Severe Maternal Obesity

Mark Alanis, MD, MSCR
Maternal-Fetal Medicine
St. Luke’s Health System
Boise, Idaho
Disclosure

I have no relevant financial conflicts of interest with any commercial entity to disclose.

I will not discuss the off-label use of any pharmaceutical agent during this lecture.
Objectives

After today's lecture, you will be better able to:

1. Counsel your patients on the risks of severe obesity in pregnancy
2. Implement antepartum interventions in the severely obese and post-bariatric patient to reduce maternal and fetal risks
3. Improve recognition and management of labor abnormalities in the severely obese parturient
4. Optimize cesarean delivery and the postpartum care for extremely obese gravida
Obesity Increases Resources

Kaiser Permanente (N = 13,422)

<table>
<thead>
<tr>
<th>Resource</th>
<th>Normal BMI 18.5-24.9</th>
<th>Overweight BMI 25.0-29.9</th>
<th>Obese I BMI 30.0-34.9</th>
<th>Obese II BMI 35.0-39.9</th>
<th>Obese III BMI ≥ 40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Days</td>
<td>3.6</td>
<td>3.7</td>
<td>4.0</td>
<td>4.1</td>
<td>4.4</td>
</tr>
<tr>
<td>Physician Visits</td>
<td>4.4</td>
<td>4.6</td>
<td>4.8</td>
<td>5.4</td>
<td>6.0</td>
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<tr>
<td>MLP Visits</td>
<td>4.9</td>
<td>4.8</td>
<td>4.6</td>
<td>4.5</td>
<td>3.9</td>
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<tr>
<td>Ultrasounds</td>
<td>3.7</td>
<td>3.9</td>
<td>4.4</td>
<td>5.4</td>
<td>7.5</td>
</tr>
<tr>
<td>Fetal Tests</td>
<td>1.6</td>
<td>1.8</td>
<td>2.1</td>
<td>2.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Medications</td>
<td>3.6</td>
<td>4.1</td>
<td>4.9</td>
<td>6.3</td>
<td>7.7</td>
</tr>
<tr>
<td>Phone Calls</td>
<td>4.8</td>
<td>5.2</td>
<td>5.4</td>
<td>6.5</td>
<td>7.0</td>
</tr>
</tbody>
</table>
**Extreme Obesity**

World Health Organization, Geneva 1997

<table>
<thead>
<tr>
<th>Classification</th>
<th>Body Mass Index (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
</tr>
<tr>
<td>Obese Class I</td>
<td>30.0-24.9</td>
</tr>
<tr>
<td>Obese Class II</td>
<td>“severe” 35.0-39.9</td>
</tr>
<tr>
<td>Obese Class III</td>
<td>“extreme” 40.0 or more</td>
</tr>
</tbody>
</table>
Super Obesity

1938: 200 lb (Matthews and der Burke, JAMA)
1969: 250 lb (Tracey and Miller, Obstet Gynecol)
1985: 200 lb (Kliegman and Gross, Obstet Gynecol)

Current: BMI ≥ 50 (various)

Pregnancy in the Obese Woman

To maintain uniformity with the definitions appearing in the literature, we will discuss those women with massive, morbid, gross, debilitating obesity (i.e., those greater than 90 kg or 200 lb) before or during pregnancy. This does not consider the mother’s height nor does it determine the prepregnancy weight as it is often unavailable to the obstetrician. The incidence of this magnitude of obesity during pregnancy varies between 6 and 10% of all pregnancies. These overweight women tend to be older and of greater parity than nonobese pregnant women.
Reproductive Age Women

Data from National Health and Nutrition Examination Survey 2011-2012, JAMA 2014; 311:806
# Obesity and Complications

<table>
<thead>
<tr>
<th>Antepartum</th>
<th>Intrapartum</th>
<th>Postpartum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miscarriage after ART</td>
<td>Labor dystocia</td>
<td>Postpartum hemorrhage</td>
</tr>
<tr>
<td>Second trimester miscarriage</td>
<td>Cesarean delivery</td>
<td>Pulmonary embolism</td>
</tr>
<tr>
<td>Stillbirth</td>
<td>Spinal hypotension</td>
<td>Surgical site infection</td>
</tr>
<tr>
<td>Preeclampsia</td>
<td>Failed epidural</td>
<td>Wound breakdown</td>
</tr>
<tr>
<td>Gestational diabetes</td>
<td>General anesthesia complications</td>
<td>Postpartum depression</td>
</tr>
<tr>
<td>Fetal overgrowth</td>
<td>Uterine rupture during TOLAC</td>
<td>Bfeeding failure</td>
</tr>
<tr>
<td>Post-term pregnancy</td>
<td>Failed VBAC</td>
<td>Postpartum weight retention</td>
</tr>
<tr>
<td>Neural tube defects</td>
<td>Meconium stained fluid</td>
<td>Infant death</td>
</tr>
<tr>
<td>Heart defects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preterm birth*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**No or Little Effect**

- Miscarriage after spontaneous conception
- Shoulder dystocia
- Fetal growth restriction

**Decreased**

- Hyperemesis
- Small for gestational age infants
- Gastroschisis
Why are we obese?

* Reuters 2012 Poll N = 1,143
  Asked respondents to identify the main cause of the obesity epidemic:

- 61% “Personal choices about eating and exercise”
- 19% “Actions of the food manufacturers and the fast-food industry”
- 20% Other
Fetal Origins of Disease

Systems biology suggests that modulation of the histone acetylation-deacetylation switch, cell differentiation, and stem cell pluripotency are involved in fetal metabolic programming.

Gene silencing or activation

Modulation transcriptional program and protein expression

Hypothalamic POMC, PROP1

Nuclear receptors HIF1α, PPARc1α

Leptin

Mitochondrial programming and copy number

Changes in physiology and metabolism of target tissues

Systems biology showed a marked redundancy of pathways associated with the regulation of gene transcription, methylation transferase activity, and histone post-translational modifications.

Systems biology suggests that hypothalamus and liver seem to be differently involved in fetal metabolic programming.

Systems biology showed that an overnutrition fetus environment might be associated with liver metabolic programming of insulin resistance and organ lipid accumulation.

Changes in tissue function and structure: growth factors

Fetal metabolic environment = under- or overnutrition

Fetal metabolic programming

Reprogramming of glucose and lipid metabolism

SGA

LGA

Adult disease

Metabolic syndrome

Cardiovascular disease

Pediatr Res 2013;73:531
Antepartum Counseling on the maternal and fetal complications of maternal obesity
Birth Defects
### Table 2. Adjusted Odds Ratios for the Association Between Maternal Body Mass Index and Selected Birth Defects

<table>
<thead>
<tr>
<th>Birth Defect</th>
<th>Cases, No.</th>
<th>Thin, BMI &lt; 18.5</th>
<th>Overweight, 25.0 ≤ BMI &lt; 30.0</th>
<th>Obese, BMI ≥ 30.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cases, No.</td>
<td>OR (95% CI)</td>
<td>Cases, No.</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Anencephaly</td>
<td>193</td>
<td>0.82 (0.42-1.59)</td>
<td>42</td>
<td>0.94 (0.65-1.36)</td>
</tr>
<tr>
<td>Spina bifida</td>
<td>425</td>
<td>0.91 (0.56-1.46)</td>
<td>84</td>
<td>1.03 (0.78-1.34)</td>
</tr>
<tr>
<td>Hydrocephaly</td>
<td>156</td>
<td>1.06 (0.54-2.09)</td>
<td>35</td>
<td>1.14 (0.76-1.71)</td>
</tr>
<tr>
<td>Microtia and anotia</td>
<td>216</td>
<td>0.82 (0.43-1.56)</td>
<td>46</td>
<td>0.86 (0.60-1.23)</td>
</tr>
<tr>
<td>Heart defects b</td>
<td>4128</td>
<td>1.12 (0.93-1.36)</td>
<td>939</td>
<td>1.13 (1.01-1.26)</td>
</tr>
<tr>
<td>Cleft palate</td>
<td>592</td>
<td>0.92 (0.62-1.36)</td>
<td>125</td>
<td>1.03 (0.82-1.28)</td>
</tr>
<tr>
<td>Cleft lip and cleft palate c</td>
<td>1064</td>
<td>1.35 (1.04-1.76)</td>
<td>215</td>
<td>0.97 (0.81-1.15)</td>
</tr>
<tr>
<td>Esophageal atresia</td>
<td>278</td>
<td>1.07 (0.63-1.82)</td>
<td>57</td>
<td>1.01 (0.74-1.39)</td>
</tr>
<tr>
<td>Small-intestinal atresia d</td>
<td>163</td>
<td>1.20 (0.63-2.31)</td>
<td>36</td>
<td>1.04 (0.70-1.56)</td>
</tr>
<tr>
<td>Anorectal atresia</td>
<td>380</td>
<td>0.81 (0.48-1.36)</td>
<td>90</td>
<td>1.19 (0.92-1.55)</td>
</tr>
<tr>
<td>Second- or third-degree hypospadias e</td>
<td>793</td>
<td>1.04 (0.71-1.52)</td>
<td>188</td>
<td>1.25 (1.01-1.54)</td>
</tr>
<tr>
<td>Limb reduction defects</td>
<td>509</td>
<td>1.08 (0.73-1.61)</td>
<td>123</td>
<td>1.22 (0.97-1.54)</td>
</tr>
<tr>
<td>Craniosynostosis</td>
<td>422</td>
<td>1.07 (0.67-1.70)</td>
<td>105</td>
<td>1.28 (1.00-1.64)</td>
</tr>
<tr>
<td>Diaphragmatic hernia</td>
<td>286</td>
<td>0.85 (0.49-1.47)</td>
<td>55</td>
<td>0.91 (0.66-1.26)</td>
</tr>
<tr>
<td>Omphalocele</td>
<td>177</td>
<td>0.98 (0.48-1.98)</td>
<td>48</td>
<td>1.50 (1.04-2.17)</td>
</tr>
<tr>
<td>Gastroschisis</td>
<td>400</td>
<td>0.85 (0.56-1.23)</td>
<td>68</td>
<td>0.69 (0.50-0.92)</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; OR, odds ratio.

The ORs are adjusted for maternal age, ethnicity, education, parity, smoking in the month prior to conception, and supplemental folic acid intake in the month prior to conception. There were 3904 controls: 233 controls in the thin group, 858 controls in the overweight group, 572 controls in the obese group, and 2241 controls in the reference group (18.5 ≤ BMI < 25.0).

All heart defects.

Cleft lip with or without cleft palate.

Includes jejunal, ileal, and multiple small-intestinal atresias.

The control group for this birth defect was limited to mothers of male infants.
Ultrasound Detection of Anomalies

Obesity increases chance of not detecting a major anomaly by 30%

Preeclampsia Rate in Obese Women

Garabedian et al. m J Perinatol 2011;28:729
# Preeclampsia Risks

<table>
<thead>
<tr>
<th>Preeclampsia Odds Ratios</th>
<th>All Preeclampsia</th>
<th>Severe Preeclampsia</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI 30-34.9</td>
<td>2.3</td>
<td>2.2</td>
</tr>
<tr>
<td>BMI 35-39.9</td>
<td>3.6</td>
<td>3.4</td>
</tr>
<tr>
<td>BMI &gt; 40</td>
<td>6.0</td>
<td>5.8</td>
</tr>
<tr>
<td>BMI &gt; 50</td>
<td>8.0</td>
<td></td>
</tr>
<tr>
<td>Obesity + IVF</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Obesity + GDM</td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

Obesity accounts for 15% for preeclampsia < 37 weeks’ and 30% of preeclampsia > 37 weeks’

Increasing weight in between pregnancies increases risk of preeclampsia in 2nd pregnancy

Alanis MC et al. Acta Obstet Gynecol 2010;89:924
Dayan N et al. Obesity;2015;23:200
Pare E et al. Obstet Gynecol 124:763
Gestational Diabetes

- 50% of GDM is attributable to obesity
  - Overweight OR = 2.1
  - Obesity OR = 3.6
  - Extreme Obesity OR = 9.0

- Arbitrary diagnosis (HAPO trial)

- Like type 2 diabetes mellitus, the cause is insulin resistance
Obesity and Glucose

Non-obese vs. Obese Non-diabetic Women

Obese women plasma glucose 5-20 mg/dL higher at every period

Harmon et al. Diabetes Care 2011;34:2398
Fetal Overgrowth

Prevalence of Large for Gestational Age Infant N = 660,396

Kim SY et al. Obstet Gynecol 2014;123:737
Stillbirth

☆ Nearly linear dose-response relationship
☆ RR 1.24 for every 5 BMI units over 20 kg/m²
☆ Linear dose-response relationship
☆ Absolute stillbirth rates:
  • BMI 20: 40/10,000
  • BMI 30: 59/10,000
  • BMI 40: 88/10,000

Meta-analysis of 18 cohort studies
N = 3,288,688 participants
16,274 stillbirths

Aune D et al. JAMA 2014;311:1536
Infant Mortality

Meehan S et al. Pediatrics 2014;133:863
Spontaneous Preterm Birth

California Births 2007-2009, N = 989,687

Adjusted Relative Risk

Antepartum Management
Screening, counseling, and lifestyle Interventions that can make a difference
Speculative Interventions

- **Diet**
  - Appropriate caloric intake
  - Standards for gestational weight gain
  - Low glycemic index diets

- **Nutrition**
  - Source and type of macronutrients
  - Micronutrient supplements
  - Use of probiotics

- **Physical activity**
  - Exercise

- **CPAP for sleep apnea**

- **Pharmacologic Therapies**
  - Aspirin
  - Metformin

Evidence?
Diet Counseling

General Principles

* Balanced intake of macronutrients
  - Carbohydrate 40-50%, Protein 20-30%, Fat 20-30%
  - Avoid fad diets, including high-protein diets

* Reduce or eliminate bad dietary behaviors
  - Added sugars
  - Calorie dense foods
  - Trans fats
  - Limit saturated fat to 10% of calories

* Add 2 servings of low-mercury fish per week

Weight Gain During Pregnancy: Reexamining the Guidelines, IOM 2009
2009 IOM GWG Guidelines

<table>
<thead>
<tr>
<th>Classification</th>
<th>Pre-pregnancy BMI</th>
<th>IOM Recommended Gestational Weight Gain (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>28-40</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
<td>25-35</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>15-25</td>
</tr>
<tr>
<td>Obese I</td>
<td>30.0-34.9</td>
<td>11-20</td>
</tr>
<tr>
<td>Obese II</td>
<td>35.0-39.9</td>
<td></td>
</tr>
<tr>
<td>Obese III</td>
<td>40.0+</td>
<td></td>
</tr>
<tr>
<td>Super-obese</td>
<td>50.0+</td>
<td></td>
</tr>
</tbody>
</table>
GWG Restriction

Controversial

**Benefits**: reduced gestational diabetes, reduced preeclampsia, reduced macrosomia, reduced cesarean rate

**Risks**: increase in small for gestational age, and unknown and theoretical neurological and cognitive risks to the fetus, secondary to nutrient or calorie restriction, which may be irreversible
GWG Restriction
Observational Data

GWG Restriction
Randomized Clinical Trial Data

- Numerous RCTs
  - Mixed quality of studies
  - No standardized interventions between studies
  - Different primary and secondary outcomes
  - Numerous meta-analyses with mixed conclusions
    - Quinlivan et al. 2011: supports GWG restriction policy
    - Cochrane review 2012: does not support GWG restriction policy

Consistent trend: dietary counseling is not enough
Eating and nutrition

It's important to eat healthy foods during pregnancy.
Most pregnant women need around 300 extra calories per day.
Take a prenatal vitamin every day.

During pregnancy, your baby counts on you for the nutrients she needs to grow healthy and strong. In this topic, find out how to eat smart and make healthy food choices.

Most foods are OK to eat during pregnancy. But some can be harmful. Learn about foods to avoid or limit during pregnancy. Learn how to prepare, cook and handle foods safely to keep both you and your baby healthy.

Even if you eat healthy every day, you may need some extra help from supplements. A supplement is a product you take to make up for certain nutrients, like vitamin C, iron or folic acid, that you don’t get enough of in the foods you eat. Find out about supplements, like folic acid, iron or calcium, that you may need during pregnancy.

In this topic

- Eating healthy during pregnancy
- Foods to avoid or limit during pregnancy
- Vitamins and minerals during pregnancy
- Peanut allergies, children and pregnancy
- Omega-3 fatty acids

See all in article library
## Low Glycemic Index Diets

### Rhodes RCT
- **Participant:** Overweight/obese women
- **Study Design:** 2 Diet arms
  - 25 in low glycemic index diet group
  - 21 in low-fat diet (25% of calories) group
- **Primary Outcome:** No difference in birth weight
- **Secondary Outcomes:**
  - No difference in GWG
  - Slightly increased fiber, gestational duration, maternal CV markers

### Moses RCT
- **Participant:** All women, stratified by BMI (obese or non-obese)
- **Study Design:** 2 Diet Arms
  - 354 in low glycemic index group
  - 337 in healthy diet group
- **Primary Outcome:** No difference in birth weight
- **Secondary Outcomes:**
  - No difference in GWG
  - No differences in neonatal outcomes or GDM

Probiotics

* Microorganisms that confer health benefits on the host
* Most are food items or dietary supplements
* Products vary in microbial composition and dosage
* The gut microbiome varies considerably between obese and lean people and associated with insulin sensitivity
* RCTS performed in Finland, Ireland, Iran
  * Finnish Study (N = 256): improvement in plasma glucose and insulin sensitivity
  * Iranian Study (N = 70): improved markers of inflammation (CRP) and cholesterol
  * Irish Study (N = 175 obese women): 2nd trimester did not reduce plasma glucose or affect any outcome

Laitinen K et al. Br J Nutr 2009;101:1679
Metformin

- 2 randomized clinical trials in PCOS women
  - early, small study was positive for neonatal outcome
  - larger, better study was negative for neonatal outcome
  - metformin associated with less gestational weight gain

Conclusion
There is no evidence that empiric metformin reduces the risk of gestational diabetes, preeclampsia, delivery of a large-for-gestational age infant, or other obstetric or neonatal outcomes among obese women with or without PCOS.
Exercise Recommendations

ACOG, CDC, American College of Sports Medicine, and US Department HHS

- **30 minutes of moderate physical activity daily**
  - Sedentary women: walking, swimming exercises
  - Active women: continue as non-pregnant
  - Strenuous Exercisers: evidence poor, consider decreasing intensity to moderate levels

- **Relative contraindications**
  - Uteroplacental insufficiency (preeclampsia, IUGR)
  - Preterm labor or cervical insufficiency
Lifestyle Interventions

<table>
<thead>
<tr>
<th>Outcome and intervention</th>
<th>No of studies</th>
<th>No of participants</th>
<th>Mean difference (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet</td>
<td>10</td>
<td>2560</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physical activity</td>
<td>14</td>
<td>1057</td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>Mixed approach</td>
<td>10</td>
<td>1864</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>All</td>
<td>34</td>
<td>5481</td>
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<td>&lt;0.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcome and intervention</th>
<th>No of studies</th>
<th>No of participants</th>
<th>Relative risk (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large for gestational age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet</td>
<td>5</td>
<td>2378</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>Physical activity</td>
<td>4</td>
<td>355</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Mixed approach</td>
<td>9</td>
<td>1500</td>
<td>0.72</td>
<td>0.72</td>
</tr>
<tr>
<td>All</td>
<td>18</td>
<td>4233</td>
<td>0.21</td>
<td>0.21</td>
</tr>
</tbody>
</table>

| Small for gestational age|               |                    |                        |         |
| Diet                     | 3             | 2252               | 0.91                   | 0.91    |
| Physical activity        | 4             | 409                | 0.60                   | 0.60    |
| Mixed approach           | 4             | 891                | 0.60                   | 0.60    |
| All                      | 11            | 3552               | 0.99                   | 0.99    |

Thangaratinam et al. BMJ 2012;344:e2088
Diet and exercise improve pregnancy outcomes

Thangaratinam et al. BMJ 2012;344:e2088
Bariatric Surgery

Restrictive

- Gastric Band: 15-20%
- Vertical Sleeve Gastrectomy: 25-30%

Restrictive + Malabsorptive

- Roux-en-Y: 50%

Purely malabsorptive procedures are rarely done
Bariatric Surgery Status

- 200,000 cases done per year
  - Rapid weight loss
  - Return to ovulatory menses in 80%
  - Clinically important complications

- Implications for pregnancy: risks and benefits
  - Reduction in GDM, preeclampsia, LGA births
  - Increase in SGA births and possibly spina bifida
  - Post-surgical risks may be increased in pregnancy
  - Micronutrient deficiencies
  - Dumping syndrome and GDM screening
Micronutrient deficiencies
- Far worse with Roux-en-Y
- Fat-soluble and water-soluble vitamins
  - Water-soluble: folate, vitamin B1 (thiamine) and B12
  - Fat-soluble: vitamins A, D, E, and K
- Minerals: iron, calcium, zinc, copper, selenium

Initial Screening and Management
- Check CBC, iron studies, calcium, vitamin D, B1, B12, and folate levels
- Prescribe: Prenatal vitamin + B12 + calcium + iron
- Ongoing laboratory surveillance each trimester
Bariatric Surgery Status

* GDM Screening
  * If patient tolerates sugar: traditional screening
  * If patient has dumping syndrome:
    * 50% of patients with Roux-en-Y
    * Check A1c at first visit
      * If A1c < 5.7%: do nothing
      * If A1c 5.7-6.4%: check home BG x 1 week
      * If A1c ≥ 6.5%: the patient has type 2 diabetes
  * At 24-28 weeks of gestation, check BG with home glucometer x 1 week 3-4 times daily
Bariatric Surgical Status

※ Risks
※ Still high risk for pregnancy complications
※ Post-surgical risks may be increased
  ※ Intussusception*
  ※ Volvus
  ※ Internal herniation through surgical windows
  ※ Band erosion and slippage
  ※ Anastomotic leaks
  ※ All are higher with Roux-en-Y
※ MUST HAVE LOW THRESHOLD FOR DIAGNOSIS
Intrapartum
Management of labor and cesarean
More Extreme Obesity

Cesarean Rate in Super-Obese Mothers

Cervical Change in First Stage

Labor prolonged >2 hours in obese women

- Dystocia occurs <7 cm
- Rate of cervical change after 7 cm is normal in obese women
- Second stage is unchanged
- Cesarean is done earlier with increasing BMI

Uterine Forces in Second Stage

<table>
<thead>
<tr>
<th>IUPC Variable</th>
<th>Lean</th>
<th>Obese</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal amplitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contraction</td>
<td>64.5</td>
<td>81.4</td>
<td>.77</td>
</tr>
<tr>
<td>Pushing</td>
<td>95.9</td>
<td>90.3</td>
<td>.91</td>
</tr>
<tr>
<td>Tone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contraction</td>
<td>20.8</td>
<td>20.8</td>
<td>.60</td>
</tr>
<tr>
<td>Pushing</td>
<td>26.3</td>
<td>24.4</td>
<td>.70</td>
</tr>
<tr>
<td>Montevideo units</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Contraction per 10 min</td>
<td>4.9</td>
<td>5.0</td>
<td>.79</td>
</tr>
</tbody>
</table>

No difference in stage II of labor uterine forces of any kind

Duration of Second Stage

Proportion undelivered vs Second stage labor duration (hours)

- Normal
- Overweight
- Obese

Robinson BK et al. Obstet Gynecol 2011;118:1309
Fyfe et al. 2011

N = 2,629 Laboring Women

Cesarean (%)

First Stage

Second Stage

Normal
Overweight
Obese
Why is obese labor slower?

- No difference in stereological smooth muscle content
- No difference in contraction strength in first stage
- In vitro models report adipokines, increased with obese states, inhibit myometrial contraction
- Higher IOL rates and oxytocin use in obese women

Obese Labor Curve

Nulliparous

Multiparous

Extreme obesity dramatically increases the incidence of persistent systolic and diastolic hypotension and resultant prolonged and late FHR decelerations.

Fetal Distress and Obesity

- pH < 7.1
- Base deficit 12+

BMI categories:
- BMI < 25
- BMI 25-30
- BMI 30-35
- BMI 35-40
- BMI 40+

Incision to Delivery

**Composite neonatal morbidity based on cord pH, Apgar scores, and NICU admission only**

It is Time to Operate

- Anesthesia considerations
- Positioning of the patient
- Antibiotic prophylaxis
- Skin preparation
- DVT prophylaxis
- Choice of incision
The Obstetrician’s View
The Panniculus
Mobilizing the Panniculus
Mobilizing the Panniculus
Securing the Panniculus
Final Positioning
Infectious Complications

% with endometritis or wound infection

- BMI ≥ 45
- BMI 30-44.9
- BMI < 30

Stamilio DM and Scrifes CM. Obstet Gynecol 2014;124:227
Wound Outcomes – BMI ≥ 50

Rate of wound complications = almost 3 per 10
- Definition = cellulitis or wound disruption
- 90% wound disruptions

pie chart:
- Seroma: 15%
- Hematoma: 15%
- Abscess: 12%
- "Wound Infection": 58%

Subcutaneous Closure

> 2 cm depth decrease in wound disruption

Level – 1 evidence: meta-analysis of RCTs

* RR 0.66 (0.48-0.91)
* NNT: 16.2

Chelmow et al. Obstet Gynecol 2004;103:974
Subcutaneous Closure

Alanis et al. unpublished data
Wound Complications – BMI 50+

Factors **NOT** associated with wound complications

* **Labor**
  * Wound comp 28% in labored versus 35% in non-labored
  * Duration of labor also insignificant

* **Rupture of membranes**
  * Wound comp 33% in ROM versus 38% in non-ROM
  * Duration of ROM also insignificant

* **Chorioamnionitis**

* **Number of cesareans** (repeat versus primary)

* **Priority** (emergent versus urgent versus routine)

* **Operative time** (63.5 min versus 65.0 min)

# Wound Complications – BMI 50+

## Diagnosis and Treatment

<table>
<thead>
<tr>
<th>Event</th>
<th>Percentage</th>
<th>Median POD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosed after discharge</td>
<td>86%</td>
<td></td>
</tr>
<tr>
<td>Median POD wound disruption</td>
<td></td>
<td>8.5 (6.0 - 11.5)</td>
</tr>
<tr>
<td>Median POD wound cellulitis</td>
<td></td>
<td>10.0 (7.0 - 12.5)</td>
</tr>
<tr>
<td>Readmission</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Reoperation</td>
<td>14%</td>
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</tr>
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</table>

## Predictors

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Bivariable</th>
<th>Multivariable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td>Smoking: OR 2.9 (1.1-7.4)</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td>SQ Drains: OR 2.4 (1.2-4.3)</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical skin incision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SQ drain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EBL &gt; 1000 mL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Potential interventions

- Supplemental intra-operative oxygen
  - Oxygen is toxic to microbes
  - Conflicting results in trials using 80% FiO2
    - 2 colorectal trials ~50% reduction in SSI
    - 1 general intra-abdominal surgery trial increased risk of SSI
    - 2 RCT double-blinded cesarean trials with no effect

- Normothermia (colorectal literature)

- Peri-operative euglycemia (trauma and general surgery literature)

- No pre-operative shave

Walsh et al. Obstet Gynecol 2009;113:411
VTE Risk in Pregnancy

Fold Change

General: 1
Vaginal Delivery: 4
Cesarean Delivery: 13
Emergent Cesarean: 26

ACCP Evidence Based Clinical Practice Guidelines, 8th Edition; Chest 2008;133:844S
Prophylactic anticoagulation does not increase wound complications.