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<i>[Insert Facility Name or Logo]</i>	POLICIES & PROCEDURES	
	LAST REVIEW DATE: MM/DD/YYYY	
TITLE: Malignant Hyperthermia Crisis	RESPONSIBLE AREA:	PAGES X of X
	EFFECTIVE DATE: MM/DD/YYYY	REVISION DATE(S): MM/DD/YYYY

POLICY

Patient risk of malignant hyperthermia (MH) will be identified to prevent an MH crisis. An MH emergency cart, supplies and full complement of dantrolene are available to clinical areas where triggering agents may be administered. Response team members participate in ongoing MH crisis management education, training and drills.

PURPOSE

To identify patients at risk of MH, develop a plan of care to minimize risk of a MH crisis, implement a standardized emergency response, and conduct ongoing team education to manage an MH crisis. This policy is based on Malignant Hyperthermia Association of the United States (MHAUS) recommendations and guidance.

DEFINITIONS

Dantrolene Formulations

- **Dantrium IV®** – Each vial of Dantrium IV® contains 20 mg of dantrolene sodium for reconstitution.
 - **Stock a minimum of 36 vials**
- **Revonto®** – Each vial of Revonto® contains 20 mg dantrolene sodium for reconstitution.
 - **Stock a minimum of 36 vials**
- **Ryanodex®** – Each vial of Ryanodex® contains 250 mg of dantrolene sodium for reconstitution.
 - **Stock a minimum of 3 vials**

<i>Dantrolene solution comparison</i>		
	<i>Dantrium IV® / Revonto®</i>	<i>Ryanodex®</i>
Required Vials	36	3
Amount of dantrolene sodium / vial	20 mg	250 mg
Mannitol / vial	3000 mg	125 mg
Shelf life	36 months	24 months
Reconstitution	60 mL of non-bacteriostatic sterile water per vial. Shaken for approx. 20 seconds or until the solution is clear.	5 mL of non-bacteriostatic sterile water per vial. Shake the vial until mixed thoroughly (approx. 10 seconds).

Malignant hyperthermia – A rare, inherited skeletal muscle syndrome that presents as a hypermetabolic reaction triggered by exposure to volatile anesthetic gases or the depolarizing muscle relaxant, succinylcholine.

Malignant hyperthermia triggering agents – Known triggers for MH-susceptible patients include inhaled general anesthetics (e.g. desflurane, sevoflurane, isoflurane) and depolarizing neuromuscular blocking agent (succinylcholine)

PROCEDURE

- 1) Employee Education
 - a) All department registered nurses, licensed practical nurses, surgical technologists, specialist techs and assistive personnel receive MH education (e.g., mock drill, annual competency assessment) and literature annually.
 - b) MH literature for review shall include, but not be limited to:
 - i. Pathophysiology
 - ii. MH triggering agents
 - iii. Clinical signs of MH
 - iv. Treatment
 - v. Drugs and equipment required for treatment
- 2) MHAUS Emergency 24-hour Hotline – (800) MH-HYPER (800-644-9737) – is clearly posted and available in areas where triggering agents are available.
- 3) MH Cart and emergency manual are located at *[insert location(s)]*
- 4) MH Cart, Equipment and Supplies
 - a) An MH cart with dantrolene is available for emergent management of a MH crisis when MH-triggering agents are available in the facility, even if triggering agent is administered only for emergent airway management.
- 5) MH Cart Contents and Refrigerated Sterile Solutions
 - a) Medication and sterile supply dates and integrity are checked and restocked on a schedule by *[an assigned individual]*.

- b) The MH emergency cart is locked when not in use and stored in a location that is secure with staff access to retrieve the cart during an emergency.
 - c) MH cart contents [*Refer to MHAUS for most recent recommendations on MH Cart Contents: <http://www.mhaus.org/faqs/stocking-an-mh-cart/>*]
 - i. All drugs, including dantrolene
 - ii. Equipment
 - iii. Supplies
 - iv. Ice and refrigerated intravenous and irrigating solutions [*insert location*]
 - d) Facility dantrolene supply
 - i. MH Cart ____ [*number of vials*]
 - ii. Pharmacy ____ [*number of vials*]
- 6) Preoperative Assessment and Evaluation
- a) Assess patient and/or family risk of MH
 - b) Document and communicate patient and/or family diagnosed or MH risk with patient care team.
 - i. Patient MH identifier (e.g., wrist band, medical record)
 - ii. Each handoff of care
 - iii. Procedure timeout
 - iv. Noted in the surgery/procedure note
- 7) Preparation for a Patient with Known MH Risk
- a) Anesthetizing Area Preparation
 - i. Remove succinylcholine from the room and MH-triggering anesthetic agents from the anesthetic machine
 - ii. Refer to manufacturer recommendation on how to clear MH-triggering agent from anesthesia delivery system or if available, use the designated MH clean anesthesia machine.
 - iii. Purge the anesthetic machine of inhaled anesthesia agent with ____ liters/minute of 100% O₂ for ____ minutes. [*Consult manufacturer and anesthesia delivery system recommendations.*]
 - iv. Change CO₂ absorbent, breathing circuit and bag.
 - v. [*Consider the following language if commercially available charcoal filters available at facility*]

Adding commercially available activated charcoal filters to the circuit will remove anesthetic gases when flushed with high fresh gas flows (≥ 10 L/min) for 90 seconds prior to placing the activated charcoal filters on both the inspiratory and expiratory ports. These filters are effective in keeping gas concentration below 5 ppm for up to 12 hours with fresh gas flows of at least 3 L/min.
 - b) OR Preparation
 - i. Verify that stocked MH cart, equipment, refrigerated solutions and ice are available.
 - ii. Verify that a cooling blanket is available and working
 - iii. Point of care testing is available and/or laboratory has been notified
- 8) Intraoperative MH Crisis Management
- *The elements below outline general steps for MH crisis management. Refer to MHAUS or*

facility manual for detailed treatment protocol. Customize policy and roles for the facility and staffing model.

- a) Circulating Nurse / Ancillary Staff
 - i. Alert staff outside of the operating/procedure room of a MH crisis (*overhead page, message, alarm*)
 - ii. Obtain MH cart, refrigerated items, ice, and the “Code Blue” cart
 - iii. Call the MHAUS Emergency 24-hour Hotline – (800) MH-HYPER (644-9737)
 - iv. Aid in preparation of dantrolene – may require 3-4 people. (*if you are preparing Dantrium IV®/Revonto®*)
 - v. Provide support as needed:
 1. Change to a clean anesthesia machine (*if available*).
 2. Provide supplies, ice and refrigerated solutions for active cooling of the patient until a temperature of 38.5° C is reached.
 3. Insert additional venous access and arterial line.
 4. Facilitate obtaining arterial blood gases and lab values.
- b) Anesthesia Professional
 - i. Turn off all MH-triggering anesthetics and remove vaporizer(s) from machine.
 - ii. If available, insert activated charcoal filters (Vapor-Clean™, Dynasthetics, Salt Lake City, UT) into the inspiratory and expiratory limbs of the anesthesia circuit. These filters may become saturated after one hour; therefore, a replacement set of filters should be substituted after each hour of use.
 - iii. Consider administering amnestic sedatives.
 - iv. Hyperventilate with 100% O₂ at 10 L/minute using bag valve mask/airway device.
 - v. Calculate, reconstitute, if necessary, and administer 2.5 mg/kg rapid IV bolus of dantrolene.
 - vi. Repeat in increments up to a total dose of 10 mg/kg until signs of MH are controlled (tachycardia, rigidity, increased end-tidal CO₂, hyperthermia). Some patients may require a higher total dose.
 - vii. Discontinue warming devices.
 - viii. Line Placement
 1. Consider placement of arterial line for serial blood sampling and monitoring in the hemodynamically unstable patient.
 2. Monitor volume status if clinically indicated (e.g., central venous line, pulmonary artery catheter).
 - ix. Lab Work
 1. Draw lab work, if possible
 - a. Blood Gas and Electrolytes
 - i. Arterial, Central, or Femoral Venous Blood Gas
 - ii. Na
 - iii. Glucose
 - iv. K⁺
 - v. Ca⁺⁺
 - b. Urine Dipstick
 - i. Hb/Myoglobin

- c. CK/Myoglobin/SMA-19
 - d. Lactic Acid Level
 - e. PT/PTT/FSP/D-DIMER/Fibrinogen
 - f. CBC/Platelets
- x. Treat metabolic acidosis
 - 1. Obtain blood gas to determine degree of metabolic acidosis
 - 2. 1-2 mEq/kg sodium bicarbonate for base excess > -8 (maximum dose 50 mEq)
 - xi. Treat hyperkalemia
 - 1. If $K^+ > 5.9$ or less with ECG changes, treat with bicarbonate, glucose/insulin and calcium (refer to organization guidelines for management of hyperkalemia)
 - 2. Dysrhythmias usually respond to dantrolene and correction of acidemia and hyperkalemia. If dysrhythmias persist or are life-threatening, standard antidysrhythmics may be used.
NOTE: Calcium channel blockers (especially verapamil) should not be used because they may cause hyperkalemia and cardiac arrest.
 - xii. Monitor core temperature.
 - xiii. Actively cool the patient if core temperature is $> 39^\circ\text{C}$ and rapidly rising (e.g., ice pack, cooling blanket). Stop cooling when the temperature has decreased to $< 38^\circ\text{C}$.
 - xiv. Place orogastric tube & initiate cold lavage with cold sterile 0.9% normal saline.
 - xv. Maintain urine output $> 1 \text{ mL/kg/hr}$.
 - 1. Treat urine output $< 0.5 \text{ mL/kg/hr}$ with hydration & diuretics.
 - 2. If CK or K^+ rise, assume myoglobinuria and give bicarbonate infusion of 1 mEq/kg/hr , to alkalinize urine.
 - 3. Note: see comparison chart for mannitol amount for different dantrolene formulations
 - xvi. Transfer patient to PACU or ICU
- c) Surgeon
- i. Pack or close the wound and stop operating as soon as possible.
 - ii. When possible, irrigate open cavities with cold sterile 0.9% normal saline.
 - iii. Assist in mixing dantrolene, if necessary, and/or line placement (A-line, CVP, 2nd IV), as necessary and if not already complete.
 - iv. Transfer patient to PACU or ICU.
- 9) Postoperative Management
- a) Admit patient to ICU for a minimum of 36 hours.
 - b) Monitor for return of MH symptoms by evaluating the patient at least every 4 hours for the first 36 hours after an MH event.
 - c) Continue to monitor labs (including blood gases), vital signs, pulse oximeter, ECG, skin color, and intake and output.
 - d) Continue to monitor core temperature.
 - e) Assess urine myoglobin for rhabdomyolysis and myoglobinuria.
 - f) Continue to administer dantrolene 1 mg/kg IV q4-6h or 0.25 mg/kg/hr infusion for at least 24 hours.

- g) Avoid potassium containing IV solutions and allow the electrolytes to return to normal.
 - h) Administer analgesics to treat muscle soreness.
 - i) Assist the patient with exercise gradually to prevent further muscle damage.
 - j) Monitor the patient for nausea, diarrhea, muscle weakness, double vision, or lightheadedness.
- 10) Patient and Family Education
- a) Provide disclosure, education and emotional support to the patient and/or his/her family or caregivers.
 - i. Provide information to obtain Medic Alert bracelet.
- 11) Restock Supplies
- a) Restocking of Dantrolene for MH cart/kit and supplies.
 - b) Ensure MH cart/kit has been returned to designated location.
- 12) Continuous Quality Improvement
- a) Conduct a team debrief after an MH event for process improvement.
 - b) Initiate a peer support process for staff emotional recovery, as needed.
- 13) Reporting
- a) Report the event to the MHAUS North American Malignant Hyperthermia Registry.
- 14) Transfer Protocol
- a) When the patient is stable, he/she is transfer to the intensive care unit (ICU).

CONSIDERATIONS FOR AMBULATORY SURGICAL CENTERS AND OFFICE-BASED FACILITIES

Transfer Protocol

- b) A transfer protocol is established with a local hospital.
- c) The patient should be transferred once he/she is stable. Signs of stability may include:
 - i. ETCO₂ declining or normal
 - ii. Heart rate stable or decreasing without dysrhythmia
 - iii. IV dantrolene has begun
 - iv. Temperature declining
 - v. If present, generalized muscular rigidity resolving

ADDITIONAL RESOURCES

- 1) Malignant Hyperthermia Association of the United States: www.mhaus.org
- 2) American Association of Nurse Anesthetists. Malignant Hyperthermia Crisis Preparedness and Treatment, Position Statement. 2015.
- 3) American Association of Nurse Anesthetists MH Resource Page: www.aana.com/MH
- 4) Larach MG, Dirksen SJ, Belani KG, et al. [Special article: Creation of a guide for the transfer of care of the malignant hyperthermia patient from ambulatory surgery centers to receiving hospital facilities.](#) *Anesth Analg.* Jan 2012;114(1):94-100.