## SLHD – CRGH Procedure

### Targeted Temperature Management Post Cardiac Arrest

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<td><strong>Author</strong></td>
<td>Dr Mark Kol, Acting Director Intensive Care</td>
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<tr>
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<td>Induced Hypothermia following Cardiac Arrest 2009</td>
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### Version History

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<thead>
<tr>
<th><strong>Date</strong></th>
<th>Current Version - List all revisions, even if minor.</th>
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Targeted Temperature Management Post Cardiac Arrest

1. **Introduction**
   This procedural guideline describes the temperature management of the unconscious patient who has had a sustained return of spontaneous circulation (ROSC) after a cardiac arrest in Intensive Care.

2. **The Aims / Expected Outcome of this Procedure**
   - To provide guidance for the implementation of targeted temperature management (TTM) in the Intensive Care unit.
   - To reduce the risk of complications related to hypothermia following cardiac arrest.

3. **Risk Statement**
   - Poor neurological outcomes following cardiac arrest.
   - Adverse effects of induced hypothermia.

4. **Procedure Statement**
   Unconscious survivors of cardiac arrest have a high incidence of death or poor neurological outcomes.

   Therapeutic hypothermia (TH) is intended to limit neurological injury. In previous trials, TH with temperatures of 32°C - 34°C has been associated with improved outcomes for out of hospital cardiac arrest (OOHCA) with Ventricular Tachycardia (VT) or Ventricular Fibrillation (VF) as a primary rhythm.

   A recent large well conducted randomised controlled trial (The Targeted Temperature management trial –TTM) found no significant difference in mortality or neurological outcome for patients who were randomised to a target temperature of 36°C versus 33°C.

   A critical message of this trial is that temperature management after cardiac arrest is an important part of management of the post cardiac arrest patient. *Failure to control temperature is associated with worse neurological outcomes in post cardiac arrest survivors.*

   The decision as to whether an individual patient should be treated with therapeutic hypothermia (TH) or Targeted Temperature management (TTM) is at the discretion of the treating Intensivist.

   As the adverse effects of hypothermia will be more pronounced at lower temperatures, this guideline will describe the targeted temperature management at 36°C in the Intensive Care Unit.

5. **Scope**
   - All Clinical Staff in Intensive care at Concord Hospital.

6. **Key Performance Indicators and Service Measures**
   - Adverse incidents are reported via IIMS and managed by the Nurse unit manager or Medical director of the Intensive care, as appropriate.
   - Audit of achieved temperature targets for departmental quality control.

Compliance with this Procedure is Mandatory
7.  Procedures

Principles

At the discretion of the treating Intensivist as to the suitability for an individual patient, unconscious patients or patients not following commands, admitted to the Intensive care unit following cardiac arrest will be treated to achieve targeted temperature management (TTM) for the first **72 hours** following cardiac arrest.

In principle, TTM goals are:

- From 0 to 28 hours post cardiac arrest, a core temperature of 35.0-36.0°C
- From 28 to 36 hours post cardiac arrest patients will thereafter be slowly and passively rewarmed, maintaining a core temperature of <37.0°C.
- From 36 to 72 hours post cardiac arrest, active temperature management will continue maintaining a core temperature of less than 37.5°C.

In summary:

<table>
<thead>
<tr>
<th>Time from Cardiac Arrest</th>
<th>Core temperature aim</th>
</tr>
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<tbody>
<tr>
<td>0 to 28 hours</td>
<td>35.0 - 36.0°C</td>
</tr>
<tr>
<td>28 to 36 hours</td>
<td>Slow passive rewarming to T&lt;37.0°C</td>
</tr>
<tr>
<td>36 to 72 hours</td>
<td>Normothermia, maintaining T&lt;37.5°C</td>
</tr>
</tbody>
</table>

Management

a) Patient selection:

- Patients who are either unconscious or not obeying commands following a cardiac arrest, regardless of the primary rhythm are potential candidates for TTM
- Patients fulfilling these criteria will be intubated, ventilated and sedated during TTM
- Appropriateness for TTM is at the discretion of the treating Intensivist

b) Temperature monitoring:

As the primary intervention is temperature management, continuous and accurate temperature determinations are necessary. Monitoring of core body temperature is indicated in TTM.

Options for core temperature measurement include:

1. Thermistor tipped Foley catheter (preferred, unless oliguric)
2. Intravascular temperature probe (eg: PiCCO, Swan Ganz)
3. Oesophageal temperature probe in the distal 1/3 of the oesophagus
4. Rectal temperature – tip 4cm inside rectum

Note: nasopharyngeal and tympanic temperature measurements are not suitable and should not be used in the post cardiac arrest patient undergoing TTM;

Axillary temperature monitoring is not a suitable surrogate for core temperature measurement. Rectal temperature may lag behind core temperature by up to 1.5°C.

C) Temperature management on admission

- The primary goal at admission is to rapidly achieve and maintain goal temperature.

Compliance with this Procedure is Mandatory
Patients admitted with a core body temperature >36.0°C should be actively cooled to a temperature between 35.0°C - 36.0°C.

The optimal rate of cooling remains to be prospectively identified. Some evidence exists to suggest that delay in initiation and achieving target temperatures are associated with worse neurological outcomes. The Intensivist or provisional fellow should be informed if the temperature goal has not been achieved within 3 hours. This is to identify patients requiring other interventions to achieve the prescribed temperature targets.

Patients admitted with a core body temperature 33.0°C – 35.0°C should be passively rewarmed to achieve a temperature of 35.0°C -36.0°C. (Do not use active warming blankets);

At temperatures below 33.0°C shivering and adaptive responses progressively fail, and passive rewarming becomes inadequate as hypothermia progresses. At temperatures below 30.0°C, the patient’s ability to spontaneously rewarm is lost and active rewarming is essential to prevent progressive hypothermia & death[8].

Patients with core temperatures < 33.0°C will require active rewarming to achieve a temperature of > 33.0°C. Once a temperature of >33.0°C has been reached, active rewarming should cease and passive rewarming should be used[7] (Supplementary material TTM Trial)

In summary: At admission and during the first 28 hours post arrest;

<table>
<thead>
<tr>
<th>Core temperature</th>
<th>Target temperature</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;36.0°C</td>
<td>35.0°C - 36.0°C</td>
<td>Active cooling</td>
</tr>
<tr>
<td>35.0°C - 36.0°C</td>
<td>35.0°C - 36.0°C</td>
<td>Maintenance of goal temperature, <em>may require ongoing active cooling.</em></td>
</tr>
<tr>
<td>33.0°C – 35.0°C</td>
<td>35.0°C - 36.0°C</td>
<td>Passive rewarming</td>
</tr>
<tr>
<td>33.0°C or below</td>
<td>&gt;33.0°C then follow the 33.0°C – 35.0°C recommendation</td>
<td>Active rewarming</td>
</tr>
</tbody>
</table>

**d) Temperature management options**

The optimal means of achieving temperature targets have not been prospectively determined. The following are therapeutic options for achieving and maintaining temperature targets.

**Sedation**

Sedation and analgesia are used to facilitate cooling, tolerance of intubation and ICP control. The clearance of many drugs, including sedation and neuromuscular blockers, are significantly reduced in the presence of hypothermia[9]. To minimise the risk of confounding subsequent neurological assessment, it is important to avoid infusions of...
long acting drugs and drugs known to accumulate in hypothermia such as midazolam & morphine.

Ensure the Richmond Agitation Sedation Score (RASS) levels are assessed and recorded as per the ICU Analgesia and sedation guidelines.

**Neuromuscular blockade**

Shivering in response to cold increases temperature, metabolic rate & oxygen demand. Neuromuscular blockade may be used to assist achieving temperature goals.

Neuromuscular blockade may only be instituted after discussion with the duty Intensivist and after informing the nursing team leader in charge.

It is mandatory to ensure that adequate sedation goals have been achieved, a secure protected airway is in place (ie: the patient is intubated) and that an appropriate (mandatory) ventilation mode has been selected before commencing neuromuscular blockade. EtCo2 monitoring and circuit disconnect alarms must be in place. Patients managed with neuromuscular blockade must remain nursed 1:1 at all times and must not be left without direct supervision.

Peripheral nerve stimulator monitoring should be instituted prior to commencing neuromuscular blockade and the intensity of blockade monitored and titrated accordingly. Refer to the ICU procedural guideline “Use of the peripheral nerve stimulator (PNS) with the use of neuromuscular blocking agents (NMB).” Neuromuscular blockade should be used for as brief a period as is feasible.

Of note, seizures complicate up to 44% of cardiac arrests, and are associated with worse mortality. Nonconvulsive status epilepticus (NCSE) has been reported in 12% of cardiac arrests undergoing TH. Neuromuscular blockade will mask the presence of seizures & need for treatment.

**Cold intravenous fluids**

Cold intravenous fluids may be used to induce hypothermia, after consideration of the patient’s volume state, comorbidities & cardiac function. Aliquots of 500-1000mls of cold fluid may be given via peripheral IVC available over 30 min as ordered. Do not administer bolus of cold fluid via central line.

Maintenance of temperature with other modalities will be required after fluid administration.

Rapid fluid boluses in patients with significantly compromised cardiac function, elevation of ICP or significant hypoxaemia are contraindicated. Cold fluids, including Hartmann’s Solution and 0.9 % Normal Saline, are kept at 4°C in the drug fridge.

**Surface temperature management**

Surface temperature management may constitute the use of

- Active cooling blankets for patients whose core body temperature is >36.0°C
- Ice packs- applied to the head, neck, axilla and groin, ensuring a barrier such as a disposable cloth is placed between ice packs and the patients’ skin to prevent
burns. Staff are to comply with the requirements in the State guideline GL2005_015 **Hot or Cold Packs Application**
- Wet towels / fan convection: do not use alcohol based solutions
- Bair – Hugger

**Antipyretics**

Paracetamol may be prescribed as an adjunct to temperature management, in the absence of significant hepatic injury post arrest or other contraindication;

e) **Rewarming indications and goals**

At 28 hours after cardiac arrest, passive rewarming will commence i.e. cessation of active cooling and covering the patient with a blanket (warming blankets are NOT to be used for patients at 35°C-36°C).

Rewarming should take place at a rate of approximately 0.25°C/hour, but no greater than 0.5°C/hour to a target of 37.0°C over the next 8 hours (i.e. until 36 hours post cardiac arrest)

From 36 to 72 hours following cardiac arrest, temperature management goals are to maintain the core temperature below 37.5°C.

<table>
<thead>
<tr>
<th>Core temperature</th>
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<th>Action</th>
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<tbody>
<tr>
<td>From 28 hours post cardiac arrest to 36 hours post arrest</td>
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<tr>
<td>35.0°C – 36.0°C</td>
<td>37.0°C</td>
<td>Passively rewarm ~0.25°C/hour (cease active measures)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ensure rewarming rate is no greater than 0.5°C/hour</td>
</tr>
<tr>
<td>From 36 to 72 hours following cardiac arrest</td>
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<tr>
<td>~ 37.0°C (normothermia)</td>
<td>Maintain the core temperature below 37.5°C, maintain normothermia.</td>
<td>Warm or cool appropriately</td>
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</table>

f) **Prescription of Temperature goals**

Temperature goals are to be prescribed on the bedside flowchart as follows:

**Compliance with this Procedure is Mandatory**
Post Cardiac Arrest Targeted Temperature Management
Cardiac arrest Time: _____:____ hrs Date: / /

- From 0-28 hours post arrest maintain core temp 35.0-36.0°C
- From 28-36 hours post arrest slowly rewarm to a maximum of 37.0°C, aiming for a rate of 0.25°C/hr
- From 36-72 hours maintain normothermia, and ensure a core temp <37.5°C

**g) Weaning of sedation & Neurologic assessment**

Sedation should be weaned to assess neurological function after a temperature of 36.5 - 37.0°C is reached or when deemed appropriate by the ICU medical team.

If the patient awakens and obeys commands within the first 36 hours, passive rewarming is indicated as described above. Fever should be aggressively treated and the core temperature should be maintained <37.5°C, as described above.

**h) Adverse effects of hypothermia**

- Arrhythmias including bradycardia and QT prolongation
- Infection, especially pneumonia
- Electrolyte disorders (hypokalaemia, hypomagnesaemia, hypophosphataemia)
- Hyperglycaemia & insulin resistance
- Alterations in drug metabolism and excretion
- Mild coagulopathy
- Cold diuresis (mediated by anti-diuretic hormone [ADH] resistance)
- Pressure injury

**i) General supportive care of the post cardiac arrest patient**

Patients surviving to ROSC remain at risk of further neurological injury due to alterations in cerebral autoregulation and the systemic effects of ischaemia-reperfusion, collectively referred to as *Post Resuscitation Syndrome*. Attention to identifying persistent precipitating factors and mitigating secondary injury during the post cardiac arrest period may improve outcomes.

The appropriateness of the following principles depends on the clinical context and prognosis. Interventions should be individualised at the discretion of the treating Intensivist and may change as evidence emerges.

**Cardiovascular**

- **12 lead and ST trend monitoring**
  Post cardiac arrest patients are at elevated risk for recurrent ischaemia, infarction and recurrent cardiac arrest. Monitoring should be instituted according to the Continuous ST Monitoring in Intensive care Unit (ICU) CRG_PG2015_9094, using full 12 lead ST trending.

- **Mean arterial Pressure (MAP) Targets**
  Optimal mean arterial pressure (MAP) targets have not been prospectively defined. The decision on the target MAP should take into consideration the patients’ premorbid blood pressure and current haemodynamic state.

Compliance with this Procedure is Mandatory
Targets should seek to balance the risks of elevated afterload on cardiac work against the loss of cerebral autoregulation. MAP targets of between 65-100mmHg have been reported\textsuperscript{12}. Prescription of MAP targets is at the discretion of the Intensivist or provisional fellow.

- **Shock reversal**
  Myocardial dysfunction occurs commonly following cardiac arrest, in conjunction with SIRS secondary to ischaemia – reperfusion injury. Measures to identify cardiac dysfunction and optimise haemodynamics to restore and maintain adequate perfusion may be indicated. In one trial, mortality was related to the rate of lactate clearance, a surrogate marker for reversal of shock.

- **Persistent Precipitating cause**
  Efforts should be made to identify and treat the underlying precipitants for cardiac arrest, to reduce the risk of further instability and to limit secondary injury both to brain and myocardium\textsuperscript{17}. Acute coronary syndromes are a common cause of cardiac arrest, and limited evidence suggests a strategy of early reperfusion may improve long term outcomes\textsuperscript{15-17}. Other causes (including sepsis, pulmonary embolism, hypovolaemia, tension pneumothorax, cardiac tamponade, cerebrovascular catastrophe, metabolic and toxicologic etc.) should be considered and treated accordingly.

- **Cold induced diuresis and hypovolaemia**
  Hypothermia may induce renal resistance to ADH, resulting in cold mediated diuresis. Attention to ensuring adequate volume resuscitation and correction of electrolyte disturbance is required.

**Respiratory**

- **Oxygenation**
  Oxygenation targets post cardiac arrest have not been conclusively identified; an association between hyperoxia (PaO2 > 300) and worse neurological outcome has been suggested, but was not confirmed in a subsequent trial\textsuperscript{13, 14}. Therefore, in the absence of specific indications or contraindications for oxygen therapy (such as carbon monoxide poisoning, decompression illness or bleomycin toxicity etc) FiO2 should be titrated to achieve normal oxygenation (Spo2 94-98\%)\textsuperscript{20}. Unnecessary hyperoxia should be avoided.

  Hypoxia is a recognized cause of secondary injury and worse clinical outcomes and must be avoided.

- **Arterial Co2 and ventilation**
  While cerebrovascular autoregulation is impaired following cardiac arrest, response to PaCO2 is preserved. Hyperventilation may contribute to vasoconstriction and reduced cerebral perfusion and should be avoided. Hypoventilation may likewise adversely affect ICP and perfusion and should be avoided.

  Ventilation should be titrated to achieve normocarbia (PaCo2 35-40mmHg); Arterial blood gas measurement rather than end tidal Co2 monitoring should be used to titrate ventilation.

- **Positive End Expiratory pressure PEEP and haemodynamics**
  Consideration should be given to the effect of PEEP

Compliance with this Procedure is Mandatory
PEEP can adversely affect venous return, cardiac performance and Intracranial Pressure (ICP), and should be titrated according to the clinical situation.

Metabolic

- **Electrolyte disturbances**
  Potassium shifts intracellularly during hypothermia, causing mild hypokalaemia. During re-warming, potassium shifts extracellularly. Therefore potassium must be replaced slowly (i.e. 10mmols per hour) as potassium levels will increase during re-warming.

  Hypophosphatemia and hypomagnesaemia may occur as a result of cold-induced diuresis and should be replaced as per drug guidelines.

  The frequency of determination of serum electrolytes levels should be guided by the clinical situation and previous results; an increased degree of vigilance for electrolyte disturbances is necessary.

Glycaemic control

- **Glycemic control**
  Hypothermia decreases insulin release and increases insulin resistance, contributing to hyperglycaemia which has been associated with adverse neurological outcomes. Hypoglycaemia has been associated with poor neurological outcomes. Strict Glycemic control does not appear to improve outcomes in the post VF cohort and is associated with an increase the rate of hypoglycaemia.18

  BSL measurement and titration of Actrapid should be according to the insulin infusion protocol, aiming for normoglycemia.

  Attention to BSL's is particularly important during the initiation of insulin therapy, during periods of cooling and rewarming when changes in insulin levels and resistance may cause rapidly changing BSL’s.

Gastrointestinal

- Consideration should be given to the use of ulcer prophylaxis
- Consider early enteral nutrition
- Consider use of aperients

Neurological

- Head of bed elevation 30 °C
- Ensure ETT tapes insitu- avoid ETT being tied
- Midline head position
- Continuous EtCO2 monitoring and SaO2 monitoring,
- Treatment of seizures as indicated
- Secondary prevention goals achieved ( Sodium, MAP, BSL, PaCO2, SaO2)
- Monitoring of neuromuscular function in those patients receiving neuromuscular blockade

General Care

In addition to general cares of the ICU patient:

Compliance with this Procedure is Mandatory
- 2-4 hourly pressure area care should be attended as these patients are at high risk of developing pressure injuries.
- Eye care (refer to Essential Care of the ICU Patient guideline)

Appendix 1: Target temperature management summary

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</tr>
<tr>
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At 28 hours after cardiac arrest, passive rewarming will commence i.e. cessation of active cooling and covering the patient with a blanket
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Appendix 2: Temperature Management Definitions

| Active cooling                  | • Use of cooling blanket  
|                                | • Use of cold fluids      |
| Passive cooling                | • Limited covering of patient  
|                                | • Use of tepid sponging  
|                                | • Use of Cold Packs       |
| Active warming                 | • Use of the warming device *Bair-Hugger*  
|                                | • Warm fluids              
|                                | • Warming of IV fluids     |
| Passive warming                | • Use of blankets, warmed blankets form warming cupboard.  
|                                | • **Do not use** warming blanket |

8. Definitions

<table>
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<tr>
<th>ADH</th>
<th>Antidiuretic hormone</th>
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<tbody>
<tr>
<td>BSL</td>
<td>Blood sugar level</td>
</tr>
<tr>
<td>ETT</td>
<td>Endotracheal tube</td>
</tr>
<tr>
<td>ROSC</td>
<td>Return of Spontaneous Circulation</td>
</tr>
<tr>
<td>TH</td>
<td>Therapeutic hypothermia</td>
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<td>TTM</td>
<td>Targeted Temperature Management</td>
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</table>

9. Consultation

Intensive Care Service

10. References


Intensive Care Service – Targeted Temperature Management after cardiac arrest. Royal Prince Alfred Hospital, Policy document RPAH_GL2014_008
Therapeutic hypothermia after cardiac arrest: An information update:  Australian Resuscitation Council (ARC) Dec 2013


Effects of hypothermia on drug disposition, metabolism, and response: A focus of hypothermia-mediated alterations on the cytochrome P450 enzyme system. Tortorici MA, Kochanek PM, Poloyac SM.  Crit Care Med. 2007 Sep 35(9): 2196-204.


