The Cesarean Section Rate
Contributors to Rate Increase
Strategies in Reduction
Cesarean Delivery

• Most commonly performed major surgery in US
• 1/3 of all deliveries in US > 1,000,000 cases per yr
• Appropriate primary C/S rate indeterminate
  – Healthy People target for 2020>> 23.9%
  – Healthy People target for 2010>> 15%
  – Difficulty of the ‘case mix adjustment’ proposals

• Total C/S rise
  – Increase in primary C/S rate
  – Decrease in TOLAC
  – Decreased use of Mechanical Assisted Vaginal Delivery
  – Virtual absence of Vaginal Breech Deliveries (3-4%)
US Cesarean Rate
World Ranking

Top Ten Countries by Caesarean Section
©2009 "Ranking America" (http://rankingamerica.wordpress.com)
US C/S Trend

SOURCES: http://www.cdc.gov/nchs/pressroom/data/NVSR_59_03.pdf
http://www.cdc.gov/nchs/data/nvsr/nvsr54/nvsr54_04.pdf
Eunice Kennedy Shriver Joint
NICHD/SMFM/ACOG
February 2012

• Implications of the first C/S delivery on future reproductive health
• Recommendations for practice opportunities in patient education
• Determine the scope of the ‘problem’
• Identify opportunities to ‘reduce unnecessary’ first C/S deliveries
Patient & Physician Attitudes

- Vaginal vs C/S delivery risks (immediate/subsequent)
- Failed appreciation of risks to subsequent pregnancy
- Risks should be presented in ‘unbiased and objective manner’
- C/S without ‘accepted indication’ > NONINDICATED (term elective C/S should be avoided)
- Provider’s interpretation, recommendation and ‘political pressures’ > Modifiable
## Indications for Primary C/S

<table>
<thead>
<tr>
<th>Stage</th>
<th>Indication</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRELABOR</td>
<td>MALPRESENTATION</td>
<td>10-15*</td>
</tr>
<tr>
<td></td>
<td>MULTIPLE GESSTATION</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>HYPERTENSIVE DISORDERS</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MACROSOMIA</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MATERNAL REQUEST</td>
<td>2-8</td>
</tr>
<tr>
<td>IN LABOR</td>
<td>FIRST-STAGE ARREST</td>
<td>15-30*</td>
</tr>
<tr>
<td></td>
<td>SECOND-STAGE ARREST</td>
<td>10-25</td>
</tr>
<tr>
<td></td>
<td>FAILED INDUCTION</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>NONREASSURING FHR</td>
<td>10</td>
</tr>
<tr>
<td>Indication</td>
<td>Diagnostic Accuracy</td>
<td>Effect on Prevention</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>---------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Failed Induction</td>
<td>Limited</td>
<td>Large</td>
</tr>
<tr>
<td>Arrest of Labor</td>
<td>Limited</td>
<td>Large</td>
</tr>
<tr>
<td>Multiple Gestations</td>
<td>High</td>
<td>Small</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marginal/Lo-lying placentation</td>
<td>High</td>
<td>Small</td>
</tr>
<tr>
<td>Prior Episiotomy complications</td>
<td>High</td>
<td>Small</td>
</tr>
<tr>
<td>Preeclampsia</td>
<td>High</td>
<td>Small</td>
</tr>
<tr>
<td>Prior Shoulder Dystocia</td>
<td>Limited</td>
<td>Small</td>
</tr>
<tr>
<td>Prior Myomectomy</td>
<td>Limited</td>
<td>Small</td>
</tr>
</tbody>
</table>
## Modifiable Fetal Indications for First C/S

<table>
<thead>
<tr>
<th>Indication</th>
<th>Diagnostic Accuracy</th>
<th>Effect on Prevention</th>
<th>Preventative Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malpresentation</td>
<td>High</td>
<td>Large</td>
<td>External Version</td>
</tr>
<tr>
<td>Nonreassuring FHR</td>
<td>Moderate</td>
<td>Large</td>
<td>Education in interpretation and management</td>
</tr>
<tr>
<td>Macrosomia</td>
<td>Limited</td>
<td>Small</td>
<td>Diabetes and Weight gain management</td>
</tr>
<tr>
<td>Malformations i.e. NTD/SCT,EXIT procedures, hydrops</td>
<td>Moderate</td>
<td>Small</td>
<td>Vaginal Delivery of Abdominal Wall Abnormalities Multidisciplinary Team involvement &amp; Patient Education</td>
</tr>
</tbody>
</table>
# Modifiable Maternal Indications for First C/S

<table>
<thead>
<tr>
<th>Indications</th>
<th>Diagnostic Criteria</th>
<th>Effect on Prevention</th>
<th>Preventative Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity (BMI &gt; 30)</td>
<td>High</td>
<td>Small</td>
<td>Preconception Weight Loss Weight gain limitation in pregnancy Obesity not indication and poor predictor of C/S risk</td>
</tr>
<tr>
<td>Viral Infections (HIV,HCV,HSV)</td>
<td>High</td>
<td>Small</td>
<td>HIV treatment to reduce viral load Not absolute indication for C/S</td>
</tr>
<tr>
<td>Cardiovascular Disease</td>
<td>High</td>
<td>Small</td>
<td>Not an independent indication for C/S Multispecialty Coordination Subspecialty transfer and Level III facility</td>
</tr>
<tr>
<td>HTN crisis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulmonary HTN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiomyopathy, CVA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate pelvis</td>
<td>Limited</td>
<td>Small</td>
<td>Few true contraindications to TOL</td>
</tr>
<tr>
<td>Request C/S</td>
<td>Not Applicable</td>
<td>Small</td>
<td>Patient education on immediate risk and future risk in procreation plans</td>
</tr>
</tbody>
</table>
Failed Induction and Arrest Disorders

• **Failed Induction**
  
  – Failure to generate regular contractions and cervical change after 24 hr of oxytocin with AROM if feasible

• **First-stage arrest**
  
  – _6 cm_* or greater dilation with ROM and no cervical change for:
    
    • > 4 hours with adequate contractions
    • > 6 hours if contractions inadequate

• **Second-stage arrest***
  
  – No progress (descent or rotation) for:
    
    • > 4 hours in nullip with epidural (> 3 hours without)
    • > 3 hours in multip with epidural (> 2 hours without)
Labor Management Risks

• Induction of ‘unfavorable’ cervix tests the fates

• Institutional policies:
  – Indications for induction
  – Definition of favorable cervix
  – Options for cervical ripening
  – Oxytocin infusion protocols
  – Criteria for failed induction

• Induction with unfavorable cervix only undertaken for clear maternal or fetal indications

• Decision to proceed with induction should be independent of the condition of the cervix and based on specific indications
The ‘favorable cervix’

- **Bishop Score**
  - Originally to predict a multiparous likelihood to go into spontaneous labor
  - Less predictive of outcome for induction in nulliparous women
  - **8** - same likelihood of vaginal delivery with induction vs. spontaneous labor
  - **6** - denotes unfavorable cervix and should consider ripening when a medical indication
Factors in Labor Management Influencing C/S Rates

• Admission at < 3 cm
  – Perceived ‘prolonged labor’
  – Patient risk profile and selection bias

• Provider Type
  – Practice philosophy and training
  – Risk and patient selection to provider levels
  – Patient expectations in active management
Contemporary Beliefs in Human Labor
(Deviations from the Friedman Curve)

• Latency similar for primiparas and multiparas
• Nullips admitted in labor at 2 to 4 cm may not change cervix for 7 to 6 hours respectively
• Active phase begins closer to 6 vs. 4 cm.
• Multips have steeper acceleration phase than previously thought
• Normal labor rates for nullips (1.2 cm/hr) vs. multips (1.5 cm/hr) no longer valid
  – Rate dependent upon dilation at time of labor onset
What statement regarding Epidural in labor is **not correct**?

A. May prolong second stage for Nullipara by as much as one hour

B. May prolong latent labor

C. Increases C/S rates when used in latent labor

D. Does not increase C/S rates when used during inductions
Epidural and Effects on Labor

Second Stage Duration

<table>
<thead>
<tr>
<th>Parity</th>
<th>Epidural Hrs (95%ile)</th>
<th>No Epidural Hrs (95%ile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nullipara</td>
<td>1.1 (3.6)</td>
<td>0.6 (2.8)</td>
</tr>
<tr>
<td>Primipara</td>
<td>0.4 (2.0)</td>
<td>0.2 (1.3)</td>
</tr>
<tr>
<td>Multipara</td>
<td>0.3 (1.6)</td>
<td>0.1 (1.1)</td>
</tr>
</tbody>
</table>

• **Epidural Use in Labor:**
  • May prolong latent labor
  • No evidence to show an increase in C/S rates when used in either latent labor or during inductions
Assisted Vaginal Delivery

- Associated with reduction in C/S rates (Cause-effect relationship not proven)
- Comparable neonatal outcome studies
- Operative Vaginal Deliveries require training and expertise to increase success and reduce complications of procedure
  - Decreased training may result in both increased C/S rates and increase in Operative Vaginal Delivery complications
Provider Contribution to C/S Trend

- Total cesarean section
- Primary (first-time) cesarean section
- Vaginal birth after cesarean section (VBAC)
...So, you're due on the 17th

...HMM, I'm all booked that week, let's go C-section on the 4th... How does 1pm sound?
Non-Medical Contributions to C/S

- Patient and Provider perception of C/S (SVD) risks
- Public perception that C/S is safer for fetus
- Social & Media perception: ‘relative’ safety of C/S
- ‘Leisure incentive’ vs. salaried provider attitudes
- Medical-legal climate: Risk of bad outcome vs risk of surgical morbidity
Summary

• ‘Nonindicated C/S’ should replace the term ‘Elective C/S’
• Induction should be performed only for medical indication
• Nonmedical induction should be >39 wks EGA and ‘favorable cervix’ > 8 Bishops score
• ‘Failed induction’ declared only after ‘adequate attempt’
  – Failure to achieve regular contractions and/or cervical change after 24 hours of adequate oxytocin with AROM
• Criteria for stages of labor should be defined as outlined
• Operative vaginal delivery should be encouraged and revival of training programs undertaken
• When discussing first C/S risks/benefits, the risks associated with subsequent pregnancies should be included in counseling
Evidence-based surgery for cesarean delivery: An updated systematic review

Dahka, J.D. MD; Mendez-Figueroa, H. MD; Rouse, D.J. MD; Berghella, V. MD; Baxter J.K. MD, MSCP; Chauhan, S.P. MD

American Journal of Obstetrics & Gynecology
Volume 209, Issue 4, Pages 294-306, October 2013

Received 23 Nov 2012; received in revised form 24 Jan 2013; accepted 25 Feb 2013. published online 04 March 2013
Background of ‘Review’

• Purpose:
  – Provide updated evidence-based guidance for surgical decisions during C/S delivery (CD)

• Search:
  – English-language MEDLINE, PubMed, COCHRANE data base
    • Jan 1, 2005 through Sept 1, 2012
  – Update previous review of 150 RCTs
    • 1960 through Dec 31, 2004 (Berghella et al)

• Results:
  – Evaluations and Recommendations based on USPSTF criteria
<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
<th>Suggestions for Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>The USPSTF recommend the service. There is high certainty that the net benefit is substantial</td>
<td>Offer or provide this service.</td>
</tr>
<tr>
<td>B</td>
<td>The USPSTF recommends the service. There is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial</td>
<td>Offer or provide this service.</td>
</tr>
<tr>
<td>C</td>
<td>Note: The following statement is undergoing revision. Clinicians may provide this service to selected patients, depending on individual circumstances. However, for most individuals without signs or symptoms, there is likely to be only a small benefit from this service</td>
<td>Offer or provide this service only if other considerations support the offering or providing the service in an individual patient</td>
</tr>
<tr>
<td>D</td>
<td>The USPSTF recommends against the service. There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits.</td>
<td>Discourage the use of this service.</td>
</tr>
<tr>
<td>I</td>
<td>The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of the service. Evidence is lacking, of poor quality, or conflicting, and the balance of benefits and harms cannot be determined.</td>
<td>If the service is offered, patients should understand the uncertainty about the balance of benefits and harms.</td>
</tr>
<tr>
<td>Level</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>The available evidence usually includes consistent results from well-designed, well-conducted studies in representative primary care populations. These studies assess the effects of the preventive service on health outcomes. This conclusion is therefore unlikely to be strongly affected by the results of future studies.</td>
<td></td>
</tr>
</tbody>
</table>
| Moderate  | The available evidence is sufficient to determine the effects of the preventive service on health outcomes, but confidence in the estimate is constrained by such factors as:  
- The number, size, or quality of individual studies  
- Inconsistency of findings across individual studies  
- Limited generalizability of findings to routine primary care practice  
- Lack of coherence in the chain of evidence  
- As more information becomes available, the magnitude or direction of the observed effect could change, and this change may be large enough to alter the conclusion. |
| Low  | The available evidence is insufficient to assess effects on health outcomes. Evidence is insufficient because of:  
- The limited number or size of studies  
- Important flaws in study design or methods/Inconsistency of findings across individual studies  
- Gaps in the chain of evidence/Findings not generalizable to routine primary care  
- Lack of information on important health outcomes. |
Evaluation

Summary

• 5361 Abstracts (Since Jan 1, 2005)
  – 73 RCTs
  – 10 meta-analyses/systematic reviews
  – 12 Cochrane reviews

• New techniques explored (since Berghella)
  – Thromboprophylaxis
  – Preoperative vaginal cleaning
  – Indwelling bladder catheterization
  – Misgav-Ladach technique
  – Supplemental Oxygen
  – Self-retaining retractors
  – Additional uterine atony prophylaxis measures
  – Placental drainage/manual cervical dilation
  – Elective appendectomy
<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophylactic antibiotics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (all CD)</td>
<td>A</td>
<td>HIGH</td>
<td>7, 8, 9, 10, 102</td>
</tr>
<tr>
<td>Type (Ampicillin or Cephalosporin)</td>
<td>A</td>
<td>HIGH</td>
<td>101, 103</td>
</tr>
<tr>
<td>Administration (systemic)</td>
<td>A</td>
<td>HIGH</td>
<td>101</td>
</tr>
<tr>
<td>Multiple Doses (NR)</td>
<td>D</td>
<td>HIGH</td>
<td>101</td>
</tr>
<tr>
<td>Timing (preskin incision)</td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11, 12, 13, 14, 15, 103, 104, 105</td>
</tr>
<tr>
<td>Thromboprophylaxis&lt;sup&gt;b&lt;/sup&gt;</td>
<td>I&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Low&lt;sup&gt;b&lt;/sup&gt;</td>
<td>16, 17, 18</td>
</tr>
<tr>
<td>Lateral tilt</td>
<td>I</td>
<td>Low</td>
<td>106, 107, 108, 109, 110</td>
</tr>
<tr>
<td>Skin cleaning (CHG or iodine)</td>
<td>I</td>
<td>Low</td>
<td>111, 112</td>
</tr>
<tr>
<td>Preoperative vaginal prep (Iodine)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>B&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate</td>
<td>20, 21, 22</td>
</tr>
<tr>
<td>Supplemental Oxygen (NR)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>D&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>29, 30</td>
</tr>
</tbody>
</table>
Prophylactic Antibiotic Use

• RCTs (3):
  – Unasyn, Amp/Gent/Metronidazole, Pen/Cephalothin
  – No improvement in ‘outcome variables’ studied

• RCTs (4) and metaanalysis (1):
  – Timing of antibiotics related to cord clamp
    • No difference in maternal infection rates (2)
    • Significance decrease in maternal infection with no neonatal complications(2)
  – Timing **15-60 minutes preskin incision** (RCTs 5)
    • Reduced maternal infection rate by 50% with no neonatal complication increases

*Recommendation A with level of certainty HIGH*
Thromboprophylaxis

- No studies on compression or pneumatic compression stockings or comparison to heparin
- RCTs (3)
  - Efficacy of Heparin and LMWH
  - Estimated risk of CD-VTE $\sim 0.23\%$
  - Studies all underpowered (i.e. subject to Type II error)

* Recommendation: I with level of certainty: low
Preoperative Vaginal Preps

• RCTs (2) and Cochrane Review
  – Lower incident of post C/S endometritis 7 vs 14% though no difference in post C/S fever or wound infection
  – Composite infection morbidity rate > nonspecific trend in reduced rate 6 vs 9.5%
  – Cochrane review (4 trials)> Significant reduction in post cesarean endometritis 5.2 vs 9.4% and in PROM 1.4 vs 15.4%

*Recommendation: B with level of certainty Moderate
Supplemental Oxygen

• RCTs (2)
  – 2L Nasal cannula during CD vs 10L by nonrebreather mask during and 2 hrs post op
  – No reduction in infection morbidity

*Recommendation D with level of certainty: HIGH
## Evidence Based Recommendations
### Intraoperative Surgical Techniques

<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indwelling bladder catheter&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- None&lt;sup&gt;b&lt;/sup&gt;</td>
<td>C&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>23, 24, 25, 26</td>
</tr>
<tr>
<td>- Immediate or 24-h removal&lt;sup&gt;b&lt;/sup&gt;</td>
<td>C&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>27</td>
</tr>
<tr>
<td>Adhesive drape (NR)</td>
<td>D</td>
<td>Moderate</td>
<td>113, 114</td>
</tr>
<tr>
<td>Skin incision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (Pfannenstiel or Joel-Cohen)</td>
<td>C</td>
<td>Moderate</td>
<td>31, 32, 33, 34, 35, 36, 115, 116, 117, 118, 119, 120, 121, 122, 123</td>
</tr>
<tr>
<td>Length</td>
<td>I</td>
<td>Low</td>
<td>123</td>
</tr>
<tr>
<td>Second scalpel (NR)</td>
<td>D</td>
<td>Moderate</td>
<td>124</td>
</tr>
<tr>
<td>Bladder flap development (NR)</td>
<td>D</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>38, 39, 40, 126</td>
</tr>
</tbody>
</table>
Indwelling Bladder Catheterization

- RCTs (2); Metaanalysis (1); NRCT (1)
  - Uncathed vs cathed group
    - Decreased UTI infection rate (0.5 vs 5.7%)
    - No increase in retention rate (0.24 vs 13.18%)
  - Immediate removal postop vs 24 hours post op
    - No difference in retention or + urine cultures (8.1 vs 11.2%)
    - Reported bladder injury > 1.4/1000
    - Reported ureteral injury > 0.27/1000
    *Underpowered to detect a difference*
    Operative time > No difference

*Recommendation: C   Level of certainty: Moderate
Skin Incision Type

- RCTs (4)
  - Misgav-Ladach vs Pfannenstiel Techniques
  - Improved operative times and cost savings
  - ‘Minimal difference in maternal morbidity

- Cochrane review and metaanalysis (14 trials)
  - Joel-Cohen based technique
    - Less blood loss
    - Less fever
    - Lower duration of post operative pain
    - Insufficient neonatal or long-term M&M

* Recommendation: C  Level of certainty: Moderate
### Evidence Based Recommendations

#### Surgical Techniques

<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcutaneous incision</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Fascial incision</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Rectus muscle cutting (NR)</td>
<td>D</td>
<td>Moderate</td>
<td>125</td>
</tr>
<tr>
<td>Dissection of fascia off rectus</td>
<td>I</td>
<td>Low</td>
<td>37</td>
</tr>
<tr>
<td>Opening of peritoneum</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Self-retaining retractors(^b)</td>
<td>Ib</td>
<td>Low(^b)</td>
<td>41</td>
</tr>
<tr>
<td>Bladder flap development (NR)</td>
<td>D</td>
<td>Moderate(^b)</td>
<td>38, 39, 40, 126</td>
</tr>
</tbody>
</table>
Fascial Dissection off Rectus Muscles

• RCT (1 small)
  – **Nondissection of inferior rectus fascia** associated with lower decline in pre and post op H/H 1.2 vs 1.6 g/dl
  – **Less pain** by visual analog scale (23 vs 30)
  – Surgical time and Degree of difficulty in fetal delivery not studied

*Recommendation: I  Level of certainty: low*
Bladder Flap Development

- RCTs (2)
  - Development vs No Development
- RCTs (1)
  - Closure vs Nonclosure Visceral Peritoneum
- Nondevelopment shortened op time without increasing postop complications
- Visceral peritoneal closure increase post op urinary frequency and incontinence (spontaneous resolution)

*Recommendation: D  Level of certainty: Moderate
Self-retaining Retractors

- Feasibility trial study (1)
  - Not powered to assess any meaningful outcomes

*Recommendation: I  Level of certainty: Low
## Evidence Based Recommendations

### Surgical Techniques

<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterine Incision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (Transverse)</td>
<td>B</td>
<td>Moderate</td>
<td>127, 128</td>
</tr>
<tr>
<td>Stapling device (NR)</td>
<td>D</td>
<td>Moderate</td>
<td>129-131</td>
</tr>
<tr>
<td>Expansion (blunt, cephalad-caudad)</td>
<td>A</td>
<td>HIGH</td>
<td>42-44, 132,133</td>
</tr>
<tr>
<td>Instrumental</td>
<td>I</td>
<td>Low</td>
<td>134, 135</td>
</tr>
</tbody>
</table>
Expansion of Uterine Incision

• RCTs (2) and Cochrane review
  – Blunt expansion preferred over sharp expansion with decreased blood loss and postop Hgb drop
  – Transverse vs Cephalad-caudal expansion significantly higher rate of:
    • Unintended extension (7.4 vs 3.7%)
    • Blood loss > 1500 cc (2.0 vs 0.2%)

* Recommendation: A  Level of certainty: Hi
## Evidence Based Recommendations
### Surgical Techniques

<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention of postpartum hemorrhage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Oxytocin or placebo (oxytocin(^b))</td>
<td>B(^b)</td>
<td>HIGH(^b)</td>
<td>136</td>
</tr>
<tr>
<td>-Infusion rate (10-40 IU over 4-8 h)(^b)</td>
<td>B(^b)</td>
<td>HIGH(^b)</td>
<td>46, 47, 49</td>
</tr>
<tr>
<td>-Carbetocin or oxytocin</td>
<td>C</td>
<td>Moderate</td>
<td>45, 50, 137, 138</td>
</tr>
<tr>
<td>-Misoprostol plus oxytocin or oxytocin only (oxytocin)(^b)</td>
<td>D(^b)</td>
<td>Moderate(^b)</td>
<td>51, 52, 53, 54, 55</td>
</tr>
<tr>
<td>-Oxytocin or tranexamic acid(^b)</td>
<td>B(^b)</td>
<td>Moderate(^b)</td>
<td>48, 56, 57</td>
</tr>
<tr>
<td>Placental removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Spontaneous or manual (spontaneous)</td>
<td>A</td>
<td>HIGH</td>
<td>139, 140, 141, 142, 143, 144, 145</td>
</tr>
<tr>
<td>-Glove change (NR)</td>
<td>D</td>
<td>Moderate</td>
<td>139</td>
</tr>
<tr>
<td>-Placental drainage(^b)</td>
<td>I(^b)</td>
<td>Moderate(^b)</td>
<td>58</td>
</tr>
</tbody>
</table>
Prevention of Postpartum Hemorrhage

Oxytocin

• RCTs (13)
  – Oxytocin mode; misoprostol, carbetocin, tranexamic acid combined or individually studied
  – No standardized oxytocin infusion doses
    • Oxytocin infusions 10-40 units/1 liter
    • Oxytocin boluses 0.5 to 5.0 IU over 30 minutes
  – RCTs (2) > Continuous IV infusion only favored
  – RCT (1) > Additional benefit to routine bolus
  – Conclusion:
    • 10-40 IU in 1 liter over 4-8 hours proven to reduce uterine atony
    • No known or proven benefit of bolus over IV infusion

* Recommendation: B  Level of certainty: HIGH
Prevention of Postpartum Hemorrhage

Misoprostol

- RCTs (5)
  - Misoprostol in combination with or in lieu of oxytocin
  - RCTs (4) > 200-800 mcg rectal or sublingual as affective as oxytocin infusion with side effects in ~ 60%
  - RCT (1) > misoprostol with routine oxytocin infusion reduced need for further uterotonics. (43 vs 26%)
  - Misoprostol is not superior to oxytocin in uterine atony ‘prevention’ with increased side-affects

* Recommendation: D Level of certainty: Moderate
Prevention of Postpartum Hemorrhage

Tranexamic Acid

- RCTs (3)
  - Antifibrinolytic agent – off label use
  - Dosing: 10 mg/kg IV prior to incision
  - Significantly decreased intraoperative and postpartum blood loss (100-200 cc)
  - Need for additional uterotonics and EBL > 1000 significantly less (2.1 vs 5.8%)

*Recommendation: B  Level of certainty: Moderate*
Prevention of Postpartum Hemorrhage

Carbetocin

- RCTs (2)
  - Carbetocin an Oxytocin agonist
  - Dosing: 100 mcg IV post delivery) compared to oxytocin
    - Fewer additional oxytocic agents required
    - NO difference in pp hemorrhage, blood transfusion or decrease in H/H

* Recommendation: C  Level of certainty: Moderate
Placental Drainage

• RCT (1)
  – Significant reduction in fetomaternal transfusion by KHB (6.8 vs 33%)
  – Insufficient evidence (small sample size) to justify technique

*Recommendation: C  Level of certainty: Moderate
<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterine exteriorization (surgeon preference&lt;sup&gt;b&lt;/sup&gt;)</td>
<td>C</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>59, 60, 61, 62, 63, 64, 65, 66, 142, 146, 147, 148, 149, 150</td>
</tr>
<tr>
<td>Cleaning of uterus</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Cervical dilation (NR)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>D&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>67, 68, 69, 70</td>
</tr>
<tr>
<td><strong>Closure of uterine incision</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undesired fertility (1-layer)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>44, 72, 75, 151, 152</td>
</tr>
<tr>
<td>Desired fertility&lt;sup&gt;b&lt;/sup&gt;</td>
<td>C</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Decidua/serosa incorporation</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Continuous or interrupted (continuous)</td>
<td>B</td>
<td>Moderate</td>
<td>153</td>
</tr>
<tr>
<td>Elective appendectomy (NR)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>D&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>73</td>
</tr>
<tr>
<td>Intraabdominal Saline irrigation(NR&lt;sup&gt;b&lt;/sup&gt;)</td>
<td>D&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>73</td>
</tr>
</tbody>
</table>
Uterine Exteriorization

• RCTs (7) & metaanalysis
  – Febrile complications and surgical time similar
• Decision to exteriorize guided by provider preference.

*Recommendation: C  Level of certainty: HIGH
Cervical Dilation

• RCTs (3) + Cochrane review
  – No difference between groups
  – Hematometra not assessed

* Recommendation: D  Level of Certainty: HIGH
## Evidence Based Recommendations

### Surgical Techniques

<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recommend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterine incision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Type (transverse)</td>
<td>B</td>
<td>Moderate</td>
<td>127, 128</td>
</tr>
<tr>
<td>-Stapling device (NR)</td>
<td>D</td>
<td>Moderate</td>
<td>129, 130, 131</td>
</tr>
<tr>
<td>-Expansion</td>
<td></td>
<td></td>
<td>42, 43, 44, 132, 133</td>
</tr>
<tr>
<td>(blunt, cephalad-caudad&lt;sup&gt;b&lt;/sup&gt;)</td>
<td>A</td>
<td>HIGH</td>
<td>42, 43, 44, 132, 133</td>
</tr>
<tr>
<td>Instrumental delivery</td>
<td>I</td>
<td>Low</td>
<td>134, 135</td>
</tr>
</tbody>
</table>
Uterine Incision Closure

• RCT (1); Metaanalysis (1); Updated Cochrane review
  – Randomized study: single vs double; peritoneal vs no closure; liberal vs restrictive SQ drainage
    • Infection; surgery time; pain; need for blood; hospital readmission, breast-feeding; transfusion > No difference
  – Single vs Double closure on uterine rupture ‘remains controversial.’
    • No randomized studies, only cohort and case-controls
    • No recommendation on women who prefer future fertility

*Recommendation: C  Level of certainty: Moderate
Elective Appendectomy

• RCT (1) small
  – Increase in operative time (8 minutes)
  – No increase in febrile morbidity

*Recommendation: D  Level of certainty: Moderate
Intraabdominal Irrigation

• RCT (1)
  – Intraoperative nausea increased (OR 1.62 CI 1.15-2.28)
  – No difference:
    • Estimate blood loss
    • Operative time
    • Intrapartum complications
    • Hospital stay
    • Return of GI function
    • Infection complications

*Recommendation: D  Level of certainty: Moderate
<table>
<thead>
<tr>
<th>CD technical aspect (Preferred technique)</th>
<th>Recomend Level</th>
<th>Level of certainty</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peritoneal closure</td>
<td>C&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 155, 156, 157, 158, 159, 160, 161</td>
</tr>
<tr>
<td>Rectus muscles reapproximation</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Technique of fascial closure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Running or locked (running, unlocked)</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>-Sharp or blunt needles (blunt)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>84, 85, 166</td>
</tr>
<tr>
<td>Irrigation of subcutaneous tissue</td>
<td>I</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Subcutaneous tissue&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-≥2 cm thickness&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--Closure or nonclosure (closure)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>167, 168, 169, 170, 171, 172, 173, 174, 175</td>
</tr>
<tr>
<td>--Closure or drain (closure)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>75, 87</td>
</tr>
<tr>
<td>Closure or drain + closure (closure only)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>A&lt;sup&gt;b&lt;/sup&gt;</td>
<td>HIGH&lt;sup&gt;b&lt;/sup&gt;</td>
<td>88</td>
</tr>
<tr>
<td>Staples or subcuticular skin suture</td>
<td>C&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Moderate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>89, 90, 91, 92, 93, 94</td>
</tr>
</tbody>
</table>
Peritoneal Closure

• RCTs (7); 2 Metaanalysis; 1 systemic review
  – Parietal vs Visceral closure or Both together
    • Presence of severity of adhesions comparable (60 vs 51%) RCT
    • Misgav-Ladach vs nonclosure Misgav-Ladach > Increased risk of abdominal adhesions in nonclosure group (OR 4.69)
    • More operative time, hospital stay, increased post op fever

*Recommendation: C  Level of certainty: Moderate
Sharp vs Blunt Needles

- RCT (1); 1 Cochrane review
  - Blunt needle usage significantly reduce overall risk of glove perforation (7.2% vs 17.5%)
  - Cochrane review analyzed 10 RCTs
    - Reduced glove sticks by 1.3% (1 perforation for every 6 operations)
  - Blunt needles are effective, should be available and used routinely in C/Ss

*Recommendation: A  Level of certainty: Moderate*
Subcutaneous Closure vs Drain

- RCT (1); Metaanalysis (1)
  - Liberal vs restricted use of SQ drains not associated with decrease in infection morbidity (16 vs 18%)
  - Metaanalysis of 6 RCTs > prophylactic drainage NOT associated with:
    - Decreased wound infection (OR 1.15 NS)
    - Hematoma (OR 1.05 NS)
    - Seroma (OR 0.44 NS)
- Closure of SQ thickness ≥ 2 cm recommended
  *Recommendation: A  Level of certainty: HIGH
- SQ drain placement does not appear to reduce wound morbidity regardless of thickness
  *Recommendation: D  Level of certainty: HIGH
Skin Closure
Staple or Subcuticular Suture

• RCT (5); Metaanalysis (2); Cochrane review (1)
  – Trials differ on suture/staple material/methods and primary outcome tested
    • 5 RCTs and 1 prospective cohort study
      – Staple closure twice rate of incisional separation/infection (13.4 vs 6.6%)
    • Cochrane review of 8 trials:
      – Wound complications and cosmetic outcomes similar

*Recommendation: C  Level of certainty: Moderate
Conclusion/Summary

• Limitations:
  – Recommendations constrained by design of varying RCTs
  – Most trials NOT blinded
  – Techniques heterogeneously defined

• Technical Aspects not sufficiently evaluated
  – CD associated VTE (≈ 10% of maternal deaths in US)
    • VTE reduction study would require tremendous N = 40,000 patients
  – PP Hemorrhage (≈ 11.9% of maternal deaths in US)
    • Reduction of transfusion rates require tremendous N = 3,400 patients
  – 2-layer closure of hysterotomy and subsequent uterine rupture risk (CORONIS and CAESAR collaborative trials)
    • Consolidated Standards of Report Trials (CONSORT)
Conclusion/Summary

• Limitations:
  – Recommendations constrained by design of varying RCTs
  – Most trials NOT blinded
  – Techniques heterogeneously defined

• Technical Aspects not sufficiently evaluated
  – CD associated VTE (~ 10% of maternal deaths in US)
    • VTE reduction study would require tremendous N = 40,000 patients
  – PP Hemorrhage (~ 11.9% of maternal deaths in US)
    • Reduction of transfusion rates require tremendous N = 3,400 patients
  – 2-layer closure of hysterotomy and subsequent uterine rupture risk (CORONIS and CAESAR collaborative trials)
    • Consolidated Standards of Report Trials (CONSORT)