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

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

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 diabetes in the US

Type 2 Diabetes
RELATIVE insulin deficiency

• About $\frac{1}{3}$ need diet and exercise therapy alone, $\frac{1}{3}$ need oral hypoglycemics, and $\frac{1}{3}$ need insulin for adequate glucose control

• Almost all need insulin for optimal control during pregnancy
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 $\geq 92 \text{ mg/dL}$
  – 1 hour $\geq 180 \text{ mg/dL}$
  – 2 hour $\geq 153 \text{ mg/dL}$

• Meters SHOULD NOT be used to diagnose GDM
First Prenatal Visit:
- ALL patients: A1C
- High Risk Patients: A1C + 1 hr GCT

At 24-28 weeks:
- 1 hr GCT on all patients (if not already done with GDM or T2DM)
- If early 1 hr GCT ≥ 130, go straight to 3 hr GTT

High Risk Patients:
All women who are overweight or obese (BMI ≥ 25 or ≥ 23 in Asian Americans) 1A1C at least 1 of the following risk factors:
- Physical inactivity
- First degree relative with diabetes
- Hispanic/Latino, African American, Native American, Asian American, Pacific Islander
- History of infant weighing 4,000 g (~9 lb) or more
- Previous GDM
- GDM
- History of cardiovascular disease
- Dyslipidemia: HDL < 35 or Triglycerides > 250
- Acanthosis Nigricans
- A1C ≥ 5.7%
- Pre-pregnancy BMI greater than 40

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)

Definitions

• People with diabetes
  – Used to be called:
    • Diabetics
Similarities

What we see
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!
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

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

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**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

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 women with Type 1 diabetes
- 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

References:
Brown, 2014; Maresh, 2010
ACOG, 2005; Maresh, 2010
Timing of Birth - GDM

- GDM who achieved adequate glucose control without medication can be managed similar to women without diabetes
- 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 for cesarean birth
- C/S rates in parts of the world at 50% for women with diabetes
- C/S may be considered when EFW > 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 > 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
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

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

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)</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>

### Fast

### Slow

## Commonly Used Insulins

<table>
<thead>
<tr>
<th>Insulin</th>
<th>Reasons given</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lispro (Humalog/Admelog); 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)
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 people with type 1 diabetes
- 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

Minimed

Parts of a (Minimed) Pump

The pump delivers tiny amounts of insulin each hour.

Images from Medtronic Minimed, 2010
SQ Insulin 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)

- 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
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, 2005; Metzger, 2007

Caughey, 2013; Jovanovic, 2009
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 (no diabetes): 4.5-5.5
  - Diabetes target (non-pregnant): 7
A1c to Glucose

Hemoglobin A1c value correlates to the estimated average glucose level

From American Diabetes Association

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”

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
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 – D5LR 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 – D5LR 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>
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<tr>
<td>151-170</td>
<td>2.5</td>
<td>3</td>
<td>4</td>
<td>4</td>
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<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:**
  - $> 91$, 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**

## 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
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

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**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
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

ACOG, 2006; Brown, 2014

Briggs, 2011

Picture from wikicommons: Ernst Krause
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

ACOG, 2009; Jovanovic, 2009
Postpartum Follow Up, continued

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%)

From Brown, 2014; Ratner, 2008; Image from Ratner et al. J Clin Endocrinol Metab 2008;93:4774
Postpartum - GDM

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 people with type 1 and type 2 diabetes
Thank you

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