Fluid Management During Cesarean Section: Should We Use Colloids Or Crystalloids?

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CC: Patient is a 28 year old, G2P01, Caucasian/white female, full term (39.5 weeks), here for a repeat C-section. No complications during the pregnancy and patient is not in active labor.

PMH: Depression and anxiety, currently not on any medication.

PE: BP 105/61, pulse 87 bpm, respiratory rate of 20, afebrile, room air SpO2 98%, 1.5 m (5’), 77 kg, BMI 33.1. The Fetal Heart Rate is normal at 150 bpm.

Airway Exam: Mallampati 2, TMD 6 cm, FROM.
Questions for Fluid Management?

- Should you administer crystalloids or colloids fluid bolus?
- Is IV fluid an effective way to prevent or treat spinal hypotension?
- What are effective ways to prevent and treat spinal hypotension? Is ephedrine or phenylephrine safe to be used to spinal hypotension? Are there any dose limitations?
- Are there perioperative complications and clinical outcomes related fluids overload during cesarean section?
Physiology during Pregnancy And Delivery

- Blood volume increases by 35% or 1000-1500 ml
- Blood auto transfusion from placenta: patient may receive blood 300-600ml
- Volume status during c-section
- Uterine arterial reactivity changes
- Capillary reactions to fluid overload
Volume Status term Pregnancy
Uterine Arterial Auto-Regulation during Pregnancy

[Graph showing the effect of Acetylcholine on % Relaxation in non-pregnant and pregnant conditions.]
Physiology during Pregnancy And Delivery

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\[ J_v = K_f [(P_c - P_i) - \delta(\pi_c - \pi_i)] \]

where \( J_v \) = net filtration; \( K_f \) = filtration coefficient; \( P_c \) = capillary hydrostatic pressure; \( P_i \) = interstitial hydrostatic pressure; \( \sigma \) = reflection coefficient, \( \pi_c \) = capillary oncotic pressure; and \( \pi_i \) = interstitial oncotic pressure.

**Ernest Henry Starling** (17 April 1866 - 2 May 1927) was an English physiologist.
Endothelial Glycocalyx

- Glycocalyx is about 0.1-0.3 μm, varies with vessel size and even across a single endothelial cell.
- Height, density and permeability are affected by:
  - Exposure to low density lipoproteins
  - Hypoxia, ischemia/reperfusion
  - Atrial natriuretic peptide (ANP)
  - Hypervolemia-fluid overload
Functions Of Glycocalyx

- **Barrier:**
  - Prevents interactions of proteins in RBC with endothelial cell membranes;
  - Assists movement of RBC through capillaries;
  - Determines micro-scale oncotic forces across endothelial layer

- **Non-adherent shield:** platelets and leukocytes

- **Site of mechano-transduction initiation:**
  - Ligand-receptor interaction;
  - Stretch activated ion channels;
  - Fluid sheer stress sensor
Capillary Reactions to Fluid Overload

- Crystalloids and colloids are less efficient in expanding functional volume than previous thought.
- Fluid loading induces atrial stretching, then releases atrial natriuretic peptide (ANP)-potent vasodilator and capillary leakage.
- Fluid overload mechanically and chemically triggers capillary leakage.
- Crystalloids overloading decreases micro-oncotic pressure and damages glycocalyx.

Anesthesia 1996:51;128-132
Perioperative Protection of the Endothelial Surface Layer

- intravascular normovolemia,
- Maintaining a certain minimal plasma protein concentration
- Surgeon or other ways to decrease the release of inflammatory factors
- Positive pressured mechanic ventilation
- Anesthesia gas vs TIVA
Perioperative Complications during C-Section

- Intraoperative complications
  - Hypotension
  - Nausea and vomiting
  - Purities
  - Shivering
  - Anaphylactic reaction

- Postoperative complications
  - Multiple complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Post-Op Complications</strong></td>
<td>Elective Cesarean*</td>
</tr>
<tr>
<td>Blood loss &gt;1500 cc</td>
<td>1.5%</td>
</tr>
<tr>
<td>Surgical re-exploration</td>
<td>0.8%</td>
</tr>
<tr>
<td>Pelvic infection</td>
<td>0.6%</td>
</tr>
<tr>
<td>Deep vein thrombosis</td>
<td>0.6%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>0%</td>
</tr>
<tr>
<td>Sepsis</td>
<td>0%</td>
</tr>
<tr>
<td>Others</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>Minor Post-Op Complications</strong></td>
<td>Elective Cesarean*</td>
</tr>
<tr>
<td>Blood loss 1000–1500 cc</td>
<td>2.8%</td>
</tr>
<tr>
<td>Febrile morbidity</td>
<td>15.7%</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>2.5%</td>
</tr>
<tr>
<td>Endometritis</td>
<td>1.3%</td>
</tr>
<tr>
<td>Wound infection</td>
<td>1.0%</td>
</tr>
<tr>
<td>Ileus</td>
<td>1.1%</td>
</tr>
<tr>
<td>Bladder paralysis</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

* Elective cesarean section is defined as a planned operation in which the patient had been admitted to our hospital with at least 8 hour of fasting before the caesarean section without symptoms of ruptured membranes, regular uterine contractions, or vaginal bleeding. All others are unscheduled cesarean section.
Techniques For Preventing Hypotension during Spinal Anesthesia For C-Section-2010
The commonest side-effect of spinal anesthesia is hypotension, which is often accompanied by nausea or vomiting, or both.

Severe hypotension poses serious risks to mother and baby.

The review of 75 trials (4624 women) found that:

- No single method completely prevents hypotension.
- The incidence is reduced by administering intravenous fluids, the drugs ephedrine or phenylephrine, and by compressing the legs.
Spinal Hypotension during C-Section

- Sympathetic block by local anesthetics
- Aortocaval compression syndrome: Uterus compression to decrease venous return
- Increased sensitivity to local anesthetics
- Reduced vasculatures reactivity to vasoconstrictors and increased endothelium-derived vasodilators
- Decreased peripheral resistance during pregnancy
- Not a volume issue
Volume Preloading Is Not Essential to Prevent Spinal-induced Hypotension at C-Section

<table>
<thead>
<tr>
<th></th>
<th>Group A (Preload)</th>
<th>Group B</th>
<th>P Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre SAB Bolus (1000 ml in 10 min)</td>
<td>Yes</td>
<td>No</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ephedrine Infusion (60mg/500ml)</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Preload Volume (ml)</td>
<td>997±18</td>
<td>204±61</td>
<td></td>
</tr>
<tr>
<td>Coload Hartmanns’ Volume (ml)</td>
<td>864±355</td>
<td>806±376</td>
<td>0.44</td>
</tr>
<tr>
<td>Infusion of Ephedrine (mg)</td>
<td>47±16</td>
<td>48±14</td>
<td>0.8</td>
</tr>
<tr>
<td>Bolus of Ephedrine (mg)</td>
<td>47±17</td>
<td>48±15</td>
<td>0.83</td>
</tr>
</tbody>
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Volume Preloading Is Not Essential to Prevent Spinal-Induced Hypotension at C-Section

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<th>Group A</th>
<th>Group B</th>
<th>P Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of woman Hypotensive</td>
<td>10</td>
<td>9</td>
<td>NS</td>
</tr>
<tr>
<td>No of episodes of hypotension</td>
<td>17</td>
<td>13</td>
<td>NS</td>
</tr>
<tr>
<td>No of episodes of severe hypotension</td>
<td>4</td>
<td>4</td>
<td>NS</td>
</tr>
<tr>
<td>No of episodes requiring ephedrine bolus</td>
<td>5</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>No of bolus of ephedrine</td>
<td>5</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>Total IV fluid in hypotensive patient</td>
<td>1925</td>
<td>1294</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Effects of Crystalloid on C-Section with Spinal Anesthesia

- Crystalloid transiently increase BV and CO, but not MBP
- Blood dilution, may increase blood loss
- Large volume and fast infusion may increase incidence of spinal hypotension
- Decrease oxygen carrying capacity
- Pulmonary and tissue edema
- Delay recovery of GI function?
- Delay wound healing?
Colloid Preload Versus Coload for Spinal Anesthesia for Cesarean Delivery: The Effects on Maternal Cardiac Output

Both group received 15 ml/kg HES

Obst. Anesthesiology 2009;108:1592-1598
Effects of Crystalloid And Colloid Preload on CO In The Parturient Undergoing Planned C-section under Spinal Anesthesia: A Randomized Trial

Fluids preload for 15 min

Anesthesia & Analgesia 2009; 109: 1916-21
Effects of Colloids on C-Section with Spinal Anesthesia

- Colloids increase BV and CO, but not MBP
- Blood dilution, may increase blood loss
- Decrease oxygen carrying capacity
- Pulmonary and tissue edema
- Delay recovery of GI function?
- Delay wound healing?
Hydroxyethyl Starch: Can The Safety Problem Be Ignored?

- Expensive
- Renal dysfunction
- Interfere coagulation
- Pruritus
- Anaphylactoid reaction
Preload or Coload For Spinal Anesthesia for Elective Cesarean Delivery: A Meta-analysis

![Graph showing the incidence of hypotension with data for colloid and crystalloidpreload and coload.](image-url)
Effects of Fluid Therapy on Neonatal Outcomes-APGAR and Gas Analysis

- Impact of Fluid Restriction on Mother during C-Section with Spinal Anesthesia on the Physiological Characteristics of Newborns. IARS 2009
- Effects of fluid preload (crystalloid or colloid) compared with crystalloid co-load plus ephedrine infusion on hypotension and neonatal outcome during spinal anesthesia for cesarean section-Anesthesia and Intensive Care 2010;38:647-653
- A Randomized trial comparing colloid preload to coload during spinal anesthesia for elective cesarean delivery-Obst. Anesthesiology 2009;109:1219-1224
- Colloid preload versus coload for spinal anesthesia for cesarean delivery: the effects on maternal cardiac output-Obst. Anesthesiology 2009;108:1592-1598
- Placental transfer and fetal metabolic effects of phenylephrine and ephedrine during spinal anesthesia for cesarean section-Anesthesiology 2009;111:506-512
Fluid Management And Clinical Outcomes in Cesarean Sections With Spinal Anesthesia

- Li Husong, etc. The University Of Texas Medical School
- Lian Qingquan, Hu MingPing, etc. Wenzhou Medical College
- Three group of treatment with LR with 200 patients each
- Focus on perioperative complications of fluid therapy
Comparison of blood Pressures During Cesarean Section With Two Fluid Regimes

Blood Pressure mmHg

Diastolic RV-10 ml/Kg
Systolic RV-10 ml/Kg
Systolic SV-40 ml/Kg
Diastolic SV-40 ml/Kg
THERE IS NO DIFFERENCE WITH OTHER INTRAOPERATIVE PARAMETERS

The percentage of Women Received Vasopressors in Two Fluid Regimens Groups

- RV-10 ml/Kg
- SV-40 ml/Kg

Treatment Groups

The Usage of Ephedrine During Cesarean Section with Two Fluid Regimens

- RV-10 ml/Kg
- SV-40 ml/Kg

The Usage of Phenylephrine During Cesarean Section with Two Fluid Regimens

- RV-10 ml/Kg
- SV-40 ml/Kg

The percentage of Women Received Vasopressors in Two Fluid Regimens Groups

- RV-10 ml/Kg
- SV-40 ml/Kg

Effect of Two Fluid Regimens during Cesarean Section on Fetal Umbilical Cord Blood Gas pH

- RV-10 ml/Kg
- SV-40 ml/Kg

Li and Lian IARS 2011
Restrictive Fluid Therapy Decreases Blood Loss during C-Section
SUGGESTIONS

- No fluid preload, but physiologic maintenance dose of LR is okay
- Vasopressors control spinal hypotension
- Uterine left displacement to facilitate venous return
- LR 10 ml/kg infusion during surgery
- Colloids usage for extra bleeding more than 1500 ml
- Early oral fluid intake encouraged
THE END