PediCrisis

CRITICAL EVENTS CARDS

Call for help!

Code Team ___________
PICU ___________
Fire ___________
Overhead STAT ___________
ECMO ___________

Notify surgeon.

Revision December 14, 2015
Air Embolism

- Stop nitrous oxide and volatile agents. Increase O₂ to 100%.
- Find air entry point, stop source, and limit further entry.
  - Tell surgeon to flood wound with irrigation AND turn off all pressurized gas sources, e.g. laparoscope, endoscope
  - Check for open venous lines or air in IV tubing
  - Lower surgical site below level of heart (if possible)
  - Perform Valsalva on patient using hand ventilation
  - Compress jugular veins intermittently if head or cranial case
- If hypotensive, consider:
  - Vasopressor infusion (epinephrine 0.02-1 MICROgrams/kg/min, norepinephrine 0.05-2 MICROgrams/kg/min)
  - Chest compressions: 100/min to force air through lock, even if not in cardiac arrest
- If available, call for transesophageal echocardiography

- EtCO₂ ↓  
- SaO₂ ↓  
- BP ↓
**Anaphylaxis**

- Increase O₂ to 100%
- Remove suspected trigger(s)
  - If latex is suspected, thoroughly wash area
- Ensure adequate ventilation/oxygenation
- If HYPOtensive, turn off anesthetic agents

### Common causative agents:
- Neuromuscular blockers
- Latex
- Chlorhexidine
- IV colloids
- Antibiotics

### Purpose, Treatments, Dosage and Administration

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Treatments</th>
<th>Dosage and Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>To restore intravascular volume</td>
<td>NS or LR</td>
<td>10-30 mL/kg IV/IO, <strong>rapidly</strong></td>
</tr>
<tr>
<td>To restore BP and ↓ mediator release</td>
<td>Epinephrine</td>
<td>• 1-10 MICROgrams/kg IV/IO, as needed, may need infusion 0.02-0.2 MICROgrams/kg/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Additionally, can give 10 MICROgrams/kg IM for depo effect</td>
</tr>
<tr>
<td>To ↓ bronchoconstriction</td>
<td>Albuterol (Beta-agonists)</td>
<td>4-10 puffs as needed</td>
</tr>
<tr>
<td>To ↓ mediator release</td>
<td>Methylprednisolone</td>
<td>2 mg/kg IV/IO MAX 100 mg</td>
</tr>
<tr>
<td>To ↓ histamine-mediated effects</td>
<td>Diphenhydramine</td>
<td>1 mg/kg IV/IO MAX 50 mg</td>
</tr>
<tr>
<td>To ↓ effects of histamine</td>
<td>Famotidine or Ranitidine</td>
<td>0.25 mg/kg IV 1 mg/kg IV</td>
</tr>
</tbody>
</table>

- If anaphylactic reaction requires laboratory confirmation, send mast cell tryptase level within 2 hours of event
# Anterior Mediastinal Mass

- Increase $O_2$ to 100%

<table>
<thead>
<tr>
<th>Intra-operative Treatments</th>
<th>Cardiovascular collapse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airway collapse</strong></td>
<td><strong>Give fluid bolus</strong></td>
</tr>
<tr>
<td>- Increase FiO₂</td>
<td><strong>Reposition to lateral or prone</strong></td>
</tr>
<tr>
<td>- Add CPAP for spontaneous ventilation; add PEEP for controlled ventilation</td>
<td><strong>Ask surgeon for sternotomy and elevation of mass</strong></td>
</tr>
<tr>
<td>- Reposition to lateral or prone</td>
<td><strong>Consider ECMO</strong></td>
</tr>
<tr>
<td>- Ventilate via rigid bronchoscope</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preoperative Considerations</th>
<th>Anesthetic Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Risk Factors</strong></td>
<td><strong>Perform surgery under local anesthesia, if possible</strong></td>
</tr>
<tr>
<td>- Diagnosis: Hodgkin’s and non-Hodgkin’s lymphoma</td>
<td><strong>Pre-treat with irradiation or corticosteroids</strong></td>
</tr>
<tr>
<td>- Clinical signs: orthopnea, upper body edema, stridor, wheezing</td>
<td><strong>Maintain spontaneous ventilation and avoid paralysis</strong></td>
</tr>
<tr>
<td>- Imaging findings: tracheal, bronchial, carinal, or great vessel compression; SVC or RVOT obstruction; ventricular dysfunction; pericardial effusion</td>
<td><strong>Ensure availability of:</strong></td>
</tr>
<tr>
<td></td>
<td>- Fiberoptic and rigid bronchoscope</td>
</tr>
<tr>
<td></td>
<td>- Cardiopulmonary bypass or ECMO</td>
</tr>
</tbody>
</table>
Bradycardia

- **Definition:**

<table>
<thead>
<tr>
<th>Age</th>
<th>HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 30 days</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>≥ 30 days &lt; 1 yr</td>
<td>&lt; 80</td>
</tr>
<tr>
<td>≥ 1 yr</td>
<td>&lt; 60</td>
</tr>
</tbody>
</table>

- **Unstable:** If hypotensive or pulseless, start chest compressions
  - Give epinephrine 10 MICROgrams/kg IV
  - Call for transcutaneous pacer (see inset)
    - Start pacing, when available

- **If NOT hypotensive or pulseless:**

**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

**Etiology**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Treatment</th>
</tr>
</thead>
</table>
| Hypoxia (most common)        | - Give 100% O₂  
                              | - Good ventilation  
                              | - See ‘Hypoxia’ card |
| Vagal                        | - Atropine 0.01-0.02 mg/kg                     |
| Surgical Stimulation         | - Stop stimulation  
                              | - If laparoscopy, de-sufflate                  |
| Beta-Blocker Overdose        | - Glucagon 0.05 mg/kg IV, then 0.07 mg/kg/hour IV infusion |
| Ca-Channel Blocker Overdose  | - Calcium chloride 10-20 mg/kg IV  
                              | - Calcium gluconate 50 mg/kg  
                              | - If ineffective, Glucagon at above doses     |
Cardiac Arrest: Asystole, PEA

- Start chest compressions (100 chest compressions/min + 8 breaths/min)
  - Place patient on backboard, maintain good hand position; if prone, see ‘Prone CPR’ card
  - Maximize EtCO₂ > 10 mmHg with force/depth of compressions
  - Allow full recoil between compressions
  - Switch with another provider every 2 min, if possible
  - Use sudden increase in EtCO₂ for ROSC. Do NOT stop compressions for pulse check

- Give 100% O₂. Turn off all anesthetic gases and infusions
- Start timer. Designate team leader. Assign roles
- Obtain defibrillator. Attach pads

- Give epinephrine 10 MICROgrams/kg IV q 3-5 min
- Check pulse and rhythm (q 2 min during compressor switch)
- If no pulse and still not a shockable rhythm (asystole, PEA), resume CPR
- If a shockable rhythm (VF, VT): see next card ‘Cardiac Arrest: VF/VT’
- Check for reversible causes (Hs and Ts) early and often (see table)

<table>
<thead>
<tr>
<th>Hs and Ts: Reversible Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolemia</td>
</tr>
<tr>
<td>Hypoxemia</td>
</tr>
<tr>
<td>Hydrogen ion (acidosis)</td>
</tr>
<tr>
<td>Hyperkalemia</td>
</tr>
<tr>
<td>Hypoglycemia</td>
</tr>
<tr>
<td>Hypothermia</td>
</tr>
<tr>
<td>Tension Pneumothorax</td>
</tr>
<tr>
<td>Tamponade (Cardiac)</td>
</tr>
<tr>
<td>Thrombosis</td>
</tr>
<tr>
<td>Toxin (anesthetic, β-blocker)</td>
</tr>
<tr>
<td>Trauma (bleeding outside surgical area)</td>
</tr>
</tbody>
</table>

- If cardiac arrest > 6 min, activate ECMO (if available)
Cardiac Arrest: VF/VT

- Start chest compressions (100 chest compressions/min + 8 breaths/min)
  - Place pt on backboard, maintain good hand position; if prone, see ‘Prone CPR’ card
  - Maximize EtCO₂ > 10 mmHg with force/depth of compressions
  - Allow full recoil between compressions
  - Switch compressor every 2 min
  - Use sudden increase in EtCO₂ for ROSC
  - Do NOT stop compressions for pulse check

- Give 100% oxygen. Turn off anesthetics
- Start timer. Designate team leader. Assign roles
- Obtain defibrillator. Attach pads. Shock 2-4 joules/kg
- Resume chest compressions immediately
- Epinephrine 10 MICROgrams/kg IV q 3-5 min while in arrest
- Check pulse & rhythm q 2 min during compressor change
- Check for reversible causes (Hs and Ts) early and often (see previous ‘Cardiac Arrest’ card)

- If VF/VT continue:
  - Shock 4 joules/kg
  - Resume chest compressions for 2 min regardless of rhythm
  - Check pulse & rhythm q 2 min during compressor switch
  - Repeat epinephrine 10 MICROgrams/kg IV q 3-5 min if VF/VT continue
  - If VF/VT continue 2 min after previous defib attempt, shock 4-10 joules/kg and resume chest compressions for 2 min; check pulse with compressor change; repeat sequence until ROSC

- Lidocaine 1 mg/kg bolus OR amiodarone 5 mg/kg bolus; may repeat (total of 2 doses)
- If cardiac arrest > 6 min, activate ECMO (if available)
Cardiac Arrest: Prone CPR

**Children/Adolescents**

- **If no midline incision:** Compress with heel of hand on spine and second hand on top

- **If midline incision:** Compress with heel of each hand under scapula

**Infants**

Compress with encircling technique:

- **If no midline incision:** Thumbs midline

- **If midline incision:** Thumbs lateral to incision

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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-Trainer, MD
Difficult Airway: After Induction

Unable to intubate or ventilate

- Increase O₂ to 100% and maintain continuous oxygen flow during airway management
- Call for airway cart, including surgical airway equipment
- Call for airway surgeon and HELP

- 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)

- If able to re-establish pt spontaneous ventilation:
  - Consider reversing neuromuscular blocker
  - Consider awakening pt if surgery not started

- Consider alternative approach for intubation; limit to 2 attempts per operator (see table)

### Alternative Approaches for Intubation

<table>
<thead>
<tr>
<th>Different blade</th>
<th>Fiberoptic scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-position head</td>
<td>Intubating stylet</td>
</tr>
<tr>
<td>Different operator</td>
<td>Blind oral</td>
</tr>
<tr>
<td>Video-laryngoscope</td>
<td>Blind nasal</td>
</tr>
<tr>
<td>Intubating LMA</td>
<td></td>
</tr>
</tbody>
</table>

- If still unable to ventilate:
  - Emergency non-invasive airway (rigid bronchoscopy)
  - Emergency invasive/surgical airway
**Fire: Airway**

Fire in tracheal tube, circuit, canister

- **Simultaneously:**
  - Disconnect circuit from tracheal tube and remove tracheal tube
  - Stop all gas flow (O₂, N₂O)
  - 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**

*Picture from ECRI: www.ecri.org*
OR Fire (non-airway)

- 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 1st attempt, use CO₂ fire extinguisher

- If fire persists:
  - **Activate fire alarm**
  - Remove patient from OR
  - Confine fire by closing all OR doors
  - Turn off O₂ gas supply to OR

- Impound all equipment and supplies for later inspection

Picture from ECRI: www.ecri.org
Hyperkalemia

Serum K+ > 6 mEq/l

Treatment:
- If hemodynamically unstable, initiate CPR/PALS
- Hyperventilate with 100% O₂
- IV calcium gluconate 60 mg/kg or calcium chloride 20 mg/kg
- Flush tubing after calcium administration
- Stop K+ containing fluids (LR/RBC); switch to NS
- Sodium bicarbonate IV 1-2 mEq/kg
- Albuterol puffs or nebulized, once cardiac rhythm stable
- Dextrose IV 0.25-1 g/kg and insulin IV 0.1 Unit/kg
- Furosemide IV 0.1 mg/kg
- 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

Causes of Hyperkalemia:
- Excessive intake: massive or “old” blood products, cardioplegia, KCl infusion
- Shift of K+ from tissues to plasma: crush injury, burns, succinylcholine, malignant hyperthermia, acidosis
- Inadequate excretion: renal failure

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

From: Slovis C, Jenkins R. BMJ 2002
Acute Hypertension

- 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

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

<table>
<thead>
<tr>
<th>Action</th>
<th>Drug (IV Dosing)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct smooth muscle relaxation</td>
<td>Sodium nitroprusside 0.5-10 MICROgrams/kg/min</td>
</tr>
<tr>
<td></td>
<td>Hydralazine 0.1-0.2 mg/kg (adult dose 5-10 mg)</td>
</tr>
<tr>
<td>β-Adrenergic blockade</td>
<td>Esmolol 100-500 MICROgrams/kg over 5 min, then 25-300 MICROgrams/kg/min</td>
</tr>
<tr>
<td></td>
<td>Labetalol (also α effect) 0.2-1 mg/kg q 10 min; 0.4-3 mg/kg/hour (infusion)</td>
</tr>
<tr>
<td></td>
<td>Propranolol 10-100 MICROgrams/kg slow push (adult bolus dose 1-5 mg)</td>
</tr>
<tr>
<td>α₂-Agonist</td>
<td>Clonidine 0.5-2 MICROgrams/kg</td>
</tr>
<tr>
<td>Calcium channel blockade</td>
<td>Nicardipine 0.5-5 MICROgrams/kg/min</td>
</tr>
<tr>
<td></td>
<td>Clevidipine 0.5-3.5 MICROgrams/kg/min</td>
</tr>
<tr>
<td>D1-dopamine agonist</td>
<td>Fenoldopam 0.0-0.5 MICROgrams/kg/min (MAX 2.5 MICROgrams/kg/min)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypertensive Blood Pressure Range*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
</tr>
<tr>
<td>newborn</td>
</tr>
<tr>
<td>1-3</td>
</tr>
<tr>
<td>4-12</td>
</tr>
</tbody>
</table>
Hypotension

- 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)

### Causes

<table>
<thead>
<tr>
<th>↓ Preload</th>
<th>↓ Contractility</th>
<th>↓ Afterload</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hypovolemia</td>
<td>• Negative inotropic drugs (anesthetic agents)</td>
<td>• Drug-induced vasodilation</td>
</tr>
<tr>
<td>• Vasodilation</td>
<td>• Arrhythmias</td>
<td>• Sepsis</td>
</tr>
<tr>
<td>• Impaired venous return</td>
<td>• Hypoxemia</td>
<td>• Anaphylaxis</td>
</tr>
<tr>
<td>• Tamponade</td>
<td>• Heart failure (ischemia)</td>
<td>• Endocrine crisis</td>
</tr>
<tr>
<td>• Pulmonary embolism</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Treatment

<table>
<thead>
<tr>
<th>↓ Preload</th>
<th>↓ Contractility</th>
<th>↓ Afterload</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Expand circulating blood volume (administer fluids rapidly)</td>
<td>• Start inotrope infusion (dopamine, epinephrine, milrinone), as needed</td>
<td>• Start vasopressor infusion: phenylephrine, norepinephrine</td>
</tr>
<tr>
<td>• Trendelenberg position</td>
<td>• Review ECG for rhythm disturbances or ischemia</td>
<td>• Go to ‘Anaphylaxis’ card, if appropriate.</td>
</tr>
<tr>
<td>• Place or replace IV; consider intraosseous line</td>
<td>• Send ABG, Hgb, electrolytes</td>
<td>• Administer steroids for endocrine crisis</td>
</tr>
</tbody>
</table>

### Sustained low blood pressure with patient at risk for end-organ hypoperfusion, typically > 20% below baseline

<table>
<thead>
<tr>
<th>Age</th>
<th>&lt; 5th% Systolic BP (mmHg)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preemie</td>
<td>47– 57</td>
</tr>
<tr>
<td>0 – 3 mo</td>
<td>62 – 69</td>
</tr>
<tr>
<td>3 mo – 1 yr</td>
<td>65 – 68</td>
</tr>
<tr>
<td>1 – 3 yr</td>
<td>68 – 74</td>
</tr>
<tr>
<td>4 – 12 yr</td>
<td>70 – 85</td>
</tr>
<tr>
<td>&gt; 12 yr</td>
<td>85 – 92</td>
</tr>
</tbody>
</table>

* Numbers are only a guide and vary for individual patients and situations
### Hypoxia with ↑ EtCO₂

<table>
<thead>
<tr>
<th>All Patients</th>
<th>Additional Items for Intubated Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Increase O₂ to 100%</td>
<td>Dislodged: Check ETT position</td>
</tr>
<tr>
<td>▪ Check:</td>
<td>▪ Mainstem</td>
</tr>
<tr>
<td>• Oxygen flow</td>
<td>▪ Not in trachea</td>
</tr>
<tr>
<td>• Airway patency</td>
<td></td>
</tr>
<tr>
<td>• Breathing circuit connected and patent</td>
<td>Obstructed: Suction ETT</td>
</tr>
<tr>
<td>• Ventilation rate and depth adequate</td>
<td>▪ Kinked</td>
</tr>
<tr>
<td>• Breath sounds:</td>
<td>▪ Mucus plug</td>
</tr>
<tr>
<td>▪ Wheezing</td>
<td></td>
</tr>
<tr>
<td>▪ Crackles</td>
<td></td>
</tr>
<tr>
<td>▪ Diminished or absent</td>
<td></td>
</tr>
<tr>
<td>• Pulse oximeter working correctly</td>
<td>Pneumothorax: Listen to breath sounds</td>
</tr>
<tr>
<td>• Presence of cardiac shunt</td>
<td>▪ Decompress with large-bore angiocatheter in midclavicular line at 2&lt;sup&gt;nd&lt;/sup&gt; or 3&lt;sup&gt;rd&lt;/sup&gt; intercostal space.</td>
</tr>
<tr>
<td>• Possibility of embolus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equipment</td>
</tr>
<tr>
<td></td>
<td>▪ Check from patient to wall:</td>
</tr>
<tr>
<td></td>
<td>• Oxygen flow</td>
</tr>
<tr>
<td></td>
<td>• Valves</td>
</tr>
<tr>
<td></td>
<td>• CO₂ canister</td>
</tr>
<tr>
<td></td>
<td>• Inspect for disconnections and obstructions</td>
</tr>
</tbody>
</table>
### Hypoxia with ↓ EtCO₂

<table>
<thead>
<tr>
<th>Respiratory Etiology</th>
<th>Low Cardiac Output State</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Increase O₂ to 100%</td>
<td>▪ Increase O₂ to 100%</td>
</tr>
<tr>
<td>▪ Check:</td>
<td>▪ Embolus: air, blood, fat</td>
</tr>
<tr>
<td>• Airway patency</td>
<td>• See ‘Air Embolism’ card</td>
</tr>
<tr>
<td>• Breathing circuit connections:</td>
<td>• Ask surgeon to flood surgical field with saline</td>
</tr>
<tr>
<td>▪ Check for kinked endotracheal tube</td>
<td>• Lower surgical site below heart</td>
</tr>
<tr>
<td>• Breath sounds and chest excursion:</td>
<td>▪ Low cardiac output or cardiac arrest</td>
</tr>
<tr>
<td>▪ Bilateral sounds and chest movement</td>
<td>• If cardiac arrest, follow PALS algorithm</td>
</tr>
<tr>
<td>▪ Quality of breath sounds</td>
<td>• Support ventilation</td>
</tr>
<tr>
<td>▪ Presence of wheezing or crackles</td>
<td>• Support blood pressure with IV saline (10-20 mL/kg bolus)</td>
</tr>
<tr>
<td>• Gas analyzer connections; ensure power on</td>
<td>• Turn off anesthetic agents</td>
</tr>
<tr>
<td>• Excessive ventilation rate</td>
<td></td>
</tr>
</tbody>
</table>
Increased Intracranial Pressure

- If GCS < 9, respiratory distress, hemodynamic instability:
  - Secure airway
  - Provide sedation prior to transport
  - Keep PaCO₂ 30-35 mmHg and PaO₂ > 60 mmHg

- Maintain cerebral perfusion pressure (CPP) > 50 mmHg
- Use vasopressors (phenylephrine or norepinephrine) as needed to maintain BP and CPP
- HOB at 30°
- Consider TIVA for anesthesia maintenance

- Give steroids as indicated
- Hypertonic saline (3% saline via central venous catheter) 1-3 mL/kg over 20 min, then 0.1-1 mL/kg/hour
  - Monitor serum sodium
  - Keep osmolarity < 360 mOsm/L
- Give mannitol 0.25-1 g/kg, to decrease ICP

- Consider seizure prophylaxis: Keppra (levetiracetam) 10 mg/kg IV

**AVOID:**
- Compression of neck vessels
- Hyperthermia
- Hyperglycemia & dextrose containing solutions (maintain glucose level < 200 mg/dL)

- Refractory elevated ICP treatment, consider:
  - Hyperventilation (PaCO₂ 28-35 mmHg)
  - Barbiturate coma
  - Paralysis with non-depolarizing agent
Local Anesthetic Toxicity

- Stop local anesthetic
- Request Intralipid kit

- Secure airway and ventilation
- Give 100% O₂

- Confirm or establish adequate IV access.
- Confirm and monitor continuous ECG, BP, and SaO₂

- 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

- Start Intralipid therapy (see inset box)

- If cardiac instability occurs:
  - Start CPR/PALS
    - Continue chest compressions (lipid must circulate)

- Avoid vasopressin, calcium channel blockers and beta blockers
- Monitor and correct acidosis, hypercarbia and hyperkalemia
- Consider alerting nearest cardiopulmonary bypass/ECMO center and ICU if no ROSC after 6 min

### 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 3 mL/kg total dose until circulation is restored
- Increase the rate to 0.5 mL/kg/min if BP remains low or declines
- Continue infusion for 10 min after hemodynamic stability is restored.
- MAX total Intralipid 20% dose: 10 mL/kg over first 30 min
Loss of Evoked Potentials

- 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
    - 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: maintain MAP > 65 mmHg using ephedrine 0.1 mg/kg IV and/or phenylephrine 0.3 - 10 MICROgrams/kg IV, with repeated doses as needed
  - Hemoglobin: if anemic, transfuse RBC to improve oxygen delivery
  - pH and PaCO₂: ensure normocarbia or slight hypercarbia (↑ I/E ratio, ↓ PEEP)
  - Temperature: ensure normothermia
  - Check for “unintended” drugs given (e.g. neuromuscular blocker)
  - Decrease depth of anesthetic
- 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
**Malignant Hyperthermia**

- Obtain Malignant Hyperthermia (MH) Kit
- Stop procedure, if possible
- Stop volatile anesthetic. Transition to non-triggering anesthetic
- Attach charcoal filter. Turn O₂ flow to 10 L/min
- Hyperventilate patient to reduce EtCO₂: 2-4 times patient’s minute ventilation

**Give dantrolene or Ryanodex 2.5 mg/kg IV every 5 min until symptoms resolve**
- 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
- Give sodium bicarbonate 1-2 mEq/kg IV for suspected metabolic acidosis; maintain pH > 7.2

**Cool patient if temperature > 39° C**
- Apply ice externally to axilla, groin and around head
- Infuse cold saline intravenously
- NG 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 gm/kg

**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 Foley catheter to monitor urine output. Call ICU to arrange disposition**

**If cardiac arrest occurs, begin CPR and consider ECMO**

MH hotline 1-800-644-9737
Myocardial Ischemia

ST changes on ECG

**Treatment:**
- Improve $O_2$ Supply:
  - Give 100% $O_2$
  - Correct anemia
  - Correct hypotension
- Decrease $O_2$ Demand:
  - Reduce heart rate
  - Correct hypertension
  - Restore sinus rhythm
- Drug therapy:
  - 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 Ped Cardiology consult and echocardiogram
Pulmonary Hypertensive Crisis

**Mean PAP > Mean SAP**

**Manifestation**
- Acute ↓ O₂ sat, ↓ BP, ↓ EtCO₂, ↑ CVP
- ↓ Airway pressures from RV failure after abrupt pulmonary vasoconstriction
- RV diastolic hypertension → reduced LV filling and ↓ cardiac output
- Bradycardia → Hypotension → Cardiac arrest

**Management**
- Give 100% O₂
- ASAP: Call for inhaled nitric oxide (iNO) 20-40 ppm
- Deepen anesthetic/sedation, administer narcotic, but avoid decreasing SVR.
- Consider using additional pulmonary vasodilators such as inhaled prostacyclin & IV milrinone
- Administer muscle relaxant
- Ventilation:
  - Use lowest PEEP necessary to maintain oxygenation, long expiratory phase
  - Ventilate with low airway pressures, but maintain adequate tidal volume to avoid atelectasis and preserve FRC
  - Hyperventilation to avoid hypercarbia
- Fluid management:
  - Use judicious fluid administration
  - Correct acidosis with sodium bicarbonate
  - Consider Plasmalyte rather than normal saline to reduce acid load
- Maintain coronary perfusion and treat RV ischemia
  - Administer norepinephrine, phenylephrine, vasopressin to maintain perfusion
  - Utilize pulmonary vasodilators as needed
- Maintain NSR and AV synchrony
- Temperature: ensure normothermia
- If cardiac arrest occurs, begin CPR and consider ECMO
Tachycardia

- Call for defibrillator and code cart
- Place pt on backboard. Attach defibrillator pads
- Give 100% O₂

- If NO pulse present, start CPR/PALS; go to 'Cardiac Arrest, VF/VT’ Card

### VT, wide-complex irregular rhythm vs. SVT, tachyarrythmia with pulse

<table>
<thead>
<tr>
<th>VT, wide-complex irregular rhythm</th>
<th>SVT, tachyarrythmia with pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biphasic 2 joules/kg, then 4 joules/kg for additional shock, increasing up 10 joules/kg</td>
<td>Synchronized cardioversion: 0.5-1 joule/kg, then 2 joules/kg for additional shocks</td>
</tr>
</tbody>
</table>

- If pulse present, administer appropriate treatment (see table below)

### Narrow complex: p waves present before every QRS vs. Wide complex vs. Torsade de Pointes: polymorphic VT with prolonged QT

| Treatment |
|-----------|---------------------------------|---------------------------------|----------------------------------|
| Narrow complex: p waves present before every QRS | Wide complex | Torsade de Pointes: polymorphic VT with prolonged QT |
| Vagal maneuvers  
  - Ice to face  
  - Valsalva  
  - Carotid massage | Amiodarone 5 mg/kg IV bolus over 20-60 min or | Magnesium sulfate |
| Adenosine 0.1-0.3 mg/kg IV push (1st dose 6 mg MAX; 2nd dose 12 mg MAX) | Procainamide 15 mg/kg IV bolus over 30-60 min or | Isoproterenol |
| | Lidocaine 1 mg/kg IV bolus | Lidocaine 1 mg/kg IV |
| | | Phenytoin |
| | | Sodium bicarbonate (for quinidine-related SVT) |
| | | Temporary pacing (see ‘Bradycardia’ card) |
Tension Pneumothorax

- Stop N₂O; increase O₂ to 100%
- Secure airway with endotracheal tube
- Reduce positive ventilation pressure
- Administer vasopressors for circulatory collapse
- Perform immediate needle decompression, then chest tube placement

- Needle decompression:
  - 2\textsuperscript{nd} rib space superior to 3\textsuperscript{rd} rib, mid-clavicular line
    - 14-16g angiocath for teens/adults
    - 18-20g angiocath for infants/children

- Chest tube insertion
  - 5-6\textsuperscript{th} intercostal space, mid-axillary line

- If no improvement in hemodynamics after a rush of air, consider:
  - Needle decompression of contralateral side
  - Presence of pneumopericardium

\[\text{HR, } \downarrow \text{SpO}_2, \downarrow \text{BP, tracheal deviation, mediastinal shift}\]
Massive Transfusion: Massive Hemorrhage

- Notify Blood Bank immediately if massive transfusion needed
  - Begin institutional massive transfusion protocol, if available
  - Consider RBC : FFP : Platelets = 2:1:1 or 1:1:1, if no protocol available
  - Use un-crossmatched O negative blood until crossmatched blood available
  - Consider intraoperative blood salvage (e.g., Cell Saver)
  - Give cryoprecipitate to maintain fibrinogen > 100
- Obtain additional vascular access if needed
- Send labs q 30 min
  - CBC, platelets, PT/PTT/INR, fibrinogen
  - ABG, Na, K, Ca, lactate
- Warm the room
- Blood product administration:
  - Use 140 micron filter for all products
  - Use a blood warmer for RBC and FFP transfusion (NOT for platelets)
  - Rapid transfusion pumps may be used when increased flow is needed
- Monitor for hypothermia, hypocalcemia, electrolyte, blood gas, and acid-base disturbances
- Consider rFactor VIIa for refractory hemorrhage if above measures are corrected
- Terminate the massive transfusion protocol once bleeding is under control

Maintain:
- HCT > 21% or Hgb > 7
- Platelet Count > 50,000 (>100K for brain injury)
- INR < 1.5 (< 1.3 brain injury)
- Fibrinogen > 100
Transfusion Reactions

Reactions may occur with any type of product. Important to determine type of reaction.

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

<table>
<thead>
<tr>
<th>Hemolytic</th>
<th>Non-Hemolytic</th>
<th>Anaphylactic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs: Hemoglobinemia,</td>
<td>Signs: ↓ BP, bronchospasm, pulmonary edema, fever,</td>
<td>Signs: Erythema, urticaria, angioedema, bronchospasm,</td>
</tr>
<tr>
<td>hemoglobinuria, DIC, ↓ BP,</td>
<td>rash</td>
<td>tachycardia, shock</td>
</tr>
<tr>
<td>↑ HR, bronchospasm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furosemide 0.1 mg/kg</td>
<td>Treat fever</td>
<td>Support airway and circulation as necessary.</td>
</tr>
<tr>
<td>Mannitol 0.5 g/kg</td>
<td>Treat pulmonary edema</td>
<td>Epinephrine 10 MICROgrams/kg IV</td>
</tr>
<tr>
<td>(2 mL/kg of 25% mannitol)</td>
<td>Observe for signs of hemolysis</td>
<td>Diphenhydramine 1 mg/kg IV</td>
</tr>
<tr>
<td>Dopamine 2-4 MICROgrams/kg/min</td>
<td></td>
<td>Hydrocortisone 2-5 mg/kg</td>
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<tr>
<td>Maintain urine output at</td>
<td></td>
<td>Maintain intravascular volume</td>
</tr>
<tr>
<td>least 1-2 mL/kg/hour</td>
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<tr>
<td>Prepare for cardiovascular</td>
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<tr>
<td>instability</td>
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<tr>
<td>Send blood and urine</td>
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<tr>
<td>sample to laboratory</td>
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</tbody>
</table>
Set-up prior to patient arrival to OR:
- Assemble team and assign roles
- Estimate weight and prepare emergency drugs
- Gather equipment:
  - airway supplies
  - invasive monitors
  - fluid warmer
  - rapid infusion device
  - code cart with programmed defibrillator
- Type and cross blood products. If severe trauma, inform blood bank that massive transfusion protocol may be needed

On patient arrival to OR:
- Maintain c-spine precautions for transport
- Secure/confirm airway (aspiration risk, unstable c-spine)
- Ensure adequate ventilation (maintain PIP < 20 cm H₂O)
- Obtain/confirm large-bore IV access (central or intraosseous if peripheral unsuccessful)
- Assess circulation
- Hypovolemia = persistent tachycardia, delayed cap refill, decreased pulse pressure
  - Bolus 20 mL/kg LR or NS (repeat x 2) and/or 10 mL/kg RBCs or 20 ml/kg whole blood
- Place invasive monitors
- Temperature: ensure normothermia
- Rapidly treat associated conditions (acidosis, electrolyte disturbances)
- Continuously assess for secondary injury (ongoing blood loss)