Cardiovascular Effects of Anesthesia for Cesarean Delivery in the Cardiac Patient

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Cardiac Problems in Pregnancy
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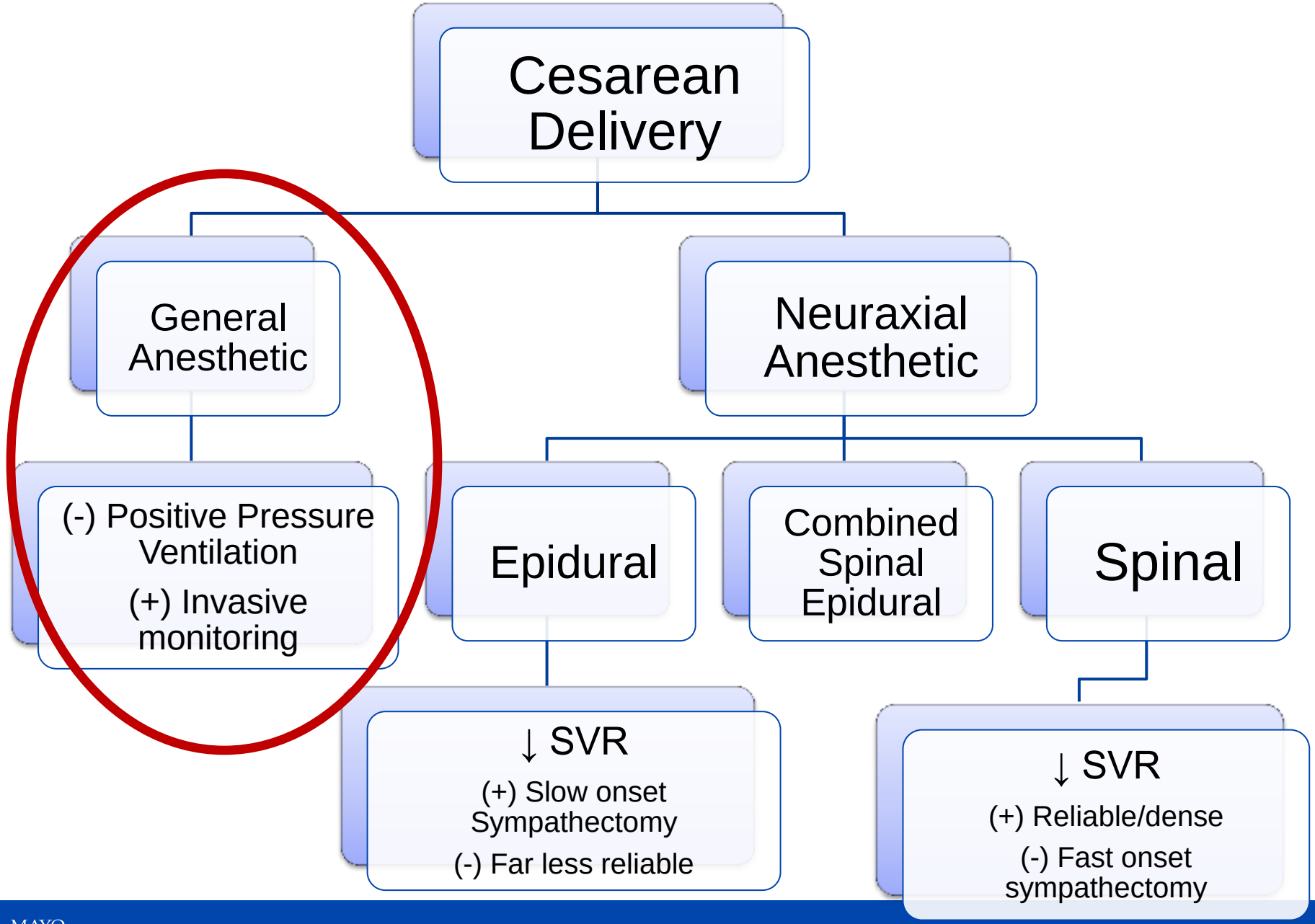

Cesarean Delivery
General Anesthetic
Neuraxial Anesthetic
(-) Positive Pressure Ventilation
(+) Invasive monitoring
Epidural
Combined Spinal Epidural
Spinal
↓ SVR
(+) Slow onset Sympathectomy
(-) Far less reliable
↓ SVR
(+) Reliable/dense
(-) Fast onset sympathectomy

Indications for General Anesthetic

- Anticoagulation
- Inability to lie flat
- Severe illness with need for:
  - Mechanical Ventilation
    - *Heart failure*
  - Pulmonary vasodilation
    - *Pulmonary HTN*
  - Risk of hemodynamic disaster
    - *Dissecting aorta*

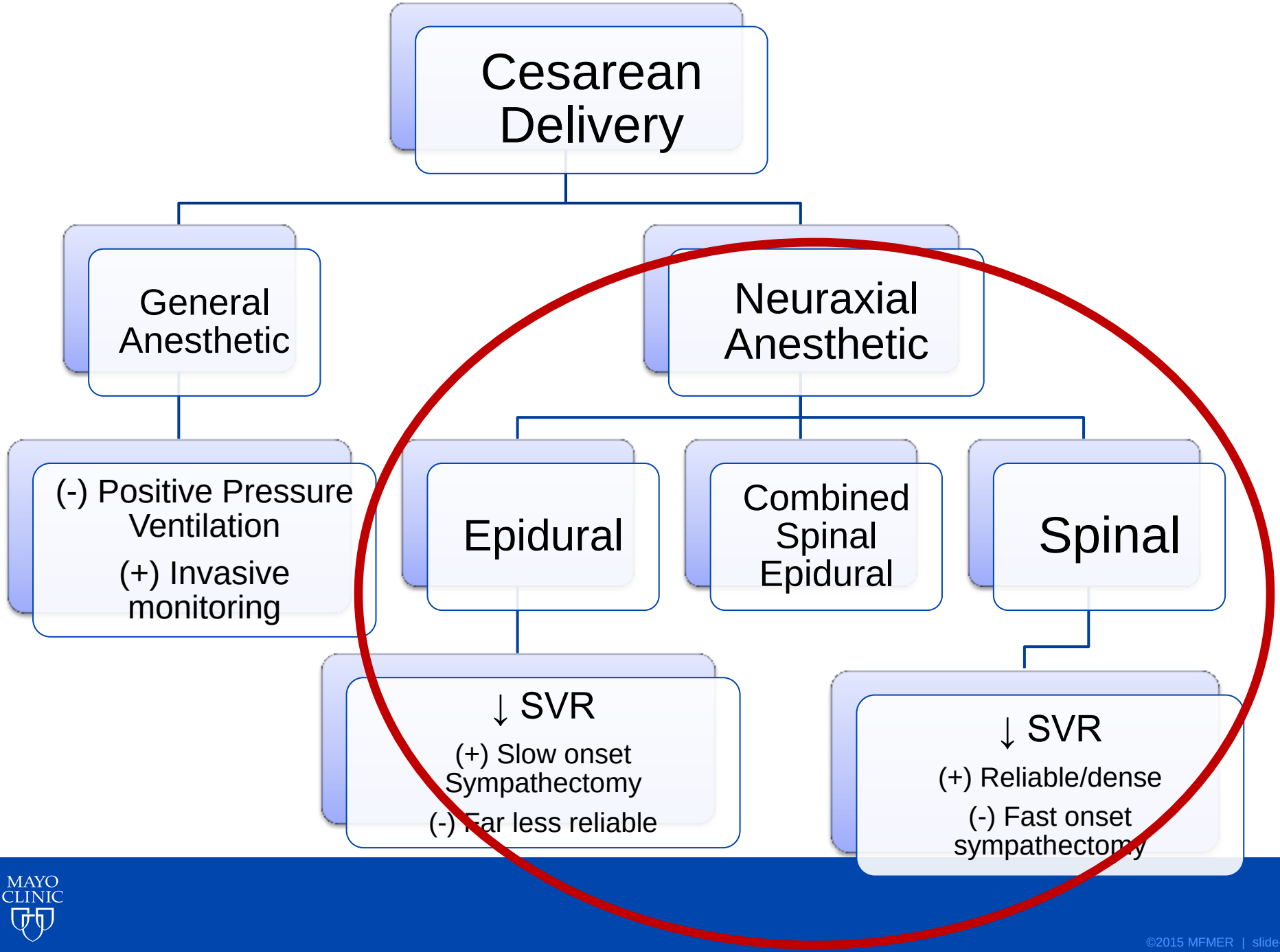
Basics of General Anesthesia Induction for CS in Cardiac Disease

GOALS: **Avoid hypotension**

1. Moderate dose opioid
   - Fentanyl 1-2mcg/kg
   - Remifentanil 1-2mcg/kg
2. Lidocaine 50-100mg

- Blunt tachycardia to laryngoscopy, intubation & incision
- **Typically avoided in CS because of neonatal depression**

3. Short-acting hypnotic, carefully titrated
   - **Ketamine: ↑BP, ↑HR, ↑ SV, ↑CO, ↑SVR**
   - **Propofol: ↓ SV, ↑HR , ↓SVR, ↓BP**
   - **Etomidate: ↑BP, ↑HR if no premed**
4. Rapid-onset muscle relaxant
   - Succinylcholine
   - Rocuronium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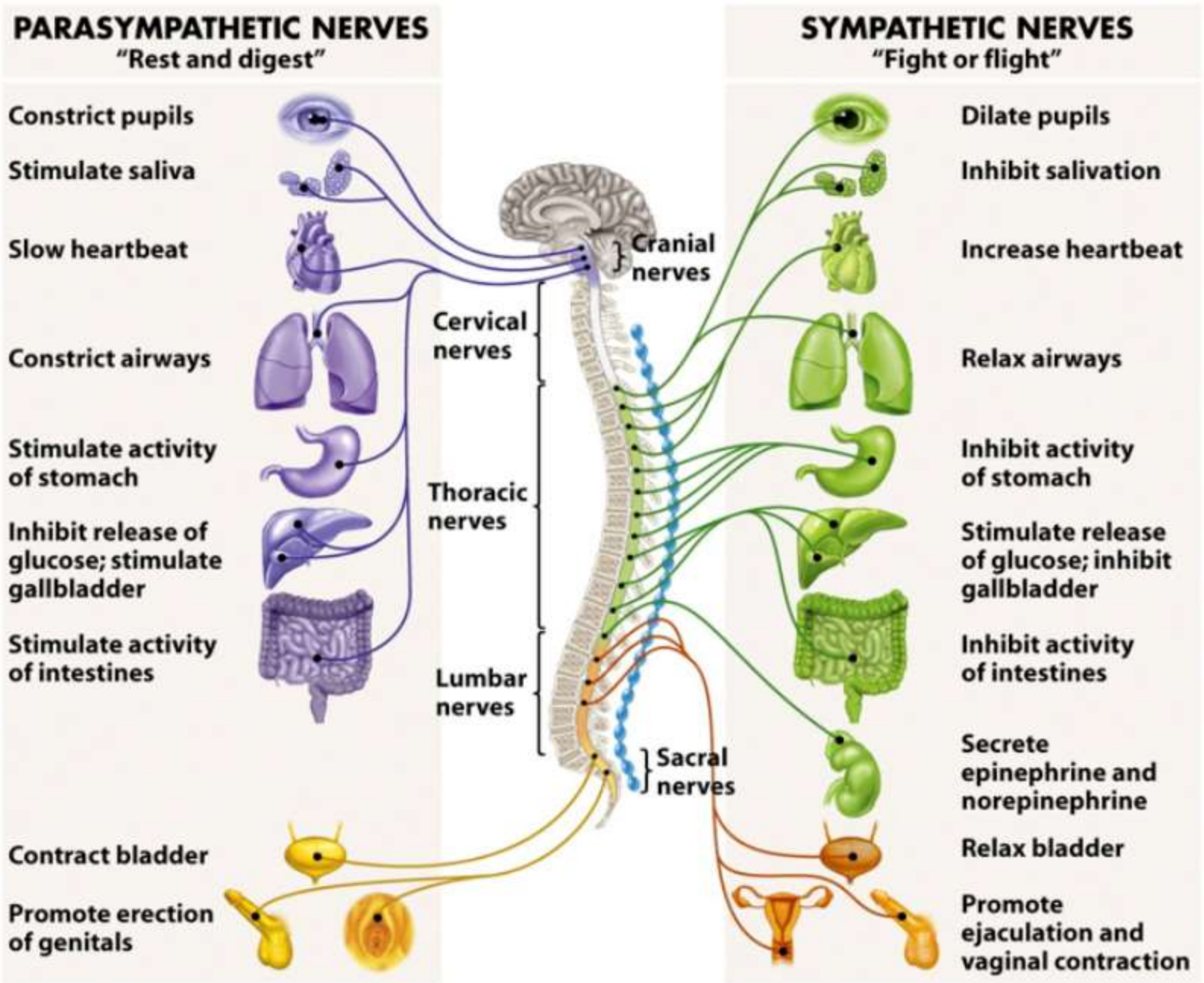

Figure 45-20 Biological Science, 2/e

Hypotension from Neuraxial Anesthesia

Box 1. Techniques to decrease hypotension with neuraxial anesthesia for cesarean delivery.

- Leg wrapping [134]
- Prehydration or co-load with intravenous colloid solution [57]
- Co-load with crystalloid intravenous solution [57]
- Lower dose intrathecal local anesthesia supplemented with opioid [86]
- Maternal left uterine displacement positioning [128]
- Consider epidural instead of spinal anesthesia [95]
- Phenylephrine infusion with rapid crystalloid co-load [160]
- Phenylephrine infusion with low-dose intrathecal bupivacaine [63]
- Phenylephrine infusion or boluses titrated to maintain a consistent heart rate [41,63]

Arendt KW, et al. Expert Rev. Obstet. Gynecol 2012. 7: 59-75.

Four Major Cardiovascular Events of Regional Anesthesia for Cesarean Delivery

1. Pre-hydration/co-hydration

2. Block onset

3. Delivery

4. Oxytocin administration

Pre-hydration/ Co-hydration

GOAL: Improve uteroplacental perfusion & prevent hypotension

Pre-hydration

- Hydration prior to placement of block
- ≥ 1L crystalloid
  - Increases CO ~11-20%
- ≥1L colloid
  - Increases CO ~45%

Co-hydration

- Rapid hydration initiated at time of block placement
- Found to be equally ineffective at preventing hypotension

Arendt KW, et al. Expert Rev. Obstet. Gynecol 2012. 7: 59-75.

Co-hydration in cardiac patients

Typical elective CS: 1-2 L crystalloid over < 1 hr

Discussions with anesthesia should include fluid management in patients vulnerable to failure

Minimizing fluids in elective CS:

- ↑ vasopressor (phenylephrine)
- Likely ↓ uteroplacental perfusion
- Likely safe for mom & baby in most circumstances

Block Onset

Spinal block onset: time of greatest hemodynamic change

Fetus comes off monitor as abdomen prepped

Drop in Preload & SVR:

Spinal > CSE > Epidural

Ease, reliability, safety & intraoperative pain relief:

Spinal > CSE > Epidural

Table 3. Cardiac output measurements during spinal anesthesia for elective cesarean delivery.

Study (year)	Measurement technique	Confounding factors	Intrathecal drug	CO after prehyd	CO after block (l/min)	CO after delivery of	CO 1 h after CD (l/min)
Ueland *et a* (1968)			Tetra 7–10 epi 2				
Niswonger *et al.* (1970			NA				± 2.50
Robson *et al.* (1992)	Suprasternal Doppler (aortic orifice measured by cross section)	Prehyd: 1.39 ± 0.18 l crystalloid Level: T1–T4 Position: LUD Ephedrine administered 60 mg/l in iv. fluids, and in boluses	HB bup 10–12.5 mg	7.90	5 min after block: 6.73 ↓15%† 15 min after block: 7.36 ↓7%†	NA	NA
Tihtonen *et al.* (2005)	Whole-body impedance cardiography	Prehyd: 10 ml/kg 6% hydroxyethyl starch Level: NA Position: LUD Hypotension treated with 50 mg/100 ml ephedrine infusion Mean dose 0.53 mg/kg	HB bup 12–13.5 mg	CI: 3.6 ± 0.2 l/min/m²	CI: 4.1 ± 0.5 l/min/m² ↑11%†	CI: 4.7 ± 0.2 l/min/m² ↑31%† ↑15%‡ (↓39% SVRI and stable MAP)	CI: 3.7 ± 0.3 l/min/m² ↑3%† ↓10%‡ ↓21%§
Langesaeter *et al.* (2008)	LiDCO*plus*	Prehyd: None Co-load of 750 ml over 20 min Level: NA Postion: LUD Prophylactic phenylephrine infusion 0.25 mcg/kg/min	IB bup 7 mg	6.1 ± 0.3	Initial immediate ↑32.8%† in first 200 s, then ↓16.8%† approximately 6 min after block	NA	NA

Modern Spinal Anesthetic:

- Low dose spinal
- Co-hydration
- Left uterine displacement
- Phenylephrine infusion

Cardiac Output:

- First 3 min: ↑33% above baseline
- Following 3 min: ↓17% below baseline

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Table 2. Cardiac output measurements during epidural anesthesia for elective cesarean delivery.

Study (year)	Measurement technique	Confounding factors	Epidural drug	CO after prehyd (l/min)	CO after block (l/min)	CO after placental delivery (l/min)	CO 1 h after birth (l/min)
Ueland *et al.* (1972)	Dye dilution	Prehyd: NA Level: T2–T10 Position: supine LUD performed if significant drop in BP occurred	2% mepivacaine (13.5–17.5 ml)	5.88 ± 1.31	5.52 ± 1.77 ↓6%†	7.34 ± 1.84 ↑25%† ↑33%‡	6.71 ± 1.95 ↑14%† ↑22%‡ ↓9%§
Maruta (1982)	Echo	Prehyd: <1 l Level: NA Position: NA	NA	5.95 ± 1.49	5.05 ± 1.59	6.08 ± 1.31	5.41 ± 0.91 %† %‡ 1%§
James *et al.* (1989)	Suprasternal Doppler (aortic orifice measured by cross-section)	Prehyd: 15 ml/kg Level: T4–T8 Position: LUD					1 ± 1.7 %† 0%‡ 1%§
Milsom *et al.* (1985)	Impedance cardiography	Co-load: 1.5–2.0 Level: NA Position: LUD Atropine 0.5 mg Subjects requiring ephedrine excluded				↑¶	A
Robson *et al.* (1992)	Suprasternal Doppler (aortic orifice measured by cross-section)	Prehyd: 1 l crystalloid 1.2 ± 0.2 l total fluids Ephedrine administered 60 mg/l in IV fluids after prehyd Level: T2–T6 Position: LUD	0.5% bup + 1:200,000 epi (18–30 ml)	7.83	10 min after 8.20 ↑5% 30 min after 7.96 ↑2%	NA	NA
Robson *et al.* (1989)	Suprasternal Doppler (aortic orifice measured with cross-sectional echo)	Prehyd: 500 ml crystalloid Level: >T5 Position: LUD Subjects requiring ephedrine excluded	0.5% bup (21 ± 3 ml)	7.14	7.08 ↓<1%†	7.69 ↑8%† ↑9%‡	6.65 ↓7%† ↓6%‡ ↓14%§
Robson *et al.* (1989)	Suprasternal Doppler (aortic orifice measured with cross-sectional echo)	Prehyd: 0.8 l mean Level: T2–T6 Position: LUD Subjects requiring ephedrine excluded	0.5% bup (20 ± 5 ml)	7.82	10 min after 7.34 ↓6%† 30 min after 7.12 ↓9%†	NA	NA

Changes in Cardiac Output ALL <10%

- Patient's requiring ephedrine were excluded.
- Epidurals are not as reliable to block intraoperative pain.

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Delivery

- Uterine evaculation →

  Aortocaval decompression & autotransfusion

↑CO (Range 10% – 61%)

↑HR

↑SV

↓SVR

↔ MAP

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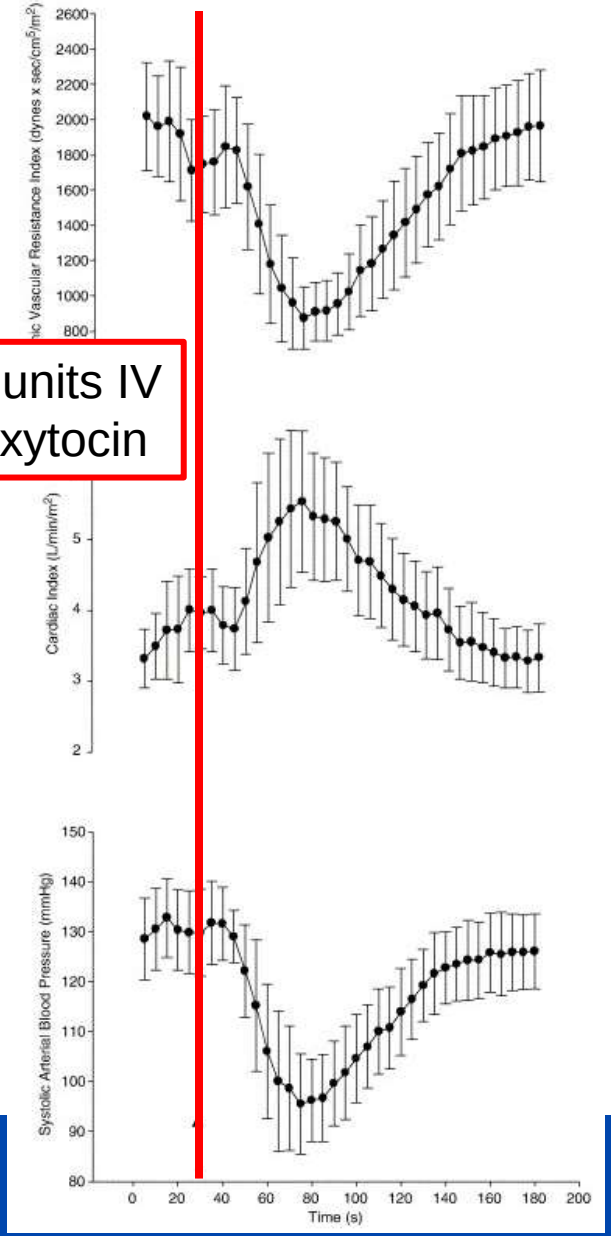
Oxytocin Administration

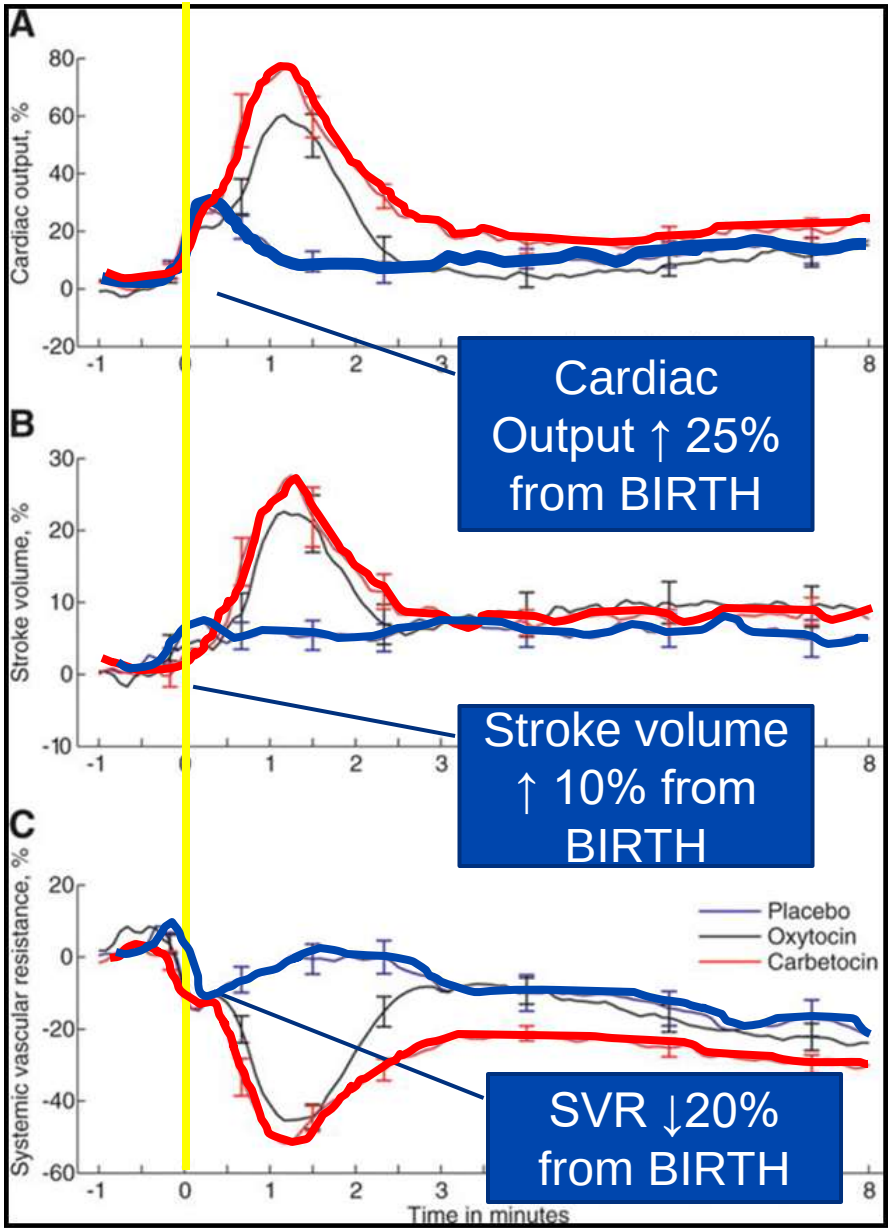


↓ Systemic Vascular Resistance

↑ Cardiac Index

↓ Systolic Blood Pressure

Langesaeter E. Int J of Gyn & Obstetrics 2006; 95: 46-47



BLUE = PLACEBO
RED = OXYTOCIN

Cardiac Index

Stroke Volume

Systemic Vascular Resistance

Rosseland LA et al. Anesthesiology 2013.119:541-551.

Optimization of CS hemodynamics

- Left uterine displacement
- Consider arterial line
- Epidural anesthetic:
  - 0.5% bup or 2% lido *without* epi
- Sequential CSE:
  - 5mg isobaric IT bup followed by 2% lido epidural titration
- Titrated to T4-6 level
- Careful minimal co-hydration with crystalloid
- Phenylephrine infusion initiated at time of block
- Minimize/titrate oxytocin on pump

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Thank you!

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