Whittington Health NHS

A Whittington Hospital Clinical Management Guideline

Malignant Hyperthermia Management

Subject:	Management of Malignant Hyperthermia
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Target Audience:	Anaesthetists, Anaesthetic nurses, Operating department Practitioners
Key Words:	Malignant Hyperthermia

Version Control Sheet

Version	Date	Author	Status	Comment
2.0	April 2015	S. Nicholson, S Makinde ST5 & consultant anaesthetist	LIVE	• Appendix 1: MH Crisis Task Allocation List • Appendix 3: Paediatric administration of Dantrolene • Update about cooling methods available within the hospital

➢ CONTENTS

➢ MANAGEMENT OF A MALIGNANT HYPERTHERMIA CRISIS

The successful management of a Malignant Hyperthermia (MH) crisis depends upon an awareness of MH by anaesthetists, early diagnosis and prompt treatment. It also requires multiple simultaneous actions that are made easier through effective teamwork and specific task allocation.

➢ RECOGNITION. CONSIDER MH IF:

1. Masseter muscle spasm after suxamethonium.

2. Unexplained increase in end-tidal carbon dioxide ($ETCO_2$) **AND**

3. Unexplained tachycardia **AND**

4. Unexplained increase in oxygen requirement.

(Temperature changes are a late sign)

➢ IMMEDIATE MANAGEMENT

1. **STOP** all trigger agents (i.e. all anaesthetic vapours).

2. **CALL FOR HELP.**

3. 'Declare the Emergency'. State to the theatre team (surgeons and ancillary staff) that you believe MH, an anaesthetic emergency, is occurring so that everyone is aware.

4. The anaesthetist diagnosing MH or the most senior anaesthetist present should assume the role of clinical leader and allocate specific tasks to avoid becoming focused on a single task (use the action plan in the MH kit).

5. Hyperventilate with 100% O_2. Set the anaesthetic machine oxygen to the highest flow to flush out volatile agent and expired CO_2.

6. Install a clean breathing circuit and disconnect the vaporizer from the anaesthetic machine (There is no alternative vapour-free anaesthetic machine available).

7. Maintain anaesthesia with a propofol infusion.

8. Ask the surgeons to abandon or finish surgery as soon as possible.

9. Maintain muscle relaxation with a non-depolarising neuromuscular blocking drug.

➢ MONITORING & TREATMENT

1. Collect the MH kit. There are 4 kits in total in the hospital. These are located in:

    1) Main theatres recovery area,
    2) Day Treatment Centre recovery area,
    3) Emergency Department and
    4) Labour ward.

2. Draw up the **dantrolene.**

3. Give an **immediate** intravenous (iv) bolus of dantrolene 2.5 mg/kg.

    For a 70 kg adult:

    • Initial bolus (2.5 mg/kg): 9 vials dantrolene (A total amount of 180 mg as each vial contains 20 mg and is mixed with 60 ml sterile water).

    For Paediatric dose see Paediatric administration of dantrolene below.

4. Give **additional** boluses of 1 mg/kg iv PRN until cardiac and respiratory systems stabilize (severe cardiac arrhythmias and cardiac arrest can occur). The maximum dose of 10 mg/kg may need to be exceeded.

    For a 70 kg adult:

    • Additional boluses (1 mg/kg): 4 vials dantrolene (A total amount of 80 mg).

5. Send a runner to collect a **second kit** from one of the alternative locations as each kit contains a total of 12 vials of dantrolene.

6. Measure arterial blood gases (approx every 30 mins initially), potassium (K+), creatinine kinase (CK), full blood count (FBC), coagulation screen and cross match.

7. Monitor core and peripheral temperatures, $ETCO_2$, SpO_2, ECG.

8. Site arterial lines and central venous catheter.

9. Catheterise and measure urine output and myoglobin levels.

10. Initiate active cooling while avoiding vasoconstriction:

• General Methods:

    • Infusion of cold iv solutions according to Resuscitation Council UK guidelines for therapeutic hypothermia: 30 ml/kg of 4°C 0.9% sodium chloride or Hartmann's solution.

    • Application of ice to the axillae and groin.

    • Switch warming blanket to a cool temperature.

- Cold fluids into bladder via urinary catheter.
- Cold fluids into stomach via NGT.
- Consider cold peritoneal lavage if cavity open.

- Specific methods:
  - Laerdal MediCool System available in the Emergency Department: external cooling blankets and pad.
  - Criticool Therapeutic Hypothermia System available in ITU: cold water body wraps.

11. **Treat**:

- **Hyperkalaemia:** Calcium gluconate 10% 10 ml, Glucose 50% 50 ml, Insulin 10 -15 units iv, Sodium bicarbonate 8.4% 50 ml.
- **Arrhythmias:** Magnesium 8 mmol (2g) / Amiodarone 300mg / Metoprolol 50 mg (AVOID calcium channel blockers due interaction with dantrolene).
- **Metabolic acidosis:** Hyperventilate, $NaHCO_3^-$ 1.26%.
- **Myoglobinaemia:** Forced alkaline diuresis (Mannitol 1g/kg or Frusemide 0.5 - 1 mg/kg & $NaHCO_3^-$ 1.26% infusion). Aim for a urine output of more than 2 ml/kg/hr and a pH greater than 6.5. Consider renal replacement therapy.
- **DIC**: FFP, Cryoprecipitate, Platelets.

For Paediatric doses see Paediatric administration of supportive therapy below.

➢ FOLLOW UP

1. Continue monitoring on ICU.
2. Repeat dantrolene as necessary.
3. Monitor for acute kidney injury and compartment syndrome.
4. Repeat CK.
5. Consider alternative diagnoses and do the appropriate investigations e.g. phaeochromocytoma (vanillyl mandelic acid), thyroid storm (thyroid function tests), sepsis (white cell count, chest X-ray).
6. Consider the possibility of myopathy: neurological opinion, electromyography.
7. Consider the possibility of neuroleptic malignant syndrome.
8. Consider the possibility of recreational drug ingestion (ecstasy).
9. Counsel the patient & family members regarding the implications of MH.

10. Refer the patient to the UK MH Investigation Unit, Academic Unit of Anaesthesia, Clinical Sciences Building, St James' University Hospital Trust, Leeds LS9 7TF. Direct line: 0113 206 5270. Emergency Hotline: 07947 609601. Alternatively, contact Professor P Hopkins or Dr Halsall via hospital switchboard: 0113 243 3144.

11. If a patient presents with a first incident then enter details on the yellow sheet in front of medical notes.

➢ PAEDIATRIC ADMINISTRATION OF DANTROLENE

1. Mix 20 mg (1 vial) of dantrolene with 60 ml (3 vials) of sterile water to make a solution of 1 mg in 3 ml.

2. Give an initial bolus of 7.5 ml/kg (2.5 mg/kg) of the dantrolene solution.

For a 10 kg infant:

• Initial bolus of 75 ml (2.5 mg/kg) of dantrolene solution.

3. Repeat further doses of 3 ml/kg (1 mg/kg) up to a maximum of 30 ml/kg.

For a 10 kg infant:

• Additional boluses of 30 ml (1 mg/kg) of solution as required up to a maximum of 300 ml (10 mg/kg) in total.

➢ PAEDIATRIC ADMINISTRATION OF SUPPORTIVE THERAPY

• **Maintenance of Anaesthesia:**

• Use Benzodiazepines and Opioids because Propofol TIVA is contraindicated in critically ill children.

• **Hyperkalaemia:**

• Calcium gluconate 10% 0.5 ml/kg to a maximum of 20 ml, 10% Dextrose 5 ml/kg, Insulin 0.1 units/kg over 20 minutes. Monitor blood sugar

• **Arrhythmias**

• Magnesium 0.2 mmol/kg (50 mg/kg) given slowly iv not exceeding 10 mg/kg/min.

• Amiodarone 5 mg/kg over 20 mins. Then 300 micrograms/kg/hour. Max 1.2 g in 24 hours.

• Esmolol loading dose 500 mcg/kg over 1 minute. Then an infusion of 50 mcg/kg/min over 4 mins. Reload with 500 mcg/kg if inadequate response and increase infusion by 50 mcg/kg/min. Repeat until effective or a maximum infusion of 200 mcg/kg/min is reached.

• AVOID calcium channel blockers due to interaction with dantrolene.

• **Metabolic acidosis**

• Sodium bicarbonate 0.5 - 1.0 mmol/kg (0.5 - 1.0 ml/kg of 8.4% $NaHCO_3^-$)

• **Urine output**

• Need to maintain urine output at least 2 ml/kg/hr. If required use Mannitol 0.5 - 1.0 g/kg (2.5 - 5.0 ml/kg of 20% solution) and / or Frusemide 1 mg/kg iv.

• **DIC**

• FFP 10 ml/kg,

• Cryoprecipitate 5 ml/kg up to 30 kg body weight. 5 units at a time are issued to children > 30 kg.

• Platelets 10 ml/kg up to 30 kg body weight. 1 pool if > 30 kg.

➢ ANAESTHESIA FOR PATIENTS WITH KNOWN MH SUSCEPTIBILITY

1. Consider regional method.

2. If administering general anaesthesia:

    • Avoid suxamethonium and volatile anaesthetics.

    • Use total intravenous anaesthesia.

    • Prepare a 'clean anaesthetic machine' as there is no dedicated MH machine in the department:

        • Change soda lime.

        • Remove all vaporizers.

        • Change the gas hose.

        • Flush the machine with 10 L of air for a minimum of 10 minutes.

➢ References

- Association of Anaesthetists of Great Britain and Ireland and the British MH Association
- The UK MH Investigation Unit, Leeds

Appendix 1

➢ MH Crisis Task Allocation List

The successful management of a malignant hyperthermia crisis requires multiple simultaneous treatment actions. This is made far easier through effective teamwork and specific task allocation.

1st anaesthetist - the anaesthetist who makes the diagnosis.

- Commence immediate management
- Assume the role of team leader *or* hand this role over to a more senior anaesthetist, as appropriate

Team Leader - allocate duties and take a 'helicopter' view - avoid being focused on a specific task

2nd anaesthetist - resuscitation

- Ensure dantrolene is given in correct doses (2.5 mg/kg initially and then 1 mg/kg every 10 – 15 mins)
- Commence TIVA
- Management of hyperkalaemia
- Management of arrhythmias
- Management of acidosis
- Renal protection (forced alkaline diuresis)

1st anaesthetic nurse / ODP

- Collect MH kit
- Collect cold saline & insulin
- Set up lines (arterial / CVC)
- Runner for resuscitation drugs / equipment

2nd anaesthetic nurse / ODP (ideally 2 people)

- Draw up dantrolene as requested by anaesthetist in charge

3rd anaesthetist - lines / investigations

- Site arterial line
- Send bloods for:
    - ABG - repeated approx every 30 mins initially
    - U&Es
    - CK
    - FBC
    - Coagulation screen
    - Cross match
- Central venous access
- Urinary myoglobin
- Monitor core and peripheral temperatures

Surgical team

- Catheterise
- Complete / abandon surgery as soon as feasible
- Undertake cooling manoeuvres e.g. cold bladder irrigation, peritoneal lavage

Health Care Assistant / Runner - fetch additional MH kit from alternative locations

- Main theatres recovery area,
- Day Treatment Centre recovery area,
- Emergency Department and
- Labour ward.

Appendix 2

➢ MH MANAGEMENT KIT

- Management of MH crisis guideline
- Task allocation list x 6
- Dantrolene: 12 vials (20 mg per vial)
- Sterile water: 40 vials (20 ml per vial). Mix 3 vials water (60 ml) per 1 vial dantrolene (20 mg)
- 50 ml syringe x 6
- Hypodermic & blunt drawing up needles
- Vacutainer x 1
- Blood bottles:
    - FBC x 2
    - Coagulation x 2
    - Biochemistry x 2
    - Group & Save x 2
- Arterial blood gas syringes x 4
- HemoCue microcuvettes x 1
- Urine sample bottle for CK & myoglobin x 1
- Arterial cannulae and transducer set x 1
- Central venous cannulae and transducer set x1
- Sodium chloride 0.9% 500 ml x 1
- Giving set for saline x 2
- Giving set for blood x 2
- Breathing circuit HME filter x 2
- Breathing circuit catheter mount x 3

Appendix 3

➢ PAEDIATRIC ADMINISTRATION OF DANTROLENE

Child's weight (kg)	**Volume (ml)** **Initial dose:** **2.5 mg/kg (7.5 ml/kg)**	**Volume (ml)** **Additional boluses:** **1 mg/kg (3.0 ml/kg)**	**Maximum (ml)** **10 mg/kg (30 ml/kg)**
5	37.5	15	150
10	75	30	300
15	112.5	45	450
20	150	60	600
25	187.5	75	750
30	225	90	900
35	262.5	105	1050
40	300	120	1200
45	337.5	135	1350
50	375	150	1500

To be completed and attached to any procedural document when submitted to the appropriate committee for consideration and approval

		Yes/No	Comments
1.	**Does the procedural document affect one group less or more favourably than another on the basis of:**		
	• Race	No	
	• Ethnic origins (including gypsies and travellers)	No	
	• Nationality	No	
	• Gender	No	
	• Culture	No	
	• Religion or belief	No	
	• Sexual orientation including lesbian, gay and bisexual people	No	
	• Age	No	
	• Disability - learning disabilities, physical disability, sensory impairment and mental health problems	No	
2.	**Is there any evidence that some groups are affected differently?**	No	
3.	**If you have identified potential discrimination, are any exceptions valid, legal and/or justifiable?**	No	
4.	**Is the impact of the procedural document likely to be negative?**	No	
5.	**If so can the impact be avoided?**	N/A	
6.	**What alternatives are there to achieving the procedural document without the impact?**	N/A	
7.	**Can we reduce the impact by taking different action?**	N/A	

If you have identified a potential discriminatory impact of this procedural document, please refer it to the Director of Human Resources, together with any suggestions as to the action required to avoid/reduce this impact.

For advice in respect of answering the above questions, please contact the Director of Human Resources.

Checklist for the Review and Approval of Procedural Document

To be completed and attached to any procedural document when submitted to the relevant committee for consideration and approval.

	Title of document being reviewed:	Yes/No	Comments
1.	**Title**		
	Is the title clear and unambiguous?	Yes	
	Is it clear whether the document is a guideline, policy, protocol or standard?	Yes	
2.	**Rationale**		
	Are reasons for development of the document stated?	Yes	
3.	**Development Process**		
	Is it clear that the relevant people/groups have been involved in the development of the document?	Yes	
	Are people involved in the development?	Yes	
	Is there evidence of consultation with stakeholders and users?	Yes	
4.	**Content**		
	Is the objective of the document clear?	Yes	
	Is the target population clear and unambiguous?	Yes	
	Are the intended outcomes described?	Yes	
5.	**Evidence Base**		
	Are key references cited in full?	N/A	
	Are supporting documents referenced?	N/A	
6.	**Approval**		
	Does the document identify which committee/ group will approve it?	Yes	
7.	**Dissemination and Implementation**		
	Is there an outline/plan to identify how this will be done?	Yes	
8.	**Document Control**		
	Does the document identify where it will be held?	Yes	

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9.	**Process to Monitor Compliance and Effectiveness**		
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	Is the review date identified?	Yes	
	Is the frequency of review identified? If so is it acceptable?	Yes	
11.	**Overall Responsibility for the Document**		
	Is it clear who will be responsible for co-ordinating the dissemination, implementation and review of the document?	Yes	

Executive Sponsor Approval			
If you approve the document, please sign and date it and forward to the author. Procedural documents will not be forwarded for ratification without Executive Sponsor Approval			
Name		Date	
Signature			
Relevant Committee Approval			
The Director of Nursing and Patient Experience's signature below confirms that this procedural document was ratified by the appropriate Governance Committee.			
Name		Date	
Signature			
Responsible Committee Approval – only applies to reviewed procedural documents with minor changes			
The Committee Chair's signature below confirms that this procedural document was ratified by the responsible Committee			
Name		Date	
Name of Committee		Name & role of Committee Chair	
Signature			

Tool to Develop Monitoring Arrangements for Policies and guidelines

What key element(s) need(s) monitoring as per local approved policy or guidance?	Who will lead on this aspect of monitoring? Name the lead and what is the role of the multidisciplinary team or others if any.	What tool will be used to monitor/check/observe/Assess/inspect/ authenticate that everything is working according to this key element from the approved policy?	How often is the need to monitor each element? How often is the need complete a report ? How often is the need to share the report?	What committee will the completed report go to?
Element to be monitored	**Lead**	**Tool**	**Frequency**	**Reporting arrangements**
The contents of the MH kits will be checked annually **Checking adherence to the guideline is very difficult as it is a very rare phenomenon (up to 1 in 50, 000 anaesthetics)**	**Clinical lead for anaesthesia**	**Manual check**	**annual**	