Goals

• Review *some* the most current obstetrical anesthesia literature regarding
  – Cesarean section rates and implications
  – TOLAC
  – Maternal hemorrhage
  – Hypotension
  – Oxytocin
  – PDPH
Case Study

- A 34 year old parturient (G3P2) was scheduled for cesarean delivery due to previous C/S X2, placenta previa and suspected placental accreta. BMI=21. Mallampati I airway
- A combined spinal-epidural (CSE) anesthetic was planned
- An inadvertent dural puncture with 17 ga epidural needle occurred at a needle depth of 4cm, the epidural catheter was threaded, and a continuous spinal anesthetic technique was used
Case Study

• A healthy infant was delivered

• *Oxytocin* 2 units IV given followed by rapid infusion of 30 units oxytocin in 1 liter LR

• Morbid adherence of the placenta to the myometrium was confirmed, placenta was left in situ, and a supracervical hysterectomy performed

• A 2 cm defect in the posterior bladder wall occurred requiring surgical closure—Extensive pelvic bleeding occurred despite no anatomical abnormalities or other complications
Case Study

- 8 liters of blood loss occurred requiring resuscitation with:
  - 3,800 ml crystalloid, 1,500 ml colloid, 16 units RBCs, 16 units FFP, 4 units Platelets, and 1 unit cryoprecipitate.
- Intraoperative hypotension was treated with ephedrine and phenylephrine boluses as needed.
- Anesthetic converted to GA 2.5 hours into the 4 hour case. Pulmonary edema ensued.
- The patient spent 18 hours post-op in the ICU on a ventilator.
Case Study

• Intrathecal catheter was removed 24 hours after placement
• No neurological sequelae or PDPH reported
• Pathology report: placenta increta extending into the uterine wall

US Cesarean Delivery Rates
CDC National Vital Statistics

Figure 5. Cesarean delivery rates: United States, final 1996-2009 and preliminary 2010

US Cesarean Delivery Rates

• Range is 25 to 45%
• Unlikely to go down over time
  – Obesity
  – Advancing maternal age
  – Maternal request
    • maternal autonomy
    • Pelvic preservation
  – Decreased TOLACs
  – Physician convenience
Figure 4. Caesarean section rate by maternal age. Reproduced by kind permission from the RCOG Sentinel Audit 2001.
Obesity and C Section Rates

- LBW: 73.1
- Pren: 56.3
- Cesarean delivery: 58

Frequency
Trial of Labor after Cesarean Section
TOLAC

- “Once a cesarean section, always a cesarean section” Dr. Craigin in 1916 and for most of the 20th century
- “Once a cesarean section, always a controversy” past 40 years
TOLAC

- Historically:
  - 1970-1980 C Section rate went from 5-15%
    - Advent of electronic fetal monitoring
  - 1980 NIH states women with previous C-Section could safely have TOL and VBAC
  - 1990-1996 VBAC rate rose from 19.9-28.3% and C-Section rate dropped from 22.7-20.7%
TOLAC

• 1996-1999 “Perfect Storm” hit
  – 1998 *New England Journal of Medicine* study found increased uterine rupture and increased maternal mortality when TOL failed
  – Increased public attention to risks of TOL
  – 1999 ACOG published practice bulletin “VBAC should be attempted in institutions equipped to respond to emergencies with physicians immediately available…”
TOLAC

– Uterine Rupture (UR) likely to result in litigation
– ACOG guidelines unattainable for many rural and community hospitals

• Result “VBAC Ban” that continues today
• Success of TOL resulting in VBAC, 60-80%
  – One previous C/Section and spontaneous labor: 86.6%
  – Previous C/Section for dystocia: 63.5%

• NIH State-of-the-Science 2006
Objective: To estimate time from dx of UR to delivery that would prevent adverse neonatal sequelae

Methods: UR cases from 2000-2009 were reviewed at Univ of Utah. Adverse neonatal outcomes analyzed

Results: 36 cases of UR during 11,195 TOLAC
Uterine Rupture with Attempted Vaginal Delivery After Cesarean Delivery
Holmgren et al. (2012) Obstetrics and Gynecology

- **Signs of UR**
  - Fetal (n=24)
  - Maternal (n=8)
  - Combination (n=3)

- **Mean time to delivery from onset of symptoms**
  - Adverse outcome group (n=13) was 23.3 mins
  - Without adverse outcome group (n=23) was 16 mins
  - No umbilical pH < 7.0 in neonates delivered in less than 18 minutes
  - Three neonates delivered at more than 30 minutes met criteria for adverse outcomes
Uterine Rupture with Attempted Vaginal Delivery After Cesarean Delivery
Holmgren et al. (2012) Obstetrics and Gynecology

• Conclusion:
• Frequency of UR was 0.32% of patients attempting a trial of labor after cesarean section delivery
• Neonates delivered within 18 minutes after suspected UR had normal umbilical pH levels or 5 minute Apgar scores greater than 7
• Poor long term outcome occurred in three neonates with a decision-to-delivery time longer than 30 minutes
Risk factors for uterine rupture during a vaginal birth after one previous caesarean section: A case-control study


• Design: Case-control study of 41 cases with UR and 157 controls with no UR in 21 Dutch hosps
• Results: Labor induction more common in UR group; prostaglandins more frequent in UR group
• Conclusion: Use of PGE2, low Bishop scores, and labor induction associated with increased UR in women undergoing VBAC after one previous C-Section
Benefits of TOLAC

• Shorter hospital length of stay
• Fewer complications such as postpartum fever, wound or uterine infection, reduced risk of thrombo-embolism, reduced risk of hemorrhage and blood transfusion, reduced risk of future placental abnormalities, and reduced risk of neonatal breathing difficulties
Risks of TOLAC and VBAC

• Risk of failed TOLAC leading to repeat cesarean section
• Risk of uterine rupture resulting in emergent delivery
  – Risk very low but higher than with elective repeat cesarean delivery
• Risk of maternal and fetal death from UR
  – Extremely low risk
Signs and Symptoms of Uterine Rupture

• Symptoms
  – Vaginal bleeding 3.4%
  – Pain 7.6%

• Signs
  – Fetal heart rate decelerations 70.3%
  – Loss of station (clear and emergent sign)
  – Maternal tachycardia and hypotension

• Clinical Clues
  – Frequent epidural dosing as marker for impending rupture
Frequent epidural dosing as a marker for impending uterine rupture in patients who attempt vaginal birth after cesarean delivery


• Relationship between the number of epidural doses and uterine rupture risk:
  – 1 dose (hazard ratio, 2.8; 95% confidence interval [CI], 1.4 –5.7),
  – 2 doses (hazard ratio, 3.1; 95% CI, 2.2– 6.2)
  – 3 doses (hazard ratio, 6.7; 95% CI, 3.8 –12.1)
  – 4 doses (hazard ratio, 8.1; 95% CI,5.4 –18.2).
  – CONCLUSION: Clinical suspicion for uterine rupture should be high in women who require frequent epidural dosing during a VBAC trial.
Summary of Recommendations

• Most women with one previous C-section with a low transverse incision are good candidates.
• Epidural analgesia can be used.
• The use of prostaglandins for cervical ripening or induction of labor in women with previous C-section should be discouraged.
• UR can be catastrophic therefore VBAC should only be attempted when the complete obstetrical, surgical, and anesthesia team is immediately available.
  – “Under the same roof as the patient”
  – 18 minutes from UR to deliver of baby is magic number.
Cesarean Section Significance

• Maternal mortality increasing in the US
• 1996: Rate was 7-8 per 100,000 live births
• 2010: 13.3 deaths per 100,000 live births
The Joint Commission
Sentinel Event Alert #44
2010

• Current trends and evidence suggest that maternal mortality rates may be increasing in the U.S...

• There clearly has been no decrease in maternal mortality in recent years, and we are not moving toward the U.S. government’s Healthy People 2010 target of no more than 3.3 maternal deaths per 100,000 live births

• Leading causes of maternal death are: hemorrhage, hypertensive disorder, pulmonary embolism, amniotic fluid embolism, infection, and pre-existing chronic conditions (such as cardiovascular disease).

*Deaths per 100,000 live births.

Leading Causes of Maternal Mortality, 2007

Direct Causes
- Complications related to the puerperium* 2.2
- Eclampsia and pre-eclampsia 1.5
- Hemorrhage of pregnancy, childbirth, and placenta previa 0.9
- Pregnancy with abortive outcome 0.7
- Other direct causes 3.8

Indirect Causes** 3.1

Unspecified Cause 0.5

Maternal Deaths per 100,000 Live Births

*Deaths occurring in the period immediately after delivery. **Deaths from pre-existing conditions complicated by pregnancy.

Etiology of Hemorrhage

• Antepartum
  – Placenta Previa
  – **Placenta Accreta**
  – Abruptio Placenta

• Intrapartum
  – **Uterine Rupture**
  – Amniotic Fluid Embolism

• Postpartum
  – Uterine Atony/Retained Placenta
Placenta Accreta

• Prior cesarean section and a current placenta previa are the major risk factors for placental accreta
  – 1980s: 1: 2,500 births
  – Current: 1: 500 births
• Placenta accreta accounts for nearly 50% of peripartum hysterectomies today
  – 1960s: 5%
Placenta Accreta

• Definition: Abnormally adherent placenta
  – Placenta accreta vera
    • Placenta is adhered to the myometrium without invasion into uterine wall
  – Placenta Increta
    • Includes invasion of the myometrium
  – Placenta Percreta
    • Invasion of the uterine serosa or other pelvic structures
## Peripartum Hysterectomy Indications (%): Per Decade


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<th>Uterine Atony</th>
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<th>Accreta</th>
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<td>9</td>
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</table>
Figure 5. Cesarean delivery rates: United States, final 1996-2009 and preliminary 2010

Preparation for Hemorrhage

**Absolute**
- Two large bore IVs
- Arterial line, possible CVP
- Blood immediately available/on the labor floor
- Phenylephrine, ephedrine, dopamine and epinephrine immediately available
- Rapid Infuser system
- Extra Help

**Variable**
- Cell Saver
- Massive transfusion protocol
- Regional vs. general anesthesia
- Interventional radiology placement of balloon catheter

Belin,Y. 2012 Sol Schnider SOAP Meeting
Oxytocin
Oxytocin

- Natural nonapeptide synthesized in the hypothalamus, secreted in the posterior pituitary
- Synthetic Octapeptide used for labor augmentation and to restore uterine tone and minimize postpartum blood loss
- Used in the majority of all births in the US and other developed countries
Oxytocin

• Frequently implicated in professional liability claims
• Approximately 50% of all paid obstetric litigation involves oxytocin misuse
• Recently added to the list of “high-alert” medications designated by the Institute for Safe Medication Practices (ISMP)
  – 12 drugs total including insulin and nipride

Clark, S. et al. (2009) AJOG
Oxytocin

• Associated with significant maternal, fetal, and neonatal adverse effects
  – Maternal hypotension
  – Maternal arrhythmias
  – Uterine hyperstimulation
  – Hyponatremia
  – Nausea and vomiting
  – Maternal deaths (cardiovascular) reported with 10u IV dosage
Minimum Effective Bolus Dose of Oxytocin During Elective Cesarean Section


• Methods: Randomized, double-blind, placebo-controlled study
  – 75 healthy ASA I and II term patients for elective cesarean section under spinal anesthesia
  – 5 groups: 0.5 units, 1 unit, 3 units, 5 units, or placebo
  – Uterine tone determined by blinded obstetrician to be adequate or inadequate
  – Side effects were also noted

Minimum Effective Bolus Dose of Oxytocin During Elective Cesarean Section

• Results: No significant differences in uterine tone between oxytocin groups at 2 mins. Uterine tone scores significantly lower at 2 and 3 minutes for subjects receiving 0 oxytocin.
  – Prevalence of hypotension significantly higher in 5 unit group
• Conclusions: Routine use of 5 units (or higher) of oxytocin not recommended. 0.5-3 units oxytocin provides adequate uterine tone.
Oxytocin “Rule of Threes” Protocol for Cesarean Delivery

- Proposed by Tsen, L. (2011)
- 3 IU oxytocin IV loading dose (administered no faster than 15 seconds)
- 3 min assessment intervals. If inadequate UT, give 3 IU oxytocin IV rescue dose
- 3 total doses of oxytocin (Initial load + 2 Rescue Doses)
- 3 IU oxytocin IV maintenance dose (3 IU/L at 100ml/h)
- 3 pharmacological options (ergotrate, carboprost, misoprostol) if inadequate UT persists
Management of Hypotension
Phenylephrine vs. Ephedrine

• Historically, ephedrine was considered “gold standard” for vasopressor management of spinal induced hypotension
  – Animal model uteroplacental studies

• Phenylephrine may improve fetal acid-base status over ephedrine
  – Lee et al. (2002). Anesth Analg; 94: 920-6
Phenyephrine vs. Ephedrine

- Phenylephrine 100 mcg bolus associated with lower incidence of N & V compared to 6-10 mg ephedrine bolus
  - May be due to faster onset of action
  - 50 mcg bolus did not show same results

- Phenylephrine as a prophylactic infusion was associated with a 13-23% incidence of hypotension compared to 85-88% incidence with 100 mcg boluses used to treat 20% decreases in BP

- Infusions also associated with lower incidence of N & V
A Double-Blind, Placebo-Controlled Trial of Four Fixed Rate Infusion Regimens for Phenylephrine for Hemodynamic Support During Spinal Anesthesia for Cesarean Delivery


- Randomized controlled trial, n=101
- Elective Cesarean Delivery, spinal anesthesia, 5 groups:
  - Placebo
  - 25 mc/min phenylephrine infusion
  - 50 mc/min phenylephrine infusion
  - 75 mc/min phenylephrine infusion
  - 100 mc/min phenylephrine infusion
• Primary outcome: number of interventions to maintain BP within 20% of normal
Percentage performance error for all patients in the control group and the phenylephrine infusion groups versus time from the time of administration of spinal anesthesia to the end of the study.

Allen T K et al. Anesth Analg 2010;111:1221-1229
• Results: There were no differences between the placebo and phenylephrine groups in the number of interventions needed to maintain maternal SBP within the target range
• 25 mcg/min and 50 mcg/min associated with significantly fewer interventions than the 100 mcg/min group
• 75 mcg/min and 100 mcg/min associated with higher incidence of pre-delivery hypertension
• No difference in incidence/severity of N & V and umbilical cord pH among groups
• Conclusions: The use of prophylactic phenylephrine infusions did not significantly reduce the number of interventions needed to maintain maternal pre-delivery SBP within 20% of baseline compared to placebo.

• Phenylephrine 25 mcg/min and 50 mcg/min administered as prophylactic fixed rate infusion provided greater hemodynamic stability that higher infusion rate groups.
• Conclusions:
• Prophylactic rate infusions of phenylephrine seem to have limited application in clinical practice
• If a fixed rate infusion is going to be used, use lower rates of 25-50 mcg/min
• Anesthesia provider bolus injections remain best at this time
Phenylephrine vs. Ephedrine

• Both ephedrine and phenylephrine are effective in managing spinal induced hypotension during cesarean section
• Phenylephrine may be associated with lower incidence of IONV and higher umbilical artery pH compared with ephedrine
• Optimum phenylephrine administration regimen is unclear

Phenylephrine vs. Ephedrine

- 2007 Society of Obstetric Anesthesia and Perinatology members
  - 32% used ephedrine to treat spinal induced hypotension
  - 23% used phenylephrine to treat spinal induced hypotension
  - 41% used either drug on the basis of maternal heart rate
Inadvertent Dural Hole and PDPH
The Scenario

- Intended epidural or CSE for analgesia/anesthesia
- Unintended dural puncture with epidural needle occurs

Spinal Catheter  Resite Epidural
The Controversy

• Spinal Catheter
  – Infectious risk
  – Spinal cord trauma
  – Neurotoxicity
  – Inappropriate injection

• Epidural after wet tap
  – Increased PDPH risk
  – Risk of unexpected high block
  – Poorer analgesia than spinal catheter
    • Nelson, K. E. SOAP 2012
Concerns

• If you are wrong about your level of block...you are wrong high.
  – Anesthetists should not assume that a spinal or epidural needle is at the interspace they believe it to be at based on iliac crests
  – Likely to be 1 interspace higher than thought and possibly more
  – Conus medullaris below body of L1 in 19% of subjects
  – Block being inserted at L2-L3 likely at L1 and cord trauma possible
  – Choose lowest suitable interspace that is available
    • Broadbent, C.R. et al. (2000) Ability of anaesthetists to identify a marked lumbar interspace. Anesthesia, 55;1106-1126
Concerns

- Epidural catheter is stronger than the cord
- Consider limiting catheter distance inserted
- Maldistribution + high dose LA = cauda equina

- Nelson, K. E. SOAP 2012
Subarachnoid catheter placement after wet tap for analgesia in labor: Influence on the risk of headache in obstetric patients

- Methods: 5 year time period, 115 consecutive patients who had unintentional dural puncture were divided into 3 groups. Group A had an epidural catheter placed at another interspace. Group B had a subarachnoid catheter placed for labor analgesia that was removed immediately after delivery. Group C had a subarachnoid catheter that was left in for 24 hours.
Results: The overall incidence of PDPH was 46.9% and need for a blood patch 36.5%, significantly less in both subarachnoid catheter groups, 31% in Group B and 3% in Group C, compared with Group A (PDPH 81%).

Subarachnoid catheter placement after wet tap in obstetric patients reduces the PDPH rate and does so to a greater extent if left in place for 24 hours after delivery.
Concerns

• Epidural after wet tap
• Can be associated with high spinals possibly due to transfer of LA through hole in the dura
• Recommendations
  – For labor analgesia, consider intermittent bolusing instead of infusion
  – For Cesarean delivery, consider reducing dose
Spinal Catheter vs. Resiting Epidural

When choosing a **spinal catheter**:
- PDPH risk is less likely
- Carefully label catheter
- Consider risk of cord trauma
- Consider risk of neurotoxicity
- Consider possible infection risk

When choosing to **resite an epidural**:
- Increased PDPH risk
- Risk of unexpected high block
- Poorer analgesia than with spinal catheter

Nelson, K. E. SOAP 2012
Summary

• *Cesarean Section rate* is increasing due to decreased attempts at vaginal birth after cesarean delivery, increased obesity, advanced maternal age, and maternal request.

• The incidence of *maternal hemorrhage* and *maternal* mortality is increasing.

• *Placental accreta/increta* is a major etiology for obstetric hemorrhage.

• Be thoughtful of your *oxytocin* management, consider the “Rule of Threes”.
Summary

- Consider CRNA delivered phenylephrine boluses for management of hypotension during cesarean section
- Extreme caution if using continuous spinal anesthesia technique