

Malignant Hyperthermia Policy

MH Cart Contents:

Drugs

- 1.) **Ryanodex** – 3 vials. Each vial should be diluted at the time of use with 5ml sterile water for injection USP (without a bacteriostatic agent).
- 2.) **Sterile water** for injection USP (without a bacteriostatic agent). Each vial of Ryanodex should be reconstituted by adding 5 ml of sterile water and the vial shaken to ensure an orange-colored uniform, opaque suspension. If the MH episode is proceeding rapidly simply mix and inject. It is imperative to get Ryanodex to its effective site, the skeletal muscle.
- 3.) **Sodium Bicarbonate (8.4%)** – 50 ml x 5
- 4.) **Calcium Chloride (10%)** – 10 ml vial x 2
- 5.) **Lidocaine * for injection (2%)** – 100 mg/5 ml or 100 mg/10 ml preloaded syringes x (3). Note: Amiodarone is also acceptable. ACLS protocols, as prescribed by the AHA, would be followed when treating all cardiac degeneration caused by MH.
- 6.) **Refrigerated cold saline solution** – A minimum of 3 Liters for IV cooling.
- 7.) **Regular Insulin:** 100 U/ml vial x 1
- 8.) **Dextrose 50%:** 50 ml vials x 2

*Lidocaine and procainamide should not be given if a wide QRS complex is likely due to hyperkalemia, this may result in asystole.

General Equipment

- 1.) **Vapor-Clean** charcoal filters for anesthesia circuit (1 set)

- 2.) **Syringes** – 60
- 3.) **Intravenous catheters** – 16G, 18G, 20G, 2 inch; 22G, 1 inch; 24G, ¾ inch (4 each) for IV access and arterial line.
- 4.) **NG tubes** – all sizes
- 5.) **Toomy irrigation syringes** – 60 ml x 2 with adapter for NG irrigation
- 6.) **Pressure bag**
- 7.) **Single Use Cooling Packs** – 4* (ice packs)

Monitoring Equipment

1. **Core temperature probes** ie: esophageal, bladder, rectal
2. **CVP kits** – all sizes for our patient population
3. **Transducer kits** for arterial and central venous cannulation

Nursing Supplies

- 1.) **Large sterile Steri-Drape** (for rapid drape of wound)
- 2.) **Urine Meter** x 1
- 3.) **Irrigation tray with piston** (60 cc irrigation) syringe
- 4.) **Small plastic bags** for ice x 4

Laboratory Testing Supplies

- 1.) **Syringes (3 ml)** for blood gas analysis x 6, iSTAT wit TB syringes
- 2.) **Blood specimen tubes** for CK, myoglobin, SMA 19 (LDH, electrolytes, thyroid studies), PT/PTT, fibrinogen, fibrin split products, lactate, CBC, platelets. If no immediate laboratory analysis is available, specimens should be kept on ice for later analysis. Blood cultures should be included to rule out bacteremia.
- 3.) **Urine collection container** for myoglobin level. Pigmenturia (brown or red urine and heme positive dipstick) indicates that renal protection is mandated. When the urine is centrifuged and or allowed to settle, and the sample shows a clear supernatant, the coloration is due to red cells in the sample.

A. Malignant Hyperthermia Protocol for Suspected MH Event (MHAUS Protocol, www.mhaus.org, 1-800-644-9737)

- 1.) Inform everyone in the room of MH event.
- 2.) Call Anesthesia board for help.
- 3.) Identify a person to bring the MH cart into room.
- 4.) Discontinue all volatile inhalational agents and succinylcholine.
- 5.) Remove patient from anesthesia machine and hyperventilate with 100% O₂ with manual bag-valve ventilation until machine prepped as below (item 9)
- 6.) Administer IV Ryanodex, 2.5 mg/kg to a total dose of 10 mg/kg IV. Repeat as frequently as needed until patient responds with decreased ETCO₂, decreased muscle rigidity, and/or lowered heart rate. Larger doses (>10mg/kg) may be required for patients with persistent contractures or rigidity.
- 7.) Maintain anesthesia with total intravenous non-triggering anesthetics.
- 8.) Increase minute ventilation to lower ETCO₂.
- 9.) Preparation of the machine with the following steps (see also APPENDIX A) :
 - a. Replace both soda-sorb canisters with clean soda-sorb.
 - b. Remove all vaporizers from the machine.
 - c. Remove breathing circuit and bag.
 - d. **Run oxygen fresh gas flow at 10L/min with ventilator running, at a tidal volume of 600ml, rate of 10 breaths/min, I:E 1:2, for 2 minutes. This should be done without a circuit attached (machine will alarm during this time- ignore alarms).**
 - e. Obtain Vapor-Clean filters, as marked on each filter place one on inspired port of the anesthesia machine and another filter on the expired port of the anesthesia machine.
[See locations below – item 10]
 - f. Replace breathing bag and connect a new breathing circuit and perform leak test.
 - g. The circuit is now ready to be attached to the patient.
 - h. **Maintain 10 L/min fresh gas flow throughout case**
 - i. **Replace the filters every hour**
- 10.) Filter locations:
 - a. In work rooms next to circuits (Floating 5 OR, North 5 OR, Labor and Delivery)
 - b. One set on MH cart
 - c. Endoscopy- one set in bottom drawer of anesthesia machine
 - d. Electrophysiology lab 3 (EP3)- one set in bottom drawer of anesthesia machine

- e. MRI-one set in bottom drawer of anesthesia cart
- 11.) Obtain blood gas analysis to determine degree of metabolic acidosis. Consider administration of sodium bicarbonate, 1-2 mEq/kg for base excess > -8 (max dose 50 mEq).
- 12.) Control fever by administering iced fluids, cooling the body surface, and cooling body cavities with sterile iced fluids. Cooling should be halted at 38 degrees C to prevent inadvertent hypothermia.
- 13.) Monitor urinary output and establish diuresis to protect the kidney from probable myoglobinuria.
- a. Diurese to > 1ml/kg/hr urine output. If CK or K rise, assume myoglobinuria and start bicarbonate infusion of 1 mEq/kg/hr to alkalinize urine
- 14.) If hyperkalemia (K > 5.9 or less with ECG changes) is present, treat with:
- a. Calcium chloride 10 mg/kg (max dose 2 gm) or calcium gluconate 30 mg/kg (max dose 3 gm)
 - b. Sodium bicarbonate 1-2 mEq/kg IV (max dose 50 mEq)
 - c. Glucose/insulin
 - i. Pediatric patients: 0.1 units/kg regular insulin IV and 0.5 gm/kg dextrose (% in formulation not important)
 - ii. Adult patients: 10 U regular insulin IV and 50 ml 50% dextrose
 - iii. Check glucose levels hourly
 - d. Refractory hyperkalemia: consider albuterol (or other beta-agonists), kayexelate, hemodialysis or ECMO if patient a candidate.
- 15.) Treat dysrhythmias with standard medication but avoid calcium channel blockers.
- 16.) Follow HR, core temperature, ETCO₂, minute ventilation, blood gases, K, CK, urine myoglobin and coagulation studies (INR, platelet count, PT, fibrinogen, fibrin split products) as warranted by the clinical severity of the patient.
- 17.) When stable, transfer to PACU or ICU for at least 24 hour monitoring. Key indicators of stability include:
- a. ETCO₂ declining or normal
 - b. Heart rate is stable or decreasing with no signs of dysrhythmias
 - c. Resolving hyperthermia
 - d. If present, generalized muscular rigidity has resolved
- 18.) After initial bolus dosing to treat acute MH crisis, maintenance dantrolene should be continued at 1mg/kg/dose every 4-6 hours while monitoring the patient for signs of recrudescence.

* Remove filters at end of case. **Failure to remove filters will result in insufficient inhalational anesthesia for the next patient!**

B. Anesthesia for MH Susceptible Elective Patients (MHAUS Protocol, www.mhaus.org, 1-800-644-9737)

- 1.) Machine prep as per Appendix A below.
- 2.) Use local or regional anesthesia. May use general anesthesia with non-triggering agents.
- 3.) Safe drugs include: barbiturates, benzodiazepines, alkylphenol derivatives (propofol), opioids, non-depolarizing muscle relaxants and their reversal agents, nitrous oxide, alpha-2 agonists, ketamine.
- 4.) Body temperature monitoring
- 5.) Capnography
- 6.) Ryanodex and MH cart immediately available
- 7.) May discharge patient from PACU 2.5 hours after an uneventful anesthetic.

C. Anesthesia for MH Susceptible Patients; Machine Prep in Urgent Situations (less than 104 minutes time to surgery) (MHAUS Protocol, www.mhaus.org, 1-800-644-9737)

- 1.) See APPENDIX A below.

D. Masseter Muscle Rigidity Following Succinylcholine Administration

- 1.) Switch to non-triggering anesthetics.
- 2.) Elective surgery should be postponed.
- 3.) Emergency surgery may continue with non-triggering anesthetics.
- 4.) Monitor for signs of MH.

- 5.) The patient should remain hospitalized post-procedure and monitored for signs of rhabdomyolysis such as myoglobinuria and myoglobinemia. CK levels and electrolytes should be checked every 8 hours until returning to normal.

E. Milder Increases in Jaw Tension During Anesthetic

- 1.) Consider discontinuing triggering agents.
- 2.) Observe for signs of MH for at least 12 hours.
- 3.) If there is evidence of myoglobinuria, dark cola-colored urine, increase in temperature, pulse rate, and abnormality of acid base balance, the patient should be admitted and observed overnight.

E. Anesthesia for non-MH Susceptible Pregnant Patients with MH partners

- 1.) Prior to delivery
 - a. If the pregnant patient requires non-emergent surgery a non-triggering anesthetic with regional anesthesia should be considered.
 - b. If general anesthesia is indicated, a TIVA is recommended, although NO₂ may be used with an anesthesia machine that has been prepared for an MH susceptible patient.
 - c. Standard ASA monitoring should be used, along with core temperature monitoring.
- 2.) Labor and delivery
 - a. Anesthesia providers should be notified of the arrival of the patient to LDR as soon as possible.
 - b. Until delivery of the fetus, the mother should be treated as MH patient, avoiding MH triggering agents. All other drugs and techniques may be used with no special modification based on MH status.
 - c. If a general anesthetic is indicated, a non-triggering anesthetic technique should be employed (total intravenous anesthesia) although nitrous oxide may be used with an anesthesia machine that has been prepared for an MH susceptible patient.
 - d. If a rapid sequence induction is needed, succinylcholine, although a known MH trigger, may be administered since so little of the drug crosses the placental barrier. However, an appropriate intubating dose of rocuronium for rapid sequence induction may be used in place of succinylcholine.
 - e. After delivery, volatile anesthetics may be given to the mother.

- f. If uterine relaxation is necessary prior to delivery, nitroglycerin 250 mcg IV may be used or 1 puff of nitroglycerin sublingual spray. Another alternative is terbutaline 2.5 mg SQ.
- 3.) Post-delivery
- a. If the father has been shown to harbor a known MH causative mutation consider obtaining an umbilical blood sample for genetic analysis for MH susceptibility. In this case, the DNA diagnostic center should be contacted prior to obtaining the blood sample.

Fig 1. Vapor clean filters (also called canisters)



Filters are available:

1. FL 5 work room
2. ASC work room
3. LDR work room
4. MH cart in the FL5 OR Fish bowl
5. Endoscopy anesthesia machine
6. EP3 anesthesia machine
7. MRI anesthesia cart

See also www.dynasthetics.com

APPENDIX A

Malignant Hypothermia Machine Preparation

Elective Case (time for machine flush available):

1. Empty and clean soda-sorb canister and replace with new soda-sorb.
2. Remove all vaporizers from the machine.
3. Perform the following procedure:

Attach a breathing circuit and reservoir bag to the Y-piece of the circle system and set the ventilator

- Run oxygen fresh gas flow at 10L/min with ventilator running, tidal volume of 600ml, rate of 10 breaths/min (1:2) **for > 104 minutes.**
- Then Place new circuit on machine and leak test per normal protocol. Machine ready for use.

Workstation Type	Anesthetic Agent	Published washout time (time to inspired agent less than 5 parts per million)	Time to inspired agent less than 5 parts per million with Vapor-Clean filters
Ohmeda Aestiva	Isoflurane	54 minutes ²	Less than 1 minute ²
Ohmeda Aestiva	Sevoflurane	48 minutes ²	Less than 1 minute ²
Ohmeda Aestiva	Desflurane	27 minutes ²	Less than 1 minute ²
Draeger Apollo	Isoflurane	84 minutes ²	Less than 1.5 minutes ²
Draeger Apollo	Sevoflurane	46 minutes ²	Less than 1 minute ²
Draeger Apollo	Desflurane	53 minutes ²	Less than 1 minute ²
Draeger Primus	Isoflurane	64 minutes ⁴	
Ohmeda Aestiva	Sevoflurane	55 minutes ²	Less than 1 minute ²
Draeger Fabius	Sevoflurane	104 minutes ²	
GE Avance	Sevoflurane	61 minutes ⁴	
Maquet Flow-i	Sevoflurane	48 minutes ⁴	
GE Aisys	Sevoflurane	55 minutes ²	

<http://www.dynasthetics.com/Vapor-Clean/>

Urgent Case (time for machine flush NOT available, see also card on anesthesia machine):

1. Empty and clean soda-sorb canister and replace with new soda-sorb.
2. Remove all vaporizers from the machine.
3. Perform the following procedure:
 - With no circuit or bag attached:

- Run oxygen fresh gas flow at 10L/min with ventilator running, tidal volume of 600ml, rate of 10 breaths/min (1:2) for **120 seconds (2 minutes)**. The machine will alarm, ignore alarms.
- 4. Obtain Vapor-clean filters (orange filters) and place on inspiration/expiratory ports (diagrams also available on filter package).
- 5. Place new circuit on machine and leak test per normal protocol.
- 6. Maintain fresh gas flow at > 3 L/min
- 7. Replace filters every 12 hours as needed

During MH crisis:

- Maintain fresh gas flow at 10 L/min throughout case
- Replace filters every hour

MN 12/2013
RS 02/2014
CPC 02/2014
MC 4/2014
RS 08/2016
RS 11/2016
MMS, AT, RXS 02/2019