



PediCrisis



CRITICAL EVENTS CARDS

Call for help!

Notify surgeon.

Air Embolism	2
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PediCrisis



**CRITICAL EVENTS
CARDS**

- Notify Surgeon, stop nitrous oxide and volatile agents. Increase O₂ to 100%.
- Stop air entrainment: Find air entry point, stop source, and limit further entry.
 - Ask surgeon to:
 - Flood wound with irrigation/soaked saline dressing
 - Turn off 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
 - Lower surgical site below level of heart (if possible)
 - Perform Valsalva on patient using hand ventilation
- Consider:
 - Compress jugular veins intermittently if head or cranial case
 - Aspirate from central venous catheter
- Hemodynamic support if hypotensive:
 - Give epinephrine 1-10 MICROgrams/kg, followed by infusion of epinephrine 0.02-1 MICROgrams/kg/min or 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
- If cardiac arrest, see card: asystole/PEA or VF/VT



- 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
To restore intravascular volume	NS or LR	10-30 mL/kg IV/IO, rapidly
To restore BP and ↓ mediator release	Epinephrine	1-10 MICROgrams/kg IV/IO, as needed, may need infusion 0.02-0.2 MICROgrams/kg/min
For continued ↓ BP after epinephrine given	Vasopressin	10 MICROunits/kg IV
To ↓ bronchoconstriction	Albuterol (Beta-agonists)	4-10 puffs as needed
To ↓ mediator release	MethylPREDNISolone	2 mg/kg IV/IO MAX 100 mg
To ↓ histamine-mediated effects	DiphenhydrAMINE	1 mg/kg IV/IO MAX 50 mg
To ↓ effects of histamine	Famotidine or Ranitidine	0.25 mg/kg IV 1 mg/kg IV

- For laboratory confirmation, if needed, send mast cell tryptase level within 2 hours of event

- Increase O₂ to 100%

Intra-operative Treatments

Airway collapse

- Increase FiO₂
- Add CPAP for spontaneous ventilation; add PEEP for controlled ventilation
- Reposition to lateral or prone
- Ventilate via rigid bronchoscope

Cardiovascular collapse

- Give fluid bolus
- Reposition to lateral or prone
- Ask surgeon for sternotomy and elevation of mass
- Consider ECMO

Preoperative Considerations

High Risk Factors

- Diagnosis: 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

Definition:

Age < 30 days	HR < 100
≥ 30 days < 1 yr	< 80
≥ 1 yr	< 60

- If hypotensive, pulseless, or poor perfusion, start chest compressions
 - Give epinephrine 10 MICROgrams/kg IV
 - Call for transcutaneous pacer (see inset)
 - ♦ Start pacing, when available
- If NOT hypotensive or pulseless:

Etiology	Treatment
Hypoxia (most common)	<ul style="list-style-type: none"> ▪ Give 100% O₂ ▪ Good ventilation ▪ See 'Hypoxia' card
Vagal	<ul style="list-style-type: none"> ▪ Atropine 0.01-0.02 mg/kg IV
Surgical Stimulation	<ul style="list-style-type: none"> ▪ Stop stimulation ▪ If laparoscopy, desufflate
Beta-Blocker Overdose	<ul style="list-style-type: none"> ▪ Glucagon 50 MICROgrams/kg IV, then 0.07 mg/kg/hour IV infusion <ul style="list-style-type: none"> • Check blood sugar
Ca-Channel Blocker Overdose	<ul style="list-style-type: none"> ▪ Calcium chloride 10-20 mg/kg IV or ▪ Calcium gluconate 50 mg/kg ▪ If ineffective, Glucagon at above doses

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

Bronchospasm

↓ EtCO₂, upslope stage III EtCO₂
↑ airway pressures, ↓ SpO₂

Intubated Patient	Non-Intubated Patient
<ul style="list-style-type: none"> ▪ Increase FiO₂ to 100% ▪ Auscultate the chest <ul style="list-style-type: none"> • Equal breath sounds? • Endobronchial ETT? • Wheezing? ▪ Check the ETT <ul style="list-style-type: none"> • Kinked? • Secretions/blood in the ETT? Need for suctioning? ▪ Give inhaled albuterol with spacer, if available ▪ If BP and HR will tolerate, increase MAC% of sevoflurane ▪ For refractory bronchospasm, give ketamine 1-2 mg/kg IV ▪ If severe, consider intravenous epinephrine 1 mcg/kg ▪ Consider IV steroids ▪ Consider chest radiograph and lung ultrasound (see 'Tension Pneumothorax' card) 	<ul style="list-style-type: none"> ▪ Administer supplemental oxygen ▪ Auscultate the chest, differentiate from stridor/extrathoracic airway obstruction ▪ Give inhaled albuterol, if needed ▪ Consider chest radiograph ▪ Consider IV steroids ▪ If severe, consider intravenous epinephrine 1-2 mcg/kg ▪ If severe, consider ICU and/or advanced airway management. If ETT, go to 'Intubated Patient' column on this card (at the left) <div data-bbox="1171 792 1896 1019" style="text-align: center; margin-top: 20px;"> </div> <p data-bbox="1283 1040 1738 1084" style="text-align: center;">Upslope Stage III EtCO₂</p>

Differential Diagnosis	
<ul style="list-style-type: none"> ▪ URI/tobacco exposure ▪ Foreign body ▪ GERD ▪ Mechanical obstruction of ETT <ul style="list-style-type: none"> • Kinking • Solidified secretions or blood • Overinflation of tracheal tube cuff ▪ Inadequate depth of anesthesia 	<ul style="list-style-type: none"> ▪ Pulmonary edema ▪ Tension pneumothorax ▪ Aspiration pneumonitis ▪ Pulmonary embolism ▪ Endobronchial intubation ▪ Persistent coughing and straining ▪ Asthmatic attack ▪ Anaphylaxis

Cardiac Arrest: Asystole, PEA

Non-shockable and/or pulseless cardiac arrest

- If ETT, 100-120 chest compressions/min + 10 breaths/min.
- If no ETT, 15:2 compression: ventilation ratio (100 chest compressions/min + 8 breaths/min)
- For chest compressions:
 - Place patient on backboard, maintain good hand position; if prone, see 'Prone CPR' card
 - Maximize EtCO₂ 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. Designate a scribe/recorder. Notify family.
- 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 below)
- If cardiac arrest > 6 min, activate ECMO (if available)

Hs and Ts: Reversible Causes	
<ul style="list-style-type: none">• Hypovolemia• Hypoxemia• Hydrogen ion (acidosis)• Hyperkalemia• Hypoglycemia• Hypothermia	<ul style="list-style-type: none">• Tension Pneumothorax• Tamponade (Cardiac)• Thrombosis• Toxin (anesthetic, β-blocker)• Trauma (bleeding outside surgical area)

- Notify surgeon, call for help and code cart/defibrillator
- If ETT, 100-120 chest compressions/min + 10 breaths/min)
- If no ETT, 15:2 compression:ventilation ratio (100 chest compressions/min + 8 breaths/min)
- For chest compressions:
 - 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 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. Designate a scribe/recorder. Notify Family.
- Obtain defibrillator. Attach pads. Shock 2-4 joules/kg (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
- Check pulse & rhythm q 2 min during compressor change
- Check for reversible causes (Hs and Ts) early and often (see table below)
- Repeat sequence until return of spontaneous circulation
- 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)

Hs and Ts: Reversible Causes	
<ul style="list-style-type: none">• Hypovolemia• Hypoxemia• Hydrogen ion (acidosis)• Hyperkalemia• Hypoglycemia• Hypothermia	<ul style="list-style-type: none">• Tension Pneumothorax• Tamponade (Cardiac)• Thrombosis• Toxin (anesthetic, β-blocker)• Trauma (bleeding outside surgical area)

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

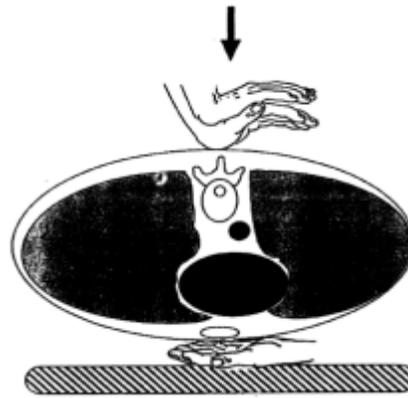


Figure 1



Figure 2

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 O₂ to 100% and maintain continuous oxygen flow during airway management
- Call for help, 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
- If able to re-establish pt spontaneous ventilation:
 - Consider reversing neuromuscular blocker with neostigmine/glycopyrrolate or sugammadex
 - Consider awakening pt if surgery not started
- Consider alternative approach for intubation (see table)
- If macroglossia (e.g. Beckwith-Wiedemann, Pierre-Robin), or mediastinal mass, consider prone or lateral position
- If still unable to ventilate:
 - Emergency non-invasive airway rigid bronchoscopy in younger children, jet ventilation in older children
 - Emergency invasive/surgical airway cricothyrotomy or tracheostomy



Alternative Approaches for Intubation

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

- 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

- 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
- Maintain ventilation. Assess for inhalation injury
- Consider input from ENT, pulmonary, plastic surgery
- Consider PICU
- Impound all equipment and supplies for later inspection



Picture from ECRI: www.ecri.org

Treatment:

- If hemodynamically unstable, initiate CPR/PALS
- Hyperventilate with 100% O₂
- IV calcium gluconate 60 mg/kg or calcium chloride 20 mg/kg
 - Directly visualize site to avoid infiltration, flush tubing after calcium administration
- Stop K⁺ containing fluids (LR/RBC); switch to NS
- Dextrose IV 0.25-1 g/kg and insulin IV 0.1 Unit/kg
- Albuterol puffs or nebulized, once cardiac rhythm stable

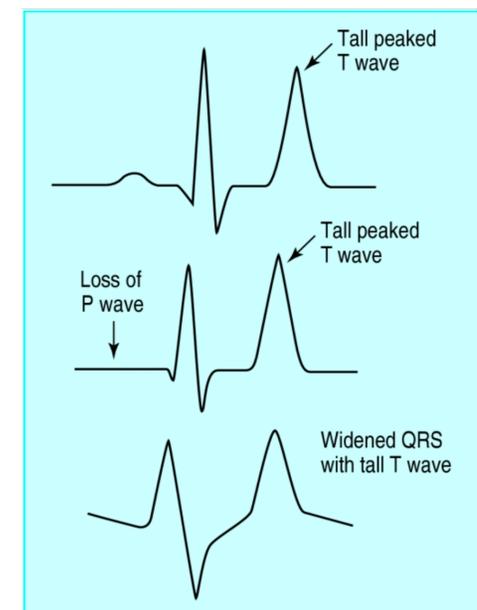
- Sodium bicarbonate IV 1-2 mEq/kg
- Furosemide IV 0.5-1 mg/kg
- Consider terbutaline 10 MICROgrams/kg load, then 0.1-10 MICROgrams/kg/min
- If cardiac arrest > 6 min, activate ECMO (if available)
- Dialysis if refractory to treatment
- If transfusion required, use washed or fresh RBC

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
- Pseudohyperkalemia: hemolyzed sample, thrombocytosis, leukocytosis

Manifestations:

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



From: Slovis C, Jenkins R. BMJ 2002

Acute Hypertension

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	97-100	70
1-3	105-120	61-75
4-12	113-135	86-91

***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.

Action	Drug (IV Dosing)
Direct smooth muscle relaxation	<ul style="list-style-type: none"> ▪ Sodium nitroprusside 0.5-10 MICROgrams/kg/min ▪ HydrALAZINE 0.1-0.2 mg/kg (adult dose 5-10 mg)
β-Adrenergic blockade	<ul style="list-style-type: none"> ▪ Esmolol 100-500 MICROgrams/kg over 5 min, then 25-300 MICROgrams/kg/min ▪ Labetalol (also α effect) 0.2-1 mg/kg q 10 min; 0.4-3 mg/kg/hour (infusion) ▪ Propranolol 10-100 MICROgrams/kg slow push (adult bolus dose 1-5 mg)
α ₂ -Agonist	<ul style="list-style-type: none"> ▪ Clonidine 0.5-2 MICROgrams/kg
Calcium channel blockade	<ul style="list-style-type: none"> ▪ NICARdipine 0.5-5 MICROgrams/kg/min ▪ Clevidipine 0.5-3.5 MICROgrams/kg/min
D1-dopamine agonist	<ul style="list-style-type: none"> ▪ Fenoldopam 0.2-0.5 MICROgrams/kg/min (MAX 2.5 MICROgrams/kg/min)

- 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 th % Systolic BP (mmHg)*
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

* Numbers are only a guide and vary for individual patients and situations

	↓ Preload	↓ Contractility	↓ Afterload
Causes	<ul style="list-style-type: none"> ▪ Hypovolemia ▪ Vasodilation ▪ Impaired venous return ▪ Tamponade ▪ Pulmonary embolism 	<ul style="list-style-type: none"> ▪ Negative inotropic drugs (anesthetic agents) ▪ Arrhythmias ▪ Hypoxemia ▪ Heart failure (ischemia) 	<ul style="list-style-type: none"> ▪ Drug-induced vasodilation ▪ Sepsis ▪ Anaphylaxis ▪ Endocrine crisis
Treatment	<ul style="list-style-type: none"> ▪ Expand circulating blood volume (administer fluids rapidly) ▪ Trendelenberg position ▪ Place or replace IV; consider intraosseous line 	<ul style="list-style-type: none"> ▪ Start inotrope infusion (DOPamine, epinephrine, milrinone), as needed ▪ Review ECG for rhythm disturbances or ischemia ▪ Send ABG, Hgb, electrolytes 	<ul style="list-style-type: none"> ▪ Start vasopressor infusion: phenylephrine, norepinephrine ▪ Go to 'Anaphylaxis' card, if appropriate. ▪ Administer steroids for endocrine crisis

- Turn FiO₂ to 100%
- Confirm presence of end-tidal CO₂, look for any changes in capnogram
- Hand-ventilate to assess compliance
- Listen to breath sounds
- Check:
 - ETT tube position and patency. Correct if mainstem or supraglottic, suction to r/o mucous plug, secretions, or kink
 - Circuit integrity: look for disconnection, kinks
 - Blood pressure, pulse. If low, see appropriate card: hypotension, bradycardia, or cardiac arrest
 - Pulse oximeter: try new probe or changing placement
- If machine problem, consider using self inflating bag and oxygen tank
- Further assessment: Draw blood gas. Perform bronchoscopy, CXR, TEE, ECG
- Is 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 card: anaphylaxis)/dose error
- Methylene blue/dyes or methemoglobinemia

Circulation

- Embolism – air (see card: 'Air Embolus'), fat, CO₂, pulmonary, septic, MI, CHF, cardiac tamponade
- Severe sepsis
- If associated with hypotension, see card: hypotension

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)
 - Hypothermia (temperature 34°C)
 - Barbiturate coma
 - Paralysis with non-depolarizing agent

- Stop local anesthetic
- Request Intralipid kit
- Secure airway and ventilation
- Give 100% O₂
- Confirm or establish adequate IV access.
- Confirm & 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

- 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 normocarbida 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

- Get MH Cart, dantrolene, and help
- Inform surgeon and stop procedure, if possible
- Stop volatile anesthetic, succinylcholine.
- Attach charcoal filter. Turn O₂ flow to 10 L/min
- Hyperventilate patient to reduce EtCO₂
- Give dantrolene 2.5 mg/kg IV, rapidly, through large bore IV if possible, every 5 min until symptoms resolve. May need up to 30 mg/kg
 - 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 if temperature > 39° C
 - 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 g/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 urinary catheter, maintain UO > 2 ml/kg/hr.
- If cardiac arrest occurs, begin CPR & consider ECMO
- 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>

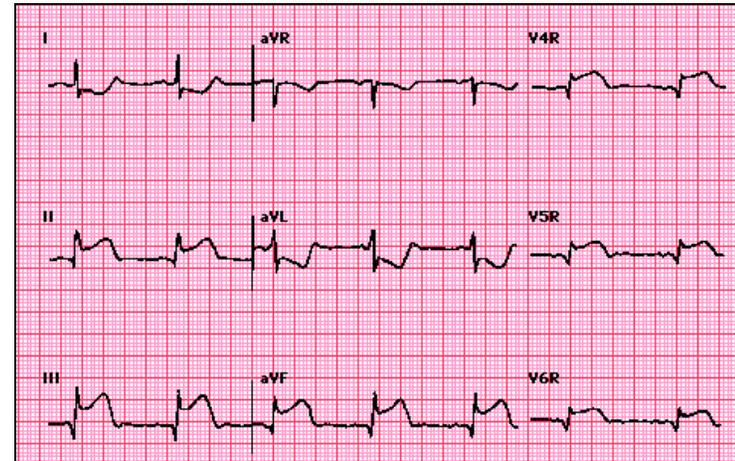
MH hotline 1-800-644-9737

Treatment:

- Improve O₂ Supply:
 - Give 100% O₂
 - Correct anemia
 - Correct hypotension
- Decrease O₂ 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 Pediatric Cardiology consult and echocardiogram

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

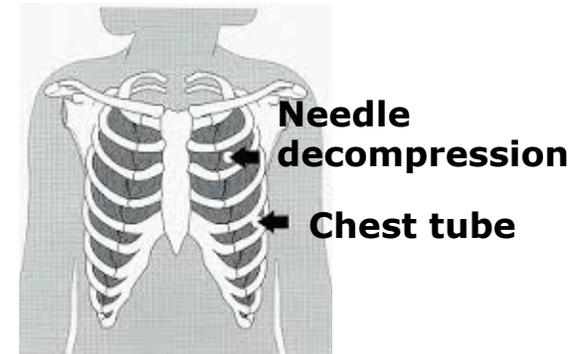
Management

- 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

- Call for defibrillator and code cart. Typically infant >180 bpm, child >220 bpm
- Place pt on backboard. Attach defibrillator pads
- Give 100% O₂, stop anesthetic agents, inform surgeon, consider cardiology consult
- If NO pulse present, start CPR/PALS; go to 'Cardiac Arrest, VF/VT' 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"> ▪ Vagal maneuvers <ul style="list-style-type: none"> • Ice to face • Valsalva • Carotid massage ▪ Adenosine (1st dose 0.1 mg/kg, 6 mg MAX; 2nd dose 0.2 mg/kg, 12 mg MAX) 	<ul style="list-style-type: none"> ▪ Synchronized cardioversion: 0.5-1 joule/kg, then 2 joules/kg for additional shocks 	<ul style="list-style-type: none"> ▪ Amiodarone 5 mg/kg IV bolus over 20-60 min or ▪ Procainamide 15 mg/kg IV bolus over 30-60 min or ▪ Lidocaine 1 mg/kg IV bolus 	<ul style="list-style-type: none"> ▪ Magnesium sulfate ▪ Isoproterenol ▪ Lidocaine 1 mg/kg IV ▪ Sodium bicarbonate (for quinidine-related SVT) ▪ Temporary pacing (see 'Bradycardia' card)

- Stop N₂O; increase O₂ to 100%
- Secure airway with endotracheal tube
- Reduce positive ventilation pressure
- Consider lung ultrasound to confirm diagnosis (see inset)
- Administer vasopressors for circulatory collapse
- Perform immediate needle decompression, then chest tube placement
- Needle decompression:
 - 2nd rib space superior to 3rd rib, mid-clavicular line
 - ♦ 14-16g angiocath for teens/adults
 - ♦ 18-20g angiocath for infants/children
- Chest tube insertion
 - 5-6th 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 to evaluate for alternate side or insufficiently decompressed pneumothorax



Downloaded from: http://www.uwhealth.org/images/ewebeditpro/uploadimages/5384_Figure_1.jpg

Lung Ultrasound Instructions

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

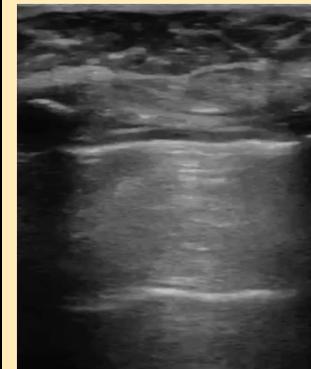


Photo S. Shahul M.D.

- If see pleural sliding, 100% PPV no ptx
- If no pleural sliding, consider pneumothorax, ARDS, fibrosis, acute asthma, pleurodesis

- Notify Blood Bank immediately
 - Activate institutional pediatric massive transfusion protocol. Consider RBC : FFP : Platelets = 2:1:1 or 1:1:1
 - Use un-crossmatched O negative blood until crossmatched blood available
 - Consider intraoperative blood salvage (e.g., Cell Saver)
- Obtain additional vascular access if needed
- Watch for hyperkalemia, give calcium chloride or gluconate 30-50 mg/kg while directly visualizing site
- 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 thawed plasma increases coagulation factors by 20%
- Fibrinogen < 100 mg/dL or rapid TEG-angle<66°, k value >120 sec:
 - 10 ml/kg pooled cryoprecipitate increases fibrinogen by 30-50 mg/dL
- Refractory hemorrhage
 - Consider factor VIIa, up to 90 MICROgrams/kg

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

Hemolytic	Non-Hemolytic	Anaphylactic
<p><u>Signs:</u> Hemoglobinemia, hemoglobinuria, DIC, ↓ BP, ↑ HR, bronchospasm</p> <ul style="list-style-type: none"> ▪ Furosemide 0.1 mg/kg ▪ Mannitol 0.5 g/kg (2 mL/kg of 25% mannitol) ▪ DOPamine 2-4 MICROgrams/kg/min ▪ Maintain urine output at least 1-2 mL/kg/hour ▪ Prepare for cardiovascular instability ▪ Send blood and urine sample to laboratory 	<p><u>Signs:</u> ↓ BP, bronchospasm, pulmonary edema, fever, rash</p> <ul style="list-style-type: none"> ▪ Treat fever ▪ Treat pulmonary edema ▪ Observe for signs of hemolysis 	<p><u>Signs:</u> Erythema, urticaria, angioedema, bronchospasm, tachycardia, shock</p> <ul style="list-style-type: none"> ▪ Support airway and circulation as necessary. ▪ Epinephrine 10 MICROgrams/kg IV ▪ DiphenhydrAMINE 1 mg/kg IV ▪ Hydrocortisone 2-5 mg/kg ▪ Maintain intravascular volume

Set-up prior to patient arrival to OR:

- Assemble team and assign roles
- Estimate weight and prepare emergency drugs
- 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 H₂O)
- Obtain/confirm large-bore IV access (central or intraosseous if peripheral unsuccessful)
- Assess hemodynamic stability. Pre-induction fluid bolus recommended if hypovolemic
 - 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