

Cognitive Aids for Perioperative Crises - V4.4 2022
Stanford Anesthesia Cognitive Aid Program

EMERGENCY MANUAL



Phone List (Back Cover)

RESOURCES

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Asystole / PEA

No pulse **AND** non-shockable rhythm on ECG
e.g. asystole  or any non-VFIB/VTACH 

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call a code • Call for code cart • Assign team member to read cognitive aid out loud
CPR	<ul style="list-style-type: none"> • Rate 100 - 120 compressions/min, minimize breaks • Depth \geq 5 cm; allow chest recoil; consider backboard • Keep EtCO₂ > 10 mmHg and diastolic BP > 20 mmHg • Rotate compressors with rhythm check every 2 min. Place defibrillator pads. If becomes shockable VF/VT: defibrillate 200 J biphasic or 360 J monophasic • See VFIB/VTACH #4 • Check pulse ONLY if signs of ROSC (sustained increased EtCO₂, spontaneous arterial waveform, rhythm change) • Prone CPR at lower edge of scapula OK if airway secured • Place defibrillator pads and check rhythm every 2 min
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • If mask ventilation: ratio 30 compressions to 2 breaths • If airway secured: 10 breaths/min, tidal volume 6 -7 mL/kg
IV Access	<ul style="list-style-type: none"> • Ensure functional IV or IO access
Meds	<ul style="list-style-type: none"> • Turn off volatile anesthetic and vasodilating drips • Epinephrine 1 mg IV push every 3 - 5 minutes • If hyperkalemia: calcium chloride 1 g IV; sodium bicarbonate 1 amp IV (50 mEq); regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g) • If acidosis: sodium bicarbonate 1 amp IV (50 mEq) • If hypocalcemia: calcium chloride 1 g IV • If hypoglycemia: dextrose/D50 1 amp IV (25 g)
ECMO/CPB	<ul style="list-style-type: none"> • Consider ECMO or cardiopulmonary bypass
Post Arrest	<ul style="list-style-type: none"> • If ROSC: arrange ICU care and consider cooling
Causes	<ul style="list-style-type: none"> • Explore H's and T's on next page


TEE / TTE and labs will aid diagnosis; Invite input from team
Heart Rate - Vagal Stimulus

- Desufflate abdomen
- Remove surgical retractors and sponges
- Remove pressure from eyes, neck, ears, and brain. Drain bladder

Hypovolemia

- Give rapid IV fluid bolus
- Check Hgb
- If anemia or hemorrhage:
 - **See Hemorrhage #12**
- Consider relative hypovolemia:
 - If auto-PEEP: disconnect circuit
 - IVC compression
 - Obstructive or distributive shock

See Anaphylaxis #5
See High Spinal #14
Hypoxemia

- O₂ 100% 10 - 15 L/min
- Check breathing circuit connections
- Confirm ETT placement with CO₂
- Check breath sounds
- Suction ET tube
- Consider chest x-ray; bronchoscopy

See Hypoxemia #17
Hydrogen Ions - Acidosis

- Consider bicarbonate
- Balance increasing ventilation with potential decrease in CPR quality

Hyperkalemia

- Calcium chloride 1g IV
- Bicarbonate 1 amp IV (50 mEq)
- Insulin 5 - 10 units IV with D50 1 amp IV (25g) and monitor glucose
- Consider emergent dialysis

Hypokalemia

- Controlled potassium infusion
- Magnesium sulfate 1 - 2 g IV

Hypoglycemia

- Dextrose/D50 1 amp (25 g)
- Monitor glucose

Hypocalcemia

- Calcium chloride 1 g IV

Hyperthermia
See Malignant Hyperthermia #19
Hypothermia

- Actively warm: forced air, warm IV fluid, warm room
- Consider ECMO or bypass

Toxins

- Consider anesthetic overdose
- Consider medication error
- Turn off volatile anesthetic and vasodilating drips
- If local anesthetic has been given:

See Local Anesthetic Toxicity #18
Tamponade - Cardiac

- Consider TEE / TTE
- Perform pericardiocentesis

Tension - Pneumothorax

- Check for asymmetric breath sounds, distended neck veins, deviated trachea
- Consider ultrasound for normal lung sliding, abnormal lung point
- Consider chest x-ray, but do NOT delay treatment
- Perform empiric needle decompression in 4th or 5th intercostal space anterior to the mid-axillary line, then chest tube

See Pneumothorax #22
Thrombosis - Coronary

- Consider TEE / TTE to evaluate ventricular wall motion
- Consider emergent coronary revascularization

See Myocardial Ischemia #20
Thrombosis - Pulmonary

- Consider TEE / TTE to evaluate right ventricular function and RVSP
- Consider fibrinolytic agents or pulmonary thrombectomy

See Embolism #9
See Right Heart Failure #24



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Bradycardia



Pulse present, heart rate < 50 bpm, and inadequate perfusion 

TREATMENT

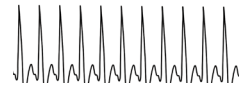
Task	Actions
Crisis Resources	<ul style="list-style-type: none">• Inform team• Identify leader• Call a code• Call for code cart
Pulse Check	<ul style="list-style-type: none">• If no pulse: start CPR and See Asystole/PEA #1
Airway	<ul style="list-style-type: none">• 100% O₂ 10 - 15 L/min• Confirm adequate ventilation and oxygenation
Stop Vagal Stimuli	<ul style="list-style-type: none">• Desufflate abdomen• Remove pressure from eyes, neck, ears, and brain• Remove retractors, surgical sponges, and packing• Drain bladder
IV Access	<ul style="list-style-type: none">• Ensure functional IV or IO access
Meds	<ul style="list-style-type: none">• Consider decreasing anesthetics or analgesics• Atropine 0.5 - 1 mg IV every 3 min. May repeat, max 3 mg• If atropine ineffective: epinephrine 5 - 10 mcg IV• Consider dopamine infusion of 5 - 20 mcg/kg/min• Consider epinephrine infusion of 0.02 - 0.3 mcg/kg/min• If stable: consider glycopyrrolate 0.2 - 0.4 mg IV
Pacing	<ul style="list-style-type: none">• Place defibrillator pads• Consider temporary transcutaneous, transvenous, or esophageal pacing<ul style="list-style-type: none">• Set pacer rate to at least 80 bpm• Increase current (mA) until electrical capture. Confirm mechanical capture with patient pulse. Set pacer output 10 mA above mechanical capture• Consult ICU and/or Cardiology
Arterial Line	<ul style="list-style-type: none">• Consider arterial line placement
Labs	<ul style="list-style-type: none">• Send ABG, Hgb, electrolytes, troponin
Ischemia Workup	<ul style="list-style-type: none">• Obtain 12-lead ECG• Consider checking BNP and serial troponins

END



SVT

Non-compensatory tachycardia and Pulse present
Often rate >150 or sudden onset



TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Call a code • Identify leader • Call for code cart
Pulse Check	<ul style="list-style-type: none"> • If no pulse: start CPR and See Asystole/PEA #1
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • Confirm adequate ventilation and oxygenation
Defib Pads	<ul style="list-style-type: none"> • Place defibrillator pads for possible cardioversion
Determine if UNSTABLE	<ul style="list-style-type: none"> • Unstable if ANY of the following: <ul style="list-style-type: none"> • SBP < 75 mmHg • Sudden SBP decrease below patient's baseline • Acute ischemia or chest pain • Acute congestive heart failure • Acutely altered mental status • If stable: rule out sinus tachycardia & go to next page • If unstable: continue below

UNSTABLE SVT:

Immediate Synchronized Cardioversion	<ul style="list-style-type: none"> • If patient is not anesthetized: consider sedation • Cardiovert with settings depending on QRS complex (narrow or wide) and rhythm (regular or irregular) <ul style="list-style-type: none"> • Narrow complex and regular: Sync 50 - 100 J biphasic • Narrow complex and irregular: Sync 120 - 200 J biphasic • Wide complex and regular: Sync 100 J biphasic • Wide complex and irregular: Unsync 200 J biphasic
Refractory UNSTABLE SVT	<ul style="list-style-type: none"> • Repeat synchronized shock with increased joules. Consider amiodarone 150 mg IV SLOW over 10 min • If still unstable: End cognitive aid & consult expert STAT

STABLE SVT ON NEXT PAGE »



TREATMENT

STABLE SVT - If unstable at any point: go to UNSTABLE SVT Page 1

- **STAT Expert consult strongly recommended** for rhythm diagnosis and medication selection
- Obtain 12-lead ECG or print rhythm strip. Place defibrillator pads
- Consider arterial line placement, ABG, and electrolytes
- Rule out sinus tachycardia. Consider vagal maneuver before medication

- Meds: Narrow and Regular**
- **Adenosine** (avoid if WPW or asthma) push 6 mg IV, flush; monitor EKG. May follow with 12 mg IV
 - If not converted, or slowing reveals afib/flutter, rate control:
 - **Esmolol** (avoid if WPW, decreased EF, or asthma) 0.5 mg/kg IV over 1 min. May repeat after 1 min. Then infusion of 50 - 300 mcg/kg/min
 - **Metoprolol** (avoid if WPW, decreased EF, or asthma) 1 - 2.5 mg IV push. May repeat or double after 3 - 5 min
 - **Diltiazem** (avoid if WPW or decreased EF) 10 - 20 mg IV over 2 min. May repeat after 5 min. Then infusion of 5 - 10 mg/hr

- Meds: Wide and Regular**
- If CAD/MI, likely VT: **SLOWLY** give **Amiodarone** (avoid if WPW) 150 mg IV over 10 min to avoid cardiovascular collapse. May repeat once. Then infusion of 1 mg/min
 - If SVT with aberrancy: **Adenosine** (avoid if WPW or asthma) push 6 mg IV, flush; monitor EKG. May follow with 12 mg IV
 - May add **Procainamide** (avoid if decreased EF or increased QT interval) 20 - 50 mg/min IV (max 17 mg/kg) until arrhythmia suppressed. Then infusion of 1 - 4 mg/min

- Meds: Narrow and Irregular**
- Rate control:
 - **Esmolol** (avoid if WPW, decreased EF, or asthma) 0.5 mg/kg IV over 1 min. May repeat after 1 min. Then infusion of 50 - 300 mcg/kg/min
 - **Metoprolol** (avoid if WPW, decreased EF, or asthma) 1 - 2.5 mg IV push. May repeat or double after 3 - 5 min
 - **Diltiazem** (avoid if WPW or decreased EF) 10 - 20 mg IV over 2 min. May repeat after 5 min. Then infusion of 5 - 10 mg/hr
 - Consider **SLOWLY** giving **Amiodarone** (avoid if WPW) 150 mg IV over 10 min to avoid cardiovascular collapse. May repeat once. Then infusion of 1 mg/min

- If Wide and Irregular**
- This is likely polymorphic VT: **Consult Cardiology STAT**
 - Consider **Magnesium** for Torsades de Pointes



VFIB / VTACH

No pulse

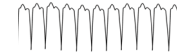
AND

VFIB



or

VTACH



TREATMENT

Task

Actions

Crisis Resources

- Inform team
- Identify leader
- Call a code
- Call for code cart

CPR

- Rate 100 - 120 compressions/min, minimize breaks
- Depth \geq 5 cm; allow chest recoil; consider backboard
- **Keep EtCO₂ > 10 mmHg and diastolic BP > 20 mmHg**
- Rotate compressors with rhythm check every 2 min. If changes to non-shockable rhythm:
 - **See Asystole/PEA #1**
- Check pulse ONLY if signs of ROSC (sustained increased EtCO₂, spontaneous arterial waveform, rhythm change)
- Prone CPR at lower edge of scapula OK if airway secured

Airway

- **100% O₂ 10 - 15 L/min**
- Defibrillation is higher priority than intubation. Mask ventilate with ratio of 30 compressions to 2 breaths
- If airway secured: 10 breaths/min; tidal volume 6 -7 mL/kg

Defib

- Place pads and **immediately defibrillate: 120-200 J biphasic or 360 J monophasic**
- Resume CPR. Increase electrical energy and repeat shock every 2 min

IV Access

- Ensure functional IV or IO access

Meds

- **Turn off volatile anesthetic and vasodilating drips**
- **After 2nd shock: epinephrine** 1 mg IV every 3 - 5 min
- **After 3rd shock: amiodarone** 300 mg IV push or lidocaine 1 - 1.5 mg/kg IV. May redose: amiodarone 150 mg or lidocaine 0.5 - 0.75 mg/kg
- If hypomagnesemia or torsades: magnesium 1 - 2 g IV
- If hyperkalemia: calcium chloride 1 g IV; sodium bicarbonate 1 amp IV (50 mEq); regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g)

H's & T's

- Consider treatable causes on next page

ECMO/CPB

- Consider ECMO or cardiopulmonary bypass

Post Arrest

- If ROSC: arrange ICU care and consider cooling

GO TO NEXT PAGE »



TEE / TTE and labs will aid diagnosis; Invite input from team

Heart Rate - Vagal Stimulus

- Desufflate abdomen
- Remove surgical retractors and sponges
- Remove pressure from eyes, neck, ears, and brain. Drain bladder

Hypovolemia

- Give rapid IV fluid bolus
- Check Hgb
- If anemia or hemorrhage:
 - **See Hemorrhage #12**
- Consider relative hypovolemia:
 - If auto-PEEP: disconnect circuit
 - IVC compression
 - Obstructive or distributive shock

See Anaphylaxis #5

See High Spinal #14

Hypoxemia

- O₂ 100% 10 - 15 L/min
- Check breathing circuit connections
- Confirm ETT placement with CO₂
- Check breath sounds
- Suction ET tube
- Consider chest x-ray; bronchoscopy

See Hypoxemia #17

Hydrogen Ions - Acidosis

- Consider bicarbonate
- Balance increasing ventilation with potential decrease in CPR quality

Hyperkalemia

- Calcium chloride 1g IV
- Bicarbonate 1 amp IV (50 mEq)
- Insulin 5 - 10 units IV with D50 1 amp IV (25g) and monitor glucose
- Consider emergent dialysis

Hypokalemia

- Controlled potassium infusion
- Magnesium sulfate 1 - 2 g IV

Hypoglycemia

- Dextrose/D50 1 amp (25 g)
- Monitor glucose

Hypocalcemia

- Calcium chloride 1 g IV

Hyperthermia

See Malignant Hyperthermia #19

Hypothermia

- Actively warm: forced air, warm IV fluid, warm room
- Consider ECMO or bypass

Toxins

- Consider anesthetic overdose
- Consider medication error
- Turn off volatile anesthetic and vasodilating drips
- If local anesthetic has been given:

See Local Anesthetic Toxicity #18

Tamponade - Cardiac

- Consider TEE / TTE
- Perform pericardiocentesis

Tension - Pneumothorax

- Check for asymmetric breath sounds, distended neck veins, deviated trachea
- Consider ultrasound for normal lung sliding, abnormal lung point
- Consider chest x-ray, but do NOT delay treatment
- Perform empiric needle decompression in 4th or 5th intercostal space anterior to the mid-axillary line, then chest tube

See Pneumothorax #22

Thrombosis - Coronary

- Consider TEE / TTE to evaluate ventricular wall motion
- Consider emergent coronary revascularization

See Myocardial Ischemia #20

Thrombosis - Pulmonary

- Consider TEE / TTE to evaluate right ventricular function and RVSP
- Consider fibrinolytic agents or pulmonary thrombectomy

See Embolism #9

See Right Heart Failure #24



Anaphylaxis

Severe hypotension
Cardiac arrest
Bronchospasm
Wheezing
High inspiratory pressure

Angioedema
Airway swelling
Tachycardia
Arrhythmia
Flushing

Rash
Itching
Hives (or no skin findings)

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for code cart • Consider pausing procedure
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • Secure airway. If angioedema: consider early intubation
IV Access	<ul style="list-style-type: none"> • Ensure functional large bore IV or IO access
Primary Meds	<ul style="list-style-type: none"> • Give epinephrine to prevent mast cell degranulation: <ul style="list-style-type: none"> • Epinephrine 10 - 100 mcg IV (if no IV: 500 mcg IM); Increase IV dose every 2 min until clinical improvement. May require > 1mg. Start early epinephrine infusion • See Infusion List #29 • If hypotensive: turn off volatile anesthetics and vasodilating drips and consider amnestic agent (e.g. midazolam)
Fluid	<ul style="list-style-type: none"> • Give rapid IV fluid bolus. May require many liters • Consider head down position; elevate legs
Stop Allergens	<ul style="list-style-type: none"> • Remove allergens: e.g. antibiotics, muscle relaxants, chlorhexidine, dyes, blood products, latex, contrast, colloids, protamine, sugammadex
ACLS	<ul style="list-style-type: none"> • Check pulse. If no pulse or SBP < 50 mmHg: <ul style="list-style-type: none"> • CPR rate 100 - 120 compressions/min • Depth ≥ 5 cm; allow chest recoil; consider backboard • Keep EtCO₂ > 10 mmHg and diastolic BP > 20 mmHg • Rotate compressors with rhythm check every 2 min • Check pulse ONLY if signs of ROSC (sustained increased EtCO₂, spontaneous arterial waveform, rhythm change) • If mask ventilation: ratio 30 compressions to 2 breaths • If airway secure: 10 breaths/min; tidal volume 6 -7 mL/kg • Place defibrillator pads in case rhythm changes • Consider ECMO or cardiopulmonary bypass



RULE OUT

- Anesthetic overdose
See Local Anesthetic Toxicity #18
- Aspiration
- Distributive or obstructive shock
- Embolism e.g. air, clot, fat
See Embolism #9
- Hemorrhage
See Hemorrhage #12
- Hypotension
See Hypotension #16
- Myocardial infarction
See Myocardial Ischemia #20
- Pneumothorax
See Pneumothorax #22
- Sepsis

TREATMENT

Task	Actions
Additional Access	<ul style="list-style-type: none"> • Consider additional IV access • Consider arterial line placement
Secondary Meds	<ul style="list-style-type: none"> • If hypotension: Continue epinephrine infusion. May add vasopressin and/or norepinephrine See Infusion List #29 • If bronchospasm, give bronchodilator: <ul style="list-style-type: none"> • If unable to ventilate, treat intravenously: epinephrine 5 - 10 mcg IV (or 200 mcg subq) or ketamine 10 - 50 mg IV (or 40mg IM) or magnesium sulfate 1 - 2 g IV • If able to ventilate: albuterol 4 - 8 puffs MDI or 2.5 mg nebulized and sevoflurane titrated to 1 MAC • If persistent bronchospasm, consider: <ul style="list-style-type: none"> • H₁ antagonist: diphenhydramine 25 - 50 mg IV • H₂ antagonist: famotidine 20 mg IV • Corticosteroid: hydrocortisone 100 mg IV or methylprednisolone 125 mg IV
ECHO	<ul style="list-style-type: none"> • Consider TEE / TTE to assess volume status and function
Labs	<ul style="list-style-type: none"> • Send peak serum tryptase 1 - 2 hr after reaction onset
Dispo	<ul style="list-style-type: none"> • Monitor for at least 6 hr. If severe, biphasic response is more likely so monitor in ICU for 12 - 24 hours • If intubated: consider keeping intubated
Allergy Follow-up	<ul style="list-style-type: none"> • Consider adding allergens to patient's allergy list • Refer the patient for follow-up allergy testing



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Bronchospasm

Inability to ventilate
High peak inspiratory pressure
Wheezing
Absent breath sounds if severe
Increased expiratory time

Increased EtCO₂
Upsloping EtCO₂ waveform
Decreased tidal volumes
Hypotension if air-trapping

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Consider pausing procedure • Calling for code cart
Early Actions	<ul style="list-style-type: none"> • If hypotensive, may be air-trapping: briefly disconnect circuit • If hypotension, tachycardia, and/or rash: <div style="background-color: #cccccc; padding: 2px; display: inline-block;">See Anaphylaxis #5</div>
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • If stridor or hypoxemia: consider intubation • Optimize exhalation: change I:E ratio (e.g. 1:3 or 1:4) minimize PEEP (0 - 5 cmH₂O); avoid hyperinflation (goal tidal volume is 6 mL/kg)
Deepen Anesthesia	<ul style="list-style-type: none"> • Bolus propofol; increase sevoflurane or isoflurane • Consider additional neuromuscular blockade
Check Airway	<ul style="list-style-type: none"> • Check CO₂ waveform to confirm airway placement • Auscultate lungs to check for endobronchial intubation • Soft suction ET tube to check for kinking or mucous plug • Check for malpositioned supraglottic airway
Meds	<ul style="list-style-type: none"> • If severe: epinephrine 5 - 10 mcg IV every 3 - 5 min or 200 mcg subq, escalate doses as needed. Consider adding glycopyrrolate 0.2 - 0.4 mg IV. Monitor for tachycardia and hypertension • If stridor or tachycardia concerns: give nebulized racemic L-epinephrine 0.5 mL of 2.25% soln in 3 mL saline • If able to ventilate, give bronchodilators: albuterol 4 - 8 puffs MDI or 2.5 mg nebulized with or without ipratropium • Consider giving ketamine 10 - 50 mg IV, magnesium sulfate 1 - 2 g IV, or hydrocortisone 100 mg IV
Labs	<ul style="list-style-type: none"> • Consider ABG and serum tryptase
ECMO/CPB	<ul style="list-style-type: none"> • If severe: consider ECMO or cardiopulmonary bypass

END



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Delayed Emergence



Patient less responsive than expected during emergence
Abnormal neurological exam in postoperative period

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none">• Inform team
Stop Meds	<ul style="list-style-type: none">• Confirm all volatile and IV anesthetics are off
Vital Signs	<ul style="list-style-type: none">• Check for and correct any hypoxemia, hypercarbia, hypothermia, or hypotension• Check for signs of high ICP: widened pulse pressure (increased systolic, decreased diastolic), bradycardia, irregular respirations
Paralysis	<ul style="list-style-type: none">• Check for and reverse residual neuromuscular paralysis with sugammadex or neostigmine with glycopyrrolate
Neuro Exam	<ul style="list-style-type: none">• Perform neurological exam• Check for pupil changes, motor asymmetry, and gag• If abnormal or suspect stroke: Call Stroke Code or equivalent if available, obtain STAT head CT scan and/or STAT Neurology/Neurosurgery consult
Med Reversal	<ul style="list-style-type: none">• Consider opioid reversal: naloxone 40 mcg IV; may double dose and repeat every 2 minutes up to 400 mcg• Consider benzodiazepine reversal: flumazenil 0.2 mg IV every 1 minute; max dose 1 mg• Consider anticholinergic syndrome (e.g. scopolamine): physostigmine 1 mg IV with atropine available for cholinergic crisis with severe bradycardia• Re-treat because reversal agents have short half lives
Sugar	<ul style="list-style-type: none">• Check for and correct hypoglycemia
Labs	<ul style="list-style-type: none">• Send ABG plus electrolytes to evaluate for hypercarbia, hyponatremia, hypernatremia, and hypercalcemia
Medication	<ul style="list-style-type: none">• Check for possible medication error• Consider delayed med clearance (e.g. hepatic, renal)
Rare Causes	<ul style="list-style-type: none">• Consider high spinal, serotonin syndrome, malignant hyperthermia, myxedema coma, seizure, thyroid storm, and hepatic/uremic encephalopathy
Follow-up	<ul style="list-style-type: none">• If residual mental status abnormalities, monitor patient in ICU with neurologic follow up



Difficult Airway / Cric

Failed laryngoscopy or difficulty oxygenating or ventilating

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Call for airway help • Call for anesthesia tech • Call for difficult airway cart
Optimize Conditions	<ul style="list-style-type: none"> • Ensure paralysis (e.g. rocuronium 1.2 mg/kg) • Ensure anesthetic depth (e.g. re-bolus or infuse propofol) • Optimize positioning (e.g. sniffing position, head of bed elevation to 30°, neck extension, bed height)
Oxygenate	<ul style="list-style-type: none"> • Do not fixate on intubation • Monitor CO₂ return by capnography and SpO₂ • If SpO₂ critically low at any time: go to red box below • Consider oxygenation modalities (max 2 attempts each): <ul style="list-style-type: none"> • Mask: use two-handed grip; insert oral/nasal airway • Supraglottic airway SGA/LMA: optimize size and fit (change position of head or device, cuff inflation); consider 2nd generation • Laryngoscopy: video preferred. Consider alternate blade, rigid stylet, bougie, external laryngeal manipulation, release of cricoid pressure • Choose experienced operator and familiar equipment

Can Oxygenate:

- Monitor CO₂ return by capnography and SpO₂
- **If cannot oxygenate at any time: go to red box**
- While oxygenating, options include:
 - Awaken patient
 - Finish case with SGA/LMA or mask
 - Intubate through SGA/LMA
 - Combined video/fiberoptic
 - Other advanced airway techniques

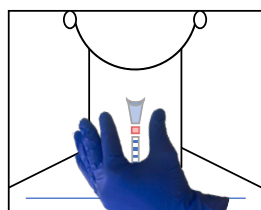
Cannot Intubate, Cannot Oxygenate (CICO):

- **Priority is cutting the neck!**
- Call for Cric-capable help
- Get Cric kit: scalpel (e.g. #10 blade), bougie, and 6.0 ET tube
- Additional operator can attempt to oxygenate from above (e.g. mask, SGA/LMA, video laryngoscopy)
- **Start Cric/eFONA (next page)**

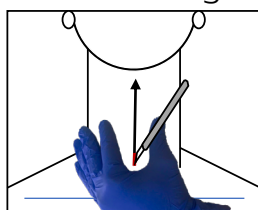
CRIC / eFONA ON NEXT PAGE »



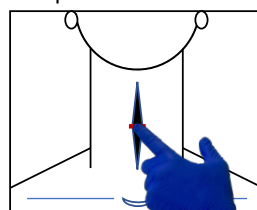
- Inform Team** • Announce emergency cric / front of neck access
- Call for Help** • ENT, Gen Surgery, ICU, Anesthesiology, Code Team
- Prep**
- Expose and **extend neck**
 - Obtain **scalpel, bougie, and lubricated 6.0 ET tube**
- Meds**
- Give **paralytic** and anesthetic
- Oxygenate and Monitor**
- Additional operator can attempt to oxygenate from above (e.g. mask, SGA/LMA, video laryngoscopy)
 - Monitor vital signs and pulse



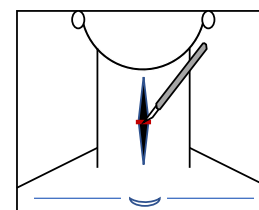
1. Expose and extend neck. Laryngeal handshake to identify midline



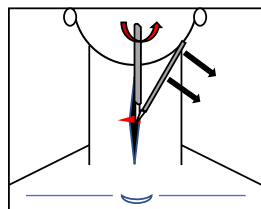
2. Make 8 cm long vertical midline skin incision. Cut away from your hand



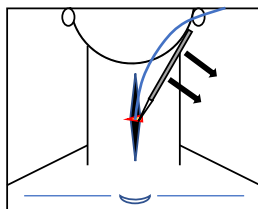
3. Palpate cricothyroid membrane



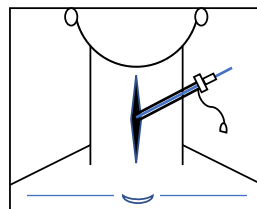
4. Stab horizontally through cricothyroid membrane. Extend to width of trachea



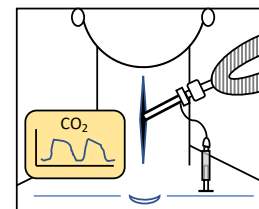
5. Rotate scalpel 90° (blade toward patient's feet) and pull toward you



6. Insert bougie along scalpel. Remove scalpel



7. Pass 6.0 ET tube over bougie



8. Inflate cuff, ventilate, confirm CO₂, check breath sounds

If risks for difficult airway, make contingency plans and consider:

- Advanced airway equipment in room (e.g. difficult airway cart, second generation SGA/LMA, intubating SGA/LMA, intubation catheter, fiberoptic bronchoscope, rigid bronchoscope, scalpel/bougie cric kit)
- Awake intubation
- High flow apneic oxygenation
- Video laryngoscopy as first attempt
- ENT or General Surgery in room
- Awake tracheostomy (in consultation with surgeon)
- ECMO pre-cannulation with perfusionist in room



Embolism - Pulmonary

Sudden decrease in EtCO₂, BP, or SpO₂
Sudden increase in central venous pressure
Dyspnea, respiratory distress, or cough in awake patient
Increased risk in long bone orthopedic surgery, pregnancy, cancer (especially renal tumor), high BMI, laparoscopic surgery, or surgical site above level of the heart

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Call for help • Consider terminating procedure • Identify leader • Get code cart
Pulse Check	<ul style="list-style-type: none"> • If no pulse: start CPR, check rhythm, and follow appropriate algorithm <p>See Asystole/PEA #1 VFIB/VTACH #4</p>
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min
Circulation	<ul style="list-style-type: none"> • Turn off volatile anesthetic and vasodilating drips • Give IV vasopressor bolus to support circulation • Consider rapid fluid bolus
Evaluate Right Heart	<ul style="list-style-type: none"> • If unstable or RV function decreased on TEE / TTE, use medication and diuresis to: <ul style="list-style-type: none"> • Maintain sinus rhythm • Maintain normal RV volume status • Maintain RV contractility • Decrease RV afterload <p>See Right Heart Failure #24</p>
ECMO/CPB	<ul style="list-style-type: none"> • If severe decompensation: consider ECMO or cardiopulmonary bypass

RULE OUT

Consider other causes:	
<ul style="list-style-type: none"> • Anaphylaxis See Anaphylaxis # 5 • Bone cement implantation syndrome • Bronchospasm See Bronchospasm #6 • Cardiac tamponade • Cardiogenic shock 	<ul style="list-style-type: none"> • Distributive shock • Hypovolemia • Myocardial ischemia See Myocardial Ischemia #20 • Pneumothorax See Pneumothorax #22 • Pulmonary edema

GO TO NEXT PAGE »



Further management depends on embolism type:

Pulmonary Thromboembolism:

- Risk Factors**
- Chronic illness, neoplasm, immobility, missed anticoagulation
- Treatment**
- Discuss feasibility and safety of **urgent thrombolysis vs. thrombectomy** with surgical team
 - Thrombolysis: If safe, use recombinant tissue plasminogen activator (rtPA) alteplase 10 mg IV followed by infusion of 90 mg over 2 hours
 - Thrombectomy: Consider STAT Cardiovascular Surgery consult (open) or STAT Interventional Radiology consult (percutaneous)
 - Supportive treatment: airway, breathing, circulation

Air or CO₂ Embolism:

- Signs**
- Air visible on TEE / TTE
- Treatment**
- **Limit entrainment of air:** check IV lines for air; flood surgical field with saline; consider placing surgical site below heart; consider left lateral decubitus position
 - **Attempt removal of air:** aspirate air from central line if present
 - Supportive treatment: airway, breathing, circulation
 - Consider hyperbaric oxygen treatment

Cement or Fat Embolism:

- Signs**
- **Petechial rash**
 - Confusion or irritability if awake
- Treatment**
- Supportive treatment: airway, breathing, circulation

Amniotic Fluid Embolism:

- Signs**
- Peripartum patient with maternal or fetal compromise: altered mental status, hypotension, hypoxemia, seizures, coagulopathy
- Treatment**
- Supportive treatment: airway, breathing, circulation
 - Monitor fetus and consider urgent Cesarean section
 - Monitor for and treat seizures and DIC



Fire - Airway

Sudden pop, spark, flame, smoke, heat, or odor

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for help
Anesthesia Professional Immediate Response	<ul style="list-style-type: none"> • Disconnect breathing circuit from the anesthesia machine to prevent torch formation • Stop fresh gas flow
Surgeon Immediate Response	<ul style="list-style-type: none"> • If clamp immediately available: clamp ET tube. If clamp not available: fold (kink) ET tube (prevents torch formation if circuit not yet disconnected) • Immediately remove ET tube and any airway foreign bodies • Pour saline into airway and suction debris
Check Extent of Fire	<ul style="list-style-type: none"> • If fire spreads beyond airway (e.g. to drapes, patient): <div style="background-color: #cccccc; padding: 2px; display: inline-block;">See Fire - Non-Airway #11</div>
After Fire Extinguished	<ul style="list-style-type: none"> • Re-establish oxygenation when fire is extinguished • Minimize FiO₂ as much as possible. Consider air ventilation • Consider prompt reintubation with ET tube ≥ 7.0 mm ID prior to swelling • Ensure adequate anesthesia: e.g. propofol infusion • Perform bronchoscopic examination of entire airway to assess injury and remove residual debris • Inspect ET tube pieces to verify none left in airway • Save all materials for later investigation • Consider steroid: e.g. dexamethasone 8 mg IV
Disposition	<ul style="list-style-type: none"> • ICU care for prolonged mechanical ventilation and airway observation

FIRE PREVENTION ON NEXT PAGE »



Fire Risk = Fuel Source + Oxidizer + Ignition Source

For All High Risk Procedures

- Discuss fire prevention and response during time out
- Avoid $FiO_2 > 0.3$ and avoid N_2O
- Anesthesia provider: communicate FiO_2 changes
- Surgeon: communicate use of laser or electrocautery

For Laser Surgery of Vocal Cord or Larynx

- Use laser resistant ET tube (single or double cuff)
- Ensure ET tube cuff is sufficiently below vocal cords
- Consider filling proximal ET tube cuff with methylene blue-tinted saline
- Surgeon: keep laser in standby when not in use
- Surgeon: protect ET tube cuff with wet gauze
- Surgeon: check $FiO_2 < 0.3$ and N_2O not in use before lasering or electrocauterizing
- Anesthesia provider: communicate FiO_2 changes

For Non-laser Surgery in Oropharynx

- Regular PVC ET tube may be used
- Surgeon: protect ET tube with wet gauze
- Consider continuous suctioning inside oropharynx
- Surgeon: confirm $FiO_2 < 0.3$ and no N_2O prior to electrocautery use
- Anesthesia provider: communicate FiO_2 changes

END



Fire - Non-Airway

Sudden pop, spark, flame, smoke, heat, or odor

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Call for help • Activate fire alarm • Call code red • Get CO₂ fire extinguisher
Prevent Airway Fire	<ul style="list-style-type: none"> • Stop fresh gas flow • Disconnect breathing circuit from the anesthesia machine to stop all airway gas flow • Ventilate with portable self-inflating bag (Ambu) on room air
Prevent Patient Harm	<ul style="list-style-type: none"> • Remove all burning and flammable materials (e.g. drapes, fabrics) from patient and onto floor; extinguish any flames
Extinguish Flames (PASS)	<ul style="list-style-type: none"> • If non-electrical fire: use CO₂ fire extinguisher (safe for wound) and saline or water (e.g. from basin, bottles, IV bags) • If electrical fire: use only CO₂ fire extinguisher <ul style="list-style-type: none"> • PULL: Pull the pin • AIM: Aim for the base of the fire • SQUEEZE: Squeeze the trigger in five second bursts • SWEEP: Sweep from side-to-side to put out fire
Care for Patient	<ul style="list-style-type: none"> • Assess for injuries; monitor vital signs • Ensure adequate anesthesia e.g. propofol infusion
Consider Evacuation	<ul style="list-style-type: none"> • If continued smoke or fire: evacuate patient and staff • If no smoke or fire: stay and shelter in place
Contain Fire	<ul style="list-style-type: none"> • Close operating room doors • Turn off external gas supply valves for O₂ and N₂O
Check Extent of Fire	<ul style="list-style-type: none"> • If fire spreads to airway: See Fire - Airway #10
Team Recap	<ul style="list-style-type: none"> • Discuss with surgeon and OR leadership the implications of fire for this patient and OR schedule

**Fire Risk = Fuel Source + Oxidizer + Ignition Source****For All High Risk Procedures**

- Discuss fire prevention and management during time out
- Avoid $FiO_2 > 0.3$ and avoid N_2O
- Communicate FiO_2 changes and electrocautery or laser use throughout case

For Highest Risk: MAC Head and Neck Procedures

- Use minimum O_2 concentration for adequate SpO_2
- Use nasal cannula instead of face mask if able
- If high O_2 concentration required: use LMA or ET tube
- Configure drapes to avoid O_2 build up, consider active scavenging if required
- Allow complete drying of alcohol skin prep solutions

END



Hemorrhage

Increased suction volume
Increased surgical sponge use

Tachycardia
Hypotension

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for Anesthesiology, Surgery, and Nursing help • Activate Massive Transfusion Protocol (MTP)
Early Response	<ul style="list-style-type: none"> • Give IV fluid bolus (e.g. crystalloid, colloid). If significant hemorrhage: prioritize transfusion of blood products • Establish large bore IV access: consider IO or central venous access • Temporize severe hypotension with vasopressor bolus • Consider head down position or leg elevation
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • Consider intubation prior to airway swelling
Critical Response	<ul style="list-style-type: none"> • If severe hemodynamic instability at any point: <ul style="list-style-type: none"> • Inform surgeon and suggest surgical temporizing measures (e.g. packing, major vessel compression or crossclamp, hemostatic agents: thrombin or fibrin glue) • Get additional surgical help (e.g. Trauma, Vascular, Cardiac, Gyn-Onc, or General Surgery)
Rapid Infuser and Cell Saver	<ul style="list-style-type: none"> • Delegate setup of: <ul style="list-style-type: none"> • Rapid infusion system • Cell saver (if surgical site is not contaminated or cancerous)
Transfuse	<ul style="list-style-type: none"> • If significant bleeding: transfuse, do not wait for lab results • Check all blood • Based on clinical picture: transfuse with ratio of 1-2 PRBC : 1 FFP : 1 Platelet pack • Adjust empiric transfusion for any clinical or laboratory signs of coagulopathy

GO TO NEXT PAGE »



TREATMENT

Task	Actions
Normothermia	• Warm room, use warm fluid, forced air, and blankets
Arterial Line	• Consider arterial line placement for monitoring and serial lab draws
Urine Output	• Place foley. Urine output goal ≥ 0.5 mL/kg/hr
Labs	<ul style="list-style-type: none"> • Monitor resuscitation adequacy with clinical stability and serial labs: Hgb, platelets, coagulation, acid base status, base deficit, electrolytes, lactate, TEG, Rotem • Actively maintain normal calcium level

BLOOD PRODUCTS AND THERAPEUTIC ADJUNCTS

PRBC	<ul style="list-style-type: none"> • Give if Hgb $< 7 - 10$ g/dL depending on hemodynamic stability, coronary disease, and rate of blood loss • Each unit should raise Hgb ~ 1g/dL or HCT $\sim 3\%$
FFP	<ul style="list-style-type: none"> • Give if INR or PTT > 1.5x normal • Give FFP 10 - 15 mL/kg then recheck labs and continue with 1:1 PRBC : FFP ratio
Platelets	<ul style="list-style-type: none"> • Give if platelets $< 50 - 100$ K/uL and ongoing bleeding • Each apheresis unit should raise platelet count ~ 50 K/uL
Cryo-precipitate	<ul style="list-style-type: none"> • Give if fibrinogen $< 80 - 100$ mg/dL (< 300 mg/dL peripartum) • Each 10 units of cryoprecipitate should raise fibrinogen level ~ 50 mg/dL
Fibrinogen Concentrate	<ul style="list-style-type: none"> • If cryoprecipitate unavailable: consider fibrinogen concentrate 0.5 - 1 g IV. May repeat to fibrinogen goal • Each gram should raise fibrinogen level ~ 50 mg/dL
Tranexamic Acid	<ul style="list-style-type: none"> • Consider TXA in all major bleeding cases • Give 1 g IV over 10 min then 1 g IV over 8 hours
Prothrombin Complex Concentrate	<ul style="list-style-type: none"> • Consider PCC in patients with warfarin induced bleeding or persistent deranged INR (PT) • Give 25 - 50 units/kg IV
Factor VIIa Concentrate	<ul style="list-style-type: none"> • Consider Factor VIIa if life-threatening, refractory coagulopathy • Seek hematology or pharmacy advice for dosing



High Airway Pressure

**Increased peak airway pressures > 5 cm H₂O above baseline
or > 35 cm H₂O**

May be accompanied by:

Wheezing and upsloping CO₂ waveform (if bronchospasm)

Increased EtCO₂

Decreased tidal volumes

Hypotension (if air-trapping)

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for help
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • Confirm presence of CO₂ • Evaluate capnography waveform: <ul style="list-style-type: none"> • Upward slope suggests obstruction • Curare cleft near end of expiratory phase suggests insufficient neuromuscular blockade • Starting at patient: inspect breathing circuit including valves, connections, and sample line
Rule Out Air Trapping	<ul style="list-style-type: none"> • Disconnect breathing circuit from ET tube or SG/LMA to rule out air-trapping (i.e. auto-PEEP)
Localize Problem	<ul style="list-style-type: none"> • During disconnect, squeeze reservoir bag. If pressure is: <ul style="list-style-type: none"> • High (machine or circuit is obstructed): Switch to self-inflating bag (Ambu) connected to O₂ source and gas sampling line • Low or zero (problem is with the ET tube or lungs): Reconnect anesthesia machine circuit
Optimize Compliance	<ul style="list-style-type: none"> • Consider increasing anesthetic: e.g. propofol 20 mg IV • Consider additional neuromuscular blockade • If abdominal insufflation: decrease or release pressure • Evaluate patient position. If head down: consider level or head-up positioning. If prone: consider turning supine • If surgical retraction contributing: notify surgeon • Check for shift in patient position (e.g. slipping off prone position supports)



TREATMENT

Task	Actions
Manually Ventilate	<ul style="list-style-type: none"> • Manually ventilate using anesthesia machine to assess compliance • Check and adjust adjustable pressure-limiting valve (APL)
Check for ET Tube Obstruction	<ul style="list-style-type: none"> • Pass soft suction catheter to rule out kinked ET tube or thick secretions (i.e. mucous plug) • Consider bronchoscopy to evaluate ET tube and airway • If unable to clear ET tube obstruction: replace ET tube
Auscultate Breath Sounds	<ul style="list-style-type: none"> • If asymmetric: <ul style="list-style-type: none"> • Rule out endobronchial intubation • Rule out pneumothorax <p>See Pneumothorax #22</p> • If symmetric but abnormal breath sounds: <ul style="list-style-type: none"> • If wheezing or decreased breath sounds: consider bronchospasm treatment <p>See Bronchospasm #6</p> • If crackles: consider pulmonary edema treatment

RULE OUT

Potential Causes	
ET tube or lungs:	
<ul style="list-style-type: none"> • Abdominal compartment syndrome • Abdominal insufflation • Abnormal anatomy (e.g. kyphoscoliosis) • Airway foreign body • Airway tumor • Anaphylaxis <p>See Anaphylaxis #5</p> <ul style="list-style-type: none"> • Aspiration • Bronchospasm <p>See Bronchospasm #6</p> <ul style="list-style-type: none"> • Chest wall rigidity • Kinked ET tube or circuit • Laryngospasm 	<ul style="list-style-type: none"> • Light anesthesia • Mucous plug • Muscle tone • Patient positioning • Pleural effusion • Pneumothorax/hemothorax <p>See Pneumothorax #22</p> <ul style="list-style-type: none"> • Pulmonary edema • Thoracic insufflation
	Machine or breathing circuit:
	<ul style="list-style-type: none"> • Circuit obstruction • Scavenger closed • Ventilator valve malfunction



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intentionally blank**



High Spinal

After neuraxial anesthesia or analgesia:

- Sensory or motor blockade higher or faster than expected
- Upper extremity numbness or weakness (hand grip)
- Dyspnea or apnea
- Nausea or vomiting
- Difficulty swallowing
- Cardiovascular collapse: bradycardia and/or hypotension
- Loss of consciousness

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call a code • Get code cart
Pulse Check	<ul style="list-style-type: none"> • If no pulse: start CPR and see Asystole/PEA #1 or VFIB/VTACH #4
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • Support oxygenation and ventilation; intubate if necessary as respiratory compromise may last several hours. Patient may be conscious and need reassurance and an amnestic agent, such as midazolam, to prevent awareness
Circulation	<ul style="list-style-type: none"> • If severe bradycardia or hypotension: epinephrine 10 - 100 mcg IV, increase as needed • If mild bradycardia: consider atropine 0.5 - 1 mg or glycopyrrolate 0.2 - 0.4 mg, but progress quickly to epinephrine if needed. Phenylephrine unlikely to be effective
Rapid Preload	<ul style="list-style-type: none"> • Give rapid IV bolus with pressure bag. May require several liters • Raise both legs to increase preload • Maintain neutral position. Head down position increases venous return but increases already high spinal level
Pregnancy Specific Care	<ul style="list-style-type: none"> • Ensure left uterine displacement • Call OB and Neonatology teams • Prepare for emergent or perimortem Cesarean • Monitor fetal heart tones

RULE OUT

- If local anesthetic toxicity is possible: give lipid emulsion 20% rapidly and **See Local Anesthetic Toxicity #18**



Hypertension

High systolic or diastolic blood pressure refractory to initial intervention

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for help • Consider pausing procedure
Airway	• 100% O₂ 10 - 15 L/min
Check BP Accuracy	<ul style="list-style-type: none"> • Check arterial line transducer position; consider zeroing • Check NIBP cuff position; cuff or cable compression

RULE OUT

Periop Causes	<ul style="list-style-type: none"> • Surgical stimulus: inspect surgical field • Recent epinephrine (e.g. local anesthesia, pledgets) or another vasopressor (e.g. vasopressin) given in surgical field • Carotid or aortic clamping • Full bladder / kinked urine catheter • Hypercarbia • Inadequate anesthesia or analgesia, including empty vaporizer or failure to deliver IV anesthetic • Inappropriate arterial line transducer height • Medication error • Pneumoperitoneum • Prolonged tourniquet time • Rebound hypertension in known hypertensive patient
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TREATMENT

Task	Actions
Treat Reversible Causes	<ul style="list-style-type: none"> • If acute self-limited cause (e.g. epinephrine): consider waiting • Treat reversible causes before giving antihypertensive • If treatable cause (e.g. tourniquet, full bladder): treat cause
Temporize	<ul style="list-style-type: none"> • Depending on clinical context and heart rate: <ul style="list-style-type: none"> • Increase anesthetic depth • Consider head up position



TREATMENT

Task	Actions
Meds	<ul style="list-style-type: none"> • Ensure functional IV; directly treat blood pressure: <ul style="list-style-type: none"> • Labetalol 5 - 10 mg IV, wait 5 min for next dose • Hydralazine 2 - 5 mg IV, wait 15 min for next dose • Nitroglycerin 20 - 50 mcg IV, wait 3 min for next dose • Nitroprusside 20 - 50 mcg IV, wait 3 min for next dose • Infusion with carrier to maintain blood pressure control: e.g. clevidipine infusion starting at 1 - 5 mg/hr <p>See Infusion List #29</p>
Arterial Access	<ul style="list-style-type: none"> • If severe or sustained hypertension: consider placing arterial line for monitoring and labs
Labs	<ul style="list-style-type: none"> • Send samples for ABG, Hgb, electrolytes, lactate, troponin
ECG	<ul style="list-style-type: none"> • Follow for signs of myocardial ischemia: (e.g. ST changes, T-wave inversions, or new arrhythmias) <p>See Myocardial Ischemia #20</p>
Team Recap	<ul style="list-style-type: none"> • Discuss patient condition with surgeon and team • Discuss adjustments of surgical plan
Disposition	<ul style="list-style-type: none"> • Arrange ICU care if vasoactive infusions or prolonged arterial line blood pressure monitoring indicated

RULE OUT

- Rare Causes**
- **Autonomic hyperreflexia:** spinal cord injury above T6, painful stimuli below cord injury level, reflex bradycardia
 - **Ischemia:** new arrhythmia, ST change or T-wave inversion
- See Myocardial Ischemia #20**
- **Malignant hyperthermia:** muscle rigidity; profound mixed respiratory and metabolic acidosis
- See Malignant Hyperthermia #19**
- **Neuroleptic malignant syndrome:** medical history of dopamine antagonist use, muscle rigidity, hyperthermia
 - **Pheochromocytoma:** episodic, resistant to treatment
 - **Preeclampsia:** pregnant, proteinuria, edema
 - **Raised ICP:** dilated pupil(s), bradycardia, trauma
 - **Serotonin syndrome:** hyperthermia, tachycardia, rigidity
 - **Stroke**
 - **Thyroid storm:** tachycardia, diaphoresis



Hypotension

Low blood pressure refractory to intervention or unclear cause

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Consider pausing procedure • Call for help • Consider calling for code cart
Pulse and Monitor Check	<ul style="list-style-type: none"> • Check for vital sign and EtCO₂ abnormalities • If no pulse or abnormal rate or rhythm, consider: <ul style="list-style-type: none"> Asystole/PEA #1 Bradycardia #2 SVT #3 VFIB/VTACH #4 • Check arterial line, transducer position, and cycle NIBP
Inspect Surgical Field	<ul style="list-style-type: none"> • Check for visible or concealed hemorrhage; consider FAST See Hemorrhage #12 • Check surgical field for pressure on heart or great vessels
Early Actions	<ul style="list-style-type: none"> • Ensure functional IV or IO access; start rapid crystalloid or colloid bolus • Consider head down position or leg elevation
Meds	<ul style="list-style-type: none"> • Turn anesthetic down or off • If ephedrine 5 - 20 mg IV or phenylephrine 100 - 300 mcg IV is not effective: consider epinephrine 10 - 50 mcg IV and/or vasopressin 0.5 - 1 units IV. May repeat or start infusion • Consider slow bolus of calcium chloride 1 g or calcium gluconate 1 - 3 g • Consider treating adrenal insufficiency: hydrocortisone 100 mg IV or methylprednisolone 125 mg IV • Consider treating vasoplegia: methylene blue 1.5 - 2 mg/kg over 20 min - 1 hour
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min
Cardiac Workup	<ul style="list-style-type: none"> • Consider TEE / TTE to differentiate causes • If persistent hypotension: consider ECMO or bypass
Access	<ul style="list-style-type: none"> • Consider additional large bore IV access • Consider arterial line placement
Labs	<ul style="list-style-type: none"> • Check ABG, Hgb, Plt, glucose, calcium, potassium, lactate
Output	<ul style="list-style-type: none"> • Place foley catheter and monitor urine output



Rule out rapidly lethal causes:

- Anaphylaxis
See Anaphylaxis #5
- Auto-PEEP: disconnect circuit
See High Airway Pressure #13
- Cardiovascular: consider TEE / TTE to evaluate volume status, LV/RV function, valvular disease, LV outflow obstruction
See Embolism #9
See Myocardial Ischemia #20
See Right Heart Failure #24
- Hemorrhage or concealed hemorrhage
See Hemorrhage #12
- IVC compression: prone, obese, pregnant, surgical manipulation
- Local anesthetic toxicity
See Local Anes Toxicity #18
- Pneumoperitoneum or pneumopericardium
- Pneumothorax
See Pneumothorax #22
- Cardiac tamponade
See Pneumothorax #22
- Vasodilators: check doses of volatile/IV anesthetics and drips

Explore Other Causes By Physiologic Differential:

- Blood Pressure = Systemic Vascular Resistance (SVR) x Cardiac Output (CO)
- Cardiac Output (CO) = Heart Rate (HR) x Stroke Volume (SV)
- Stroke Volume (SV) components: Preload, Inotropy, Afterload

- Low SVR**
- Anaphylaxis
See Anaphylaxis #5
 - Neuraxial block
See High Spinal #14
 - Shock (septic/spinal/neurogenic)
 - Transfusion reaction
See Transfusion Reaction #25
 - Vasodilators

- Low HR**
- Bradycardia/heart block
 - Vagal stimulus
See High Spinal #14
 - High spinal

- Low Preload**
- Auto-PEEP
 - Embolism e.g.air,clot,fat
See Embolism #9
 - Hypovolemia
See Hemorrhage #12
 - IVC compression
 - Pericardial tamponade
 - Pneumothorax
See Pneumothorax #22
 - Right heart failure
See Right Heart Failure #24
 - Vasodilators

- Low Inotropy**
- Acidosis
 - Arrhythmias
See Local Anes Toxicity #18
 - Cardiomyopathy
 - Hypoxemia
See Hypoxemia #17
 - Local anesthetic toxicity
 - Myocardial depressants
 - Myocardial ischemia
See Myocardial Ischemia #20

- High Afterload**
- Stenotic valvular disease
 - LVOT obstruction

- Low Forward Flow**
- Regurgitant valvular disease



Hypoxemia

Low SpO₂ and/or PaO₂ refractory to intervention or unclear cause

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Consider pausing procedure • Call for help • Consider calling for code cart
Oxygenate	• 100% O₂ 10 - 15 L/min
Check Monitors and Vitals	<ul style="list-style-type: none"> • Check gas analyzer to rule out low FiO₂ or high N₂O • See Oxygen Failure #21 • Check SpO₂ waveform, probe positioning, limb perfusion • Check vitals: ECG, cycle NIBP, check pulse, airway pressure • Check CO₂ waveform, look for circuit disconnection
Initial ETT Check	<ul style="list-style-type: none"> • Manually ventilate to check compliance • Consider using self-inflating (Ambu) bag with non-machine O₂ source (e.g. e-cylinder) or nothing (room air) to rule out machine or oxygen supply issue. Connect sample line and consider IV anesthetic • Check ET tube position and auscultate breath sounds • See Bronchospasm #6 • Soft suction ET tube to assess secretions and patency
Recruit Alveoli	<ul style="list-style-type: none"> • Perform recruitment breaths • Consider PEEP. If hypotensive: use caution • Increase FRC: head up position, desufflate abdomen
Meds	<ul style="list-style-type: none"> • If BP stable: deepen anesthetic with propofol or volatile • If wheezing: albuterol 4 - 8 puffs MDI or 2.5 mg nebulized. If severe: epinephrine 5 - 10 mcg IV, or ketamine 10 - 20 mg IV • Consider additional neuromuscular blockade or reversal
Advanced Evaluation	<ul style="list-style-type: none"> • Fiberoptic bronchoscopy: confirm tracheal rings, check for endobronchial intubation or obstruction • Lung ultrasound: check for pneumothorax, effusion consolidation, interstitial edema
Access	• Consider arterial line placement and ABG
X-Ray	• Consider STAT portable chest x-ray
ECMO/CPB	• If persistent: consider ECMO or bypass



Low FiO₂:

- If gas analyzer reads low FiO₂ despite "100% O₂," then likely O₂ pipeline failure or crossover

See Oxygen Failure #21

Hypoventilation:

- Spontaneously breathing:
 - Bronchospasm
 - Excess anesthetic
 - High spinal

See High Spinal #14

- Laryngospasm
- Obstructed airway
- Opioid
- Pain
- Pulmonary edema
- Residual neuromuscular blockade
- Mechanically ventilated:
 - High pressure alarm:
 - Asynchronous breathing
 - Bronchospasm**See Bronchospasm #6**
 - High peak airway pressure
See High Airway Pressure #13
- Insufficient neuromuscular blockade
- Obstructed or kinked ET tube
- Ventilator on manual, APL closed
- Low pressure alarm:
 - ET tube dislodged or cuff tear
 - Circuit leak
 - Low TV or RR setting
 - Ventilator on manual and APL open

Diffusion abnormality:

- Usually chronic lung disease

Hemoglobinopathy:

- Carboxyhemoglobin: SpO₂ often normal
- Methemoglobin: SpO₂ ~85%
- If suspected, send lab co-oximetry

V/Q Mismatch:

Shunt = perfused, but not ventilated (less responsive to O₂)

Dead space = ventilated, but not perfused (more responsive to O₂)

- Common causes:

- Aspiration
- Atelectasis
- Bronchospasm

See Bronchospasm #6

- Endobronchial intubation
- Mucus plug
- One lung ventilation
- Pleural effusion
- Pulmonary edema

- Rare but critical:

- Anaphylaxis

See Anaphylaxis #5

- Embolism: e.g. air, clot, fat

See Embolism #9

- Pneumothorax

See Pneumothorax #22

- Right heart failure

See Right Heart Failure #24

- Severe hypotension

See Hypotension #16

Increased O₂ Demand:

- Iatrogenic hyperthermia
- Malignant hyperthermia

See Malignant Hyperthermia #19

- Neuroleptic Malignant Syndrome
- Sepsis
- Thyrotoxicosis

SpO₂ Artifact:

- Confirm with ABG
- Poor SpO₂ waveform:
 - Cautery interference
 - Cold or poorly perfused digit
 - Light interference
 - Probe malposition
- Dyes:
 - Blue nail polish
 - Indigo carmine
 - Methylene blue



Local Anesthetic Toxicity

Can present with any combination of:

Neurologic symptoms:

- Seizures
- Altered mental status
- Tinnitus
- Metallic taste
- Perioral numbness

Cardiac symptoms:

- Cardiovascular collapse
- Hypotension
- Arrhythmia (e.g. ectopy, asystole, bradycardia, VFIB, VTACH)

TREATMENT

Task

Actions

Crisis Resources

- Inform team • Call for help
- **Call for lipid emulsion 20% (Intralipid™) STAT**
- If unstable: consider early call for ECMO or bypass

Stop Triggers

- Stop any local anesthetic injection or infusion

CPR

- If pulseless: start CPR. May require prolonged CPR +/- ECMO
- **100% O₂ 10 - 15 L/min**
- Start lipid emulsion, then intubate if indicated

Lipid Emulsion

- **Bolus lipid emulsion 20% 100 mL IV over 2 - 3 min**
(If < 70 kg: give 1.5 mL/kg IV bolus)
- **Infuse lipid emulsion 20% 250 mL IV over 15 - 20 min**
(If < 70kg: infuse 0.25 mL/kg/min for 20 min)
- **If unstable: repeat bolus and double the infusion until stable.** Maximum lipid emulsion 20% dose: 12 mL/kg
- Once stable, continue infusion for at least 15 minutes

Post-event Care

- Continue PACU/ICU-level monitoring for at least:
 - 2 hours after seizure
 - 6 hours after hemodynamic instability
 - 24 - 48 hours after cardiac arrest

Consult ASRA

- For latest recommendations: <http://www.asra.com>

Next page: Treatment depending on LAST presentation



TREATMENT

If Seizure:**Recovery Position**

- Place patient lateral and head down to prevent aspiration; prevent falls and head injury

Meds

- Give benzodiazepine to break seizure: midazolam 2 - 4 mg IV. If refractory, give neuromuscular blockade: rocuronium
- If benzodiazepines not available and BP stable: give propofol 20 mg IV. May repeat until seizure stops

Airway

- Support breathing; intubate if appropriate

If Arrhythmia or Hypotension:**Rhythm Meds**

- If persistent arrhythmia: give amiodarone 150 mg IV slowly over 10 - 15 min. Avoid calcium channel blockers, beta blockers, local anesthetics, and any negative inotrope

Meds

- Treat hypotension with **low dose epinephrine**: start with 0.2 - 1 mcg/kg IV; **avoid vasopressin**

If Cardiac Arrest:**CPR**

- Rate 100 - 120 compressions/min
- Depth \geq 5 cm; allow chest recoil; consider backboard
- Keep EtCO₂ > 10 mmHg and diastolic BP > 20 mmHg
- Rotate compressors with rhythm check every 2 min
- Check pulse ONLY if signs of ROSC (sustained increased EtCO₂, spontaneous arterial waveform, rhythm change)
- Place defib pads

Airway

- If mask ventilation: ratio 30 compressions to 2 breaths
- If airway secured: 10 breaths/min; tidal volume 6 - 7 mL/kg

Defib

- If VFIB or unstable VTACH: immediately defibrillate 120-200 J biphasic or 360 J monophasic
- Resume CPR immediately
- Reasonable to increase energy of repeat shock every 2 min

Meds

- Give **LOW DOSE epinephrine**: start at 0.2 - 1 mcg/kg IV
- If VFIB/VTACH unresponsive to defibrillation: **amiodarone** 300 mg IV push. May redose amiodarone 150 mg IV push. **Avoid lidocaine**

ECMO/CPB

- If prolonged need for CPR: **consider ECMO or bypass**



Malignant Hyperthermia

May be early signs:	Mixed (metabolic and respiratory) acidosis Increased EtCO₂, heart rate, respiratory rate Hyperthermia Masseter spasm/trismus Muscle rigidity without shivering, tremor, or clonus
May be late signs:	Myoglobinuria Arrhythmias including hyperkalemic cardiac arrest

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Get MH cart with dantrolene • Call for help • Consider pausing procedure
Stop MH Triggers	<ul style="list-style-type: none"> • Stop volatile anesthetic and succinylcholine • Do NOT change machine or circuit • 100% O₂ 10 - 15 L/min • If easily available, add charcoal filters to breathing circuit
Airway	<ul style="list-style-type: none"> • Maximize minute ventilation. Mechanical ventilation is preferred. Avoid air-trapping
Give Antidote Rapidly	<ul style="list-style-type: none"> • Initial dantrolene dose is 2.5 mg/kg IV. Formulations: <ul style="list-style-type: none"> • Concentrated, easily soluble formulation: Ryanodex: Dilute one 250 mg vial in 5 mL preservative-free sterile water. 70 kg patient dose: 175 mg = 3.5 mL • Non-concentrated formulation: Dantrium or Revonto: Assign several people to prepare. Dilute each 20 mg vial in 60 mL preservative-free sterile water. 70 kg patient dose: 175 mg = 9 VIALS • Repeat dantrolene 2.5 mg/kg every 5 min until hypercarbia and rigidity are resolved and temperature is not increasing. May need > 10 mg/kg
Team Recap	<ul style="list-style-type: none"> • If appropriate, stop procedure • Give non-triggering maintenance anesthetic or sedation (e.g. propofol, benzodiazepine, opioid)

RULE OUT

- | | | |
|--------------------------------|----------------------------------|----------------------|
| • CO ₂ insufflation | • Illicit stimulants | • Pheochromocytoma |
| • Hypoventilation | • Light anesthesia | • Serotonin syndrome |
| • Hypoxemia | • Neuroleptic malignant syndrome | • Thyroid storm |
| • Iatrogenic warming | | |

GO TO NEXT PAGE »



TREATMENT

Task	Actions
Treat Hyper-K⁺	<ul style="list-style-type: none"> • Calcium chloride 10 mg/kg IV, max 2 g • Regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g); monitor glucose • Albuterol 8 - 12 puffs MDI or 2.5 mg nebulized • Sodium bicarbonate: 0.5 amp (25 mL) at a time; maintain minute ventilation to exhale additional CO₂ produced • If severe: consider emergent dialysis
Treat Rhythm	<ul style="list-style-type: none"> • Treat arrhythmias with amiodarone 150 mg IV over 10 - 15 min, esmolol 10 - 20 mg IV bolus followed by infusion, or magnesium sulfate 1 g IV; avoid calcium channel blockers and sodium channel blockers (e.g. verapamil, diltiazem, lidocaine, procainamide) • If unstable, call for code cart and also see ACLS event: Asystole/PEA #1 Bradycardia #2 SVT #3 VFIB/VTACH #4
Active Cooling	<ul style="list-style-type: none"> • If core temperature > 38° C: actively cool with cold IV fluid (20 - 30 ml/kg normal saline or plasmalyte) • Additional cooling: Stop active warming; set forced air on ambient; cool room; put ice packs on head, axilla, and groin; wet skin; cool lavage if open abdomen or peritoneal catheter (avoid bladder lavage to preserve urine output measurement)
Access	<ul style="list-style-type: none"> • Consider additional IV access and arterial line placement
Labs	<ul style="list-style-type: none"> • Send ABG, K⁺, CK, urine myoglobin, coagulation panel, lactate
Urine Output	<ul style="list-style-type: none"> • Place Foley catheter and monitor urine output: goal 1 - 2 mL/kg/hr; consider IV fluids and diuretics
MH Hotline	<ul style="list-style-type: none"> • Call 24/7 for expert consultation: 1-800-MH-HYPER (1-800-644-9737) http://www.mhaus.org
ICU Care	<ul style="list-style-type: none"> • Transport with experienced personnel after stabilization • Mechanical ventilation commonly required because 20% of MH events relapse within 16 hours. Extubate once metabolically and hemodynamically stable • Continue dantrolene: 1 mg/kg bolus every 4 - 6 hours or 0.25 mg/kg/hr infusion for up to 24 hours • Monitor for rhabdo, DIC, hyperK⁺, compartment syndrome
Post Event	<ul style="list-style-type: none"> • Complete AMRA (Adverse Metabolic Reaction to Anesthesia): https://anest.ufl.edu/namhr/ • Test genes: https://www.mhaus.org/testing/genetic-testing/



Myocardial Ischemia

ST segment depression or elevation

T-wave inversion

Arrhythmias: conduction abnormality (e.g. new LBBB), irregular rhythm, tachycardia, bradycardia, or hypotension

Regional wall motion abnormality

New or worsened mitral regurgitation

Chest pain, dyspnea, nausea, or diaphoresis

TREATMENT

Task

Actions

Crisis Resources

- Inform team
- Get code cart
- Call for Cardiac Anesthesiology or Cardiology help

Airway

- **Set supplemental O₂ to maintain SpO₂ ≥ 95%**

Monitor

- Get 12-lead ECG; verify ECG leads in correct position
- Expand ECG monitor view to leads II, V5, and others
- Prepare for arrhythmia: apply defibrillator pads and leads

Team Recap

- Pause or stop procedure if possible
- **Discuss bleeding and risk of anticoagulation**

Meds

- Treat any tachycardia, bradycardia, hypotension or hypertension
- **See Infusion List #29**
- Discuss with surgeon the explicit contraindications and benefits of dual antiplatelet therapy and anticoagulation:
 - **Aspirin 160 - 325 mg PO, nasogastric, or rectal**
 - **P2Y12 ADP receptor inhibitor:**
e.g. clopidogrel 300 mg PO, prasugrel 60 mg PO, or ticagrelor 180mg PO
 - **Heparin infusion**
- Treat pain with narcotics: **fentanyl or morphine**
- Consider **nitroglycerin** paste or infusion. Avoid if hypotensive
- Consider **beta blocker** to slow heart rate and allow coronary perfusion. **Esmolol** preferred because it can be stopped if it precipitates CHF. Avoid if bradycardia, 1st or 2nd degree heart block, or hypotensive
- If acute pulmonary edema, consider diuresis: furosemide 10 - 40 mg IV. Monitor urine output



TREATMENT

Task	Actions
Cardiology Consult	<ul style="list-style-type: none"> • If STEMI: consult Cardiology for possible emergent coronary revascularization or fibrinolysis • Consider emergent transfer to Cath Lab or PCI Center
Access	<ul style="list-style-type: none"> • Consider additional IV access • Place arterial line for monitoring and labs • Consider central line placement
Labs	<ul style="list-style-type: none"> • Send ABG, electrolytes, Hgb, troponin, coagulation panel
ECHO	<ul style="list-style-type: none"> • Consider TEE / TTE to assess volume status, wall motion, ventricular function, and valvular disease • Use contractility to guide vasoactive infusion choice
ECMO/CPB	<ul style="list-style-type: none"> • Consider ECMO, cardiopulmonary bypass, or intra-aortic balloon pump
Disposition	<ul style="list-style-type: none"> • May require ICU care

END




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Oxygen Failure



Audible or visible O₂ failure alarm
Inappropriately low FiO₂ value on gas analyzer
Flow meter reads abnormally low

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Consider pausing procedure • Call for help • Get code cart with O₂ cylinder
Non-Machine Ventilation 	<ul style="list-style-type: none"> • Disconnect patient from machine and ventilate with self-inflating bag (Ambu) on room air • Do NOT connect self-inflating bag (Ambu) to machine auxiliary oxygen because it has the same faulty O₂ source • Consider assigning capable person to manual ventilation
Pulse Check	<ul style="list-style-type: none"> • If no pulse: start CPR and <div style="background-color: #800000; color: white; padding: 2px; display: inline-block;">See Asystole/PEA #1</div>
Non-Machine O₂ Source	<ul style="list-style-type: none"> • Attach self-inflating bag (Ambu) to: <ul style="list-style-type: none"> • Nozzle on transport O₂ e-cylinder OR • Nothing (continue ventilating on room air)
Attach Gas Sampling Line	<ul style="list-style-type: none"> • Connect gas sampling line with elbow connector between patient and self-inflating bag (Ambu) • Verify correct airway placement with CO₂ • Verify patient is receiving expected O₂ concentration on gas analyzer: 100% if on e-cylinder, 21% if on room air
Low Pressure	<ul style="list-style-type: none"> • Confirm orogastric/nasogastric tube not in trachea
Non-Machine Anesthetic	<ul style="list-style-type: none"> • Maintain anesthesia with IV medications • Turn off volatile anesthetic
Conserve O₂	<ul style="list-style-type: none"> • Use lowest possible fresh gas flow and FiO₂
Report Problem	<ul style="list-style-type: none"> • Inform Charge Nurse, Anesthesia Lead, and all ORs • Contact bio-engineering to: <ul style="list-style-type: none"> • Report problem; ask for help with diagnostics and repair while you focus on patient care • Find out if issue is system wide
Team Recap	<ul style="list-style-type: none"> • Discuss plan for this patient and OR schedule



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Pneumothorax



Increased peak inspiratory pressures (PIPs)
Tachycardia
Hypotension or hypoxemia
Decreased or asymmetric breath sounds
Hyperresonance to chest percussion
Tracheal deviation (late sign)
Increased JVD/CVP
Decompensation upon initiation of mechanical ventilation or central line placement
Higher incidence in trauma, COPD, cardiothoracic, and upper abdominal surgery patients

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none">• Inform team• Call for help• Call Trauma, General, or Cardiothoracic Surgery STAT• Identify leader• Get code cart
Airway	<ul style="list-style-type: none">• 100% O₂ 10 - 15 L/min
Fast Checks	<ul style="list-style-type: none">• Exclude endobronchial intubation: listen to breath sounds and check ET tube depth• Exclude ET tube obstruction: pass soft suction catheter• Exclude auto-PEEP: briefly disconnect breathing circuit
Decompress Emergently	<ul style="list-style-type: none">• If unstable and chest tube is not immediately available:<ul style="list-style-type: none">• Place 14 (or 16) gauge IV catheter in 4th or 5th intercostal space between anterior and mid-AXILLARY line per ATLS 2018 (may hear a whoosh of air if under tension)• Leave IV catheter in place while awaiting chest tube• Have appropriate personnel place chest tube
Advanced Checks	<ul style="list-style-type: none">• Fiberoptic bronchoscopy to evaluate for endobronchial intubation, ET tube obstruction• Lung ultrasound: Lung sliding (normal) vs. lung point (pneumothorax) seashore sign (normal) vs. barcode (pneumothorax)• Consider STAT portable chest x-ray; do not delay treatment
Disposition	<ul style="list-style-type: none">• Consider ICU care for respiratory monitoring and chest tube management

END



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Power Failure



Sudden darkness
Loss of electrically powered equipment

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none">• Inform team• Call for help
Obtain Light Source	<ul style="list-style-type: none">• Use any available light sources: laryngoscope, cell phone, flashlight, ambient light from opening door or shades
Confirm Ventilator	<ul style="list-style-type: none">• Ventilator may have temporary (~30 minute) battery. Consider utilizing transport ventilator• If ventilator is not working:<ul style="list-style-type: none">• Consider converting to spontaneous ventilation• Ventilate with self-inflating bag (Ambu)• Convert to TIVA with battery operated pump or dial-a-flow / manual flow regulator
Confirm Monitor	<ul style="list-style-type: none">• If monitors fail:<ul style="list-style-type: none">• Assign person for continuous pulse check• Perform manual blood pressure measurement• Use transport monitor or defibrillator monitor
Confirm Backup O₂	<ul style="list-style-type: none">• If power failure affects oxygen supply or alarms: See Oxygen Failure #21
Confirm Backup Power	<ul style="list-style-type: none">• Ensure generator-supplied emergency power outlets are functional• Connect all life-sustaining equipment to emergency outlets• Disconnect non-life-sustaining equipment from emergency outlets
Report Problem	<ul style="list-style-type: none">• Inform Charge Nurse, Anesthesia Lead, and all ORs• Call bio-engineering to:<ul style="list-style-type: none">• Report problem; ask for help with diagnostics and repair while you focus on patient care: if only in your OR, suggest checking if circuit breaker was tripped• Find out if issue is system wide
Team Recap	<ul style="list-style-type: none">• Discuss with surgeon and team the implications of power failure for this patient and OR schedule

END



Right Heart Failure

Dyspnea, dizziness, edema, right upper abdominal discomfort
Hypotension
ECG with RV strain
TEE / TTE with dilated RV, reduced RV function
Flattening of interventricular septum
Decompensation after hypoxemia, hypercarbia, or acidosis
Decompensation upon initiation of mechanical ventilation

TREATMENT

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Call for a pulmonary vasodilator such as nitric oxide (e.g. INOmax) or epoprostenol (e.g. Flolan, Veletri) • Call for code cart and TEE / TTE • Call for Cardiac Anesthesiology, Cardiology, or ICU help
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • Decrease tidal volume and increase respiratory rate to lower intrathoracic pressure and avoid hypercarbia. Avoid breath stacking • Minimize PEEP if tolerated; avoid hypoxemia
ECHO	<ul style="list-style-type: none"> • Assess key TEE / TTE findings: <ul style="list-style-type: none"> • Decreased RV function: Tricuspid Annular Plane Systolic Excursion (TAPSE): severely reduced < 6mm; normal 16-20 mm • RV volume/pressure overload: Flattened interventricular septum makes left ventricle appear D-shaped • RV dilation and/or hypertrophy • Underfilled LV despite adequate preload

RULE OUT

Consider Life-Threatening Causes of RV Failure

- Cardiac tamponade: perform emergent pericardiocentesis
- Protamine: stop administration
- Embolism: e.g. air, clot, fat
See Embolism #9
- RV infarction
See Myocardial Ischemia #20
- Tension pneumothorax
See Pneumothorax #22



TREATMENT

Task	Actions
ECMO/CPB	<ul style="list-style-type: none"> • If significant instability: consider ECMO or cardiopulmonary bypass
Decrease RV Afterload	<ul style="list-style-type: none"> • Offload RV by decreasing pulmonary vascular resistance (PVR): <ul style="list-style-type: none"> • Give inhaled prostacyclin derivatives, inhaled nitric oxide, or intravenous pulmonary vasodilators • Avoid hypoxemia, hypercarbia, acidosis, or excessive intrathoracic pressure
Maintain RV Contractility	<ul style="list-style-type: none"> • Avoid hypotension to maintain myocardial perfusion <ul style="list-style-type: none"> • If decreased RV contractility: consider epinephrine • If normal RV contractility: consider vasopressin or norepinephrine • See Infusion List #29 • If refractory hypotension: consider intra-aortic balloon pump (IABP) to maintain coronary perfusion
Maintain Normal RV Volume Status	<ul style="list-style-type: none"> • RV overload is more dangerous than mild hypovolemia • RV overload suggested by CVP > 20mmHg and/or SvO₂ < 65% • If RV overload: consider diuresis and seek expert advice • If RV under-filled: careful volume replacement with blood or crystalloid per HCT
Maintain Normal Sinus Rhythm	<ul style="list-style-type: none"> • Avoid bradycardia or extreme tachycardia to maintain cardiac output • Identify and treat electrolyte abnormalities • Maintain atrial kick to augment cardiac output <ul style="list-style-type: none"> • If irregular rhythm: <ul style="list-style-type: none"> • See SVT #3

END



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Transfusion Reaction



Hemolytic Reaction:

Fever
Back/flank pain
Tachycardia
Tachypnea
Hypotension
Dark urine
Oozing or DIC

Febrile Reaction:

Fever
Chills
Rigors
Headache
Vomiting

Anaphylactic Reaction:

Hypotension
Urticaria
Other rash
Wheezing
Tachycardia

TREATMENT

Task	Actions
Stop Transfusion	<ul style="list-style-type: none"> • Stop transfusion(s) • Retain blood product bag(s)
Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for help • Call for code cart • Consider pausing procedure
Airway	<ul style="list-style-type: none"> • 100% O₂ 10 - 15 L/min • If no ET tube in place: consider intubation
Circulation	<ul style="list-style-type: none"> • Consider IV fluid bolus • If hypotensive: <ul style="list-style-type: none"> • Turn anesthetic down or off • Treat with vasopressor bolus (e.g. phenylephrine, ephedrine) • If severe: give epinephrine 10 - 100 mcg IV and/or vasopressin 0.5 - 1 units IV
Blood Bank	<ul style="list-style-type: none"> • Send appropriate labs and return units per local protocol
Specific Reaction Treatments	<ul style="list-style-type: none"> • Hemolytic Reaction: monitor for signs of DIC; maintain urine output with IV fluids, diuretics • Febrile Reaction: treat with antipyretic acetaminophen 1000 mg IV; rule out hemolysis; rule out bacterial contamination • Anaphylactic Reaction: give epinephrine bolus and then infusion. Consider steroid: dexamethasone 4 - 8 mg IV or hydrocortisone 100 mg and antihistamine: diphenhydramine 25 - 50 mg IV and famotidine 20 mg IV <p style="text-align: center;">See Anaphylaxis #5</p>
Disposition	<ul style="list-style-type: none"> • May require ICU care

END



Trauma

Blunt force or penetrating injury to major organs

TREATMENT - TRAUMA BAY

Task	Actions
Crisis Resources	<ul style="list-style-type: none"> • Call trauma code • Activate trauma operating room • Activate massive transfusion protocol (MTP)
On Arrival to Trauma Bay	<ul style="list-style-type: none"> • All team members state name and role. Use clear, closed-loop communication; record events • Check pulse. If no pulse: start ACLS while transfusing and performing primary survey to find and treat cause • Place standard monitors and obtain large-bore IV access • Maintain c-spine precautions with all movement
Primary Survey	<ul style="list-style-type: none"> • Airway and Breathing: <ul style="list-style-type: none"> • Evaluate airway, ensure oxygenation and ventilation • Intubate in indicated. Recommend RSI with video laryngoscopy, in-line stabilization, and capnography. • If hypotensive: modify or eliminate induction medication. • If indicated, surgical airway • Treat pneumo or hemothorax with emergent chest tubes • Circulation: <ul style="list-style-type: none"> • Control external hemorrhage. Transfusion preferred over crystalloid bolus. Do FAST: Focused Assessment with Sonography for Trauma • Disability: <ul style="list-style-type: none"> • Assess level of consciousness, pupils, glucose, and Glasgow Coma Scale (GCS), on right • Exposure: <ul style="list-style-type: none"> • Fully expose to assess injury then cover to prevent hypothermia
Secondary Survey	<ul style="list-style-type: none"> • AMPLE History: Allergies, Meds, Past medical history, Last meal, Events leading to injury • AT MIST: Age, Time of injury, Mechanism of injury, Injuries sustained, Systemic review, Treatments • Head-to-toe physical exam and radiologic evaluation

GCS
Eye opening:
4 - Spontaneous
3 - To speech
2 - To pain
1 - None
Verbal response:
5 - Oriented
4 - Confused
3 - Inappropriate words
2 - Sounds
1 - None
Motor response:
6 - Obeys
5 - Localizes to pain
4 - Flexion to pain
3 - Abnormal flexion
2 - Abnormal extension
1 - None



Task	Actions
Trauma OR Setup (Prep in advance and check before patient arrival)	<ul style="list-style-type: none"> • Warm OR to $> 25^{\circ} \text{C}$ (77°F) to maintain normothermia • Setup: machine, suction, monitors, airway (video laryngoscope and surgical airway), IV and IO kits, rapid infusion device, ultrasound machine, code cart, invasive monitoring equipment (e.g. arterial line, CVP), cell saver • Meds: e.g. midazolam, ketamine, propofol, etomidate, scopolamine, succinylcholine, rocuronium, epinephrine, vasopressin, ephedrine, phenylephrine, calcium, antibiotics • Check: crystalloid, colloid, and blood products (MTP)
Induction and Airway	<ul style="list-style-type: none"> • Place standard ASA monitors and preoxygenate • If patient conscious: briefly reassure them • Discuss among team (e.g. Anesthesiology, Surgery, Nursing, others) timing and order of priorities including IV and arterial access, inducing anesthesia, securing airway, hemorrhage resuscitation, and incision • Perform RSI with c-spine precautions • Place additional IVs and arterial line • If stable: anesthetic maintenance with volatile anesthetic. If unstable, maintenance with benzodiazepine or ketamine
Temporize	<ul style="list-style-type: none"> • If severe instability: inform surgeon; discuss temporizing measures (e.g. packing, aortic compression, aortic crossclamp, thrombin, fibrin glue, REBOA)
Transfuse	<ul style="list-style-type: none"> • Based on clinical picture: transfuse with ratio of 1-2 PRBC : 1 FFP : 1 Platelet pack • Coagulopathy may require cryo, fibrinogen, calcium, TXA
Traumatic Brain Injury	<ul style="list-style-type: none"> • Maintain CPP while decreasing ICP: $\text{MAP} \geq 80$, $\text{SBP} \geq 100 \text{ mmHg}$, $\text{SpO}_2 \geq 90\%$, EtCO_2 35 - 40 mmHg, mannitol or hypertonic saline, head up position, and burst suppression
Labs	<ul style="list-style-type: none"> • Crossmatch, serial ABG, lytes, lactate, coags
Meds	<ul style="list-style-type: none"> • If < 3 hours since injury give tranexamic acid (TXA): 1g IV over 10 min, then 1g every 8 hrs • Give calcium for coagulation and blood pressure • Treat hyperkalemia: calcium chloride 1 g IV; sodium bicarbonate 1 amp IV (50 mEq); regular insulin 5 - 10 units IV with dextrose/D50 1 amp IV (25 g)
Post Event	<ul style="list-style-type: none"> • ICU care for continued resuscitation

CRISIS RESOURCE MANAGEMENT





CRISIS RESOURCE MANAGEMENT

Call for Help Early

- Call for help early enough to make a difference
- Err on the side of getting more help
- Mobilize early personnel with special skills if they may be needed

Designate Leadership

- Establish clear leadership
- Inform team members who is in charge
- 'Followers' should be active in asking who is leading

Anticipate and Plan

- Plan & prepare for high work-load periods during low work-load periods
- Know where you are likely headed during the crisis and make backup plans early

Establish Role Clarity

- Determine who will do what
- Assign areas of responsibility appropriate to knowledge, skills, and training
- Active followers may offer specific roles

Know the Environment

- Maintain situational awareness
- Know how things work and where things are
- Be aware of strengths and vulnerabilities of environment

Use All Available Information

- Monitor multiple streams of data and information
- Check and cross check information

Distribute the Workload

- Assign specific tasks to team members according to their abilities
- Revise the distribution if there is task overload or failure

Allocate Attention Wisely

- Eliminate or reduce distractions
- Monitor for task saturation & data overload
- Avoid getting fixated
- Recruit others to help w/ monitoring

Communicate Effectively

- Command and request clearly
- Seek confirmation of request (close the loop)
- Avoid "thin air" statements
- Foster input and atmosphere of open information exchange among all personnel

Mobilize Resources

- Activate all helpful resources including equipment and additional personnel

Use Cognitive Aids

- Be familiar with content, format, and location
- Support the effective use of cognitive aids



Emergency Manual V4 - Design Overview

Cognitive Aids for Perioperative Crises - V4 2021
Stanford Anesthesia Cognitive Aid Program

EMERGENCY MANUAL

Phone List (Back Cover)

ACLS	OTHER EVENTS	RESOURCES
Asystole / PEA		1
Bradycardia		2
SVT - Unstable and Stable		3
VFIB / VTACH		4
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Delayed Emergence		7
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Fire - Airway		10
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Hypertension		15
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Transfusion Reaction		25
Trauma		26
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Cognitive Aid Information		28
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- ACLS events in red and listed first
- Combined event for Unstable and Stable SVT

- Other events in gray and listed alphabetically for easy access
- Content updated for all events after in-depth literature review
- New events: Hypertension, High Airway Pressure, Right Heart Failure, Trauma
- Combined event for multiple Embolism etiologies

- Important resources in teal: Crisis Resource Management (CRM), Cognitive Aid Information, and Infusion List

Embolism - Pulmonary

Sudden decrease in EtCO₂, BP, or SpO₂
Sudden increase in central venous pressure
Dyspnea, respiratory distress, or cough in awake patient
Increased risk in long bone orthopedic surgery, pregnancy, cancer (especially renal tumor), high BMI, laparoscopic surgery, or surgical site above level of the heart

TREATMENT	Task	Actions
9	Crisis Resources	<ul style="list-style-type: none"> • Inform team • Identify leader • Call for help • Get code cart • Consider terminating procedure
	Pulse Check	<ul style="list-style-type: none"> • If no pulse: start CPR, check rhythm, and follow appropriate algorithm • See Asystole/PEA #1 • VFIB/VTACH #4
	Airway	<ul style="list-style-type: none"> • 100% O₂, 10-15 L/min
	Circulation	<ul style="list-style-type: none"> • Turn off volatile anesthetic and vasodilating drips • Give IV vasopressor bolus to support circulation • Consider rapid fluid bolus
	Evaluate Right Heart	<ul style="list-style-type: none"> • If unstable or RV function decreased on TEE/TTE, use medication and diuresis to: <ul style="list-style-type: none"> • Maintain sinus rhythm • Maintain normal RV volume status • Maintain RV contractility • Decrease RV afterload • See Right Heart Failure #24
	ECMO/CAB	<ul style="list-style-type: none"> • If severe decompensation: consider ECMO or cardiopulmonary bypass
28	Consider other causes:	
	<ul style="list-style-type: none"> • Anaphylaxis (See Anaphylaxis #5) • Bone cement implantation syndrome (See Myocardial Ischemia #20) • Bronchospasm (See Bronchospasm #6) • Cardiac tamponade (See Pneumothorax #22) • Cardiogenic shock 	<ul style="list-style-type: none"> • Distributive shock • Hypovolemia • Myocardial ischemia (See Myocardial Ischemia #20) • Pneumothorax (See Pneumothorax #22) • Pulmonary edema

GO TO NEXT PAGE »

- Each event title is followed by potential signs and symptoms so you know if you are on the right track

- Blue "Treatment" boxes list critical tasks and actions in order of importance, starting with Crisis Resource Management (CRM) key points
- Can be used during a crisis, to anticipate and plan, for teaching, and for post-event debriefing
- "Task" categories with "Actions" to be completed in order or sampled for specific information
- "See Event #" highlights help you consider other relevant events

- Gray boxes assist with diagnosis or prevention tips



Use: Recent research suggests that Emergency Manual (EM) use improves teamwork, facilitates coordination, decreases stress, and enables delivery of better patient care.¹ The Stanford EM, and other similar tools, are used effectively in both clinical and educational settings:

Clinical:

- Pre-event for 'just in time' review for at-risk patients
- During event for crisis management
- Post-event for team debriefing

Educational:

- Self-review
- 1:1 or small group teaching
- Studying for oral exams
- During simulation cases and debrief sessions

We welcome your feedback and continuously learn from our community of users.

Implementation: These websites include a number of tips and free resources to support EM implementation by your interprofessional team:

- Stanford EM - <https://emergencymanual.stanford.edu/>
[Download](#) the EM in English or another language, find implementation tips, and learn more
- Emergency Manual Implementation Collaborative (EMIC) - <https://www.emergencymanuals.org/>
- EM Implementation Toolkit - <https://www.implementingemergencychecklists.org>
This resource-rich guide, developed with Ariadne Labs, includes videos you can use or adapt, and other training materials.

Stanford EM Formats:

- Large (8 ½ x 11") hanging printed version (most popular), with or without event number tabs*
- Small (4 ¼ x 5 ½") printed pocket version*
- [PDF](#) with hyperlinks (accessible on a computer, mobile device, or an electronic health record)
- [E-book](#)

*Our printed versions are operating room safe (wipeable, and MRI-safe). You can use any printer you choose. See our [website](#) for information about our printer.

EM Customization - See our [website](#) for templates to customize for your setting:

- Infusion List (inside back cover)
- Phone List (outside back cover)

EM Training:

- EM Reader: reads aloud to team/leader to interactively ensure vital actions are performed, medication doses correct, diagnoses considered, find specific desired information, while allowing leader to maintain situational awareness and team communication.²
- Train team members to ask empowering questions: Would you like me to get/read the emergency manual? Which event in the emergency manual are we dealing with? These can help the leader remember the EM is available and can trigger its use. In our experience, leaders often answer, "Yes," and had forgotten about the EM due to the stress of the crisis.

1. Goldhaber-Fiebert SN, Howard SK, Gaba DM, et al. Clinical Uses and Impacts of Emergency Manuals During Perioperative Crises. *Anesth Analg*. 2020 Dec;131(6):1815-1826.

2. Burden AR, et al. Does every code need a "reader?" Improvement of rare event management with a cognitive aid "reader" during a simulated emergency: a pilot study. *Simul Healthc*. 2012 Feb;7(1):1-9.



Emergency Manual V4 - Publication Details

Stanford Anesthesia Cognitive Aid Program (SACAP) EM V4 Team:

Ellile Sultan, MD
Amanda Burden, MD
Barbara K. Burian, PhD
Naola S. Austin, MD
Kyle Harrison, MD
Sara Goldhaber-Fiebert, MD
Steven K. Howard, MD
David M. Gaba, MD

Summer Reid, BA (Administrative Associate)

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References: Citations are not written on each event given usability priorities, but you can visit our website if interested in relevant content literature. We strive to integrate the most pertinent clinical information from published literature and clinical practice guidelines.

Citation: Stanford Anesthesia Cognitive Aid Program,* Emergency Manual: Cognitive aids for perioperative crises, Version 4, 2021. See <http://emergencymanual.stanford.edu> for latest version. Creative Commons BY-NC-ND (<https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode>).
*Goldhaber-Fiebert SN, Austin N, Sultan E, Burian BK, Burden A, Howard SK, Gaba DM, Harrison TK.

Local Modifications and Creative Commons Licensing: Research supports that local customization of cognitive aids is helpful for many reasons. We allow all needed modifications for use at your local institution, without further permissions. You should keep original authorship attribution and add 'Adapted By ___.' For more than minor PDF modifications or local phone list for back cover, we suggest requesting our original InDesign file: Email EMadminanes@lists.stanford.edu. We are not responsible for any errors introduced and caution that there are usability cons to adding too much information. See this review for an overview of effective cognitive aid design.¹ No derivatives may be shared beyond local use without explicit permission (e.g. translations or hospital systems that contact us first), and all use must be non-commercial. We use Creative Commons 4.0 International Licensing, With Attribution, Non-Commercial, and No Derivatives; See details at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Disclaimers: The material in this Manual is not intended to be a substitute for sound medical knowledge and training. Clinicians should always use their clinical judgment and decision making for patient management. Departure from the information presented here is encouraged as appropriate, since situations can vary widely.

We use generic medication names whenever possible and include some brand names, which might be better known to clinicians, to support effective use during crises. To reduce potentially distracting visual clutter, TM superscripts have not been included with brand name medications in the cognitive aids.

Enabling clinical uses during crises requires systematic implementation efforts beyond simply hanging emergency manuals (EM) in operating rooms, as EMs can be forgotten when under stress. Use the resources on the previous page to efficiently and effectively integrate EMs into your practice.

1. Burian BK, Clebone A, Dismukes K, Ruskin KJ. More Than a Tick Box: Medical Checklist Development, Design, and Use. *Anesth Analg.* 2018 Jan;126(1):223-232.

Infusion List



<p>Amiodarone 1200 mg in 250 mL D5W 4.8 mg/mL Load 150 mg over 10min; 300 mg bolus if pulseless Infuse 1 mg/min (no weight calc)</p>	<p>Lidocaine (Xylocaine™) 2 g in 250 mL NS 8 mg/mL Load 1-1.5 mg/kg Infuse 1-2 mg/kg/hr</p>
<p>Clevidipine (Cleviprex™) 25 mg in 50 mL 0.5 mg/mL Infuse 1-16 mg/hr (no weight calc)</p>	<p>Milrinone (Primacor™) 20 mg in 100 mL D5W 200 mcg/mL Load 50-75 mcg/kg over 10 min Infuse 0.375-0.75 mcg/kg/min</p>
<p>Dexmedetomidine (Precedex™) 400 mcg in 100 mL NS 4 mcg/mL Load 0.5-1 mcg/kg over 10 min Infuse 0.2-1.5 mcg/kg/hr</p>	<p>Nesiritide (BNP) 1.5 mg in 250 mL D5W 6 mcg/mL Load 2 mcg/kg over 1 min Infuse 0.01 mcg/kg/min</p>
<p>Diltiazem (Cardizem™) 125 mg in 100 mL NS/D5W 1.25 mg/mL Load 2.5 mg up to 25 mg Infuse 2-10 mg/hr (no weight calc)</p>	<p>Nicardipine (Cardene™) 40 mg in 200 mL 0.2 mg/mL Infuse 5-15 mg/hr (no weight calc)</p>
<p>Dobutamine 500 mg in 250 mL D5W 2000 mcg/mL (2 mg/mL) Infuse 2-20 mcg/kg/min</p>	<p>Nitroglycerin (Tridil™) 50 mg in 250 mL D5W 200 mcg/mL Infuse 0.1-1 mcg/kg/min</p>
<p>Dopamine 400 mg in 250 mL D5W 1600 mcg/mL Infuse 2-10 mcg/kg/min</p>	<p>Nitroprusside (Nipride™) 50 mg in 250 mL NS 200 mcg/mL Infuse 0.1-1 mcg/kg/min</p>
<p>Epinephrine 4 mg in 250 mL NS 16 mcg/mL Infuse 0.02-0.3 mcg/kg/min (20-300 nanograms/kg/min)</p>	<p>Norepinephrine (Levophed™) 4 mg in 250 mL NS 16 mcg/mL Infuse 0.02-0.3 mcg/kg/min (20-300 nanograms/kg/min)</p>
<p>Esmolol (Brevibloc™) 2500 mg in 250 mL NS 10 mg/mL Infuse 0.05-0.3 mg/kg/min (50-300 mcg/kg/min)</p>	<p>Phenylephrine (Neosynephrine™) 40 mg in 250 mL NS 160 mcg/mL Infuse 0.1-1 mcg/kg/min (or 5-100 mcg/min)</p>
<p>Fenoldopam (Corlopan™) 10 mg in 250 mL NS/D5W 40 mcg/mL Infuse 0.05-0.20 mcg/kg/min</p>	<p>Remifentanyl (Ultiva™) 2000 mcg (2 mg) in 40 mL NS 50 mcg/mL Infuse 0.01-0.2 mcg/kg/min</p>
<p>Isoproterenol (Isuprel™) 1 mg in 250 mL NS/D5W 4 mcg/mL Infuse 1-5 mcg/min (no weight calc)</p>	<p>Vasopressin 60 units in 100 mL NS 0.6 units/mL Infuse 0.01-0.1 units/min (no weight calc)</p>

EMERGENCY MANUAL

**Phone List
Placeholder**