



# Malignant Hyperthermia

## It Happened to Us.

### What if It Happened at Your ASC?

**I**n 2001, a young, healthy male underwent surgery at the Peachtree Orthopaedic Surgery Center in Atlanta, Georgia, and moved into the ASC's recovery room in good condition. Fifteen minutes later he was non-responsive to verbal requests and painful stimuli. When the anesthesiologist came to the bedside to evaluate the patient, she announced "Initiate malignant hyperthermia (MH) protocol," and staff sprang into action. While the ASC was able to report a successful patient outcome in this case, its post-review of this event indicated several improvements the ASC has since introduced to enhance its staff's ability to respond if another MH crisis should ever occur.

#### About MH

MH is an inherited disorder that affects calcium regulation within the muscle cells. It was first identified in 1960 but occurs so rarely that the ASC's anesthesiologist had not encountered an actual case in 15 years of practice. Despite its rarity, untreated MH can rapidly result in patient death.

MH is triggered by the administration of the injectable drug succinylcholine or any of the volatile inhalation anesthetic agents that could be used during surgery, including sevoflurane, desflurane, isoflurane, and halothane. MH is typically characterized by

- elevated CO<sub>2</sub> production, often two to three times the normal rate
- unexpected tachycardia, tachypnea, jaw muscle rigidity
- body rigidity (not always present)
- both respiratory and metabolic acidosis (therefore, arterial blood gases [ABG] are a useful early test, notes Strick)
- elevated temperature that can exceed 110° Fahrenheit

The information in this article is based on one ASC's experience managing an MH crisis. This article is not a substitute for comprehensive medical training and advice and does not establish a clinical standard. The information presented does not represent FASA policy or opinion in any way.

This article is based on a presentation made at FASA 2006 by Cheryl Fielder, RN, administrator of the Peachtree Orthopaedic Surgery Center, and David Strick, MD, an anesthesiologist with Georgia Perioperative Consultants, LLC, and director of anesthesiology at the Peachtree Orthopaedic Surgery Center at that time.

**An important note:** An elevated temperature is typically a late sign of MH that indicates the patient faces significant risk. As a result, Fielder, Strick and others with experience managing MH recommend that an ASC should not wait for an elevated temperature to present before diagnosing MH and instituting its MH protocol.

MH typically occurs intra-operatively but can occur as late as 4 to 12 hours postoperatively. In addition, a patient can have several surgeries without complications and then, suddenly, experience MH in conjunction with a surgical procedure. The rate at which a patient's temperature rises during an MH crisis varies with each patient.

Response to an MH crisis, say Fielder and Strick, should include the following:

- issue an immediate call for help
- discontinue inhalation anesthetic
- discontinue succinylcholine
- hyperventilate with 100% oxygen
- administer dantrolene sodium, beginning with 2.5 mg/kg of body weight
- treat respiratory and metabolic acidosis
- institute body cooling measures attempting to bring the body temperature to 38° Centigrade; use cold intravenous normal saline, ice packs and cold body lavage (nasogastric/rectal)

- monitor urine output and attempt to keep the urine output elevated to 2 ml/kg/hr using fluid and diuretics
- obtain ABGs, electrolytes, calcium, coagulation studies and creatine phosphokinase (CPK)
- refrain from using calcium channel blockers
- treat hyperkalemia/dysrhythmia
- admit to intensive care unit for at least 24 hours

### **Determining Risk**

Fewer than 10 health care facilities in the US are capable of performing the muscle biopsy test that is considered the "gold standard" for determining whether or not a patient is likely to experience MH. Some patients who are aware of the test and consider taking it eventually elect not to take it since it requires the extraction of tissue from the patient's thigh muscle.

Given the low incidence of MH in the general population and the limited number of testing centers that offer reliable testing for MH, most of an ASC's patients are not likely to have undergone this test. Still, according to Fielder and Strick, an ASC may want to ask all of its patients if they have had the test and attempt to identify at-risk patients by questioning them preoperatively about their past surgical experiences and their relatives who are known to have or

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whose past surgical experiences indicate they may have MH. For example, asking patients whether or not they have a relative who suddenly developed severe complications during or immediately after surgery and whether or not any of their relatives ever died for no apparent reason either during or immediately after surgery could help ASC staff determine a patient's risk of having MH.

### Life-Saving Strategies

According to Fielder and Strick, to be able to respond to an MH crisis, every ASC should have 36 vials of dantrolene sodium on hand at all times, an amount that would enable a 70 kg patient to receive 4 doses of the drug. Dosage recommendations are available from the MH hotline (1.800.644.9737 or 1.800.MH HYPHER), a service provided by the Malignant Hyperthermia Association of the United States (MHAUS). The hotline gives medical professionals access to physicians who specialize in MH crises treatment 24 hours a day, 365 days per year. The association also has numerous educational and training resources available that can help an ASC prepare for an MH crisis. To learn more, go to [www.mhaus.org](http://www.mhaus.org).

Based on their experience providing care to a patient with MH in an ASC, Fielder and Strick recommend the following:

1. When MH is diagnosed, take action immediately! Don't wait for MH to go away because it won't. Organize everything at your ASC to be able to respond as quickly as possible.
2. Maintain a written treatment plan.
3. Make certain your staff has been trained to respond to MH. Renew that training at least annually and, preferably, quarterly.
4. Dantrolene sodium, which must be administered during MH, is a difficult drug to mix. If your ASC's supply expires, use the out-of-date supply in a hands-on training session for your staff to give them the experience they will need to be able to respond as quickly as possible in a crisis. Mixing the drug in an assembly-line or "bucket-brigade" fashion where several people each take responsibility for just one small step in the process will take less time than expecting one or two people to take responsibility for all of the steps on their own.
5. To help you quickly determine the correct dosage of dantrolene sodium your patient will need—a determination made based on the patient's body weight—keep a pounds to kilograms conversion chart in your MH cart.
6. During an MH crisis, assign a team leader to delegate duties to all responders. Specific responsibilities that need to be assigned are
  - airway
  - IV access
  - dantrolene sodium
  - ice
  - Foley catheter (intake and output)
  - drugs
  - recorder
  - runner
7. Designate a member of your team to record each dose of dantrolene sodium as it is being administered.
8. Make certain your MH cart is sturdy, spacious enough to hold all of your MH supplies and convenient to use. For example, make certain the cart won't tip over if all of its drawers are open at the same time and make certain you can see inside all of the drawers at the same time when they are all open.
9. Obtain an MHAUS poster that shows how to administer emergency therapy for MH. Affix it to the top of your MH cart. Visit the MHAUS web site to determine what other resources MHAUS offers would be useful for your ASC.
10. Make certain your MH cart is fully stocked at all times. Lock it whenever it is not in use so that the supplies the cart contains are not borrowed for other uses. The supplies the cart should contain are:

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- dantrolene sodium kits, which include 1,000 cc sterile water for injection, a 60 cc Luer-Lok syringe, a 3-way stopcock and a fluid path
- needles
- syringes
- IV catheters
- IV tubing
- blood collection tubes and sets
- 60 cc Toomey syringe
- nasogastric tube
- esophageal stethoscope
- Foley catheter with urimeter

11. The drugs your MH cart should include are

- dantrolene sodium (36 vials)
- sterile water for injection (preservative free)
- calcium chloride
- mannitol
- 50% dextrose
- digoxin
- physostigmine
- furosemide
- heparin lock
- dexamethasone
- lidocaine 2%
- sodium bicarbonate

12. Keep an MH cart Content Verification Log (see the sample below) that anyone can use as a checklist to verify that all of the cart's contents are in place. Create categories on the log that will alert you 30 days before the drugs and supplies your cart contains expire. Review your log at least monthly.

13. Other supplies you must have at hand at all times are cold 0.9% saline for injection, cold sterile water for lavage, regular insulin (refrigerate) and ice.

14. Make certain your MH ice supply is stored inside a locked freezer so that no one can put it to another use and leave you without the supply you need to provide

MH Hotline  
1-800-644-9737

Outside the US:  
1-315-464-7079

## EMERGENCY THERAPY FOR MALIGNANT HYPERTHERMIA

DIAGNOSIS

**Signs of MH:**

- Increased ETCO<sub>2</sub>
- Trunk or total body rigidity
- Masseter spasm or trismus
- Tachycardia/tachypnea
- Acidosis
- Increased temperature (may be late sign)

**Sudden/Unexpected Cardiac Arrest in Young Patients**

- Presume hyperkalemia and initiate treatment (see #6)
- Measure CK, myoglobin, ABGs, until normalized
- Consider dantrolene
- Usually secondary to occult myopathy (e.g., muscular dystrophy)
- Resuscitation may be difficult and prolonged

**Trismus or Masseter Spasm with Succinylcholine**

- Early sign of MH in many patients
- If limb muscle rigidity, begin treatment with dantrolene
- For emergent procedures, continue with non-triggering agents; consider dantrolene
- Follow CK and urine myoglobin for 36 hours at least. Check CK immediately and at 6-hour intervals until returning to normal. Observe for cola colored urine. If present, test for myoglobin.
- Observe in PACU or ICU for at least 12 hours

ACUTE PHASE TREATMENT

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

- Discontinue volatile agents and succinylcholine.
- Hyperventilate with 100% oxygen at flows of 10 L/min. or more.
- Halt the procedure as soon as possible; if emergent, use non-triggers.

(The circle system and CO<sub>2</sub> absorbent need not be changed.)

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

To convert kg to lbs for amt of dantrolene, give patients 1 mg/lb (2.5 mg/kg approximates 1 mg/lb).

- Repeat 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. Prewarming (not to exceed 38°C) the sterile water will speed solubilization of dantrolene.

**3 Bicarbonate** for metabolic acidosis.

- 1-2 mEq/kg if blood gas values are not yet available.

**4 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 <36°C.

**5 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.**

**6 Hyperkalemia** - Treat with hyperventilation, bicarbonate, glucose/insulin, calcium.

**7 Follow** ETCO<sub>2</sub>, electrolytes, blood gases, CK, core temperature, urine output and color, coagulation studies. If CK and/or K<sup>+</sup> 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.

- Venous blood gas (e.g., femoral vein) 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 recrudescence.

**2** Dantrolene 1 mg/kg q 4-6 hours or .25 mg/kg/hr by infusion for at least 24 hours. Further doses may be indicated.

**3** Follow vitals and labs as above (see #7)

- Frequent ABC
- CK every 6 hours

**1** Follow urine myoglobin and institute therapy to prevent myoglobin precipitation in renal tubules and the subsequent development of Acute Renal Failure. Follow standard intensive care therapy for acute rhabdomyolysis and myoglobinuria (urine output > 200 ml/hr, alkalization of urine with Na-bicarbonate infusion with careful attention to both urine and serum pH values, etc.).

**2** Counsel the patient and family regarding MH and further precautions; refer them to MHAUS. Fill out and send in the Adverse Metabolic Reaction to Anesthesia (AMRA) form ([www.mhreg.org](http://www.mhreg.org)) and send a letter to the patient and her/his physician. Refer patient to the nearest Biopsy Center for follow-up.

**Non-Emergency Information**


**MHAUS**  
11 East State Street  
PO Box 1069  
Sherburne, NY 13460-1069

**Phone**  
1-800-986-4287  
(507-674-7901)

**Fax**  
607-674-7910

**Email**  
[info@mhaus.org](mailto:info@mhaus.org)

**Websites**  
[www.mhaus.org](http://www.mhaus.org)



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

Produced by the Malignant Hyperthermia Association of the United States

Chart available from the Malignant Hyperthermia Association of the United States (MHAUS), [www.mhaus.org](http://www.mhaus.org)

care to a patient with MH. Mark your MH ice supply clearly, e.g., in large red letters applied using an indelible marker, so that all staff know that particular ice supply is to be used only to treat a patient with MH.

You can not have too much help in an MH crisis. Call in your anesthesiologists, surgeons and all available personnel immediately. Call 911 and begin preparing to transfer your patient to a tertiary care facility as soon as MH is diagnosed. ♦

MH CART: <MONTH>					
DRUG/SUPPLY	# NEEDED	NDC #	EXPIRATION MONTH/YEAR	ORDERED	RECEIVED

Sample MH cart content verification log