

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.

INITIAL EVALUATION

Assess signs and symptoms of MH:

Early signs and symptoms:

- Tachycardia/tachypnea
- Abrupt increase in end tidal carbon dioxide (ETCO₂)
- Muscle rigidity/masseter muscle rigidity
- Hyperthermia (temperature > 38.8°C)
- Mixed respiratory/metabolic acidosis
- Hyperkalemia
- Hypotension
- Rhabdomyolysis (*i.e.* myalgia, elevated creatinine kinase and blood myoglobin levels)
- Cardiac arrhythmias
- Hypoxia
- Profuse sweating
- Mottling of the skin

Late signs and symptoms:

- Acute renal/circulatory failure
- Dark colored urine due to myoglobinuria
- Disseminated intravascular coagulation
- Rhabdomyolysis (*i.e.* myalgia, elevated creatinine kinase and blood myoglobin levels)
- Hyperkalemia
- Hyperthermia (temperature > 38.8°C)
- Hypotension
- Cardiac arrhythmias

- If MH suspected, page Anesthesia¹ and notify Pharmacy¹ STAT
- Bring MH cart² to bedside

MH confirmed?

Yes
No

- **MH team lead (anesthesiologist)³** assembles crisis team
- Assigns roles to MH team members
- Assists with drawing arterial blood gases (ABGs) as needed
- Calls **MH hotline (1-800-644-9737)**

For acute phase treatment, see [Page 2](#)

- Monitor in current location and make arrangements for patient to transfer to a higher level of care, if clinically indicated
 - Notify ICU⁴ regarding possible transfer
 - HALs⁵ will require a transfer to another facility

¹ See [Appendix A](#) for Contact Information

² MH cart locations:

- **Main building**
 - Main OR in Pod B across OR 18 (G5.3638) (Badge access only)
 - Main IR near G3.3301A
 - G5 PACU behind the bay/room 59
 - P3.3028 (Access code only)
- **Houston Area Locations (HALs)**
 - The Woodlands PACU
 - West Houston PACU
- **Mays building**
 - ACB1.1269
 - Anesthesia storage room ACB4.2517
- **Proton Therapy Center**
 - Next to crash cart near PTCB.2075

³ Anesthesia providers may refer to the Optime Malignant Hyperthermia Intra-op Care Guidelines in OneConnect for an additional reference regarding management of patients with MH

⁴ Patients < 18 years old, contact Pediatric Intensive Care Services (PICS) at 713-745-0570 or Charge RN at 713-483-8143

If patients are 18 – 21 years old and Pediatric is the primary service, contact PICS at 713-745-0570 or Charge RN at 713-483-8143

Patients ≥ 18 years old, contact Adult Intensive Care Unit (ICU) at 713-792-1101 or ICU Triage at 281-851-0979

⁵ Call 911 to have the patient transported via EMS to nearest emergency center

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.

ACUTE PHASE TREATMENT

Cooling team member:

- Initiates cooling process **only** if patient's temperature exceeds 39°C
- Brings cold IV normal saline (NS) bags and ice
 - Packs IV NS bags in ice for infusion
 - Prepares ice packs
- **Surface cooling measures:**
 - Ice packs to body surfaces
 - Cooling blankets set temperature at 32°C, if available
- **Internal cooling measures:**
 - Nasogastric (NG) tube for stomach lavage using cold NS
 - Indwelling foley catheter for irrigation using cold NS
 - Peritoneal lavage with cold NS to cavity¹
- Continuously monitors patient's temperature
- Discontinue cooling measures when temperature < 38°C

Dantrolene Sodium (Ryanodex[®]) team member:

- Administers dantrolene sodium 2.5 mg/kg IV push
 - Reconstitute each vial by adding 5 mL of sterile water for injection (without a bacteriostatic agent), shake vial for over 10 seconds to ensure an orange-colored uniform suspension, and visually inspect the vial for particulate matter and discoloration prior to administration
- Subsequent doses of 1 mg/kg IV push can be given per Anesthesia request based upon clinical symptoms and/or lab results

Note: Cumulative doses of 10 to 30 mg/kg may be needed.

Medication team member:

- Assists with preparation and administration of **dantrolene sodium** and other medications

Ventilation team member:

- Ventilates with 100% oxygen
- Adds activated charcoal filter to the ventilation circuit

Primary nurse:

- Maintains documentation of all medications administered, procedures performed, and continued patient assessment
- Infuses cold NS intravenously
- Inserts NG tube for cold NS lavage
- Inserts foley catheter for cold NS irrigation
- Assists MH team leader
- Draws labs: ABGs, basic metabolic panel (BMP) with total calcium, creatine kinase, urine myoglobin, coagulation studies (PT/PTT/INR), and additional labs as clinically indicated

- Perform ongoing evaluation for signs and symptoms of MH (see [Page 1](#))
- Transfer patient to a higher level of care:
 - Notify ICU² regarding transfer
 - HALs³ will require a transfer to another facility
- Complete a safety intelligence (SI) report
- Report to Malignant Hyperthermia Association of the United States (MHAUS)
 - Call **MH hotline (1-800-644-9737)**
- Provide patient education regarding MH and future precautions

¹ Applicable to OR only

² Patients < 18 years old, contact Pediatric Intensive Care Services (PICS) at 713-745-0570 or Charge RN at 713-483-8143

If patients are 18 – 21 years old and Pediatric is the primary service, contact PICS at 713-745-0570 or Charge RN at 713-483-8143

Patients ≥ 18 years old, contact Adult Intensive Care Unit (ICU) at 713-792-1101 or ICU Triage at 281-851-0979

³ Call 911 to have the patient transported via EMS to nearest emergency center

Malignant Hyperthermia (MH)

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.

APPENDIX A: Contact Information

Location	Information	Contact number
Anesthesia Anesthesia control room Anesthesia airway pager ACB Anesthesia Proton Therapy Center	Monday - Friday 6:00 AM – 9:00 PM After hours 9:00 PM – 6:00 AM and weekends coverage Please contact the Anesthesiologist assigned for the day	713-792-2524 (phone) 713-404-2946 (pager) 713-834-6520 (phone) 713-792-2524 (phone) 713-563-8961 (phone)
Anesthesia HAL – The Woodlands HAL – West Houston	Please contact the Anesthesiologist assigned for the day	832-657-2505 (phone) 281-467-5328 (phone)
Main OR Pharmacy	Monday - Friday 6:00 AM – 11:30 PM After hours coverage 11:30 PM – 6:00 AM	713-794-1258 (phone) 713-404-2946 (pager)
ACB OR Pharmacy	Monday - Friday 6:00 AM – 7:00 PM For coverage between 7:00 PM – 10:00 PM call ATC Pharmacy After hours coverage 10:00 PM – 6:00 AM	713-563-8242 (phone) 713-745-1010 (phone) 713-404-2946 (pager)
The Woodlands Pharmacy	Please contact the Pharmacist assigned for the day	936-446-5034 (phone)
West Houston Pharmacy	Please contact the Pharmacist assigned for the day	281-646-4341 (phone)

Disclaimer: This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.

SUGGESTED READINGS

- Aderibigbe, T., Lang, B. H., Rosenberg, H., Chen, Q., & Li, G. (2014). Cost-effectiveness analysis of stocking dantrolene in ambulatory surgery centers for the treatment of malignant hyperthermia. *Anesthesiology: The Journal of the American Society of Anesthesiologists*, 120(6), 1333-1338. doi:1097/ALN.0000000000000257
- Glahn, K. P., Ellis, F. R., Halsall, P. J., Müller, C. R., Snoeck, M. M., Urwyler, A., & Wappler, F. (2010). Recognizing and managing a malignant hyperthermia crisis: Guidelines from the European Malignant Hyperthermia Group. *British Journal of Anaesthesia*, 105(4), 417-420. doi:10.1093/bja/aeq243
- Herlich, A. (personal communication, March 12, 2020)
- Hopkins, P. M., Rüffert, H., Snoeck, M. M., Girard, T., Glahn, K. P., Ellis, F. R., ... Urwyler, A. (2015). European Malignant Hyperthermia Group guidelines for investigation of malignant hyperthermia susceptibility. *British Journal of Anaesthesia*, 115(4), 531-539. doi:10.1093/bja/aev225
- Karlet, M.C. (1998). Malignant Hyperthermia: Considerations for Ambulatory Surgery. *Journal of PeriAnesthesia Nursing*, 13(5), 304-312. doi:10.1016/S1089-9472(98)80035-X
- Larach, M. G., Localio, A. R., Allen, G. C., Denborough, M. A., Ellis, F. R., Gronert, G. A., ... Wedel, D. J. (1994). A clinical grading scale to predict malignant hyperthermia susceptibility. *Anesthesiology*, 80(4), 771-779. doi:10.1097/00000542-199404000-00008
- Malignant Hyperthermia Association of the United States. (2020). *Healthcare professionals*. Retrieved from <https://www.mhaus.org/healthcare-professionals/>
- Redmond, M. C. (2001). Malignant Hyperthermia: Perianesthesia Recognition, Treatment, and Care. *Journal of PeriAnesthesia Nursing*, 16(4), 259-270. doi:10.1053/jpan.2001.25566
- Rosenberg, H., Pollock, N., Schiemann, A., Bulger, T., & Stowell, K. (2015). Malignant Hyperthermia: A review. *Orphanet Journal of Rare Diseases*, 10(1), 93. doi:10.1186/s13023-015-0310-1

Disclaimer: *This algorithm has been developed for MD Anderson using a multidisciplinary approach considering circumstances particular to MD Anderson's specific patient population, services and structure, and clinical information. This is not intended to replace the independent medical or professional judgment of physicians or other health care providers in the context of individual clinical circumstances to determine a patient's care. This algorithm should not be used to treat pregnant women.*

DEVELOPMENT CREDITS

This practice consensus algorithm is based on majority expert opinion of Malignant Hyperthermia work group at the University of Texas MD Anderson Cancer Center for the patient population. These experts include:

Raina Balthazar, MSN, RN (Nursing Education)
Jermeca Branch, MSN, RN (Nursing Education)
Jessica K. Brown, MD (Anesthesiology & PeriOper Med)
Garry Brydges, DNP, CRNA (Anesthesiology)[‡]
Jeff Bruno, PharmD (Pharmacy - Clinical)[‡]
Karen Chen, MD (Critical Care & Respiratory Care)
Mary Ann Del Rosario, MSN, RN, CAPA (Nursing Post Anesthesia)
M. Chris Diaz, MSN, RN (Nursing Education)[‡]
Staci Eguia, MSN, RN (Nursing Post Anesthesia)[‡]
Olga N. Fleckenstein[♦]
Stefani Gautreaux, PharmD (Pharmacy Inpatient)
Harjeet Kaur, MSN, RN, CNL, CMQ[♦]
Thoa Kazantsev, MSN, RN, OCN[♦]
Cori Kopecky, MSN, RN (Nursing)
Piotr A. Kwater, MD (Anesthesiology & PeriOper Med)
Lorraine S. Layton, BSN, RN (Nursing ICU)
Maria F. Ramirez Manotas, MD (Anesthesiology & PeriOper Med)

M. Estela Mireles, PharmD (Pharmacy - Clinical)
Julie P. Nguyen, PharmD (Pharmacy – The Woodlands)
Soo Ok, MSN, RN (Nursing Post Anesthesia)
Karen Plexman, MSN, RN (Nursing ICU)[‡]
Kimberly A. Potts, MSN, RN, CNOR (Nursing Post Anesthesia)
Elsy Puthenparampil, DNP, RN (Nursing Post Anesthesia)
Jenise Rice, MSN, RN (Nursing Perioperative)
Leonard H. Roes III, PharmD (Pharmacy Inpatient)
Maritza Salazar-Abshire, M.Ed, RN (Nursing Education)
Kenneth Sapire, MD (Anesthesiology & Perioperative Medicine)[‡]
Ali-Reza Shah-Mohammadi, PharmD (Pharmacy – Quality & Regulatory)
Mark Templonuevo, BA, BS, RN (Nursing Post Anesthesia)
Armond C. Trimier, PharmD (Pharmacy – West Houston)
Katelyn Welch, MSN, RN (Nursing Perioperative)
Clint Westaway, MSN, APN (Anesthesiology)[‡]
Uduak Ursula Williams, MD (Anesthesiology & Perioperative Medicine)
Acsa Zavala, MD (Anesthesiology & Perioperative Medicine)

[‡] Core Development Team Leads

[♦] Clinical Effectiveness Development Team