Malignant Hyperthermia (MH)

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Children’s Hospital of Wisconsin
What is Malignant Hyperthermia?

MH is a biochemical chain reaction response, “triggered” in susceptible individuals by commonly used general anesthetics and the paralyzing agent Succinylcholine (neuromuscular blocker)
Incidence - Under General Anesthesia

• The exact incidence of MH is unknown.
• Epidemiologic studies reveal that MH complicates one in about 100,000 surgeries in adults and one in about 30,000 surgical procedures in children.
• The incidence varies depending on the concentration of MH families in a given geographic area. High incidence areas in the United States include Wisconsin, Nebraska, West Virginia and Michigan. However, the prevalence of genetic change that predisposes to MH is much higher. About one in 2,000 patients harbor a genetic change that makes them susceptible to MH.
Who is susceptible to MH?

- MH is considered a dominantly inherited disorder in humans.
- All closely related members of a family in which MH has occurred must also be considered MH susceptible and managed accordingly, unless proven otherwise.
- Those who are susceptible may be completely unaware of this risk unless exposed to anesthetics leading to a life-threatening crisis.
- Not everyone who has the MH gene develops an MH episode upon each exposure to triggering anesthetics.
- MH related deaths have occurred even though patients have undergone multiple prior uneventful surgeries.
Some disorders associated with MH

- Muscular Dystrophy
- Heat Stroke
- Ptosis
- Strabismus
- Scoliosis
- Muscle cramps
- Intolerance to caffeine

- Hyperthyroidism
- Pheochromocytoma
- Neuroleptic malignant syndrome
- King Denbourgh syndrome
- Center Core disease
What drugs trigger MH?

- Volatile gaseous inhalation anesthetics
  - Desflurane
  - Enflurane
  - Ether
  - Halothane
  - Isoflurane
  - Methoxyflurane
  - Sevoflurane

- Muscle Relaxant Succinylcholine
“Safe” Drugs

- Depressant drugs (barbiturates, tranquilizers)
- Non-Depolarizing Muscle Relaxants (NDMR)
- Antibiotics, Antihistamines, Antipyretics, Ketamine, Local Anesthetics, Nitrous oxide, Opioids, Porpanolol, and Propofol.
Causes of an MH episode

Although the cause of MH is not yet known with certainty in all inherited forms, research evidence points to a generalized derangement of the processes which regulate muscle contraction.
Causes of MH episodes

- The triggering agents induce increased concentrations of calcium in the muscle cells.
- High calcium levels cause the muscles to contract and become rigid, leading to greatly increased metabolism. The process results in heat production (hyperthermia) and muscle cell breakdown.
General Signs of MH

Increased heart rate, greatly increased body metabolism, muscle rigidity and/or fever that may exceed 110 degrees F along with muscle breakdown, derangements of body chemicals and increased acid content in the blood.
Signs and symptoms of MH:

- **Early signs**
  - masseter muscle rigidity
  - unexplained increased in exhaled CO2
  - unexplained tachycardia
  - generalized muscle rigidity

- **Late signs**
  - dark, brown urine
  - bleeding/oozing from wound sites
  - dark blood in the operative field
  - temperature elevation
Biochemical changes

- **Early**
  - increased pCO2
  - acidosis (respiratory and metabolic)
  - hyperkalemia
  - hyper or hypo calcemia
  - hyperglycemia

- **Late**
  - elevated CK (peaks 12-24 hours after crisis)
  - myoglobinuria
  - increase in liver enzymes (unusual)
  - prolonged PT/PTT
  - decreased platelet count
Severe Complications

Cardiac arrest, brain damage, internal bleeding or failure of other body systems. Thus, death, primarily due to a secondary cardiovascular collapse, can result.
Currently the most definitive diagnostic test for MH is a muscle biopsy.
Treatment of MH

- Since 1979, the antidote drug dantrolene sodium was identified for the treatment of MH and contributed greatly to the dramatic decline of mortality. Dantrium® (dantrolene sodium for injection) is available in powdered form. It must be reconstituted by adding sterile water to it.

- Dose- Initial dose 2.5mg/kg, then 1 mg/kg every 5 minutes to total of 10 mg/kg.
MH Schematic

- Finding: Tachycardia, Tachypnea
  - Diagnosis: Light anesthesia, Surgical stimulus
  - Action: Obtain arterial or venous blood gases
  - Findings: Resolved, Unresolved
  - Action: Repeat blood gases every 20-30 minutes
  - Mixed acidosis
  - Malignant hyperthermia crisis
  - Initiate malignant hyperthermia treatment protocol
- Deepen anesthesia
  - Diagnosis: Unexplained
  - Findings: Normal acid-base status
  - Action: Repeat blood gases every 20-30 minutes
Treatment of symptoms of MH

- Hypocalemia - Calcium Chloride
- Decrease Glucose - Dextrose
- Calcium Uptake - Dantrolene
- Decrease HR and BP - Epinephrine
- Tachycyrsrhythmia - Esmolol

- Fluid Retention - Lasix
- Increase Glucose - Insulin
- Ventricular Dysrhythmia - Lidocaine
- Fluid Retention - Mannitol
- Dysrhythmias - Procainamide
- Acidosis - Sodium Bicarb

ALL DRUGS LISTED CAN BE FOUND IN THE MH CART
Supplies located in MH cart:

DRAWER ONE: Medications

DRAWER TWO: Dantrolene supplies

DRAWER THREE: Artline and lab supplies

DRAWER FOUR: Anesthesia supplies

DRAWER FIVE: Irrigation supplies
Remember to add at time of MH crisis

• Located in Center core 2 refrigerator:
  – 1000cc NS bags
  – 3000cc NS bags
  – Pediatric or adult NG

• Located in Pharmacy refrigerator:
  – Regular insulin

• Located in Pump room (between 1 + 2):
  – ICE
Labs for MH crisis:

Labs for a MH crisis are located in Epic under the OR bundles.
MH CRISIS ORDER SET INCLUDES:

- ABG
- CBC no Differential
- Creatine Kinase
- LDH
- Na, Cl, Ca, Mg
- PT, PTT, Platelet
- Fibrin-split product
- Fibrinogen, D dimer
- Urine (UMAC)
  - myoglobin
  - note specimen source
## Laboratory Findings

### Table 3: Laboratory Findings of Acute MH

<table>
<thead>
<tr>
<th>ABG</th>
<th>Normal Ranges</th>
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<tbody>
<tr>
<td>pH</td>
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<tr>
<td>PO₂</td>
<td>80–100 mm Hg</td>
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<tr>
<td>PCO₂</td>
<td>35–45 mm Hg</td>
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<table>
<thead>
<tr>
<th>Electrolytes</th>
<th>Normal Ranges</th>
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<tbody>
<tr>
<td>K</td>
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<tr>
<td>Ca</td>
<td>4.5–5.5 mEq/L</td>
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<tr>
<td>Mg</td>
<td>1.8–2.4 mg/dL</td>
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<tr>
<td>Na</td>
<td>138–148 mEq/L</td>
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<table>
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<tr>
<th>Serum</th>
<th>Normal Ranges</th>
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<tbody>
<tr>
<td>Lactate</td>
<td>0.7–2.1 mmol/L</td>
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<tr>
<td>Pyruvate</td>
<td>0.03–0.08 mmol/L</td>
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<tr>
<td>CPK (creatine phosphokinase)</td>
<td>40–280 U/L</td>
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<tr>
<td>LDH (lactic dehydrogenase)</td>
<td>3.13–6.18 U/L</td>
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<tr>
<td>Aldolase</td>
<td>Age specific</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>6–85 ng/mL</td>
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<tr>
<td>Glucose</td>
<td>80–120 mg/dL</td>
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<tr>
<td>Creatinine</td>
<td>0.5–1.4 mg/dL</td>
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<td>PT</td>
<td>10–12</td>
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<td>PTT</td>
<td>22–27</td>
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<tr>
<td>Platelets</td>
<td>50,000</td>
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MH Crisis Tasks

- The nurse taking care of the child is responsible for task one and nine:
  - **Task One**: Call for more help and assign tasks
  - **Task Two**: Retrieve the MH cart and code cart, open carts and wait for further assignments
  - **Task Three**: Retrieve supplies listed on top of MH cart and start to fill ice bags
MH Crisis Tasks cont.

- **Task Four**: Assist with anesthesia art line, cvp line, and lab draws and retrieving labs when results are final
- **Task Five**: Prepare Dantrolene add 60cc of sterile water to vial and hand to anesthesia
- **Task Six**: Insert Foley and NG
- **Task Seven**: Assist surgeon with placement of peritoneal catheter is applicable
Task Eight: Temperature regulation: ice head, arm pits, and groin area, lavage bladder, peritoneal cavity, and stomach: stop once temp. reaches 38.5 C

Task Nine: Assist with transfer of patient to PICU

Tasks are to be done simultaneously
 Task one and nine should be combined
 Tasks two and six can be combined
 Tasks three and seven can be combined
Can MH occur outside of the Operating Room?

- Yes. While most cases of MH occur during general anesthesia, the one-hour period immediately following surgery (including the recovery room) is also a critical time. In addition, MH can occur if trigger anesthetics and/or succinylcholine are used in any location, such as emergency rooms, dental surgeries, surgeon’s offices or intensive care units.
Can Anything other than Anesthetic Drugs Trigger MH?

Studies have shown that a small percent of people who develop muscle breakdown following exercise only, or afterheat stroke, harbor the genetic changes associated with MH susceptibility. It is still unclear if the muscle breakdown and other changes result from these non-anesthetic incidences. In the absence of a personal or family history of heat stroke or exercise-induced muscle breakdown or evidence of muscle disorders, ask your personal physician to consult with an MH expert.
Additional information

- Malignant Hyperthermia Association of the United States (MHAUS)
  - 1-800-98-MHAUSS
- http://www.mhaus.org
- MH Hotline: On-call anesthesiologists available to consult in MH emergencies may be obtained 24 hours a day:
  - 1-800-MH HYPER (1-800-644-9737)
Table 2: Malignant Hyperthermia Flow Chart

Assess → At increased risk? → No → Minimal risk

Yes → MH susceptible

Prevention
→ Muscle testing
→ Family involvement
→ Patient/family teaching

Acute unexpected event
→ Dantrolene

Treatment of symptoms
→ Monitor physical parameters
→ Continue treatment of symptoms
→ Lab values, oxygenation/ventilation, fluid balance, temperature
→ 48–72 hours postoperative

AORN Standards & Guidelines
<table>
<thead>
<tr>
<th>Family Names</th>
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<tr>
<td>Ambrowiak</td>
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<td>Kamenick</td>
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MH QUIZ:

1. Malignant Hyperthermia is a complication of:
   a. General anesthesia
   b. Local anesthesia
   c. Regional anesthesia
   d. Spinal anesthesia

2. The etiology of MH is:
   a. A bacteria
   b. A virus
   c. Muscle degeneration
   d. Unknown
MH QUIZ cont.

3. This is the most consistent early symptom of MH.
   A. Dark blood in the operative field
   b. Increased skin temperature
   c. Muscle flaccidity
   d. Increased of end-tidal CO2

4. Currently this is the most definitive diagnostic test for MH?
   a. A tourniquet test of muscle ischemia
   b. Muscle biopsy
   c. Muscle contraction strength in the hand
   d. The metabolism of blood platelets
MH QUIZ cont.

5. Which of these are likely to trigger MH?

A. Enflurane
B. Halothane
C. Nitrous Oxide
D. Succinylcholine

a. A, B
b. C, D
c. A, B, D
d. All of the above
6. A sudden increase in this element within muscle cells initiates the biochemical reactions of MH:
   a. Calcium
   b. Magnesium
   c. Potassium
   d. Sodium

7. This is currently the drug of choice in treating MH?
   a. Calcium chloride
   b. Dantrolene sodium
   c. Lidocaine hydrochloride
   d. Procainamide hydrochloride
MH QUIZ cont.

8. Which of the following are essential if the drug of choice is to be fully effective in treating MH?

A. Body temperature must be lowered
B. Dantrolene must be given as soon as possible
C. Hypertension must be corrected
D. Metabolic Acidosis must be corrected

a. C, D
b. A, B, C
c. A, B, D
d. All of the above
MH QUIZ cont.

9. Treatment of MH may include which of the following?
   A. Administering iced intravenous solutions
   B. Inserting a Foley catheter
   C. Irrigating the wound with cold saline solution
   D. Surface cooling with a cooling mattress

   a. A, B
   b. C, D
   c. A, C, D
   d. All of the above
MH QUIZ cont.

10. A patient can experience a MH crisis
   a. Prior to surgery
   b. In the recovery room
   c. A month after surgery
   d. None of the above

Congratulations you’ve completed the MH quiz, please return quiz answers to the labeled envelope in the OR Nurse’s lounge