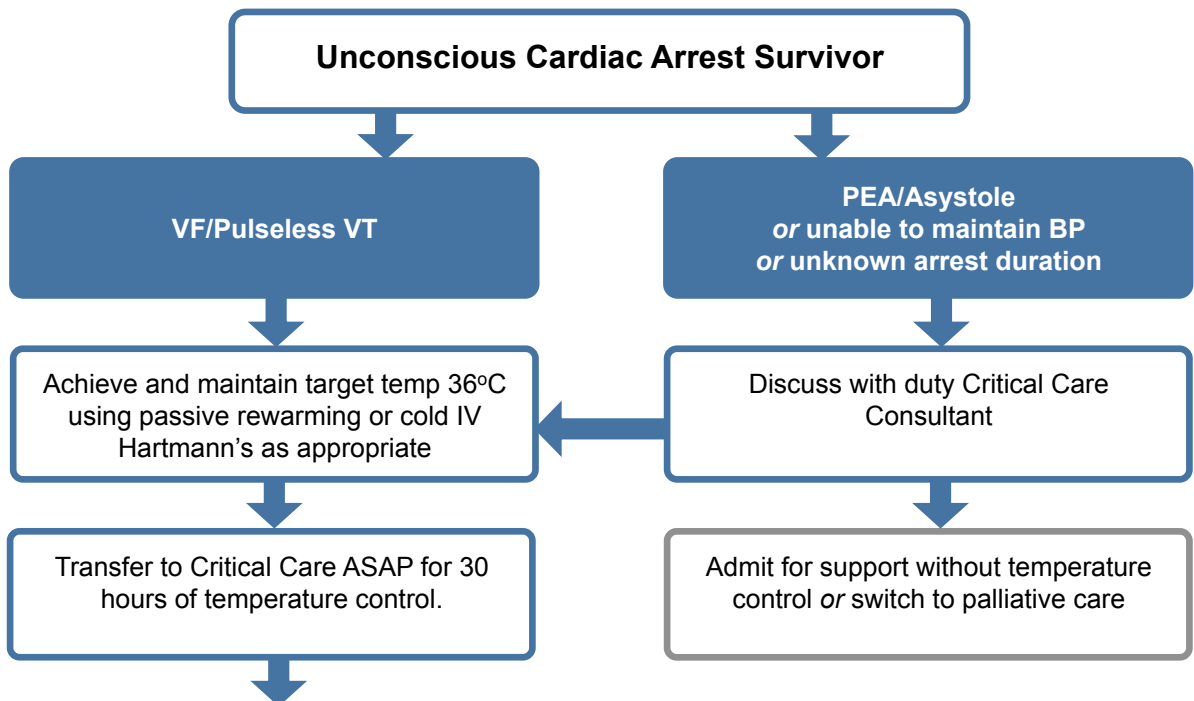


Temperature Control after Cardiac Arrest

Aim To provide guidance on therapeutic temperature control in Critical Care to improve neurological outcome after cardiac arrest
Scope All patients admitted to Critical Care after witnessed VT/VF arrest. Patients with non-VT/VF arrest may also be included at the discretion of the duty consultant for Critical Care.

Goals of Temperature Control

1. Rapidly achieve and maintain a core body temperature of 36°C when circulation is restored after arrest.
2. Maintain this temperature at a steady state for 30 hours after the initiation of temperature control.
3. Provide an excellent standard of critical care support and other neuroprotective measures.



Temperature Control at 36°C

- Use Coolguard device set to 36°C in Critical Care
- If patient presents cold, allow controlled rewarming to 36°C at 0.5°C/h using Coolguard.
- Establish continuous temperature monitoring
- Maintain deep sedation using propofol + opioid
- Use lactate clearance to guide shock resuscitation
- Control shivering with surface warming or neuromuscular blocking drugs
- Maintain standard neuroprotective measures including MAP >80 mmHg, normoglycaemia, normal PaO₂ (8-12 kPa) and normal PaCO₂ (4.5-5.3 kPa)

Rewarming

- Stop sedation 30 hrs after initiation of therapeutic normothermia.
- Use continued active cooling to prevent rebound hyperthermia. This should be vigorously guarded against, eg by using Coolguard set at 36.5-37°C for 24 hrs after the first 30 hr period has finished.

Version: 2.1 | Date: 26 Jan 14 | Revision Due: 26 Jan 15 | Authors: Dr D Pogson, SN Claire Davies

The use of this guideline is subject to professional judgement and accountability. This guideline has been prepared carefully and in good faith for use within the Department of Critical Care at Queen Alexandra Hospital. No liability can be accepted by Portsmouth Hospitals NHS Trust for any errors, costs or losses arising from the use of this guideline or the information contained herein. Portsmouth Hospitals NHS Trust © 2014

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1. INTRODUCTION

Mild therapeutic hypothermia had been shown to be the most important post cardiac arrest therapy to reach clinical application in recent times.¹ After successful animal studies in the 1980's, three randomised control trials (RCTs) reported higher rates of favourable neurological outcome associated with the use of mild hypothermia.^{2,3,4} The largest study also observed an increase in survival. A subsequent Meta analysis⁵ concluded that the number needed to treat for patients in cardiac arrest with an initial rhythm of VF/VT was six. The TTM trial has subsequently confirmed that control to 36°C is equally effective as 33 °C.¹⁶

2. PURPOSE

The purpose of this guideline is to provide an evidence-based framework for use in critically ill patients with the aim of improving their neurological outcome following witnessed VT/VF cardiac arrest.

3. SCOPE

This guideline applies to all critical care patients admitted to DCCQ following witnessed VT/VF cardiac arrest, including patients admitted via ED and other ward areas. This should be implemented at the earliest opportunity possible by experienced practitioners e.g. by the ED senior medic or critical care transfer team. Subsequent management should continue in the critical care department and should be the responsibility of experienced medical and nursing personnel. This guideline is subject to professional judgement and accountability.

4. DEFINITIONS

AHA: American Heart Association
 DCCQ: Department of Critical Care Queen Alexandra Hospital
 DNAR: Do Not Attempt Resuscitate
 ED: Emergency Department
 ERC: European Resuscitation Council
 HME: Heated moisture exchange filter
 ILCOR: International Liaison Committee on Resuscitation
 IV: Intra-Venous
 MAP: Mean Arterial Pressure
 OOH: Out of Hospital
 PEA: Pulseless Electrical Activity
 RCT: Randomised Control Trial
 ROSC: Return of Spontaneous Circulation
 TOF: Train of Four
 VF: Ventricular Fibrillation
 VT: Ventricular Tachycardia

5. DUTIES AND RESPONSIBILITIES

- The decision to implement this guideline is at the discretion of the on-call critical care consultant.
- Implementation of this guideline is the joint responsibility of appropriate critical care medical/nursing staff.
- This guideline is subject to professional judgment and accountability.
- Subsequent medical management may be influenced by predicted neurological outcome (see appendix 1)

6. PROCESS

Action	Rationale
<p>Inclusion Criteria</p> <ul style="list-style-type: none"> *Witnessed cardiac arrest in VT/VF with ROSC in or out of hospital * Unconscious patient with no responses to pain or eye opening (no waiting period required) <p>*Systolic blood pressure of 90mmHg maintained with or without fluids and/or Inotropes</p>	<p>Only this group of patients have been shown to benefit from temperature control⁶ The duration of arrest correlates poorly with outcome.</p> <p>To prevent further neurological impairment.⁶</p>
<p>Exclusion Criteria</p> <ul style="list-style-type: none"> *Other causes of coma e.g. status epilepticus, hypoglycaemia *Known terminal illness *Valid DNAR status *Active haemorrhage *Isolated respiratory arrest without cardiac arrest *Refractory shock unresponsive to Inotropes * PEA/Asystole should only be cooled after discussion with the DCCQ consultant in charge 	<p>There is no proven clinical benefit in these situations. Scandinavian Society of Anaesthesiology and Intensive Care Medicine (SSAI) recommend that cooling should not necessarily be ruled out in these cases, but there is conflicting evidence.</p>
<p>Pre DCCQ Guidance</p> <ul style="list-style-type: none"> *Patients should be intubated and ventilated using appropriate drugs if necessary. *Patients should be maintained strictly at 36 °C once the above criteria are met *Cooling must commence in the ED for OOH arrest or at the site of resuscitation for intra-hospital arrest in the event of presentation over 36 °C *Patients in refractory shock unresponsive to inotropes should be discussed with the duty DCCQ consultant as soon as possible *To achieve immediate cooling in patients over 36 °C use up to 30ml/kg Hartmann's solution stat IV at 4 degrees Celsius via peripheral cannula. (This is kept in fridges in ED) *Dysrhythmias or pulmonary oedema are rare and do not preclude cold IV fluids *Record clearly the time ROSC was achieved or the time of admission if unknown 	<p>For airway protection and to minimise neurological activity</p> <p>36 °C in accordance with the TTM trial. This is done rapidly to maximise neurological protection⁶</p> <p>To maximise the benefit of cooling on neurological outcome.⁶</p> <p>No proven clinical benefit at present</p> <p>Almost all arrests actually present cold, but fever is deleterious. Immediate cooling is best achieved using cold IV fluids⁶ Central line administration of cold fluids risks cardioplegia¹⁰</p> <p>Cooling below 30C can precipitate dysrhythmias.</p> <p>To accurately time 30 °C of normothermia to 36 °C</p>

<p>...Pre DCCQ Guidance (continued)</p> <p>*Rectal, bladder, oesophageal or tympanic (not axillary) temperature should be monitored continuously</p>	<p>To achieve accurate recording of temperature⁵</p>
<p>In DCCQ Guidance</p> <p>*The patient should be mechanically ventilated but the ventilator humidifier turned off. HME filters can be used instead</p> <p>*Propofol should be used in acute brain injury to maintain a sedation score of -4 (Please refer to DCC peripheral nerve stimulator and sedation guidelines)</p> <p>*Arterial pressure should be monitored and a MAP >80mmHg maintained with fluids and vasopressors. Hypotension must be avoided. Cooling will raise MAP.</p> <p>*Use lactate clearance and SvO₂ to assess shock resolution. Do not target CI>3.5.</p> <p>*Proceed with the insertion of the 'IcyCath' central venous cooling catheter (refer to detailed instructions on catheter insertion) and use of 'coolguard' system (instructions attached to machine). Insertion of IcyCath should be by an experienced practitioner e.g. DCC Registrar or Consultant.</p> <p>*Aim to achieve core temperature of 36°C for 30 hrs</p> <p>*The medicool cooling kit is placed as per enclosed instructions (see appendix 2)</p>	<p>Use of a heated humidified circuit with the ventilator, could further increase patient temperature</p> <p>To promote patient comfort, prevent shivering and to minimise neurological activity⁶ Midazolam should be reserved for unstable CVS. Propofol is redistributed whereas midazolam metabolism is cytochrome dependent and may therefore be prolonged.</p> <p>To maintain adequate circulation, renal and cerebral perfusion.⁹</p> <p>CI is unreliable in cooled subjects as the HR falls, but cardiac performance improves whilst cooled. Clinical signs of hypoperfusion are also unreliable. Serial echocardiography may be useful before commencing inotropes.</p> <p>This is the preferred temperature control equipment for DCCQ. Equipment consumable costs are high and it is important to achieve a first-time successful line placement where possible.</p> <p>TTM Trial protocol</p> <p>These are other accepted methods for cooling⁶ if the patient exceeds 36 °C and the IcyCath is unavailable.</p>

<p>...In DCCQ Guidance (continued)</p>	
<p>*Shivering may occur during cooling . Shivering can be controlled with surface counterwarming using a warm air blanket or with neuromuscular blocking drugs given as a bolus, with or without infusion. TOF monitoring must be used if these drugs are used. (Please refer to DCCQ peripheral nerve stimulator and sedation guideline). Tramadol, Pethidine and Magnesium Sulphate have also been used successfully. Seek senior medical advice if shivering persists</p>	<p>Guidelines as per ILCOR, ERC and AHA recommendations^{6,7,8}</p> <p>Shivering may prevent patient from ventilating adequately, prevent accurate monitoring, cause patient discomfort, will increase overall oxygen consumption and may cause patient's temperature to rise or plateau (or prevent it from lowering). Surface warming will stop shivering without raising core temperature if IV normothermia is used, particularly over the hands,feet and face.⁷</p>
<p>*Cardiac medications including aspirin, anti-arrhythmias, thrombolysis and cardiac catheterisation/PCI should be considered urgently if indicated. Seek senior medical advice prior to administering</p>	<p>To prevent cardiac instability and to commence secondary protection against further MI¹¹ (11) See DCCQ Standard Operating Procedure on PCI in Critical Care patients.</p>
<p>*If cardiac catheterisation is considered avoid cannulating the right radial or femoral arteries if possible</p>	<p>These are preferred sites for cardiac catheterisation</p>
<p>*Temperature rises should be identified and treated. Seek senior medical advice if cooling techniques do not lower temperature. Use the graph function on the CoolGuard to assess how hard it is working to achieve hypothermia.</p>	<p>Even short rises in temperature may worsen neurological outcome.⁶</p>
<p>*Critical care nursing should include specific attention to care related to immobility and potential for raised intracranial pressure e.g. pressure area care and neuroprotective measures</p>	<p>Prevention of pressure areas due to immobility and cooling.</p>
<p>* Avoid hypoxia, superoxia and hypocarbia. Aim for PaO₂ 8-12 kPa and normocarbia PaCO₂ 4.5-5.3 kPa.</p>	<p>Accepted neuroprotective measures include 30 degree head elevation, ET tube secured with tape, EtCO₂ 4.5kpa¹² There is a U shaped survival curve with worse mortality at extremes of PaO₂ and PaCO₂</p>
<p>*There is no evidence that feeding during the cooling period has any benefit. There is a risk of overfeeding as the metabolic rate is greatly reduced. Usual feeding should commence after rewarming.</p>	<p>.</p>

<p>Management of re-warming</p> <p>*If patients present hypothermic, warm to 36 °C no faster than 0.5 °C /hr. Aim to re-warm by 0.5°C per hour if possible using IV cooling device if it is in situ.</p> <p>* At 30 hrs of therapeutic normothermia, turn on ventilator heater/humidifier</p> <p>*Passive re-warming by removing ice packs or jacket if used as method for cooling</p> <p>*Cease sedative drugs at 30 hrs and assess neurological function and patient safety. Recommence if indicated.</p> <p>*Continued cooling at 36°C to maintain normothermia is likely to be necessary in the first 24hours post re-warming, due to the risks of rebound hyperthermia. Use the graph function to see how hard the CoolGuard is working to achieve normothermia.</p> <p>*'Icycath' device should be removed once IV temperature control and re-warming is complete and replaced with CVC if necessary. This may be 24-48h after re-warming if there has been rebound hyperthermia, <i>i.e</i> 72h total. Consultant approval is required to use the line for longer.</p>	<p>Guidelines as per ILCOR, ERC and AHA recommendations^{6,7,8}</p> <p>To prevent or treat rebound hyperthermia⁶ A faster rate of re-warming has been associated with poorer outcome.</p> <p>To reduce risks associated with rebound hyperthermia (further brain damage can occur with rebound hyperthermia)⁶</p> <p>To reduce risk of infection/bleeding.</p> <p>Manufacturers recommendations.</p>
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7. TRAINING REQUIREMENTS

All members of medical and nursing staff, who would be required to manage the care of patients following cardiac arrest, will be given training on appropriate methods available to achieve active cooling in critically ill patients, subsequent clinical care and re-warming procedures. Staff will be shown this guideline and how to access it via Critical Care online resources.

8. MONITORING COMPLIANCE WITH, AND THE EFFECTIVENESS OF, PROCEDURAL DOCUMENTS

This guideline will be reviewed initially at 6 months and thereafter 2 yearly by the DCCQ Guidelines Group. Measurement of compliance will be achieved by unit-based audit. Results reviewed will be fed back to members of the senior medical /nursing team and the Critical Care Governance Group.

9. REFERENCES AND ASSOCIATED DOCUMENTATION

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Appendix A

Neuroprognostication of Cooled Arrest Survivors

Bouwes *et al* in a study of 391 comatose adult arrest survivors treated with therapeutic hypothermia (TH), found that motor response (MR) gave a false outcome prediction in up to 15% of patients.¹³ This confirms other studies that showed MR at 72h gave false positive rates (FPR) of 12-24% for poor prognosis.¹⁴ Full motor recovery may take up to 6 days post cardiac arrest, with sedation and TH as potential confounders. Brainstem reflexes have a higher predictive value than motor responses, but even absent corneal/papillary reflexes may have a FPR of 4-6%. Early myoclonus has a FPR of 3-10% for poor prognosis.

A continuous EEG pattern, without flat periods or burst suppression during hypothermia has been associated with regain of consciousness. Non-reactive EEG background upon painful stimulation is associated with poor recovery. Reactive EEG background is a positive sign. Adding EEG to standard neurological examination improves outcome prediction as early as 12-24h post arrest.¹⁵

Somato-sensory evoked potentials (SSEP) are usually used to confirm a bad prognosis of coma after arrest/TH at 48h. Except in very rare cases, absent bilateral N20s are invariably associated with irreversible coma and poor prognosis (FPR 0-2%). Preserved SSEP is not necessarily associated with a good prognosis. The predictive value of EEG reactivity is superior to SSEP.

For patients in the grey zone with coma but present N20s, a multimodal approach is recommended.

High Neuron Specific Enolase (NSE) is a marker of acute brain damage. Patients with NSE greater than 33 mcg/l at 48-72h may still recover with good long term recovery. Cut off NSE level with FPR of 0% is 78-97 mcg/l. NSE is available (5ml, yellow tube) for £15.40 from Sheffield, via our labs, but takes 3 days for the result.

A subset of patients who have late seizures after the rewarming phase but display EEG reactivity and brainstem activity may survive with good neurological recovery and warrant aggressive therapy with anticonvulsants.

There is currently no evidence to support choice of first line anticonvulsant. Valproate, levotiracetam and phenytoin are widely used according to avoiding their side effects, with approx 60% efficacy in hypoxic brain damage. Addition of a 2nd agent has a limited efficacy of a further 10% or less and propofol should be considered.

Appendix B

Laerdal Medicoool Kit – Instructions for Preparation and Use

(taken from Lateral Medicoool instruction leaflet)

1. Each set has two sets of pads, one in white and one in blue.
2. Each set consists of;
 - A padded chest pad
 - Head bonnet
 - 2x pads for axillae
 - 2x pads for groin
3. Initially soak all pads individually in water for 30-35mins until crystal in pockets become a gel. Pads are now activated for use. Activated pads should be firm but not bursting. Use fingers to distribute gel evenly within pocket.
4. Towel off excess water
5. Place each activated pad in the plastic bags provided. Then place white and blue pad sets in individual plastic bag.
6. Place each pad set into the freezer for a minimum of 2 hours. (freezer located on west side of DCCQ)
7. When required place one set of cooling pads in the same colour, on the patient
8. When kit warms up (after approximately 2 hours) remove the kit from the patient and into the freezer in saved bags.
9. Apply second set of cooling pads onto patient from freezer
10. Continue to alternate kits as long as required.
11. Each kit is for single patient use only and may be discarded when cooling has ceased.

Appendix C

Checklist for the Review and Ratification of Procedural Documents and Consultation and Proposed Implementation Plan

To be completed by the author of the document and attached when the document is submitted for ratification: a blank template can be found on the [Trust Intranet. Home page -> Policies -> Templates](#)

CHECKLIST FOR REVIEW AND RATIFICATION			
TITLE OF DOCUMENT BEING REVIEWED:		YES/NO N/A	COMMENTS
1	Title		
	Is the title clear and unambiguous?	Yes	
	Will it enable easy searching/access/retrieval??	Yes	
	Is it clear whether the document is a policy, guideline, procedure, protocol or ICP?	Yes	
2	Introduction		
	Are reasons for the development of the document clearly stated?	Yes	
3	Content		
	Is there a standard front cover?	Yes	
	Is the document in the correct format?	Yes	
	Is the purpose of the document clear?	Yes	
	Is the scope clearly stated?	Yes	
	Does the scope include the paragraph relating to ability to comply, in the event of a infection outbreak, flu pandemic or any major incident?	No	Ability to comply to some method of cooling should not be affected
	Are the definitions clearly explained?	Yes	
	Are the roles and responsibilities clearly explained?	Yes	
	Does it fulfill the requirements of the relevant Risk Management Standard? (see attached compliance statement)		
	Is it written in clear, unambiguous language?	Yes	
4	Evidence Base		
	Is the type of evidence to support the document explicitly identified?	Yes	
	Are key references cited?	Yes	
	Are the references cited in full?	Yes	
	Are associated documents referenced?	Yes	
5	Approval Route		
	Does the document identify which committee/group will approve it?	Yes	DCCQ Clinical Governance Group
6	Process to Monitor Compliance and Effectiveness		
	Are there measurable standards or KPIs to support the monitoring of compliance with the effectiveness of the document?	Yes	
7	Review Date		
	Is the review date identified?	Yes	
6	Dissemination and Implementation		
	Is a completed proposed implementation plan attached?	Yes	
7	Equality and Diversity		
	Is a completed Equality Impact Assessment attached?	Yes	

Temperature Control after Cardiac Arrest Version 2.1 dated 26 Jan 14

Appendix C
continued

CONSULTATION AND PROPOSED IMPLEMENTATION PLAN			
Date to ratification committee			
Groups /committees / individuals involved in the development and consultation process		DCCQ Guidelines Group Critical Care Governance Group Multidisciplinary staff working in DCCQ (<i>& revised 13 Jan 14</i>)	
Is training required to support implementation?		Yes	
If yes, outline plan to deliver training		Multidisciplinary teaching via unit based teaching teams, regular teaching sessions on Fridays and bedside teaching from experienced staff	
Outline any additional activities to support implementation		Promotion of introduction of guideline via unit based webpage and verbally through presentation at teaching sessions	
Individual Approval			
If, as the author, you are happy that the document complies with Trust policy, please sign below and send the document, with this paper, the Equality Impact Assessment and NHSLA checklist (if required) to the chair of the committee/group where it will be ratified. To aid distribution all documentation should be sent electronically wherever possible.			
Name	Dr David Pogson	Date	10 May 2013
Signature	<i>signed electronically (& revised 13 Jan 14)</i>		
Committee / Group Approval			
If the committee/group is happy to ratify this document, would the chair please sign below and send the policy together with this document, the Equality Impact Assessment, and NHSLA checklist (if required) and the relevant section of the minutes to the Trust Policies Officer. To aid distribution all documentation should be sent electronically wherever possible.			
Name	Dr Nick Tarmey	Date	10 May 2013
Signature	<i>signed electronically (& revised 13 Jan 14)</i>		

If answers to any of the above questions is 'no', then please do not send it for ratification.

Appendix D

Equality Impact Assessment

To be completed by the author of the document and attached when the document is submitted for ratification: a blank template can be found on the [Trust Intranet. Home page -> Policies -> Templates](#)

Title of document for assessment	Therapeutic Cooling following Cardiac Arrest -DCCQ
Date of assessment	02/04/2013 (revised 13 Jan 14)
Job title of person responsible for assessment	Dr D Pogson
Division/Service	DCCQ / CHAT CSC

	Yes/No	Comments
Does the document affect one group less or more favorably than another on the basis of:		
Race	No	
Gender (including transgender)	No	
Religion or belief	No	
Sexual orientation, including lesbian, gay and bisexual people	No	
Age (for HR policies only)	No	
Disability – learning disabilities, physical disabilities, sensory impairment and mental health problems	No	
Does this document affect an individual's human rights?	No	
If you have identified potential discrimination, are the exceptions valid, legal and/or justified?		

If the answers to any of the above questions is 'yes' you will need to complete a full Equality Impact Assessment (available from the Equality and Diversity website) or amend the policy such that only an disadvantage that can be justified is included. If you require any general advice please contact staff in the Equality and Diversity Department on 02392 288511