**EMERGENCY NUMBERS:**

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# EMERGENCY MANUAL

## COGNITIVE AIDS FOR PERIOPERATIVE CRITICAL EVENTS 2016, V3.1


STANFORD ANESTHESIA COGNITIVE AID GROUP

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***Core Stanford Anesthesia Cognitive Aid Group contributors listed here in random order**
Steve Howard, Larry Chu, Sara Goldhaber-Fiebert, David Gaba, Kyle Harrison



## HOW THIS WORK CAME TO BE:

This Emergency Manual has a long history, evolving from decades of prior work on both Crisis Resource Management (CRM) concepts and cognitive aids for critical incidents. The 1994 book entitled 'Crisis Management in Anesthesiology' by Dr. David Gaba, Dr. Steven Howard, and Dr. Kevin Fish provided the initial foundations for this project. Their simulation group has been involved in developing cognitive aids for operating rooms in the Palo Alto VA and then a national VA project, each with bulleted points for many critical events. Observing that practitioners often miss key actions under stress, Drs. Harrison and Goldhaber-Fiebert along with Dr. Geoff Lighthall, Dr. Ruth Fanning, Dr. Howard, and Dr. Gaba developed several iterations of pocket cards for perioperative critical events, including some with rhythm strips, icons, and color design. In 2004, Dr. Larry Chu conceived of adapting crisis management cognitive aids to a more visually striking format for a new book he envisioned for today's highly visual millennial learners. This became The Manual of Clinical Anesthesiology, published in 2011. To create the current Emergency Manual, the Stanford Anesthesia Cognitive Aid Group was formed. All team members have had integral roles. Dr. Larry Chu, who directs the Stanford AIM (Anesthesia Informatics Management) lab provided the new graphics and layout, applying his design skills and an understanding of user interface to make the content more easily usable. Drs. Sara Goldhaber-Fiebert, Kyle Harrison, Steven Howard, and David Gaba worked jointly to provide the content, including exact phrasing, ordering, and emphasis, as well as iterative simulation testing to revise both content and design elements. Observing how cognitive aids are used by teams during hundreds of simulated crises has been crucial for pilot testing throughout. We hope that this Emergency Manual will support both education and patient safety efforts. Effective use has included pre-event review, post-event team debriefing, and 'during' critical event management—the latter particularly after adequate help has arrived or when the patient is sufficiently stable for a clinician to pause from acute care actions. We encourage the use of this Manual and welcome feedback from all practitioners.

**Acknowledgments:** We appreciate the faculty and residents at Stanford and VA Palo Alto anesthesia departments for their support of the development and implementation of the emergency manual. We are especially grateful to our chair, Dr. Ron Pearl, for helping us make this project a reality. We are grateful to Barbara Burian for her expertise in human factors and cognitive aid design reflected in the design of Version 3. While references are not written on each event for space, we have tried to integrate the most pertinent clinical information from published literature for each event, including practical publications e.g. A-ACLS modifications to AHA ACLS algorithms, ASA difficult airway algorithms, ASRA LAST guidelines, MHAUS poster, and appreciate the work of their developers. We thank all our colleagues from the Emergency Manuals Implementation Collaborative (EMIC), a global group fostering the dissemination, implementation, and effective use of emergency manuals to enhance patients' safety. Join EMIC at **www.emergencymanuals.org**.

**Disclaimer:** 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. Since treatment for the medical conditions described in this Manual can have variable presentations, departure from the information presented here is encouraged when appropriate.

## APPROPRIATE CITATION OF THIS EMERGENCY MANUAL

Stanford Anesthesia Cognitive Aid Group*. Emergency Manual: Cognitive aids for perioperative clinical events. See http://emergencymanual.stanford.edu for latest version. Creative Commons BY-NC-ND. 2013 (creative commons.org/licenses/by-nc-nd/3.0/legalcode). *Core contributors in random order: Howard SK, Chu LK, Goldhaber-Fiebert SN, Gaba DM, Harrison TK.

## MANUAL OF CLINICAL ANESTHESIOLOGY

Much of the work in this Anesthesia Emergency Manual was adapted from cognitive aids originally published in Appendix of Crisis Management Algorithms in Anesthesia in the Manual of Clinical Anesthesiology, edited by Larry Chu and Andrea Fuller, published by Lippincott Williams & Wilkins, 2011. The authors were*: Harrison TK (21), Goldhaber-Fiebert SN (21), and Chu L (21), as well as on specific cognitive aids, contributions by: Lighthall G (2),

PRODUCED BY THE **STANFORD ANESTHESIA INFORMATICS AND MEDIA LAB (AIM)**
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TESTED BY THE **STANFORD SIMULATION GROUP** AND THE **STANFORD ANESTHESIA INFORMATICS AND MEDIA (AIM) LAB**

# ASYSTOLE

By Stanford Anesthesia Cognitive Aid Group

## SIGNS

**FLAT LINE:**

**+**

**⃠ PULSE**

**CPR:**

1. **100–120** compressions/minute;
   **≥ 2”** deep.
   Allow complete chest recoil.
2. **Minimize breaks** in CPR.
3. Rotate Compressors q2 Min.

**Assess CPR quality, improve IF:**

- **$ETCO_2$ < 10 mmHg**
- **Arterial line Diastolic < 20 mmHg**

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. INFORM TEAM.**

## IMMEDIATE

1. Turn **OFF** vasodilating volatile & IV drips; Increase to 100% $O_2$, high flow.
2. Ventilate **10 breaths/minute**; do not over ventilate.
3. Ensure **IV access** (or consider intraosseous).
4. **Epinephrine** – 1 mg IV push q 3-5 minutes.
5. If **rhythm changes** to **VF/VT** (shockable rhythm) → Immediate Defibrillation. **Go To VF/VT, event #6.**
6. Consider **ECMO** if available and reversible cause.
7. Consider TTE or TEE **Echocardiography** to evaluate cause.

## DIAGNOSIS

Consider common perioperative Ddx:

1. Hemorrhage
2. Anesthetic overdose
3. Septic or other shock states
4. Auto PEEP
5. Anaphylaxis
6. Medication error
7. High spinal
8. Pneumothorax
9. Local anesthetic toxicity
10. Vagal stimulus
11. Pulmonary Embolus

**Find and Treat Causes – H’s and T’s: Expanded on next page.**

Go To Next Page ➔

# ASYSTOLE *continued*



DETAILS

1. **Hypovolemia:** Give rapid bolus of IV fluid. Check hemoglobin/hematocrit. If anemia or massive hemorrhage, give blood. Consider relative hypovolemia: Auto-PEEP (disconnect circuit); High Spinal; or Shock States (e.g. anaphylaxis). **Go To relevant event.**
2. **Hypoxemia:** Increase $O_2$, to 100% high flow. Confirm connections. Check for bilateral breath sounds. Suction ET tube and reconfirm placement. Consider chest X-ray. **Go To Hypoxemia, event #16.**
3. **Tension pneumothorax:** Unilateral breath sounds, possible distended neck veins and deviated trachea (late signs). Perform emergent needle decompression (2nd intercostal space at mid-clavicular line) then chest tube placement. Call for chest x-ray, but do NOT delay treatment. **Go To Pneumothorax, event #21.**
4. **Thrombosis – Coronary:** Consider transesophageal (TEE) or transthoracic (TTE) echocardiography to evaluate ventricle wall motion abnormalities of the ventricles. Consider emergent coronary revascularization. **Go To Myocardial Ischemia, event #19.**
5. **Thrombosis – Pulmonary:** Consider TEE or TTE to evaluate right ventricle. Consider fibrinolytic agents or pulmonary thrombectomy.
6. **Toxins (e.g. infusions):** Consider medication error. Confirm no infusions running and volatile anesthetic off. If local anesthetic toxicity **Go To Local Anesthetic Toxicity, event #17.**
7. **Tamponade – Cardiac:** Consider placing TEE or TTE to rule out tamponade. Treat with pericardiocentesis.
8. **Hypothermia ↓:** Active warming by forced air blanket, warm IV fluid, raise room temperature. Consider cardiopulmonary bypass.
9. **Hyperthermia ↑:** If Malignant Hyperthermia, call for MH Cart. Give Dantrolene immediately: start at 2.5 mg/kg. MH Hotline: (800) 644-9737. **Go To Malignant Hyperthermia, event #18**.
10. **Obtain ABG to rule out:**
    - **Hyperkalemia ↑:** Give Calcium Chloride 1 g IV; D50 1 Amp IV (25 g Dextrose) + Regular Insulin 10 units IV. Monitor glucose. Sodium Bicarbonate 1 Amp IV (50 mEq).
    - **Hypokalemia ↓:** Controlled infusion of potassium & magnesium.
    - **Hypoglycemia:** If ABG delay, check Fingerstick. Give D50 1 Amp IV (25 g Dextrose). Monitor glucose.
    - **H+ Acidosis:** If profound, consider Sodium Bicarbonate 1 Amp IV (50 mEq). May consider increasing ventilation rate (but can decrease CPR effectiveness so monitor).
    - **Hypocalcemia:** Give Calcium Chloride 1 g IV.

END

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# BRADYCARDIA – UNSTABLE

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

**1. CHECK FOR PULSE**

- If NO pulse, **Go To PEA event #3**.
- If pulse present but hypotensive, proceed with treatment.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. HALT SURGICAL STIMULATION.**

**TREATMENT**

1. Increase to **100% $O_2$**, high flow.
2. Confirm adequate **ventilation** and **oxygenation**.
3. Consider turning down or **OFF** all anesthetics.
4. **Atropine**: 0.5 to 1 mg IV, may repeat up to 3 mg. Consider infusions below.
5. Consider transcutaneous **pacing**:
   - ↑ • Set rate to at least 80 bpm.
   - **OR** • Increase current until capture achieved.
   - ↓ • Confirm patient has pulse with capture.
6. Consider Infusions:
   - **Dopamine**: 2 to 20 µg/kg/min
   - **Epinephrine**: 2 to 10 µg/min

**SECONDARY**

1. Place **arterial line**.
2. Send labs: ABG, hemoglobin, electrolytes.
3. Rule out **ischemia**: Consider EKG, troponins.

END

# PULSELESS ELECTRICAL ACTIVITY

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

\+

⊘ **PULSE**

**CPR:**

1. **100–120** compressions/minute;
   ≥ 2" deep.
   Allow complete chest recoil.
2. **Minimize breaks** in CPR.
3. Rotate Compressors q2 Min.

Assess CPR quality, improve IF:

- $ETCO_2$ < 10 mmHg
- Arterial line Diastolic < 20 mmHg

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. INFORM TEAM.**

**IMMEDIATE**

1. Turn **OFF** vasodilating volatile & IV drips; Increase to 100% $O_2$, high flow.
2. Ventilate **10 breaths/minute**; do not over ventilate.
3. Ensure **IV access** (or consider intraosseous).
4. **Epinephrine** – 1 mg IV push q 3-5 minutes.
5. If **rhythm changes** to **VF/VT** (shockable rhythm) → Immediate Defibrillation. **Go To VF/VT, event #6.**
6. Consider **ECMO** if available and reversible cause.
7. Consider TTE or TEE **Echocardiography** to evaluate cause.

**SECONDARY**

Consider common perioperative Ddx:

1. Hemorrhage
2. Anesthetic overdose
3. Septic or other shock states
4. Auto PEEP
5. Anaphylaxis
6. Medication error
7. High spinal
8. Pneumothorax
9. Local anesthetic toxicity
10. Vagal stimulus
11. Pulmonary Embolus

**Find and Treat Causes – H's and T's: Expanded on next page.**

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# PULSELESS ELECTRICAL ACTIVITY *continued*

DETAILS

1. **Hypovolemia:** Give rapid bolus of IV fluid. Check hemoglobin/hematocrit. If anemia or massive hemorrhage, give blood. Consider relative hypovolemia: Auto-PEEP (disconnect circuit); High Spinal; or Shock States (e.g. anaphylaxis). **Go To relevant event.**
2. **Hypoxemia:** Increase $O_2$, to 100% high flow. Confirm connections. Check for bilateral breath sounds. Suction ET tube and reconfirm placement. Consider chest X-ray. **Go To Hypoxemia, event #16.**
3. **Tension pneumothorax:** Unilateral breath sounds, possible distended neck veins and deviated trachea (late signs). Perform emergent needle decompression (2nd intercostal space at mid-clavicular line) then chest tube placement. Call for chest x-ray, but do NOT delay treatment. **Go To Pneumothorax, event #21.**
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6. **Toxins (e.g. infusions):** Consider medication error. Confirm no infusions running and volatile anesthetic off. If local anesthetic toxicity **Go To Local Anesthetic Toxicity, event #17.**
7. **Tamponade – Cardiac:** Consider placing TEE or TTE to rule out tamponade. Treat with pericardiocentesis.
8. **Hypothermia ↓:** Active warming by forced air blanket, warm IV fluid, raise room temperature. Consider cardiopulmonary bypass.
9. **Hyperthermia ↑:** If Malignant Hyperthermia, call for MH Cart. Give Dantrolene immediately: start at 2.5 mg/kg. MH Hotline: (800) 644-9737. **Go To Malignant Hyperthermia, event #18**.
10. **Obtain ABG to rule-out:**
    - **Hyperkalemia ↑:** Give Calcium Chloride 1 g IV; D50 1 Amp IV (25 g Dextrose) + Regular Insulin 10 units IV. Monitor glucose. Sodium Bicarbonate 1 Amp IV (50 mEq).
    - **Hypokalemia ↓:** Controlled infusion of potassium & magnesium.
    - **Hypoglycemia:** If ABG delay, check Fingerstick. Give D50 1 Amp IV (25 g Dextrose). Monitor glucose.
    - **H+ Acidosis:** If profound, consider Sodium Bicarbonate 1 Amp IV (50 mEq). May consider increasing ventilation rate (but can decrease CPR effectiveness so monitor).
    - **Hypocalcemia:** Give Calcium Chloride 1 g IV.

END

# SUPRAVENTRICULAR TACHYCARDIA – STABLE

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

1. **CHECK FOR PULSE.**
   - If NO pulse, **Go To PEA, event #3**.
   - If **Unstable, Go To SVT – UNSTABLE event #5.** Prepare for Synchronized Cardioversion. UNSTABLE = ANY OF: Sudden and/or continuing sharp decrease in BP; Acute Ischemia; SBP <75.
2. **Sinus Tachycardia** is **NOT SVT**. May be compensatory. Search for and treat underlying cause(s).
3. More likely **SVT THAN SINUS** if any of:
   - Rate >150.
   - Irregular.
   - Sudden onset.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

**IMMEDIATE**

1. Increase to **100% $O_2$**, high flow.
2. Confirm adequate ventilation, oxygenation.
3. Consider **12-lead EKG or Print Rhythm Strip**, then treat per rhythm (**Go To** next page).
4. **If UNSTABLE at any point: Go To SVT – UNSTABLE, event #5.**
5. Consider placing defibrillator pads.
5. If still STABLE Supraventricular Tachycardia consider:
   - arterial line.
   - check ABG & electrolytes.
7. Consider STAT cardiology consult.
8. **Go To** next page.

Go To Next Page ➔

# SUPRAVENTRICULAR TACHYCARDIA – STABLE
continued

## Narrow Complex and Regular

1. **Adenosine** 6 mg IV push with flush. May give 2nd dose: 12 mg IV (Avoid adenosine if asthma or WPW).
2. If NOT converted, may Rate Control.
   Choose beta blocker or calcium channel blocker:
   - Beta Blocker: (consider avoiding if asthma)
     - **Esmolol**: Start 0.5 mg/kg IV over 1 min. May repeat after 1 min and may start infusion 50 µg/kg/min.
     - **Metoprolol**: Start 1-2.5 mg IV. May repeat or double after 2.5 min.
   - Calcium Channel Blocker:
     - **Diltiazem**: 5-10 mg IV over 2 min. May repeat after 5 min.

## Narrow Complex and Irregular

1. Choose beta blocker or calcium channel blocker:
   - Beta Blocker: (Consider avoiding if asthma)
     - **Esmolol**: Start 0.5 mg/kg IV over 1 min. May repeat after 1 min and may start infusion 50 µg/kg/min.
     - **Metoprolol**: Start 1-2.5 mg IV. May repeat or double after 2.5 min.
   - Calcium Channel Blocker:
     - **Diltiazem**: 5-10 mg IV over 2 min. May repeat after 5 min.
2. **Amiodarone**: 150 mg IV **SLOWLY** over 10 min. May repeat once. Start infusion 1 mg/min for first 6 hours.

## Wide Complex and Regular (monomorphic)

1. If SVT with aberrancy **Adenosine**: 6 mg IV push with flush. May give 2nd dose: 12 mg IV (avoid adenosine if asthma or WPW).
2. If VT or uncertain VT versus SVT with aberrancy:

**Amiodarone**: 150 mg IV SLOWLY over 10 min. May repeat once. Start infusion 1 mg/min for first 6 hours.

May also consider Procainamide or Sotalol.

## Wide Complex and Irregular (Likely Polymorphic VT)

If Unstable, immediate defibrillation.

If Stable, have defibrillator pads on and consult cardiology.

END

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# SUPRAVENTRICULAR TACHYCARDIA – UNSTABLE

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

1. **CHECK FOR PULSE.**
   - If NO pulse, **Go To PEA, event #3.**
2. **UNSTABLE** = ANY OF: Sudden and/or continuing sharp decrease in BP; Acute Ischemia; SBP <75.
3. Sinus Tachycardia is **NOT SVT**. May be compensatory. Search for and treat underlying cause(s).
4. More likely **SVT THAN SINUS** if any of:
   - Rate >150.
   - Irregular.
   - Sudden onset.

**1. CALL FOR HELP.**

**2. CALL FOR CODE CART.**

**3. INFORM TEAM.**

**TREATMENT**

1. Increase to **100% $O_2$**, high flow. Decrease volatile anesthetic.
2. Confirm adequate ventilation, oxygenation.
3. If unstable SVT, **IMMEDIATE SYNCHRONIZED CARDIOVERSION** – biphasic doses.
   - Narrow complex and Regular: 50-100J.
   - Narrow complex and Irregular: 120-200J.
   - Wide complex and Regular: 100J.
   - Wide complex and Irregular requires Unsynchronized Defibrillation: 200J.
4. **If unsuccessful cardioversion**: Re-SYNC and increase Joules incrementally for Synchronized Cardioversion.
5. While preparing to cardiovert (do NOT delay), if narrow-complex and regular, consider **Adenosine** 6 mg rapid IV push with flush, via access closest to heart. May give 2nd dose of 12 mg IV.

END

# VENTRICULAR FIBRILLATION
# VENTRICULAR TACHYCARDIA – PULSELESS

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

**V-TACH:**

**V-FIB:**

**CPR:**

1. **100–120** compressions/minute; ≥ 2" deep. Allow complete chest recoil.
2. **Minimize breaks in CPR.**
3. Rotate compressors q2 min.

Assess CPR quality, improve IF:
- $ETCO_2$ < 10 mmHg.
- Arterial line Diastolic < 20 mmHg.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. INFORM TEAM.**

**TREATMENT**

1. **DEFIBRILLATE**: 120-200 J (biphasic, per manufacturer).
2. **RESUME CPR IMMEDIATELY.**
3. **REPEAT SHOCK q 2 minutes**, reasonable to increase energy with subsequent shocks, resume CPR.
4. **AFTER 2nd SHOCK EPINEPHRINE:** 1 mg IV push q 3-5 minutes.

**CHECK**

1. In OR: Turn **OFF** volatile; Increase to **100% $O_2$,** high flow.
2. Ventilate **10 breaths/minute**; do **not** overventilate.
3. Ensure IV access (or consider intraosseous).

**CONSIDER**

**Consider Antiarrhythmics:**

- **If pulseless:** Amiodarone 300 mg IV PUSH or Lidocaine 100 mg IV PUSH.
- **If HypoMg or Torsades + prolonged QT:** Magnesium sulfate 2 grams IV.
- **If HyperK:** Calcium, insulin & glucose, sodium bicarbonate.

Search for Treatable Causes (H's & T's on next page).

Go To Next Page ➔

# VENTRICULAR FIBRILLATION
# VENTRICULAR TACHYCARDIA – PULSELESS
*continued*

**If still VF/VT, keep shocking q2 minutes.**

DETAILS

1. **Hypovolemia:** Give rapid bolus of IV fluid. Check hemoglobin/hematocrit. If anemia or massive hemorrhage, give blood. Consider relative hypovolemia: Auto-PEEP (disconnect circuit); High Spinal; or Shock States (e.g. anaphylaxis). **Go To relevant event.**
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    - **H+ Acidosis:** If profound, consider Sodium Bicarbonate 1 Amp IV (50 mEq). May consider increasing ventilation rate (but can decrease CPR effectiveness so monitor).
    - **Hypocalcemia:** Give Calcium Chloride 1 g IV.

**If still VF/VT, keep shocking q2 minutes.**

END

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# AMNIOTIC FLUID EMBOLISM

By Stanford Anesthesia Cognitive Aid Group



## SIGNS

**Consider amniotic fluid embolism if there is the sudden onset of the following in a pregnant or post-partum patient:**

1. Respiratory distress, decreased $O_2$ saturation.
2. Cardiovascular collapse: hypotension, tachycardia, arrhythmias, cardiac arrest.
3. Coagulopathy +/- Disseminated intravascular coagulation (DIC).
4. Seizures.
5. Altered mental status.
6. Unexplained fetal compromise.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. INFORM TEAM.**

## TREATMENT

1. Anticipate possible **cardiopulmonary arrest** and **emergent C-section.**
2. Place patient in left uterine displacement (**LUD**).
3. Increase to **100% $O_2$**, high flow.
4. Establish large volume **IV access** (upper body best).
5. Support circulation with **IV fluid, vasopressors, and inotropes.**
6. **Prepare for emergent intubation.**
7. When possible, place arterial line. Consider central venous access or IO line in humerus.
8. Anticipate **massive hemorrhage** and DIC. **Go To Hemorrhage – MTG, event #14.**
9. Consider **circulatory support**: IABP/ECMO/CPB.

## RULE OUT

**Rule out other causes that might present in a similar fashion:**

1. Eclampsia.
2. Hemorrhage.
3. Air embolism.
4. Aspiration.
5. Anaphylaxis.
6. Pulmonary embolism.
7. Anesthetic overdose.
8. Sepsis.
9. Cardiomyopathy/cardiac valvular abnormality/MI.
10. Local anesthetic toxicity.
11. Total Spinal.

END

# ANAPHYLAXIS

By Stanford Anesthesia Cognitive Aid Group

## SIGNS

**Some signs may be absent in an anesthetized patient:**

1. Hypoxemia, difficulty breathing, tachypnea.
2. Rash/hives.
3. Hypotension (may be severe).
4. Tachycardia.
5. Bronchospasm/wheezing.
6. Increase in peak inspiratory pressure (PIP).
7. Angioedema (potential airway swelling).

**1. CALL FOR HELP.**

**2. CALL FOR CODE CART.**

**3. INFORM TEAM.**

**4. CONSIDER PAUSING SURGERY.**

1. **If patient becomes pulseless, start CPR, continue epinephrine 1 mg IV boluses and large volume IV fluid.**
2. **Also Go To PEA, event #3.**

## RULE OUT

**Consider and rule out other causes:**

- Pulmonary embolus.
- Myocardial infarction.
- Anesthetic overdose.
- Pneumothorax.
- Hemorrhage.
- Aspiration.

For anaphylaxis treatment, Go To Next Page ➔

# ANAPHYLAXIS *continued*

**TREATMENT**

1. **Discontinue potential allergens:** muscle relaxants, latex, antibiotics, colloids, protamine, blood, contrast, chlorhexidine.
2. **Discontinue volatile anesthetic** if hypotensive. Consider amnestic agent.
3. Increase to **100% $O_2$**, high flow.
4. **Give IV fluid bolus.** May require many liters!
5. **Give epinephrine IV in escalating doses** every two minutes. Start at 10-100 µg IV and increase dose every 2 minutes until clinical improvement is noted. **Start early epinephrine infusion.** May require large doses > 1 mg.
6. **IF no improvement:** continue treatment, but consider other causes (**Go To Hypotension, event #15, and Hypoxemia, event #16** – consider Differential Diagnoses).
7. Consider **vasopressin** bolus IV or **norepinephrine** infusion.
8. Treat **bronchospasm** with **albuterol** and **epinephrine** (if severe).
9. Consider **additional IV access** and **invasive monitors** (arterial line).
10. If signs of **angioedema**, consider **early intubation** to secure airway.
11. After stable consider **$H_1$ antagonist** (e.g. Diphenhydramine 25-50 mg IV),$H_2$ antagonist (e.g. Ranitidine 50 mg IV), and **corticosteroids** (e.g. Methylprednisolone 125 mg IV).

**POST EVENT**

**Consider the following interventions when patient stable:**

1. Send serum tryptase level (peaks <60 min post-event).
2. Send serum histamine (peaks <30 min post-event).
3. If the event was severe, consider keeping patient intubated and sedated.
4. Can recur after initial treatment: Consider monitoring patient for 24 hours post-recovery.
5. Refer the patient for postoperative allergy testing.

END

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# BRONCHOSPASM

## (INTUBATED PATIENT)

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

1. Increased peak airway pressures.
2. Wheezing on lung exam.
3. Increased expiratory time.
4. Increased $ETCO_2$ with upsloping $ETCO_2$ waveform.
5. Decreased tidal volumes if pressure control.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

**Bronchospastic patients who develop sudden hypotension may be airtrapping – disconnect patient from circuit to allow for complete exhalation.**

**TREATMENT**

1. Increase to **100% $O_2$**, high flow.
2. Change **I:E ratio** to allow for adequate exhalation.
3. **Deepen** anesthetic (sevoflurane or propofol).
4. **Rule out problems with ETT** via auscultation & suction catheter (mainstem intubation, kinked ETT, mucus plug) .
5. Give inhaled agents: Beta 2 agonist (**albuterol,** multiple puffs required) +/- anticholinergic (**Ipratropium**).
6. If severe consider **epinephrine** (start with 10 µg IV and escalate, monitor for tachycardia and hypertension).
7. Consider **ketamine**: 0.2 – 1.0 mg/kg IV.
8. Consider **hydrocortisone** 100 mg IV.
9. Consider **nebulized racemic epinephrine**.
10. Rule out anaphylaxis (hypotension/tachycardia/rash). **Go To Anaphylaxis, event #8.**
11. Consider ABG.

END

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# DELAYED EMERGENCE

By Stanford Anesthesia Cognitive Aid Group

**CHECK**

1. Confirm that all anesthetic agents (inhalation/IV) are **OFF**.
2. Check for residual muscular paralysis (if patient is asleep, use twitch monitor), and reverse accordingly.

**CONSIDER**

**Consider:**

1. Opioid reversal: start with **naloxone** 40 µg IV; repeat every 2 minutes, increasing up to 400 µg.
2. Benzodiazepine reversal: start with **flumazenil** 0.2 mg IV every 1 minute; max dose = 1 mg.
3. Scopolomine reversal (e.g. Patch): **Physostigmine** 1 mg IV (Potential cholinergic crisis, including severe bradycardia, so have atropine ready).

**CHECK**

1. Monitors: Check **Hypoxemia**? **Hypercarbia**? **Hypothermia**?
2. Complete **Neuro exam**, as able, for focal neurologic deficits (if intubated look for: pupils, asymmetric movement, gagging, etc.)

   If abnormal exam or **suspect stroke**, obtain **stat Head CT scan** and consult neurology/neurosurgery.
3. **Hypoglycemia**: check glucose (glucometer).
4. Labs: **ABG plus electrolytes**. Rule out $CO_2$ narcosis from Hypercarbia, Hypo- or Hypernatremia.
5. Check for **medication swap** or dosing error.

**TREATMENT**

1. Correct any abnormalities in oxygenation, ventilation, laboratory values, or temperature.
2. If residual mental status abnormalities, monitor the patient in the ICU with **neurological follow up**, including serial exams. Repeat Head CT or MRI as needed.

END

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# DIFFICULT AIRWAY
## UNANTICIPATED

By Stanford Anesthesia Cognitive Aid Group and Vladimir Nekhendzy, MD

**If unable to see vocal cords or pass ET tube during first Direct Laryngoscopy (DL):**

1. Consider External Laryngeal Manipulation, BURP (Backwards Upwards Rightwards Pressure).
2. Consider placing Bougie introducer.
3. **Limit total number of DL attempts to 2.**
4. Recommend Video Assisted Laryngoscopy.
5. Before repeating DL, consider mask ventilation with oral/nasal airways.
6. Consider optimizing patient position and/or blade selection.
7. **If successful, confirm placement with $ETCO_2$ and bilateral breath sounds.**

**Can NOT Intubate**

1. Attempt face mask ventilation – consider oral airway.
2. **Call for Difficult Airway cart.**

**Can NOT Ventilate**

**CALL FOR HELP!**
**Place oral, nasal airway switch to two-handed mask ventilation.**

**Can NOT Ventilate**

1. **Place LMA if feasible.**
2. Consider any SGA, Intubating LMA, Combitube, or Laryngeal Tube.

**Can NOT Ventilate**

**Emergency Airway Ventilation**

1. Call for Surgical Help.
2. Perform Cricothyrotomy.
3. Confirm successful placement with $ETCO_2$ and bilateral breath sounds.

**Successful Ventilation**

If at any point inadequate ventilation by mask or LMA,

**Go To Red Box.**

**Successful Ventilation**

**If ventilation remains adequate, CONSIDER:**

1. Awakening patient.
2. Complete case with LMA or face mask.
3. Video assisted Laryngoscopy.
4. Asleep fiberoptic bronchosocopy.
5. LMA as conduit for intubation or intubating LMA.
6. Retrograde wire intubation.

For more details, see latest ASA Practice Guidelines for the Management of Difficult Airway

END

# FIRE – AIRWAY

**FOR NON-AIRWAY FIRE: Go To Fire – Patient, event #13**

By Stanford Head & Neck Anesthesia & Surgery, Stanford Anesthesia Cognitive Aid Group

**SIGNS**

**SUSPECT FIRE if:**

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

**1. CALL FOR HELP.**

**2. INFORM TEAM.**

**IMMEDIATE**

**SURGEON:**

1. **REMOVE ENDOTRACHEAL TUBE.**
2. **Remove** airway foreign bodies e.g. ETT pieces.
3. **Pour** saline or water into patient's airway.
4. **Examine** entire airway (including bronchoscopy) to assess injury and remove residual debris.

**ANESTHESIOLOGIST:**

1. **STOP ALL AIRWAY GAS FLOW BY DISCONNECTING THE BREATHING CIRCUIT FROM THE ANESTHESIA MACHINE.**
2. When sure fire is extinguished: **Re-establish** ventilation; avoid supplemental $O_2$ if possible .
3. Consider prompt **reintubation** prior to swelling and coordinated with surgeon's bronchoscopy.
4. **Inspect** ETT pieces to verify none left in airway.
5. **Save** all materials for later investigation.

For prevention of airway fires, see next page.

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# FIRE – AIRWAY *continued*

**FOR NON-AIRWAY FIRE: Go To Fire – Patient, event #13**

PREVENTION

**If high risk** procedures, including those listed below:

- Discuss fire prevention & management with team during time-out.
- Avoid $FiO_2$ > 0.3 and avoid $N_2O$.

For **laser** surgery of vocal cord or larynx:

- Use laser resistant ETT (single or double cuff).
- Assure ETT cuff sufficiently deep below vocal cords.
- Fill proximal ETT cuff with methylene blue-tinted saline.
- Ensure Laser in STANDBY when not in active use.
- Surgeon protects ETT cuff with WET gauze.
- Surgeon confirms $FiO_2$ < 0.3 and no $N_2O$ prior to laser use.

For **non-laser** surgery in oropharynx:

- Regular PVC ETT may be used.
- Consider packing wet gauze around ETT to minimize $O_2$ leakage.
- Consider continuous suctioning of the operating field inside oropharynx.

END

# FIRE – PATIENT

**FOR AIRWAY FIRE: Go To Fire – Airway, event #12**

By Stanford Anesthesia Cognitive Aid Group, Stanford Head & Neck Anesthesia & Surgery

**SIGNS**

**SUSPECT FIRE if:**

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

**1. INFORM TEAM.**
**2. CALL FOR HELP.**
**3. CALL FOR FIRE EXTINGUISHER.**

**IMMEDIATE**

1. **Stop flow** of all airway gases to patient.
2. **Remove** burning or flammable materials from patient immediately for other team member to extinguish.
3. **Extinguish patient fire:**
   - If electrical equipment burning, use only **$CO_2$ fire extinguisher** (safe in wounds).
   - If non-electrical, attempt to extinguish with saline and soaked gauze.
4. **Care for the patient:** ventilate with room air, control bleeding, assess injuries and vital signs.
5. Consider **evacuating** patient and OR if smoke or continued fire, per local protocol.
6. Close OR doors.
7. **Turn OFF** external gas supply to OR.
8. **Alert fire department.**

For prevention of airway fires, see next page.

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# FIRE – PATIENT *continued*

**FOR AIRWAY FIRE: Go To Fire – Airway, event #12**

**PREVENTION**

- Team Communication at Time Out if high risk procedure.
- Highest risk in MAC head and neck procedures
  - Use nasal cannula instead of face mask, if able.
  - Configure drapes to avoid $O_2$ build-up, consider active scavenging if required.
  - Use minimum $O_2$ concentration for adequate $SpO_2$.
- If high $O_2$ concentration required, use an LMA or ETT.
- Allow complete drying of Alcohol skin prep solutions.
- Consider coating patient's head hair and facial hair with water soluble surgical lubricating jelly.

**Remember: Fuel Source + Oxidizer + Spark = FIRE**

END

# HEMORRHAGE

## MASSIVE TRANSFUSION GUIDELINES

By Stanford Anesthesia Cognitive Aid Group

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

**IMMEDIATE**

1. Follow local protocol to order Massive Transfusion Guideline (**MTG**) or equivalent.
2. Increase to **100% $O_2$**, high flow.
3. **Treat hypotension with IV fluid bolus.**
4. Consider **Trendelenburg** or **elevation of patient's legs**.
5. Use **vasopressor boluses** (ephedrine, phenylephrine, epinephrine) as a temporizing measure. Consider accepting low normal blood pressure until bleeding is controlled.
6. Call for **rapid infuser**.
7. Establish **additional IV access** as needed. Consider intraosseous if needed.
8. Ask surgeon: "Should we page a **vascular surgeon** or other additional help for you?"
9. **Send Type and Cross sample.** TS will provide emergency release Type O PRBC until crossmatched blood is available.
10. **Maintain normothermia.** Use fluid warming devices for IV and blood products. Use forced air warmers.
11. Place **arterial line** as indicated.
12. Follow patient's acid/base status by **ABG as indicator of adequate resuscitation. Monitor for hypocalcemia.**
13. Place **Foley Catheter** when able.
14. Call for **cell-saver** (if non-contaminated, non-malignant case).

**Replace products EARLY!** until current lab data available:

- If > 1 blood volume of loss expected: give **1 unit FFP for every 1 unit PRBC. Give 1 apheresis unit of platelets** (= old '6-pack') for every 6 units PRBC.
- When labs back: replace factors, platelets, fibrinogen as indicated on next page, but do not wait if blood loss is too rapid.

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# HEMORRHAGE
## MASSIVE TRANFUSION GUIDELINES *continued*

**COMPONENTS**

**PRBC: Give** for Hgb <7-10 (CAD? Rate of blood loss?) Each unit PRBC raises Hgb ~ 1g/dL.

**PLATELETS: Give** for <50,000-100,000 per µL with signs of ongoing bleeding. Each apheresis unit raises platelets ~50,000 per µL.

**FRESH FROZEN PLASMA: Give** for INR (PT) or PTT >1.5X normal. Give 10-15 cc FFP per kg body weight, then recheck labs and continue with 1:1 FFP:PRBC ratio.

**CRYOPRECIPITATE: Give** for fibrinogen <80-100 mg/dL. Each 10 units of cryoprecipitate raises fibrinogen ~50 mg/dL.

**VOLUMES**

$$\text{Est. Blood Loss} = \text{EBV} \times \frac{HCT_{starting} - HCT_{measured}}{HCT_{starting}}$$

**Estimated Blood Volume (EBV) ~65-70 ml per kg body weight (~4.5 L for 70 kg)**

END

# HYPOTENSION

By Stanford Anesthesia Cognitive Aid Group and Geoff Lighthall, MD

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

## IMMEDIATE

**Immediate Actions:**

1. Feel for **pulse** and check **monitors**. If no pulse, slow or abnormal rhythm, **Go To appropriate ACLS event.**
2. Inspect **surgical field** for blood loss or manipulation. Consider pausing surgery if non-bleeding cause.
3. Give **IV fluid** bolus. Ensure IV working.
4. Give **phenylephrine** or **ephedrine** to temporize.
   - If severe refractory hypotension, consider: **epinephrine** 10-100 µg and/or **vasopressin** 1-4 units.
5. **If bleeding**, consider lower normal MAP until surgeon controls source. Consider ordering blood.
6. Turn down or off **anesthetic agent**.
7. Consider **Trendelenburg** or elevation of patient's legs.
8. Increase to **100% $O_2$**, high flow.
9. Consider **terminating surgical procedure** or getting **surgical help**.
10. Consider **code cart** if severe. Monitor all **vitals** continuously.
11. If **pulseless**: alert team, start CPR, **Go To PEA, event #3.**

## RULE OUT

**First Rule out Rapidly Lethal Causes:**

1. Hemorrhage ?occult (**Go to Hemorrhage – MTG, event #14**).
2. **Vasodilators** (volatile, IV anesthetics, or drips).
3. **Auto-PEEP** (disconnect circuit).
4. Pneumothorax (**Go to Pneumothorax, event #21**).
5. Anaphylaxis (**Go to Anaphylaxis, event #8**).
6. **Cardiac event:** Myocardial infarction/ischemia (**Go to Myocardial Ischemia, event #19**), Low Ejection Fraction, Systolic Anterior Motion of mitral valve, Hypertrophic Obstructive Cardiomyopathy. TEE to assess.
7. **Pneumoperitoneum** or surgical manipulation.
8. **IVC Compression** e.g. prone, obese, pregnant, or surgical.
9. **Expand Ddx** using **Physiologic approach on next page.**

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# HYPOTENSION *continued*

DDX

## Physiological Differential Diagnosis of Hypotension

MAP = **CO** x SVR **CO** = SV x HR
(SV components: preload, contractility, afterload)

1. **Decreased Preload** e.g. Auto-PEEP, hypovolemia including hemorrhage, arrhythmias, IVC compression, embolism (air, blood, fat, AFE), pneumothorax, pericardial tamponade, venodilators.
2. **Low SVR** e.g. vasodilation (medications, neuraxial block), shock (anaphylaxis, sepsis, spinal, neurogenic), endocrine abnormalities.
3. **Decreased Contractility** e.g. medications, low EF, myocardial ischemia, valvular disease, increased afterload, hypoxemia, local anesthetic toxicity.
4. **Low HR**: including vagal stimulus.

SECONDARY

## Depending on likely diagnosis, consider:

1. Treat the problem, if diagnosed. **Go To relevant event** if ACLS, Anaphylaxis, Hemorrhage, Hypoxemia, Local Anesthetic Toxicity, Myocardial Ischemia, Pneumothorax, Total Spinal Anesthesia, Transfusion Reaction, Venous Air Embolism. For sepsis: refer to local guidelines (IV fluids, invasive monitoring?, send lactate, blood cultures, appropriate antibiotics).
2. **Transesophageal echo** if unclear cause.
3. More **IV access**.
4. Place **arterial line**.
5. Steroid for adrenal insufficiency.
   (e.g. **hydrocortisone** 100 mg IV).
6. Send labs: ABG, Hgb, electrolytes, calcium, lactate, type & cross.
7. **Foley catheter** if not present. Monitor urine output.

END

# HYPOXEMIA

By Stanford Anesthesia Cognitive Aid Group and Geoff Lighthall, MD

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

## IMMEDIATE

### Immediate actions:

1. Increase to **100% $O_2$**, high flow.
2. Check gas analyzer to **rule out low $FiO_2$** or **high $N_2O$**.
   If concerned, **Go To Oxygen Failure, event #20**.
3. Check other **vitals** (cycle NIBP) and PIP. Feel for **pulse**.
4. Check for **$ETCO_2$** (?extubated, disconnected, low BP).
5. **Hand-ventilate**: check compliance. Rule out leaks, machine factors.
6. Listen for **breath sounds** (bilateral? clear?). Check **position ETT**.
7. **Suction** catheter via ETT (to clear secretions and check obstructions).
8. Consider **Pneumothorax, event #21.**
9. Consider **Code Cart** if severe.

## DDX

### Differential diagnosis: See next page for details.

1. Hypoventilation.
2. Low $FiO_2$.
3. V/Q mismatch or shunt.
4. Diffusion problem.
5. Increased metabolic $O_2$ demand.

## SECONDARY

### Depending on likely diagnosis, consider:

1. Large **recruitment breaths**, consider PEEP – caution if hypotensive.
2. **Bronchodilators** (e.g. albuterol MDI or nebulizer).
3. Additional **neuromuscular blockade** if indicated.
4. Increase FRC: head up (if BP ok), desufflate abdomen.
5. **Check placement of ETT**:
   - **Fiberoptic** to confirm tracheal rings, rule out mainstem intubation or ETT obstruction.
   - **Ultrasound**: bilateral sliding pleura are reassuring.
6. **ABG** and/or **CXR**.
7. Consider **terminating procedure** for refractory hypoxemia.
8. Plan for **postop care**: remain intubated? ICU bed?
9. **Artifacts**: See next page, consider after Ddx.

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# HYPOXEMIA *continued*

DDX

## Physiological differential diagnosis of hypoxemia:

1. **Low $FiO_2$**: If gas analyzer states low $FiO_2$ while on '100% $O_2$' likely have $O_2$ failure or pipeline crossover of gases. **Go To Oxygen Failure, event #20** immediately.
2. **Hypoventilation**: Check for **signs** of low minute ventilation:
   - Low TV or RR.
   - High or low $ETCO_2$.
   - Poor chest rise.
   - Decreased breath sounds.
   - Patient bucking ventilator.

   **Rule out** or fix equipment and patient causes:
   - Circuit leak.
   - Obstructed or kinked ETT.
   - High PIP.
   - Residual neuromuscular blockade.
   - Patient breathing asynchronously with ventilator.

   **Postoperative respiratory failure** common causes: residual nmb, opioid, anesthetic, laryngospasm (sudden), bronchospasm, pulmonary edema, high spinal, pain.
3. **V/Q Mismatch or Shunt**: A-a Gradient common causes:
   - Mainstem intubation. (+?Anaphylaxis).
   - Atelectasis.
   - Aspiration.
   - Bronchospasm
   - Mucus plug.
   - Pleural effusion.

   **CONSIDER rare but critical:**
   - **Pneumothorax.**
   - **Hypotension – any cause of poor perfusion.**
   - **Embolus – air, blood, fat, AFE.**
4. **Diffusion abnormality**: Usually chronic lung disease.
5. **Methemoglobinemia** ($O_2$ Sat ~85%), **COHgb** ($O_2$ Sat often normal). **If suspect, send for co-oximetry.**
6. **Increased metabolic $O_2$ demand**: MH, thyrotoxicosis, sepsis, hyperthermia, neuroleptic malignant syndrome.
7. **Artifacts**: finally, confirm by ABG. e.g. poor waveform (probe malposition, cold extremity, light interference, cautery), dyes (methylene blue, indigo carmine, blue nail polish).

END

# LOCAL ANESTHETIC TOXICITY

By Stanford Anesthesia Cognitive Aid Group

## SIGNS

1. Symptoms:
   Tinnitus, metallic taste, or circumoral numbness.
2. Altered mental status.
3. Seizures.
4. Hypotension.
5. Bradycardia.
6. Ventricular arrhythmias.
7. Cardiovascular collapse.

**1. CALL FOR HELP.**

**2. Alert possible CPB.**

**3. CALL FOR CODE CART.**

**4. INFORM TEAM.**

## TREATMENT

1. **Call for Intralipid kit.**
2. **If pulseless, start CPR** and give **<1 mcg/kg epinephrine**.
3. **Avoid vasopressin**.
4. **Stop local anesthetic** injection and/or infusion.
5. Establish airway – ensure adequate **ventilation and oxygenation**. Consider endotracheal intubation.
6. Treat seizure activity with **benzodiazepines**.
7. If signs persist or patient unstable: **Rapidly give 1.5 mL/kg bolus of 20% Intralipid IV (70 kg adult gets 105 mL fast)** then start infusion at 0.25 mL/kg/min. May repeat loading dose (max 3 total doses). May increase infusion rate (max 0.5 mL/kg/min).
8. Monitor for hemodynamic instability – **treat hypotension** (see next page for details).

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# LOCAL ANESTHETIC TOXICITY

*continued*

**SECONDARY**

1. **Variable arrhythmias: Go to** appropriate ACLS event with the following **modifications per ASRA** Practice Advisory:
   - **CONSIDER** reducing Epinephrine doses <1 mcg/kg IV.
   - **AVOID**: Vasopressin, calcium channel blockers, beta blockers, and local anesthetics.
2. If refractory to treatment, alert personnel for **potential cardiopulmonary bypass.**
3. May require **prolonged resuscitation.**
4. Monitor the patient post event in **ICU.**

For latest recommendations, see ASRA website (http://www.asra.com).

**CPR:**

1. **100–120** compressions/minute; **≥ 2”** deep. Allow complete chest recoil.
2. **Minimize breaks in CPR.**
3. Rotate Compressors q2 min.

**Assess CPR quality, improve IF:**

- $ETCO_2$ < 10 mmHg.
- Arterial line Diastolic < 20 mmHg.

END

# MALIGNANT HYPERTHERMIA

By Stanford Anesthesia Cognitive Aid Group and Henry Rosenberg, MD

## SIGNS

**EARLY:**

1. Increased $ETCO_2$.
2. Tachycardia.
3. Tachypnea.
4. Mixed Acidosis (ABG).
5. Masseter spasm/trismus.
6. Sudden cardiac arrest in young person due to hyperkalemia.

**May be LATER**

1. Hyperthermia.
2. Muscle rigidity.
3. Myoglobinuria.
4. Arrhythmias.
5. Cardiac Arrest.

**1. CALL FOR HELP.**
**2. CALL FOR MH CART.**
**3. INFORM TEAM.**
**4. START PREPARING DANTROLENE or RYANODEX!**

## DDX

- Light anesthesia.
- Hypoventilation.
- Insufflation of $CO_2$.
- Over-heating (external).
- Hypoxemia.
- Thyroid Storm.
- Pheochromocytoma.
- Neuroleptic Malignant Syndrome (NMS).
- Serotonin Syndrome.

## TREATMENT

1. **Discontinue** anesthetic triggers (volatiles and succinylcholine). Do **NOT** change machine or circuit.
2. Increase to **100% $O_2$, high flow** 10 L/min.
3. **Halt procedure** if possible. If emergent, continue with non-triggering anesthetic.
4. **Increase minute ventilation** (but avoid air trapping).
5. **Assign several people to prepare 2.5 mg/kg IV Dantrolene or Ryanodex bolus:**
   - **Dantrolene**: Dilute **each 20 mg Dantrolene vial in 60 mL** preservative-free **sterile water** (for **70 kg person give 175 mg so prepare 9 vials** of 20 mg Dantrolene each as above).
   - **Ryanodex** (new formulation of Dantrolene): Dilute **250 mg Ryanodex vial in 5 mL** preservative-free **sterile water** (for **70 kg person give 175 mg**).
6. **Rapidly give Dantrolene** or **Ryanodex**. Continue giving until patient stable (may need >10 mg/kg, call MHAUS 800-644-9737 for advice).
7. For metabolic acidosis, give **sodium bicarbonate** 1-2 mEq/kg.

MH Treatment continued on next page.



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# MALIGNANT HYPERTHERMIA

*continued*

**TREATMENT**

8. **Hyperkalemia** – or suspect from EKG, treat with:
   - **Calcium chloride** 10 mg/kg IV; Max dose 2000 mg or **Calcium gluconate** 30 mg/kg IV, Max dose 3000 mg.
   - **D50** 1 Amp IV (25 g or 50 ml Dextrose) + **Regular Insulin** 10 units IV (monitor glucose).
   - **Sodium Bicarbonate** 1-2 mEq/kg, Max dose 50 mEq.
9. Arrhythmias are usually secondary to Hyperkalemia. Treat as needed except **avoid calcium channel blockers. Go to ACLS events** as relevant and return.
10. Actively **cool patient** with ice packs, lavage if open abdomen. Stop cooling at 38°C.
11. Send **labs** for ABG, Potassium, CK, urine myoglobin, coagulation studies, lactate.
12. Place Foley catheter. **Monitor UO. Goal 1-2 mL/kg** per hour. Can give IV fluid and diuretics.
13. **Consider alkalinizing urine** if CK or urine myoglobin elevated (Sodium Bicarbonate 1mEq/kg/hour).
14. Arrange **ICU** bed. Mechanical ventilation usually required.
15. **Continue Dantrolene** or **Ryanodex**: 1 mg/kg every 4-6 hours or 0.25 mg/kg/hr infusion for at least 24 hours (**25 % of MH events relapse**). Observe patient in ICU for at least 24 hours.
16. Call **MH hotline** (below)for any suspected case with any questions.

**Contact the Malignant Hyperthermia Association of the United States (MHAUS hotline) at any time for consultation if MH is suspected:**

**1-800-MH-HYPER (1-800-644-9737)**

**or see suggestions online at http://www.mhaus.org**

END

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# MYOCARDIAL ISCHEMIA

By Stanford Anesthesia Cognitive Aid Group



## SIGNS

Suspect myocardial ischemia if:

1. Depression or elevation of ST segment.
2. **Arrhythmias**: conduction abnormalities, **unexplained tachycardia, bradycardia, or hypotension.**
3. Regional wall motion abnormalities or new/worse mitral regurgitation on TEE/TTE.
4. In **awake patient:** chest pain, etc.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. INFORM TEAM.**

## TREATMENT

1. **If hypoxemic**, increase to 100% $O_2$, high flow.
2. Verify ischemia (expanded monitor view vs 12-lead EKG).
3. Treat **hypotension** or hypertension.
4. Be prepared for **Arrhythmias** and have **Code Cart** at bedside. Consider applying pads.
5. **Beta-blocker** to slow heart rate. Hold for bradycardia or hypotension.
6. Discuss with surgeon: **aspirin** 160-325mg PR, PO, NG.
7. Consider **STEMI team** or **consult Cardiology** – stat. Discuss among cardiology, surgery, anesthesia:
    - Heparin +/- Clopidogrel.
8. Treat pain with **narcotics** (fentanyl or morphine).
9. Consider **nitroglycerin** infusion (hold until hypotension treated).
10. Place **arterial line** and send **Labs**: ABG, CBC, Troponin.
11. **If Anemic**, treat with packed red blood cells.
12. Consider TTE or TEE **Echocardiography** for monitoring volume status and regional wall motion abnormalities.
13. Consider central venous access.
14. If hemodynamically unstable, consider **Intra-Aortic Balloon Pump.**

END

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# OXYGEN FAILURE

## $O_2$ CROSS OVER / PIPELINE FAILURE

By Stanford Anesthesia Cognitive Aid Group and Seshadri C. Mudumbai, MD

**SIGNS**

• Hear $O_2$ failure alarm. **OR** • Inappropriately low $FiO_2$ value on gas analyzer.

**IMMEDIATE**

**Immediate Actions:**

1. **Disconnect the patient from the machine and ventilate with an Ambu™ bag on Room Air.** Do **not** connect the patient to auxiliary flowmeter on machine – comes from SAME central source!
2. **Open $O_2$ tank** on back of anesthesia machine (check not empty) and disconnect pipeline oxygen to force flow from tank into circuit

   **Alternative:** Obtain full E cylinder of $O_2$ with a regulator. Ventilate with Ambu™ bag or Jackson Rees circuit attached to new $O_2$ tank.
3. Connect gas sampling adaptor to allow monitoring of respiratory gases:

   **Is the patient receiving 100% oxygen?**
4. Maintain anesthesia (if necessary) with IV drugs

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

**SECONDARY**

1. Reduce $O_2$ flow rates to minimum needed to conserve oxygen.
2. Obtain extra backup sources of $O_2$.
3. When patient more stable, contact Bioengineers to alert them to problem and enlist help with machine diagnosis while you focus on patient.
4. Inform OR leadership, ICU, hospital of potential large-scale $O_2$ problem.
5. Discuss with surgeon implications of $O_2$ failure for this patient's management and OR schedule.

END

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# PNEUMOTHORAX

By Stanford Anesthesia Cognitive Aid Group

## SIGNS

1. Increased peak inspiratory pressures.
2. Tachycardia.
3. Hypotension.
4. Hypoxemia.
5. Decreased or asymmetric breath sounds.
6. Hyperresonance of chest to percussion.
7. Tracheal deviation (late sign).
8. Increased JVD/CVP.
9. Have **high index of suspicion** for pneumothorax in **trauma patients** and **COPD patients.**

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

## TREATMENT

1. Increase to **100% $O_2$**, high flow.
2. **Rule out** mainstem intubation.
3. Consider **Ultrasound** or stat CXR.
4. **Do Not Delay Treatment If Hemodynamically Unstable.**
5. **Place 14 or 16 gauge needle mid clavicular line 2nd intercostal space on affected side,** may hear a whoosh of air if under tension.
6. Immediately follow up needle decompression with thoracostomy (chest tube).

END

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# POWER FAILURE

By Stanford Anesthesia Cognitive Aid Group

## IMMEDIATE LIFESAVING ACTIONS:

1. **Get additional light sources:**
   - Laryngoscopes, cell phones, flashlights, etc.

2. **Open doors and shades** to let in ambient light.

3. **Confirm ventilator is working** and **if not, ventilate patient with Ambu™ bag and switch to TIVA.**

4. If monitors fail, **check pulse and manual blood pressure.**

5. **Request Transport Monitor** or defibrillator monitor.

6. **Confirm adequate backup $O_2$ supply:**
   - Power failure may affect oxygen supply or alarms.

7. **Check extent of power failure:**
   - Call bio-med or engineering.
   - Is the problem in one OR, all ORs, or hospital-wide?
   - If only in your OR, check if circuit breaker has been tripped.

END

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# TOTAL SPINAL ANESTHESIA

By Stanford Anesthesia Cognitive Aid Group

## SIGNS

**AFTER NEURAXIAL ANESTHESIA BLOCK:**

1. Unexpected rapid rise in sensory blockade.
2. Numbness or weakness in upper extremities (check hand grip).
3. Dyspnea.
4. Bradycardia.
5. Hypotension (or nausea/vomiting).
6. Loss of consciousness.
7. Apnea.
8. Cardiac arrest.

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART.**
**3. INFORM TEAM.**

## TREATMENT

1. **If Cardiac Arrest:** Start CPR, immediate epinephrine, **Go To appropriate ACLS event.**
2. Support **ventilation** and intubate if necessary.
3. Treat significant **bradycardia or hypotension** with immediate **epinephrine** (start 10-100 µg, increase as needed). If mild bradycardia, consider **atropine** (0.5-1 mg), but progress quickly to epinephrine if needed.
4. Give **IV fluid** bolus.
5. **If parturient:** Left uterine displacement, call OB and neonatology, prepare for possible emergent C-section, monitor fetal heart rate.

END

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# TRANSFUSION REACTIONS

By Stanford Anesthesia Cognitive Aid Group

**SIGNS**

| Hemolytic Reaction | Febrile | Anaphylactic |
|---|---|---|
| 1. Fever.<br>2. Back/flank pain.<br>3. Tachycardia.<br>4. Tachypnea.<br>5. Hypotension.<br>6. Dark urine.<br>7. Oozing – DIC? | 1. Fever.<br>2. Chills/rigors.<br>3. Headache.<br>4. Vomiting. | 1. Hypotension.<br>2. Urticaria/hives.<br>3. Wheezing.<br>4. Tachycardia. |

**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

**TREATMENT**

1. **Stop the transfusion.**
2. Support blood pressure with IV fluids and vasoactive medications if needed.
3. Retain blood product bag and notify Transfusion Service. Additional patient samples will need to be drawn.
4. Consult Transfusion Medicine MD if advice needed.
5. Consider TRALI or volume overload if evidence of lung injury (hypoxemia, pulmonary edema). May require post-operative ventilation.

| Hemolytic Reaction | Febrile | Anaphylactic |
|---|---|---|
| • Maintain urine output – IV fluids, diuretics, renal dose dopamine.<br>• Monitor for signs of DIC. | • Treat with anti-pyretics.<br>• Rule out hemolysis.<br>• Rule out bacterial contamination. | • Epinephrine infusion.<br>• Give antihistamines.<br>• **Go To Anaphylaxis event #8.** |

END

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# VENOUS AIR EMBOLUS

By Stanford Anesthesia Cognitive Aid Group



## SIGNS

**OBSERVE SUDDEN:**

1. Air on TEE or change in Doppler tone (if monitoring).
2. Decrease in $ETCO_2$.
3. Decrease in BP.
4. Decrease in $SpO_2$.
5. Rise in CVP.
6. Onset of dyspnea and respiratory distress or cough in awake patient.

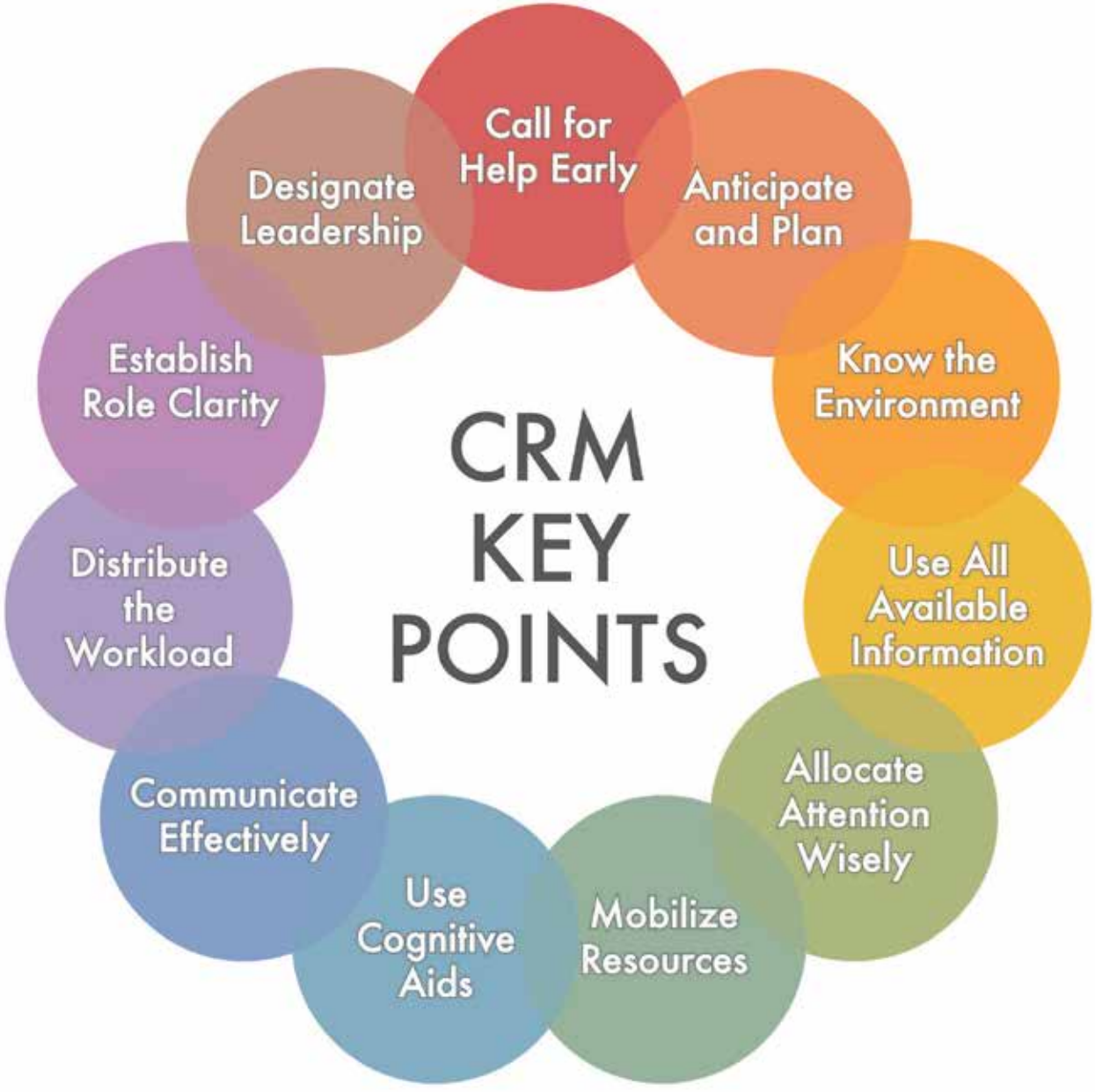
**1. CALL FOR HELP.**
**2. CALL FOR CODE CART?**
**3. INFORM TEAM.**

## TREATMENT

1. Increase to **100% $O_2$**, high flow.
2. **Flood** surgical field with saline.
3. Place **surgical site below heart** (if able).
4. **Aspirate air** from the central line if present.
5. Give rapid fluid bolus to increase CVP.
6. Turn down or **off volatile anesthetic**.
7. Give **epinephrine** (start 10-100 µg) to maintain cardiac output.
8. Start **CPR** if BP catastrophically low.
9. Consider TTE or TEE **Echocardiography** to assess air & RV function.
10. Consider left lateral decubitus.
11. If severe, terminate procedure if able.

END

# 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

## Establish Role Clarity

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

## Distribute the Workload

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

## 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

## 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

## 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

## Allocate Attention Wisely

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

## 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

Place holder
for phone numbers