

# Management of Emergency Cases in the OR: Identifying & Treating Malignant Hyperthermia

*Karol A Gutowski, MD, FACS*

# Learning Objectives

- Understand pathophysiology of MH
- Identify patients at risk for MH
- Recognize onset of MH
- Know treatment & stabilization of acute MH
- Incorporate MH awareness & treatment plans in your surgical facility

# Malignant Hyperthermia

- Inherited myopathy
- Hypermetabolic reaction/crisis to certain volatile anesthetic gases & succinylcholine
- Worldwide attention after published series of anesthetic deaths in a family (1960)

# Malignant Hyperthermia

- MH *susceptibility*
  - 1 in 200 in certain populations
- MH incidence during anesthesia encounters
  - Between 1 in 5000 and 1 in 50,000 to 100,000
  - More common in males & children
- Mortality
  - 70% in 1960, now <5%
  - Accurate diagnosis, timely recognition, treatment

# MH Genetics

Inherited skeletal muscle disorder

- Autosomal dominant with variable penetrance
- Ryanodine receptor type 1 gene (*RYR1*)
  - >100 associated mutations identified
  - Present in >50% of MH susceptible patients
    - Almost all families with central core disease
- Mutation at 1S subunit of dihydropyridine receptor
  - <1% of MH susceptible families worldwide



# Agents that Trigger MH

- Halothane (most potent)
- Enflurane
- Isoflurane
- Desflurane\*
- Sevoflurane\*

\* Less potent, gradual MH onset

- Succinylcholine (explosive MH onset)



# Other Triggering Agents

- d-Tubocurarine\*
- Ether derivatives and chloroform
- Rapid intravenous  $K^+$
- Theophylline, aminophyllin, phosphodiesterase inhibitors in supertherapeutic doses

# Safe Non-Triggering Agents

- Anticholinergics
- Anticholinesterases
- Barbiturates (e.g., thiopental)
- **Benzodiazepines**
- Droperidol
- Etomidate
- **Ketamine**
- **Local anesthetics**
- Narcotics
- Nitrous oxide
- Nondepolarizing muscle relaxants
  - Vecuronium
  - Rocuronium
  - Pancuronium
  - Atracurium
  - Mivacurium
  - Cisatracurium
- NSAIDS
- **Propofol**
- **IV Anesthetics**

## **Use with care**

- Haloperidol
- Catecholamines
  - May cause secondary sympathetic response (not a trigger)
- Phenothiazines (e.g., chlorpromazine, prochlorperazine)
  - May cause neuroleptic malignant syndrome (confused with MH)



# Non-Triggering Agents Triggering MH

MH can be triggered in < 1% of MH susceptible patients by “non-triggering” agents

***Keep MH diagnosis in mind in any case with clinical presentation***

# Patient Evaluation

- MH susceptible patients may undergo anesthesia several times before a clinical episode occurs
- Preop questions:
  - Family history of adverse outcomes after general anesthesia
  - Conditions that predispose to true MH
    - Evans myopathy, King-Denborough syndrome, central core disease
- Patients with MH in 1<sup>st</sup> degree relatives are considered MH susceptible until proven otherwise
  - Must not receive triggering agents
  - Counseled and referred for evaluation

# Musculoskeletal Disorders

- Duchenne muscular dystrophy
  - Risk life-threatening hyperkalemia with succinylcholine
  - Do not exhibit classic signs of malignant hyperthermia
- Patients with any form of myotonia should not receive succinylcholine
- No triggering agents for patients with:
  - Hypokalemic periodic paralysis
  - Central core disease
  - Multi-minicore disease (*RYR1-related* forms)
  - Duchenne or Becker muscular dystrophy
  - Paramyotonia
  - Myotonia fluctuans

# Associated with MH?

## Heat Stroke

- Anecdotal reports of MH and death from heat stroke
- Many anesthesiologists believe a patient with history of heat stroke & rhabdomyolysis should be considered susceptible to MH

## Exercise-related Rhabdomyolysis

- Some patients with exercise-induced rhabdomyolysis developed MH-like clinical syndrome and were found to be susceptible to MH on biopsy testing and genotyping
- Many anesthesiologists consider patients with exercise-induced rhabdomyolysis to be susceptible to MH

## Neuroleptic Malignant Syndrome (NMS)

- Many of the same manifestations as MH
- Triggered by neuroleptic antipsychotics
- Many features similar to MH but no definitive association
- Most anesthesiologists do not consider patients with NMS to be susceptible to MH

# MH Susceptibility Testing

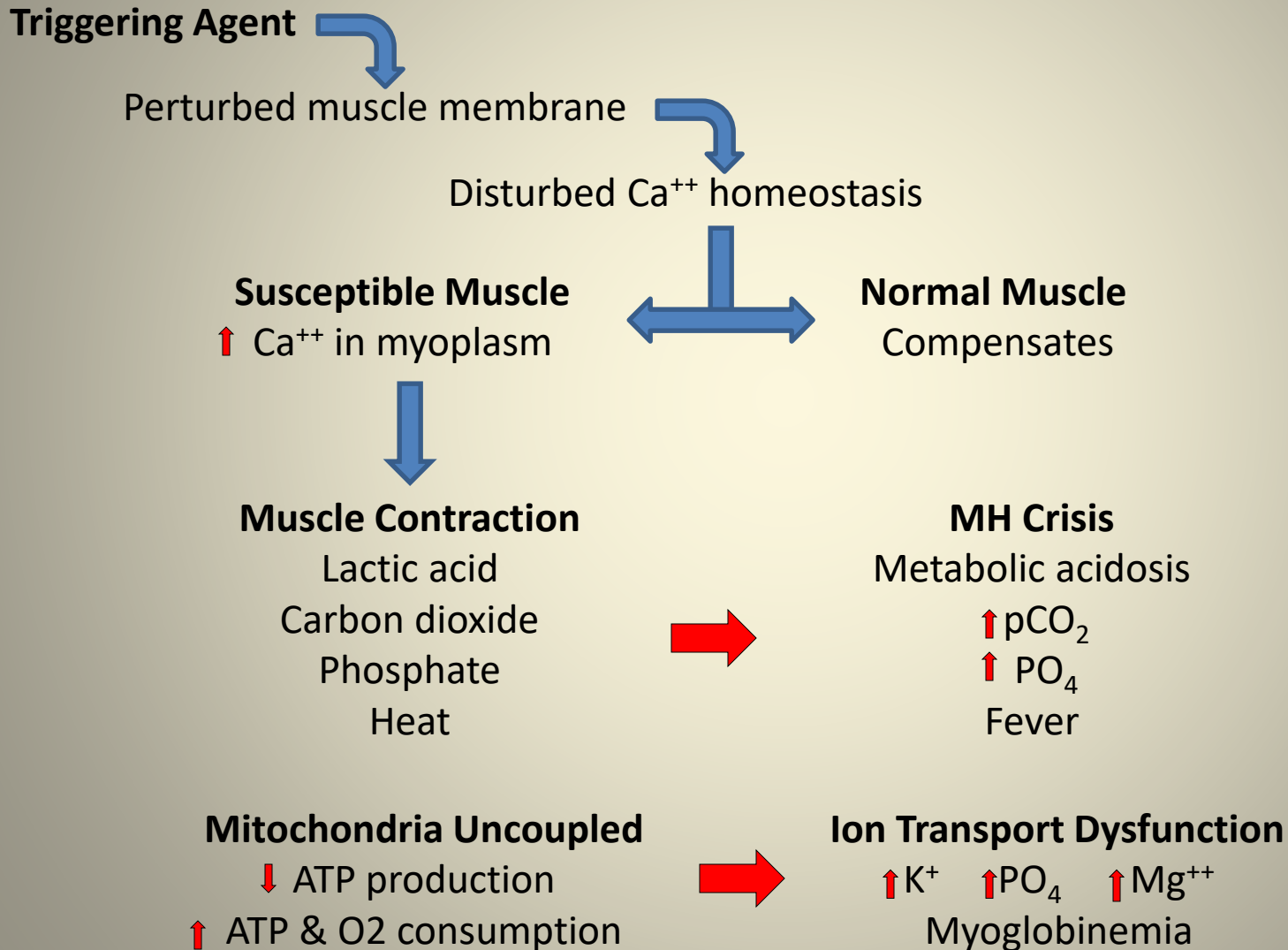
- Caffeine-halothane contracture test
  - Requires muscle biopsy
  - Done at specialized centers (8 in US)
- Genetic testing
  - RYR1 mutation screen
  - High specificity
  - Low sensitivity
    - Negative test requires caffeine-halothane contracture test



# MH Susceptible Patients

- Minor procedures
  - Simple excisional surgery with topical or local anesthesia in the office or ambulatory surgical center
  - No evidence that local anesthetics, vasoconstrictors, or patient anxiety increase the chance of a MH reaction in this setting
- Complex procedures
  - Minimal or moderate IV or IM sedation/analgesia
  - General anesthesia
  - Major conduction blockade
  - ***Refer to an accredited ASC or hospital***

# Cascade of MH



# MH Presentation

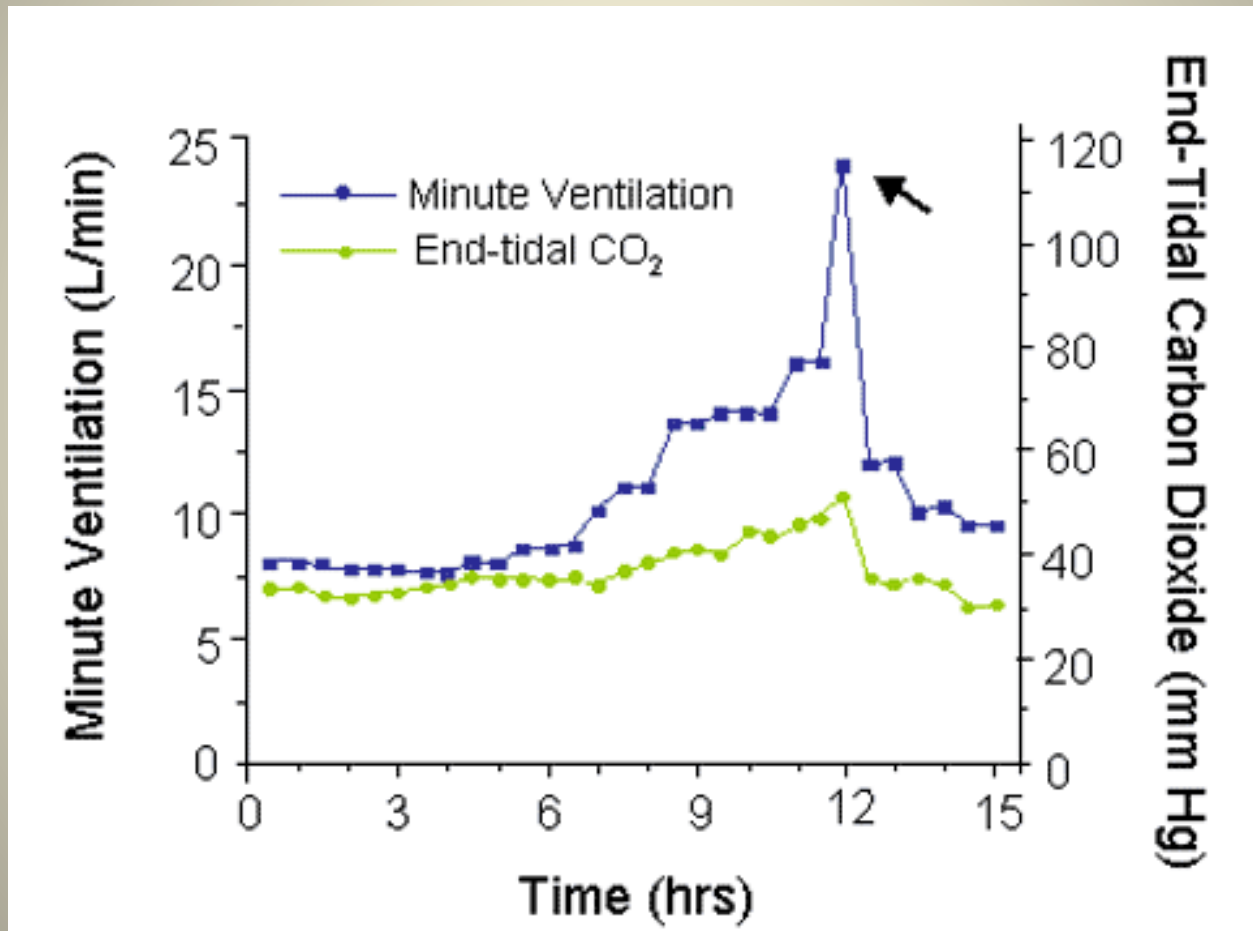
## Clinical

- Tachycardia
- Markedly increased minute ventilation (when breathing spontaneously)
- **Muscle rigidity**
- Skin mottling
- **Hyperthermia (late sign)**
  - Increase 1° to 2° C every 5 min
- Cola-colored urine
- Disseminated intravascular coagulation

## Laboratory

- Increased end-tidal CO<sub>2</sub> and increased PaCO<sub>2</sub>
- Decreased pH (metabolic and respiratory acidosis)
- Decreased PaO<sub>2</sub>
- Hyperkalemia (PVC, VT, VF)
- Increased CK
- Myoglobin in blood or urine
- Abnormal coagulation tests
- Increased plasma lactate level

# Increased Minute Ventilation vs pCO<sub>2</sub>



# Masseter Muscle Rigidity (MMR)

- Inability to open mouth after receiving a triggering agent
- 1% of children after succinylcholine + inhalation agent
- Usually can provide bag-mask ventilation
- Normal effect of succinylcholine is to increase masseter muscle tension above baseline
  - Significant MMR signals MH in up to 30% of cases
- If MMR is observed
  - Stop all triggering agents
  - Cancel surgery if possible
  - Observation for MH





# Aborted or Subclinical MH

- Nonspecific hypermetabolism after inhalational anesthetic
- Postoperative muscle pain, myoglobinuria, or elevated  $K^+$  or CK
- Hospital observation for MH
  - Serial CK &  $K^+$
  - ABG if increased minute ventilation (mixed metabolic and respiratory acidosis)

# Differential Diagnosis

- Anticholinergic syndrome
- Extrapyrarnidal syndrome
- Serotonin syndrome
- Neuroleptic malignant syndrome
- Contrast induced neurotoxicity
- Pheochromocytoma
- Thyrotoxicosis
- Drug withdrawal
- Drug toxicity
- Iatrogenic overheating
- Hypoventilation
- Heat stroke
- Sepsis
- Hypoxic encephalopathy
- Intracranial hemorrhage
- Brain injury
- Meningitis
- Faulty equipment

# What to do if you Suspect MH

- Call for help
- Discontinue volatile agents & succinylcholine
- Get MH cart & Dantrolene
- Notify OR team that you suspect MH
- Finish procedure as fast as possible
  - If surgery must continue use nontriggering anesthetic
  - Propofol + opioid
- Hyperventilate with 100% O<sub>2</sub> at >10 L/min to remove excess CO<sub>2</sub>
- Obtain core temperature

# What to do if you Suspect MH

- Administer Dantrolene
- Repeat until the end-tidal CO<sub>2</sub> begins to decline
  - Doses > 10 mg/kg may be necessary
  - If a dramatic response does not occur within minutes consider alternative diagnoses
- Ensure adequate IV access
  - Consider central line placement
- Insert an arterial line & urinary bladder catheter
- Call 1-800-MH-HYPER for management assistance
- ICU admission or transfer



# Have Treatment Plan Available

MH Hotline  
1-800-644-9737  
Outside the US:  
1-315-464-7079

## EMERGENCY THERAPY FOR MALIGNANT HYPERTHERMIA

### DIAGNOSIS

<p><b>Signs of MH:</b></p> <ul style="list-style-type: none"> <li>•Increased ETCO<sub>2</sub></li> <li>•Trunk or total body rigidity</li> <li>•Masseter spasm or trismus</li> <li>•Tachycardia/tachypnea</li> <li>•Acidosis</li> <li>•Increased temperature (may be late sign)</li> </ul>	<p><b>Sudden/Unexpected Cardiac Arrest in Young Patients</b></p> <ul style="list-style-type: none"> <li>•Presume hyperkalemia and initiate treatment (see #6)</li> <li>•Measure CK, myoglobin, ABGs, until normalized</li> <li>•Consider dantrolene</li> <li>•Usually secondary to occult myopathy (e.g., muscular dystrophy)</li> <li>•Resuscitation may be difficult and prolonged</li> </ul>	<p><b>Trismus or Masseter Spasm with Succinylcholine</b></p> <ul style="list-style-type: none"> <li>•Early sign of MH in many patients</li> <li>•If limb muscle rigidity, begin treatment with dantrolene</li> <li>•For emergent procedures, continue with non-triggering agents; consider dantrolene</li> <li>•Follow CK and urine myoglobin for 36 hours at least. Check CK immediately and at 6-hour intervals until returning to normal. Observe for dark colored urine. If present, test for myoglobin.</li> <li>•Observe in PACU or ICU for at least 12 hours</li> </ul>
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### ACUTE PHASE TREATMENT

**GET HELP, GET DANTROLENE – Notify Surgeon.**

- Dantrolene volatile agents and succinylcholine.
- Hyperventilate with 100% oxygen at flows of 10 L/min, or more, until the procedure is over as soon as possible if emergent use not triggered.

*(The most potent anesthetic agent should be changed.)*

**Dantrolene 2.5mg/kg rapidly IV through large-bore IV, if possible**

1 mg/10.2 mL ampoule contains 1 mg/10.2 mL

- Stop until there is control of the signs of MH.
- Sometimes more than 10 mg/kg (up to 30 mg/kg) is necessary.
- Dissolve the 20 mg in each vial with at least 60 ml sterile preservative-free water for injection. Pre-warming (not to exceed 38°C) the sterile water will speed solubilization of dantrolene.

*(The crystals also contain NaOH for a pH of 9; each 20 mg vial has 3 gm minimal for isotonicity.)*

- 1 Bicarbonate** for metabolic acidosis.
  - 1.2 mEq/kg if blood gas values are not yet available.
- 2 Cool** the patient with core temperature >39°C. Lavage open body cavities, stomach, bladder, or rectum. Apply ice to surface. Infuse cold saline intravenously. Stop cooling if temp. <38°C and falling to prevent drift <35°C.
- 3 Dysrhythmias** usually respond to treatment of acidosis and hyperkalemia.
  - Use standard drug therapy except calcium channel blockers, which may cause hyperkalemia or cardiac arrest in the presence of dantrolene.
- 4 Hyperkalemia:** Treat with hyperventilation, bicarbonate, glucose/insulin, calcium.

- Bicarbonate 1-2 mEq/kg IV.
- For **pediatric**, 0.3 units insulin/kg and 1 mL/kg 50% glucose or for **adult**, 50 units regular insulin IV and 50 mL 50% glucose.
- Calcium chloride 10 mg/kg or calcium gluconate 10-50 mg/kg for life-threatening hyperkalemia.
- Check glucose levels hourly.

**5 Saline** ETCO<sub>2</sub>, electrolytes, blood gases, CK, core temperature, urine output and color, coagulation studies. If CK and/or E<sub>a</sub> rise more than transiently or urine output falls to less than 0.5 mL/kg/hr, induce diuresis to >1 mL/kg/hr urine to avoid myoglobinuria-induced renal failure.

- Arterial blood gas (pH, arterial/venous) values may document hypermetabolism better than arterial values.
- Central venous or PA monitoring as needed and record minute ventilation.
- Place Foley catheter and monitor urine output.

### POST ACUTE PHASE

- 1 Observe** the patient in an ICU for at least 24 hours, due to the risk of re-occurrence.
- 2 Dantrolene** 1 mg/kg q 6 hours or 20 mg/kg in 24 hours for at least 20 hours. Further doses may be indicated.
- 3 Follow** lab and clinical data per #5.
  - Hypoglycemia
  - CK every 6 hours
- 4 Follow** urine myoglobin and creatinine levels to prevent myoglobinuria precipitate. Also renal failure and the subsequent development of acute renal failure. Administered intravenous calcium therapy for acute hyperkalemia and myoglobinuria (after response to 100-150 mL administration of urine with bicarbonate) indicates with careful attention to both urine and serum potassium, etc.)
- 5 Counsel** the patient and family regarding MH and further precautions. Refer either to the NIOSH, FDA and/or local or the National Malignant Hyperthermia Association (MHSA), for more information and send a letter to the patient and family explaining what further to do in the nearest Sleep Center for follow-up.


**Non-Emergency Information**

**1-800-644-9737**  
 77 Sun Lane Drive  
 PO Box 1000  
 Cortland, NY 13840-1000

**Hours:**  
 1,800,644,9737  
 M-F 9:00-5:00  
 Sa 9:00-5:00

**Web:**  
[www.mhonline.org](http://www.mhonline.org)

**Mail:**  
 Malignant Hyperthermia Association  
 1000 Main Street  
 Cortland, NY 13840



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

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# MH Cart



+ Ice Machine

# Manage Hyperthermia

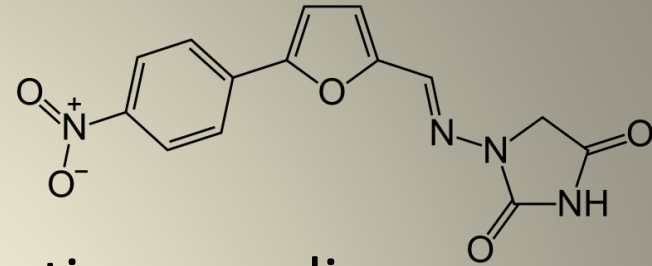
- **Cooling Measures to Lower Core < 38°C**
- Lower OR temperature
- Discontinue patient warming measures
- Place ice packs around patient
- Administer iced saline lavage by NG tube
- Irrigate surgical site with iced saline

# Laboratory Studies

- Electrolytes
- Coagulation studies
- Complete blood count
- Creatine kinase
- Myoglobin
- Lactate
- Urinalysis
  - If heme positive, confirm probable myoglobinuria by absence of red blood cells on microscopic examination
- Urine myoglobin



# Dantrolene



- Binds to ryanodine receptor
  - Depresses muscle excitation-contraction coupling
  - Decreasing intracellular calcium concentration
- May interact with  $\text{Ca}^{++}$  channel blockers (diltiazem/verapamil)
  - Cardiovascular collapse, arrhythmias, hyperkalemia
- Dissolve the 20 mg dantrolene in each vial with 60 mL warmed, sterile, preservative-free water
- One vial of dantrolene contains 3 g of mannitol



# Dantrolene

- Initial dose 2.5 mg/kg IV push (up to 10 mg/kg)
- If no response to 20 mg/kg consider other diagnosis
- Once the initial signs have resolved
  - Start at 1 mg/kg
  - Titrate to clinical signs of hypermetabolism
  - Continue every 6 hrs x 36 hrs
  - Alternative: Infusion (0.1-0.3 mg/kg/hour)



# MH Drugs to Stock in OR Suite

- Dantrolene (36 vials) + sterile nonbacteriostatic water
- Glucose + insulin + calcium
  - Treat hyperkalemia
- Bicarbonate
  - Treat metabolic acidosis
- Diuretic (Furosemide)
  - Maintain urinary output
- Antiarrhythmics

# Treat MH Complications


- Metabolic acidosis
  - Bicarbonate
- Hyperkalemia
  - Hyperventilation
  - Glucose + insulin +  $\text{Ca}^{++}$
- Ventricular arrhythmias
  - Usually respond to treatment of acidosis & hyperkalemia
  - ACLS protocols **except calcium channel blockers**
  - Cardiopulmonary bypass as last resort
- Rhabdomyolysis
  - Furosemide + bicarbonate



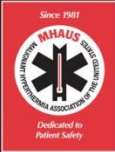
# Annual MH Mock Drill



# Have a Transfer of Care Plan



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## Transfer Plans for Suspected MH Patients

### Guidance for Ambulatory Surgical Centers (ASCs) with Regard to the Development of Emergent Malignant Hyperthermia (MH) Transfer Plans for Suspected MH Patients

The following diagram and accompanying text represent guidelines issued by the Ambulatory Surgery Foundation, affiliated with the Ambulatory Surgical Center Association (ASC Association), and the Malignant Hyperthermia Association of the United States (MHALS) to be utilized in the development of an Emergent MH Transfer Plan for suspected MH patients at ambulatory surgery centers (ASCs). These guidelines are intended to assist each ASC through the development of its own individualized Emergent MH Transfer Plan taking into account the resources and capabilities available to each ASC. It is advisable for each ASC to enter into a transfer agreement with a receiving facility that meets state, federal and accreditation requirements.

Due to the variety of state laws and the composition of emergency transport teams, it is not possible to recommend a specific protocol that will serve the transport needs of all ASCs across the country. Therefore, a listing of potential clinical associated problems and therapeutic intervention capabilities for consideration will be noted versus dictation of a specific transport protocol. The specific characteristics of each patient encounter and accompanying patient care needs may dictate alternative care, transport, or choice of healthcare receiving facility, as determined by the treating clinician.

**1**

**Recognition of Suspected MH**

- Use MHALS "Emergency Therapy for MH" protocol poster criteria (see [www.mhous.org](http://www.mhous.org)) or the following clinical signs: elevated ETCO<sub>2</sub>, muscle rigidity, hyperthermia, acidemia/acidosis, myoglobinuria on exposure to triggering agents.
- Trained anesthesia providers must be available on site for any ASC that uses triggering agents so that the providers may serve as primary consultants for the recognition and treatment of MH.
- **Call the MHALS MH Hotline 1-800-MH-HYPER (644-9737)** for additional assistance from MH experts 24 hours-a-day, 365 days per year. **001-315-464-7079 (for calls outside North America)**
- 36 vials of dantrolene sodium for injection must be available wherever MH trigger agents are used.

**2**

**Discontinuation of Triggering Agents, Initiation of Treatment**

IV dantrolene 2.5 mg/kg (dissolved with sterile preservative-free water for injection) should be given immediately when a presumptive diagnosis of MH is made and MHALS "Emergency Therapy for MH" protocol (see [www.mhous.org](http://www.mhous.org)) should be initiated pending transfer.

**3**

**Initiate Emergent Malignant Hyperthermia Transfer Plan**

**4**

**Review Transfer Considerations and Capabilities**

Receiving Health Care Facility (RHCF) Considerations and Capabilities	Clinical Information/Best Interests of the Patient	Transport Team (TT) Considerations and Capabilities
<ul style="list-style-type: none"> <li>• Existing transfer agreements</li> <li>• Inpatient capabilities: These should include pediatric or adult critical care, continuous temperature and cardiopulmonary monitoring, administration of therapeutic options, including (but not limited to) non-invasive/invasive cooling, continuous sedation, and antidote therapy (dantrolene by bolus and maintenance therapy with at least 36 vials available for crisis treatment), dantrolene treatment, and hemodialysis.</li> <li>• Possible consultant availabilities may include Anesthesia, Critical Care, Hematology, Surgery, Nephrology, Neurology, and Medical Toxicology.</li> </ul>	<ul style="list-style-type: none"> <li>• Report data should include: cardiovascular signs; temperature and site; minute ventilation with end tidal CO<sub>2</sub>; electrolytes (if available); IV site; amount of dantrolene administered and response; presence or absence of muscle rigidity; presence of urinary catheter and color of urine.</li> <li>• If possible, the patient should be moved when, according to the clinician's judgment, the patient is stable.*</li> </ul> <p><i>*Some key indicators of stability</i></p> <ul style="list-style-type: none"> <li>• ETCO<sub>2</sub> is declining or normal</li> <li>• Heart rate is stable or decreasing with no signs of ominous dysrhythmias</li> <li>• IV dantrolene administration has begun</li> <li>• Temperature is declining</li> <li>• If present, generalized muscular rigidity is resolving</li> </ul>	<ul style="list-style-type: none"> <li>• Transport services may include ground or air, dependent on clinical scenario and transport time.</li> <li>• When possible, it is desirable that the transport team have the following capabilities: ventilatory support; cardio-pulmonary and temperature monitoring; fluid resuscitation; medication administration that include(s), but is not limited to, IV dantrolene, non-depolarizing muscle relaxants, sedatives/hypnotics, analgesics/opioids, medications to treat hyperkalemia and provide life-support. This may sometimes require participation of the ASC anesthesia staff.</li> <li>• Capabilities of phone communication with command center and/or MH Hotline.</li> </ul>

**5**


**Implement Transfer Decision**

- Decisions regarding timing of transfer and choice of TT and RHCF should be made by the health care professional on-site at the ASC.
- Transport time, bed availability, and clinical stability may guide disposition.
- Do not delay transfer pending specific personnel or equipment if, in the judgment of on-site professionals, emergent transfer is mandatory.

**6**

**Notification of Receiving Health Care Facility (RHCF): Coordination of Communication**

- Direct personal communication is strongly recommended between
  - Anesthesia Care Provider (and/or other Health Care Professional in consultation with the anesthesia professional on-site) at ASC
  - AND
  - Physicians, e.g., Critical Care, Primary or Emergency Medicine Physician or Anesthesiologist accepting care at the RHCF.
- Physician to physician coordination of admission location depending on acute crisis management and anticipated post-resuscitation needs is essential.



ASF and the Foundation have developed these guidelines using general consensus methods and regional experts in the field. These guidelines are for reference, guidance, and educational purposes only. Implementation at a facility must be done in accordance with applicable laws and regulations. ACSH should consult the standards based on unique site medical programs, hospital affiliations, the physician, and ACSH Association needs. It is recommended that all participating facilities have a written transfer agreement in place. The document will be available on the website. Reproduction or distribution of this document in any form without the written consent of ASF and the Foundation is prohibited. Copyright 2011 ASF and Ambulatory Surgery Foundation. All rights reserved.



# Common MH Questions

**Are MH susceptible patients candidates for outpatient surgery?**

Yes, if non-triggering anesthetics are used



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**Should MH susceptible patients be pretreated with dantrolene?**

Prophylaxis is not recommended for most MH-susceptible patients

Use non-triggering anesthetics

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Yes, if non-triggering anesthetics are used

**Should MH susceptible patients be pretreated with dantrolene?**

Prophylaxis is not recommended for most MH-susceptible patients

Use non-triggering anesthetics

**How should an anesthesia machine be prepared for an MHS patient?**

Disable vaporizers

Flow 10L/min O<sub>2</sub> through circuit for at least 20 minutes.

Use a new breathing circuit.

Newer anesthesia machines may require up to 60 minutes of preparation

# Common MH Questions

**How long should MHS patients be monitored after uneventful anesthesia?**

May be discharged on the day of surgery

Minimum 1 hour in PACU

Additional hour in phase 2 PACU /step down unit

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## How long should MHS patients be monitored after uneventful anesthesia?

May be discharged on the day of surgery

Minimum 1 hour in PACU

Additional hour in phase 2 PACU /step down unit

## When should a MH susceptible patient be discharged after masseter spasm?

A patient with marked rigidity should **not** be discharged.

Overnight observation for temperature rise, myoglobinuria, elevated CK levels or progression to MH

# Malignant Hyperthermia Association of the United States



Malignant Hyperthermia Association of the United States



FOR PATIENTS



FOR MEDICAL PROFESSIONALS



ABOUT MHAUS



MH REGISTRY



NMSIS WEBSITE



PLACE ORDER

## Welcome



### Malignant Hyperthermia (MH): Did you know...?

Start your visit with this short video overview of the disorder called "malignant hyperthermia" and the history of the MHAUS organization.

Whether you are a patient or a medical professional, MH resources are here for you. Contact us directly if you have any additional questions you need help with, or if you want to talk to the MHAUS administrative office staff about a specific need or concern.

We are here to help!

Management of Malignant Hyperthermia (MH) crises requires various supportive measures individualized for the patient's condition. Administration of Dantrium® IV is one component of therapy and should not be considered a substitute for these measures. Even when properly treated, an MH crisis can result in death. Adverse events with Dantrium® IV include loss of grip strength, weakness in the legs, drowsiness, dizziness, thrombocytopenia, and tissue necrosis/injection site reactions secondary to extravasation. There have been rare reports of pulmonary edema, urticaria and erythema. Please see full prescribing information for Dantrium® IV at [www.dantrium-iv.com](http://www.dantrium-iv.com).

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[www.dantrium.com](http://www.dantrium.com)

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# More Information

## PATIENT SAFETY

### Outcomes Article

## Evidence-Based Patient Safety Advisory: Malignant Hyperthermia

Raffi Gurunluoglu, M.D.,  
Ph.D.  
Jennifer A. Swanson, B.S.,  
M.Ed.  
Phillip C. Haeck, M.D.  
and the ASPS Patient Safety  
Committee  
*Denver, Colo.; and Arlington Heights, Ill.*

**Summary:** As more and more routine plastic surgery procedures move from the hospital to outpatient surgery facilities, plastic surgeons must be aware of the risk factors for life-threatening events that might occur in this setting. This awareness includes recognition of the signs and symptoms and the management of a rare but life-threatening condition, malignant hyperthermia. This article reviews the current understanding of the concepts pertinent to malignant hyperthermia diagnosis and treatment in the outpatient setting and current standards and recommendations for physicians and support personnel regarding malignant hyperthermia preparedness in office-based surgery and anesthesia. (*Plast. Reconstr. Surg.* 124 (Suppl.): 68S, 2009.)

For a copy of this presentation or article pdf file,  
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