

Bridging Clinical Foundations and Digital Innovation: Optimizing Hypertension Care in Pregnancy and Beyond

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Today's Focus

- The state of maternal health in the US
- Why hypertension matters in pregnancy
- What are hypertensive disorders of pregnancy
- Why families face gaps in care
- Innovations in maternal hypertension care
- Core elements of quality hypertension care



The state of maternal health in the US

A national crisis

U.S. Maternal Mortality Crisis

*There are more pregnancy-related deaths today than 40 years ago, and the number is **rising**.*

Maternal mortality ratio in the U.S. (1987-2013)

(Per 100,000 live births per year)

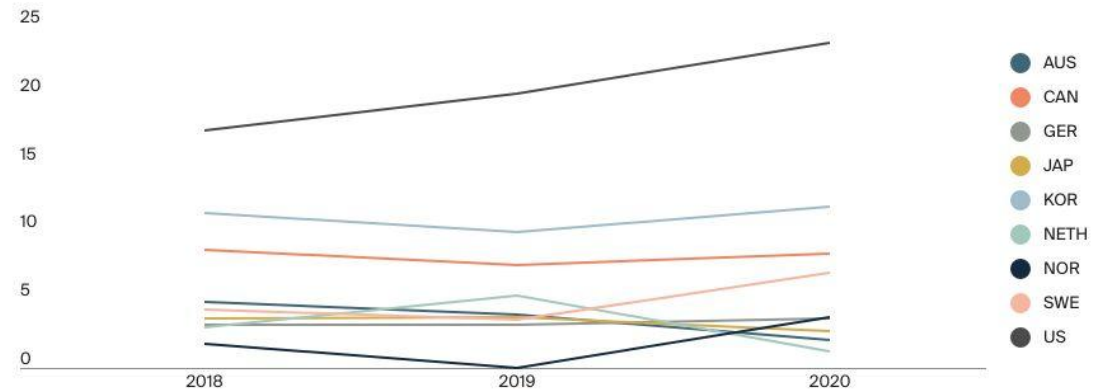


Source: CDC

Angelica Quintero / @latimesgraphics

U.S. Maternal Mortality Rate Has Been Getting Worse over Time

Deaths per 100,000 live births



Notes: The maternal mortality ratio is defined by the World Health Organization as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.

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Source: Munira Z. Gunja, Evan D. Gumas, and Reginald D. Williams II, "The U.S. Maternal Mortality Crisis Continues to Worsen: An International Comparison," To the Point (blog), Commonwealth Fund, Dec. 1, 2022. <https://doi.org/10.26099/8vem-fc65>



Why hypertension in pregnancy matters

A maternal mortality case study



16%

maternal deaths attributable to **HYPERTENSIVE DISORDERS OF PREGNANCY** globally



25%

increase in preeclampsia incidence in the United States between *1987 and 2004*

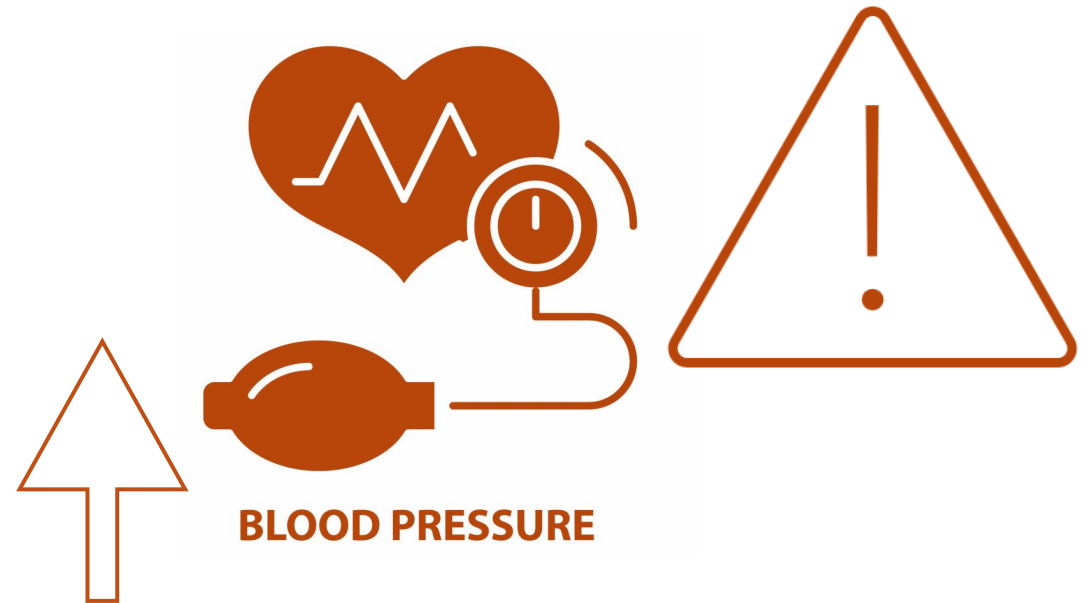


> 110%

increase in hypertensive disorder or pregnancy increase between *2010 and 2021*

Why hypertension in pregnancy matters

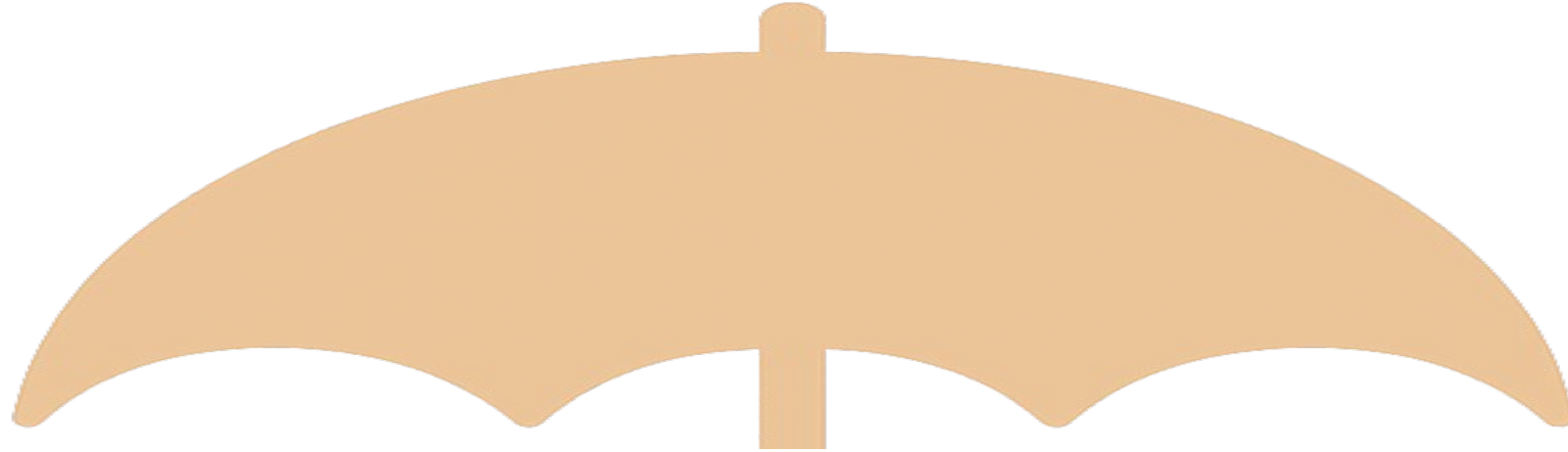
- Leading cause of maternal morbidity and mortality
- Causes up to 15% of preterm births and contributes to nearly 20% of stillbirths
- Impacts Black and Indigenous patients disproportionately
- Often develops silently, during or after pregnancy
- Early recognition and continued care save lives





What are hypertensive disorders of pregnancy

Opportunities for understanding and educating



Gestational hypertension

Chronic hypertension

HELLP

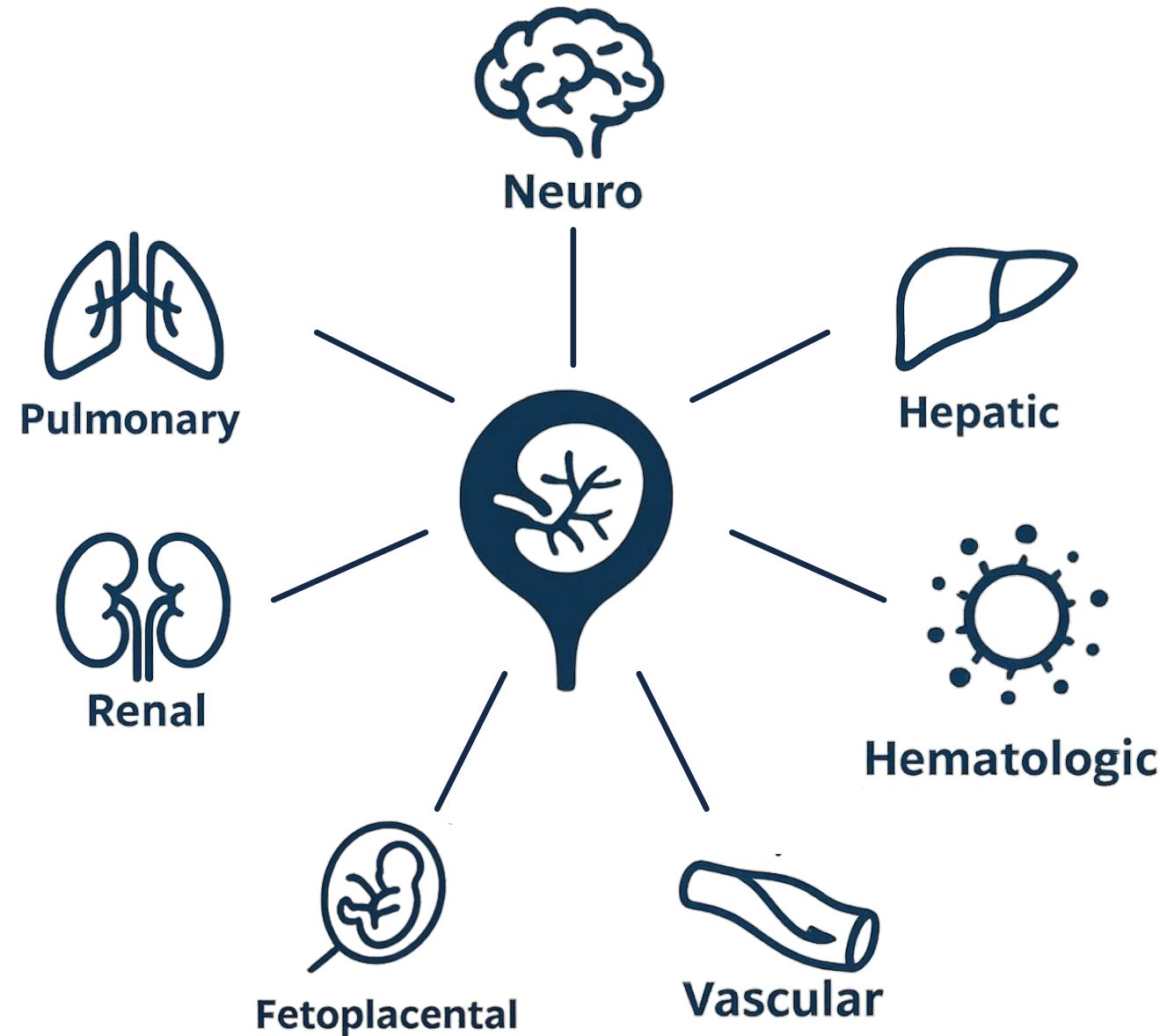
Superimposed preeclampsia

Preeclampsia

Postpartum hypertension

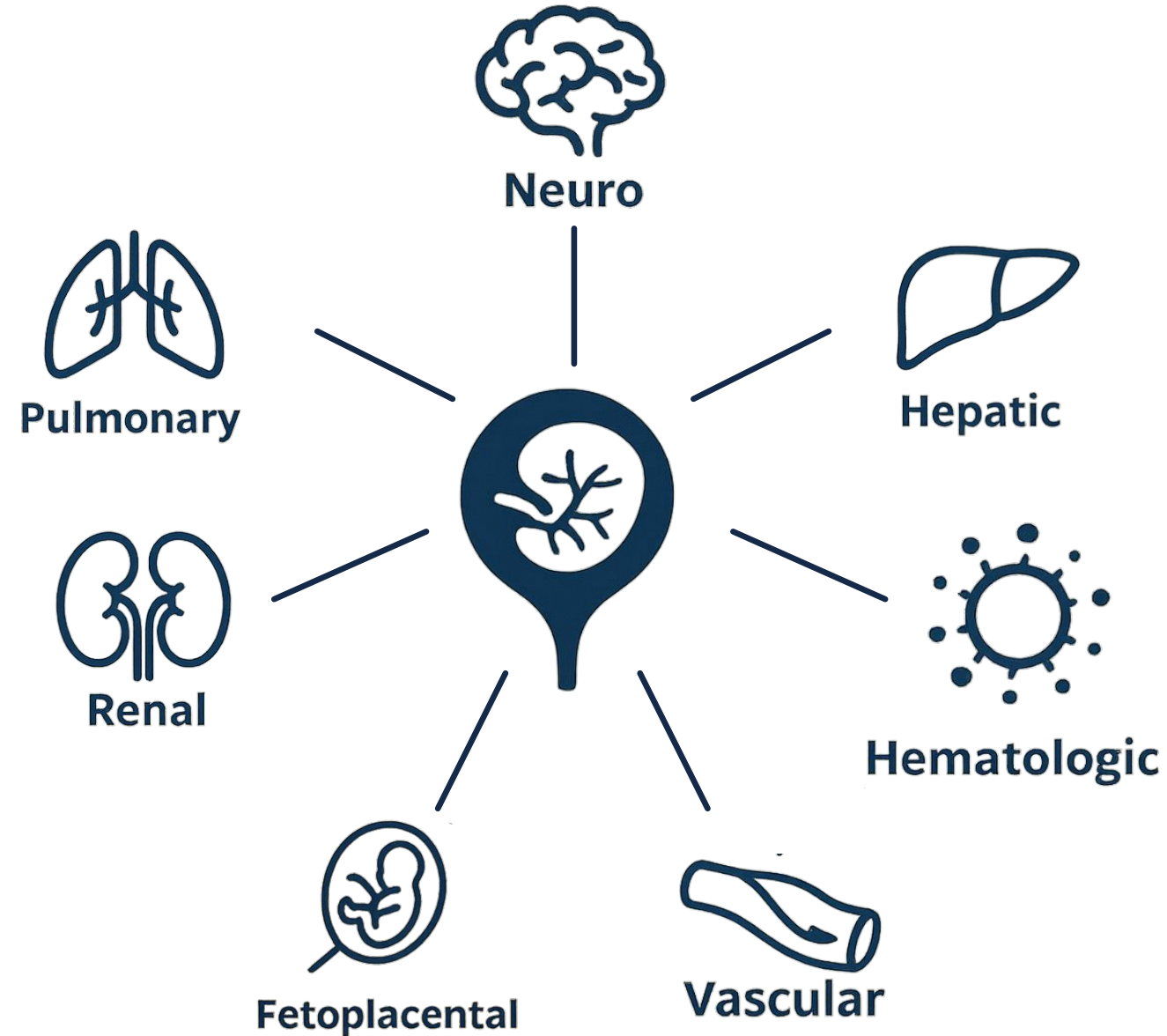
A placental problem

- **RENAL:** proteinuria, edema, renal dysfunction
- **PULMONARY:** shortness of breath, pulmonary edema
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- **(CARDIO)VASCULAR:** high blood pressure, edema, hemolysis
- **FETOPLACENTAL:** fetal growth restriction, fetal heart tracing abnormalities, abruption



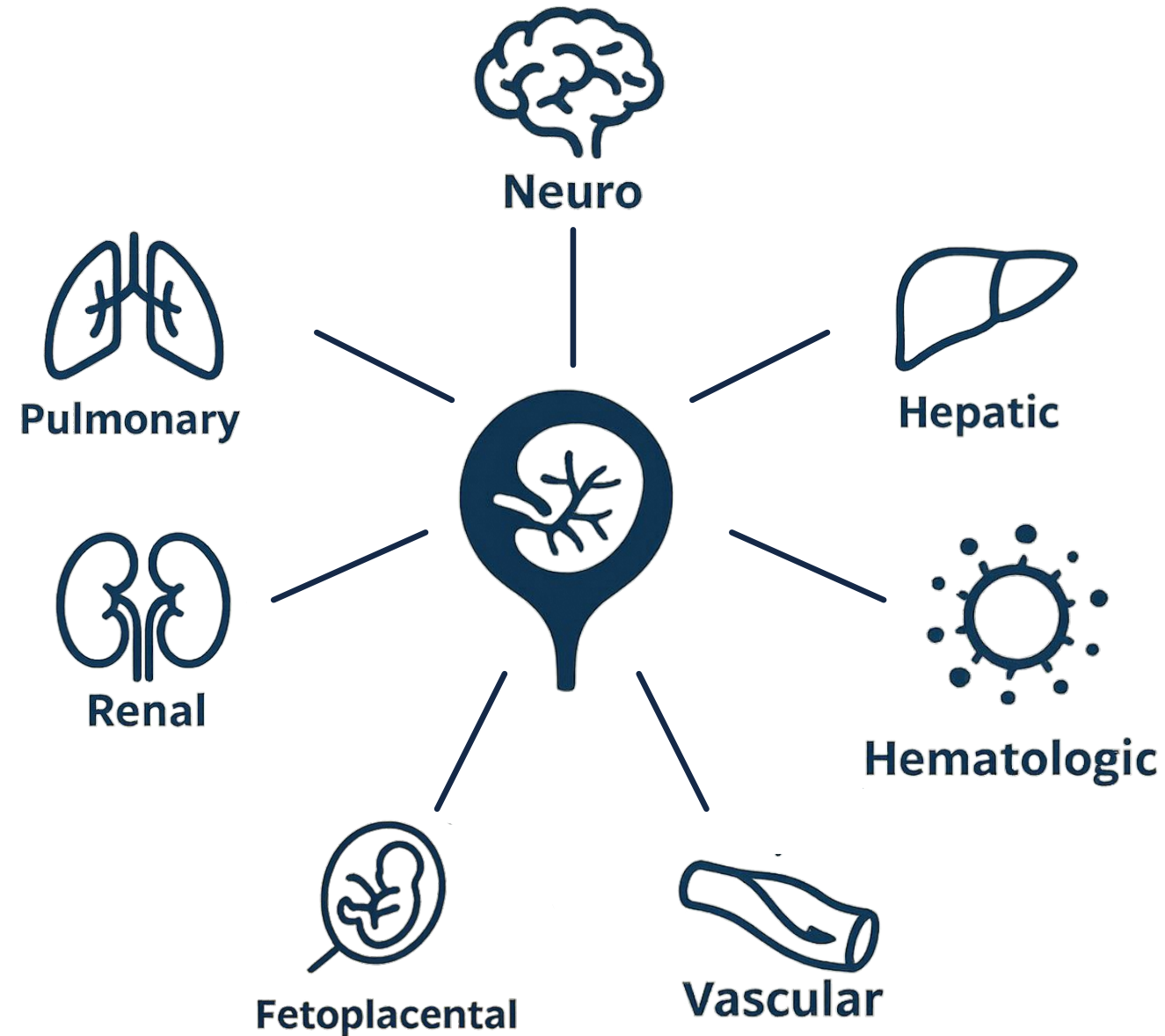
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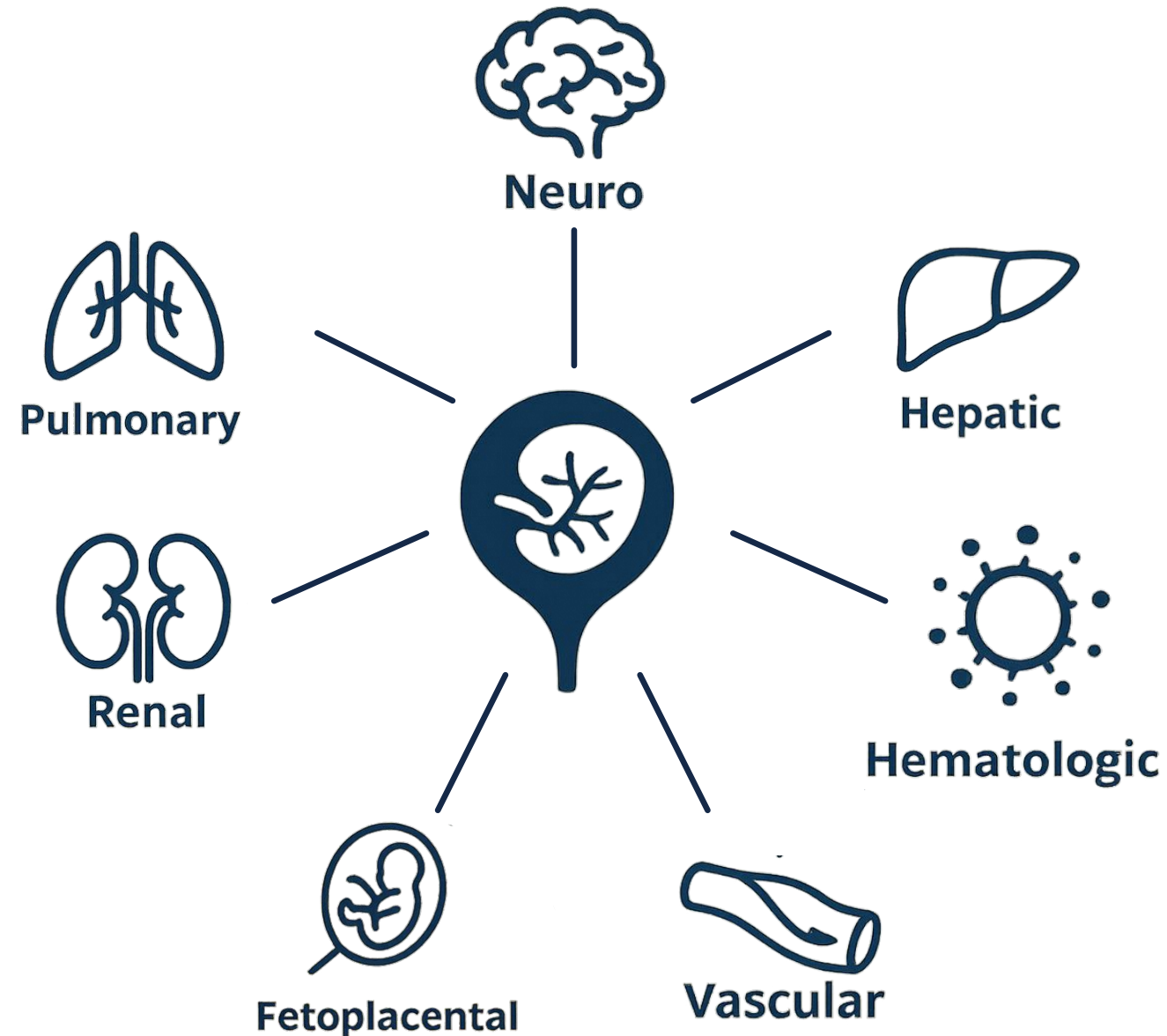
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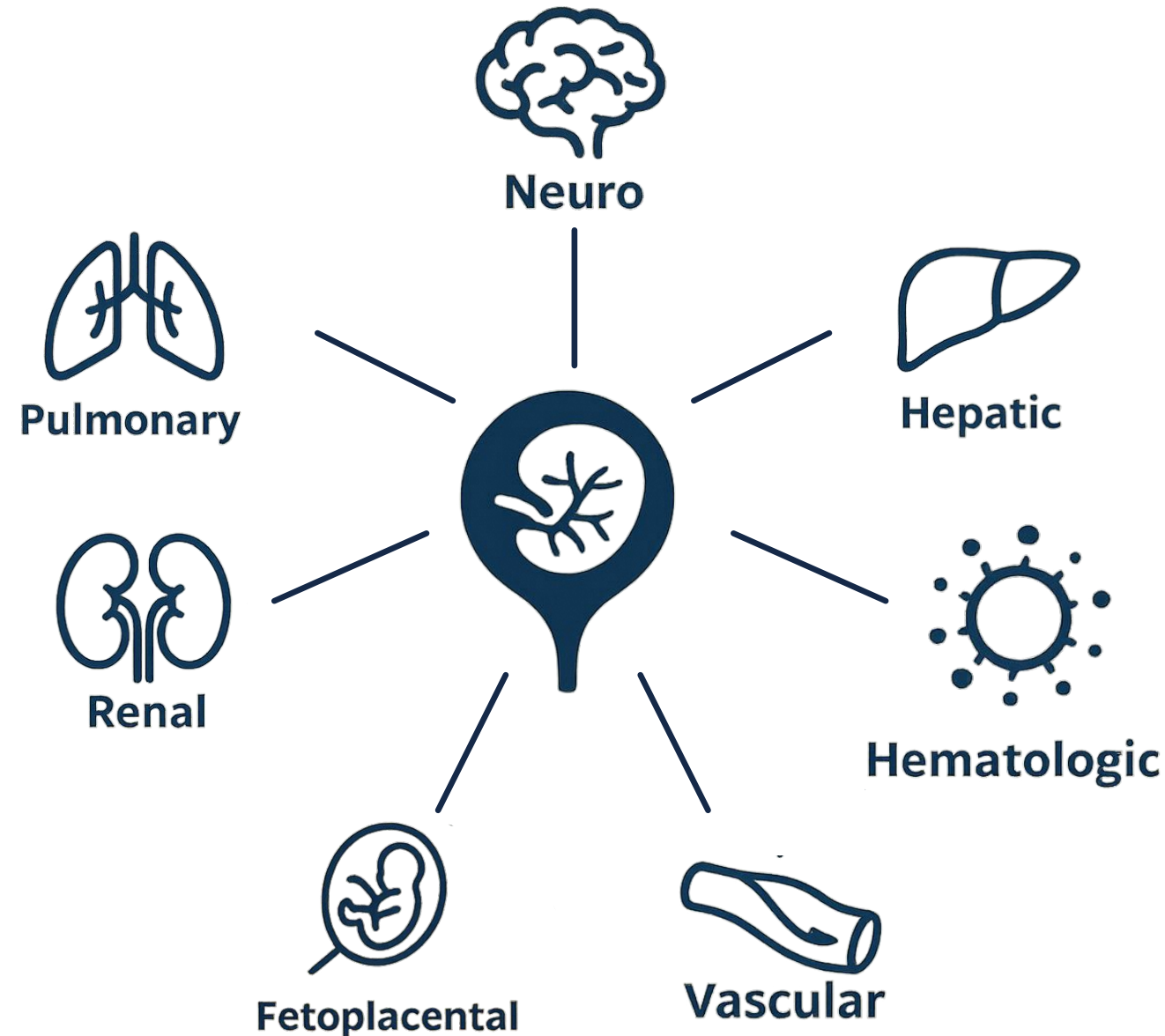
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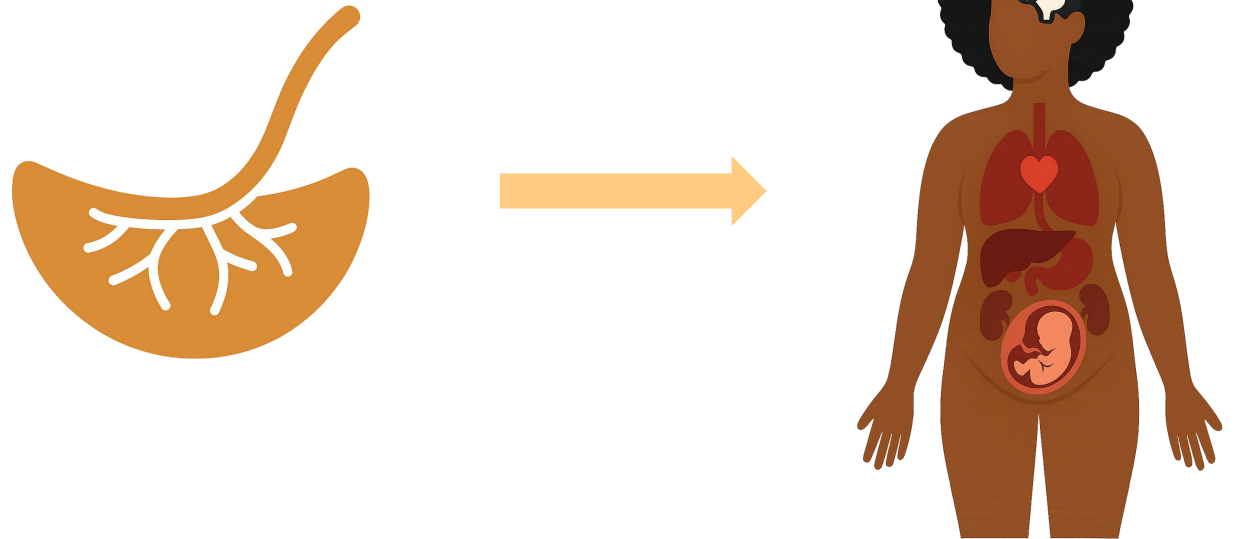
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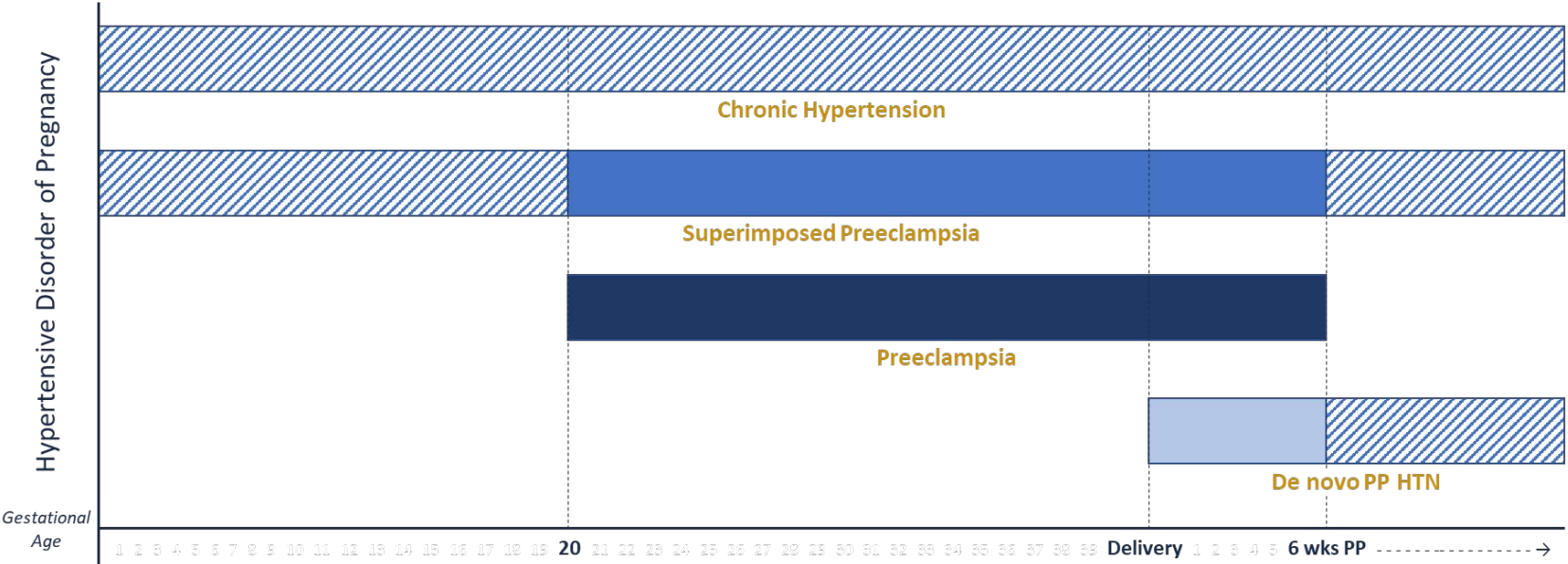
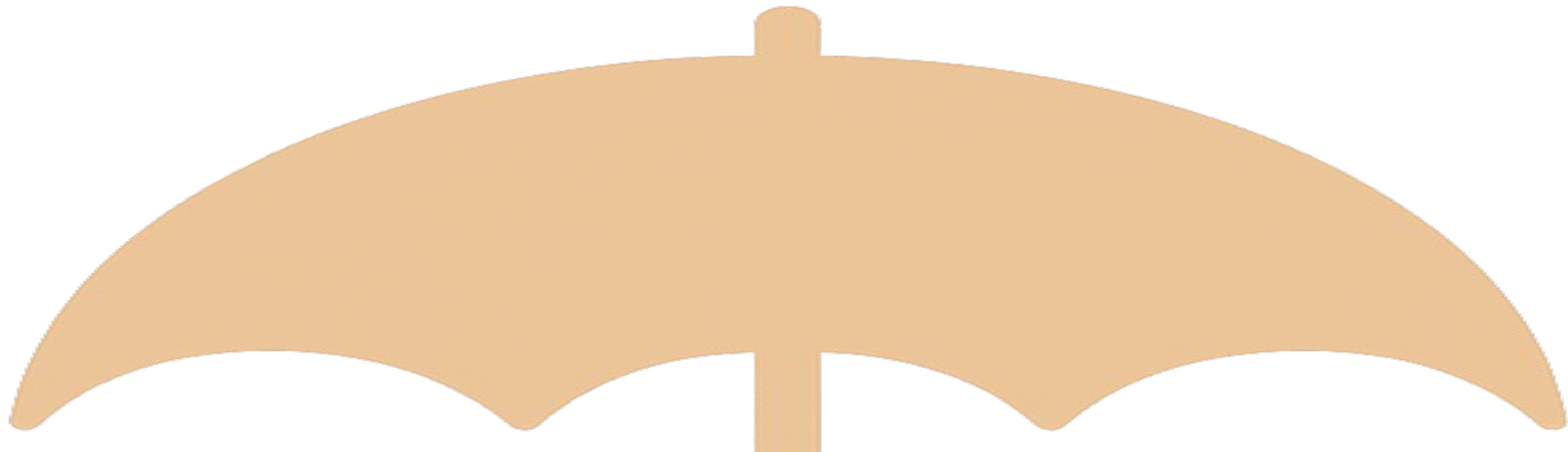


What is preeclampsia?

*Part of a spectrum of conditions of
HYPERTENSIVE DISORDERS OF PREGNANCY
(HDP):*

Placental dysfunction which
releases factors that can affect
almost every system in your body

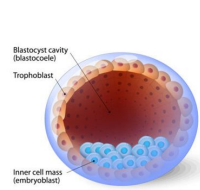
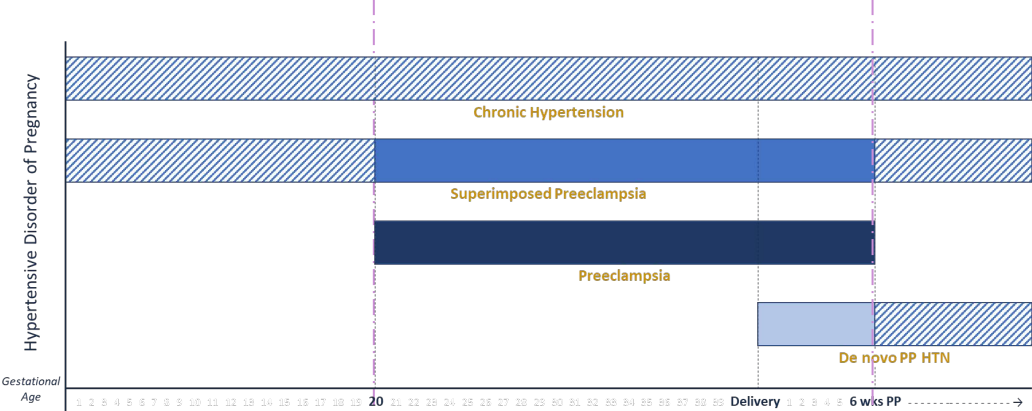




Diagnostic criteria for hypertensive disorders of pregnancy

Table 1: Definitions of hypertensive disorders of pregnancy^{12,13}

Condition	Definition
Chronic Hypertension 	SBP ≥130 or DBP ≥80 mmHg prior to 20 th week pregnancy
Gestational Hypertension 	SBP ≥140 or DBP ≥90 mmHg after to 20 th week pregnancy on >2 occasions
Preeclampsia 	Blood Pressure • SBP ≥140 or DBP ≥90 mmHg after to 20th week pregnancy on >2 occasions • OR Single reading of SBP ≥160 or DBP ≥110 mmHg after 20th week pregnancy AND Proteinuria • ≥300g 24hr urine collection • OR protein:creatinine ratio ≥ 0.3 • OR dipstick reading of ≥2+ OR any of the following: • Platelets <100x10⁹/L • Serum creatinine >1.1 mg/dL • Doubling of baseline creatinine • Doubling of baseline transaminases • New onset headache unresponsive to medication without alternative diagnosis



Gestational Hypertension and Preeclampsia: ACOG Practice Bulletin, Number 222. *Obstet Gynecol.* 2020;135(6):e237-e260.
American College of O, Gynecologists' Committee on Practice B-O. ACOG Practice Bulletin No. 203: Chronic Hypertension in Pregnancy. *Obstet Gynecol.* 2019;133(1):e26-e50.

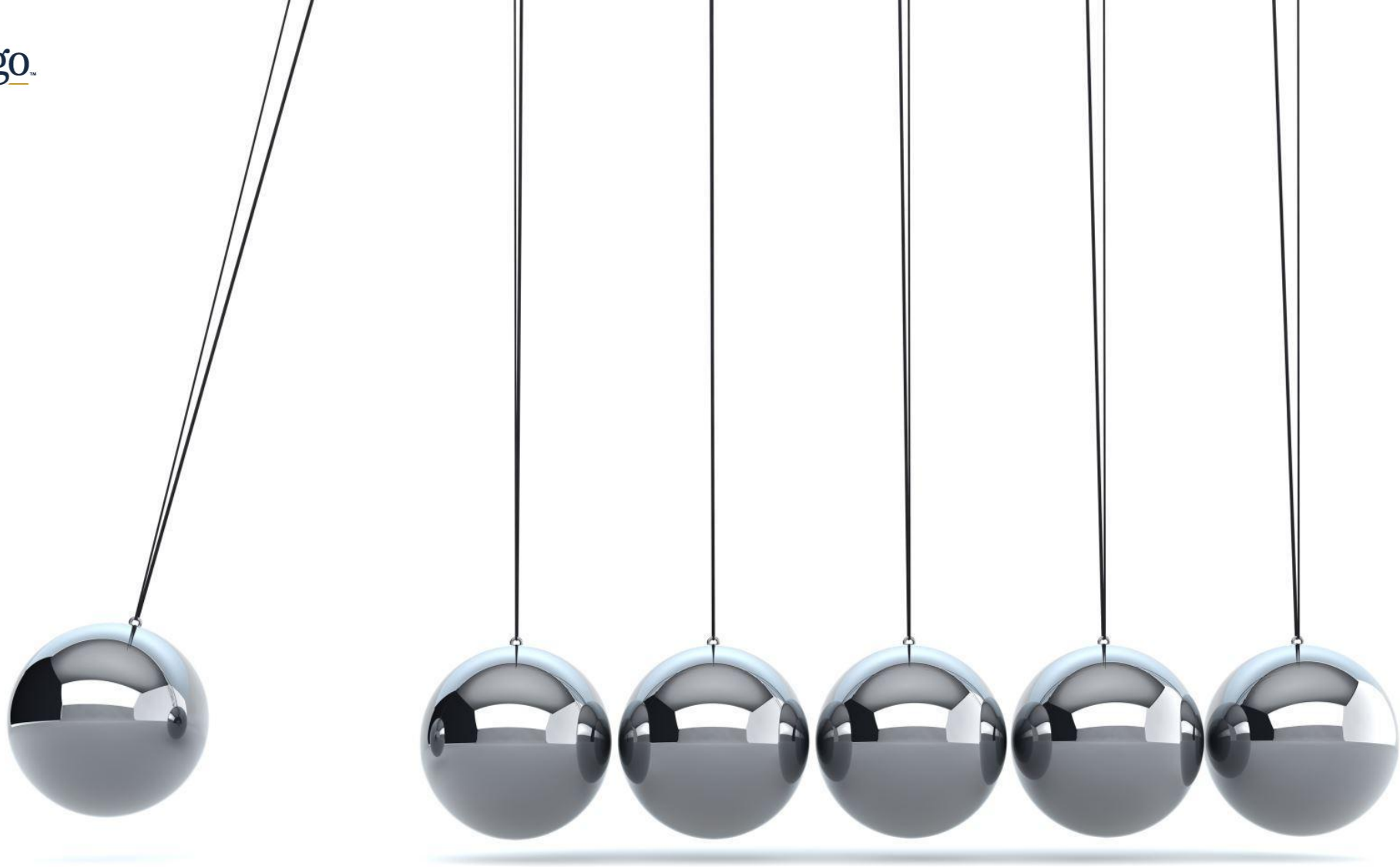
Tools to reduce HDP Risk

-  **EDUCATION** of disorder, signs, and symptoms
-  **SCREENING** at prenatal visits (and beyond)
-  **PROPHYLAXIS** with aspirin 81 mg for the right candidate
-  **TREATMENT** as soon as indicated
 - ☐ Antihypertensives: PO over 140/90, IV over 160/110
 - ☐ Magnesium sulfate for seizure prophylaxis
-  **FETAL MONITORING** when any HDP is diagnosed
-  **DELIVERY** when maternal (or fetal) risks outweigh fetal benefits
-  **RESEARCH** into better diagnostics and treatments



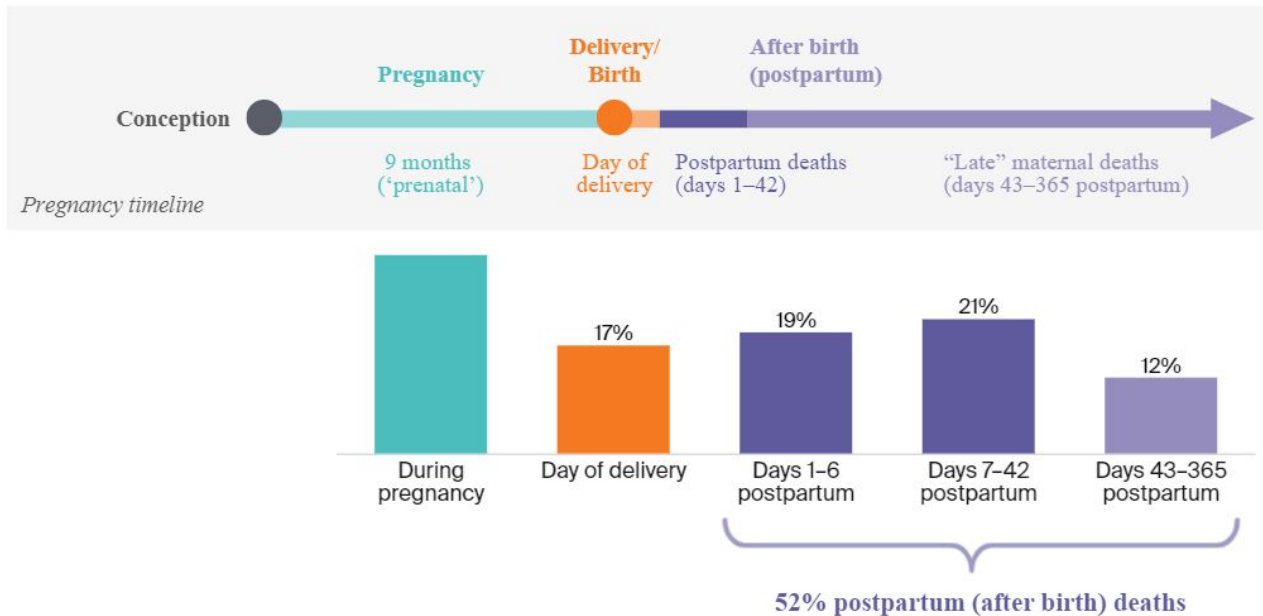
Why families face gaps in care

The “Fourth Trimester” danger zone



The rise of postpartum morbidity and mortality

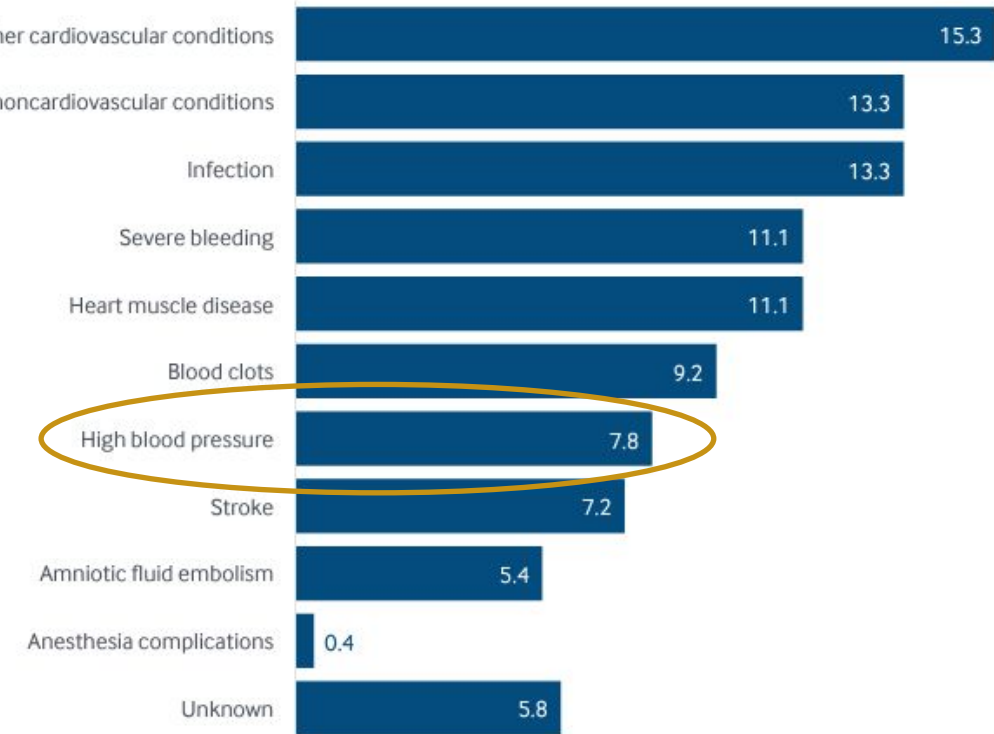
Exhibit 2
Timing of U.S. Maternal and Pregnancy-Related Deaths, 2011–2015



Data: Centers for Disease Control and Prevention Pregnancy-Related Mortality Surveillance data from: Emily E. Petersen et al., “Vital Signs: Pregnancy-Related Deaths, United States, 2011–2015, and Strategies for Prevention, 13 States, 2013–2017,” *Morbidity and Mortality Weekly Report* 68, no. 18 (May 10, 2019): 423–29.

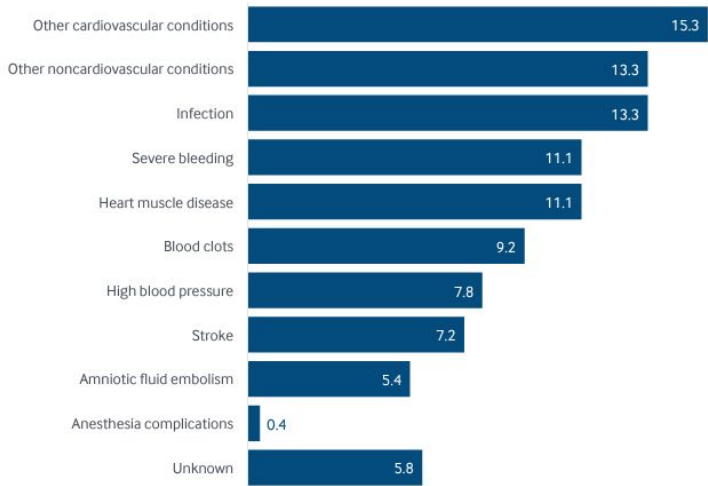
Source: Roosa Tikkanen et al., *Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries* (Commonwealth Fund, Nov. 2020). <https://doi.org/10.26099/411v-9255>

Leading clinical causes of pregnancy-related mortality up to one year post-birth, U.S., 2007–2016 (%)

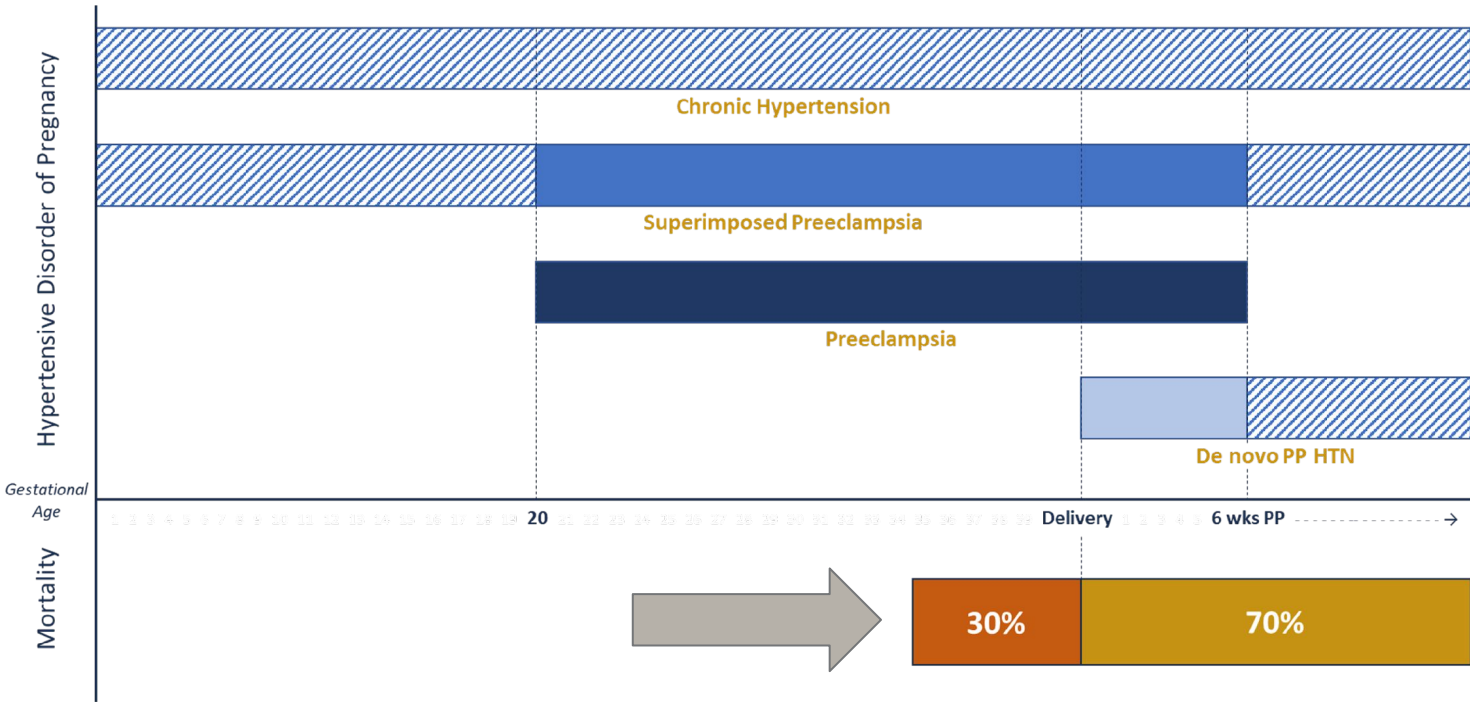


The rise of postpartum morbidity and mortality

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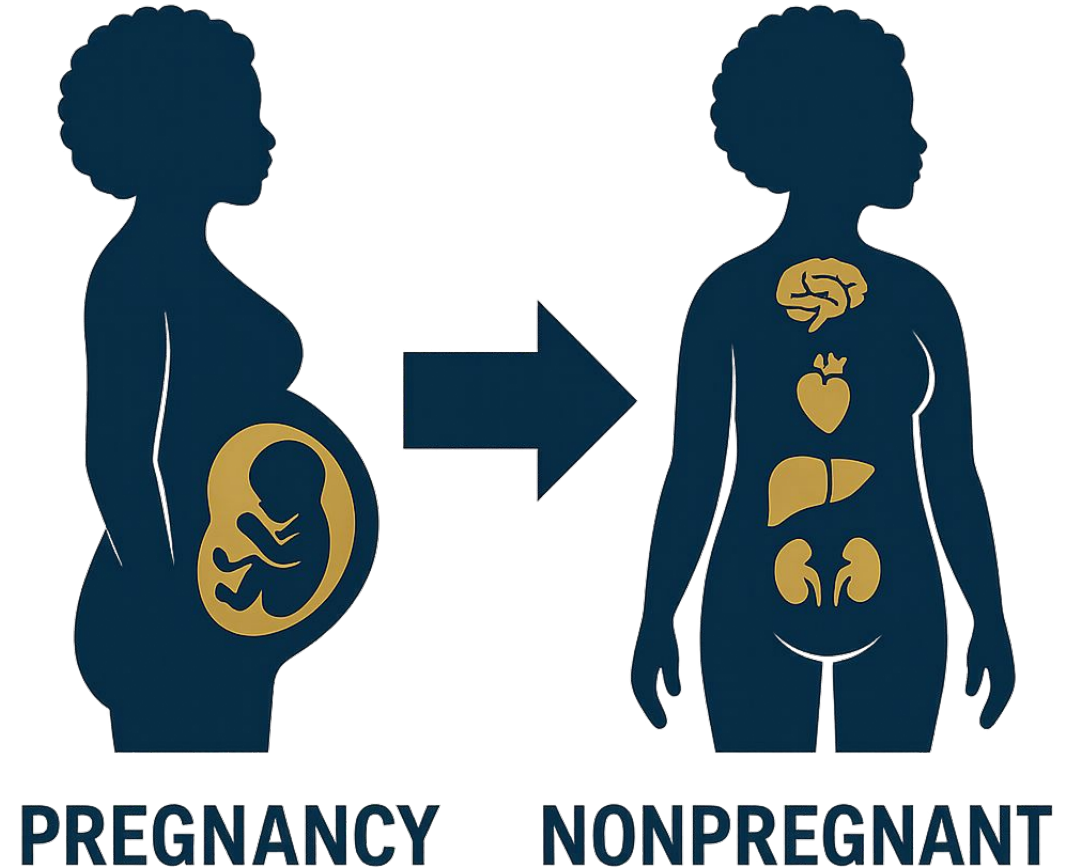
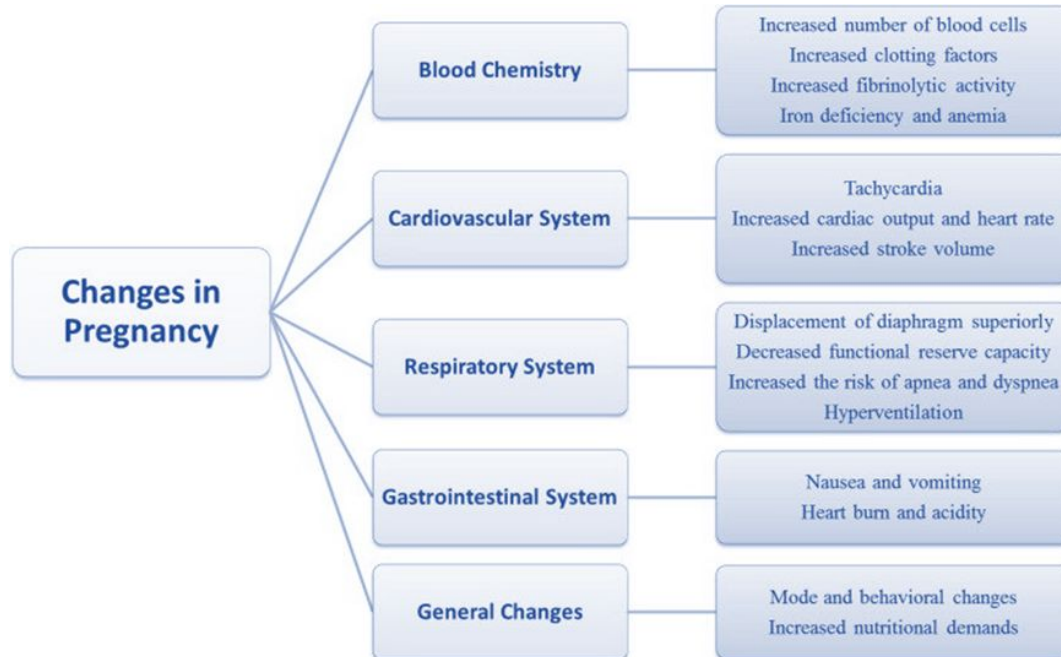
Hypertensive Disorders of Pregnancy (HDP)



70%

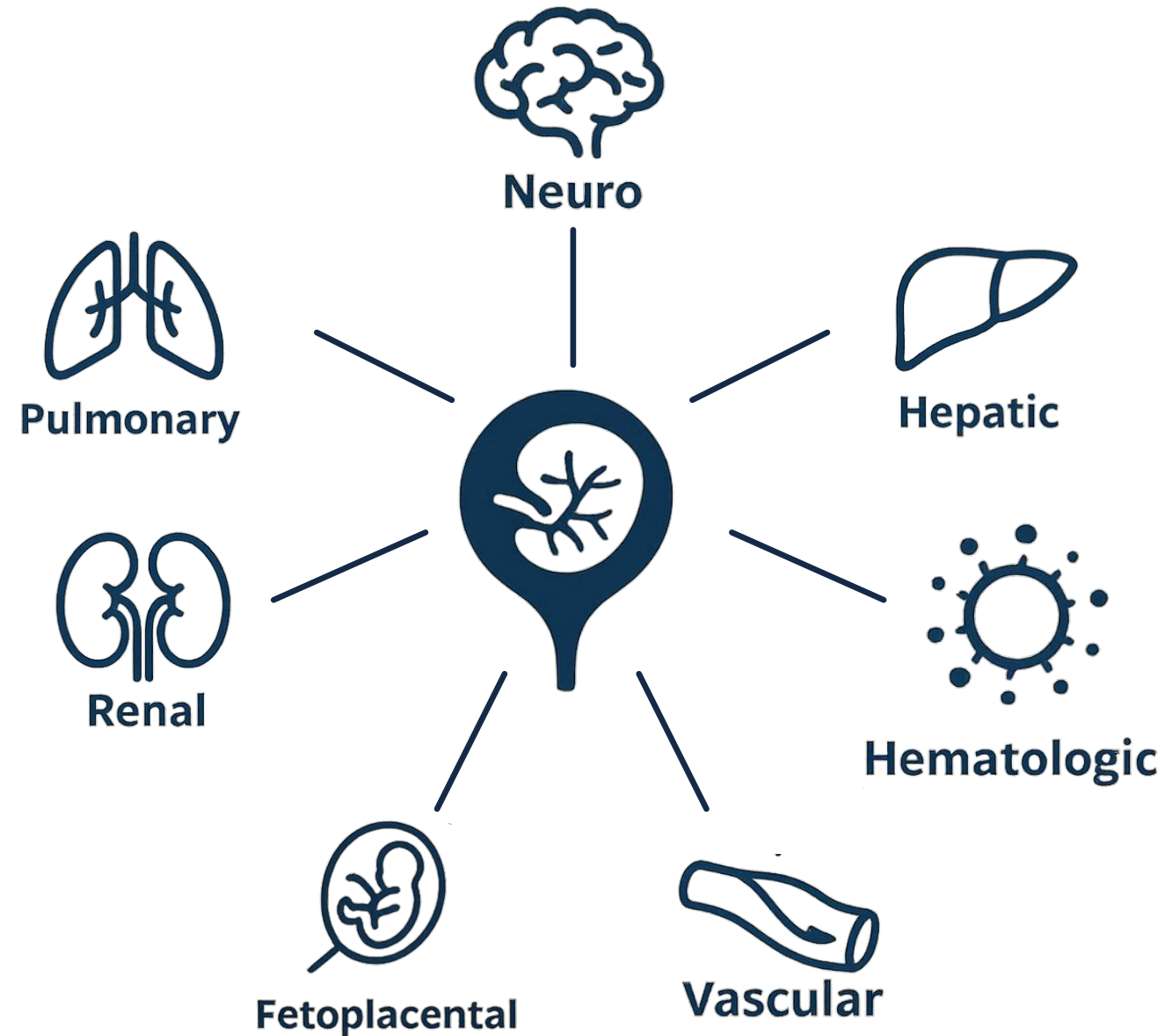
of hypertension-related maternal deaths occur after delivery

Contributors to postpartum HDP



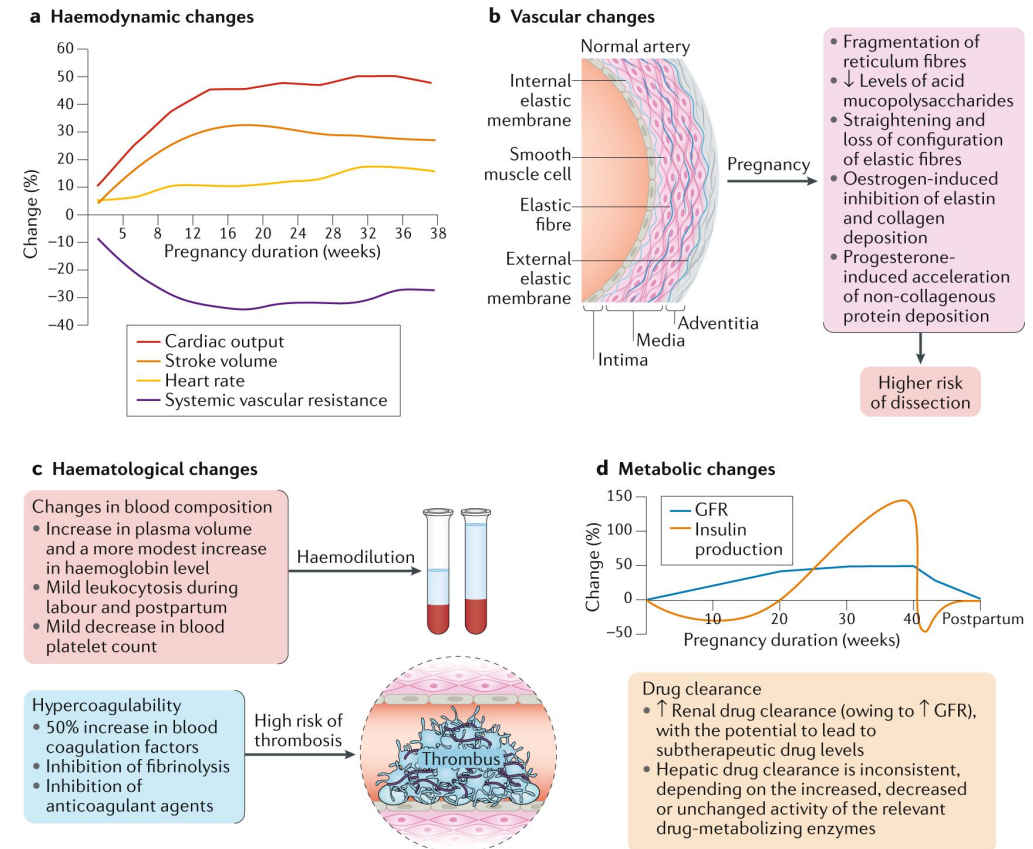
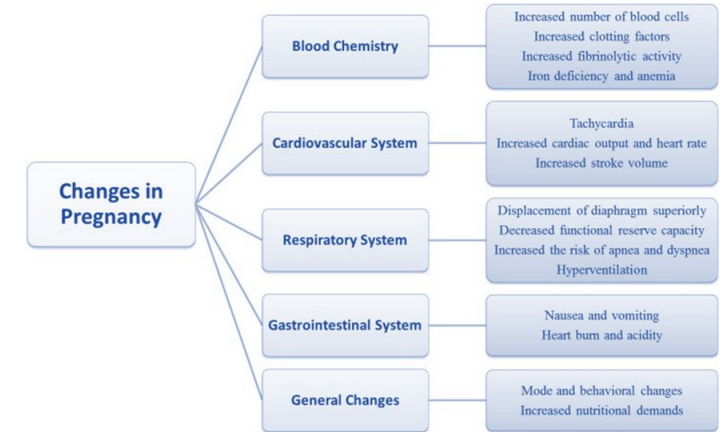
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Warning signs and symptoms or *normal pregnancy*?

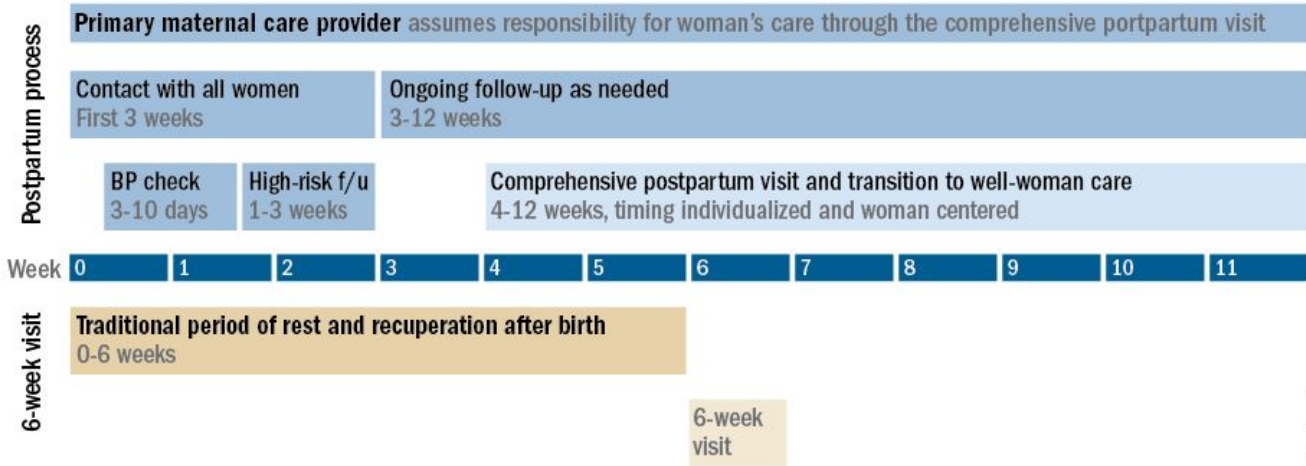
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Contributors to postpartum HDP morbidity and mortality



Proposed paradigm shift for postpartum visits

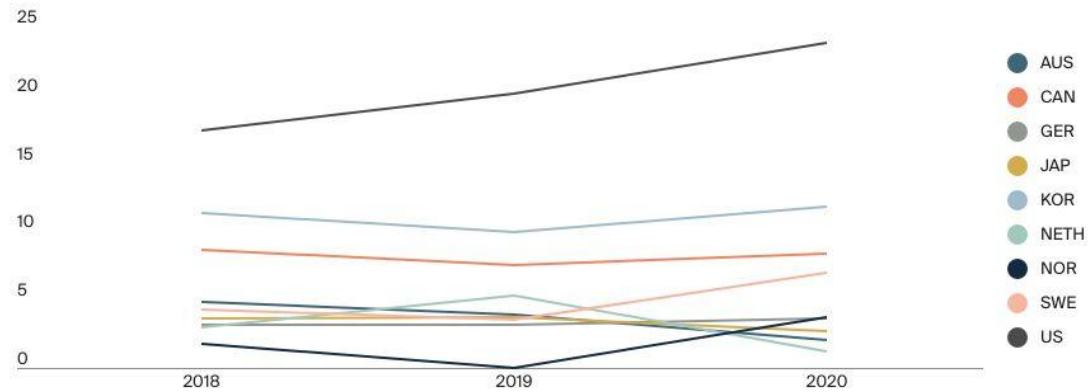


Notes: Adapted from ACOG Committee Opinion Number 736: Optimizing postpartum care. F/U = follow-up.
Source: Obstet Gynecol. 2018;131:e140-50

U.S. Maternal Mortality Crisis

U.S. Maternal Mortality Rate Has Been Getting Worse over Time

Deaths per 100,000 live births



Notes: The maternal mortality ratio is defined by the World Health Organization as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.

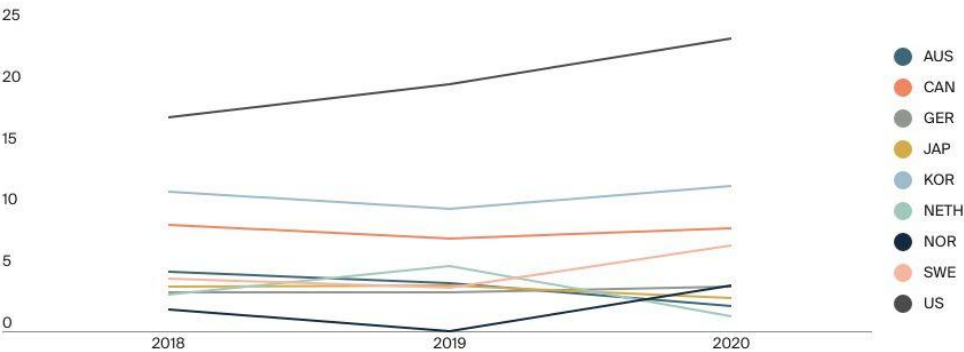
Data: Data for all countries except US from [OECD Health Statistics 2022](#). Data for US from Donna L. Hoyert, [Maternal Mortality Rates in the United States, 2020](#) (National Center for Health Statistics, Feb. 2022).

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Care models and social supports

U.S. Maternal Mortality Rate Has Been Getting Worse over Time

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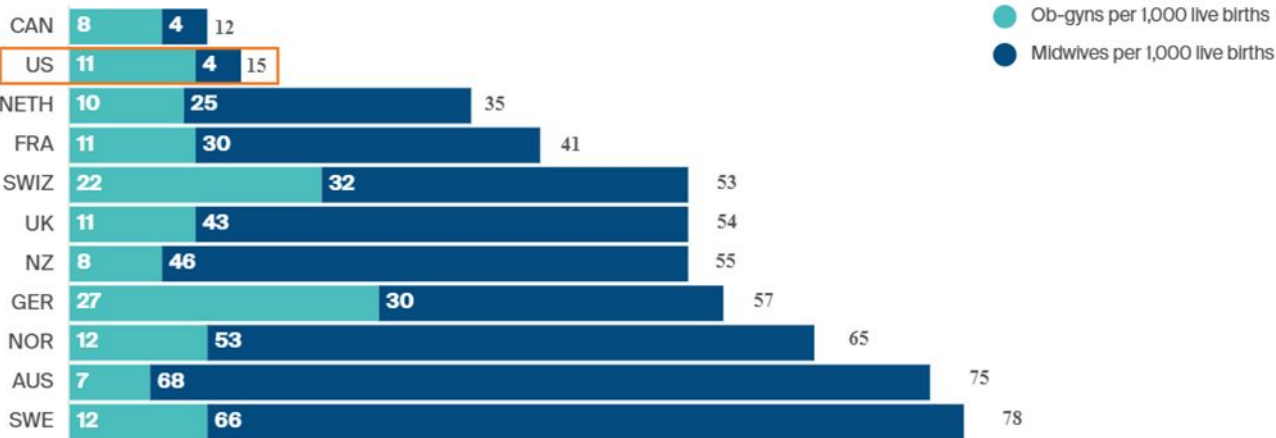
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Exhibit 3 Maternal Care Workforce: Supply of Midwives and Ob-Gyns, 2018 or Latest Year

Number of providers (head counts) per 1,000 live births*



Download data

* The "sum" figure shown to the right of horizontal bars may not reflect arithmetic sum of figures shown for Ob-Gyn and midwife providers because calculations were performed on exact figures, while the figure presents rounded figures.

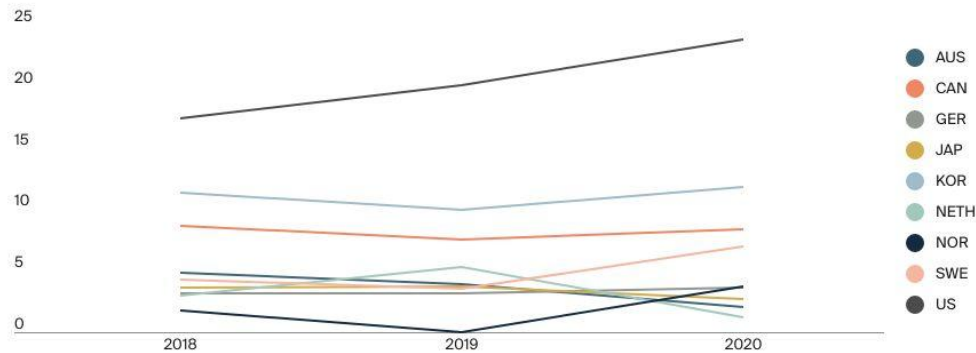
Data: OECD Health Data 2020, representing "practicing midwives" except: Canadian data reflect "professionally active" midwives; U.S. data reflect midwives "licensed to practice." Data for professionals "licensed to practice" tend to be higher than data for "professionally active," while numbers of "practicing" professionals tend to be the lowest. Data for 2018 except 2017 for Australia, Canada, Sweden, and 2015 for the U.S. Reflects midwifery professionals and midwifery associate professionals as defined by the International Standard Classification of Occupations (ISCO-08 codes 2222 and 3222, respectively). U.S. data reflect certified nurse-midwives (CNM), certified midwives (CM), and certified professional midwives (CPM) by the AMCB, and the NARM, but excludes noncertified midwives (i.e., lay midwives). "Sum" does not reflect total maternity care workforce, since primary care physicians/family practitioners also deliver some care in many countries (not shown here).

Source: Roosa Tikkanen et al., [Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries](#) (Commonwealth Fund, Nov. 2020). <https://doi.org/10.26099/411v-9255>

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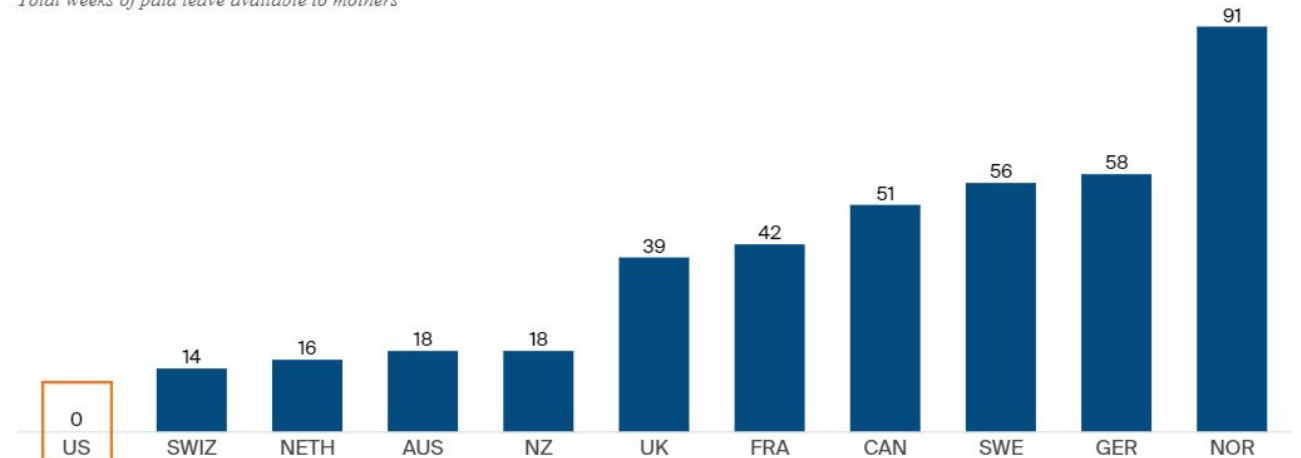
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Exhibit 5

Weeks of Paid Maternity Leave, 2018

Total weeks of paid leave available to mothers



Download data

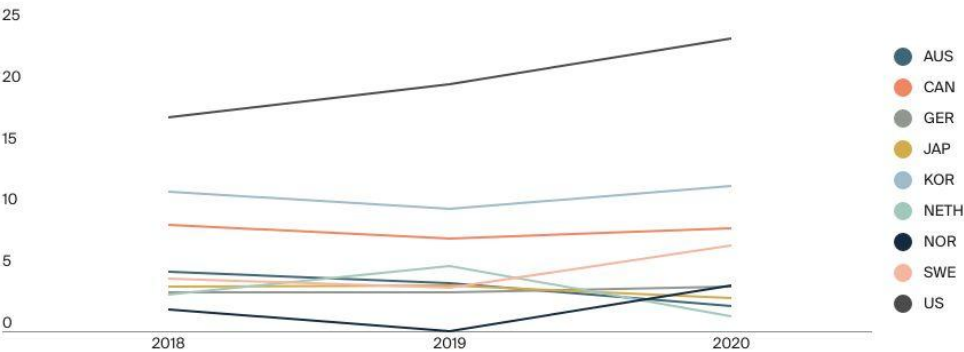
Data: OECD Family Database, 2018 data. Data reflect paid maternity, parental, and home care leave available to mothers.

Source: Roosa Tikkanen et al., [Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries](#) (Commonwealth Fund, Nov. 2020). <https://doi.org/10.26099/411v-9255>

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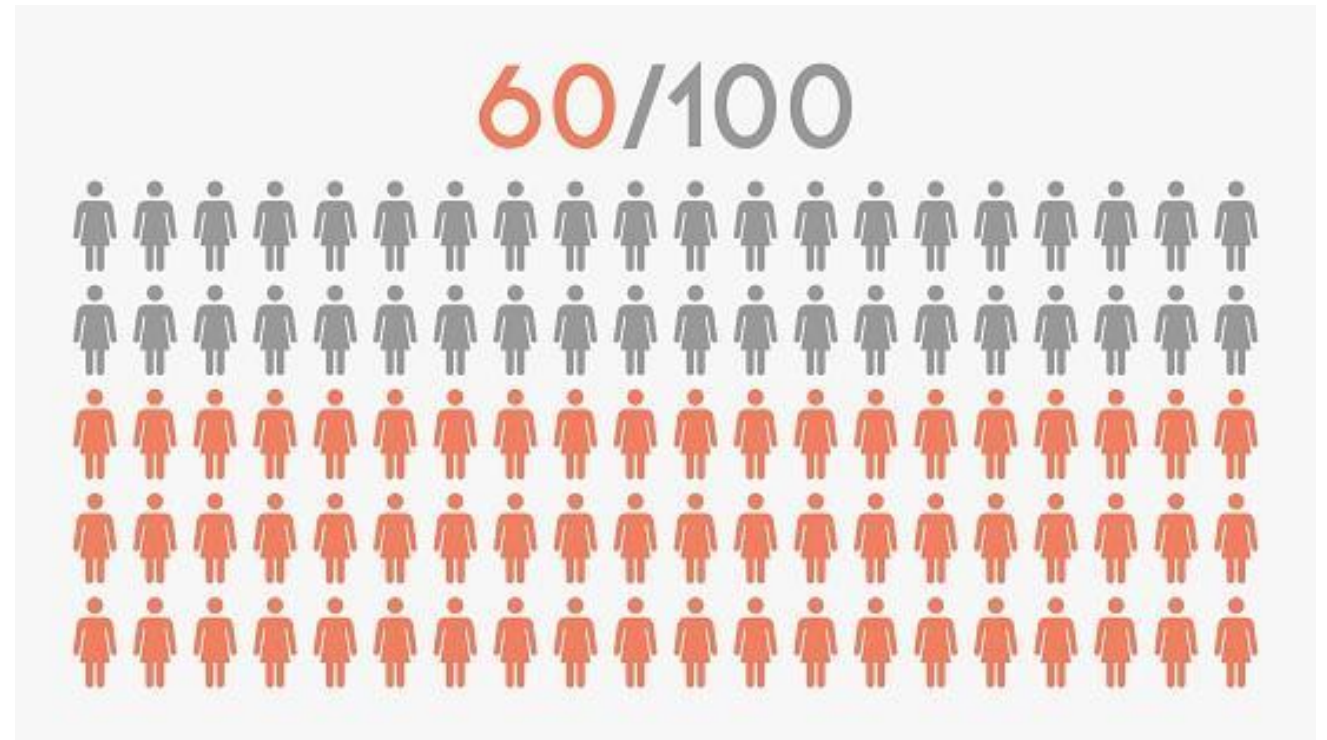
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Exhibit 4 Postpartum Home Visits

	Covered by national insurance?	Timing and number of covered visits	Provider
Australia	Yes	Within week 1, typically one to three visits	Midwife
Canada	Yes	Contacted or visited within 24 to 48 hours after going home	Public health nurse
France	Yes	Starting within 24 hours after discharge, one to three visits	Midwife
Germany	Yes	Daily if needed until day 10, plus 16 visits as needed until eight weeks postpartum	Midwife
Netherlands	Yes	Daily, starting immediately after birth and up to 10 days postpartum, staying at a minimum 4 hours per day	Maternity nurse
New Zealand	Yes	At least five visits over six weeks, starting within 48 hours postpartum	Midwife
Norway	Yes	Midwife: Starting at 24 to 48 hours, or three days (for low-risk multiparous women) after going home Nurse: First visit on days 7 to 10 postpartum; second visit on days 14 to 21	Midwife, nurse
Sweden	Yes	First visit during week 1; visits thereafter every one to two weeks until week 8	Midwife, nurse
Switzerland	Yes	Daily, up to 10 days postpartum	Midwife
United Kingdom	Yes	At least until 10 days postpartum	Midwife, nurse
United States	Covered by some state Medicaid programs and certain health plans	Varies by state Medicaid program and by individual insurer	Nurse, physician, community health worker, doula, home health worker

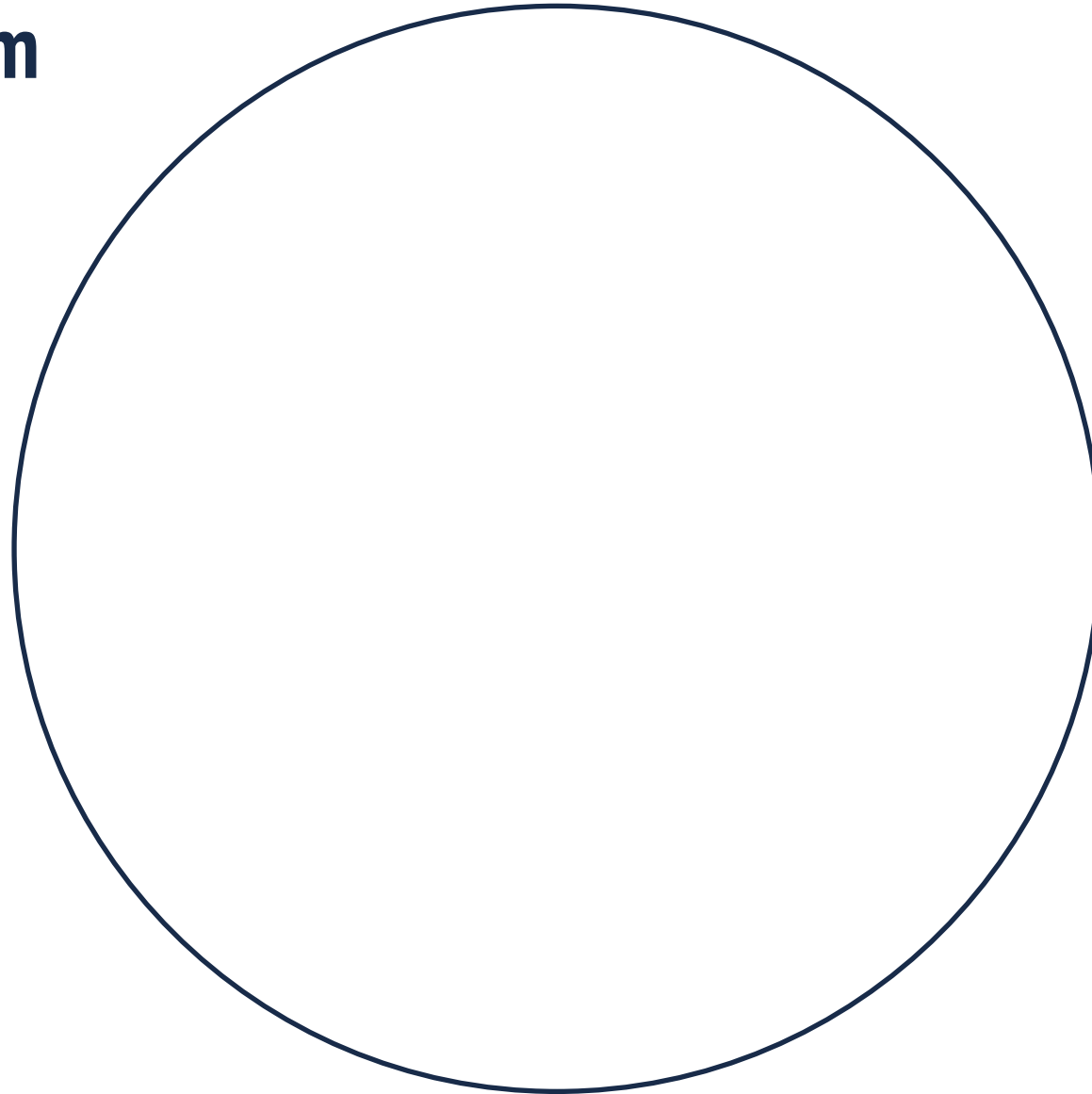
Contributors to postpartum HDP morbidity and mortality

**Follow-up
rates**

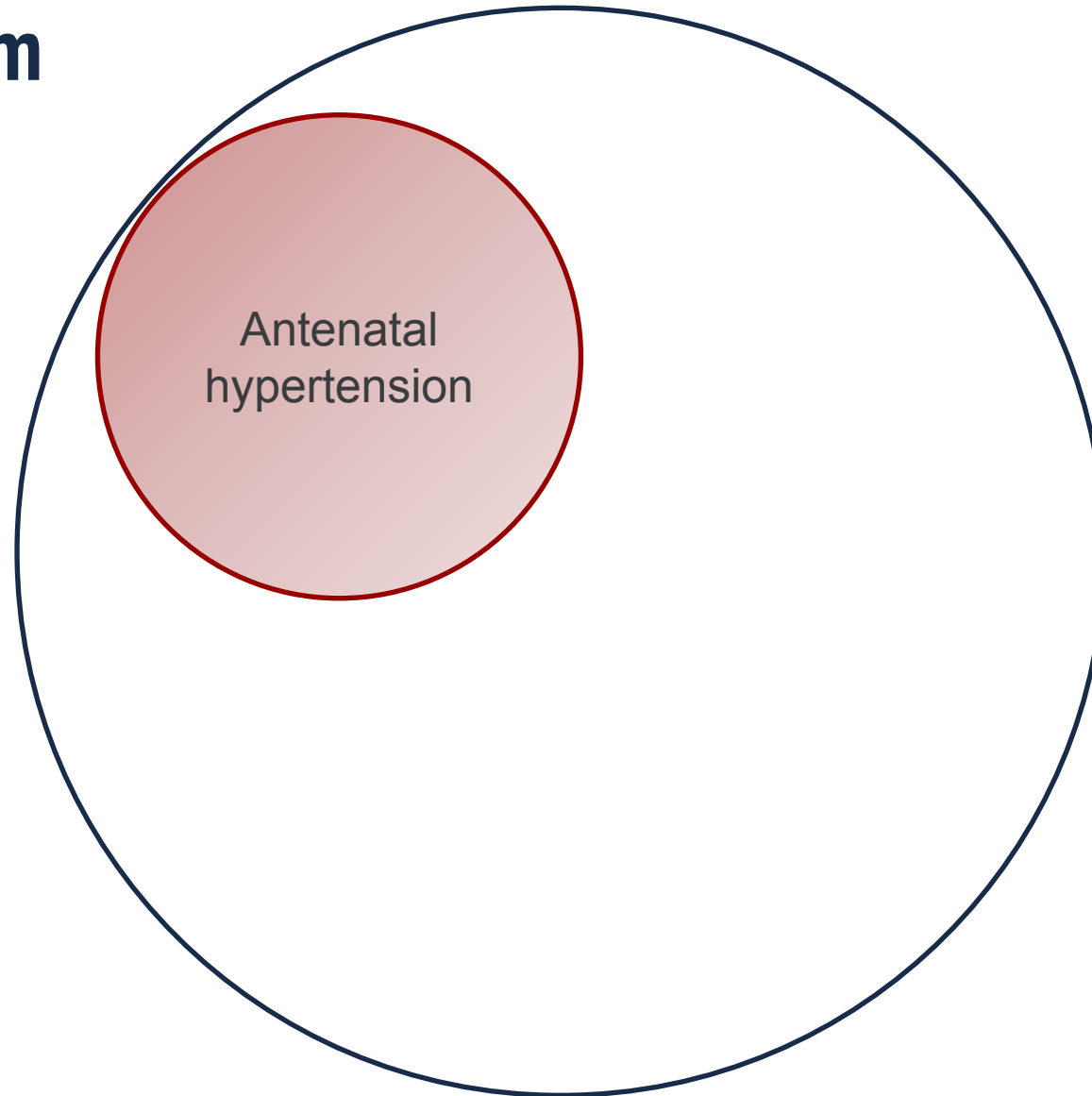


Of those with postpartum
preeclampsia, 33-69% are
normotensive antepartum.

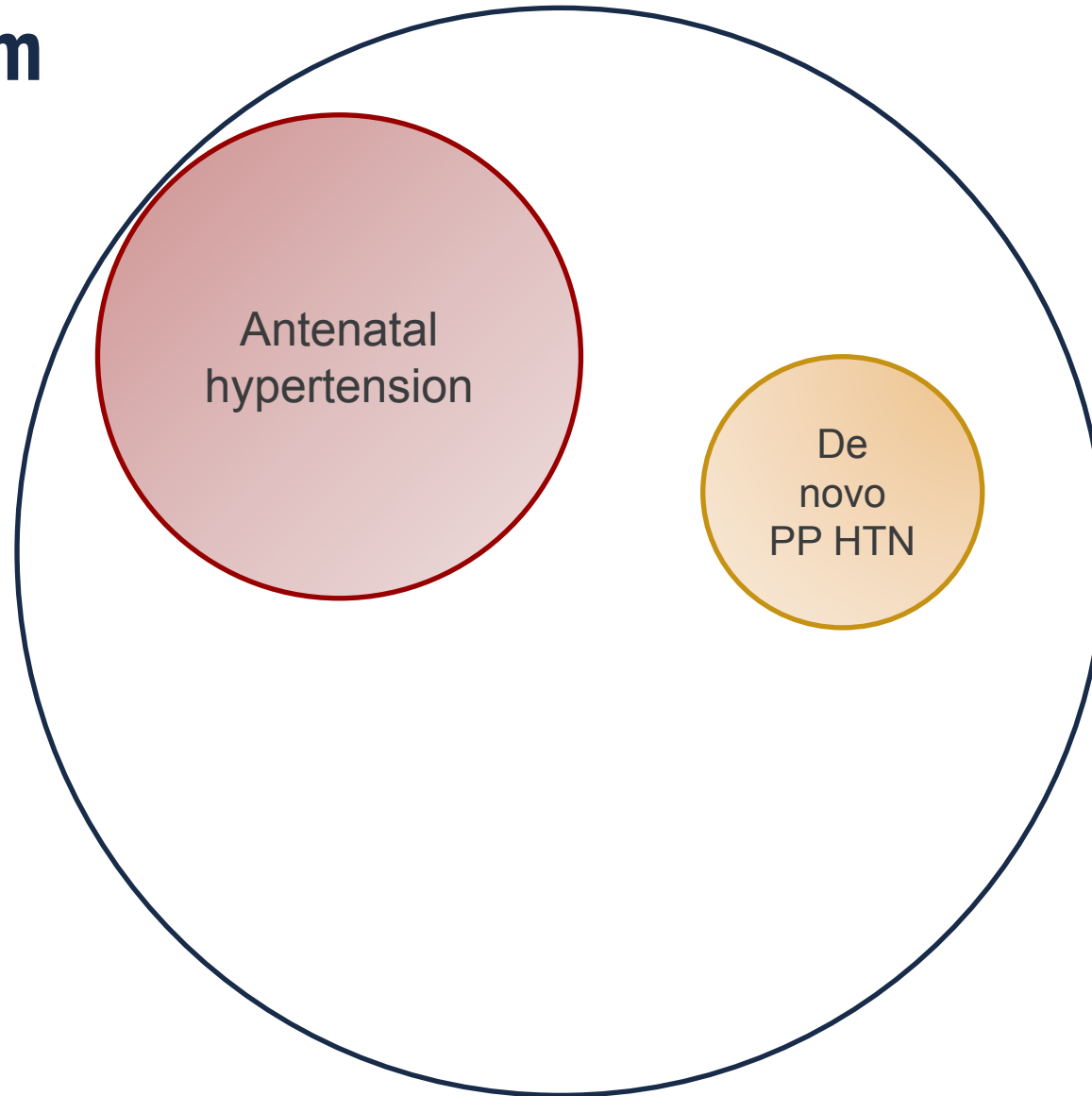
The postpartum population



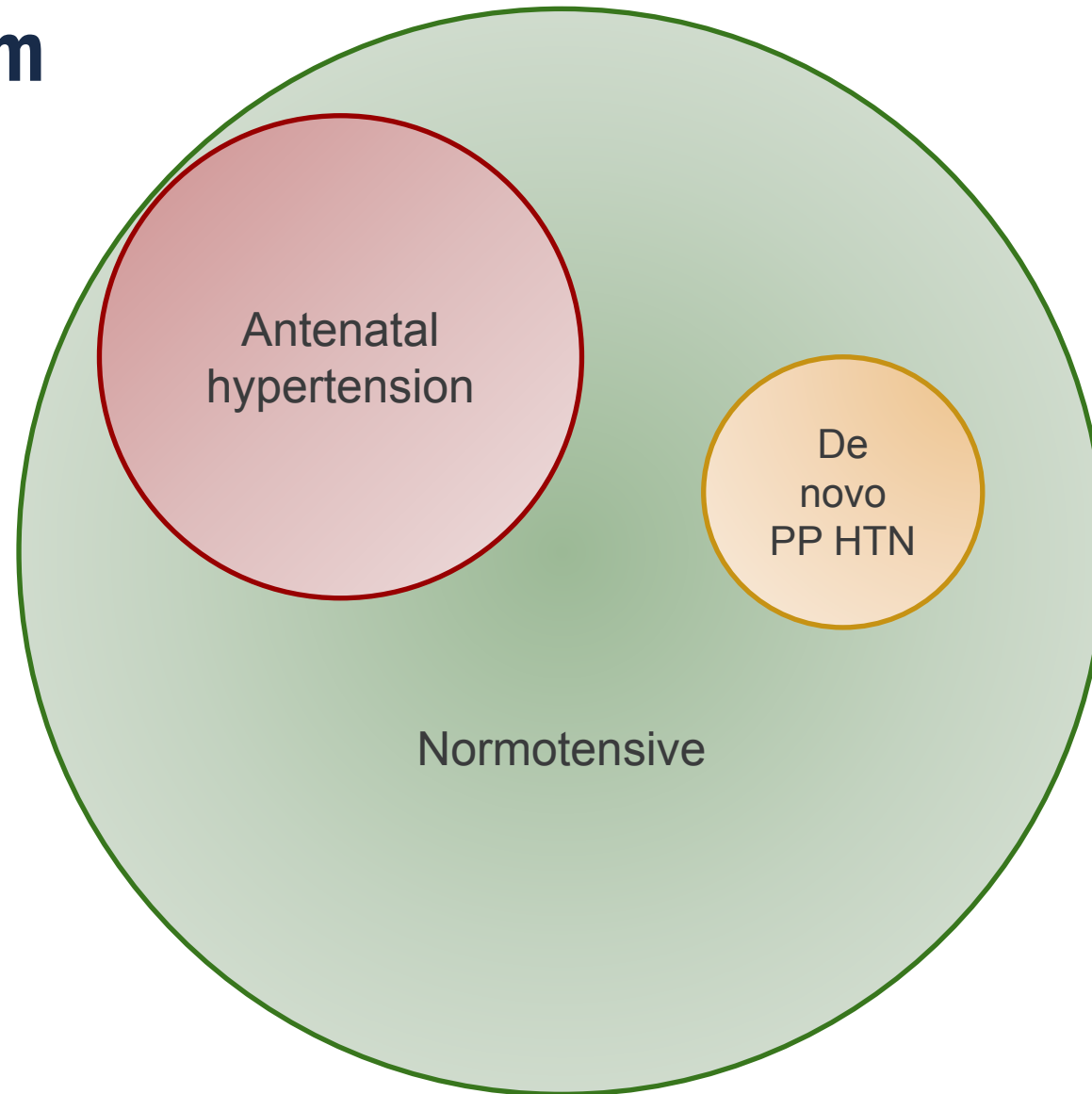
The postpartum population



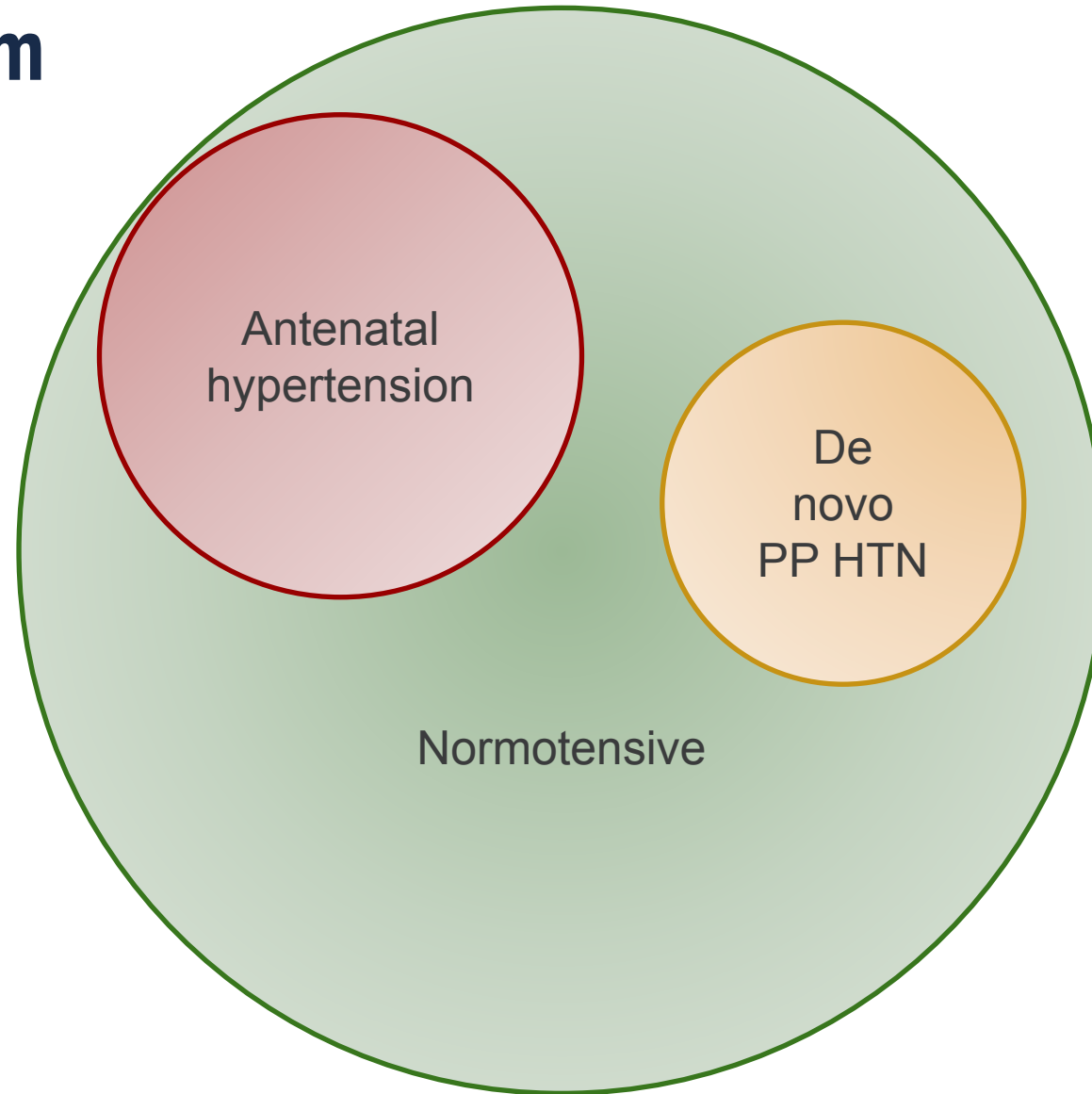
The postpartum population



The postpartum population



The postpartum population



Let's (fight to) reimagine care.

UC San Diego: Fourth Trimester Program

A program dedicated to providing comprehensive postpartum care for birthing people and their newborns through integration and co-location of health services.





Innovations on the horizon



DIAGNOSTICS

- Imbalance in antiangiogenic/pro-angiogenic circulating factors
- Volume overload



THERAPEUTICS

- Immunologic therapy
- Diuretic agents



MANAGEMENT

- Digital health tools
- Extended care
- Improvements in social support

Diuretics for postpartum hypertension



Original Research

ajog.org

OBSTETRICS

Lasix for the prevention of de novo postpartum hypertension: a randomized placebo-controlled trial (LAPP Trial)



Ukachi N. Emeruwa, MD, MPH; Hooman Azad, MD; Samsiya Ona, MD; Shai Bejerano, MS; Sarah Alnafisee, MD; Jordan Emont, MD, MPH, ScM; Sharon Mathew, BA; Michelle Batlle, MA; Denice Arnold, MD; Erinma P. Ukoha, MD, MPH; Louise C. Laurent, MD, PhD; Marni Jacobs, PhD; Janice J. Aubey, MD, MPH; Russell S. Miller, MD; Cynthia Gyamfi-Bannerman, MD, MS

Effects of Immediate Postpartum Diuretic Treatment on Postpartum Blood Pressure among Individuals with Hypertensive Disorders of Pregnancy: A Systematic Review and Meta-Analysis

 Susan K. Keen, Koura Sall,  Agnes Koczo, Yisi Wang, Rebekah S. Miller,  Matthew F. Muldoon,  Alisse K. Hauspurg,  Malamo E. Countouris

doi: <https://doi.org/10.1101/2025.01.03.25319983>

Exploring equity in the use of innovation

**New moms face barriers to care.
Digital engagement tools can help.**



Transportation issues

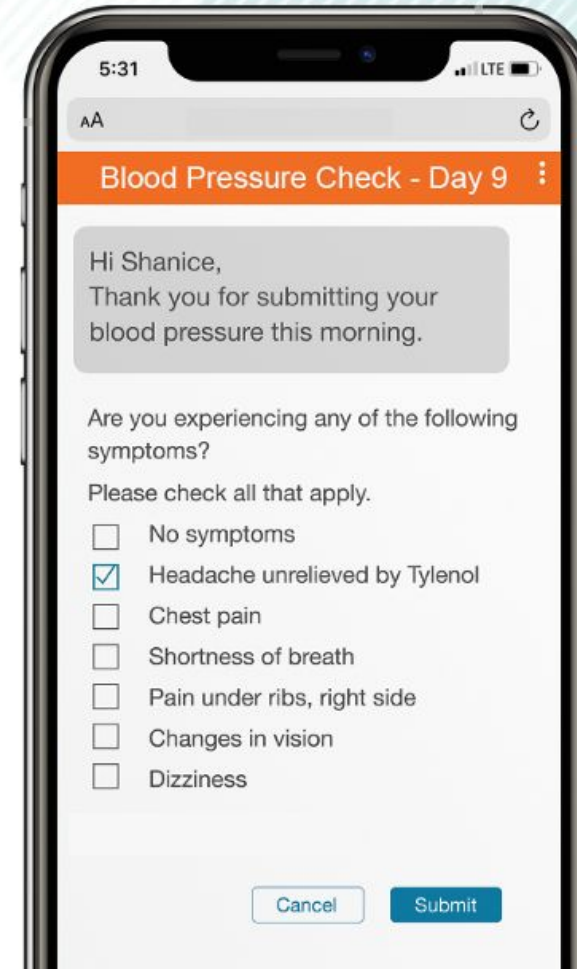


Childcare challenges



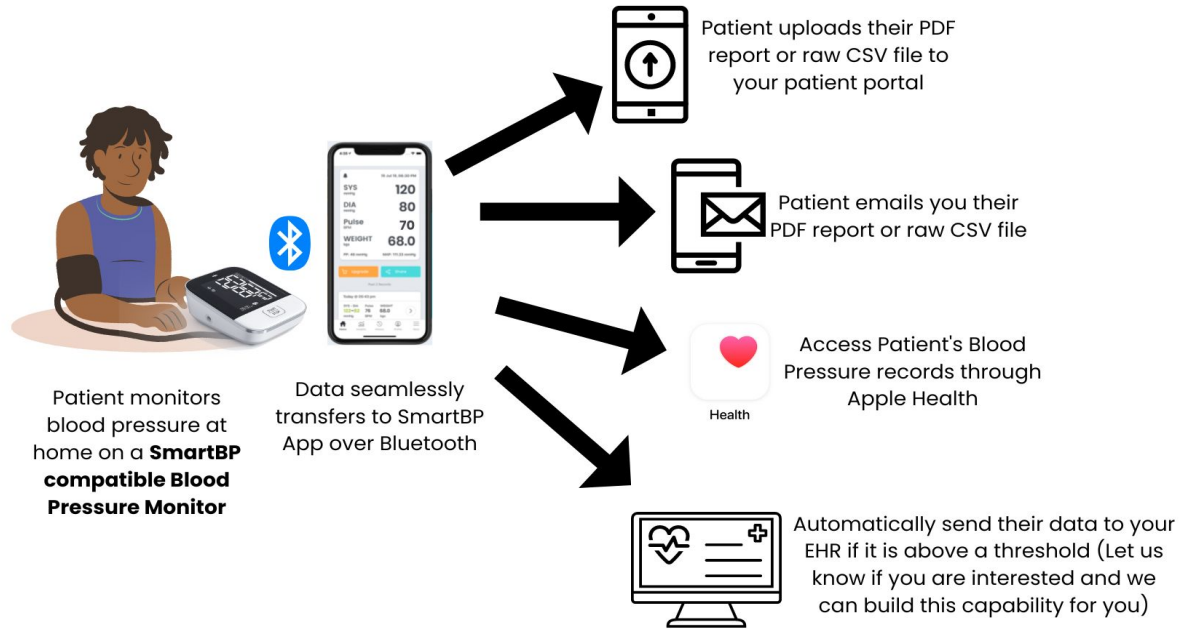
Work obligations

**Ensure patients have access to care
with digital tools – right from home**



The smartphone screen shows a mobile app interface for a blood pressure check. At the top, the status bar displays the time 5:31, LTE signal, and battery level. The app header is orange with the text "Blood Pressure Check - Day 9" and a menu icon. Below the header, a grey message bubble says "Hi Shanice, Thank you for submitting your blood pressure this morning." The main content area asks, "Are you experiencing any of the following symptoms?" and "Please check all that apply." It lists seven symptoms with checkboxes: "No symptoms" (unchecked), "Headache unrelieved by Tylenol" (checked), "Chest pain" (unchecked), "Shortness of breath" (unchecked), "Pain under ribs, right side" (unchecked), "Changes in vision" (unchecked), and "Dizziness" (unchecked). At the bottom, there are "Cancel" and "Submit" buttons.

Emerging digital health tools



Big Data Analytics

VECTOR ILLUSTRATION







Novel Fourth Trimester Services: early and frequent opportunities for interaction

Co-located Postpartum assessment and newborn check up

Contraception counseling and provision

Mental health services

Lactation counseling and support

Coordinated transition to Primary Care

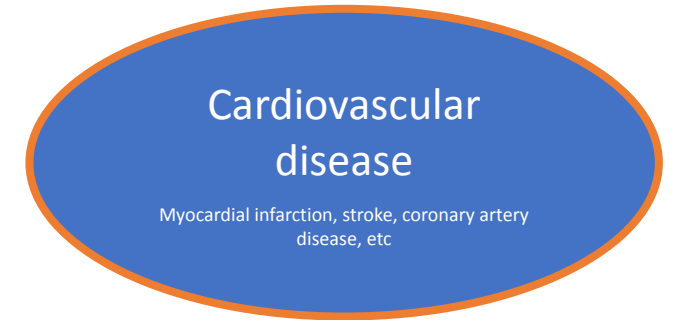
Stages of life and health



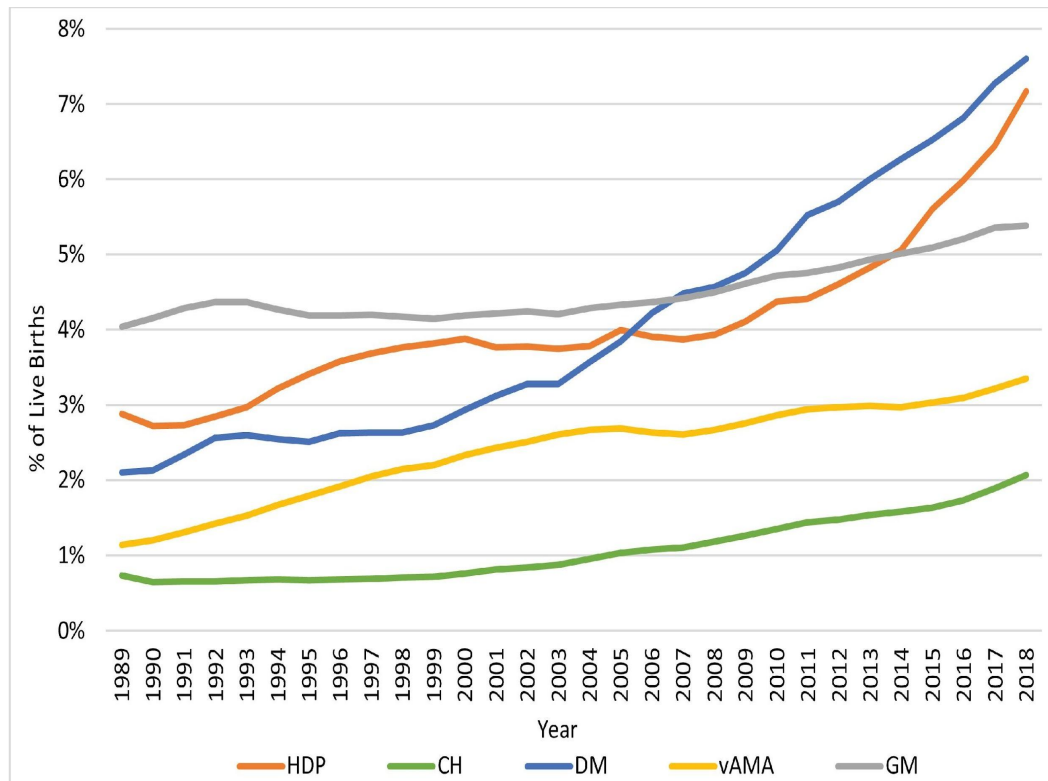
Natural stress-test



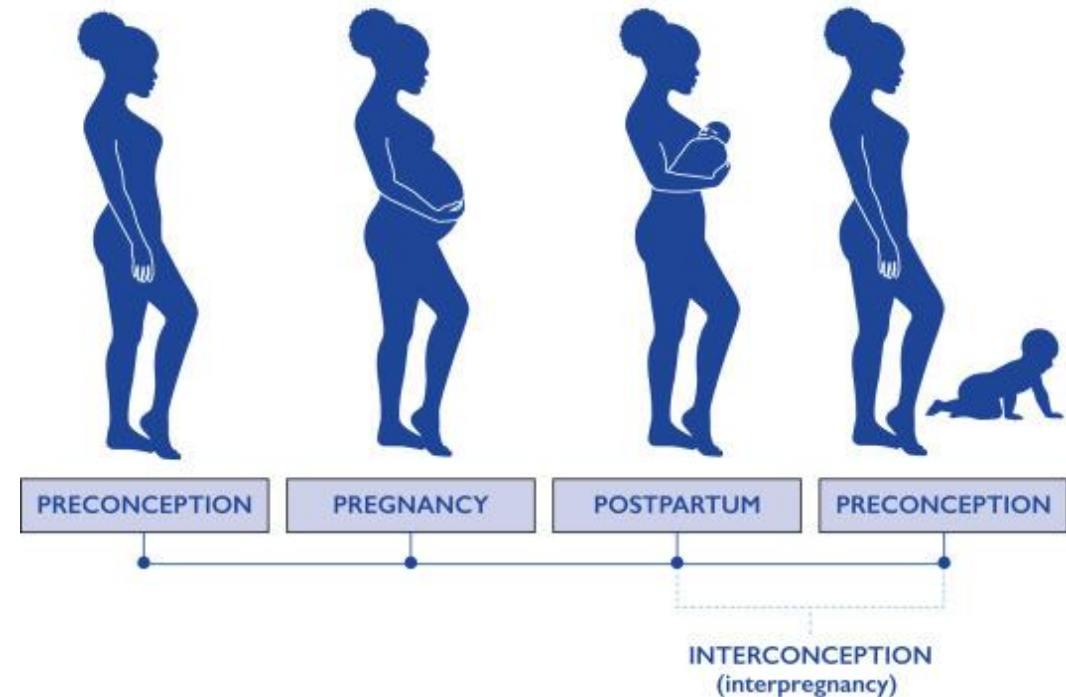
Life after pregnancy



Risk reduction: Preventing HDP



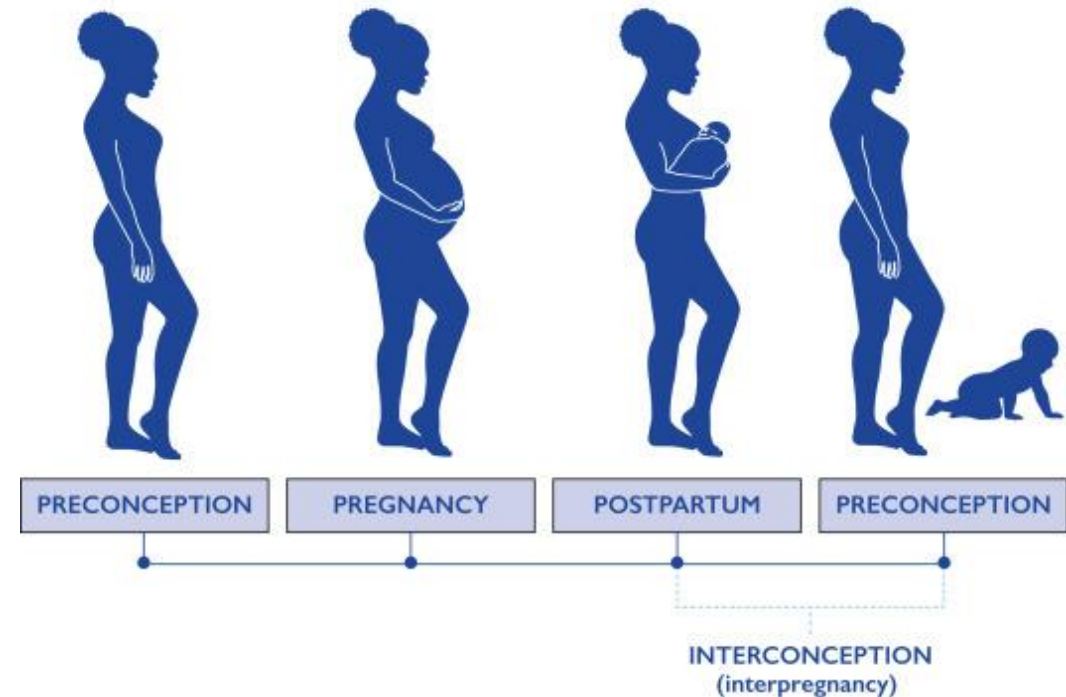
PREGNANCY CONTINUUM AND INTERCONCEPTION CARE



Risk reduction: Preventing HDP

- Optimize pre-pregnancy health

PREGNANCY CONTINUUM AND INTERCONCEPTION CARE



Innovations on the horizon



Successful transitions of care.



Empowering our patients and ourselves

Core elements of quality hypertension care

Whole system problem, Whole system approach



Medical assistants

Accurate BP is vital
Ask about symptoms during intake

Community health workers

Vital link post-discharge
Home visits
BP checks
Reinforce education
Connect to health system



Physicians/ CNMs/Providers

Diagnose
Manage
Ensure and communicate clear plan
Refer to higher level

Health educators

Create clear materials
Lead patient classes

Nurses

Reinforce education
Assess symptoms
Escalate concerns





“Education is the most powerful weapon which you can use to change the world.”

~ Nelson Mandela



“When you know better, you do better.”

~ Maya Angelou

/

Thank you. Questions?

 uemeruwa@health.ucsd.edu

 @MissUkachi  (#edUKation)

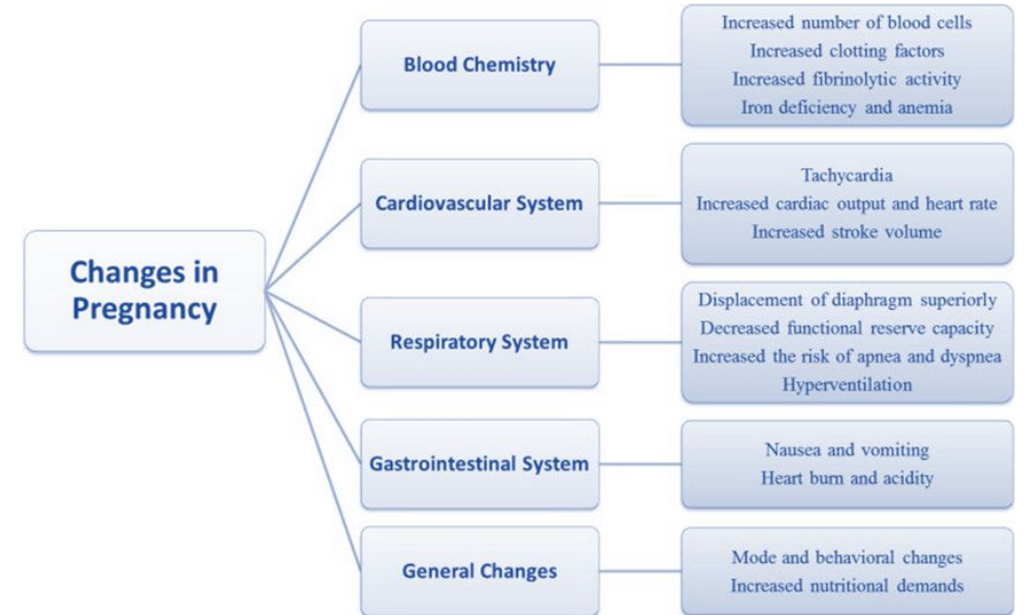
 @MissUkachi

 MissUkachiisDrUk / ukachi.emeruwa

 ukachi-emeruwa

Who is at risk?

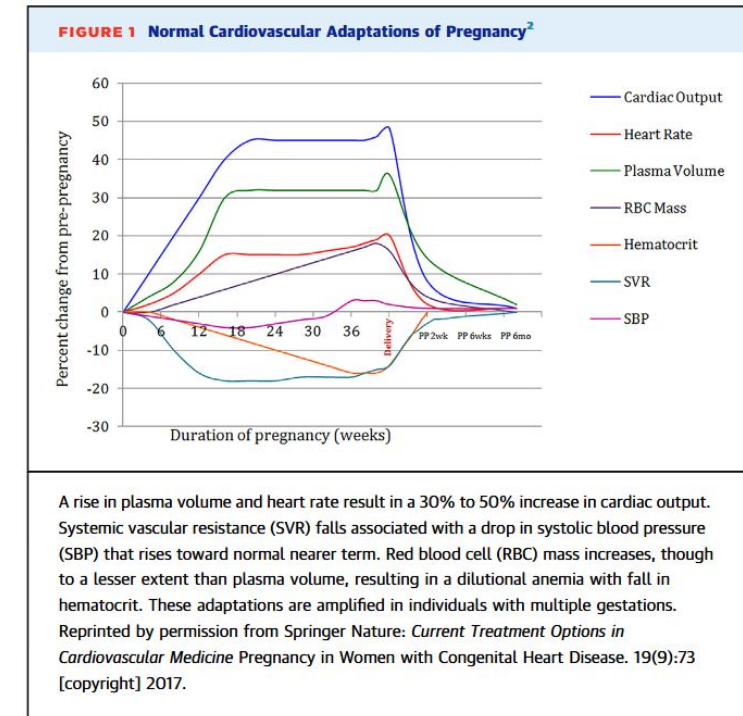
Risk Level	Risk Factors
High (1 or more)	• History of preeclampsia in previous pregnancy • Multifetal gestation (twins, triplets, etc.) • Chronic hypertension (high blood pressure) • Type 1 or 2 diabetes • Renal disease (kidney disease) • Autoimmune disease (lupus, antiphospholipid syndrome, etc.)
Moderate (2 or more)	• Nulliparity (never having given birth) • Obesity (body mass index (BMI) >30) • Family history of preeclampsia (mother or sister) • Age ≥35 or <18 years old • Personal history (e.g., low birthweight or small for gestational age, previous adverse pregnancy outcome, >10-year pregnancy interval) • Social Drivers of Health (e.g., Black, rural, Medicaid)
Low	• Previous uncomplicated full-term delivery



- Pregnancy is marked by profound physiologic adaptations to accommodate (and secondary to) the growing feto-placental unit

Who is at risk?

Risk Level	Risk Factors
High (1 or more)	• History of preeclampsia in previous pregnancy • Multifetal gestation (twins, triplets, etc.) • Chronic hypertension (high blood pressure) • Type 1 or 2 diabetes • Renal disease (kidney disease) • Autoimmune disease (lupus, antiphospholipid syndrome, etc.)
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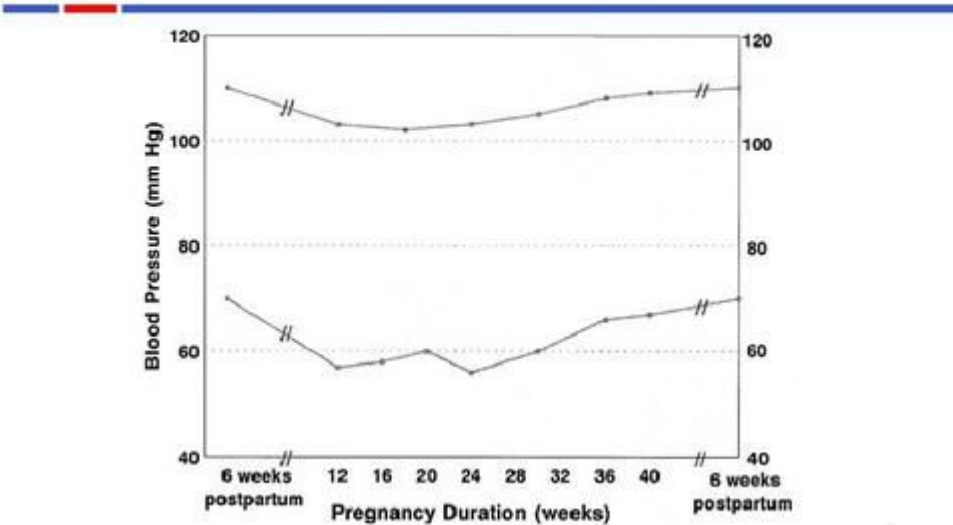


- Pregnancy is marked by profound physiologic adaptations to accommodate (and secondary to) the growing feto-placental unit

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Low	• Previous uncomplicated full-term delivery

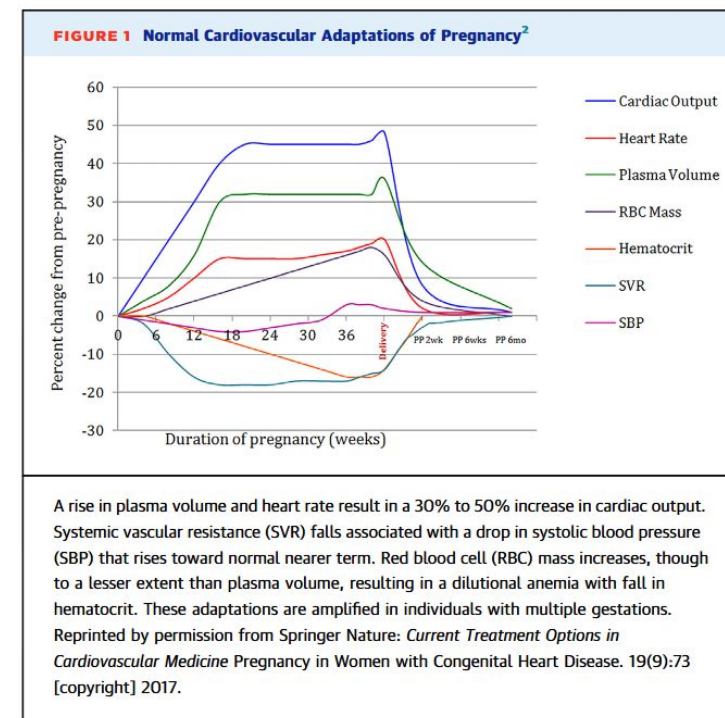
Normal Pregnancy Blood Pressure



- Pregnancy is marked by profound physiologic adaptations to accommodate (and secondary to) the growing feto-placental unit

Who is at risk?

Risk Level	Risk Factors
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Low	• Previous uncomplicated full-term delivery



- Derangements, deviations, or **inability to accommodate these adaptations** lead to pregnancy-associated pathology

Who is at risk?

Risk Level	Risk Factors
High (1 or more)	• History of preeclampsia in previous pregnancy • Multifetal gestation (twins, triplets, etc.) • Chronic hypertension (high blood pressure) • Type 1 or 2 diabetes • Renal disease (kidney disease) • Autoimmune disease (lupus, antiphospholipid syndrome, etc.)
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Low	• Previous uncomplicated full-term delivery

- Proven predisposition
- More placenta
- Baseline compromise in systems:
 - Vascular
 - Renal
 - Inflammatory
- “Guilty until proven innocent”
- Baseline physiologic stress
- ?Genetic predisposition
- Immature or compromised adaptive potential
- Predisposition to other placental dysfunction
- Contributors to physiologic stress