

MH Resource Kit

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The information contained within is designed for use within Australia & New Zealand only.

1.1 Malignant Hyperthermia Resource Kit

Malignant Hyperthermia (MH) is a rare pharmacogenetic disorder. MH reactions are potentially fatal if prompt appropriate treatment is not instituted.

An MH crisis is increasingly rare and many anaesthetists will not experience one in their practising career. There are many high priority tasks that must be attended to simultaneously.

For these reasons, the group of anaesthetists responsible for MH investigation in Australia and New Zealand (mhanz) have completed the attached MH Resource Kit.

In some cases the recommendations represent re-worked or refined versions of pre-existing documents. The mhanz group acknowledges the staff of Palmerston North Hospital (New Zealand) and the Southern Health Simulation Centre (Victoria) for their contribution to our final package.

The Resource Pack consists of:

MH Education Poster: "MH – You've only got a few minutes"

Pfizer (distributor of Dantrolene) with input from MHANZ have produced a poster for quick reference in an MH crisis.

This poster is designed as a general education resource for all operating theatre staff and can be prominently displayed in your operating location. Additional pdf copies available online – www.malignanthyperthermia.com.au

MH Crisis Task cards:

Based on the aviation safety model, MH task cards are intended as a simple and reliable way to delegate the multiple high priority tasks to available theatre staff. The cards are self-explanatory to staff, even when the task is not their usual job. The cards should be kept with your dantrolene (see recommended contents for "MH box") and distributed by the coordinating anaesthetist to the most appropriate staff members. In some situations staff will be required to complete more than one task card in an MH crisis.

The cards in this document represent a basic template for the management of MH crisis tasks. ***Fill in the appropriate local details on the cooling & logistics task cards.***

MHANZ actively encourages hospitals to modify the contents to suit your local needs.

It is recommended that each A6 card is laminated and the cards has a suitable neck-string attached (to avoid misplacing during a crisis)



The task cards are:

- Co-ordinator - An over-view of all required tasks (print as A4)
- Anaesthetist 1: Resuscitation (print as A6)
- Dantrolene (print as A6) - x 3
- Anaesthetic assistant (print as A6)
- Anaesthetist 2: Lines & Investigations (print as A6)
- Cooling (print as A6)
- Surgical Team (print as A6)
- Logistics (normally the operating suite co-ordinator) (print as A6)

In addition it is recommended that the double-sided A4 sized card entitled "MH Crisis Initial Management" should be attached to each anaesthetic machine. This card will assist an anaesthetist in MH crisis diagnosis and provides initial management guidelines, while the MH box and extra staff are being sent for. As colour coding is helpful, cards should be printed in colour.

Additional Points regarding MH crisis management:

Dantrolene:

Dantrolene stocks:

The mhanz group recommends that a minimum of 24 (20mg) vials of dantrolene are held in any anaesthetising location where triggering anaesthesia is performed. Larger or remote hospitals should carry 36 vials. This stock level represents 2-3 x 2.5mg/kg doses for an average sized adult and is a reasonable compromise between clinical need and economy.

Borrowing from other local hospitals

The mhanz group does not recommend reliance on dantrolene stocks from other hospitals for **initial** crisis management. Early and appropriate doses of dantrolene result in lowest morbidity and mortality. Dosing interval is every 10-15 minutes until signs of hypermetabolism are normalised.

Replenishing supplies after use

Each hospital should consider where additional dantrolene for acute management or replacement will be obtained (recurrence of an MH crisis occurs in up to 25% of patients during the first 24 hours).

Water for mixing Dantrolene:

It is **extremely important** that sterile **water** used for reconstituting dantrolene is **not mistakenly infused** into the patient during an MH crisis. Suggestions to reduce the risk of this life-threatening error include:

- Use of 100ml water for injections plastic bottles
- Use of 250ml bags sterile water to visually distinguish from other safe IV fluid (available from B/Braun, it can be obtained via Biomed Code BPW001. (In New Zealand Ph 0800-833-133)
- Additional labelling of 1000ml bags of sterile water in the MH box
 - e.g. "NOT for Intravenous infusion"

Dantrolene Mixing:

Mixing dantrolene can be time consuming and rapid administration is critical. As many as 36 vials may be required in the acute treatment of a large adult. Staff should practice mixing dantrolene with expired stock. The attached dantrolene task card demonstrates ONE method of reconstituting dantrolene. Newer stocks of Dantrolene may be easier to reconstitute due to a different freeze drying process. Newer stocks are identified by the "flip off" plastic top and Dantrium written in orange (the old stock has Dantrium written in blue).

As many staff as possible should be assigned to mixing dantrolene (hence three task cards). Ensure that ALL other tasks cards are assigned before giving out extra dantrolene cards to staff.

Vial Access Needle:

The BAXA ported "Two-fer drawing up needle" has been recommended for this purpose. It is a 16G short needle with a Huber point. It is available to order from St Ives Medical, PO Box 65-069 Mairangi Bay, Auckland 10, New Zealand, Phone or fax +64 (9) 479-6038. Another alternative is the B.Braun Micro Pin (product code MP2000).

Recommended Contents of an MH box:

A list of contents for a dedicated MH box is given in the attached document. Mobility is essential for the kit. A 50 L Esky/Chilly Bin on wheels is ideal.

Providing safe anaesthesia for a patient who has known or suspected MH susceptibility (1.5):

"Guidelines for managing the patient who is susceptible to malignant hyperthermia (MH)" is a set of recommendations from the mhanz group. Once an operating theatre and anaesthetic machine have been prepared according to instructions and non-triggering anaesthesia is instituted the patient should be treated like all "normal" patients. There is no clinical precedent to suggest that these patients are at risk of an MH crisis.

This document can be incorporated into operating theatre policy documents.

1.2 MH Crisis Initial Management

The most senior anaesthetist present should coordinate crisis management

If an MH crisis is suspected/confirmed (see over):

Declare Emergency (complete or abandon surgery)

Call for **HELP**

Send for the MH box and refrigerated supplies

Turn off volatile agent and remove vaporisers from anaesthetic machine

Hyperventilate with 100% oxygen and high fresh gas flows (>15L/min)

(Do not waste time changing machine or circuit)

Commence intravenous anaesthesia maintenance
eg Propofol infusion (target 4mcg/ml or 30-50ml/hr)

Task Cards: The MH box contains individual task cards for MH crisis management:

Give each available staff member a card (or two) and ask them to complete the self-explanatory instructions.

There are multiple high priority tasks, but

Dantrolene administration is the priority.
(Assign as many staff as possible to this task)

How can I tell if it's really Malignant Hyperthermia?

MH can be difficult to diagnose.

Know who is susceptible:

Malignant Hyperthermia may occur in any patient, including patients who have previously had uneventful general anaesthesia

MH is more likely with: Diagnosed malignant hyperthermia susceptibility after halothane / caffeine contracture test on biopsied muscle, Malignant Hyperthermia susceptible relatives, significantly & consistently raised resting serum CK, several very rare muscle disorders

Know the signs & symptoms:

Not all need to be present to initiate treatment

Early:

Prolonged masseter spasm after suxamethonium

Inappropriately raised end tidal carbon dioxide or tachypnoea during spontaneous respiration

Inappropriate tachycardia

Cardiac arrhythmias, particularly ventricular ectopic beats

Developing:

Rapid rise in temperature (0.5°C per 15 min)

Progressive respiratory and later metabolic acidosis (ABG)

Hyperkalaemia

Profuse sweating

Cardiovascular instability

Decreased SpO₂ or mottling of skin

Generalised muscular rigidity

Late:

"Cola" coloured urine – due to myoglobinuria

Generalised muscle ache (in an awake patient)

Grossly raised serum CK

Coagulopathy

Cardiac arrest

Differential Diagnoses:

Inadequate anaesthesia / machine malfunction

Sepsis or infection

"Thyroid Storm"

Ecstasy or other recreational drugs

Phaeochromocytoma

Neuroleptic Malignant Syndrome

Intracerebral infection or haemorrhage

An arterial blood gas is the single most useful investigation to perform

See over for MH Crisis Initial Management

1.3.1 MH Crisis Management :

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Co-ordinator's Overview

- 1) Check that Vaporiser removed from machine
- 2) Check Fresh Gas Flow > 15L/min
- 3) Hyperventilate with 100% O₂

Anaesthetist 1: Resuscitation	Anaesthesia Assistant	Dantrolene	Anaesthetist 2: Lines & Investigations	Cooling	Logistics	Surgical Team
Dantrolene: 2.5mg/kg every 10-15 minutes	Collect MH Box	20mg / vial	Arterial line	Collect ICE	Call for:	Complete or abandon surgery
TIVA	A-line set-up	2.5mg / kg every 10-15 minutes	Frequent blood tests: ABG U+E CK COAG myoglobin	Collect refrigerated IV fluids & insulin	Additional Anaesthetists	Insert urinary catheter
Hyperkalaemia management	CVL set-up	Reconstitute with 60ml sterile water	Central venous line	Collect defibrillator	Arrange transfer to ICU and call for ICU bed	Expose patient to aid cooling
Arrhythmia management	Restock resuscitation & TIVA drugs		Anaesthetic Record	Cover all exposed parts with ICE		
Renal protection						

* In most cases it is expected that the co-ordinator will be "Anaesthetist 1"

The following are the recommended contents of an MH Box

Dantrolene

- 24 x 20 mg vials of Dantrolene
- Sterile water for injection (2000ml) clearly labelled as unsuitable for IV infusion
eg 250 ml bag from B/Braun or 100ml bottles of sterile water for parenteral injections (Pfizer)
- Drawing up needles (see above)
- 60 ml syringes 5-10

Include information on where to obtain additional dantrolene

Drugs

8.4% sodium bicarbonate (1mmol/ml)
50% dextrose 50 ml
Lignocaine 1%
Amiodarone 300mg

Cold Box in fridge

2 litres normal saline for IV use
Actrapid insulin

Blood tubes for

haematology, coagulation profile
electrolytes, creatinine, urea, creatine kinase (CK)
crossmatch
blood gas syringes

Urine sample pot for myoglobin
Pathology forms (pre-written)

Task Cards

As described in the MH Resource kit instructions

If space in your MH Box allows:

(otherwise, have instructions on where to find)

Urinary catheter

Urinary catheter and hourly urine bag

Monitoring equipment

Arterial line equipment
Central line catheter

1.5 Guidelines for managing the patient who is susceptible to malignant hyperthermia (MH)

The information contained within is designed for use within Australia & New Zealand only.

Who is treated as susceptible?

Patients with one of the following:

1. Previous malignant hyperthermia reaction
2. Positive in vitro contracture test (IVCT) on muscle biopsy
3. Positive DNA test for MH
4. If an IVCT has not been done:
 - a. Relative has positive IVCT
 - b. Patient (with MHS relative) has negative DNA result
- c. Relative with clinical MH reaction

Preparation of a Boyles anaesthesia machine (or equivalent)

Remove vaporiser, replace sodalime with fresh sodalime

Replace hoses and rebreathing bags with new hoses and bags

Flush with 10 L/min oxygen or medical air for at least 20 minutes (at least 30 minutes if isoflurane has been used recently in the anaesthetic machine)¹ through the circuit using a new rebreathing bag as an artificial lung, including the ventilator and carbon dioxide absorber in the circuit.

Anaesthesia Workstation preparation

Different workstations may require longer times for flushing. See the table on next page for your workstation. Manufacturers do not tend to have information on flushing of machines so if your machine is not present on this list you may have to consult the appropriate peer reviewed publication for more information.

Charcoal filters may be effective alternatives to long flush times³

Use a new mask, new LMA or new ETT

Continue to use **HIGH FLOWS** throughout the anaesthetic to avoid accumulation of small quantities of volatile agent

Preferably place MHS patients first on the operating list

Monitoring

During surgery monitor and record temperature and respiratory rate in addition to standard ANZCA guidelines (PS18)

After surgery continue minimum mandatory monitoring as per PS4

All patients should have a temperature recorded on arrival and on leaving PACU

There is no requirement to keep patients in PACU for longer than for standard patient care²

Machine Type	Fresh gas flow (FGF) for flushing	Numbers of minutes to flush	Maintenance FGF during case	Components to change							Reference article
				remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber	replace ventilator diaphragm	replace non-disposable ventilator tube with new or autoclaved	replace CO2 absorber	
Ohmeda modulus 1	10 litres/min	5 minutes	no specific recommendations	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Beebe JJ, Sessler DI: Preparation of anesthesia machines for patients susceptible to malignant hyperthermia. <i>Anesthesiology</i> 1988; 69:395- 400
Ohmeda modulus 2	12 litres/min	15 minutes	no specific recommendations	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				McGraw TT, Keon TP: Malignant hyperthermia and the clean machine. <i>Can J Anaesth</i> 1989; 36:530 -2
Ohmeda Exel Z10	10 litres/min	7 minutes	no specific recommendations	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Prinzhausen H, Crawford MW, O'Rourke J, Petroz GC: Preparation of the Dräger Primus anesthetic machine for malignant hyperthermia-susceptible patients. <i>Can J Anaesth</i> 2006; 53:885-90
Datec/Ohmeda ADU	10 litres/min	30 minutes	no specific recommendations	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Schonell LH, Sims C, Bulsara M: Preparing a new generation anaesthetic machine for patients susceptible to malignant hyperthermia. <i>Anaesth Intensive Care</i> 2003; 31:58 - 62
Narkomed GS	10 litres/min	20 minutes	no specific recommendations								Gunter JB, Ball J, Than-Win S: Preparation of the Dräger Fabius anesthesia machine for the malignant hyperthermia susceptible patient. <i>Anesth Analg</i> 2008; 107:1936 - 45
Dräger Primus/Apollo	10 litres/min	5 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber	replace ventilator diaphragm	replace non-disposable ventilator tube with new or autoclaved		Crawford MW, Prinzhausen H, Petroz GC: Accelerating the washout of inhalational anesthetics from the Dräger Primus anesthetic workstation: Effect of exchangeable internal components. <i>Anesthesiology</i> 2007; 106:289 -94
Dräger Primus	10 litres/min	70 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Prinzhausen H, Crawford MW, O'Rourke J, Petroz GC: Preparation of the Dräger Primus anesthetic machine for malignant hyperthermia-susceptible patients. <i>Can J Anaesth</i> 2006; 53:885-90
Dräger Fabius	10 litres/min	36 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber	replace ventilator diaphragm	replace non-disposable ventilator tube with new or autoclaved		Shanahan, H, O'Donoghue, R, O'Kelly, P, Symott, A, O'Rourke, J. Preparation of the Dräger Fabius CE and Dräger Zeus anaesthetic machines for patients susceptible to malignant hyperthermia. <i>European Journal of Anaesthesiology</i> . 29(5):229-34, 2012 May
Dräger Zeus	10 litres/min	90 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Shanahan, H, O'Donoghue, R, O'Kelly, P, Symott, A, O'Rourke, J. Preparation of the Dräger Fabius CE and Dräger Zeus anaesthetic machines for patients susceptible to malignant hyperthermia. <i>European Journal of Anaesthesiology</i> . 29(5):229-34, 2012 May
Dräger Fabius GS	10 litres/min	104 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Whitty RJ, Wong GK, Petroz GC, Pehora C, Crawford MW:Preparation of the Dräger Fabius GS workstation for malignant hyperthermia-susceptible patients. <i>Can J Anaesth</i> 2009; 56:497-501
Datec/Ohmeda (GE)/Aisys	10 litres/min	90 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Jones,C, Bennett, K, Kim,T, W, Bulger T, F., Pollock, N. Preparation of Datec-Ohmeda Aestiva® and Aisys® anaesthetic machines for use in malignant hyperthermia susceptible patients <i>Anaesth Intensive Care</i> 2012; 40: 490-497
Datec/Ohmeda (GE)/Aestiva	10 litres/min	90 minutes	10 litres/min	remove vapouriser	replace disposable tubing	replace reservoir bag	replace CO2 absorber				Jones,C, Bennett, K, Kim,T, W, Bulger T, F., Pollock, N. Preparation of Datec-Ohmeda Aestiva® and Aisys® anaesthetic machines for use in malignant hyperthermia susceptible patients <i>Anaesth Intensive Care</i> 2012; 40: 490-497

Drugs that **MUST** be avoided with MHS patients

1. Depolarising muscle relaxants (ie suxamethonium)
2. **ALL** potent inhalational agents – including; desflurane, sevoflurane, isoflurane, enflurane, halothane, methoxyflurane

Drugs that can be used with MHS patients

ALL other pharmacological agents are safe including the following common drugs

nitrous oxide (and xenon)
propofol and all intravenous induction agents including ketamine and benzodiazepines, nondepolarising muscle relaxants, all local anaesthetics with or without adrenaline, opioids and other analgesics, syntocinon, ergometrine, magnesium sulphate, ephedrine, metaraminol, phenylephrine

Patients with a negative in vitro contracture test can receive normal anaesthesia

Followup:

Refer patient for IVCT or DNA testing, if not already carried out, to:

*New South Wales: Department of Anaesthesia, Westmead Children's Hospital.
61-2-9845-0000*

New Zealand: Department of Anaesthesia, Palmerston North Hospital. 64-6-356-9169

Victoria: Department of Anaesthesia, Royal Melbourne Hospital. 61-3-9342-7000

*Western Australia: Department of Anaesthesia, Royal Perth Hospital.
61-8-9224-1038*

References:

1. Schonell LH, Sims C, Bulsara M. **Preparing a new generation anaesthetic machine for patients susceptible to malignant hyperthermia.** *Anaesth Intensive Care* 2003;31:58-62
2. Pollock N, Langton E, Macdonell N, Tiemessen J, Stowell K **Malignant Hyperthermia and day stay anaesthesia** *Anaesth Intensive Care* 2006;34:40-45
3. Birgenheier, Nathaniel MD; Stoker, Robert BA; Westenskow, Dwayne PhD; Orr, Joseph PhD. **Activated Charcoal Effectively Removes Inhaled Anesthetics from Modern Anesthesia Machines.** *Anesthesia & Analgesia.* 112(6):1363-1370, June 2011.