Impact of Maternal Diabetes on Fetal Development and Neonatal Care

Stephanie Murdoch, MSN, RN

Definitions

- IDM –
  - Infant of a Diabetic Mother
    - The fetus or infant of a gestational diabetic or insulin dependant diabetic woman

- GDM –
  - Gestational Diabetes Mellitus
    - Carbohydrate intolerance that is first detected during pregnancy.
    - Disappears post pregnancy, but, in a significant number of cases, returns years later as Type 2 diabetes mellitus. 60 out of 100

(CDAPP Sweet Success: A Guide for Pregnant Women, 2009)

Education is Key!

- The goal for the patient is to be as healthy as possible before becoming pregnant so that they can have healthy children and remain healthy to take care of those children.

- Patients who have a hard time controlling blood sugar pre-pregnancy will have an even harder time controlling it when they are pregnant

- Studies have shown that $5.19 saved for every $1.00 spent on diabetes and pregnancy care.

(CDAPP Sweet Success: A Guide for Pregnancy, 2009)
Statistics

- About 347 million people worldwide have diabetes (WHO)
- Diabetes is predicted to become the seventh leading cause of death in the world by the year 2030.
  - Total deaths from diabetes are projected to rise by more than 50% in the next 10 years.
- Over 2 million women of reproductive age have diabetes
- 7 out of 100 pregnancies affected
- Poor control during first trimester = congenital malformations & SAB
- Poor control in 2nd and 3rd trimesters = macrosomia
- Higher incidence compared to non-hispanic white women (10.8%)
  - Hispanic/Latina: 66% higher incidence
  - American Indian: 67% higher incidence
  - Non-Hispanic black: 77% higher incidence (CDPH, 2011).
- Perinatal mortality: 20/1000 births

Maternal Comorbidity Statistics: Regional Comparison

Maternal Complications

- Perinatal Mortality (1-4%)
- Vision problems
- Kidney problems
- High blood pressure
- Miscarriage and stillbirth
- Sepsis
- Premature delivery
  - <37 weeks: 24-39%
  - <34 weeks: 15-16%
- Difficult delivery
- Higher risk for cesarean delivery (12-49%)
- Difficult recovery
- Gum disease
Fetal & Neonatal Complications

- Diabetic Embryopathy (poor early control)
  - Renal vein thrombosis
  - Cardiomyopathy (Symptomatic = 2-10%, Asymptomatic = 30-50%)
  - Skeletal anomalies
- Related to the severity of maternal hyperglycemia
  - Strict glycemic control pre-conception and during pregnancy

(CDAPP Sweet Success Guidelines for Care, 2012)

- Fetopathy (poor control 2nd /3rd trimester)
  - Macroglossia (20-30%)
  - Intracranial Growth Restriction (2.8%)
  - Perinatal Asphyxia (9.29%)
  - Fetal Deaths, Low Birth Weight, intrauterine death
  - Hypoglycemia (5-25%)
  - Hypocalcemia (4%)
  - Hypomagnesemia
  - Hyperbilirubinemia (11-29%)
  - Polycythemia (5-31%)

- General increase in risk for diabetes, heart problems, and obesity in the future

(CDAPP Sweet Success Guidelines for Care, 2012)

Delivery Complications

- Brachial plexus palsy
- Fractured clavicle
- Shoulder dystocia
- Cephalopelvic Disproportion (CPD)
- Risks associated with operative vaginal deliveries
  - Cervical tear
  - Perineal and vaginal injury (16-40.8%)
  - Urinary incontinence (4.7%)
  - Bowel habit urgency (44%)
  - Loss of bowel control (20%)
  - Neuronal intracranial hemorrhage (1 in 864)
  - Subgaleal hematoma (1.6-4.7%)
  - Retinal hemorrhage
    - Vacuums (7.5%)
    - Forceps (Cephalohematoma)
    - Forceps (Cephalohematoma)
    - Forceps (2%)
  - Increased risk for jaundice

(Aldie Norwitz, 2008)
**Perinatal Asphyxia**

- Associated with Type 1 diabetes
  - Fetal heart rate abnormalities
  - Low Apgar scores
  - Intrauterine death
- Study showed 27% fetuses of diabetic mothers had perinatal asphyxia
  - Hyperglycemia during labor
  - Prematurity
  - Nephropathy
  - Maternal vascular disease, manifested by nephropathy, contributes to fetal hypoxia, oxidative stress, subsequent perinatal asphyxia, and potential stillbirth

(CEAPP Sweet Success Guidelines for Care, 2012)

---

**Premature Delivery**

- More frequent in diabetic women (31%) than in Non-diabetic women (20%)
- 1/3 delivered prematurely because of preeclampsia

(CDAPP Sweet Success Guidelines for Care, 2012)

---

**Intrauterine Growth Restriction (IUGR)**

- IUGR occurs in poorly controlled diabetics, especially when diabetes in complicated by vasculopathy
- Excessively aggressive blood glucose control can also lead to IUGR
- Preeclampsia impairs growth by impeding blood flow and nutrients to fetus

(CDAPP Sweet Success Guidelines for Care, 2012)
Macrosomia & LGA

- Term infant > 4,000 grams = macrosomia (20-30% of infants of diabetic mothers)
- Infant whose weight > 90th percentile for gestational age = large for gestational age (LGA)

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>WI (≤4000 g)</th>
<th>WI (4001-4499 g)</th>
<th>WI (≥4500 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth trauma</td>
<td>2.6%</td>
<td>0.9%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Respiratory morbidity</td>
<td>9.7%</td>
<td>5.8%</td>
<td>6.3%</td>
</tr>
<tr>
<td>5 min Apgar &lt;7</td>
<td>2.1%</td>
<td>1.1%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Resuscitation at delivery</td>
<td>14%</td>
<td>12%</td>
<td>9%</td>
</tr>
<tr>
<td>Emergency CS</td>
<td>2.7%</td>
<td>1.9%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Obstetric trauma</td>
<td>5.3%</td>
<td>4.2%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>6.9%</td>
<td>7.1%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Maternal transfusion</td>
<td>0.6%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Maternal diabetes</td>
<td>11%</td>
<td>8%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Respiratory Distress Syndrome

- Occurs more frequently in infants of diabetic mothers
  - Delayed maturation of surfactant synthesis caused by hyperinsulinemia
  - Interference of lung maturation by glucocorticoids
  - Hypertrophic Cardiomyopathy
  - Other cardiac or pulmonary anomalies
  - Transient tachypnea of the newborn (TTN)

- In contrast, diabetic pregnancies stressed by vasculopathy may cause early fetal lung maturation

Transient Tachypnea of the Newborn (TTN)

- Most common cause of respiratory distress in term IDM (2 – 3 times more common)
- Displays tachnypnea within first 2 hours of life
- R/T residual lung fluid
- Usually benign, resolves within hours, can last up to two days
- Cesarean for macrosomia increases risk for TTN
Hypocalcemia

- Total serum Ca+ concentration < 7 mg/dl
- Ionized Ca+ < 4 mg/dl in newborns, < 3.2 birth weight
  < 1500 grams
- Occurs in 10-20% IDM
- Develops in first 3 days
- Caused by lower concentration of parathyroid hormone
- More prevalent in prematurity, asphyxia, RDS, and infected infants
- Usually asymptomatic, but levels should be checked:
  - Jitteriness
  - Lethargy
  - Apnea
  - Tachypnea
  - Seizures

(CDAP Sweet Success Guidelines for Care, 2012)

Hypomagnesemia

- Serum Magnesium < 1.5 mg/dl
- Occurs in 40% IDM
- Occurs within 3 days after birth
- Caused by urinary loss related to diabetes
- Usually asymptomatic, but if infant hypocalcemia, may not respond to treatment until hypomagnesemia is corrected

(CDAP Sweet Success Guidelines for Care, 2012)

Polycythemia

- Central venous hematocrit of more than 65
- 13-33% IDM
- Symptoms
  - Poor feeding
  - Tachypnea
  - Plethora
  - Lethargy
  - Cyanosis
  - Irritability
  - RDS
  - Hyperbilirubinemia
  - Hypoglycemia
  - Thrombocytopenia
- Treatment
  - Treat underlying symptoms
  - Hydration
  - Phototherapy
  - Partial exchange transfusion

(CDAP Sweet Success Guidelines for Care, 2012)
Hyperbilirubinemia

- Occurs in 23-50% IDM
- Poor maternal glycemic control
- Macrosomic infants at highest risk
  - Increased red blood cell production secondary to increased erythropoietin results in increased breakdown of red blood cells and an increase in bilirubin production.
  - The relative immaturity of hepatic bilirubin conjugation and excretion contributes to this process. In addition, the excess hemolysis may result from glycosylation of erythrocyte membranes.
  - Polycythemia and prematurity are contributing factors

Treatment of Hyperbilirubinemia

- Early breastfeeding
- Adequate hydration and nutrition
- Exchange transfusion, if severe
- Appropriate follow-up after discharge

- Medications
- Phototherapy
- Family education

Neonatal Assessment

- Chart review and hand off report to include GDM
  - Gestational age
  - Outcomes of previous pregnancies
  - Estimation of fetal size (if available, IUGR, macrosomia)
  - Pre-conception and prenatal control of diabetes
  - A1c levels and blood glucose levels
  - Results of screening, diagnosis, treatment of GDM and genetic evaluations
  - Antenatal fetal surveillance results
    - Ultrasound biometry and amniotic fluid assessment
    - Doppler blood flow studies of fetal and uteroplacental circulation
    - Evaluation of biophysical fetal parameters
Symptoms of Hypoglycemia

- 50% hypoglycemia in infants - asymptomatic
- Routine screening is recommended for all IDM
- Temp < 97 degrees Fahrenheit
- Hypotonia/Lethargy (26%)
- Jittery, tremors (8%)
- Seizures (58%)
- Apnea / Cyanosis (47%)
- Irritability (41%)
- Suspected polycythemia
- Suspected sepsis
- Abnormal or Shri1l cry

Hypoglycemia in the Newborn

- Etiology
  - Inadequate substrate supply/glycogen stores
  - Abnormal endocrine regulation of glucose metabolism
  - Increased rate of glucose utilization

- Stress contributes to hypoglycemia
  - Birth asphyxia/trauma
  - Pain
  - Hypothermia

- Reduce glucose utilization –
  - Thoroughly dry and place newborn skin to skin with mother
  - Cover with dry, warm blankets.
  - Cover newborn’s head with dry warm cap

Blood Glucose Checks

- Use heel warmer to warm infant’s heel before stick, promotes increased circulation (3-5 min)
- Swaddle baby, dim lights, provide comfort
  - It’s ok to let mom or dad stay and give kisses…this hurts like heck! Thank stepping on Lego or pebble hard enough to break skin, youch!
- Up to your policy whether or not you use sweet-ease in IDM (if so, at least 1 min before to kick in)
- Use alcohol wipe
- Let completely dry (wet alcohol is why flu shots hurt)
- Wipe away 1st drop of blood!!
  - Alcohol or other substance left on the skin can throw off result
Family Education

- Educate your infant’s family! What are you doing to their baby, and why?
  - What is happening/what to expect at every point
  - Antenatal
  - At time of delivery
  - After baby is delivered
  - At each glucose check

Checking Blood Sugars in the IDM

- All infants at risk should have a glucose checked within 30 minutes of birth
- Depending on your policy, IDM checks:
  - within 30 min. of delivery
  - at 1 hour of life
  - at 2 hours of life
  - continue to check ac bedside blood sugars and treat as appropriate until WNL x 4

Preemies

- Glucose > 45 mg/dl
  - Proceed with normal IV fluid/feeding
- Glucose 30-45 mg/dl, asymptomatic
  - Proceed with normal IV fluid/feeding
  - Recheck 30 minutes after the feeding
- Glucose < 30 mg/dl
  - Recheck bedside glucose & send a serum level to lab
  - If asymptomatic, proceed with normal IV fluid/feeding
  - If symptomatic, give IV glucose (usual dosage 1.2mg/kg) and proceed with normal IV fluid/feeding. Recheck in 30 minutes after bolus/infusion started

(CDAPP Sweet Success Guidelines for Care, 2012)
Term or Late Pre-term Infants

- Blood glucose >45 mg/dl, feed as mom had planned (put to breast), continue to monitor
- Blood glucose 30-45 mg/dl and asymptomatic, feed (put baby to breast) and recheck 30 minutes after the feeding
- Blood glucose <30, recheck a serum level and feed if asymptomatic, if symptomatic give IV glucose (usual dosage 2ml/kg)

(CDAPP Guidelines for Care, 2012)

Special Considerations: Late Pre-term Infants

- Multiple risk factors
  - Mom's history
  - Thermoregulation
  - Feeding difficulties/extra energy expenditure when eating

- If hypoglycemic may need supplement sooner than their term counterparts

(CDAPP Guidelines for Care, 2012)

Recommended Feeding: Asymptomatic Infant

- Breastfeed early and often - immediately or within the first 30 to 60 minutes after birth.
- Avoid scheduling breastfeeding - encourage frequent feeding until the blood glucose is stable

("Baby-friendly" Recommendations)
Benefits of Exclusive Breastfeeding

- Breast milk is the best nutrition for an infant
- Immunity protection - (especially important in hospitalized infants)
  - Mothers who get the flu shot pass that immunity on to their babies
- Reduced risk for SIDS (36%)
- Reduced risk for infections
  - Ear
  - Gastroenteritis
  - NEC
  - RSV
  - Pneumonia
  - UTI
  - Sepsis

(Breastfeeding, 2014; CDAPP Sweet Success Guidelines for Care, 2012; La Leche League, 2012)

Breastfeeding Benefits for Mother

- Lose “baby weight” faster
- Helps promote bonding
- Reduces risk for depression and stress levels
  - Oxytocin is released from posterior pituitary in mother and baby
  - FETO - Oxytocin mediates the release of other hormones and factors in the gut and CNS
  - Autism individuals have low levels of serum oxytocin levels
  - Oxytocin infusion in adults and children results in temporary reversal of some autistic symptoms
- Reduces risk that mother will develop Type 2 diabetes
- Reduced risk for ovarian and breast cancer
- Environmentally friendly – reduced carbon footprint from formula packaging

(Breastfeeding, 2014; CDAPP Sweet Success Guidelines for Care, 2012; La Leche League, 2012)

Long Term Benefits of Exclusive Breastfeeding

- Reduction in the rate of childhood obesity
  - 4% decrease for every month up to 9 months (36%)
  - At age 5-6 (38% less likely)
  - At age 9-12 (22% less likely)
- Reduction in the rate of Type 1 and Type 2 Diabetes
- Reduction in the rate of hypercholesterolemia (14% lower levels)
- Reduction in the rate of cardiovascular disease (35%)
- Reduction in the rates of hypertension
- Reduction in the rate of leukemia
- Reduced rate of juvenile rheumatoid arthritis
- Reduced incidence of allergies
- Improved cognitive development
- Cost savings between $1200-1500 just on formula
- Reduction in the rate of cavities

(CDC, 2014; CDAPP Sweet Success Guidelines for Care, 2012; La Leche League, 2012)
Feeding the Asymptomatic IDM

- The first colostrum has the highest level of glucose and may be given by spoon when pumped or hand-expressed
- Breastfeeding is not contraindicated for most hypoglycemic infants
- It may require the support of a lactation consultant and supplementation
- Due to lethargy, feeding difficulties, and need for optimal intake, it may be necessary to gavage feed while the mother uses a breast pump to establish and maintain a milk supply
- Glucose water is not recommended. It is rapidly absorbed by the gastrointestinal tract and can stimulate the release of insulin, which may further worsen hypoglycemia in the IDM
- If oral or gavage infant feedings are not tolerated, or the infant blood glucose level drops to <40 mg/dl, parenteral treatment may be indicated

Treatment for Symptomatic Infants

- Hypoglycemia despite feeding, low birth weight, preterm
  - IV glucose administration is best accomplished with a peripheral IV catheter
  - Due to the likelihood and danger of infiltration into the tissues, central access is required if glucose concentrations greater than 12.5% are necessary
- Initial treatment includes:
  - 2 ml/kg D10W (200 mg/kg/dose) bolus
  - Follow with 4-8 mg glucose/kg/minute (D10W at 80-120 ml/kg/day) infusion
- Do not delay treatment awaiting lab confirmation of hypoglycemia
- Measure blood glucose levels every 15 to 30 minutes until glucose is stable and above 40 mg/dl.
- Observe IV site frequently and treat loss of IV access as an emergency.
- Reactive hypoglycemia may follow a sudden interruption of glucose infusion.
- Begin oral feedings if not contraindicated; monitor plasma blood glucose and decrease glucose infusion concentration and rate as tolerated oral feeding volume increases.

Post-Neonatal Complications

- Metabolic Syndrome (identifiable early precursor to adult chronic diseases including diabetes, heart disease, neurological sequelae of hypoxic episodes, certain cancers, and others)
  - Childhood Obesity
  - Glucose Intolerance
  - Dyslipidemia
  - Hypertension
  - Predisposing factors
    - Infant of a diabetic mother
    - Infant of an obese mother
    - Large for gestational age infant
**Links & Algorithms**

- Patient Education Material
- CDAPP Sweet Success Guidelines for Care
  - [http://www.cdappsweetsuccess.org/Professionals/CDAPPSweetSuccessGuidelinesforCare.aspx](http://www.cdappsweetsuccess.org/Professionals/CDAPPSweetSuccessGuidelinesforCare.aspx)
- Guidelines for Diagnosis of Hyperglycemia in Pregnancy (2011) Great Algorithm
- Other Useful Links
  - [http://www.cdappsweetsuccess.org/Professionals/UsefulLinks.aspx](http://www.cdappsweetsuccess.org/Professionals/UsefulLinks.aspx)

**How to Become an Affiliate**

- Benefits
  - Monthly webinars
  - Personal consultation and education with our on-site Regional Perinatal System Staff Members
  - Materials (available to everyone)
    - [http://www.cdph.ca.gov/programs/cdapp/Pages/SweetSuccessMaterials.aspx](http://www.cdph.ca.gov/programs/cdapp/Pages/SweetSuccessMaterials.aspx)
  - Guidelines for Care:
    - [http://www.cdappsweetsuccess.org/Professionals/CDAPPSweetSuccessGuidelinesforCare.aspx](http://www.cdappsweetsuccess.org/Professionals/CDAPPSweetSuccessGuidelinesforCare.aspx)

- How to:
  - [http://www.cdappsweetsuccess.org/](http://www.cdappsweetsuccess.org/)
    - Click on link
    - In bottom of pink “Popular Topics” box, click on “New Affiliate Application”

**California Diabetes and Pregnancy Program – Prevention Benefits**

“Hospital charges were about 30% less for program participants and days in the hospital were roughly 25% less. The program effects were larger for women that enrolled before 8 weeks gestation.”

“$5.19 is saved for every dollar spent on the program.”

*American Journal of Public Health: Scheffler, Feuchtbaum, and Phibbs, 1992*
References