



## CRITICAL EVENTS CHECKLISTS

For use in the peri-anesthesia setting

# Call for help!

Code Team \_\_\_\_\_  
 PICU \_\_\_\_\_  
 Fire \_\_\_\_\_  
 Overhead STAT \_\_\_\_\_  
 ECMO \_\_\_\_\_

# Notify surgeon/team

Use expert clinical judgment when using this  
and all emergency manuals.

1	Air Embolism
2	Anaphylaxis
3	Anterior Mediastinal Mass
4	Bradycardia
5	Bronchospasm
6-7	Cardiac Arrest
8	Difficult Airway
9-10	Fire: Airway / OR
11	Hyperkalemia
12	Hypertension, Acute
13	Hypotension
14	Hypoxia
15	Intracranial Pressure
16	Laryngospasm
17	Local Anesthetic Toxicity
18	Loss of Evoked Potentials
19	Malignant Hyperthermia
20	Massive Hemorrhage
21	Myocardial Ischemia
22	Pulmonary Hypertension
23	Tachycardia
24	Tamponade, Cardiac
25	Tension pneumothorax
26	Transfusion Reaction
27	Trauma
28	Maternal OB Hemorrhage

- Notify team, stop nitrous oxide and volatile agents. Increase O<sub>2</sub> to 100%
- Stop air entrainment: Find air entry point, stop source, and limit further entry
- Ask surgeon:
  - Flood wound with irrigation/soaked saline dressing
  - Stop all pressurized gas sources, e.g. laparoscope, endoscope
  - Place bone wax or cement on exposed bone edges
- Check for open venous lines or air in IV tubing
- Position surgical site below heart, head down, lateral (if possible)
- Consider:
  - Compress jugular veins intermittently if head or cranial case
- If hypotensive:
  - Give EPINEPHrine 1-10 MICROgrams/kg IV, consider infusion EPINEPHrine 0.02-1 MICROgrams/kg/min IV or NOREPInephrine 0.05-2 MICROgrams/kg/min IV
  - Chest compressions: 100-120/min to force air through lock, even if not in cardiac arrest
  - If available, call for TEE/US. Consider ECMO
- If cardiac arrest, see 'Cardiac Arrest' card
- Consider Differential (Partial)
  - Embolus (fat, thrombotic, cement, amniotic fluid)
  - Anaphylaxis
  - Local anesthetic systemic toxicity



- Increase O<sub>2</sub> to 100%, evaluate ventilation
- Remove suspected trigger(s)
  - If latex is suspected, thoroughly wash area
- If HYPOtensive, turn off anesthetic agents

### Common causative agents:

- Neuromuscular blockers
- Latex
- Chlorhexidine
- IV colloids
- Antibiotics

Indications	Treatments
To restore intravascular volume	NS or LR, 10-30 mL/kg IV/IO, <b>rapidly</b>
To increase BP and reduce mediator release	<ul style="list-style-type: none"> <li>▪ EPINEPHrine 1-10 MICROgrams/kg IV/IO, as needed or 10 MICROgrams/kg IM q5-15 min as needed</li> <li>▪ May need EPINEPHrine infusion 0.02-1 MICROgrams/kg/min IV</li> <li>▪ If BP remains low, give Vasopressin 10 MILLIunits/kg IV</li> </ul>
To reduce histamine-mediated effects	DiphenhydrAMINE 1 mg/kg IV/IO (MAX 50 mg) or Famotidine 0.25 mg/kg IV (MAX 20 mg)
To reduce mediator release	MethylPREDNISolone 2 mg/kg IV/IO (MAX 100 mg)
To reduce bronchoconstriction	Albuterol (Beta-agonists) 4-10 puffs, repeat as needed

- Send tryptase within 3 hours
- Consider Differential (partial):
  - Severe bronchospasm from URI or underlying condition: go to 'Bronchospasm' card
  - Air, fat, thrombotic, or cement embolus: go to 'Air Embolism' card
  - Sepsis: support BP, antibiotics

## Intra-operative Treatments

### Airway Collapse

- Increase O<sub>2</sub> to 100%
- Increase FiO<sub>2</sub>
- Add CPAP for spontaneous ventilation; add PEEP for controlled ventilation
- Reposition to lateral or prone
- Ventilate via rigid bronchoscope

### Cardiovascular Collapse

- Increase O<sub>2</sub> to 100%
- Give fluid bolus
- Reposition to lateral or prone
- Ask surgeon for sternotomy and elevation of mass
- Consider ECMO

## Preoperative Considerations

### High Risk Factors

- Etiology:
  - Hodgkin's and non-Hodgkin's lymphoma
- Clinical signs:
  - Orthopnea, upper body edema, stridor, wheezing
- Imaging findings:
  - Tracheal, bronchial, carinal, or great vessel compression; SVC or RVOT obstruction; ventricular dysfunction; pericardial effusion

### Anesthetic Plan

- Perform surgery under local anesthesia, if possible
- Pre-treat with irradiation or corticosteroids
- Maintain spontaneous ventilation and avoid paralysis
- Ensure availability of fiberoptic and rigid bronchoscope
- Cardiopulmonary bypass or ECMO
- Type and cross and sternal saw (for surgeons) available

# Bradycardia

Definition:

<b>Age</b> < 30 days	<b>HR</b> < 100
≥ 30 days < 1 yr	< 80
≥ 1 yr	< 60

- If hypotensive, pulseless, or poor perfusion: start chest compressions. See 'Cardiac Arrest' card
  - Give EPINEPHrine 10 MICROgrams/kg IV
  - Call for transcutaneous pacer (see inset)
    - Start pacing, when available
- Confirm NSR. If heart block or slow junction/ventricular, call EP
- If NOT hypotensive or pulseless:

Etiology	Treatment
Hypoxia (most common)	<ul style="list-style-type: none"> <li>▪ Increase O<sub>2</sub> to 100%</li> <li>▪ Ensure ventilation</li> <li>▪ See 'Hypoxia' card</li> </ul>
Vagal	<ul style="list-style-type: none"> <li>▪ Atropine 0.01-0.02 mg/kg IV</li> </ul>
Surgical Stimulation	<ul style="list-style-type: none"> <li>▪ Stop stimulation</li> <li>▪ If laparoscopy, desufflate</li> </ul>
Ca-Channel Blocker Overdose	<ul style="list-style-type: none"> <li>▪ Calcium chloride 10-20 mg/kg IV or Calcium gluconate 50 mg/kg IV</li> <li>▪ If ineffective, Glucagon as dosed below</li> </ul>
Beta-Blocker Overdose	<ul style="list-style-type: none"> <li>▪ Glucagon 50 MICROgrams/kg IV, then 0.07 mg/kg/hour IV infusion (MAX 5 mg/hr)                             <ul style="list-style-type: none"> <li>• Check blood sugar</li> </ul> </li> </ul>

## Instructions for PACING

1. Place pacing ECG electrodes AND pacer pads on chest per package instructions
2. Turn monitor/defibrillator ON, set to PACER mode
3. Set PACER RATE (ppm) to desired rate/min. (Can be adjusted up or down based on clinical response once pacing is established)
4. Increase the milliamperes (mA) of PACER OUTPUT until electrical capture (pacer spikes aligned with QRS complex; threshold normally 65-100mA)
5. Set final mA to 10mA above this level
6. Confirm pulse is present
7. Must change pacing pads hourly to avoid burns

# Bronchospasm

↓ EtCO<sub>2</sub>, upslope stage III EtCO<sub>2</sub>  
↑ airway pressures, ↓ SpO<sub>2</sub>

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## Bronchospasm

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### Intubated Patient

- Increase FiO<sub>2</sub> to 100%
- Auscultate the chest:
  - Equal breath sounds?
  - Endobronchial ETT?
  - Wheezing?
- Check ETT:
  - Kinked?
  - Secretions/blood in ETT? Needs suctioning?
- Consider albuterol 2-10 puffs, repeat as needed
- Consider deepening anesthetic
- If needed, give ketamine 1-2 mg/kg IV
- If severe, consider EPINEPHrine 1-2 MICROgrams/kg IV (MAX 1 mg)
- Consider IV steroids: methylprednisolone 2 mg/kg IV (MAX 60 mg) or dexamethasone 0.15-0.25 mg/kg (MAX 16 mg)
- Consider chest radiograph
- For refractory bronchospasm, consider magnesium sulfate 50-75 mg/kg (MAX 2 grams) bolused over 20 minutes, (CAUTION, may cause hypotension)

### Non-Intubated Patient

- If ETT in, go to 'Intubated Patient' column on this card (at the left)
- Administer supplemental oxygen
- Auscultate the chest, differentiate from stridor/extrathoracic airway obstruction
- Consider inhaled albuterol (with spacer) 2.5-5 mg. If severe, 5-20 mg/hr inhaled
- Consider chest radiograph
- Consider IV steroids: methylprednisolone 1 mg/kg IV (MAX 60 mg) or dexamethasone 0.15-0.25 mg/kg (MAX 16 mg)
- If severe, consider EPINEPHrine 1-2 MICROgrams/kg IV (MAX 1 mg) or 10 MICROgrams/kg subcutaneous/intramuscular (MAX 0.5 mg)
- If severe, consider ICU and/or advanced airway management.

### Differential Diagnosis

- Endobronchial intubation
- Mechanical obstruction of ETT
  - Kinking
  - Solidified secretions or blood
  - Overinflation of tracheal tube cuff
- Inadequate depth of anesthesia
- URI/tobacco exposure
- Foreign body
- Pulmonary edema
- Tension pneumothorax
- Aspiration pneumonitis
- Pulmonary embolism
- Persistent coughing and straining
- Asthmatic attack
- Anaphylaxis

- Notify team, designate team leader, call for help and code cart/defibrillator
- Increase O<sub>2</sub> to 100%. Turn off anesthetics. Start timer
- If ETT, 100-120 chest compressions/min + 10 breaths/min. Avoid hyperventilation
- If no ETT, 15:2 compression:ventilation ratio (100-120 chest compressions/min + 8 breaths/min)
- For chest compressions, maximize EtCO<sub>2</sub> > 10 mmHg (see next card for more details):
  - Switch compressor every 2 min
  - Use sudden increase in EtCO<sub>2</sub> for ROSC, Do NOT stop compressions for pulse check
- Obtain defibrillator. **Attach pads**. If VF/VT, shock 2 joules/kg. Continue chest compressions for 2 minutes
- Assign roles. Designate a scribe/recorder. Notify family. Continue with items in yellow box

Repeat sequence below until return of spontaneous circulation:

- If still in VF/VT, shock 4 joules/kg q2 min (up to 10 joules/kg on subsequent shocks)
- Resume chest compressions immediately regardless of rhythm
- EPINEPHrine 10 MICROgrams/kg IV q 3-5 min while in arrest (MAX 1 mg)
  - If still no ROSC after second dose of EPINEPHrine, **activate ECMO** (if available)
- Check pulse & rhythm q 2 min during compressor change
- Check for reversible causes (Hs and Ts) early and often (see table below)
- Lidocaine 1 mg/kg bolus (MAX 100 mg); may repeat (total: 2 doses) **OR** amiodarone 5 mg/kg bolus; may repeat (total: 3 doses)
- Repeat sequence in this box until return of spontaneous circulation

### Hs and Ts: Reversible Causes

- |   |  |
|---|--|
| <ul style="list-style-type: none"><li>• Hypovolemia</li><li>• Hypoxemia</li><li>• Hydrogen ion (acidosis)</li><li>• Hyperkalemia/Hypoglycemia</li><li>• Hypothermia</li></ul> | <ul style="list-style-type: none"><li>• Tension Pneumothorax</li><li>• Tamponade (Cardiac)</li><li>• Thrombosi</li><li>• Toxin (anesthetic, β-blocker)</li><li>• Trauma (surgical or nonsurgical bleeding)</li></ul> |
|---|--|

# Cardiac Arrest: Supine/Prone Chest Compressions

- Chest compression instructions (see previous card for full CPR instructions):
  - Place patient on backboard, maintain good hand position; if prone, see instructions below
  - Maximize EtCO<sub>2</sub> > 10 mmHg with force/depth of compressions
  - Allow full recoil between compressions
  - Switch compressor every 2 min
  - Use sudden increase in EtCO<sub>2</sub> for ROSC, Do NOT stop compressions for pulse check

## Prone: Children/Adolescents

- **If no midline incision:**

Compress with heel of hand on spine and second hand on top

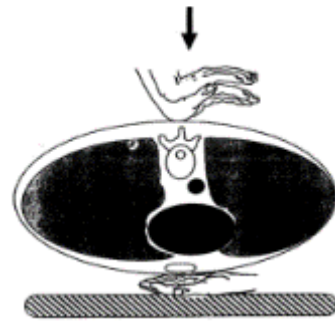


Figure 1

- **If midline incision:**

Compress with heel of each hand under scapula



Figure 2

## Prone: Infants

Compress with encircling technique:

- **If no midline incision:**

thumbs midline

- **If midline incision:**

thumbs lateral to incision



Figure 3

Figure 1: From Dequin P-F et al. Cardiopulmonary resuscitation in the prone position: Kouwenhoven revisited. Intensive Care Medicine, 1996;22:1272

Figure 2: From Tobias et al, Journal of Pediatric Surgery, 1994;29, 1537-1539

Figure 3: Original artwork by Brooke Albright-Trainer, MD



# Difficult Airway, Unexpected

- Increase O<sub>2</sub> to 100% and maintain continuous oxygen flow during airway management
- Call for help, surgical airway expert and cart, rigid bronchoscope and tracheostomy kit
- If unable to mask ventilate, ask for 2-handed assistance and:
  - Insert oral and/or nasal airway
  - If unsuccessful, insert supraglottic airway (e.g., LMA)
  - Decompress stomach with orogastric tube
  - Consider reversing rocuronium or vecuronium with sugammadex (16 mg/kg). Call to obtain if not in OR.
- If able to re-establish pt spontaneous ventilation:
  - Consider awakening patient
  - Consider reversal of neuromuscular blocker
- After two attempts: change providers and consider alternative approaches to intubation (see table)
- If macroglossia (e.g. Beckwith-Wiedemann, Pierre-Robin), or mediastinal mass, consider prone or lateral position
- If still unable to ventilate:
  - Younger children: Emergency non-invasive airway such as rigid bronchoscopy
  - In older children: Jet ventilation or emergency invasive/surgical airway such as cricothyrotomy or tracheostomy



## Alternative Approaches for Intubation

- Different blade
- Re-position head
- Different provider
- Video-laryngoscope
- Bougie
- Intubating LMA
- Fiberoptic scope
- Intubating stylet
- Blind oral
- Blind nasal

- Simultaneously:
  - Disconnect circuit from tracheal tube then remove tracheal tube
  - Stop all gas flow (O<sub>2</sub>, N<sub>2</sub>O)
  - Remove sponges and other flammable materials from airway
  - Pour saline into airway
- Re-intubate and re-establish ventilation
  - If intubation difficult, don't hesitate to obtain surgical airway
- Consider bronchoscopy to assess for thermal injury
  - Look for tracheal tube fragments
  - Remove residual material
- Impound all equipment and supplies for later inspection
- Maintain ventilation. Assess for inhalation injury
- Consider input from ENT, pulmonary, plastic surgery
- Consider PICU
- Shut off gases to affected OR if fire not self-contained
  - Verify gases are not shut off to adjacent rooms



Picture from ECRI: [www.ecri.org](http://www.ecri.org)

- Simultaneously:
  - Stop flow of medical gases
  - Remove drapes and all burning and flammable material from patient
  - Make one attempt to extinguish fire by pouring saline on fire
- If fire not extinguished on 1<sup>st</sup> attempt, use CO<sub>2</sub> fire extinguisher
- If fire persists:
  - **Activate fire alarm**
  - Remove patient from OR
  - Confine fire by closing all OR doors
  - Turn off O<sub>2</sub> gas supply to OR
- Maintain ventilation. Assess for inhalation injury
- Consider input from ENT, pulmonary, plastic surgery
- Consider PICU
- Shut off gases to affected OR if fire not self-contained
  - Verify gases are not shut off to adjacent rooms
- Impound all equipment and supplies for later inspection



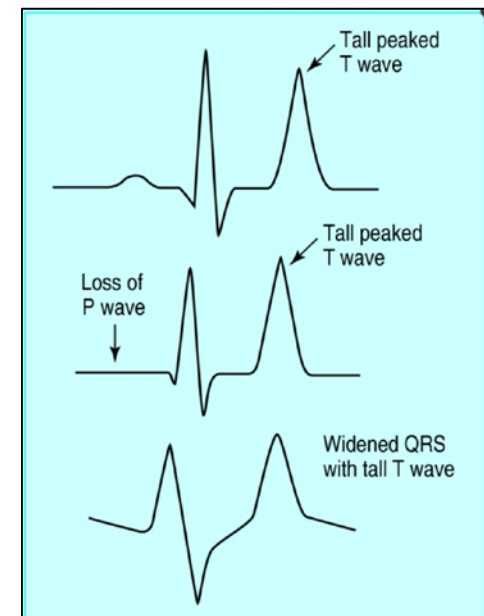
Picture from ECRI: [www.ecri.org](http://www.ecri.org)

## Treatment:

- If hemodynamically unstable, start CPR/PALS
- Hyperventilate with 100% O<sub>2</sub>
- Calcium gluconate 60-100 mg/kg or calcium chloride 20 mg/kg IV
  - Directly visualize site to avoid infiltration
  - Flush tubing after calcium administration
- Stop K<sup>+</sup> containing fluids (LR/RBC); switch to NS
- Dextrose IV 0.5-1 g/kg and insulin IV 0.1 Unit/kg (MAX 10 units)
- Albuterol puffs or nebulized, once cardiac rhythm stable
- Sodium bicarbonate IV 1-2 mEq/kg
- Furosemide IV 0.5-1 mg/kg
- Consider terbutaline 10 MICROgrams/kg load, then 0.1-10 MICROgrams/kg/min
- If cardiac arrest > 6 min, activate ECMO (if available)
- Dialysis if refractory to treatment
- If transfusion required, use washed or fresh RBC

## Manifestations:

- Tall peaked T wave
- Heart block
- Sine wave
- V fib or asystole



From: Slovis C, Jenkins R. BMJ 2002

## Causes of Hyperkalemia:

- Excessive intake: massive or “old” blood products, TPN, cardioplegia, KCl infusion
- Shift of K<sup>+</sup> from tissues to plasma: crush injury, burns, succinylcholine, malignant hyperthermia, acidosis
- Inadequate excretion: renal failure
- Pseudohyperkalemia: hemolyzed sample, thrombocytosis, leukocytosis

# Hypertension, Acute

Sustained high blood pressure refractory to treating reversible causes

- In pediatrics, hypertension is almost always treated by addressing likely causes such as light anesthesia or measurement error:
  - Ensure correct BP cuff size: cuff bladder width ~ 40% of limb circumference
  - Ensure arterial line transducer is at level of heart
    - Consider placing arterial line if not already present

Hypertensive Blood Pressure Range*		
Age (yr)	Systolic	Diastolic
newborn	>97	>70
1-3	>105	>61
4-12	>113	>86

\* **CAUTION:** Anti-hypertensive drugs are almost never needed for routine pediatric cases. These medications are used almost exclusively for specialized cardiac, neurosurgical, or endocrine (pheochromocytoma) cases. Consult an expert before use. Rule-out increased ICP.

Action	Drug (IV Dosing)
Direct smooth muscle relaxation	<ul style="list-style-type: none"> <li>▪ Sodium nitroprusside 0.5-10 MICROgrams/kg/min</li> <li>▪ HydrALAZINE 0.1-0.2 mg/kg (adult dose 5-10 mg)</li> </ul>
β-Adrenergic blockade	<ul style="list-style-type: none"> <li>▪ Esmolol 100-500 MICROgrams/kg over 5 min, then 25-300 MICROgrams/kg/min</li> <li>▪ Labetalol (also α effect) 0.2-1 mg/kg q 10 min; 0.4-3 mg/kg/hour (infusion)</li> </ul>
Calcium channel blockade	<ul style="list-style-type: none"> <li>▪ niCARdapine 0.5-5 MICROgrams/kg/min</li> <li>▪ Clevidipine 0.5-3.5 MICROgrams/kg/min</li> </ul>
D1-dopamine agonist	<ul style="list-style-type: none"> <li>▪ Fenoldopam 0.2-0.8 MICROgrams/kg/min</li> </ul>

- Consider Differential (Partial):
  - Light anesthesia (consider vaporizer or infusion pump empty or malfunctioning)
  - Hypoxemia
  - Thyroid Storm
  - Hypercarbia
  - Arterial line transducer too low or BP cuff too small
  - Pheochromocytoma
  - Withdrawal (EtOH or opioid)
  - Drug Error

- Ensure oxygenation/ventilation
- Turn anesthetic agents down or off
- Check cuff size and transducer position
- Consider placing arterial line if not already present
- Give appropriate treatment (see table below)

Age	< 5 <sup>th</sup> % Systolic BP (mmHg) *	* Numbers are only a guide and vary for individual patients and situations
Preemie	47 – 57	
0 – 3 mo	62 – 69	
3 mo – 1 yr	65 – 68	
1 – 3 yr	68 – 74	
4 – 12 yr	70 – 85	
> 12 yr	85 – 92	

	↓ Preload	↓ Contractility	↓ Afterload
Causes	<ul style="list-style-type: none"> <li>▪ Hypovolemia/hemorrhage</li> <li>▪ Vasodilation</li> <li>▪ Impaired venous return</li> <li>▪ Tamponade</li> <li>▪ IVC compression (prone, obese, surgical)</li> <li>▪ Pneumothorax/pneumoperitoneum/PE</li> <li>▪ Increased PIP or PEEP</li> </ul>	<ul style="list-style-type: none"> <li>▪ Negative inotropic drugs (anesthetic agents)</li> <li>▪ Arrhythmias</li> <li>▪ Hypoxemia</li> <li>▪ Heart failure (ischemia)</li> <li>▪ Hypocalcemia/blood product administration</li> </ul>	<ul style="list-style-type: none"> <li>▪ Drug-induced vasodilation</li> <li>▪ Sepsis</li> <li>▪ Anaphylaxis</li> <li>▪ Adrenal crisis</li> <li>▪ Hypocalcemia</li> <li>▪ Thyroid crisis</li> </ul>
Treatment	<ul style="list-style-type: none"> <li>▪ Expand circulating blood volume (administer fluids rapidly, consider PRBCs and albumin)</li> <li>▪ Trendelenberg position</li> <li>▪ Place or replace IV; consider intraosseous line</li> </ul>	<ul style="list-style-type: none"> <li>▪ Start inotrope if needed: DOPamine 2-20 MICROgrams/kg/min IV infusion, or EPINEPHrine 1-10 MICROgrams/kg IV bolus then EPINEPHrine 0.02-1 MICROgrams/kg/min IV infusion</li> <li>▪ Calcium chloride 10-30 mg/kg IV or Calcium gluconate 50 mg/kg IV</li> <li>▪ Review ECG (rhythm, ischemia), send ABG, Hgb, electrolytes</li> </ul>	<ul style="list-style-type: none"> <li>▪ Start vasopressor if needed: phenylephrine 1-20 MICROgrams/kg IV bolus, then phenylephrine 0.1-2 MICROgrams/kg/min IV infusion, or norepinephrine 0.05-2 MICROgrams/kg/min IV infusion</li> <li>▪ Go to 'Anaphylaxis' card, if appropriate.</li> <li>▪ Administer steroids for adrenal crisis</li> </ul>

- Turn FiO<sub>2</sub> to 100%
- Confirm presence of end-tidal CO<sub>2</sub>, look for any changes in capnogram
- Hand-ventilate to assess compliance
- Listen to breath sounds
- Consider DOPE: displacement, obstruction, pneumothorax, equipment failure
- Check:
  - ETT tube position and patency. Correct if mainstem or supraglottic, suction to rule out mucous plug, secretions, or kink
  - Consider circuit integrity: kink in circuit or ETT, bronchospasm, obstruction, mucous plug
  - Pulse oximeter: try new probe or changing placement
  - Check BP and HR
  - Consider recruitment maneuvers
  - Consider deepening anesthetic or muscle relaxant if patient-ventilator asynchrony
- Further assessment: Draw blood gas. Perform bronchoscopy, CXR, TEE, ECG
- Consider Differential Diagnosis. If airway cause suspected, see appropriate table below

## YES, Airway Cause IS Suspected

### Lungs

- Bronchospasm/atelectasis
- Aspiration
- Pneumothorax
- Pulmonary Edema

### ETT

- Mainstem intubation
- Mucous Plug
- ETT kinked or dislodged

### Machine

- Ventilator settings: RR, TV, I:E ratio, auto-PEEP
- Machine malfunction

## NO, Airway Cause is NOT Suspected

### Drugs/Allergy

- Recent drugs given
- Allergy / anaphylaxis (see 'Anaphylaxis' card)/dose error
- Methylene blue/dyes or methemoglobinemia

### Circulation

- Embolism – air (see 'Air Embolus' card), fat, CO<sub>2</sub>, pulmonary, septic, MI, CHF, cardiac tamponade
- Severe sepsis
- Right to left intracardiac or intrapulmonary shunt
- If associated with hypotension, see 'Hypotension' card

- If GCS < 9, respiratory distress, hemodynamic instability:
  - Secure airway
  - Provide sedation prior to transport
- Keep PaCO<sub>2</sub> 30-35 mmHg and PaO<sub>2</sub> > 80 mmHg
- Maintain cerebral perfusion pressure (discuss goal CPP with team)
- Discuss target ICP with neurosurgery, will often want ICP < 20
- Use vasopressors (phenylephrine or NOREPinephrine) as needed to maintain BP and CPP.
- Consider head of bed at 30°
- Hypertonic saline (3% saline via central venous catheter) 1-5 mL/kg over 20 min, then 0.1-2 mL/kg/hour; goal ICP < 20 mmHg
  - Monitor serum sodium
  - Keep osmolarity < 360 mOsm/L
- If hypertonic saline not available, can give mannitol 0.25-1 g/kg, over 20 minutes to decrease ICP
- Consider furosemide 1-2 mg/kg (starting MAX 20 mg) to decrease ICP
- Consider seizure prophylaxis: Keppra (levetiracetam) 10-30 mg/kg IV (MAX 2500 mg)
- Consult with neurosurgery colleagues about draining CSF directly or via ventriculostomy
- Refractory elevated ICP treatment, consider:
  - Barbiturate coma
  - Paralysis with non-depolarizing agent
- **AVOID:**
  - Compression of neck vessels
  - Hyperthermia
  - Hyperglycemia & dextrose containing solutions (maintain glucose level < 200 mg/dL)

MAP to optimize CPP	
Age (yrs)	MAP
0-4	>45
5-8	>55
>8	>60



## Signs and Symptoms

- Inspiratory stridor, accessory muscle use, sternal retractions, paradoxical chest movement, airway obstruction, ↓SpO<sub>2</sub>, ↓HR, loss of EtCO<sub>2</sub>

## Treatment

- Notify team to cease stimulation/surgery
- Give 100% O<sub>2</sub>, evaluate ventilation
- Apply CPAP and jaw thrust
- Confirm or establish adequate IV access
- Deepen anesthesia with IV and/or inhaled agents. Consider propofol 1-3 mg/kg
- Give succinylcholine 0.1-2 mg/kg (if no IV: 2-4 mg/kg IM)
- If bradycardia, give atropine 0.02 mg/kg IV (if no IV: 0.04 mg/kg IM)
- Consider direct laryngoscopy to secure the airway and/or suction
- Avoid further patient stimulation during stage 2 anesthesia
- If further airway instrumentation needed, consider airway topicalization with lidocaine
- Monitor for negative pressure pulmonary edema (pink frothy secretions). If present, consider ETT, PPV, PEEP, ICU

## Differential Diagnosis

- Circuit disconnect or obstruction
- Upper airway obstruction
- Lower airway obstruction/bronchospasm

- Stop local anesthetic
- Request Intralipid kit
- Secure airway and ventilation
- Give 100% O<sub>2</sub>
- Confirm or establish adequate IV access.
- Confirm & monitor continuous ECG, BP, and SaO<sub>2</sub>
- Seizure treatment:
  - Midazolam 0.05-0.1 mg/kg IV
  - Be prepared to treat resultant hypoventilation
- Treat hypotension with small doses of EPINEPHrine 1 MICROgram/kg
- **Avoid** propofol, vasopressin, calcium channel blockers and beta blockers
- Start Intralipid therapy (see inset box)
- If cardiac instability occurs:
  - Start CPR/PALS
    - Continue chest compressions (lipid must circulate). May need prolonged compressions
- Consider: alert nearest cardiopulmonary bypass/ECMO center & ICU if no ROSC after 6 min
- Monitor and correct acidosis, hypercarbia and hyperkalemia
- Monitor for recurrence for 4-6 hours following the event
- Consider Differential (partial):
  - Anaphylaxis: go to Anaphylaxis card
  - Air, fat, thrombotic, or cement embolus: go to Air Embolism card

## Intralipid Dosing

- Bolus Intralipid 20% 1.5 mL/kg over 1 min
- Start infusion 0.25 mL/kg/min
- Repeat bolus every 3-5 min up to 4.5 mL/kg total dose until circulation is restored
- Double the rate to 0.5 mL/kg/min if BP remains low
- Continue infusion for 10 min after hemodynamic stability is restored.
- MAX total Intralipid 20% dose: 10 mL/kg over first 30 min

- Notify all members of health care team. Call a "time out"
- Loss of evoked potentials (EP) requires definitive steps to re-establish perfusion/remove mechanical cause; MEP loss for > 40 min may increase possibility of long term injury
  - Assure the presence of attending surgeon, attending anesthesiologist, senior neurologist or neurophysiologist, and experienced nurse
  - Each service: review situation, report on management and corrective actions taken
    - Surgeon: rule out mechanical causes for loss/change including traction weights
    - EP technologist: rule out technical causes for loss/change
    - Anesthesiologist: assure no neuromuscular blockade is present; reverse NMB if necessary
- Check patient positioning (neck, upper and lower extremities)
- Review the anesthetic and consider improving spinal cord perfusion by modifying:
  - Mean arterial pressure: MAP > 65 mmHg using ePHEDrine 0.1 mg/kg IV (MAX 10 mg/dose) and/or phenylephrine 0.3-1 MICROgrams/kg IV (MAX 100 MICROgrams/dose), with repeated doses as needed
  - Hemoglobin: if anemic, transfuse RBC to improve oxygen delivery
  - pH and PaCO<sub>2</sub>: ensure normocarbida or slight hypercarbia (↑ I/E ratio, ↓ PEEP)
  - Temperature: ensure normothermia
  - Check for "unintended" drugs given (e.g. neuromuscular blocker)
  - Decrease depth of anesthetic and ensure N<sub>2</sub>O is under 50%
- Discuss feasibility of a useful wake-up test:
  - Patient is appropriate candidate if capable of following verbal commands
- Consider high-dose steroid if no improvement:
  - MethylPREDNISolone 30 mg/kg IV over one hour, then 5.4 mg/kg/hour IV for 23 hours

**MH hotline 1-800-644-9737**

- Get MH Cart, dantrolene, and help
- Notify team and stop procedure, if possible
- Stop volatile anesthetic, succinylcholine.
- Attach charcoal filter. Turn O<sub>2</sub> flow to 10 L/min
- Hyperventilate patient to reduce EtCO<sub>2</sub>
- Give dantrolene 2.5 mg/kg IV, rapidly, through large bore IV if possible, every 5 min until symptoms resolve. May need up to 10 mg/kg (if no response at this dose, consider alternative diagnoses)
  - Dantrium/Revonto: Assign dedicated person to mix these formulations of dantrolene (20 mg/vial) with 60 mL non-bacteriostatic sterile water
  - Ryanodex: 250 mg is mixed with 5 mL non-bacteriostatic sterile water
- Transition to non-triggering anesthetic
- Give sodium bicarbonate 1-2 mEq/kg IV for suspected metabolic acidosis
- Cool patient:
  - Apply ice externally to axilla, groin and around head
  - Infuse cold saline intravenously
  - NG and open body cavity lavage with cold water
  - Stop cooling when temperature < 38° C
- Hyperkalemia treatment:
  - Calcium gluconate 30 mg/kg IV or calcium chloride 10 mg/kg IV;
  - Sodium bicarbonate 1-2 mEq/kg IV;
  - Regular insulin 0.1 units/kg IV (MAX 10 units) and dextrose 0.5-1 g/kg IV
- VT or afib treatment: Do NOT use calcium channel blocker; give amiodarone 5 mg/kg
- Send labs: ABG or VBG, electrolytes, serum CK, serum/urine myoglobin, coagulation
- Place urinary catheter, maintain UO > 2 ml/kg/hr
- If cardiac arrest occurs, begin CPR & consider ECMO, see 'Cardiac Arrest' card
- If no response after 10 mg/kg dantrolene, consider other dx: sepsis, NMS, serotonin synd., myopathy, pheochromocytoma
- Call ICU to arrange disposition. For post-acute management, see: <http://www.mhaus.org>

- Notify Blood Bank immediately, send blood sample for type and cross
- Activate institutional pediatric massive transfusion protocol. Consider RBC : FFP : Platelets = 2:1:1 or 1:1:1
  - Use un-crossmatched O negative PRBCs and AB+ plasma until crossmatched blood available
  - Consider intraoperative blood salvage (e.g., Cell Saver)
- Obtain additional vascular access if needed
- Watch for hyperkalemia, if needed give calcium gluconate 60 mg/kg or calcium chloride 20 mg/kg while directly visualizing IV site (if peripheral)
- Warm the room
- Send labs/perform point of care testing q 30 min: CBC, platelets, PT/PTT/INR, fibrinogen, rapid TEG, ABG, Na, K, Ca, lactate
- Blood product administration:
  - Use 140 micron filter for all products
  - Use a blood warmer for RBC and FFP transfusion (NOT for platelets)
  - Consider use of rapid transfusion pumps
  - Monitor ABG, electrolytes, and temperature
- When under control: call blood bank to terminate

## Treatment

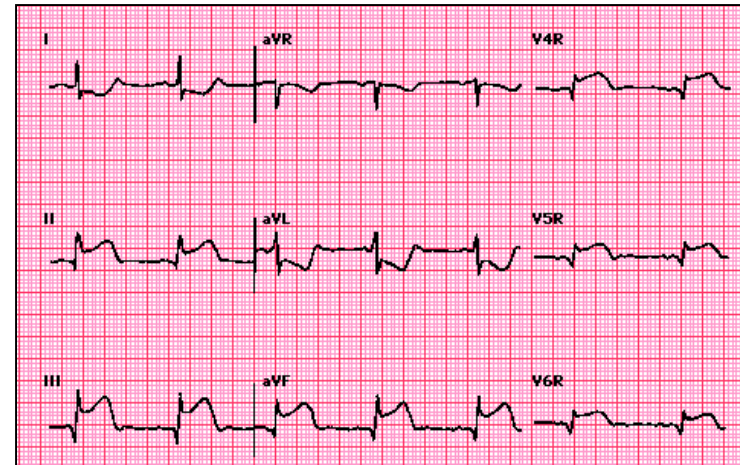
- HCT < 21% or Hgb < 7:
  - 4 ml/kg PRBC increases Hct by 3%
- Platelet count < 50,000 (< 100K for brain injury), rapid TEG-MA < 54mm:
  - 10 ml/kg apheresed platelets increases platelet count by 30 – 50k
- INR > 1.5 (or > 1.3 brain injury), rapid TEG-ACT >120 sec:
  - 10ml/kg plasma increases coagulation factors by 20%
- Fibrinogen < 100 mg/dL or rapid TEG-angle < 66°, k value >120 sec:
  - 10 ml/kg cryoprecipitate increases fibrinogen by 30-50 mg/dL
- Refractory hemorrhage
  - Consider factor VIIa, up to 90 MICROgrams/kg

### Treatment:

- Improve O<sub>2</sub> Supply:
  - Increase O<sub>2</sub> to 100%
  - Correct anemia
  - Correct hypotension
- Decrease O<sub>2</sub> Demand:
  - Reduce heart rate
  - Correct hypertension
  - Restore sinus rhythm
- Drug therapy (rarely needed in peds, consult a pediatric cardiac expert):
  - NitroGLYCERIN 0.5-5 MICROgrams/kg/min
  - Consider heparin infusion 10 Units/kg bolus, then 10 Units/kg/hour

### Potential Causes:

- Severe hypoxemia
- Systemic arterial hypo- or hypertension
- Marked tachycardia
- Severe anemia
- Coronary air embolus
- Cardiogenic shock
- Local anesthetic toxicity



### Recognition

- ST depression >0.5 mm in any lead
- ST elevation >1 mm (2mm in precordial leads)
- Flattened or inverted T waves
- Arrhythmia: VF, VT, ventricular ectopy, heart block

### Diagnostic studies

- 12-lead ECG:
  - II, III, aVF for inferior (RCA)
  - V5 for lateral ischemia (LCx)
  - V2, V3 anterior ischemia (LAD)
- Compare to previous ECGs
- Request Pediatric Cardiology consult and echocardiogram

### Initial Management

- Give 100% O<sub>2</sub> Call stat for inhaled nitric oxide (iNO) 20-40 ppm. Reduced O<sub>2</sub> saturation may not be immediate
- Consider stat TEE and ECMO
- Deepen anesthetic/sedation, consider fentanyl 1 MICROgram/kg or ketamine 0.5-1 mg/kg
- Administer muscle relaxant
- If poor perfusion, consider chest compressions early

### Hypotension Management

- If hypotensive, give vasopressin 0.03 units/kg bolus, then:
  - To maintain perfusion:
    - Vasopressin 0.17-0.67 milliunits/kg/minute = 0.01 to 0.03 units/kg/hour
    - or**
    - NOREPInephrine 0.05-0.3 MICROgrams/kg/min

### Ventilation

- Ventilate with low airway pressures & long expiratory phase to maintain adequate tidal volume, avoid atelectasis and preserve FRC. Maintain normocapnia or mild hypocapnia. PEEP may worsen pulmonary hypertension

### Further Management

- Administer isotonic fluid judiciously to achieve normovolemia and to reduce acid load, correct acidosis with sodium bicarbonate
- Maintain NSR and AV synchrony
- Temperature: ensure normothermia

### Crisis Management

- If cardiac arrest occurs or is imminent, give epinephrine 1-10 MICROgrams/kg
- If cardiac arrest occurs, begin CPR and call for ECMO as CPR may be ineffective if no intracardiac communication

- Call for defibrillator and code cart. Typically infant  $\geq 220$  bpm, child  $\geq 180$  bpm
- Place patient on backboard. Attach defibrillator pads
- Give 100% O<sub>2</sub>, stop anesthetic agents, notify team, consider cardiology consult
- If NO pulse present: start CPR/PALS; go to 'Cardiac Arrest' card
- If pulse present: administer appropriate treatment (see table below)

Treatment			
Narrow complex: p waves present before every QRS	SVT, tachyarrhythmia	Wide complex	Torsade de Pointes: polymorphic VT with prolonged QT
<ul style="list-style-type: none"> <li>▪ Probably sinus tachycardia</li> <li>▪ Identify and treat underlying etiology</li> </ul>	<ul style="list-style-type: none"> <li>▪ Consider vagal maneuvers</li> <li>▪ Adenosine: 1st dose 0.1 mg/kg IV, <b>rapid push</b> (6 mg MAX); 2nd dose 0.2 mg/kg IV (12 mg MAX)</li> <li>▪ Synchronized cardioversion: 0.5-1 joule/kg, additional shocks @ 2 joules/kg</li> </ul>	<ul style="list-style-type: none"> <li>▪ Amiodarone 5 mg/kg IV bolus over 20-60 min</li> <li style="text-align: center;"><b>OR</b></li> <li>▪ Procainamide 15 mg/kg IV bolus over 30-60 min</li> <li style="text-align: center;"><b>OR</b></li> <li>▪ Synchronized cardioversion: 0.5-1 joule/kg, additional shocks @ 2 joules/kg</li> </ul>	<ul style="list-style-type: none"> <li>▪ Magnesium sulfate 25-50 mg/kg IV/IO (MAX 2 g)</li> <li>▪ Lidocaine 1 mg/kg IV (MAX 100 mg)</li> <li>▪ Sodium bicarbonate (for quinidine-related SVT) 1 mEq/kg IV</li> <li>▪ Temporary pacing (see 'Bradycardia' card)</li> </ul>

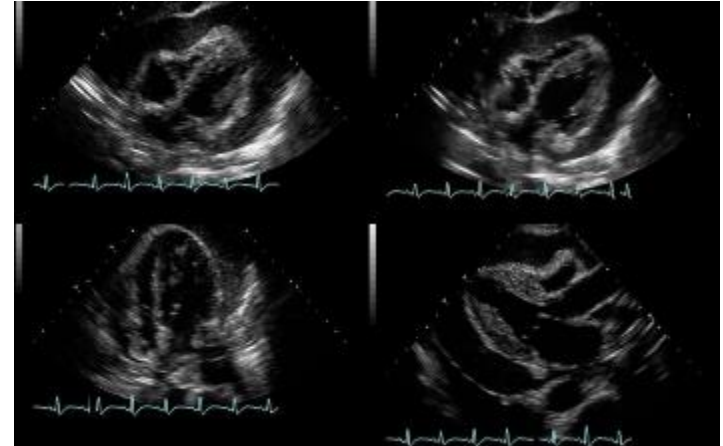


## Signs & Symptoms

- Beck's Triad: muffled heart tones, distended neck veins, decreased systolic blood pressure
- Pulsus Paradoxus: cyclic inspiratory decrease in systolic BP of more than 10mmHg
- Electrical Alternans: cyclic alteration in magnitude of p waves, QRS complex & t-waves
- Typical presentation of acute tamponade = sudden hypotension, tachycardia & tachypnea; patient may be unable to lie flat

## Diagnosis

- Echocardiography/ultrasound: diastolic compression or collapse of RA/RV, leftward displacement of ventricular septum, exaggerated increase in RV size with reciprocal decrease in LV size during inspiration



## Treatment - imaging is key in deciding treatment

- Pericardiocentesis awake/local for large effusions prior to GA
- Surgical for postoperative tamponade (cause is often local collections of clotted blood)

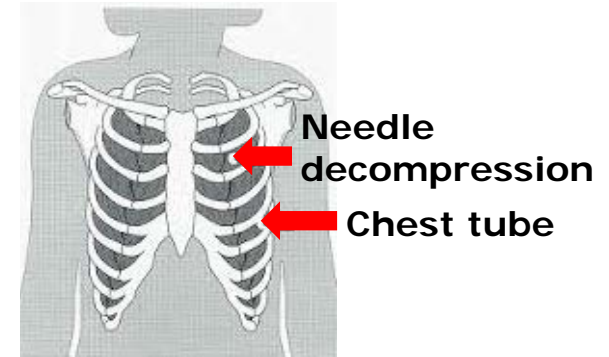
## Anesthetic Considerations

- Progressive decrease in SV with an increased CVP → systemic hypotension → cardiogenic shock
- Goals: maintain sympathetic tone and CO via ↑ HR and contractility/fluid bolus prn
  - Induction: Ketamine (1-2 mg/kg IV), muscle relaxant
  - If CV collapse: EPINEPHrine 0.05-0.1 MICROgrams/kg IV bolus or infusion (0.01-0.1 MICROgrams/kg/min)
  - Access: Large bore PIV; arterial line ideal but should not delay treatment in hemodynamically unstable patient
  - Avoid: cardiac depression, vasodilation, ↓ HR; ↑ airway pressure (will ↓ venous return) so may need small tidal volumes or hand ventilation

## Differential Diagnosis

- CHF, PE
- If pulsus paradoxus: respiratory distress, airway obstruction, COPD, PE, RV infarction

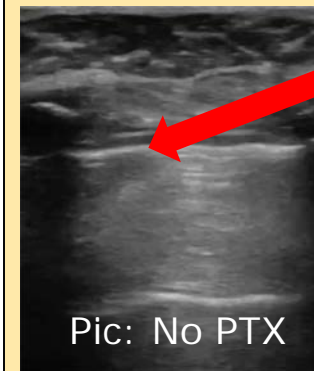
- Stop N<sub>2</sub>O; increase O<sub>2</sub> to 100%
- Perform immediate needle decompression, then chest tube placement
- Needle decompression:
  - 2<sup>nd</sup> rib space superior to 3<sup>rd</sup> rib, mid-clavicular line
    - 14-16g angiocath for teens/adults
    - 18-20g angiocath for infants/children
- Secure airway with endotracheal tube
- Reduce positive ventilation pressure
- Consider CXR, lung ultrasound, transillumination to confirm diagnosis (see inset)
- Administer vasopressors for circulatory collapse
- Chest tube insertion
  - 5-6<sup>th</sup> intercostal space, mid-axillary line
- If no improvement in hemodynamics after a rush of air, consider:
  - Needle decompression of contralateral side
  - Presence of pneumopericardium
  - Scan both lungs with ultrasound or transillumination to evaluate for alternate side or insufficiently decompressed pneumothorax



Downloaded from:  
[http://www.uwhealth.org/images/ewebeditpro/uploadimages/5384\\_Figure\\_1.jpg](http://www.uwhealth.org/images/ewebeditpro/uploadimages/5384_Figure_1.jpg)

## Lung Ultrasound Instructions

- High frequency probe, place longitudinally on chest, 2<sup>nd</sup> intercostal space. Slide probe downwards to observe pleural sliding



- If see pleural sliding, 100% positive predictive value no pneumothorax
- If no pleural sliding, consider pneumothorax, ARDS, fibrosis, acute asthma, pleurodesis

## For All Reactions:

- Stop transfusion
- Disconnect donor product and IV tubing
- Infuse normal saline through clean tubing
- Examine blood product ID; determine correct pt
- Send product to Blood Bank
- Determine the type of reaction:

	Hemolytic	Non-Hemolytic	Anaphylactic
Signs	Hemoglobinemia, hemoglobinuria, DIC, ↓ BP, ↑ HR, bronchospasm	↓ BP, bronchospasm, pulmonary edema, fever, rash	Erythema, urticaria, angioedema, bronchospasm, tachycardia, shock
Treatment	<ul style="list-style-type: none"> <li>▪ Furosemide 1-2 mg/kg IV (MAX 40 mg)</li> <li>▪ Mannitol 0.25-1 g/kg</li> <li>▪ Support BP to maintain renal perfusion</li> <li>▪ Maintain urine output at least 1-2 mL/kg/hour</li> <li>▪ Prepare for cardiovascular instability</li> <li>▪ Send blood and urine sample to laboratory</li> </ul>	<ul style="list-style-type: none"> <li>▪ Treat fever</li> <li>▪ Treat pulmonary edema</li> <li>▪ Observe for signs of hemolysis</li> </ul>	<ul style="list-style-type: none"> <li>▪ Support airway and circulation as necessary</li> <li>▪ EPINEPHrine 1-10 MICROgrams/kg IV</li> <li>▪ DiphenhydrAMINE 1 mg/kg IV (MAX 50 mg)</li> <li>▪ MethyIPREDNISolone 2 mg/kg IV (MAX 60 mg)</li> <li>▪ Maintain intravascular volume</li> </ul>

**Set-up prior to patient arrival to OR:**

- Assemble team and assign roles
- Estimate weight and prepare emergency drugs
- Warm the room
- Gather equipment:
  - Airway supplies
  - Line placement and monitoring devices
  - Fluid warmer/rapid infusion device
  - Code cart with programmed defibrillator
- Type and cross blood products. Activate massive transfusion protocol if indicated

**On patient arrival to OR:**

- Maintain c-spine precautions for transport
- Secure/confirm airway (often aspiration risk, unstable c-spine)
- Ensure adequate ventilation (maintain PIP < 20 cm H<sub>2</sub>O)
- Obtain/confirm large-bore IV access (central or intraosseous if peripheral unsuccessful)
- Assess hemodynamic stability.
  - If hypovolemic, pre-induction fluid bolus recommended: 20 mL/kg LR or NS (repeat x 2) and/or 10 mL/kg RBCs or 20 mL/kg whole blood
- Arterial and central venous line placement if indicated
- Maintain normothermia
- Monitor and treat associated conditions
  - Anemia, coagulopathy, acidosis, electrolyte derangements
- Continuously assess for undiagnosed secondary and/or developing injuries, blood loss

# MATERNAL CRISIS

- **ATTENTION:** This checklist is for **ADULT-SIZED** maternal patients **ONLY**
- Prepare for crystalloid and blood product resuscitation
- Obtain vascular access with 2 large-bore IVs
- Call Blood Bank to activate Massive Transfusion with PRBC:FFP:platelet in a 4:2:1 ratio. Ask blood bank to prepare next round when each round is picked up.
  - Give calcium chloride ADULT DOSE 200-500mg/Unit PRBCs, in separate line. Monitor for hyperkalemia
  - Consider giving tranexamic acid early
  - If refractory hemorrhage, consider fVIIa and cryoprecipitate or fibrinogen concentrate
- Give uterotonics
- Call for rapid transfuser or pressure bags
- Warm room, patient and fluids (NOT platelets)
- Send CBC, PT/PTT/INR, fibrinogen, calcium, K, ABG

Obstetric Interventions	Consider
<ul style="list-style-type: none"> <li>• Intrauterine balloon</li> <li>• External uterine compression sutures</li> <li>• Uterine artery ligation</li> <li>• Hysterectomy</li> </ul>	<ul style="list-style-type: none"> <li>• Arterial line</li> <li>• If awake, convert to general anesthesia</li> <li>• Embolization in IR</li> <li>• TEG/ROTEM monitoring</li> </ul>

## Treatment

### ADULT MATERNAL Uterotonics:

- Oxytocin ADULT DOSE 3-5 Units rapid infusion, then start 40 Units slow infusion
- Methylergonovine (Methergine) ADULT DOSE 0.2mg IM **NOT IV**, may repeat in 2 hours (AVOID in HTN and pre-eclampsia)
- Carboprost (Hemabate) ADULT DOSE 0.25mg IM **NOT IV**, may repeat q 15 minutes up to 8 doses (AVOID in asthma, pulmonary hypertension)
- Misoprostol ADULT DOSE 800-1000 MICROgrams rectal

### Hemostatics:

- Tranexamic acid ADULT DOSE 1g IV
- If low fibrinogen, give cryoprecipitate ADULT DOSE 10 units or fibrinogen concentrate
- If refractory hemorrhage, consider factor VIIa 90 MICROgrams/kg, up to 3 doses