Diabetes from Antepartum to Postpartum:
What the Bedside Nurse Needs to Know

Molly M. Killion,
RNC-OB, MS, CNS-BC
High-Risk OB Program Nurse Coordinator – including Diabetes and Pregnancy Program
Perinatal Outreach
September 2018

Disclosures

• I have no financial relationships to disclose
Objectives

- To review the types of diabetes and the effects of pregnancy on each
- To review glycemic management during pregnancy
- To discuss intrapartum glycemic management techniques and targets prior to birth
- To outline postpartum glycemic monitoring and follow-up recommendations

Causes of Hyperglycemia:
- Insufficient Insulin
- Insufficient Insulin Receptor Sensitivity
- Glucose >> Insulin
Pre-Gestational Diabetes Mellitus

Diabetes that precedes pregnancy

- Complicates around 1-2% of all pregnancies
  - Up to 10% of pregnancies with diabetes
- Chronic metabolic disorder
- Absolute or relative deficiency of insulin
- Microvascular complications (e.g. retinopathy, nephropathy, neuropathies)
- Macrovascular disease (e.g., HTN, stroke, cardiovascular disease)
Pre-Gestational Diabetes Mellitus

Diabetes that precedes pregnancy

- Two main types
  - Type 1 Diabetes
  - Type 2 Diabetes
Type 1 Diabetes

ABSOLUTE insulin deficiency

- Genetic and environmental (triggered by viruses or toxins) etiology... may occur any time (usually in childhood/earlier adulthood)
- Autoimmune process that attacks beta-cells of the pancreas
- Must have exogenous insulin to survive
- Prone to ketoacidosis with hyperglycemia
Type 1 Diabetes

ABSOLUTE insulin deficiency

- May develop at any age and is typically associated with lean body habitus and no family history
- Accounts for 5-10% of all diabetes in the US and 0.2-0.5% of pregnancies

[Diagram of Type 1 Diabetes with labels: Blood Stream, Receptor, CELL, Glucose]
Type 2 Diabetes

RELATIVE insulin deficiency

- Insulin resistance at the cellular level
  - Glucose does not readily enter insulin-sensitive tissue (muscle and fat cells)
  - Pancreatic beta-cells increase insulin production in response to this resistance
  - Over time, the extra insulin is ineffective in lowering blood glucose
  - Beta-cells “exhaust” and insulin secretion decreases, resulting in hyperglycemia

Type 2 Diabetes

RELATIVE insulin deficiency

- Usually adult onset associated with obesity and strong family history

- May also occur in adolescents with a strong family history and obesity

- Consist of about 90-95% of pre-gestational diabetics in the US
Type 2 Diabetes

RELATIVE insulin deficiency

- About $\frac{1}{3}$ need diet and exercise therapy alone, $\frac{2}{3}$ need oral hypoglycemics, and $\frac{1}{3}$ need insulin for adequate glucose control
- Almost all need insulin for optimal control during pregnancy

Drawing by Gina Levy at 9yo (Maribeth Inturrisi's daughter)
Gestational Diabetes (GDM)

- RELATIVE insulin deficiency from the insulin resistance of pregnancy from placental hormones
  - Carbohydrate intolerance of variable severity with first recognition during pregnancy (usually 2\textsuperscript{nd} half)
  - Some are able to maintain glycemic control with diet/exercise (GDM-A1) and others require medication (GDM-A2)

Screening for GDM

- Low risk for GDM:
  - < 25 years of age
  - Normal body weight
  - No diabetes in 1\textsuperscript{st} degree relative
  - Member of ethnic group with low prevalence of diabetes
  - No history of abnormal glucose metabolism
  - No history of poor obstetric outcome
Screening for GDM

• **High Risk (need only 1 for early screening)**
  – Native Americans
  – Obese individuals (BMI > 29)
  – Diabetes in 1st degree relative
  – History of GDM or glucose intolerance
  – Previous unexplained IUFD, congenital anomalies (i.e., NTD, cardiac)

• **Moderate Risk (need at least 3 for early screening)**
  – African, Asian, Hispanic, Filipina, Pacific Islander, Middle Eastern
  – Age > 35
  – Previous infant with macrosomia (> 4000g)
  – Repetitive glucosuria

• **Low risk women should be screened for GDM no later than 24-28 weeks gestation**

• **Screen women at high risk for gestational diabetes at first visit**
  – If initial screen is negative, repeat at 24-28 weeks gestation

• **Many are moving to universal screening**
Screening for GDM – 2 hour OGTT

• Oral Glucose Tolerance Test (OGTT) - new
  – Fasting 8-10 hr (usually done in morning)
    – Not more than 10 hr fasting…
  – 75 gram glucose load
  – Remain seated during test
  – Fasting, 1 hr after, 2 hr after
  – Diagnostic

• If any one of the results are abnormal – diagnosed with GDM
  – Fasting $\geq 92$ mg/dL
  – 1 hour $\geq 180$ mg/dL
  – 2 hour $\geq 153$ mg/dL

• Meters SHOULD NOT be used to diagnose GDM
Screening for GDM – 1 hour GTT

- **Glucose screening (GLT)**
  - 50 gram glucose load, non-fasting, anytime of day
  - Blood drawn 1 hour later
  - Abnormal result: ≥ 140mg/dl
  - Not necessarily diagnostic
Screening for GDM – 1 hour GTT

- If GLT > 200 mg/dl – diagnosed with GDM
  - DO NOT ADMINISTER 3-hour OGTT
  - Diabetes And Pregnancy Program (DAPP) referral ASAP

- If GLT > 141-199 mg/dl
  - Administer 3-hour 100-gm OGTT

- Meters are never used with the diagnostic tests

Diagnostic Test for GDM

- 3-hour 100-gm OGTT
  - Fasting 8-10 hr (usually done in morning)
    - Not more than 10 hr fasting...
  - Get FASTING result FIRST (if FBG > 110mg/dl, DO NOT LOAD – dx GDM)
  - Remain seated during test
  - FBS > 95 mg/dL
  - 1 hour ≥ 180 mg/dL
  - 2 hour ≥ 155 mg/dL
  - 3 hour ≥ 140 mg/dL

- If two or more hourly values are met or exceeded, or if fasting > 110, diagnosis of gestational diabetes is made
Types of GDM

- **GDMA1** -
  - Diet
  - Exercise

- **GDMA2** -
  - Diet
  - Exercise
  - Medication

Gestational Diabetes (GDM)
RELATIVE insulin deficiency from the insulin resistance of pregnancy from placental hormones

- Some women will have GDM in one pregnancy and not in others

- Lifetime risk for developing Type 2 diabetes:
  - 50% develop within 10 years of index pregnancy if insulin was required during pregnancy
  - 25% develop if diet-controlled only during pregnancy
Gestational Diabetes (GDM)

- Incidence of GDM is 2-15% of all pregnancies depending on the ethnic population
- Represents approximately 90% of diabetes in pregnancy
- Postprandial hyperglycemia
  - May be treated with diet and exercise
  - About half will also need the addition of medication
- Fasting hyperglycemia
  - Requires medication therapy
  - Greater risk for stillbirth when FBG >95mg/dL

Rates of Diabetes in Pregnancy

Data from Lawrence, 2008 – So.CA Kaiser Database
Definitions

- **Type 1 Diabetes Mellitus/DM1/T1DM**
  - Used to be called:
    - Juvenile diabetes
    - IDDM: Insulin Dependent Diabetes Mellitus

- **Type 2 Diabetes Mellitus/DM2/T2DM**
  - Used to be called:
    - NIDDM: Non Insulin Dependent Diabetes Mellitus

- **GDM A-1/Gestational Diabetes-Diet Controlled**
- **GDM A-2/Gestational Diabetes-On Medication(s)**

Similarities
What we see

Level of Concern

Type 1

Type 2
Changes in Normal Pregnancy

As pregnancy progresses

- Human placental lactogen & progesterone:
  - Decreased gastric motility
  - Reduced insulin receptor sensitivity/increased insulin resistance
- Decreased tolerance to glucose
- Increased hepatic glucose production
- Insulin secretion increases to compensate
- Insulin production doubles by the 3rd trimester

Brown, 2014; image from Creative Commons
Characteristics of Pregnancy

- Mild fasting hypoglycemia
- Progressive insulin resistance
- Hyperinsulinemia
- Mild postprandial hyperglycemia
  - Serves to increase the amount of time of elevated maternal glucose level
  - Increases the flux of maternal ingested nutrients to the fetus

Effect of Pregnancy: Type 1 Diabetes

- Glucose control often becomes erratic
- Insulin requirements can also be erratic
- Fetal organogenesis: first 7-8 weeks of gestation critical to have euglycemia
  - Hyperglycemia is teratogenic
- Potential acceleration of maternal disease including progression of diabetic retinopathy
- Preconception counseling is ideal!

Picture from wikicommons: Bruce Blaus
**Effects on Type 1, continued**

- Insulin requirements in pregnancy
  - Increase weeks 0-9
  - Decline weeks 9-16
  - Increase to double or triple preconception values weeks 16-36
  - Plateau or start to decline weeks 36-40

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**Effect of Pregnancy: Type 2 Diabetes**

- Blood glucose control less erratic than in Type 1
- Insulin requirement may increase significantly to counteract insulin resistance (i.e. they need a lot more insulin than Type 1)
- Potential for fetal defects related to extent of disease and degree of hyperglycemia during first 7-8 weeks of pregnancy
- Potential acceleration of maternal disease
- Preconception counseling is ideal!
Effects on Type 2, continued

- Women with baseline insulin resistance outside of pregnancy have varying levels of carbohydrate intolerance from the inadequacy of hyperinsulinemia when combined with the pregnancy induced plus underlying insulin resistance

Women with diabetes have

- Higher incidence of gestational hypertension
- Higher incidence of preeclampsia
A review of why…

Glucose Crosses the Placenta, Insulin Does NOT

- Maternal hyperglycemia
- Fetal hyperglycemia
- Increased fetal insulin production
- Umbilical cord is cut
- Maternal glucose supply stops abruptly
- Neonatal insulin production does not

WHEN & HOW TO DELIVER

Picture from wikicommons
Timing of Birth

- Diabetes—pre-gestational well controlled
  - Late preterm/early term birth not recommended
- Diabetes—pre-gestational with vascular disease
  - 37–39 wk
- Diabetes—pre-gestational, poorly controlled
  - 34–39 wk (individualized to situation)
- Diabetes—gestational well controlled on diet
  - Late preterm/early term birth not recommended
- Diabetes—gestational well controlled on medication
  - Late preterm/early term birth not recommended
- Diabetes—gestational poorly controlled on medication
  - 34–39 wk (individualized)

Timing of Birth – Pre-gestational

- Used to be recommended to achieve delivery 4-6 weeks early as late-stage fetal death was more common in women with diabetes
  - At one time, 50% of stillbirths occurred after 38th week of gestation
- Iatrogenic prematurity has resulted in high rates of NICU admissions to infants of Type 1 diabetics
- With tight glucose control, routine pre-term birth is not indicated
Timing of Birth – Pre-gestational, cont.

- Optimal timing relies on balancing the risk of stillbirth with risks of preterm birth
- Maternal & fetal factors that may necessitate preterm birth:
  - Progression of maternal complications: retinopathy, renal impairment, hypertension, neuropathy, prior stillbirth
  - Fetal growth restriction or compromise
  - Poor maternal glycemic control: maternal hyperglycemia can lead to fetal acidemia and higher risk of IUFD
    - ACOG recommends amniocentesis for lung maturity in poorly controlled patients being delivered before 39 weeks

Timing of Birth - GDM

- GDM who achieved adequate glucose control without medication can be managed similar to non-diabetic women
- GDM requiring medications or with coexisting medical conditions
  - Birth by 39-40 weeks
Timing of Birth - GDM

- Not well studied
- Spontaneous labor preferred
- In GDM A-1 (well controlled with diet and exercise)
  - Induction by 41+0
- In GDM A-2 (use of insulin or oral hypoglycemics)
  - Induction at 39+0
- Suboptimal glucose control or coexisting medical condition
  - Induction at 38+0 with documented fetal lung maturity

Mode of Delivery

- Diabetes is not an independent contraindication to VBAC
- Diabetes is not an independent indication cesarean birth
- C/S rates in parts of the world at 50% for women with diabetes
- C/S may be considered when EFW $\geq 4500$ grams with maternal diabetes
  - 3rd trimester ultrasound have 16-20% +/- variability
  - U/S EFW $> 4800$ g is associated with approx. 50% chance of a birth weight $\geq 4500$ g
Betamethasone

- Use of corticosteroids should not be withheld due to diagnosis of diabetes
- If BMZ needed due to immature fetal lungs, intensified monitoring indicated as insulin needs increase drastically:
  - GDM A-1 may need insulin
  - GDM A-2, type 1 or type 2 will need markedly more insulin
- If the goal is BMZ then IOL, attempt euglycemia prior to induction to minimize the amount of maternal/fetal hyperglycemia and fetal insulin production

McLaughlin, 2010; Metzger, 2007; NICE, 2008

Betamethasone, continued

- SQ doses will need to be increased:
  - Day 0: 6-10 hr after 1st dose, increase insulin by 30%
  - Day 1: all insulin doses increase by 50% from baseline
  - Day 2: all insulin doses are doubled from baseline
  - Day 3: if needed, insulin increases by 20-30%
  - Day 4: if needed, insulin increases by 10-20%
  - Day 5-7: insulin is gradually decreased to pre-steroid levels

McLaughlin, 2010; NICE, 2008
Betamethasone, continued

- **Alternate:**
  - Keep insulin SQ basal doses as they were
  - 6-10 hours after 1st dose, add insulin drip algorithm without any maintenance dextrose infusion *if the patient is eating

- If a patient is on an insulin drip, this augments or replaces basal insulin, rapid acting insulin must be given for carbohydrate coverage
Oral Hypoglycemics

- Metformin & Glyburide most common
- Metformin has a higher failure rate and crosses the placenta at maternal concentration levels with no outcome studies on fetal exposure
- Glyburide has worse neonatal outcomes (rarely used anymore)
- Treatment with insulin may provide better control
- Often reserved for patients noncompliant with injections

Treatment of GDM – Oral Agents

- Glyburide (sulfonylurea) – Increases insulin release from beta cells in pancreas
- Metformin (biguanide) – Increases insulin sensitivity, decreases gluconeogenesis
Action of Insulin

- Facilitates the conversion of glucose to fat in adipose tissue
- Speeds the conversion of glucose to glycogen in the liver
- Speeds the oxidation of glucose in the cells of peripheral tissue (i.e., muscle, fat)

**Guideline:**
- 1 unit of insulin disposes of about 5-10 g of CHO when administered premeal in a normoglycemic state
- 1 unit of insulin will decrease BG levels 15-30 mg/dl

### Insulin Action Times

<table>
<thead>
<tr>
<th>Type</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lispro (Humalog)</td>
<td>15-30 min</td>
<td>30-90 min</td>
<td>3 - 5 hr</td>
</tr>
<tr>
<td>Aspart (Novolog)</td>
<td>10-20 min</td>
<td>40-50 min</td>
<td>3 - 5 hr</td>
</tr>
<tr>
<td>Regular (Humalin) (Novolin)</td>
<td>30-60 min</td>
<td>2-5 hr</td>
<td>5 - 8 hr</td>
</tr>
<tr>
<td>NPH</td>
<td>1-2 hr</td>
<td>4-12 hr</td>
<td>18-24 hr</td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>1-1.5 hr</td>
<td>mild</td>
<td>20-24</td>
</tr>
<tr>
<td>Detemir (Levemir)</td>
<td>1-2 hr</td>
<td>mild</td>
<td>up to 24</td>
</tr>
</tbody>
</table>
### Commonly Used Insulins

<table>
<thead>
<tr>
<th>Insulin</th>
<th>Reasons given</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lispro (Humalog); Aspart (Novolog)</td>
<td>Used to cover CHO and high BG corrections</td>
</tr>
<tr>
<td>Regular (Novolin; Humulin) rarely recommended SQ</td>
<td>Used in insulin drips</td>
</tr>
<tr>
<td>NPH</td>
<td>Used to cover basal needs; if given in AM, may cover lunch CHO</td>
</tr>
<tr>
<td>Glargine (Lantus); Detemir (Levemir)</td>
<td>Used to cover basal needs</td>
</tr>
</tbody>
</table>

### Insulin

- Long acting – Glargine (Lantus), Detemir (Levemir)
- Intermediate – NPH (Humalin)
- Short acting – Lispro (Humalog), Aspart (Novolog)
Be Careful!

Think about:
- Drug
- Brand
- Concentration

“U100” - 100 units/ml vs U200 vs U300 vs U500)

Be Careful!

SQ Insulin Injection

- All insulin injections should be in the abdomen with < 40-50 units per injection to enhance effectiveness
  - Divide injections if patient taking > 50 units for any one shot
- Arms may be acceptable as a last choice for patients who won’t inject into the abdomen
- Avoid legs
What about the PUMP!?!

- Insulin pumps most commonly utilized by type 1 diabetics
- Usually more knowledgeable in features than other pump wearers
- Have been used safely during hospital stays

SQ Insulin Pump

- Animas and Minimed are the most common

Animas
- t:slim

Minimed
- Omnipod
Parts of a (Medtronic) Pump

- Insulin can be delivered in a pattern that more closely mimics physiologic insulin secretion
- Only rapid acting insulin should be used
  - Aspart (Novolog)
  - Lispro (Humalog)
  - Glulisine (Apidra)
  - …rarely Regular, not ideal
- Replaces the need for any long acting insulin (NPH, Lantus, etc.) through basal rate settings

ACOG, 2005
SQ Insulin Pump

- Basal rates (around 50-60% total daily dose)
  - Programmed in 30-60 min increments
  - Usually several different settings/day
- Blood glucose targets
  - Can be different at different times of day
- Corrections
  - Add or subtract insulin based on sensitivity and current BG level
- Carbohydrate coverage
  - How many units/grams of carbohydrate
  - Can be different at different times of day

ACOG, 2005

Continuous Glucose Monitor (CGM)

Dexcom

Minimed
Continuous Glucose Monitor (CGM)

- Take readings every 1-5 minutes
- Provide visual trends of blood glucose levels
- Must be calibrated with finger stick BGs
- Usually about 15 minutes behind
- Must use finger stick BG value to give insulin
  - These aren't really used inpatient

INTRAPARTUM MANAGEMENT
Goals of Intrapartum Management

Euglycemia

• Blood glucose levels of less than 110 mg/dL to prevent fetal hyperglycemia and fetal hypoxia

• Blood glucose levels of greater than 70 mg/dL to prevent maternal hypoglycemia

• Targets based on pre-gestational diabetes as no ideal targets for GDM during labor have been established

Managing Glucose Levels in Labor

• Not well studied in GDM
• GDM A-1 will rarely need insulin
• GDM A-2 might not need insulin

• Type 1 & 2 will need insulin
• Insulin needs often decrease in labor
• Uterine contractions and maternal pushing efforts burn energy
• Caloric intake is often decreased
ACOG BG Targets

- Fasting glucose ≤ 95 mg/dl
- 1 hour post-prandial < 130-140 mg/dl
- 2 hour post-prandial ≤ 120 mg/dl
- Active labor < 110 mg/dL

Hemoglobin A₁C glycohemoglobin

- Hemoglobin A₁C: target < 6
  - Normal (non-diabetic): 4.5-5.5
  - Diabetic target (non-pregnant): 7
A1c to Glucose

Hemoglobin A1c value correlates to the estimated average glucose level

<table>
<thead>
<tr>
<th>A1c%</th>
<th>eAG (mg/dL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>97</td>
</tr>
<tr>
<td>5.5</td>
<td>111</td>
</tr>
<tr>
<td>6</td>
<td>126</td>
</tr>
<tr>
<td>6.5</td>
<td>140</td>
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<td>7</td>
<td>154</td>
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<td>7.5</td>
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<td>10.5</td>
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<td>11</td>
<td>269</td>
</tr>
<tr>
<td>11.5</td>
<td>283</td>
</tr>
<tr>
<td>12</td>
<td>298</td>
</tr>
</tbody>
</table>

From American Diabetes Association

EARLY LABOR INDUCTION OF LABOR

Photo used with permission
Early Labor or Induction of Labor

• Continue to achieve pre-labor BG goals

• GDM A-1
  – Capillary blood glucose testing:
    • Fasting, post-prandial
    • Continue carbohydrate controlled diet

• GDM A-2
  – Capillary blood glucose testing:
    • Fasting, post-prandial, additional times PRN
  – Continue carbohydrate controlled diet w/ short acting insulin for meal coverage if needed
  – Long acting insulin or oral hypoglycemics “dose by dose”

Maresh, 2010; McLaughlin, 2010

Early Labor or Induction of Labor, cont

• Continue to achieve pre-labor BG goals

• Type 1 and 2
  – Capillary blood glucose testing:
    • Fasting, pre-prandial, post-prandial, bedtime, overnight, PRN
  – Continue carbohydrate controlled diet w/ short acting insulin for meal coverage if needed
  – Long acting insulin “dose by dose”

Maresh, 2010; McLaughlin, 2010
Managing Glucose in Active Labor

- **GDM A-1**
  - Capillary blood glucose testing Q 2-4 hr
  - Consider insulin if consistently > 110-120 mg/dL
  - Avoid dextrose IV fluids unless on insulin drip
  - Diet or non-caloric clear liquids

- **GDM A-2**
  - Capillary blood glucose testing Q 1-2 hr
  - Stop long/intermediate acting insulin
  - Insulin drip if > 110-120 mg/dL
  - Avoid dextrose containing IV fluids until insulin drip
  - Give rapid acting as meal coverage and diet or non-caloric clear liquids when not

Caughey, 2013; Jovanovic, 2009
Type 1 and 2 - Active labor

- Capillary blood glucose testing Q 1-2 hr
- Stop long/intermediate acting insulin
- Initiate insulin drip (or insulin algorithm)
- Give rapid acting as meal coverage if eating
- Diet or non-caloric clear liquids when not

Insulin Use in Active Labor

- **Staff familiarity is the safest**
- **No demonstrated superior model or algorithm**
  - Insulin/glucose combined infusion with supplemental insulin doses
  - Insulin IV with glucose as needed
  - SQ doses of rapid acting insulin
  - Insulin pump

- **Avoid boluses of glucose**
  - Increases risk of neonatal hypoglycemia, fetal hypoxia, fetal/neonatal acidosis

References:
- Jovanovic, 2009; McLaughlin, 2010;
- ACOG, 2006; Langer, 2006; McLaughlin, 2010; Ryan, 2012
Insulin Use in Active Labor, continued

- Can be given SQ
  - Injections
  - Continuous subcutaneous insulin infusion pump

- Often given IV
  - Fixed infusion: 10 units Regular insulin in 1000 mL 5% dextrose at 100-125 mL/hr (1 unit/hr)
  - Tiered infusion: fixed rate of insulin based on hourly capillary blood glucose levels
  - Titrated infusion: insulin rate titrated up or down based on hourly blood glucose levels

Langer, 2006; McLaughlin, 2010; Ryan, 2012

Tiered (Fixed) Infusion: currently in use at UCSF

- Fluid Orders
  - For Type 1 and Type 2:
    - When BG > 130 mg/dL – LR at 125 mL/hr
    - When BG < 130 mg/dL – D$_5$L at 125 mL/hr
  - For GDM A-2
    - LR at 125 mL/hr until IV Insulin required then
    - When BG > 130 mg/dL – LR at 125 mL/hr
    - When BG < 130 mg/dL – D$_5$L at 125 mL/hr

<table>
<thead>
<tr>
<th>Blood glucose (mg/dL)</th>
<th>Type 1</th>
<th>GDM</th>
<th>Type 2</th>
<th>Custom</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 70</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>71-90</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>91-110</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>111-130</td>
<td>1.5</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>131-150</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>151-170</td>
<td>2.5</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>171-190</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>&gt;190</td>
<td>Call MD, check urine ketones</td>
<td>Call MD, check urine ketones</td>
<td>Call MD, check urine ketones</td>
<td></td>
</tr>
</tbody>
</table>
Titrated Infusion: adapted from Ryan, et al. 2012

- $D_{10}$ at 80 mL/hr with 10 mEq KCl
- IV Insulin 50 units Regular in 500 mL NaCl (1 unit/10 mL)
  - Start infusion at 1 unit/hr unless glucose $\leq 72$ mg/dL
  - If glucose $\leq 72$ mg/dL, start $D_{10}$ and hold insulin

**Adjustments – If glucose is:**
- $\leq 54$ mg/dL, stop insulin x 1 hr, increase $D_{10}$ to 100 mL/hr
- 55-64 mg/dL, decrease insulin by 1 unit/hr, increase $D_{10}$ to 75 mL/hr
- 65-73 mg/dL, decrease insulin by 0.5 units/hr
- 74-108 mg/dL, leave insulin at current rate
- 109-126 mg/dL, increase insulin by 0.5 units/hr
- 127-153 mg/dL, increase insulin by 1 unit/hr
- 154-180 mg/dL, increase insulin by 1.5 units/hr
- 181-216 mg/dL, increase insulin by 2 units/hr
- $>216$ mg/dL, increase insulin by 2 units/hr, stop $D_{10}$ for 1 hr

**If glucose falls by >35 mg/dL in 1 hr and is now:**
- $\geq 91$, decrease insulin to 1 unit/hr
- $\leq 90$, stop insulin infusion

**Anytime insulin is stopped and glucose is > 81 mg/dL, restart insulin at 0.5 units/hr**

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Labor Conversion from an Insulin Pump to Insulin Drip

- May need to happen before “active”
- Work with the patient regarding relinquishing control of pump
- Downside: hourly BG measurements
- Upside: she can focus on labor instead of on diabetes
Monitoring for Hyperglycemia

- Check CBG every hour and follow algorithm to maintain normal glucose levels
- Check ketones when CBG >190mg/dL
- Notify provider when CBG outside of range
- Modify insulin algorithm as needed to achieve euglycemia

Signs & Symptoms of Hypoglycemia

- Mental confusion /"Distant"
- Cold, clammy skin
- Shaking
- Sweating
- Light-headedness
- Pallor
- Numbness of tongue or lips
CESAREAN SECTION MANAGEMENT

Insulin Before Scheduled C/S

- **GDM A-1**
  - Fasting blood glucose

- **GDM A-2**
  - Take regular doses of insulin or oral hypoglycemics the day/night before surgery
  - No medications the morning of surgery
  - Glucose checks q 1-2 hours
  - Avoid dextrose containing IV fluids
  - Insulin management if > 110-140 mg/dL
  - Euglycemia will promote maternal wound healing

Jovanovic, 2009
Insulin Before Scheduled C/S, cont.

- **Type 1 and 2**
  - Take regular doses of insulin the day and night before surgery
  - Should be first OR case
  - No medications the morning of surgery
  - Glucose check on arrival to unit and start active labor insulin algorithm (IV or SQ regimen)
  - Consider postpartum insulin drip to maximize euglycemia to promote wound healing

McLaughlin, 2010

POSTPARTUM

Picture from wikicommons: Ernest F
Postpartum Care

• **Insulin sensitivity increases dramatically after delivery of placenta**
  – Insulin requirements drop markedly during birth and immediate postpartum period
  – During first few days to 2 weeks postpartum, can drop to less than pre-pregnancy levels with variable return to baseline
  – Aggressive glucose control should be relaxed to avoid significant hypoglycemia

• **Most women will revert back to pre-pregnancy glycemic levels**

Brown, 2014; Caughey, 2013; McLaughlin, 2010; Ryan, 2012

Postpartum Care, continued

• **Glucose testing should be continued**
• **Resume regular diet**
  – Consistent with what they normally eat
  – Carbohydrate controlled vs. unrestricted
  – Want to see how glucose levels respond to what they will be eating when discharged
Frequency of Blood Glucose Testing

• No formal recommendations or studies about how long nor how often blood glucose testing should continue postpartum for GDM
• Consider individualizing based on:
  – Controlled with diet and exercise vs. medications
  – Degree of insulin resistance
  – Mode of delivery
  – Type of diabetes
    • Type 1 and 2 should continue regular testing
    • GDM may only need a few checks

Managing GDM After Vaginal Birth

GDM A-1

• Fasting blood glucose on the day after birth
  – Goal:
    • Fasting ≤ 110 mg/dL
    • Fasting > 110 mg/dL, retest next day
Managing GDM After Vaginal Birth

GDM A-2

- If on insulin, d/c at delivery of placenta
- Fasting and post-prandial x 1 on day 1 vs. continued for 24-48 hours
  - Goal:
    - Fasting < 110 mg/dL
    - 2 hr post-prandial < 140 mg/dL

Managing GDM After Cesarean Birth

- Insulin resistance will decrease
- Insulin need may continue d/t stress response

- If on insulin drip during surgery
  - Consider continuation until needs decrease or until tolerating POs

- Follow recommendations as for vaginal birth
  - May have a lower threshold to restart medications to maximize wound healing
Managing Suspected Type 2 Postpartum

- Persistently elevated fasting (>126 mg/dL)
  - Continue home CBG monitoring
  - May need earlier follow up appointment
    - 2-3 weeks postpartum
  - May need to go home on oral hypoglycemic agent or insulin
    - Approximately 1/3 dose used in pregnancy

Managing Pre-gestational Diabetes after Vaginal Birth

- Consider reducing or stopping insulin infusion after birth
  - Type 1: restart pre-gestational insulin regimen if known, may also use 1st trimester
  - Type 2: return to method of controlling diabetes pre-pregnancy
    - Diet and exercise
    - Oral hypoglycemic medication
    - Insulin regimen

McLaughlin, 2010
Managing Pre-gestational Diabetes after Cesarean Birth

- May consider continuing insulin infusion (or other aggressive management routines) to maximize wound healing
  - Less insulin may be needed per hour
  - Revert to pre-pregnancy regimen once regular diet tolerated

Breastfeeding

- Strongly encouraged
- Same benefits as the rest of the world
- Importance for women with diabetes:
  - Prevention of hypoglycemia in the newborn
  - Less risk of diabetes to mother and baby
  - Faster recovery and can help with weight loss
  - Can cause a reduction in insulin requirements
Breastfeeding – Type 1

- Reduction of insulin requirements during breastfeeding can cause hypoglycemia
- Careful monitoring of glucose levels warranted
  - May need to monitor before feedings
  - Women should be vigilant for signs of hypoglycemia and maximize newborn safety if hypoglycemia occurs
- Insulin adjustments may be needed during initiation and during weaning
- Eating a snack (CHO+protein) before nursing may help to prevent

Breastfeeding and Medications

- Insulin is excreted in human milk
  - Naturally occurring component of maternal blood but not a risk as it’s digested in the infant’s gut
- Oral hypoglycemics in breast milk
  - Glyburide is virtually undetectable
  - Metformin is seen in too small of an amount to adversely affect the infant
POSTPARTUM FOLLOW-UP CARE

Postpartum Follow Up

- Diet and exercise are still important
  - Counsel to maintain nutrition information they learned during pregnancy
- Weight loss and the achievement of healthy weight
  - May prevent recurrence of GDM
  - May prevent or delay type 2 diagnosis
- Breastfeed
- Contraception
  - Consider avoiding progesterone only methods if of Latina or Native American descent

ACOG, 2006
Postpartum Follow Up

- 2 week follow up visit if any insulin or oral hypoglycemics needed on hospital discharge
- 2 hour 75 gram OGTT at 6-12 weeks postpartum for all women with GDM
  - Normal: Fasting < 100 mg/dL, 2 hr < 140 mg/dL
  - Impaired Fasting Glucose: Fasting 100-125 mg/dL
  - Impaired Glucose Tolerance: 2 hr 140-199 mg/dL
  - Type 2 Diabetes: Fasting > 126, 2 hr > 200

From ACOG Practice Bulletin 435 (June, 2009). PP screening for abnormal glucose tolerance in women who had GDM. Obstetrics & Gynecology, 113(6), Figure 1, p. 1420
Postpartum - GDM

- > 40% of women with GDM will develop type 2 diabetes within 10 years
- Low postpartum screening rates (most studies < 50%)

Cumulative incidence of diabetes in the Diabetes Prevention Program by randomized treatment group in women with a history of GDM:

Intensive Lifestyle: 7% reduction in weight via low-calorie, low-fat diet & moderate physical activity at least 150 min/week
Postpartum Follow Up, continued

- Only approximately 2 out of 5 women with GDM get follow up testing
- Latinas have been shown among the lowest groups to get follow up yet are among the highest risk for elevated results
- Overall outcomes from UCSF of follow up testing
  - 28% with impaired glucose tolerance
  - 2% with type 2 diabetes
- When UCSF implemented nurse counseling of importance of PP screening in 3rd trimester
  - Overall compliance went from 33% to 53%

Conclusion

- Maintaining euglycemia can maximize maternal, fetal and neonatal outcomes
  - Both during pregnancy and during labor & birth
- GDM brings a lifelong increased risk of developing type 2 diabetes of 15-50%
  - Refrain from “curing” patients at delivery of placenta and encourage continuation of habits developed in pregnancy
Conclusion

- Continuing healthy living habits learned during pregnancy will benefit everyone
  - Can prolong or prevent the onset of type 2 diabetes in a woman who had GDM
  - Can maximize long-term health outcomes for type 1 and type 2 diabetics

Four successes from a type 1 mom!
Thank you

- **Contact information:**
  - molly.killion@ucsf.edu

- **Acknowledgements:**
  - Aaron Caughey
  - Tekoa King
  - Kirsten Salmeen
  - Maribeth Inturissi

**REFERENCES**


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