Emergency Therapy for MALIGNANT HYPERTHERMIA

CAUTION! This protocol may not apply to all patients; alter for specific needs.

Effective February 2015

DIAGNOSIS

Signs of MH:
- Increasing ETCO₂ (despite hyperventilation)
- Trunk or total body rigidity
- Masseter spasms or trismus
- Tachycardia/tachypnea
- Mixed respiratory and metabolic acidosis (MH can occur without significant metabolic acidosis)
- Increased temperature (may be an early or a late sign)
- Myoglobinuria

Sudden/Unexpected Cardiac Arrest in Young Male Patients:
- Presume hyperkalemia and initiate treatment (see #6)
- Measure blood gases and electrolytes
- Measure CK, myoglobin, ABGs, until normalized
- Usually secondary to occult myopathy (e.g., muscular dystrophy)
- Resuscitation may be difficult and prolonged
- Myoglobinuria is common

Trismus or Masseter Spasm with Succinylcholine
- Early sign of MH in many patients
- If limb muscle rigidity, begin treatment with dantrolene.
- For emergency procedures, continue with non-triggering agents, evaluate and monitor the patient, and consider dantrolene treatment.
- Check CK immediately and at 6-8 hr intervals until returning to normal. Observe for dark- or cola-colored urine. If present, liberalize fluid intake and test for serum and urine myoglobin. (see D below)
- Observe in PACU or ICU for at least 24 hours if metabolic signs of MH were present.

ACUTE PHASE TREATMENT

1. GET HELP. GET DANTROLENE. Notify Surgeon. Call MH Hotline.
   - Discontinue volatile agents and succinylcholine.
   - Hyperventilate with 100% oxygen at flows of 10 L/min. to flush volatile anesthetics and lower ETCO₂. If available insert activated charcoal filters into the inspiratory and expiratory limbs of the breathing circuit. The Vapor-Clean® filter may become saturated after one hour; therefore, a replacement set of filters should be substituted after each hour of use.
   - Halt the procedure as soon as possible; if it is not possible to stop surgery, continue with non-triggering anesthetic technique.
   - Don't waste time changing the circle system and CO₂ absorbent.

2. Dantrium®/Revonto®/Ryanodex®
   - 2.5 mg/kg rapidly IV, if possible through large-bore IV
   - To convert kg to lbs, for amount of dantrolene, give patients 1 mg/lb (2.5 mg/kg approximates 1 mg/lb).
   - Dantrium/Revonto — Each 20 mg vial should be reconstituted with at least 60 mL sterile water for injection, USP (without a bacteriostatic agent). There are 3 grams of mannitol in each 20 mg vial of Dantrium and Revonto.
   - Ryanodex — Each 250 mg vial should be reconstituted with 5 mL sterile water for injection, USP (without a bacteriostatic agent) and shaken to ensure an orange-colored uniform, opaque suspension. There are 125 mg of mannitol in each 250 mg vial of Ryanodex.
   - Repeat until signs of MH are reversed.
   - Sometimes more than 10 mg/kg (up to 30 mg/kg) of dantrolene is necessary.

3. Bicarbonate for metabolic acidosis
   - 1.2 mEq/kg if blood gas values are not yet available

4. Cool the patient
   - If core temperature > 39°C
     - Apply ice to surface.
     - Infuse cold saline intravenously.
     - Lavage open body cavities.
     - Other cooling techniques may be applied at clinician's discretion.
     - Stop cooling if temperature < 38°C and falling to prevent hypothermia.

5. Dysrhythmias
   - Usually responds to treatment of acidosis and hyperkalemia.
   - Use standard drug therapy EXCEPT avoid calcium channel blockers—(may cause hyperkalemia or cardiac arrest in the presence of dantrolene).

6. Hyperkalemia
   - Treat with hyperventilation, bicarbonate, glucose/insulin, calcium.
     - Bicarbonate 1-2 mEq/kg IV
     - For pediatric, 0.1 units regular insulin/kg and 2 mL/kg 25% dextrose or for adult, 10 units regular insulin IV and 50 mL 50% dextrose
     - Calcium chloride 10 mg/kg IV or calcium gluconate 10-50 mg/kg IV for life-threatening hyperkalaemia
     - Check glucose levels hourly.

7. Follow...
   - ETCO₂, minute ventilation electrolytes, blood gases, CK, core temperature, urine output and color, coagulation studies. If CK and/or K⁺ rise more than transiently or urine output falls to less than 0.5 mL/kg/hr, induce diuresis to >1 mL/kg/hr and give bicarbonate to alkalize urine and prevent myoglobinuria-induced renal failure (see D below).
   - Venous blood gases (e.g., femoral vein) values may document hypermetabolism earlier than arterial values.
   - Central venous or PA monitoring as needed.
   - Place Foley catheter and monitor urine output.