Appendix 3: Protocols For Emergencies

For All Emergencies

1. **Stop the procedure.**
2. **Continue to monitor vital signs.**
3. **Consider calling 911 early.**

All complications should be handled in an organized manner following the basic algorithm:

- **Position the patient (P)**
- **Airway (A)**
- **Breathing (B)**
- **Circulation (C)**
- **Definitive treatment, consisting of differential diagnosis, drugs and defibrillation (D)**

Respiratory

Laryngospasm

1. Administer 100% oxygen via nasal mask.
2. Suction the oropharynx, hypopharynx and nasopharynx with a tonsil suction tip.
3. Suction/remove all blood, saliva and foreign material from the oral cavity.
4. Pack the surgical site to prevent bleeding into the hypopharynx.
5. Draw the tongue and/or mandible forward.
6. Depress the patient's chest while listening with the ear close to the patient's mouth for a rush of air. If a clear "huff" of air is heard, the airway is patent, and the spasm probably is resolved.
7. If a clear "huff" is not heard:
    - Try to break the spasm mechanically by attempting to ventilate the patient with a full face mask and 100% oxygen.
    - Deepen the anesthetic with 0.5 mg/kg propofol before administering muscle relaxant.
    - Administer an IV dose of succinylcholine (0.5mg/kg) immediately and oxygen under pressure (alternative: rocuronium 1.2mg/kg IV).
    - Support airway with bag-valve mask ventilation until spontaneous ventilation returns (if rocuronium given, consider reversal with sugammadex).
    - Depending on circumstances, consider intubation.
    - Consider atropine with repeat dose of succinylcholine for pediatric patients to prevent bradycardia.

Bronchospasm

A complete discussion of bronchospasm can be found in the Asthma section of Chapter 3. A brief summary can be found here.

Awake patient. Practitioners must document the patient's asthma action plan prior to treatment. This plan will outline each intervention, times to evaluate results, and when to transfer to an acute care facility.

The initial dose of a short-acting rescue inhaler can range from 2 to 10 puffs as per the action plan. A spacer as discussed in Chapter 3 will deliver a more consistent dose of medication. Pediatric patients may benefit from the use of a nebulizer. Place the patient in a comfortable position, monitor vital signs, and use oxygen by nasal cannula or face mask if saturations decrease.

Bronchospasm in open airway, non-intubated cases. These patients will be the most difficult to manage. They cannot administer an inhaled rescue drug; that is entirely the doctor's responsibility. The drug of choice in the office will be a short-acting β agent, albuterol. In adults, the dose will still be 4 to 10 puffs. With pediatric patients, start with their asthma action plan and dose with incremental dosing as needed.

Refer to Chapter 3 for practical administration of inhaled medications. For moderate sedation patients who respond to instructions, nebulizer treatment can also be effective.

Continue to administer oxygen by nasal cannula or face mask as per oxygen saturations. Deepening the anesthetic with a bronchodilating drug, propofol or ketamine, can be considered. Resistant bronchospasm requires EMS activation and transfer. Epinephrine 5 to 20 mcg IV can improve the situation as well until EMS arrives. Epinephrine for emergencies should dictate activation of EMS. If ipratropium or magnesium is available, these can be administered for bronchodilation as well.

Intubated patients. Albuterol 8 to 10 puffs can be administered down the endotracheal tube. This is not as effective as in-line albuterol MDI therapy or nebulized albuterol. The anesthetic can be deepened by a TIVA agent, but an inhalation agent would be preferred. If this is ineffective, call EMS for transfer. While awaiting transport, additional albuterol can be used as well as IV epinephrine in the 5 to 20 mcg dose.

Hypoxemia in spontaneously breathing patient

1. Airway maneuvers to ensure airway is open.
2. 100% O_2: Consider switching to full face mask at 5–10 L/min.
3. Monitor capnography and pulse oximetry.
4. Consider drug reversal.
5. Listen to lungs: Rule out pneumothorax.
6. Unresponsive patient: place LMA, call EMS.
7. Manage until transferred.

Emesis and Aspiration

A complete discussion of emesis and aspiration can be found in Chapter 10: Complications and Emergencies.

The primary determinant of complications from emesis and aspiration is the level of anesthesia at the time of the event. Moderate sedation patients should have protective reflexes intact to protect against lung damage. Patients under general anesthesia do not maintain those protective reflexes so vomitus can be aspirated.

- Risk factors for lung damage
  - Aspiration ≥ 25 mL of fluid.
  - pH < 2.5.
  - Type of aspirant: Solids greater risk than liquids.
- Signs and symptoms
  - Hypoxia is the earliest and most reliable sign of aspiration.
  - Gastric contents in oral pharynx and oral cavity.
  - Wheezing, cough and dyspnea.
  - Tachycardia.
- Moderate sedation with protective reflexes intact
  - Recline the patient, place on right side and increase oxygen flow.
  - Suction oral cavity and pharynx.
  - Auscultate the lungs for wheezing.

    - If there is no wheezing and saturations are maintained, the patient can be monitored for at least 2 hours. If there is no wheezing or desaturation at that time, the patient can be discharged. If unable to comply, transfer the patient.
- Deep sedation – general anesthesia
    - Place the patient in Trendelenburg on their right side.
    - Suction and debride any large food particles.
    - Activate EMS.
    - Oxygen 100% by face mask.
    - Albuterol for wheezing using the same protocols for bronchospasm.
    - BVM ventilations or intubation as needed.
    - PEEP at 5 cm of water to maintain open alveoli.
    - No blind lavage of lungs.

OMS difficult airway algorithm

- Chin lift/jaw thrust.
- Pull tongue forward, reposition airway.
- Full face mask positive pressure ventilation.
- Consider nasal/oral pharyngeal airways.
- Consider a supraglottic airway device or other adjunct airway devices.
- Consider endotracheal intubation.
- Consider needle cricothyrotomy.
- Consider surgical cricothyrotomy.
- Consider tracheostomy.

Cardiovascular

Angina/Acute Myocardial Infarction

- Place patient in comfortable chair.
- Administer oxygen if $SPO_2 < 93$, dyspneic, or signs of heart failure.
- Apply monitors.
- Chewable aspirin 160–325 mg if no contraindications.
- NTG if SBP > 90, HR between 50 and 100, and avoid if recent phosphodiesterase inhibitor use (Viagra, Cialis, etc., in past 24–36 hours).
- Repeat NTG q 5 mins if pain and SBP > 90.
- Call EMS if no response.
- Morphine for pain not relieved by NTG. Use fentanyl as an alternative.
- Continue NTG if meets criteria.
- Transfer.

Management of Perioperative Hypotension

- Treatment of hypotension is directed toward its cause.
- Decrease anesthetic depth if patient is under anesthesia.
- Place the patient in the supine position with legs elevated.

- Administer 100% oxygen.
- Re-evaluate blood pressure, heart rate, and rhythm and treat dysrhythmias.
- Administer a bolus of isotonic fluid.
- Titrate ephedrine or phenylephrine or other suitable vasopressor to preserve adequate systemic pressures. (Ephedrine is generally used unless there is tachycardia and hypotension, in which case phenylephrine may be a better choice.)

Dosing of Sympathomimetic Agents for Treatment of Hypotensive Emergencies

- Ephedrine: Dilute a 50-mg vial in 9 mL of saline to make a 5-mg/mL solution and administer at a dose of 2.5 to 5 mg IV, which can be repeated until the blood pressure is stabilized. The drug's effects occur in approximately 10 minutes, peak at 20 minutes, and last approximately 4 hours.
- Phenylephrine: Dilute single-dose vial (10 mg/mL) in 10 mL of saline; discard 9 mL and dilute with an additional 9 mL of saline to create a 0.1-mg/mL concentration; administer IV in 0.1-mg/mL increments until the desired effects are achieved. The effects are seen within 2 to 3 minutes and last for approximately 15 minutes.
- Epinephrine (may not be the drug of choice in the treatment of hypotensive episodes related to anesthesia): Dilute 1 mg in 500 mL of 5% dextrose (2 mcg/mL); administer as mini drip 2–10 mcg/min to clinical end point.

Management of Perioperative Hypertension

Therapeutic approaches to treating perioperative hypertension are directed at producing vasodilatation or altering cardiac output by β-adrenergic receptor blockers. Among the drugs that may be useful are β blockers such as esmolol (Brevibloc) and metoprolol (Lopressor), the selective α blocker labetalol (Normodyne, Trandate) and the vasodilator hydralazine.

Esmolol dosing

- Immediate control dosing
  - 80 mg (approximately 1 mg/kg) over 30 seconds.
  - Followed with a 150 mcg/kg/min infusion (0.15 mg/kg/min) that is adjusted as required to a maximum of 300 mcg/kg/min (0.30 mg/kg/min) to maintain the desired heart rate and/or blood pressure.
- Gradual control dosing (when there is time to titrate)
  - Loading dose infusion of 500 mcg/kg/min for 1 minute.
  - Followed with a 50 mcg/kg/min over 4 minutes.
- If an adequate therapeutic effect is not seen in 5 minutes
  - Loading dose infusion of 500 mcg/kg/min for 1 minute.
  - Followed with 100 mcg/kg/min.

Metoprolol dosing

- Initial dose 2 mg IV over 2 minutes and then re-evaluate.

Labetalol dosing (a selective α 1 blocker and nonselective β blocker)

- Initial adult dose 5 to 10 mg IV over 2 minutes.
- Followed by 2 mg/min (maximum dose, 300 mg) IV infusion.
- Onset 5 minutes, duration 3-6 hours.

Hydralazine dosing (a direct vasodilator for patient who can tolerate an increase in heart rate and cardiac output but who has a history of asthma)

- Initial adult dose of 2 mg, wait 5 minutes and then re-evaluate, can titrate up to 25 mg.
- Onset 5 minutes, duration 2 hours.

Venipuncture Complications

Hematoma

- Apply pressure to the venipuncture site.

Extravasation

- Apply moist heat and elevate extremity above level of heart (for many cases this simple treatment is all that is required).
- If irritating drugs have extravasated, then consider:
  - Infiltrate 1% plain lidocaine (Xylocaine) at the site, if needed for pain.
  - Administration of ibuprofen, and possible use of steroids and antibiotics may be necessary to prevent or lessen the sloughing.

Phlebitis

- Apply heat to the area.
- Administer ibuprofen or other nonsteroidal anti-inflammatory drugs, steroids and antibiotics.
- Limit motion to alleviate symptoms.
- Seek appropriate consultation if severe symptoms persist beyond 3 or 4 days.

Intra-arterial injection

- Prevention is the best treatment.
- No single treatment regimen has been found to be completely effective.
- Leave the needle in place.
- Inject 10 mL of 1% plain lidocaine into the artery.
- Consider transfer patient to a hospital for further therapy and consider vascular consult.

Neurocardiogenic (Vasovagal) Syncope

- Place patient in a reclining position with the legs elevated.
- Maintain airway.
- Deliver 100% oxygen.
- Support respiration if needed.
- Take vital signs.
- Apply cool compress to forehead.
- Administer spirits of ammonia, if necessary.
- Administer IV atropine 0.5 mg every 3–5 minutes up to 3 mg in the presence of bradycardia.

Hyperventilation Syndrome

- Maintain adequate oxygen levels while reducing carbon dioxide elimination.
- If using oxygen delivery system with full face mask, closed circuit and no carbon dioxide absorber:
  - Deliver oxygen at 600 mL/min.
  - Have patient breathe into the circuit until the rebreathing bag is distended.
  - Repeat until episode subsides.
- If using anesthesia reservoir or paper bag:
  - Have patient exhale and inhale into the paper bag 6–10 times/min.
- If a nonsedated patient fails to respond:

- Consider other causes for hyperventilation, (e.g., metabolic acidosis).
- Administer suitable sedative to abort the hyperventilation episode.

Seizures

- Prevent injury to the uncontrolled unconscious patient.
- Loosen clothing about the neck.
- Place pillow under the head.
- Consider checking blood sugar.
- If a local anesthetic overdose is suspected:
  - Place patient in supine position.
  - Administer oxygen.
  - Maintain airway.
  - Transport to hospital for consideration of lipid rescue.
- If seizures continue unabated following initial treatment:
  - Activate EMS system.
  - Administer IV diazepam 5 mg over 1 minute titrated to effect OR; IV midazolam 2.5 mg over 1 minute titrated to effect.

Allergic Reactions

A complete discussion of allergic reactions – mild, moderate and anaphylactic – is found in Chapter 10: Complications and Emergencies.

Mild Allergic Reactions

Mild allergic reactions typically involve skin. Signs include urticaria, flushing or rash, and pruritus. Angioedema is typically seen in moderate and anaphylactic reactions.

1. Removal of offending agent if possible.
2. Diphenhydramine.
   a. Adult dose: 25 to 50 mg IV.
      - Alternative if awake: 25 to 50 mg PO.
   b. Children dose:
      - Age 6 to 11: 12.5 to 25 mg PO/IV/IM.
      - If < 40 kg: 1 mg/kg IV.
   c. Slow IV administration to prevent hypotension: 25 mg/min.

Moderate Allergic Reactions

In addition to skin signs seen with mild reactions, there may be angioedema. Angioedema can occur in extremities, thorax and abdomen. Angioedema of the airway is found in 10% to 20% of reactions.

1. Removal of agent.
2. Diphenhydramine dosing same as mild reactions.
3. Angioedema present: May decide to use epinephrine as first agent.
   a. 0.3 to 0.5 mg IM in lateral thigh in adults.
   b. 0.15 mg IM in children.
   c. Unless the airway is severely compromised, IM epinephrine is the route.

4. Famotidine.
    a. Adult dose: 20 mg IV.
        - Alternative if awake: 20 mg PO.
    b. Children dose: 0.25 mg/kg IV over 2 minutes.
    c. Adjunct medication to consider.

All mild to moderate allergic reactions should be monitored in the office for a minimum of 1 hour before considering discharge. Cases involving angioedema should always be transferred to monitor for expansion.

Severe Allergic Reactions – Anaphylaxis

Anaphylactic reactions involve two or more organ systems. Perioperative anaphylaxis may lack initial cutaneous signs due to decreased blood flow to the skin, but once circulation is restored, they will appear. During any anesthetic, if hypotension, tachycardia and wheezing are detected, anaphylaxis becomes very high on your differential diagnosis.

1. Removal of agent if possible.
2. Oxygen and ABCs.
3. Vital signs and auscultation.
    a. Hypotension, tachycardia and wheezing present.
4. Call EMS early if suspect anaphylaxis.
5. Epinephrine in adults.
    a. No IV present, epinephrine 0.3 mg IM.
    b. IV present: 50 to 100 mcg IV initially, then increase dose as needed.
    c. Most anaphylactic reactions resolve with 1 or 2 doses of epinephrine.
6. Epinephrine in children.
    a. IM dosing:
        - 0.01 mL/kg of 1:1000 epinephrine.
        - Can be repeated q 5–15 min prn.
        - Maximum dose: 0.5 mL IM.
    b. IV dosing:
        - 0.01 mL/kg of 1:10,000 epinephrine.
        - Can be repeated q 3–5 min prn.
7. IV fluids: Start a second line.
    a. Adults: 1 to 2 liters NSS rapidly.
    b. Children: 20 mL/kg.
8. Albuterol for wheezing.
    a. Adults: 4 to 10 puffs.
    b. Children: Use asthma action plan and escalate as needed.
9. Diphenhydramine and steroids.
    a. Not urgent but adjunct.

Follow-up Measures

Pharyngeal edema and upper airway obstruction can occur and persist after the administration of epinephrine. Endotracheal intubation or tracheotomy may be necessary to secure an airway. If shock continues, the patient should be placed in a slight Trendelenburg position to provide circulatory support. If the patient develops dyspnea and wheezing, a semi-reclining position may be more helpful. If a significant decrease in blood pressure persists despite appropriate volume expansion and the use of epinephrine, an adjunctive vasopressor should be considered. (See the section on treatment of hypotension for management of this problem.)

Seizures may occur during allergic reactions and usually are due to circulatory and/or respiratory inadequacy. If convulsions persist after corrective measures have been taken to ensure cardiorespiratory sufficiency, diazepam 1 mL (5 mg), can be administered IV over 1 minute, with midazolam used as an alternative. It is important to wait 2 minutes for the effect before giving another dose.

After successful treatment of severe allergic reaction, the patient should be hospitalized and observed for 24 hours, receiving prophylactic antihistamines. Anaphylactic reactions have been known to recur after the initial effects of the counteracting drugs have worn off. Consider tryptase levels on arrival to confirm anaphylaxis on arrival at hospital to confirm anaphylaxis.

Malignant Hyperthermia

The following are the primary signs of impending MH:

- Increase in end-tidal carbon dioxide (doubling or tripling, may occur rapidly or over 10 to 20 minutes).
- Unexplained tachycardia, tachypnea, hypercarbia.
- Generalized muscle rigidity.
- Masseter muscle rigidity.
- Hyperthermia (often a late sign).
- Respiratory and/or metabolic acidosis.
- Sudden/unexpected cardiac arrest (consider as secondary to hyperkalemia and treat as such).

Contact telephone number: 800-MHHYPER (800-644-9737)

Emergency Treatment

Caution: These protocols may not apply to every patient and may require alteration according to specific patient needs.

Acute Phase

1. Immediately activate the EMS for patient transport and notify the receiving hospital to prepare for continuing treatment of an MH patient.
2. Immediately discontinue use of all volatile inhalation anesthetics and succinylcholine. Attach Vapor Clean filters to the anesthesia machine. Hyperventilate with 100% oxygen at high gas flows, at least 10 L/min. The circle system and carbon dioxide absorbent need not to be changed.
3. Solubilize the dantrolene according to manufacturer's instructions. If using the older formulation (Dantrolene), **it takes time to mix the solution, so it is recommended that one person be designated for this task.**
4. Administer dantrolene, 2 to 3 mg/kg initial bolus rapidly, with increments up to a total of 10 mg/kg. Continue to administer dantrolene until signs of MH (e.g., tachycardia, rigidity, increased end-tidal carbon dioxide and temperature elevation) are controlled. Occasionally, a total dose greater than 10 mg/kg may be needed.
5. Administer bicarbonate to correct metabolic acidosis, as guided by blood gas analysis. In the absence of blood gas analysis, administer 1 to 2 mEq/kg.
6. Simultaneously with the previous steps, actively cool the hyperthermic patient with IV cold saline (not Ringer's lactate) 15 mL/kg every 15 minutes 3 times.
    - Lavage stomach, bladder, rectum and open cavities with cold saline as appropriate. May not be appropriate for OMS patients.

- Intragastric, intra-rectum and bladder lavage are no longer recommended due to injury to the stomach and rectum. With respect to bladder lavage, the ability to assess urine output during an MH crisis becomes obscured with lavage UNLESS there is evidence of blood clotting.
- Surface cool with ice and hypothermia blanket. A supply of ice or an ice machine is helpful for this purpose.
- Monitor closely because excessively vigorous treatment may lead to hypothermia.
- Overall, these maneuvers are a distraction in the OMS office. The most important care by the OMS is to administer dantrolene and actively cool the patient with ice to the groin and axilla, as well as the administration of cool IV saline.

7. Arrhythmias usually respond to treatment of acidosis and hyperkalemia. If they persist or are life-threatening, use standard antiarrhythmic agents, except calcium channel blockers, which may cause hyperkalemia and cardiovascular collapse.
8. Determine and monitor end-tidal carbon dioxide concentrations; arterial, central or femoral venous blood gases; serum potassium and calcium levels; clotting studies; and urine output.
9. Treat hyperkalemia with hyperventilation, bicarbonate, and IV glucose and insulin (10 U of regular insulin in 50 mL of 50% glucose titrated to potassium level or 0.15 U/kg of regular insulin in 1 mL/kg of 50% glucose). Life-threatening hyperkalemia also may be treated with calcium (e.g., 2–5 mg/kg of calcium chloride).
10. Ensure urine output of greater than 2 mL/kg/h by hydration and/or administration of furosemide and additional mannitol, if necessary. Consider central venous or direct arterial monitoring because of potential fluid shifts and hemodynamic instability.
11. Sudden unexpected cardiac arrest in children: Children younger than 10 years of age who experience sudden cardiac arrest after succinylcholine administration, in the absence of hypoxia or anesthetic overdose, should be presumed to have subclinical muscular dystrophy and treat initially for acute hyperkalemia. In this situation, give bicarbonate 1-2 mEq/kg IV. Calcium chloride, 10 mg/kg or calcium gluconate, 10-50 mg/kg IV, should be administered along with other means to reduce serum potassium levels, including use of a B2 agonist, e.g., albuterol nebulized or MDI at a dose 2-4 times dose to treat bronchospasm. Additionaly, an insulin (0.1 units regular insulin) with glucose (2ml/kg of 25% Dextrose) infusion may be used to rapidly lower serum potassium levels. A neurologist should be consulted once the patient is stabilized for appropriate workup.