# Malignant Hyperthermia

## Site Applicability:

MSJ and SPH Operating Rooms/PACU/ICU/CSICU/CICU

## Skill Level:

**Specialized**

Anesthesia, Anesthesia Assistant, Operating Room RN and Critical Care RN

## Need to Know:

**Clinical Indication:** Patient's with a suspected malignant hyperthermia (MH) crisis

Malignant hyperthermia is an inherited disorder that manifests clinically as a hypermetabolism crisis when susceptible patients are exposed to a triggering agent such as a volatile anesthetic (desflurane, sevoflurane) and/or depolarizing muscle relaxant (succinylcholine). Exposure to the triggering agent leads to unregulated passage of calcium into the skeletal muscle cell causing sustained muscle contraction. Accelerated levels of aerobic metabolism produce carbon dioxide, cellular acidosis, and heat but deplete oxygen and adenosine triphosphate (ATP). Once ATP stores are exhausted, rhabdomyolysis occurs resulting in the production of lactate, hyperkalemia and myoglobinuria.

Clinical manifestation of MH may vary but typical early presentation includes an unexpected rise in end-tidal carbon dioxide ($EtCO_2$) that is difficult to decrease despite increasing minute ventilation, nonspecific sinus tachycardia, and/or masseter muscle rigidity or generalized muscle rigidity in the presence of a neuromuscular blockade. Hyperthermia is often considered a later sign of MH and may be absent when an initial diagnosis is suspected, however, in some circumstances an elevated or rapidly increasing temperature can be an early indication. Further progression of an acute crisis can lead to renal failure, ventricular dysrhythmias and disseminated intravascular coagulation (DIC).

MH signs and symptoms can present on immediate exposure to a triggering agent or may be delayed for up to 12 hours. Once an MH crisis is suspected treatment should begin immediately. The **only known successful treatment is Dantrolene**, a skeletal muscle relaxant. It works by blocking the sarcoplasmic reticulum from releasing calcium into the cell thereby reducing or eliminating the sustained muscle contractions. Relapse occurs in up to 25 percent of patients following initial successful treatment and ongoing monitoring and maintenance with Dantrolene should continue for the next 24 to 48 hours as determined by the clinical presentation.

## Equipment & Supplies:

1. Malignant Hyperthermia Cart
   SPH: Zone 3
   MSJ: outside OR 4
2. Cooled NS for IV infusion/irrigation
   SPH: OR core blood fridge
   MSJ: fridge outside OR 4
3. Cardiac Arrest Cart

## Guideline

### Initial Management: (in the OR)

The following emergency treatment should be initiated immediately upon suspicion of an acute MH event. The anesthesiologist manages the crisis and gives direction to all team members. The steps listed below can happen simultaneously and are to be used in conjunction with advanced cardiac life support treatment.

| Steps | Criteria and Directives |
|---|---|
| Anesthesia to communicate to surgical team the suspicion of an MH crisis.<br>Use code blue button in room as directed by anesthesia. | This notifies the team to initiate an emergency response.<br>This alerts the need to get the MH cart, crash cart and extra personnel.<br>It opens discussion with the surgeon the ability to abort the procedure if at all possible. |
| Stop any triggering agents. | If surgery must continue maintain general anesthesia with non-triggering agents (see Appendix A).<br>Ensure communication to perfusion when applicable. |
| Hyperventilate (increase minute ventilation) with 100% oxygen at flows of 18 L/min. | Help flush volatile anesthetics and lower $EtCO_2$ and support oxygen demand. |
| Insert activated charcoal filter (Vapor-Clean™) into the inspiratory and expiratory limbs of the breathing circuit. | The filter may become saturated after one hour of use and replacement filters may need to be substituted. |

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| **Give IV Dantrolene 2.5 mg/kg rapidly** through large bore IV at the port closest to the patient.<br>Repeat as frequently as needed until the patient responds with a decrease in $EtCO_2$, decrease muscle rigidity, and/or lowered heart rate. Large doses may be required for patients with persistent contractures or rigidity. Large doses are more common with muscular patients. | Dantrolene is compatible with sterile water for injection only and requires 60 mL for reconstitution. Use 1 liter bags of sterile water for reconstitution and 60 mL syringes with blunt cannula (final concentration 0.3 mg/mL). Shake solution until clear; inject air prior to withdrawing medication from vial once reconstituted.<br><br>More than 1 person may need to mix Dantrolene to mix required amount. For a 70 kg patient 9 vials (525 mL) is required for an initial dose see Appendix B dantrolene dosing guide for quick reference. |
| Initiate continuous core temperature monitoring | Initiate cooling methods if core temperature is greater than 39°C or less if rising rapidly. |
| If giving **large doses of Dantrolene (greater than 10 mg/kg) with no symptom resolution**, consider alternate diagnosis such as insufficient anesthesia, analgesia or both, sepsis, insufficient ventilation or fresh gas flow, increased $CO_2$ absorption during laparoscopy, anesthetic machine malfunction, anaphylactic reaction, pheochromocytoma, thyroid storm, cerebral ischemia, malignant neuroleptic syndrome or neuromuscular disorders.<br>**Alert pharmacy that large doses are being used to ensure availability of ongoing supply.** | |

## Initial Management: (outside of OR)

The following emergency treatment should be initiated immediately upon suspicion of an acute MH event. The steps listed below can happen simultaneously and are to be used in conjunction with advanced cardiac life support treatment. **If not already involved in care consider anesthesia consult.**

| **Steps** | **Criteria and Directives** |
|---|---|
| Initiate emergency response – Use Code Blue button at head of bed.<br>**Consult anesthesia.** | Bring MH cart and crash cart to bedside |
| Hyperventilate with 100% oxygen:<br>If patient is not intubated plan for oral endotracheal intubation. **DO NOT USE succinylcholine** for neuromuscular blockade during intubation.<br>Initiate $EtCO_2$ monitoring once intubated and mechanically ventilated.<br>If unable to intubate or not clinically indicated initiate $EtCO_2$ monitoring for spontaneous breathing patients when | Control of ventilation can help eliminate excess $CO_2$.<br>$FiO_2$ of 100% will help oxygen supply to keep up to demand.<br><br>Use non-triggering agents (see appendix A) for neuromuscular block during intubation and continued sedation to facilitate ventilation compliance. |

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| available. | |
| **Give IV Dantrolene 2.5 mg/kg rapidly** through large bore IV at the port closest to the patient.<br><br>Repeat as frequently as needed until the patient responds with a decrease in $EtCO_2$, decrease muscle rigidity, and/or lowered heart rate. Large doses may be required for patients with persistent contractures or rigidity. Large doses are more common with muscular patients. | Dantrolene is compatible with sterile water for injection only and requires 60 mL for reconstitution. Use 1 liter bags of sterile water for reconstitution and 60 mL syringe with a blunt cannula (final concentration 0.3 mg/mL). Shake solution until clear; inject air prior to withdrawing medication.<br><br>More than 1 person may need to mix Dantrolene to mix required amount. For a 70 kg patient 9 vials (525 mL) is required for an initial dose see Appendix B dantrolene dosing guide for quick reference. |
| Initiate continuous core temperature monitoring using a general purpose temperature probe. | Initiate cooling methods if core temperature is greater than 39°C or less if rising rapidly. |
| If giving **large doses of Dantrolene (greater than 10 mg/kg) with no symptom resolution**, consider alternate diagnosis such as sepsis, anaphylaxis, pheochromocytoma, thyroid storm, cerebral ischemia, malignant neuroleptic syndrome or neuromuscular disorders.<br>**Alert pharmacy that large doses are being used to ensure availability of ongoing supply.** | |

## Ongoing Management: For additional support call 1.800.644.9737 – MHAUS

Consider placement of advanced lines for arterial and/or central venous monitoring if warranted by the clinical severity of the patient.

| Issue | Management |
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| Dantrolene Administration | Intravenous administration of Dantrolene should be infused through a large bore IV (preferable central line) as the pH is 9.5 and the alkaline solution can easily cause irritation to the vein.<br>Large doses greater than 10 mg/kg may be required for patients with persistent contractures or rigidity.<br>Post crisis management with Dantrolene is either 1 mg/kg Q4 to 6H or 0.25 mg/kg/hour for at least 24 hours and sometimes longer if clinically indicated. Dantrolene can be stopped or the interval between doses increased to Q8 to 12H if the following criteria are met: metabolic stability for 24 hours, core temperature is less than 38°C, CK is decreasing, no evidence of myoglobinuria, muscles are no longer rigid. |
| Recrudescence occurs in up to 25% of patients following | If recurrent signs appear in spite of ongoing treatment, additional dantrolene boluses may be required.<br>Signs of relapse include: |

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| initial treatment at an average of 13 hours after the initial reaction. | • Increase muscular rigidity in the absence of shivering<br>• Inappropriate hypercarbia with respiratory acidosis<br>• Metabolic acidosis without other causes<br>• Inappropriate temperature rise<br><br>Therapy may be required for up to 3 days. Oral dantrolene (4 to 8 mg/kg/day in 4 divided doses) can be considered if enteral absorption is thought to be possible.<br><br>See parenteral drug therapy manual for further information.<br>At **SPH** additional vials of Dantrolene can be obtained from pharmacy.<br>At **MSJ** 36 vials of Dantrolene are stored in the MH cart. |
| Monitor and treat hyperkalemia<br><br>Labs:<br>• $K^+$<br>• Ion $Ca^{2+}$<br>• pH | Hyperkalemia results from the release of potassium from damaged muscle cells. Potassium may rise rapidly and lead to life-threatening arrhythmias or cardiac arrest. If Hyperkalemia (K greater than 5.9 or less with ECG changes) is present, treat with:<br>**Insulin with glucose** – insulin administration lowers the serum potassium concentration by driving potassium into the cells by enhancing the sodium-potassium pump. Glucose is given with insulin to prevent the development of hypoglycemia. Close monitoring of blood sugar following administration for the next 6 hours is recommended. Give dextrose 50% 25 g (50 mL) followed by 10 units insulin regular IV direct.<br>**Calcium** – calcium directly antagonizes the membrane actions of hyperkalemia and a combined hypocalcemia can increase the cardiotoxicity of hyperkalemia. For calcium chloride (via central line) or calcium gluconate (via peripheral line) give 1000 mg IV and repeat if necessary.<br>**Sodium bicarbonate** – raising the systemic PH with sodium bicarbonate results in hydrogen ion release from the cells as part of the buffering reaction. This results in the movement of potassium into the cells to maintain electroneutrality. Give sodium bicarbonate 1 mEq/kg IV initially.<br><br>For refractory hyperkalemia consider salbutamol, kayexelate, dialysis or ECMO if patient is in cardiac arrest.<br>Treat dysrhythmias with standard medication but **avoid calcium channel blockers** – combined therapeutic doses of intravenous dantrolene with calcium channel blockers can result in severe hyperkalemia with ventricular fibrillation and cardiovascular collapse. |
| Thermal Regulation | Monitor core temperature continuously using a general purpose probe for esophageal, nasopharyngeal, or rectal route.<br>Patients with a core temperature greater than 39°C or rapidly rising should be |

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| | cooled until a temperature of 38°C. Temperatures greater than 40°C are linked to the development of disseminated intravascular coagulation (DIC)<br>Cooling measures are:<br>• Cold intravenous saline infusions (stored in OR fridge)<br>• Ice packs applied to skin surfaces (groin, axilla, neck, palms, soles, etc.)<br>• Lavage open body cavities (cold saline for irrigation stored in OR fridge)<br>• Cooling blanket (used for therapeutic hypothermia, from MDRD – SPH)<br>• Other cooling techniques may be used at anesthesia's discretion |
| Acid-Base Balance<br><br>Labs:<br>• ABG<br>• Lactate<br>• Venous blood gas | MH often results in a combined metabolic and respiratory acidosis. $CO_2$ is a byproduct of cellular metabolism and in a hypermetabolic state more $CO_2$ is created. Lactate is a byproduct of anaerobic cellular metabolism; as muscle cells deplete their ATP stores more lactate is created.<br>Venous blood gas may better indicate hypermetabolism before arterial blood gas.<br>Controlled ventilation rather than spontaneous ventilation will allow greater control of blood pH levels and $PetCO_2$. Consider intubation (if not already intubated) to allow for preferential control of acid-base balance.<br>Hyperventilate with higher respiratory rate and larger tidal volumes to lower $CO_2$ levels to normocapnea and maintain a pH at 7.35 or above. Give sodium bicarbonate IV if pH is less than 7.2. |
| Myoglobinuria<br><br>Labs:<br>• CK<br>• Renal function<br>• Serum electrolytes<br>• Creatinine<br>• Urine pH, myoglobin levels | Myoglobin is released from damaged muscle tissue and is filtered by the kidneys. The ferrihemate portion of the myoglobin is toxic to the renal tubular epithelium and can cause acute kidney injury. The presence of myoglobin in the urine produces a reddish-brown coloured urine.<br>• Insert a bladder catheter to monitor urine color and volume.<br>• Urine output should be maintained at 100 mL/hr or greater than 2 mL/kg/hr until urine colour returns to normal or creatinine kinase (CK) has decreased.<br>• Maintain adequate hydration to meet target urine output.<br>• To alkalinize urine infuse sodium bicarbonate at 1 mEq/kg/hr.<br>• May need to use diuretics to maintain urine output (3000 mg of mannitol is in each vial of dantrolene).<br>CK levels above 10,000 unit/L are presumptive sign of rhabdomylosis and myoglobinuria. |

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| Compartment Syndrome | Compartment syndrome occurs when increased pressure threatens the viability of muscles and nerves within a compartment. It often occurs as a result of fluid resuscitation and worsening edema of muscles. Signs and symptoms of acute compartment syndrome are:<br>• Pain with passive stretch of muscles<br>• Impaired circulation (colour, warmth, movement, sensation)<br>• Persistent pain difficult to manage despite interventions<br>• Tense or firm swelling<br>Compartment syndrome is secondary to rhabdomyolysis and will require prompt treatment to release compartments. |
| Disseminated Intravascular Coagulation (DIC)<br><br>Labs:<br>• CBC<br>• INR<br>• pTT<br>• Fibrinogen<br>• Peripheral blood smear | DIC is a systemic event in which the processes of coagulation and fibrinolysis become abnormally activated and puts the patient at an increased risk of bleeding due to the depletion of coagulation factors.<br>Primary treatment is aimed to treat the underlying cause (MH episode – temperatures greater than 40°C are linked to DIC) to eliminate the stimulus while secondary treatment aims to correct hemostasis.<br>Monitor for signs of bleeding, such as purpura, hematomas, unexpected oozing/bleeding from IV sites, incision sites, mucous membranes, epistaxis, or urethral bleeding, etc. Confirmed DIC is based on clinical findings and laboratory diagnosis. Secondary treatment will include administration of PRBC, FFP, fibrinogen, platelets and other depleted coagulation factors. Consider consultation to hematology to assist in management of DIC. |

## Patient Education:

It is essential that the patient understands the risk of future MH episodes and because of the autosomal-dominant inheritance, family members (blood relatives) should also be made aware of the event. The patient and their family members are considered MH susceptible and managed accordingly unless proven otherwise. Many patients that develop an acute MH episode have negative family histories and some have had uneventful general anesthetics in the past. Therefore, even if patients or family members have had multiple uneventful surgeries it cannot be certain that they are not at risk.

The Malignant Hyperthermia Association of the United States (MHAUS) provides many resources to patients, family members and health care professionals and can connect patients with the information they need to learn more such as, I am MH-Susceptible – Now What? A Roadmap to Answers.

## Documentation:

**In OR**

Form No. PHC-IC013 Cardio-Pulmonary Resuscitation Record

Form No. PHC-OR016 Operative Record

Form No. MR026 Department of Anesthesia Pre-Anesthetic Assessment (SPH)

Form No. GF 8133 Anesthetic Record and Preoperative Assessment (MSJ)

**In PACU/ICU/CSICU/CICU**

Form No. PHC-IC013 Cardio-Pulmonary Resuscitation Record

Form No. PA015 PACU Patient Record (SPH, MSJ)

Form No. IC037 Critical Care Flowsheet (PACU, CSICU, CICU)

Form No. PHC-IC049 ICU Flowsheet (ICU – SPH, MSJ)

Form No. PHC-NF035 Nurses Notes

## Related Documents and Resources:

1. B-00-12-10052 – Cardiac Arrest in the OR
2. Targeted Temperature Control Guidelines (ICU)

## References:

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2. Glahn, K.P.E., Ellis, F.R., Halsall, P.J., Müller, C.R., Snoeck, M.M.J., 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.
3. Hernandez, J.F., Secrest, J.A., Hill, L., & McClarty, S.J. (2009). Scientific Advances in the Genetic Understanding and Diagnosis of Malignant Hyperthermia. *Journal of PeriAnesthesia Nursing, 24(1)*, 19-34.
4. Litman, R.S. (2016, September 1). Malignant Hyperthermia: Clinical diagnosis and management of acute crisis. *UpToDate*. Retrieved September 30, 2016.
5. Malignant Hyperthermia Association of the United States. (2016). Healthcare Professionals: Managing a Crisis. Retrieved September 29, 2016, from http://www.mhaus.org/healthcare-professionals/managing-a-crisis.
6. Riazi, S., & Brandom, B.W. (2015). Malignant Hyperthermia – An Update for Perioperative Nurses. *ORNAC Journal 33(4)* 16-26.

### Persons/Groups Consulted:

Anesthesia Assistant Supervisor – PHC

Clinical Pharmacy Specialist, Critical Care – SPH

Nurse Educator, Surgical Program – MSJ

Nurse Educator, Cardiac Surgery Intensive Care Unit – SPH

Department of Anesthesiology – PHC

Nurse Educator, Operating Rooms – SPH

Department of Anesthesiology – PHC

Medical Director ICU – PHC

Nurse Educator, Operating Room and DTPR - MSJ

**Developed By:**

Lia Cave RN, Nurse Educator, PACU - SPH

**Revised By**

Nurse Educator Surgical Program MSJ

Nurse Educator Operating Room and DTPR MSJ

**Approved By: Professional Practice Standards Committee**

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Revised: January 2008

August 2012

April 2017

October 2018 (revised Appendix C: MH Cart MSJ)

## Appendix A: Triggering Agents and Safe Anesthesia Alternatives

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|---|---|---|
| **TRIGGERS** | **Pharmacological** | |
| | Volatile Inhalation General Anesthetics:<br>• Desflurane<br>• Sevoflurane | |
| | Depolarizing Muscle Relaxants:<br>• Succinylcholine | |
| | **Non-Pharmacological** | |
| | Other potential triggers are:<br>• Exercise<br>• Heat Stroke | |
| **NON-TRIGGERS** | **Safe Anesthesia Alternatives** | |
| | Intravenous Anesthetics:<br>• ProPOFol<br>• Midazolam | • Ketamine<br>• Methohexital |
| | Inhaled Non-Volatile General Anesthetics:<br>• Nitrous Oxide | |
| | Local Anesthetics:<br>• Lidocaine<br>• Bupivicaine | • ROPIVacaine |
| | IV Narcotics:<br>• Fentanyl<br>• HYDROmorphone<br>• Morphine | • REMIfentanil<br>• SUfentanil<br>• |
| | Non-Depolarizing Muscle Relaxants:<br>• ROcuronium | • Cisatracurium |

## Appendix B: Dantrolene Dosing Guide

| Patient's Weight | | Volume of Dantrolene IV Solution* required to achieve the following concentrations based on the patient's weight | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **kg** | **lbs** | [1 mg/kg] | Total # of Vials | [2.5 mg/kg] | Total # of Vials | [5 mg/kg] | Total # of Vials | [10 mg/kg] | Total # of Vials |
| 30 | 66 | 90 mL | 2 | 225 mL | 4 | 450 mL | 8 | 900 mL | 15 |
| 35 | 77 | 105 mL | 2 | 262.5 mL | 5 | 525 mL | 9 | 1050 mL | 18 |
| 40 | 88 | 120 mL | 2 | 300 mL | 5 | 600 mL | 10 | 1200 mL | 20 |
| 45 | 99 | 135 mL | 3 | 337.5 mL | 6 | 675 mL | 12 | 1350 mL | 23 |
| 50 | 110 | 150 mL | 3 | 375 mL | 7 | 750 mL | 13 | 1500 mL | 25 |
| 55 | 121 | 165 mL | 3 | 412.5 mL | 7 | 825 mL | 14 | 1650 mL | 28 |
| 60 | 132 | 180 mL | 3 | 450 mL | 8 | 900 mL | 15 | 1800 mL | 30 |
| 65 | 143 | 195 mL | 4 | 487.5 mL | 9 | 975 mL | 17 | 1950 mL | 33 |
| 70 | 154 | 210 mL | 4 | 525 mL | 9 | 1050 mL | 18 | 2100 mL | 35 |
| 75 | 165 | 225 mL | 4 | 562.5 mL | 10 | 1125 mL | 19 | 2250 mL | **38** |
| 80 | 176 | 240 mL | 4 | 600 mL | 10 | 1200 mL | 20 | 2400 mL | **40** |
| 85 | 187 | 255 mL | 5 | 637.5 mL | 11 | 1275 mL | 22 | 2550 mL | **43** |
| 90 | 198 | 270 mL | 5 | 675 mL | 12 | 1350 mL | 23 | 2700 mL | **45** |
| 95 | 209 | 285 mL | 5 | 712.5 mL | 12 | 1425 mL | 24 | 2850 mL | **48** |
| 100 | 220 | 300 mL | 5 | 750 mL | 13 | 1500 mL | 25 | 3000 mL | **50** |
| 105 | 231 | 315 mL | 6 | 787.5 mL | 14 | 1575 mL | 27 | 3150 mL | **53** |
| 110 | 242 | 330 mL | 6 | 825 mL | 14 | 1650 mL | 28 | 3300 mL | **55** |
| 115 | 253 | 345 mL | 6 | 862.5 mL | 15 | 1725 mL | 29 | 3450 mL | **58** |
| 120 | 264 | 360 mL | 6 | 900 mL | 15 | 1800 mL | 30 | 3600 mL | **60** |
| 130 | 286 | 390 mL | 7 | 975 mL | 17 | 1950 mL | 32 | 3900 mL | **65** |
| 140 | 308 | 420 mL | 7 | 1050 mL | 18 | 2100 mL | 35 | 4200 mL | **70** |
| 150 | 330 | 450 mL | 8 | 1125 mL | 19 | 2250 mL | **38** | 4500 mL | **75** |
| 160 | 352 | 480 mL | 8 | 1200 mL | 20 | 2400 mL | **40** | 4800 mL | **80** |
| 170 | 374 | 510 mL | 9 | 1275 mL | 22 | 2550 mL | **43** | 5100 mL | **85** |
| 180 | 396 | 540 mL | 9 | 1350 mL | 23 | 2700 mL | **45** | 5400 mL | **90** |
| 190 | 418 | 570 mL | 10 | 1425 mL | 24 | 2850 mL | **48** | 5700 mL | **95** |

***Calculations made using 20 mg vials of Dantrium® IV (dantrolene sodium for injection) reconstituted with 60 mL of sterile water (without a bacteriostatic agent)**

## Appendix C: Malignant Hyperthermia Cart (SPH)

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| **Drawer #1 (Left)** | | | | | |
| 1 | Phlebotomy Quick Reference Guide | | 5 | Hematology & Chemistry Requisitions/Biohazard Bags | |
| **Drawer #1 (Right)** | | | | | |
| 1 | Malignant Hyperthermia NCS & MH Cart checklist | | 1 | MH Emergency Contact Poster | |
| **Drawer #2 (Left)** | | | | | |
| 1 | Arterial Blood Sampler | | 3 | Dark Purple Blood Tube | |
| 3 | Light Green Blood Tube | | 3 | Grey Blood Tube | |
| 3 | Light Blue Blood Tube | | 4 | Self-filling Arterial Sampler | |
| 3 | Lavender Blood Tube | | 4 | Vacutainer | |
| 3 | Gold Blood Tube | | | | |
| **Drawer #2 (Right)** | | | | | |
| 1 | NBP Cuffs (1/each size) | | | | |
| **Drawer #3** | | | | | |
| 2 | Dextrose 50% 25 g | | 1 | Dexamethasone 20 mg/5 mL | |
| 6 | Amiodarone 150 mg (3 mL) | | 4 | Furosemide 40 mg/4 mL | |
| 2 | Lidocaine HCl Inj 2% (preservative free) 20 mg/mL (5 mL) | | 5 | Sodium Bicarbonate 8.4% (50 mL) | |
| 4 | Calcium Chloride 10% 1g/10mL | | 10 | Medication Labels | |
| **Drawer #4** | | | | | |
| 2 | Plasmalyte 1000 mL | | 2 | NaCl 250 mL | |
| 2 | NaCl 1000 mL | | 1 | D5W 50 mL | |
| 1 | NaCl 100 mL | | 1 | D5W 250 mL | |
| **Drawer #5** | | | | | |
| 1 | MAC 2-Lumen Central Venous Access Kit | | 1 | Spring Wire Guide | |
| 1 | Pressure Monitoring Set | | 2 | Carefusion Smartsite Infusion Set (pump) | |
| 1 | Arterial Catheterization Set 18G | | 5 | Radial Artery Catheterization Set 20G | |
| 1 | Micropuncture Introducer Set | | 2 | Radial/Arterial Artery Catheterization Set 22G | |

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| **Drawer #6** | | | | | |
| 3 | Esophageal Temperature Probe | | 1 | Cincinnati Head Wrap/Instant Cold Pack | |
| 1each | Ventilating Masks (purple, blue, yellow) | | 2 | Volulyte 500 mL | |
| 2 | Vapor Clean Filters | | 5 | Plastic Bags for Ice *(obtain ice from CSICU)* | |
| **Drawer #7** | | | | | |
| 12 | Dantrolene 20 mg *(more available from Pharmacy)* | | 1 each | 3-way Foley Catheter size 20 Fr& 18 Fr | |
| 3 | Sterile Water for injection 1000 mL | | 2 | Toomey Syringes | |
| 6 | 60 mL Syringe with luer lock | | 1 | Y-Type Bladder Irrigation Set | |
| 6 | Blunt Fill Needles | | 1 | NG Tube 16 Fr | |
| **OR CORE** | | | **ZONE 3 OR** | | |
| 6 | Refrigerated IV NaCl 1000 mL – Blood Fridge | | 1 | High Flow Rapid Infuser | |
| 6 | Refrigerated NaCl for Irrigation – Blood Fridge | | **MDRD** | | |
| 1 | Regular Insulin 100 units – Medication Fridge | | 1 | Cooling Blanket and Hypo/Hyperthermia Machine | |

## Malignant Hyperthermia Cart (MSJ)

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| **Drawer #1** | | | |
| 36 | Dantrolene , 20 mg vials | 40 | Blunt needle |
| 2 | Sterile Water for Injection, 1000 mL | 6 | 60 mL syringes with luer lock tip |
| 12 | Vial adapter *(to insert to dantrolene vial)* | 1 | Mixing Dantrolene poster |
| **Drawer #2** | | | |
| 2 | Mannitol 20% | 2 | 0.22 Micron Filters |
| 1 | MH EMERGENCY CONTACT Poster | | |
| **Drawer #3** | | | |
| 5 | Sodium bicarbonate (8.4%) 50 mL syringe | 2 | Amiodarone 150 mg, 3 mL |
| 2 | Calcium Chloride Inj 10% PLS | 2 | Dextrose 50% , 50 mL syringe |
| 4 | Prefilled saline syringes, 10 mL *(extras from PACU)* | 3 | Lidocaine HCl Inj 2% *preservative free,* 20 mg/mL, 5 mL |
| 10 | Med labels | 2 | Furosemide 10 mg/ml, 2 mL |
| 4 | Syringe 5 mL | 2 | Ampoule breaker |
| 4 | Blunt needle/blunt needle with filter | 2 | procainamide inj 100mg/mL, 10 mL |
| **Drawer #4** | | | |
| 2 | Plastic bucket for ice *(on top of the cart)* | 4 | ABG kit |
| 8 | Plastic bags for ice *(obtain ice from 4West or PACU)* | 4 | 3 mL Lavender top blood tube |
| 2 | Lactated Ringers 1000 mL | 4 | 6 mL purple top blood tube |
| 2 | Normal Saline 1000 mL | 4 | Gold top blood tube |
| 2 | Normal Saline 250 mL | 4 | Green top blood tube |
| 1 | Vacutainer for blood sample collection | 4 | Grey top blood tube |

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| 1 | Tourniquet for blood samples collection | 4 | Blue top blood tube |
| **Drawer #5** | | | |
| 2 | Arterial Line Pressure monitoring Kit | 1 | CVP Kit (2 lumen) |
| 2 | Alaris Pump med administration set | 3 | Tegaderm dressing |
| 2 | Arrow Arterial catheter set with guide wire 20g | 2 | SecurAcath, CVP anchoring device, 8 Fr |
| 2 | Arrow Arterial catheter set with guide wire, 22g | 1 | Pressure bag, artline |
| **Drawer #6** | | | |
| 4 | Instant cold pack (Large) | 1 | 3-way Foley catheter 18 Fr /20 Fr |
| 2 | NG tube 16 Fr | 2 | Foley Catheter Tray |
| 2 | Toomey Syringe | 1 | Y-type bladder irrigation set & Foley catheter bag |
| 5 | Lubricant Gel | | |
| **Drawer #7** | | | |
| 2 | Vapor Clean Filters | 1 | Anesthesia breathing circuit, bag and filter |
| **OR Fridge** | | | |
| 1 | Regular Insulin 100 units – OR refrigerator *( extra from PACU Omnicell)* | 6 | Refrigerated Normal Saline irrigation ,500 mL |
| | | 6 | Refrigerated Normal Saline IV solution, 1000 mL |
| **OUTSIDE OR 4** | | | |
| 1 | Cooling machine and blanket | 1 | High Flow Rapid infuser machine |