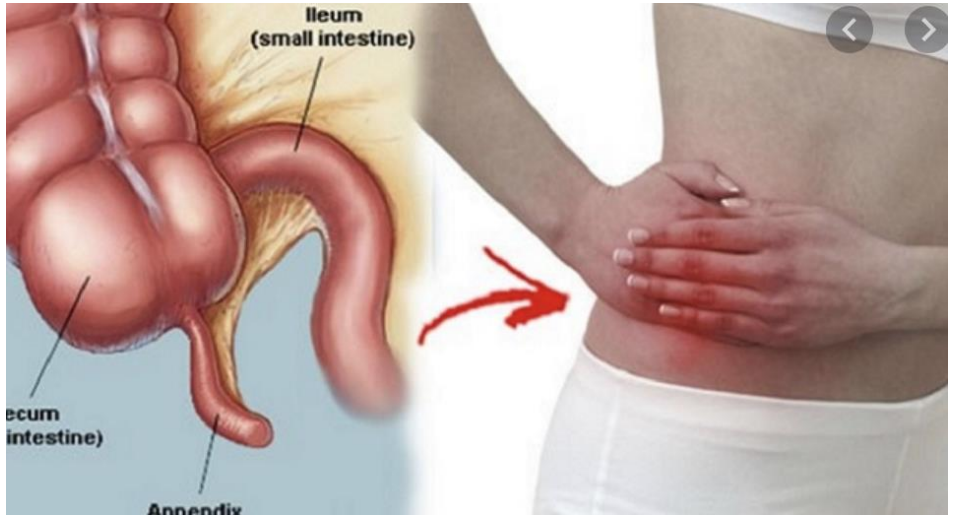
- Retained products of conception: remove the source
- Hysterectomy required rarely

Chorioamnionitis / Intraamniotic infection

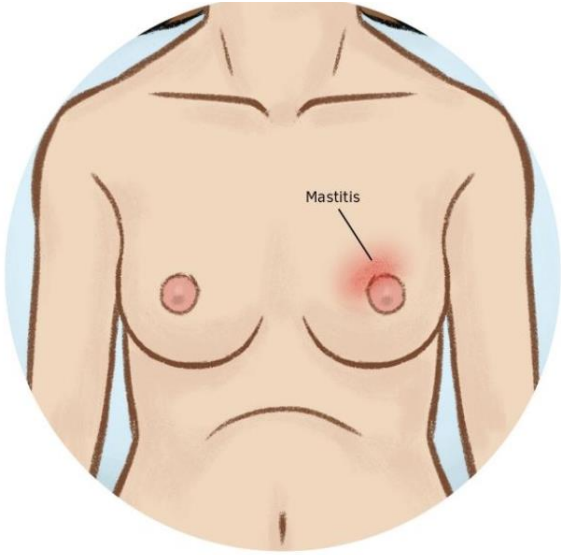
- Definitions, definitions…
- Common causative organisms:
  - Group B streptococcus (GBS)
  - Other genitourinary flora
  - *Ureaplasma sp.*
- Treatment: broad spectrum antibiotics with GBS coverage
- Consider maternal penicillin allergy when treating
  - Ampicillin + gentamicin
  - Mild PCN allergy: Cefazolin plus gentamicin
  - Severe penicillin allergy: Clindamycin (if susceptible) or vancomycin plus gentamicin
- Source control: Delivery is required for cure

Appendicitis

- High risk of peritonitis, preterm labor if ruptured
- Suspected clinically
  - May be confirmed with ultrasound or MRI
  - General surgery consultation early
  - Intravenous hydration, NPO
  - Broad spectrum antibiotics: cefoxitin plus metronidazole
  - Observation for labor in antepartum patients



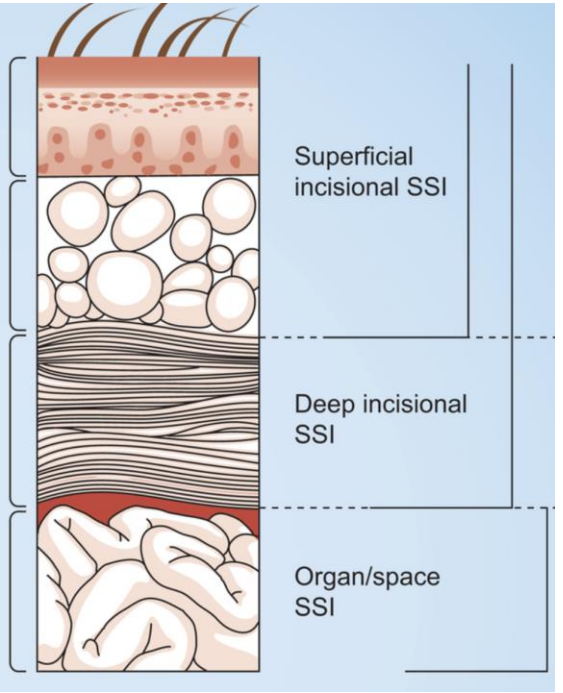
Mastitis



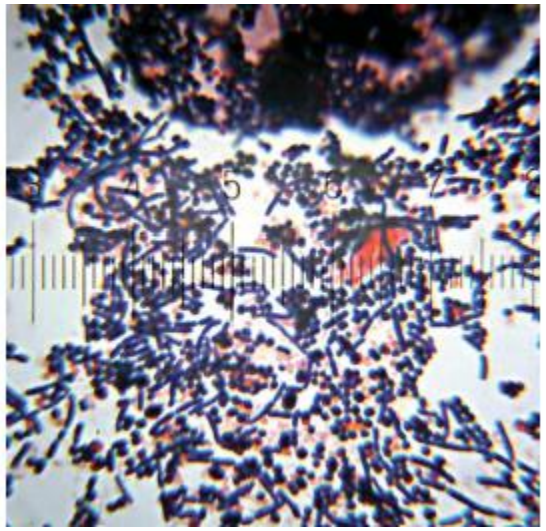
- Approximately 3% of postpartum breastfeeding women
- 10% of women with mastitis develop an abscess
- Common causative organisms:
  - *S. aureus* (or MRSA)
  - Coagulase-negative staph
  - Viridans streptococci
- Management:
  - Oral or intravenous antibiotics: nafcillin vs vancomycin (MRSA coverage)
  - Ultrasound to evaluate for breast abscess
  - Drain abscess if present
  - Continue breast milk expression

Surgical site infections

- More common in women who had intraamniotic infection
- Common causative organisms (often polymicrobial):
  - *S. aureus*, coagulase-negative
  - Genitourinary species (*E. coli, proteus, klebsiella*, etc)
  - *Pseudomonas aeruginosa*
  - Streptococci, including *S. pyogenes* (Group A)
  - Treatment:
    - Source control: exploration and debridement
  - Broad spectrum antibiotics:
    - Piperacillin/tazobactam plus vancomycin for severe infections, plus clindamycin for suspected necrotizing fasciitis
    - Ampicillin plus gentamicin plus clindamycin
    - For known or suspected Group A streptococcus or clostridium: penicillin plus clindamycin



Group A streptococcus



Rare but potentially devastating (if sepsis/shock – mortality is 40-60%)

1847: *Ignaz Semmelweiss instituted handwashing in an Austrian obstetric clinic, decreasing puerperal sepsis (likely from GAS) mortality from 10% to 2%*

- Pathophysiology:
- Toxins allow spread across tissue planes while evading maternal containment by immune system (abscess)
- M protein: major virulence factor (resistance to phagocytosis)
- Toxins: stimulate cytokine production by T cells that lead to profound hypotension and diffuse capillary leakage

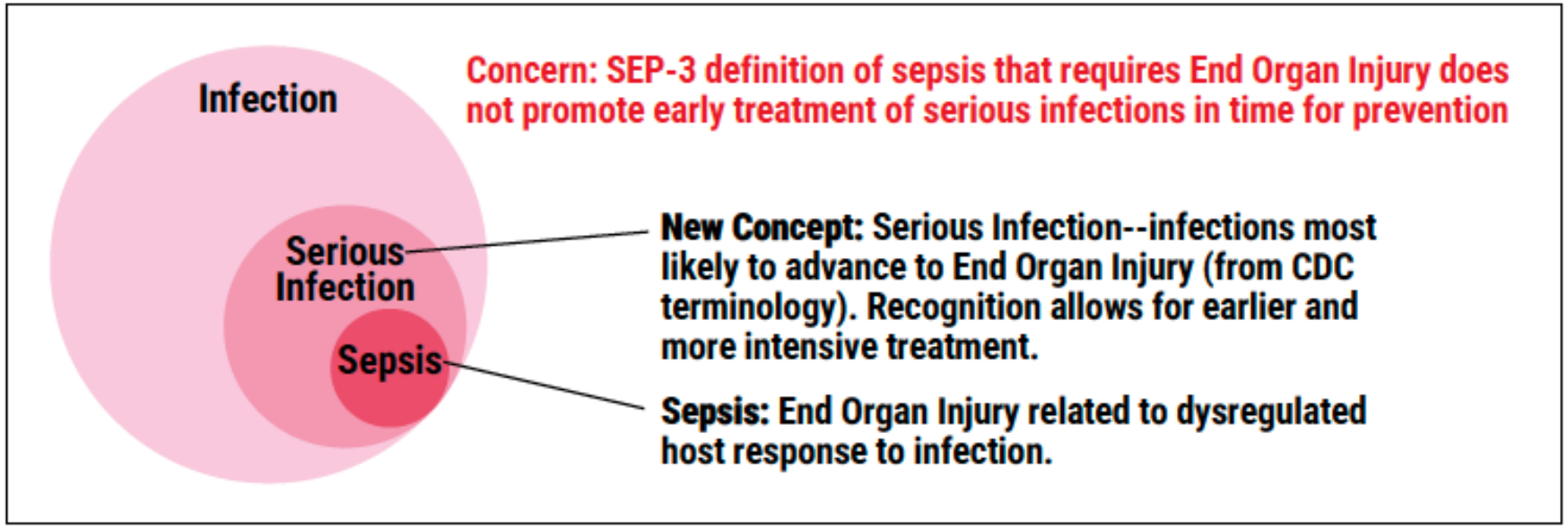
Anderson, 2014

How do we detect sepsis?

Goal

- Strike a balance between overdiagnosis of sepsis with nonspecific vital signs abnormalities, and diagnosing sepsis after end-organ injury has already occurred.
- Solution = 2-step screening process: CMQCC

Figure 2. Terminology for Maternal Infections

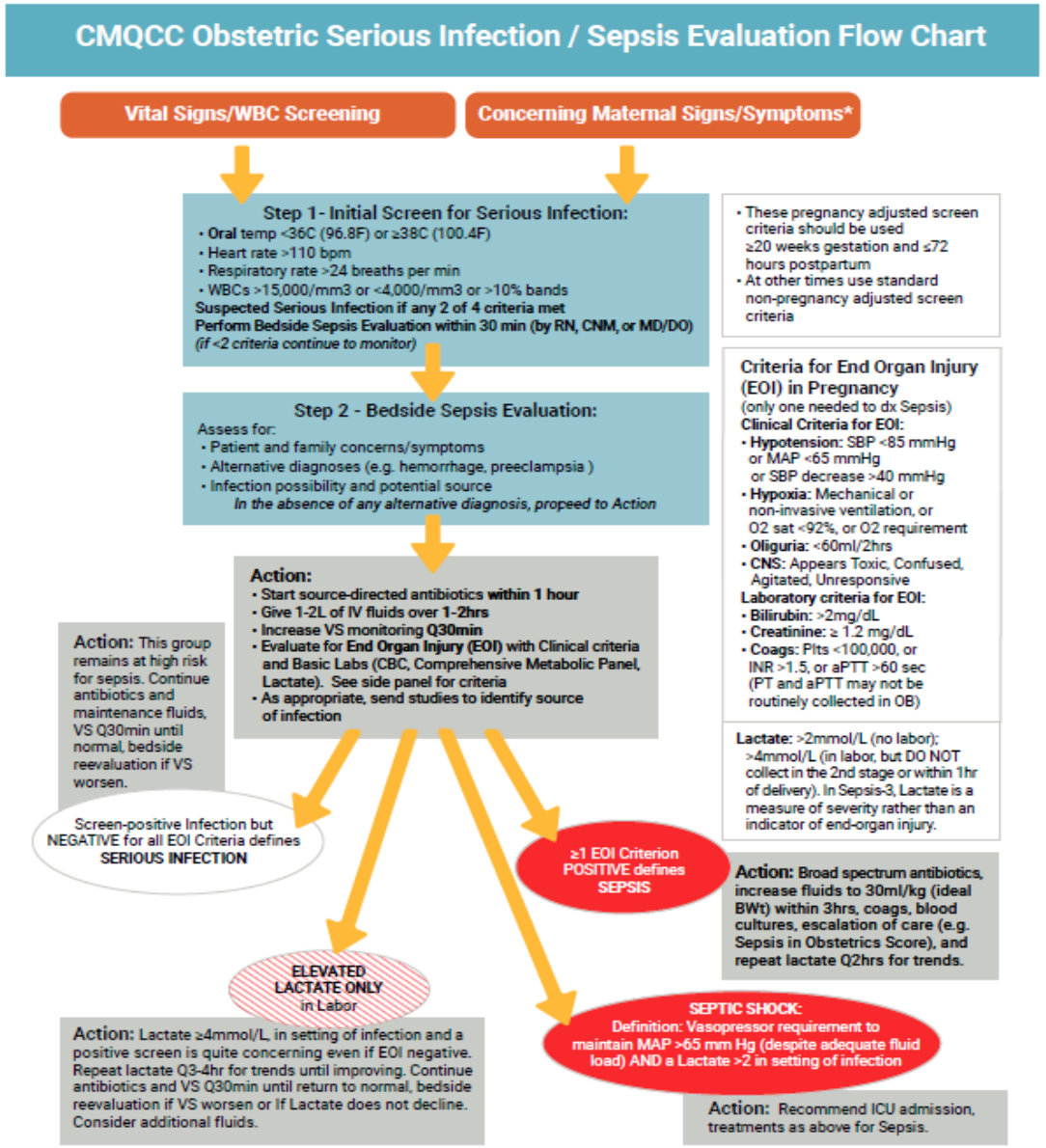


CMQCC Tool kit

CMQCC

California Maternal Quality Care Collaborative

Figure 3. CMQCC Obstetric Serious Infection/Sepsis Evaluation Flow Chart



TexasAIM Safe Care for Every Mother

A program of the Texas Department of State Health Services

TexasAIM Sepsis in Obstetric Care (Sepsis) Learning Collaborative Family of Measures

12 Structure Measures (includes four "All Bundle Measures" (ABM). These are measures included in other AIM patient safety bundle data collection plans. ABM data you report during a reporting period for TexasAIM Sepsis will record for the measure across all bundles. Assessment of current systems on a scale of 1-5	**7 Process Measures** Monitoring adoption of evidence-informed clinical best practices (includes two ABMs)	**3 Outcome Measures** Track changes in maternal health outcomes related to adoption of clinical best practices	
		OPTIONAL Unit-Reported Outcome Measures (Lead Measure) Hospital improvement teams choose option to collect report and monitor their hospital-collected timely data	**TexasAIM-Reported State Surveillance (SS) Measures (Lag Measures)** DSHS uses Texas Health Care Information Collection (THCIC) Hospital Inpatient Discharge Research Data Files to monitor outcomes
OB Provider and Nursing Education: Sepsis	Blood Cultures Drawn Prior to Antibiotics	Severe Maternal Morbidity (SMM) Excluding Transfusion Codes Alone	SMM Excluding Transfusion Codes Alone (All Bundle Measure)
Multidisciplinary Case Review: Suspected or Confirmed Obstetric Sepsis	Timely Antibiotic Administration	Sepsis in Delivery Hospitalizations	Sepsis in Delivery Hospitalizations
Obstetric Sepsis Screening and Diagnosis System	Timely Fluid Resuscitation		Sepsis with Severe Maternal Comorbidity
Protocols for Management of Suspected and Confirmed Obstetric Sepsis	Timely Lactate Level Measurement		
Post-Obstetric Sepsis Resources and Referrals	Escalation of Care		
ED Education Program - Obstetric Sepsis	Provider Education: Respectful, Supportive, and Patient Centered Care		
ICU Education Program - Obstetric-Sepsis	Simulation and Drills: Number and Topics		

Parkland OB Sepsis BPA and protocol

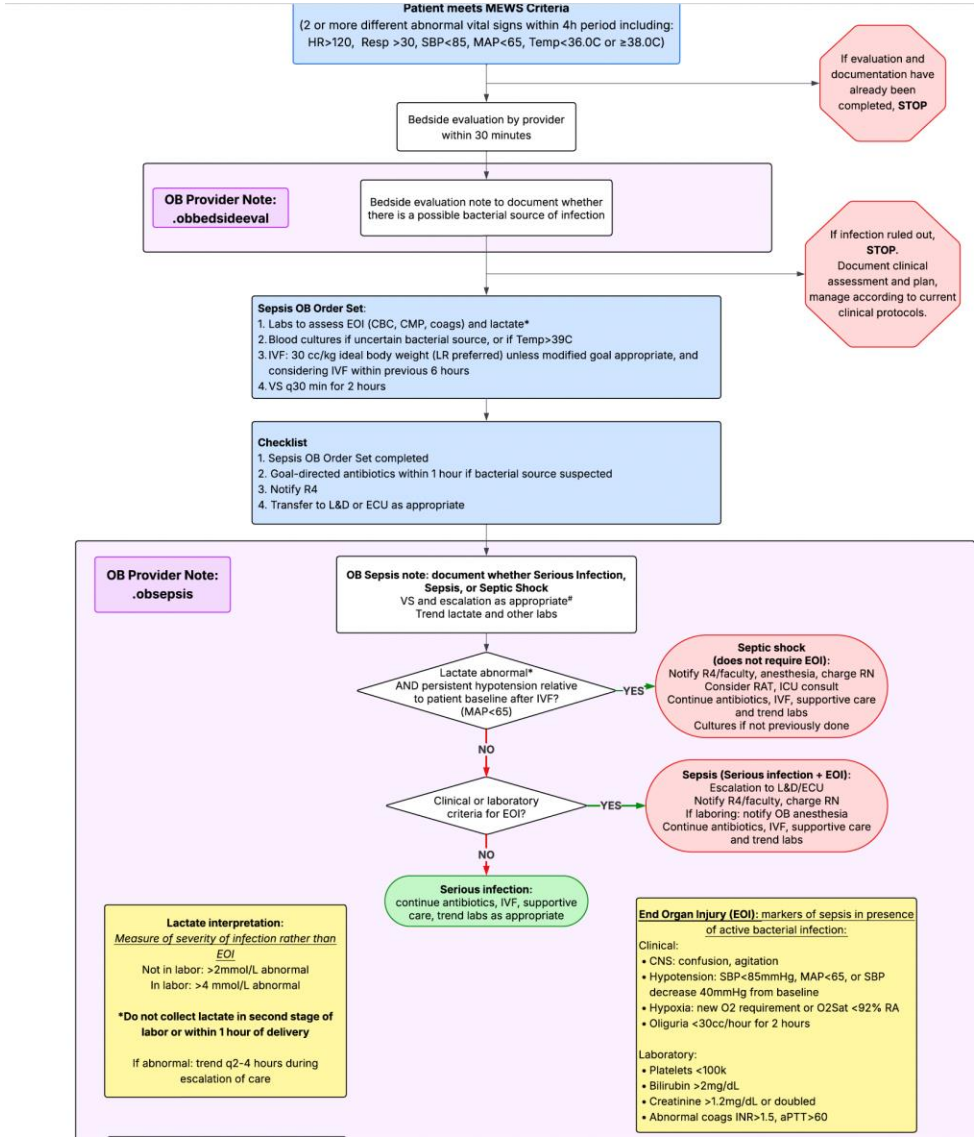
Go live: March 4, 2026

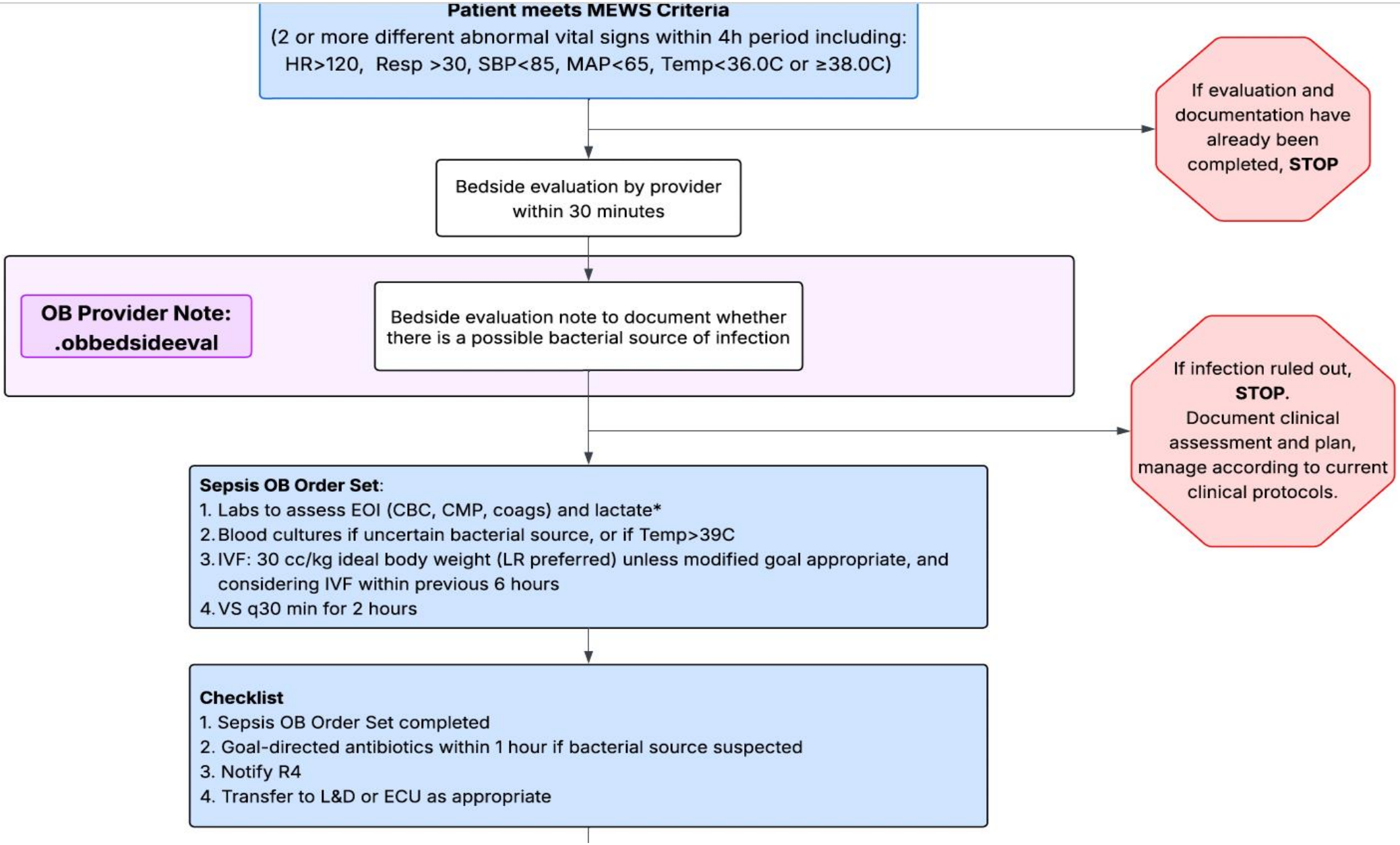
Parkland OB Sepsis Screening Algorithm

Step 1: BPA, initial evaluation, quick note

Immediate actions for all

Step 2: Review results, determine level of severity, escalate as appropriate, and document




Patient meets MEWS Criteria
(2 or more different abnormal vital signs within 4h period including:
HR>120, Resp >30, SBP<85, MAP<65, Temp<36.0C or ≥38.0C)
If evaluation and documentation have already been completed, STOP
Bedside evaluation by provider within 30 minutes
OB Provider Note:
.obbedsideeval
Bedside evaluation note to document whether there is a possible bacterial source of infection
If infection ruled out, STOP.
Document clinical assessment and plan, manage according to current clinical protocols.
Sepsis OB Order Set:
1. Labs to assess EOI (CBC, CMP, coags) and lactate*
2. Blood cultures if uncertain bacterial source, or if Temp>39C
3. IVF: 30 cc/kg ideal body weight (LR preferred) unless modified goal appropriate, and considering IVF within previous 6 hours
4. VS q30 min for 2 hours
Checklist
1. Sepsis OB Order Set completed
2. Goal-directed antibiotics within 1 hour if bacterial source suspected
3. Notify R4
4. Transfer to L&D or ECU as appropriate

Definitions

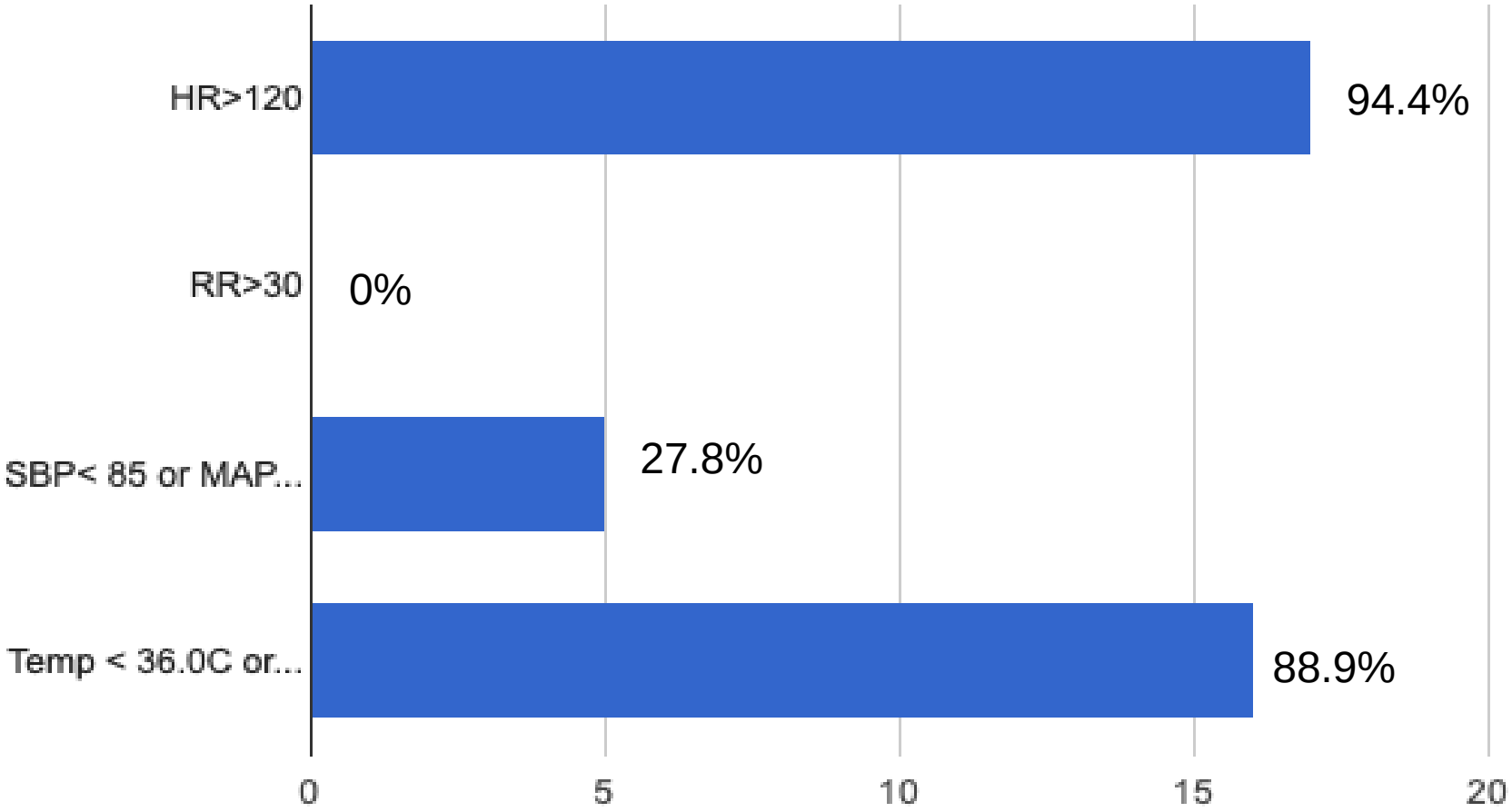
- Serious infection = no EOI
- Sepsis = serious infection + EOI,
- Septic shock = abnormal lactate + hypotension after weight-based fluids, does not require lab EOI

<u>End Organ Injury (EOI): markers of sepsis in presence of active bacterial infection:</u>

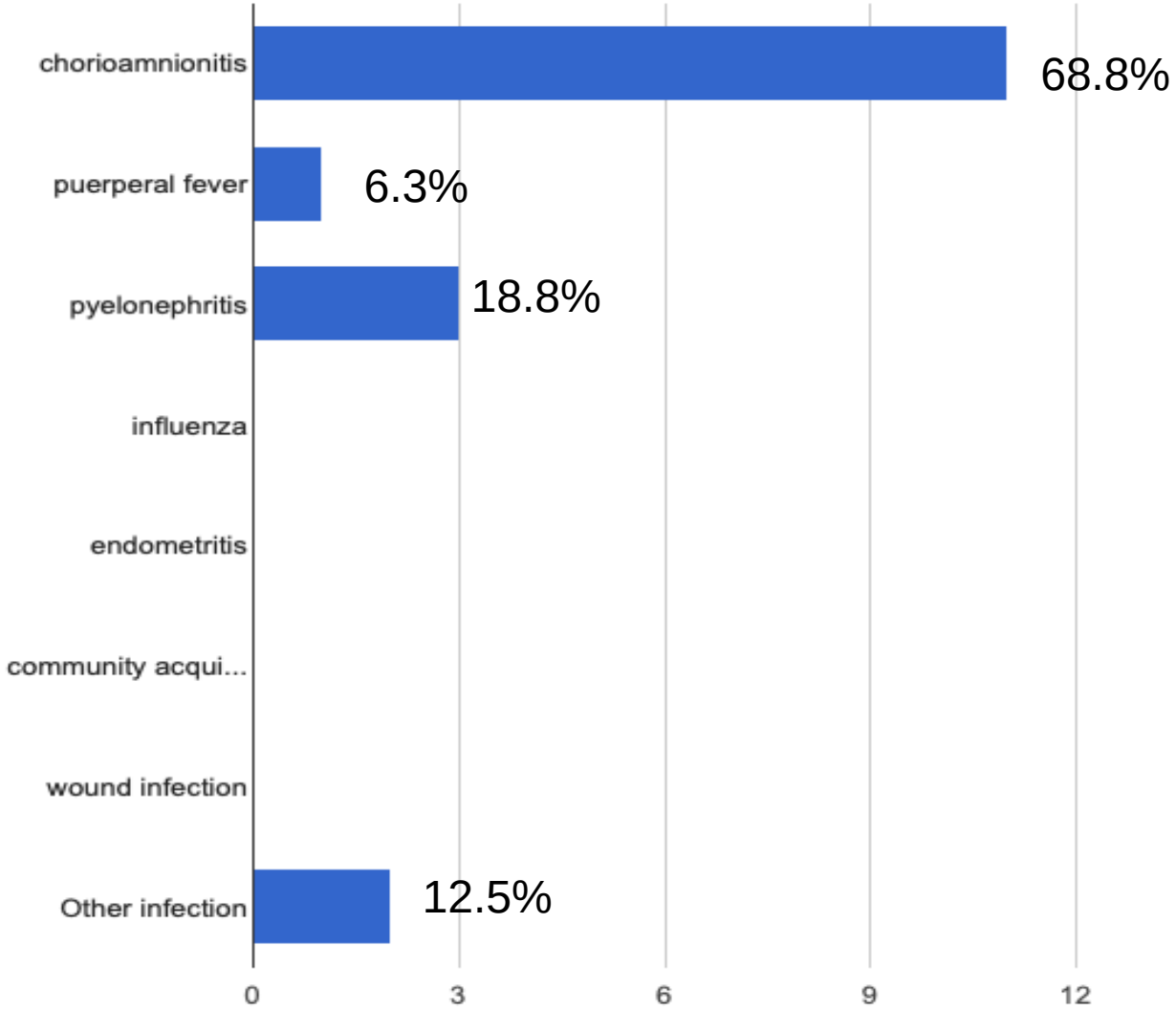
Clinical:
- CNS: confusion, agitation
- Hypotension: SBP< 85mmHg, MAP< 65, or SBP decrease 40mmHg from baseline
- Hypoxia: new O2 requirement or O2Sat < 92% RA
- Oliguria < 30cc/hour for 2 hours

Laboratory:
- Platelets < 100k
- Bilirubin >2mg/dL
- Creatinine >1.2mg/dL or doubled
- Abnormal coags INR>1.5, aPTT>60

Criteria met: Week 1.5 of OB Sepsis BPA (n=18)



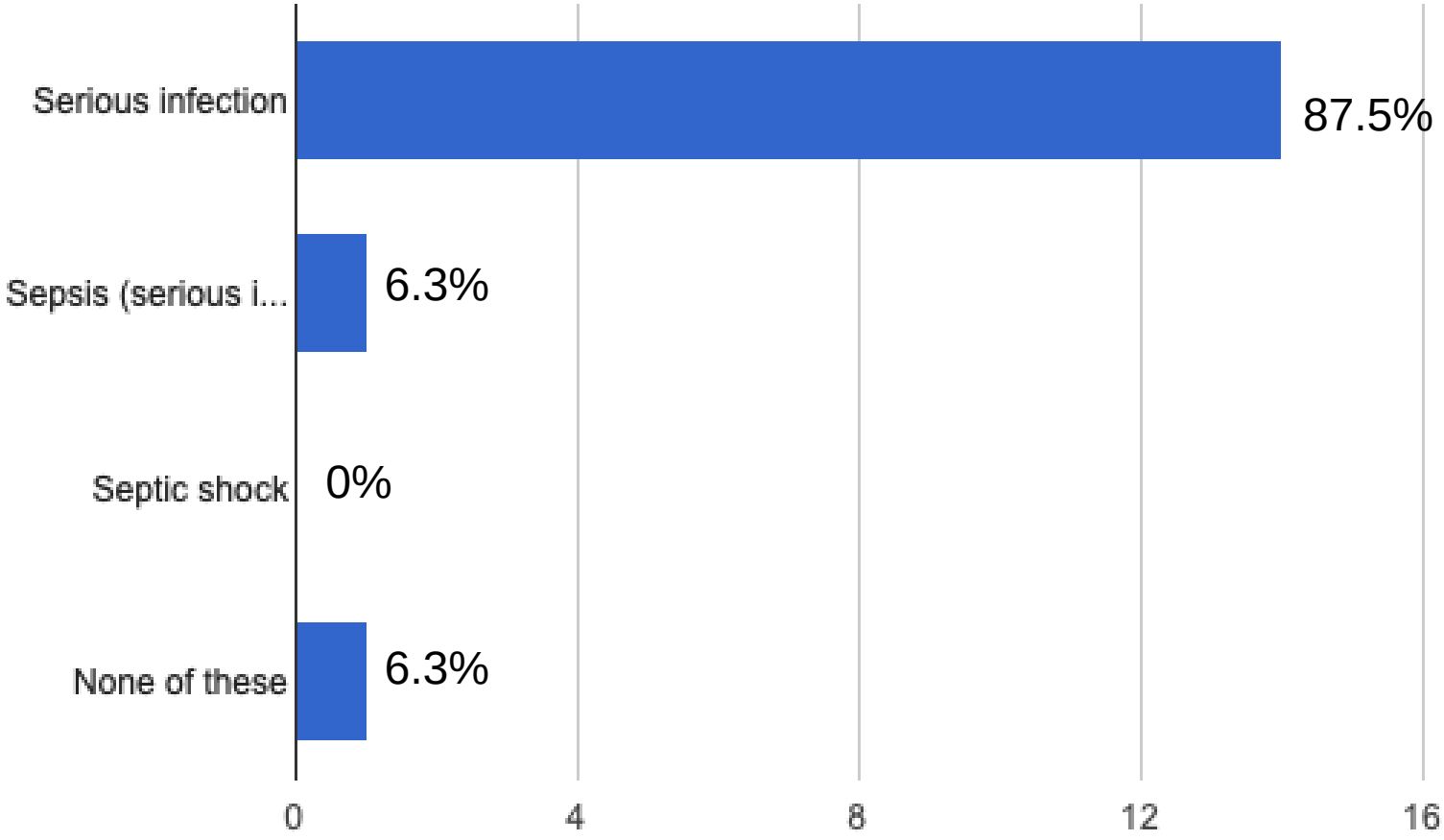
Week 1.5 of OB Sepsis BPA (n=16)



Characteristic	N(%)
Second stage of labor	7 (43.8)
Source-directed antibiotics if bacteria infection suspected	14/15 (93.3)

*Other: anaphylaxis, pyelo + rhinovirus

Infection classification after case review: Week 1.5 of OB Sepsis BPA (n=16)

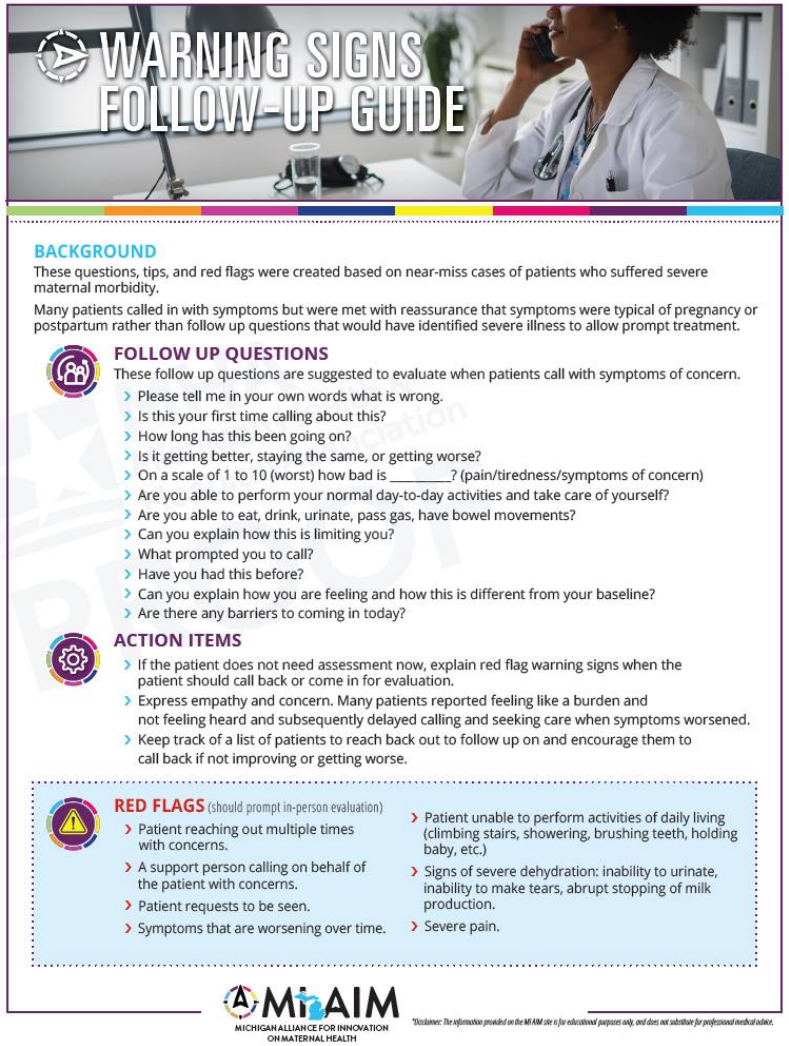


Characteristic	N(%)
Correct infection class documented (i.e., no sepsis documentation appropriate)	14 (87.5)
Incorrect or inconsistent documentation	2 (12.5)

Wellness bias and normalization deviance

- 3 deadly delays: delay, denial, and dismissal

- From patients who experienced sepsis:
- “I wasn’t just tired. I was short of breath after brushing my teeth and had to lie down on the bed.”
- “I was so weak I couldn’t stand up”
- ”I had no strength and couldn’t get a glass of water.”



WARNING SIGNS FOLLOW-UP GUIDE

BACKGROUND

These questions, tips, and red flags were created based on near-miss cases of patients who suffered severe maternal morbidity.

Many patients called in with symptoms but were met with reassurance that symptoms were typical of pregnancy or postpartum rather than follow up questions that would have identified severe illness to allow prompt treatment.

FOLLOW UP QUESTIONS

These follow up questions are suggested to evaluate when patients call with symptoms of concern.

- Please tell me in your own words what is wrong.
- Is this your first time calling about this?
- How long has this been going on?
- Is it getting better, staying the same, or getting worse?
- On a scale of 1 to 10 (worst) how bad is _____? (pain/tiredness/symptoms of concern)
- Are you able to perform your normal day-to-day activities and take care of yourself?
- Are you able to eat, drink, urinate, pass gas, have bowel movements?
- Can you explain how this is limiting you?
- What prompted you to call?
- Have you had this before?
- Can you explain how you are feeling and how this is different from your baseline?
- Are there any barriers to coming in today?

ACTION ITEMS

- If the patient does not need assessment now, explain red flag warning signs when the patient should call back or come in for evaluation.
- Express empathy and concern. Many patients reported feeling like a burden and not feeling heard and subsequently delayed calling and seeking care when symptoms worsened.
- Keep track of a list of patients to reach back out to follow up on and encourage them to call back if not improving or getting worse.

RED FLAGS (should prompt in-person evaluation)

- Patient reaching out multiple times with concerns.
- A support person calling on behalf of the patient with concerns.
- Patient requests to be seen.
- Symptoms that are worsening over time.
- Patient unable to perform activities of daily living (climbing stairs, showering, brushing teeth, holding baby, etc.)
- Signs of severe dehydration: inability to urinate, inability to make tears, abrupt stopping of milk production.
- Severe pain.

MiAIM
MICHIGAN ALLIANCE FOR INNOVATION ON MATERNAL HEALTH

*Disclaimer: The information provided on the MI AIM site is for educational purposes only, and does not substitute for professional medical advice.

Summary

- Infection and sepsis in pregnancy are major contributors to maternal morbidity and mortality

- A thorough History and Physical examination (**with pelvic exam**) are fundamental to identifying a suspected source of infection in pregnant and postpartum women

- Implementing a standardized response or protocol allows measurement of outcomes at an organizational level: Row in the same direction

Questions?