Perinatal Diabetes: Diagnosis, Management, and Life-course Impacts

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AWHONN MN Section Annual Meeting

1

Learning Objectives

- Describe Diabetes Classifications and prevalence
- Pathophysiology of Diabetes in Pregnancy
- Describe Risks of Diabetes in Pregnancy
- Goals of diabetes management in pregnancy
- Recognize DKA in pregnancy
- Lifelong impacts of diabetes in pregnancy

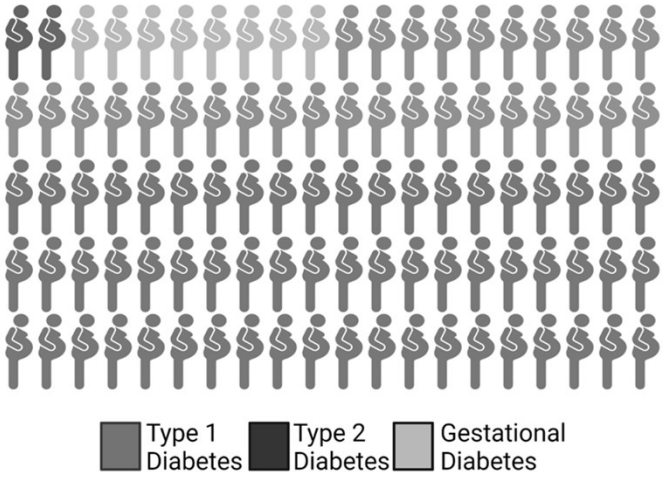
2

Disclosures

- No Financial Disclosures

3

Diabetes complicates 10% of all pregnancies

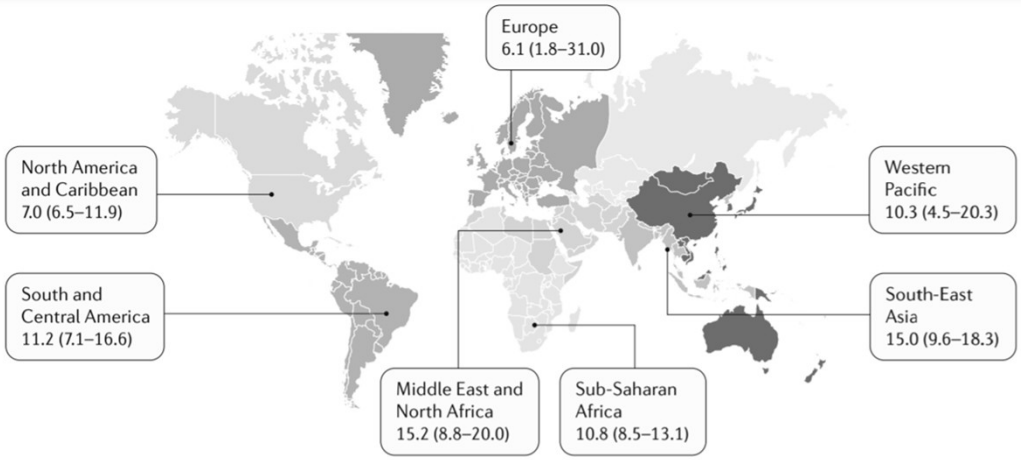


Gestational Diabetes:
A1-managed with diet and exercise

A2-managed with medication

4

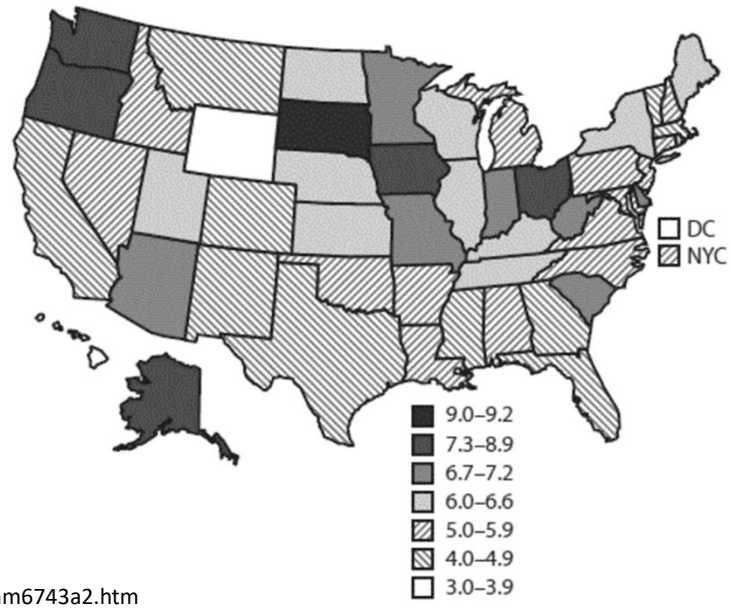
Rates of GDM vary across populations



McIntyre et al Nat Rev Disease Primers 2019

5

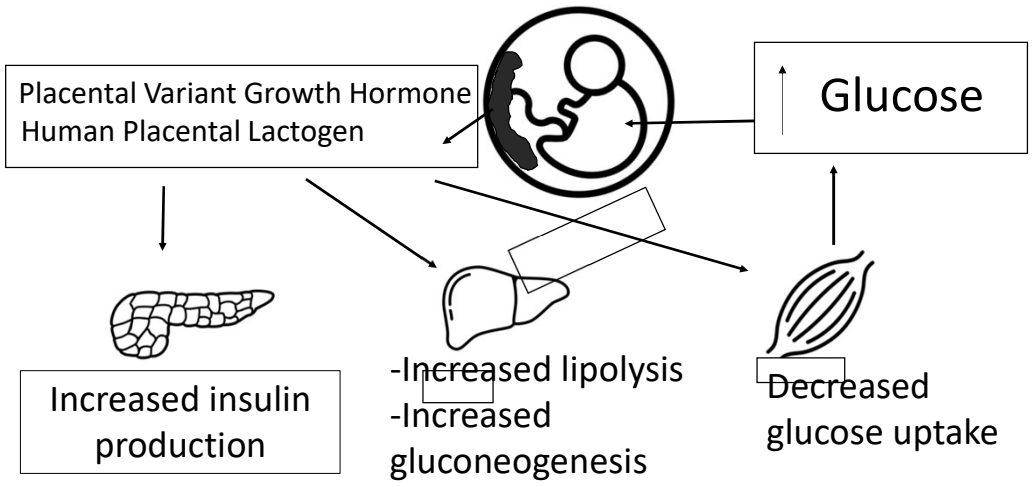
Rates of gestational diabetes in the US



https://www.cdc.gov/mmwr/volumes/67/wr/mm6743a2.htm

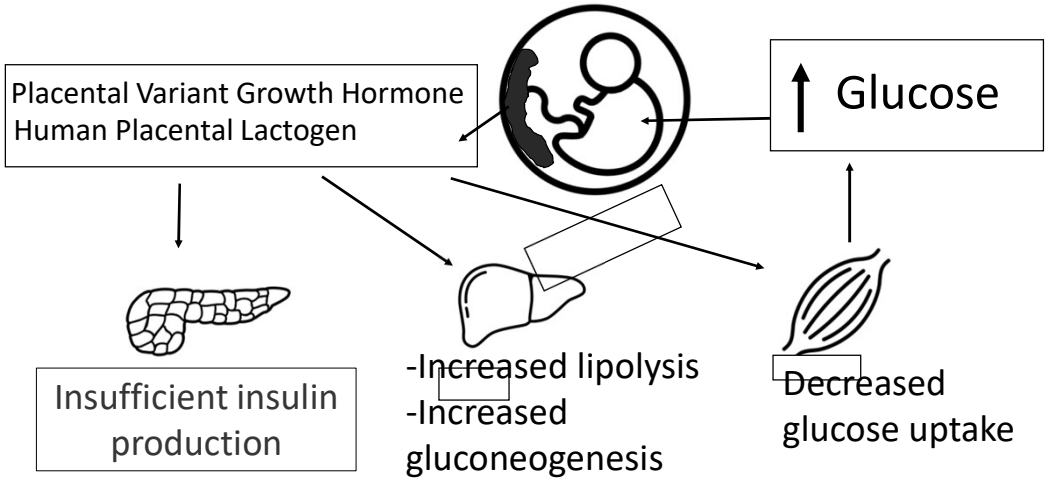
6

Pregnancy promotes transfer of glucose to the fetus



7

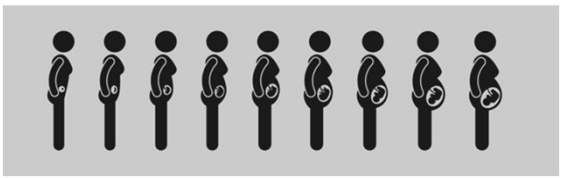
Abnormal glucose homeostasis in pregnancy results in Gestational Diabetes



8

Diabetes increases risks of pregnancy complications

Early Development:
-Congenital anomalies
-SAB



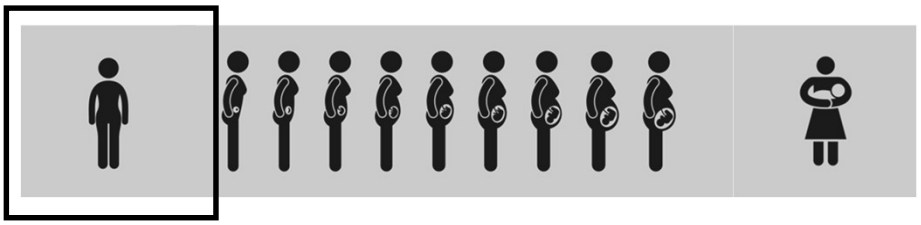
Neonatal Risks:
-Neonatal death
-Hypoglycemia

Pregnancy:
-Fetal Growth Abnormalities
-Stillbirth
-Preeclampsia

Delivery:
-Shoulder Dystocia
-Cesarean Delivery

9

If your patient has type 1 or type 2 diabetes, optimize pre-conception care



Contraception?

Establish Healthy Lifestyle

Optimize medical management: HgbA1c<6.5%?

Assess medications:
-Insulin

-Stop GLP-1, SGLT, DPP4 inhibitors
-Stop ACE inhibitors
-Stop Statins
-Stop ARBs

10

Gestational Diabetes Increases Risks **BEYOND** Gestation

- Mother:
  - Type 2 diabetes
  - Cardiovascular disease
- Child:
  - Obesity
  - Diabetes
  - Neurodevelopmental Abnormalities

11

Changing definition of diabetes in pregnancy

OLD

DIAGNOSED in pregnancy
=
Gestational Diabetes

DIAGNOSED in
"1st (or early 2nd) Trimester"
(ACOG)
or
<15 weeks (ADA)
=
Pre-existing Diabetes

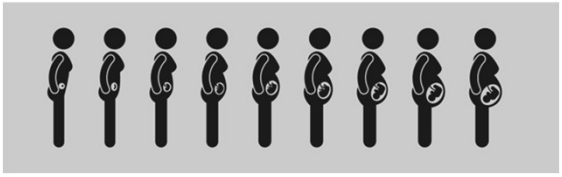
DIAGNOSED in
"late 2nd (or 3rd) Trimester"
(ACOG)
or
> 15 weeks (ADA)
=
Gestational Diabetes

NEW

-Classification of Diabetes: ADA, 2025
-Preexisting Diabetes, ACOG 2018

12

Opportunities to diagnose diabetes in pregnancy



< 15 weeks: Diagnosis of preexisting diabetes

24-28 weeks: **Screening** for gestational diabetes

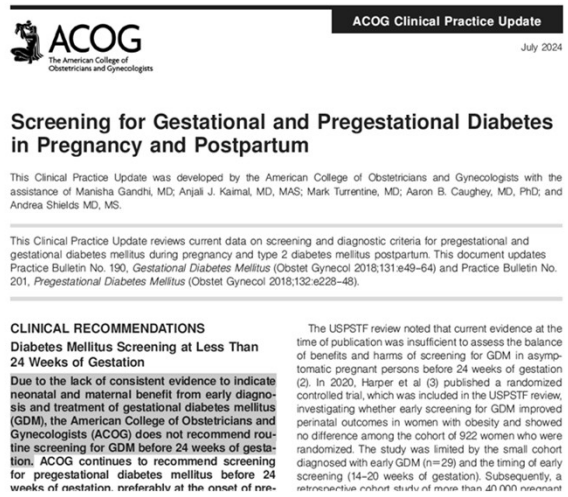
Post-partum: **Screening** for Type 2 diabetes

13

Diabetes Screening: ACOG new recommendation

-Early screening for gestational diabetes (16-24 weeks) no longer recommended by ACOG for high-risk populations

-Lack of evidence of improved clinical outcomes with early detection and treatment



ACOG
The American College of Obstetricians and Gynecologists

ACOG Clinical Practice Update

July 2024

Screening for Gestational and Pregestational Diabetes in Pregnancy and Postpartum

This Clinical Practice Update was developed by the American College of Obstetricians and Gynecologists with the assistance of Manisha Gandhi, MD; Anjali J. Kaimal, MD, MAS; Mark Turrentine, MD; Aaron B. Caughey, MD, PhD; and Andrea Shields MD, MS.

This Clinical Practice Update reviews current data on screening and diagnostic criteria for pregestational and gestational diabetes mellitus during pregnancy and type 2 diabetes mellitus postpartum. This document updates Practice Bulletin No. 190, *Gestational Diabetes Mellitus* (Obstet Gynecol 2018;131:e49–64) and Practice Bulletin No. 201, *Pregestational Diabetes Mellitus* (Obstet Gynecol 2018;132:e228–48).

CLINICAL RECOMMENDATIONS

Diabetes Mellitus Screening at Less Than 24 Weeks of Gestation

Due to the lack of consistent evidence to indicate neonatal and maternal benefit from early diagnosis and treatment of gestational diabetes mellitus (GDM), the American College of Obstetricians and Gynecologists (ACOG) does not recommend routine screening for GDM before 24 weeks of gestation. ACOG continues to recommend screening for pregestational diabetes mellitus before 24 weeks of gestation, preferably at the onset of pre-

The USPSTF review noted that current evidence at the time of publication was insufficient to assess the balance of benefits and harms of screening for GDM in asymptomatic pregnant persons before 24 weeks of gestation (2). In 2020, Harper et al (3) published a randomized controlled trial, which was included in the USPSTF review, investigating whether early screening for GDM improved perinatal outcomes in women with obesity and showed no difference among the cohort of 922 women who were randomized. The study was limited by the small cohort diagnosed with early GDM (n=29) and the timing of early screening (14–20 weeks of gestation). Subsequently, a retrospective cohort study of more than 40,000 pregnant

14

14

Early screening for overt diabetes in pregnancy

American Diabetes Association.

- If not screened prior to pregnancy, universal early screening at <15 weeks for undiagnosed diabetes may be considered.
  - Fasting ≥ 126 mg/dL OR
  - 2-hr ≥ 200 mg/dL OR
  - ***A1C ≥ 6.5%***

Practice Recommendation:

HgbA1c screening with initial prenatal labs for all pregnant individuals

15

Diagnosis of Gestational Diabetes (24-28 weeks) : 2 step approach

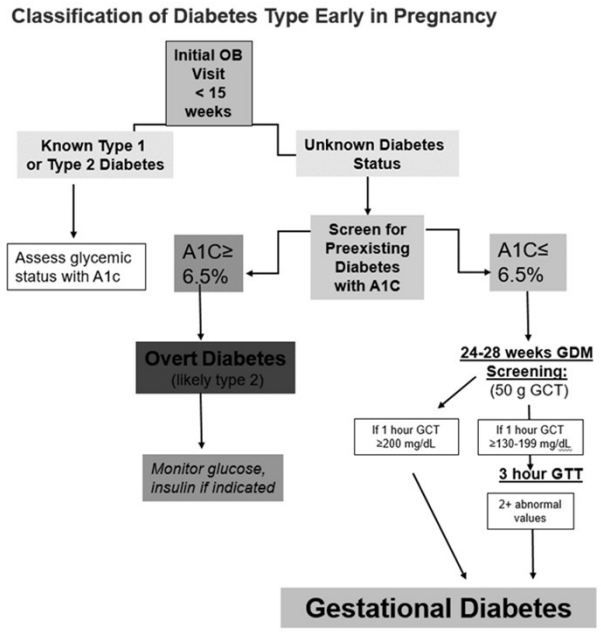
DIAGNOSIS:
100 gram: 3 hour glucose tolerance test:

-100 gram glucose
-2 abnormal values
Fasting>95
1 hour>180
2 hour > 155
3 hour >140

SCREENING: 50 gram (1 Hour) glucose tolerance test:
-Returns 140-199→diagnostic testing
-Returns 200 +→ Gestational Diabetes

16

Diabetes Classification: New Algorithm



17

17

Management of Diabetes in Pregnancy

Maintain Euglycemia

Self-blood glucose monitoring

Exercise & Diet

Insulin

18

Management of Diabetes in Pregnancy

Maintain Euglycemia

Self-blood glucose monitoring

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Insulin

19

Self-glucose monitoring is the most critical element of diabetes care

GDM and Type 2 Diabetes

- Fasting
- 1 hour post breakfast
- 1 hour post lunch
- 1 hour post dinner

Glucose Goals in Pregnancy:

- Fasting<95
- 1 hour Post prandial <140
- *2 hour Post Prandial <120*
- *Preprandial 60-100*

Type 1 Diabetes

- Fasting
- 1 hour post breakfast
- Pre-lunch
- 1 hour post lunch
- Pre-dinner
- 1 hour post dinner
- Bedtime

+ Continuous Glucometer

20

Does adherence to glucose testing recommendations matter?

For every **10% increase** in adherence to glucose monitoring

15-20% decrease in:

-Cesarean Delivery

-Neonatal Hypoglycemia

-Large for Gestational Age Neonates

Wernimont et al 2019

21

Where did target blood glucose values come from?

- Fasting<95
- Post prandial <140

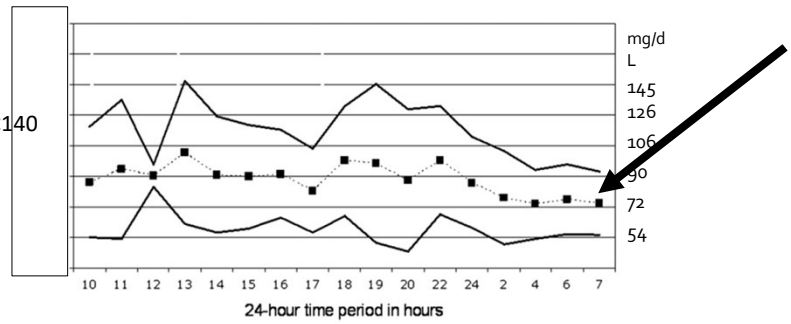


Fig. 3. The glucose profile (mean and 2 standard deviations) in the normal, non-diabetic pregnancy in the third trimester.

22

Why do we recommend post prandial glucose monitoring in pregnancy?

The New England
Journal of Medicine

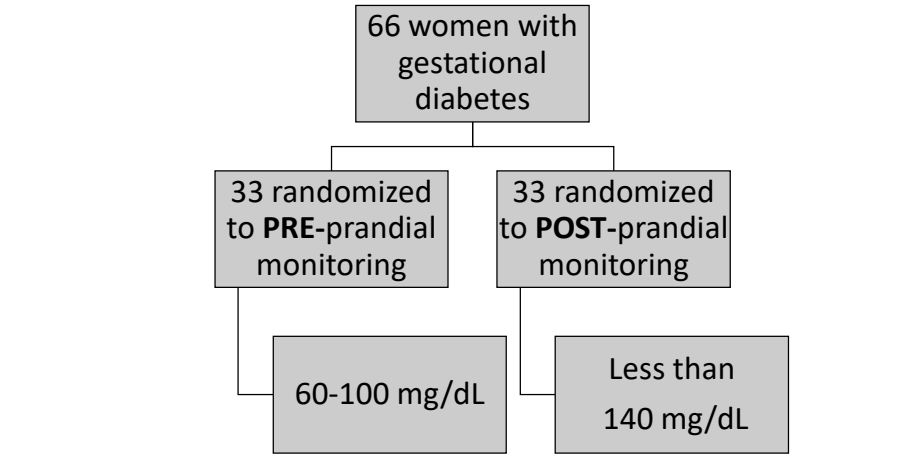
Volume 333 NOVEMBER 9, 1995 Number 19

POSTPRANDIAL VERSUS PREPRANDIAL BLOOD GLUCOSE MONITORING IN WOMEN WITH GESTATIONAL DIABETES MELLITUS REQUIRING INSULIN THERAPY

MARGARITA DE VECIANA, M.D., CAROL A. MAJOR, M.D., MARK A. MORGAN, M.D., TAMEROU ASRAT, M.D., JULIANNE S. TOOHEY, M.D., JEAN M. LIEN, M.D., AND ARTHUR T. EVANS, M.D.

- Post prandial blood glucose monitoring led to:
  - Increased insulin dosing
  - Improved HgbA1c at delivery
  - Fewer C sections
  - Decreased rates of:
    - Neonatal hypoglycemia
    - Large for Gestational Age fetuses

23



24

Better neonatal outcomes are noted with postprandial glucose monitoring

	PRE-prandial Monitoring (N=33)	POST-prandial Monitoring (N=33)	Relative Risk (95% CI)	P Value
Large for Gestational Age	14 (32%)	4 (12%)	3.5 (1.3-9.5)	0.01
Shoulder dystocia	6 (18%)	1 (3%)	6.0 (0.8-47.1)	0.1
Neonatal Hypoglycemia	7 (21%)	1 (3%)	7.0 (0.9-53.8)	0.05

25

Better maternal glucose levels and lower C section rates with post-prandial glucose monitoring

	PRE-prandial Monitoring (N=33)	POST-prandial Monitoring (N=33)	Relative Risk (95% CI)	P Value
Initial HgbA1c	8.6 % +/- 2.3%	8.9% +/-3.2%		0.55
Delivery HgbA1c	8.1% +/- 2.2	6.5% +/- 1.4%		0.006
Change	-0.6 +/- 1.6	-3.0 +/- 2.2		<0.001
C Section for CPD	12 (36%)	4 (12%)	3.0 (1.1-8.3)	0.04

26

Continuous Glucose Monitoring is here…

From ChatGPT: Tidal Wave of CGM

Benefits of CGM compared Self-Blood Glucose Monitoring

-More Data

-Fewer Finger Sticks

-Fewer phantom glucose values

-Online portals for provider monitoring

-Improved neonatal outcomes and cost-effective in Type 1 diabetes*

*CONCEPTT: FEIG et al Lancet 2017

*Hage et al AJOG MFM 2024

27

Why is GDM not ready for CGM?

- No high-quality evidence of improved clinically, meaningful outcomes with CGM use in GDM
- Increases cost without clear clinical benefit
- Uncertainty of optimal CGM glucose targets in pregnancy
  - CGM is changing what we know about glucose homeostasis in pregnancy
- De-implementation is difficult

28

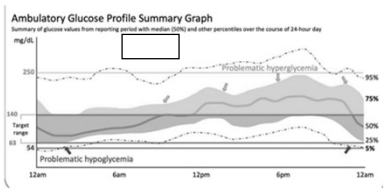
No one likes making decisions on inaccurate data….

30-40% of self reported glucose values are modified

Before Breakfast	1 Hour After Breakfast	1 Hour After Lunch	1 Hour After Supper
60-95	Less than 140	Less than 140	Less than 140
66	86	166	158
62	96	116	113
61	126	111	95
60	116	138	165
63	96	114	166

Kendrick JM, et al. J Obstet Gynecol Neonatal Nurs. 2005;34:

CGM



Consider alternatives—

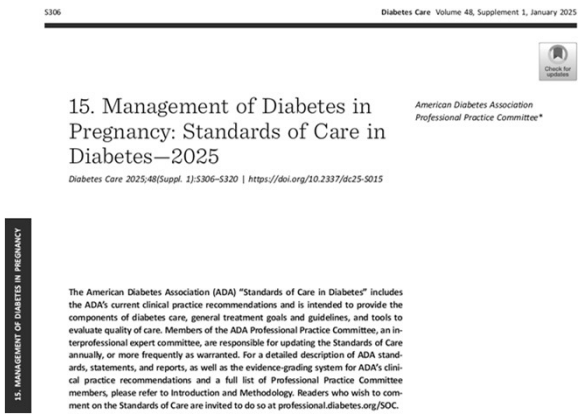
- Bluetooth and cellular connected glucometers

+

- Remote viewing management platform:
  - -glucometer-specific blue tooth apps (i.e. MySugr App, Accucheck)
  - -Universal monitoring products (i.e.Glooko)
  - -Cellular-enabled products (i.e. Biotelemetry, Philips)

29

ADA 2025 Standards of Practice in Diabetes



S306 Diabetes Care Volume 48, Supplement 1, January 2025

15. Management of Diabetes in Pregnancy: Standards of Care in Diabetes—2025

Diabetes Care 2025;48(Suppl. 1):S306–S320 | https://doi.org/10.2337/dc25-S015

*American Diabetes Association Professional Practice Committee**

15. MANAGEMENT OF DIABETES IN PREGNANCY

The American Diabetes Association (ADA) "Standards of Care in Diabetes" includes the ADA's current clinical practice recommendations and is intended to provide the components of diabetes care, general treatment goals and guidelines, and tools to evaluate quality of care. Members of the ADA Professional Practice Committee, an interprofessional expert committee, are responsible for updating the Standards of Care annually, or more frequently as warranted. For a detailed description of ADA standards, statements, and reports, as well as the evidence-grading system for ADA's clinical practice recommendations and a full list of Professional Practice Committee members, please refer to Introduction and Methodology. Readers who wish to comment on the Standards of Care are invited to do so at professional.diabetes.org/SOC.

"There are insufficient data to support the use of CGM in all people with type 2 diabetes or GDM"

30

Management of Diabetes in Pregnancy

Maintain Euglycemia

Self-blood glucose monitoring

Exercise & Diet

Insulin

31

Diet and Exercise are first line of treatment of diabetes in pregnancy

30 minutes daily
vs
15 minutes after each meal

32

Dietary Recommendations

40%

40%

20%

33

If diet and exercise don't work ….

34

Insulin

- **First line therapy**
  - **ADA, ACOG, SMFM**
- Not thought to cross placenta
- Can be titrated to treat specific needs
- **Decreases rates of:**
  - **large for gestational age fetuses**
  - **shoulder dystocia**
  - **hypertensive disorders of pregnancy**

Cowruther et al 2005

Landon et al 2007

35

Why have recommendations changed?

Long term follow up

Metformin

- Metformin accumulates in fetus at 150-200% of maternal levels
- Increased rates of obesity and glucose intolerance in exposed children at 9+ years
- Increasingly viewed as epigenetic regulator with broad metabolic effects
- 43% eventually require insulin anyway

Glyburide

- Glyburide accumulates in fetus (~70% maternal levels)
- Associated with increased rates of neonatal hypoglycemia
- 6% eventually require insulin.

36

If medication is required, antenatal testing is recommended and IOL at 39 weeks

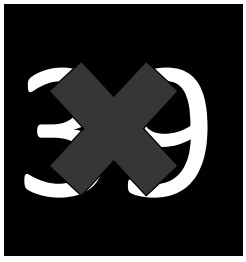
Rate of stillbirth 8/10,000 at 39 weeks

Rate of stillbirth 15/10,000 with expectant management.

Rosenstein AJOG 2012

37

If diabetes managed with diet and exercise, additional antenatal testing not required and IOL not required



38

Mode of delivery

If EFW >4500 g, consider

39

Labor management glucose targets

70-110 mg/dL

Latent Labor:
monitoring postprandial
or every 4 hours

Active Labor:
Monitoring every 1-2 hours
Insulin Infusion as needed

If a patient has type 1 diabetes, *always continue insulin*

40

Implementing new tools to improve management of Diabetes in Pregnancy

Prior Insulin Infusion Order

Orders

OB Intrapartum (Active Labor) Diabetes Management

insulin regular (MYXREDLIN) infusion
Intravenous, CONTINUOUS PRN, Start infusion if blood glucose greater than or equal to 110 mg/mL, Starting today at 1704
Notify provider if blood glucose has not decreased by 40 mg/dL or does not meet target range (60-109 mg/dL) within 2 hours.

BLOOD GLUCOSE LEVEL (mg/dL)	INSULIN (units/hr)
60-109	0 unit/hr
110-140	1 unit/hr
141-180	1.5 units/hr
181-220	2 units/hr
greater than 220	2.5 units/hr

Intrapartum, Sign

RISK OF DKA especially for patients with Type 1 diabetes

New Insulin Infusion Order

1

OB DIAB INSULIN infusion in Labor

Insulin Infusions will be provided as 1 Unit of Regular Insulin/1 mL Sodium Chloride 0.9%.

GOAL is to maintain glucose level between 70-110 mg/dL.

- IF blood glucose (BG) is 111 – 199 mg/dL AND BG has not decreased by at least 10 mg/dL within the PREVIOUS HOUR, move to next higher Algorithm.
- IF BG is 200 mg/dL or above AND BG has not decreased by at least 50 mg/dL within the PREVIOUS HOUR, move to next higher Algorithm.
- If BG is above 375 mg/dL and at MAXIMUM insulin dose in Algorithm 4, titrate the infusion up by 1 unit per hour AND notify provider.

Hypoglycemia Management:

- IF BG is less than 70 mg/dL and patient **ALREADY on a D10W infusion:**
  1. Set insulin rate to 0 units/hr.
  2. Treat hypoglycemia with 150 ml bolus of D10W over 15 minutes.
- IF BG is less than 70 mg/dL and patient **NOT on a D10W infusion:**
  1. Set insulin rate to 0 units/hr.
  2. Treat hypoglycemia per orders.
  3. Start D10W at 50 mL/hr continuous infusion.

2

- After BG >= 70 mg/dL x 2 consecutive15-minute checks, restart insulin and move to next lower Algorithm. If already at Algorithm 1, increase D10W by 25 mL/hr.

3

Algorithm 1			Algorithm 2			Algorithm 3			Algorithm 4		
CBG mg/dL	Units/ hour	D10W ml/hr	CBG mg/dL	Units/ hour	D10W ml/hr	CBG mg/dL	Units/ hour	D10W ml/hr	CBG mg/dL	Units/ hour	D10W ml/hr
< 70	0	50	< 70	0	50	< 70	0	50	< 70	0	50
70-79	0.5	50	70-79	0.5	50	70-79	0.5	50	70-79	1	50
80-110	0.6	50	80-110	1	50	80-110	1.5	50	80-110	2	50
111-124	0.7	50	111-124	2	50	111-124	3	50	111-124	4	50
125-149	1	50	125-149	3	50	125-149	4	50	125-149	6	50
150-175	1.5	0	150-175	4	0	150-175	5.5	0	150-175	8	0
176-200	2	0	176-200	5	0	176-200	7	0	176-200	10	0
201-225	2.5	0	201-225	6	0	201-225	8.5	0	201-225	12	0
226-250	3	0	226-250	7	0	226-250	10	0	226-250	14	0
251-275	3.5	0	251-275	8	0	251-275	11.5	0	251-275	16	0
276-300	4	0	276-300	9	0	276-300	13	0	276-300	18	0
301-325	4.5	0	301-325	10	0	301-325	14.5	0	301-325	20	0
326-350	5	0	326-350	11	0	326-350	16	0	326-350	22	0
351-375	5.5	0	351-375	12	0	351-375	17.5	0	351-375	24	0
>375	6	0	>375	13	0	>375	19	0	>375	26	0

*CBG: Capillary Blood Glucose

4

Postpartum Insulin Transition:

- Initiate postpartum diabetes management using OB DIAB POSTPARTUM DIABETES MANAGEMENT order set for all patients NOT transitioning to ambulatory insulin pump.
- For patients with gestational diabetes (GDM), stop insulin infusion following delivery of placenta.
- For patients with Type 1 or Type 2 diabetes on insulin, stop drip 2 hour after resumption of subcutaneous insulin.
- For patients transitioning to ambulatory insulin infusion pump use AMBULATORY INSULIN PUMP order set, stop insulin drip 1 hour after resumption of ambulatory pump.

Post delivery Insulin dosing recommendations:

5

- Patients with Type 2 diabetes: if postpartum medication recommendations have not been provided, restart subcutaneous basal and mealtime bolus insulin at 50% of pre-delivery insulin. Transition to pre-prandial glucose monitoring with correction as indicated.
- Patients with Type 1 diabetes: if postpartum insulin recommendations have not been provided, restart subcutaneous basal and mealtime bolus insulin at 20% of pre-delivery levels with pre-meal correction. Transition to pre-prandial glucose monitoring with correction as indicated.

41

Insulin requirements decrease following delivery of placenta

Type 1 Diabetes:

- Continue insulin at ~20% of pre-delivery dose
- Gradually increase over next 2-4 weeks to pre-pregnancy amounts

Type 2 Diabetes:

- Continue insulin at 50% of pre-delivery dose

Gestational Diabetes:

- Discontinue insulin
- Fasting blood glucose
- 6 week glucose tolerance test

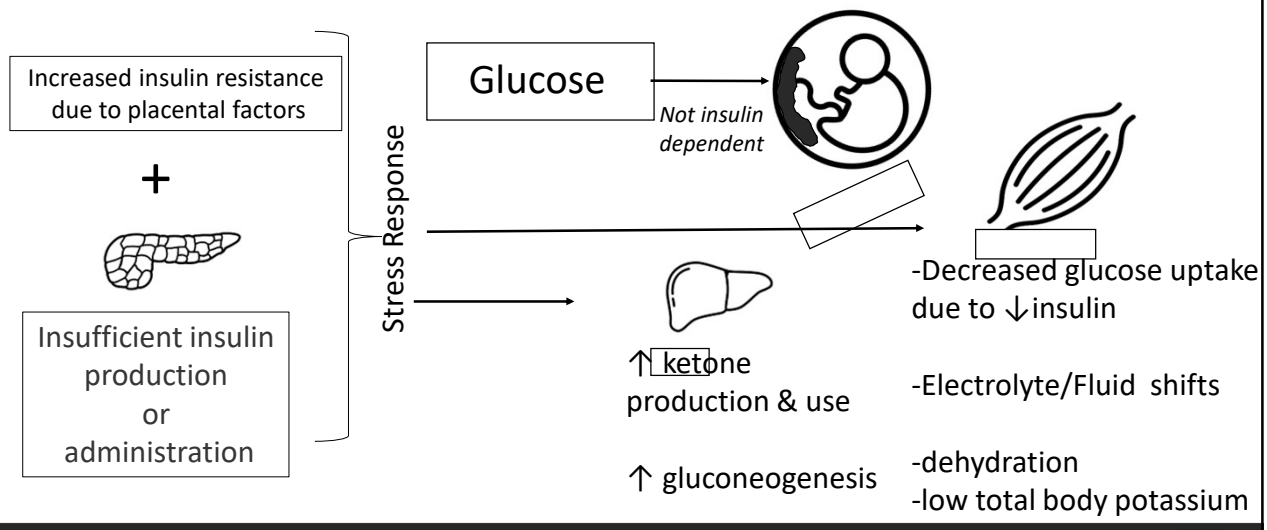
42

Diabetic Ketoacidosis in Pregnancy

- 0.5-3% of pregnant individuals with diabetes
  - 85% Type 1 diabetes
  - 15% Type 2 or GDM
- **Life-threatening to fetus**
- ***Why it's easy to miss:***
  -Glucose > 200 rare
- ***Good news:***
  - ***Treatable***

43

Pathophysiology of DKA in Pregnancy



44

RISKS of DKA in pregnancy

- Maternal Critical Illness
- Stillbirth/Perinatal Mortality
  - General population Risk ~4/10000
  - Type 1/Type 2 Risk ~14/1000
  - DKA Risk ~160/1000 (16%!)
- Preterm Birth in 46%
- *Long term neuro-developmental changes*

deGuisto et al 2021
Turchin et al Diabetes Care 2017

45

Signs and Symptoms of DKA in pregnancy

Signs/Symptoms

- Nausea/Vomiting
- Abdominal Pain/Contractions
- Non-Reassuring Fetal Status
- Dehydration
- Abnormal Vital Sign Change
  - Hyperventilation
  - Tachycardia
  - Hypotension

Precipitating Factors

- Infection ~25%
- Vomiting ~25 %
- Steroid therapy ~21%
- Medication error/ Pump Failure
- Trauma/Labor

Sibai et al 2013

46

DKA in Pregnancy

Diagnosis

- **Anion Gap > 12 mEq/L**
- **Positive Ketones (Serum or Urine)**

- **Supporting laboratory criteria (not required for diagnosis):**
  - Low Bicarb <15
  - Elevated glucose, (only ~50% have)
  - ABG pH<7.3 (difficult to obtain on L&D units)

Treatment

- Aggressive Fluid Resuscitation (on average ~5-7 L over 24 hours)
- Insulin Infusion
- Manage Electrolytes
  - Check labs every 2 hours
- Treat underlying cause of DKA

Sibai et al 2013

47

Diabetic Ketoacidosis in Pregnancy

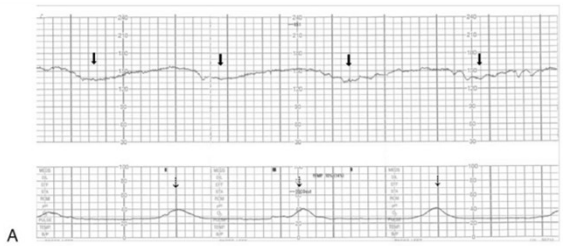
Myth	Truth
• Only occurs in Type 1 Diabetes	• Can occur in Type 2 diabetes and Gestational Diabetes (15%)
• Caused by High Glucose	• Caused by Insulin Insufficiency
• Always has elevated glucose	• 50% have normal glucose

A pregnant patient with diabetes who feels unwell has DKA until proven otherwise

48

Should you deliver for a non-reassuring tracing? No----Fix DKA

Pre treatment



A

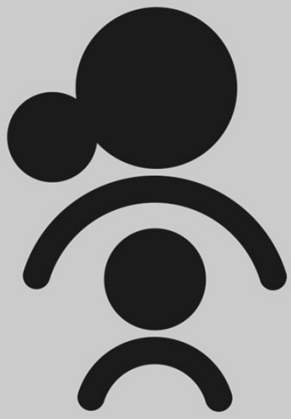
After treatment

B

49

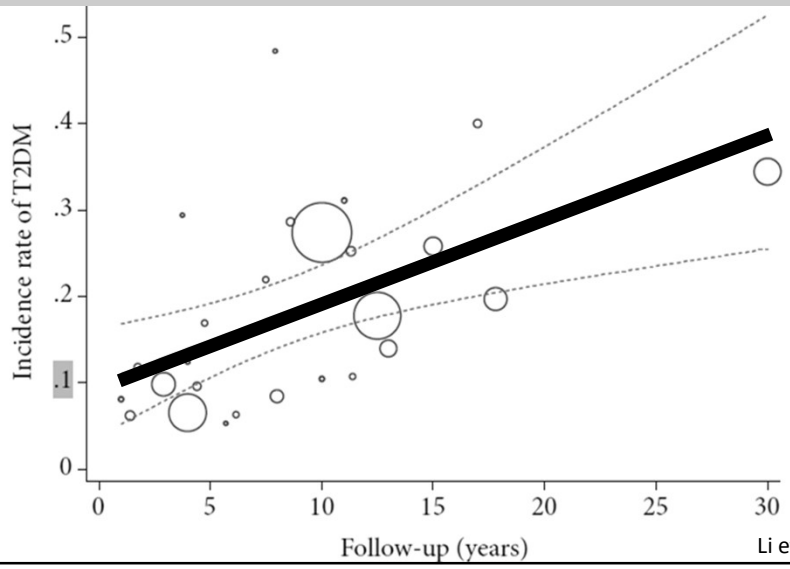
Gestational Diabetes Increases Risks **BEYOND** Gestation

- **Mother:**
  - **Type 2 diabetes**
  - **Cardiovascular disease**
- Child:
  - Obesity
  - Diabetes
  - Neurodevelopmental Abnormalities



50

Risk of Type 2 Diabetes increases by ~10% every 10 years



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51

"Glad it's over"

- Only 20-40% with GDM have post partum screening at 4-6 weeks
- Only 40% with GDM know of increased risk for complications

52

How to manage increased risk

- Awareness
  - Only 40% of individuals note that they are at increased risk for type 2 diabetes
- Breast Feeding:
  - 15% decrease T2DM risk for each year of lactation
- Lifestyle intervention
  - Diet, exercise, weight reduction

53

Caring for Individuals with perinatal diabetes continues after birth

- Promote breast feeding
- Offer contraception
- Promote weight loss
- Encourage healthy lifestyles
- For individuals with GDM:
  - Screen for diabetes post partum
    - 4-12 weeks
  - Screen for diabetes every 1-3 years

54

Inpatient Perinatal Diabetes Management:

A practical guide for clinicians

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55