

Patient safety

Malignant hyperthermia: A crisis response plan

Malignant hyperthermia (MH) is a genetic skeletal muscle disorder that is incited by anesthesia drugs including succinylcholine and inhaled anesthetic agents (Gurunluoglu et al, 2009; Hopkins, 2011; Kim et al, 2011). The disorder is particularly dangerous because it rapidly develops into a hypermetabolic state resulting in hyperpyrexia, tachycardia, and intense and unrelenting muscle contraction as well as alterations in electrolyte and acid-base balance (Kim et al, 2011).

Though the incidence is reported to have increased from 2000 to 2005 from 10.2 episodes per 1 million hospital discharges to 13.3, the mortality rate has steadily declined to approximately 11.7% as greater understanding of the pathophysiology and treatment of the disorder has developed (Rosero et al, 2009).

Clinician and patient preparation are key in developing a plan of care for any patient having a general anesthetic. Personal and family histories should be obtained to delineate which patients have a greater risk for an MH crisis, such as those who have a myopathy (Wappler, 2010). Gender and geographic factors have also been found to contribute to increased mortality rates in persons already having an MH diagnosis (Rosero et al, 2009).

Preparation also involves having emergency equipment and medications readily available as well as developing an action plan to address an MH crisis.

Crisis management

An MH crisis develops rapidly and taxes resources quickly. Managing an MH crisis requires an approach involving multiple personnel and multiple tasks promptly initiated and deliberately executed.

Crisis resource management is a methodology focusing on task delegation during stressful situations such as an MH crisis. Deeply rooted in the aviation industry, crisis resource management has become essential in health care because it promotes development of team dynamics and cooperation (Rudy et al, 2007). Similarly, crew resource management inspires a group of personnel to function cooperatively as a team with an ultimate goal of safety (McConaughey, 2008).

Crew resource management practices often center on team training and building to prepare for crisis situations (France et al, 2008).

Teamwork and task sharing are important to master before a crisis because most health care providers are specialists and have limited understanding of their colleagues' responsibilities (Sundar et al, 2007).

Responding to an MH crisis demands multiple activities to be executed concurrently, which can have a severe impact on a limited staff.

Therefore, all members of the operating team must understand team member responsibilities and roles and actively participate in managing this event.

Treatment guidelines

Specific treatment guidelines are essential in the management of an MH crisis. The Malignant Hyperthermia Association of the United States (MHAUS) provides treatment guidelines, which are generally accepted in anesthesia practice (sidebar, p 19).

A task distribution worksheet

Treating the patient in an MH crisis is complicated and potentially manpower-consuming. Cognitive aids that outline the necessary steps can be helpful (Harrison et al, 2006). Principles of crisis resource management, crew resource management, and task distribution assignments can also be applied.

Previous authors have developed task distribution assignments using a model employing strictly nursing personnel (Hommertzheim, 2006).

Ziewacz et al described crisis checklists outlining steps for operating room emergencies, including MH. The current literature has not, however, outlined a model that delineates specific tasks for particular personnel.

This article describes a task distribution worksheet that highlights and fully utilizes the skills and cooperation of each member of the operating team, including anesthesiology, the operating surgeon, nursing personnel, and ancillary staff such as surgical technologists and perfusionists.

The MH task distribution worksheet is intended to ensure that the roles necessary to treat a patient having an MH crisis are fulfilled. The worksheet assigns roles for:

- the circulating nurse/OR staff
- anesthesia technician
- anesthesia team
- surgeon
- ancillary personnel.

Color-coded sections

The task worksheets are printed on half-sheets of laminated paper joined with a ring, allowing each party to take a color-coded section that pertains to his or her individual responsibilities during the MH event (sidebar, p 20).

Though the MH task distribution worksheet was created using the staff mix of our current facility, it should be viewed as a dynamic model that can be tailored to any surgical venue or staffing model.

Task distribution roles

The roles of OR personnel are distributed as follows:

Circulating nurse

The circulating nurse/OR staff member must initiate the call for help and declare an MH crisis with an overhead page alerting the OR suite that an MH event is occurring. The overhead page must include a request for the MH cart and solicit additional staff for assistance. The circulating nurse also calls the MHAUS hotline to allow the anes-

MHAUS Treatment Recommendations for Malignant Hyperthermia

CALL the MH 24-hour Hotline (for emergencies only)

United States: 1+800-644-9737

Outside the US: 00+1+303-389-1647

START Emergency Therapy for MH Acute Phase Treatment

1. **Get help. Get Dantrolene. Notify surgeon.**
2. **Dantrolene Sodium for Injection 2.5 mg/kg rapidly IV through large-bore IV, if possible.**
3. **Bicarbonate for metabolic acidosis.**
4. **Cool the patient.**
5. **Dysrhythmias: Usually respond to treatment of acidosis and hyperkalemia.**
6. **Hyperkalemia.**
7. **Follow: ETCO₂, electrolytes, blood gases, CK, serum myoglobin, core temperature, urine output and color, and coagulation studies.**

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thetia team to concentrate on treatment tasks. In addition, the circulating nurse is responsible for assisting with Dantrolene reconstitution, obtaining supplies needed for cold lavage, and placing a Foley catheter if required.

Anesthesia technician

The anesthesia technician functions as a supply and delivery agent. The anesthesia technician is responsible for bringing supplies to the room, specifically, the MH cart, i-STAT machine with appropriate items for lab work, bags of ice, extra rescue medications from pharmacy, and sterile water with tubing for the reconstitution of the Dantrolene. The anesthesia technician also primes the sterile water line through a fluid warming device to speed reconstitution of the Dantrolene.

Surgeon

The surgeon's primary responsibility is to cease operating as soon as possible and administer cold lavage to open cavities.

Anesthesia team

The anesthesia team, consisting of the certified registered nurse anesthetist (CRNA) and anesthesiologist, is ultimately responsible for task distribution and providing additional assignments to ancillary personnel as needed. The anesthesia team must:

- instruct the circulator to place an overhead announcement declaring the MH emergency and requesting the MH cart be brought to the operating room
- cease all trigger agents and hyperventilate the patient with 100% oxygen via a bag valve mask separate from the anesthesia machine.
- calculate, reconstitute, and deliver an appropriate dose of Dantrolene.

Initial doses of Dantrolene of 2.5 mg/kg up to 8-10 mg/kg (24-hour limit of 30 mg/kg) repeated serially as necessary is accepted as the definitive treatment (Guranluoglu et al, 2009). The initial dose in an average adult requires the reconstitution of 9 vials of Dantrolene, which consumes the greatest manpower.

Malignant Hyperthermia Task Distribution Worksheet

Each set of tasks is printed on a different-colored card. The cards are held together with a ring and can be easily separated for use.

Circulator/OR staff

- Overhead announcement of MH emergency & summon MH cart to room.
- Call MHAUS (1-800-644-9737). Hand phone to anesthesia team.
- Help reconstitute Dantrolene.
- Insert Foley catheter and obtain urine specimen as needed.
- Obtain supplies for cold lavage of open cavities.

Anesthesia technician

- Bring MH cart to room.
- Bring i-STAT and appropriate lab containers to room.
- Bring bags of ice to room.
- Bring additional drugs to room.
- Prime a bag of sterile water using warming device & label "DO NOT CONNECT TO PATIENT."

Surgeon

- Stop operating ASAP.
- Cold lavage of open cavities.

Anesthesia team

- Instruct circulator to call an overhead announcement of MH emergency and ask for MH cart.
- Turn off all triggering anesthetics.
- Hyperventilate at 10 L/minute with 100% O₂ via bag valve mask.
- Assign tasks and delegate as required.
- Calculate Dantrolene dose (2.5 mg/kg. Note: each bottle contains 20 mg) & repeat as needed.
- Cease warming devices.
- Draw lab work (whole blood profile, CK, coagulation studies, electrolytes).
- Place NG & initiate cold lavage.
- Treat metabolic acidosis (1-2 mEq/kg sodium bicarbonate) if lab values unknown.
- Treat urine output <0.5 mL/kg/hr with hydration & diuretics.
- Monitor urine output (treat dark/cola-colored urine with bicarbonate, hydration, & diuretics).
- Continue to follow MHAUS treatment protocol.

Additional anesthesia/ancillary staff.

- 3 to 4 people mix 2.5 mg/kg of Dantrolene (utilize 60 mL sterile water per 20 mg bottle).
- Insert A-line & large-bore IVs/central line as needed.
- Maintain charting of events & interventions.

MHAUS = Malignant Hyperthermia Association of the United States. www.mhaus.org

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Warming devices are discontinued, and labwork is obtained. A nasogastric tube is also placed by the anesthesia team to allow for cold saline lavage. Acidosis is treated, and hydration is maintained with further treatment administered as indicated by the MHAUS recommendations.

Additional and ancillary staff

These staff should be assigned to mix Dantrolene; insert invasive monitors as indicated, such as an arterial line or additional intravenous lines; and assist with charting.

Introducing the worksheet

The MH task distribution worksheet was formally introduced at a joint staff meeting consisting of members of the anesthesiology service, OR nursing personnel, surgical technologists, and ancillary staff. A slide presentation covered the basic pathophysiology of MH and treatment modalities.

The MH task distribution worksheet was presented with time for questions and answers about the implementation of the worksheet during the actual emergency. Hands-on scenarios in the ORs allowed staff members to interact and collaborate as they worked through simulated MH scenarios.

Since that time, new employees are introduced to the MH task distribution worksheet in small group training and orientation sessions. The training program has extended beyond the main OR to other areas where anesthesia care is provided, including gastroenterology, endoscopy, and the outpatient surgery center.

Because MH is rare, the tool has not been formally used during a real-life MH crisis event. A pilot study quantifying the perceived benefits of this tool in practice is under development.

MH is an extremely dangerous medical condition requiring prompt intervention. Ziewacz et al imply that interventions should be instituted within 3 to 7 minutes of the onset of the MH crisis to improve the outcome. The task distribution worksheet is a guide to promote efficient and rapid intervention during an MH crisis, ensuring that each team member rapidly completes essential tasks in an organized manner. ❖

—Christopher D. Johns, CRNA, DNP
—Rebecca S. Stoudt, CRNA, DNP
—Michael P. Scholtis, CRNA, DNP
—Theodore Gavel, CRNA, MSN
Geisinger Medical Center,
Danville, Pennsylvania

A photo of Geisinger's color-coded task cards and an Excel spreadsheet are in the OR Manager Toolbox at www.ormanager.com

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