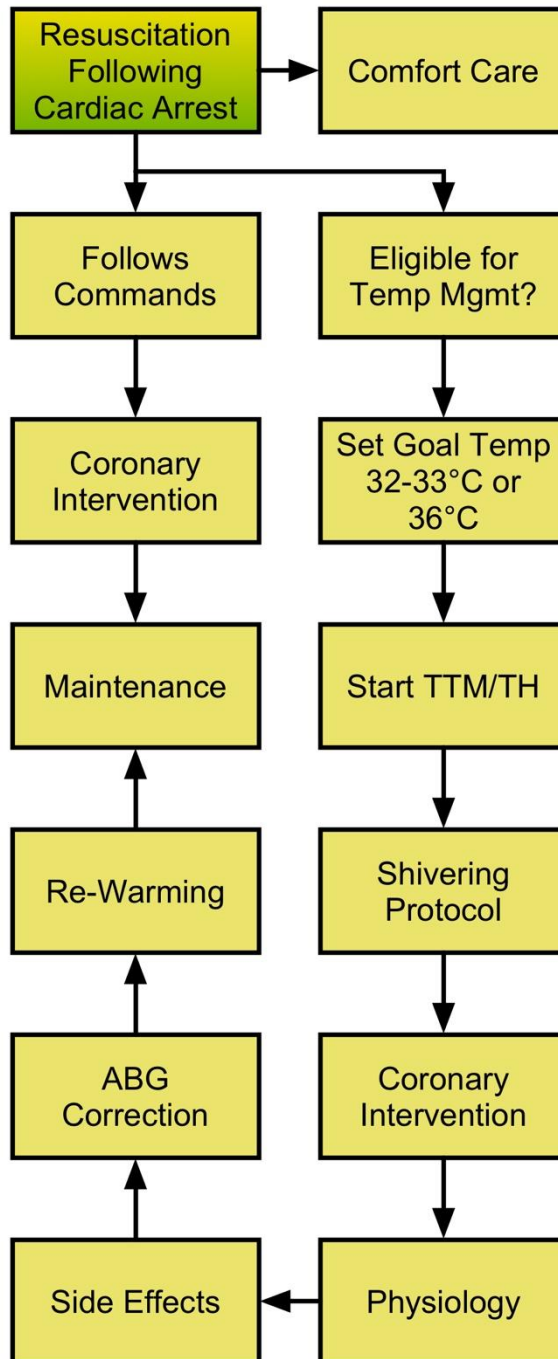


Emergency Neurological Life Support

Resuscitation following Cardiac Arrest Protocol

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[Checklist and Communication](#)

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Checklist

- Eligibility for hypothermia assessed
- Target temperature decided
- Initiation of temperature management
- Anti-shivering plan in place

Communication

- Duration of cardiac arrest
- Neurological examination on first assessment in the Emergency Department
- When temperature management was initiated
- When target temperature was reached (if applicable)
- Any relative or minor contraindications to temperature management
- Current core temperature



Comfort Care

- Presence of a do not resuscitate (DNR or Physician Orders for Life Sustaining Treatment [POLST]) order
- Contraindication to intensive care unit (ICU) admission
- Illness that precludes meaningful neurologic recovery

Discussion with family or proxy regarding goals of care



Coronary Intervention

Does the patient need coronary intervention?

Coronary angiography can be safely performed during TTM, TH, or normothermia. Specifically, TH is not a contraindication for anticoagulants or anti-platelet agents. Mild to moderate hypothermia (32-34°C) does not increase the risk of arrhythmias.



Correction of ABG

Correct ABG for temperature

Correction of blood gas values:

- **PO₂**: for every °C below 37°C: subtract 5 mm Hg from the value as measured in the lab. Example: Lab value pO₂ 90 mmHg; patient core temp = 32°C; corrected pO₂ level = 65 mmHg
- **PCO₂**: for every °C below 37°C subtract 2 mm Hg from the value as measured in the lab. Example: Lab value pCO₂ 35 mmHg; patient core temp = 32°C; corrected PCO₂ level = 25 mmHg.
- **pH**: for every °C below 37°C add 0.012 units to the value as determined by the lab. Example: Lab pH 7.20, patient core temp = 32°C, corrected pH value = 7.26.



Eligible for Therapeutic Temperature Management?

The patient is eligible for either Targeted Temperature Management (TTM) or Therapeutic Hypothermia (TH) if she/he

- Suffered a cardiac arrest
- Has return of spontaneous circulation
- Does not follow commands



Follows Commands

Do not induce targeted temperature management or therapeutic hypothermia if:

- Rapid neurologic recovery (patient is following commands; squeezes fingers/lets go, wiggles toes on command)

Maintaining normothermia (Temperature $<37.5^{\circ}\text{C}$) is recommended in this population.



Maintenance After Rewarming

Rewarming phase ends when temperature reaches 36.5°C

- Begin controlled eutherma
- Switch off cooling device; if temperature increases to >37.5°C re-start cooling, set target temperature at 36.5°C. If temp >37.8°C infuse 500-1000 ml of cold fluids.
- Combat shivering as described above
- Maintain eutherma for 72 hours



Maintenance Phase of TTM or TH

Temp is now < 34°C or =36°C

- Duration of maintenance phase: usually 24 hours
- Keep target temperature within narrow range (within 0.5°C of target)
- With paralysis, temperature may overshoot target temperature immediately following induction phase by about 1.0°C
- Use cooling device with controlled feedback system, set at target temperature
- Temperature should never decrease below 30°C
- If temperature increases to 1 degree or more above target temperature, the cause is usually shivering. Carefully evaluate the patient and give (extra) anti-shivering medication if needed
- In general, the target MAP should be ≥ 80 mmHg and heart rate 36-100 BPM
- Continuous monitoring of blood pressure and heart rhythm
- Lab: Glucose (conform insulin protocol); ABG, K, Mg, phosphate, lactate every 6 hours; PT, CBC every 12 hours
- Target electrolyte levels: (normal/high normal) K > 4.0 mEq/l, Mg > 2.0 mg/dl (1.0 mmol/l), Phos > 3.0 mg/dl
- Magnesium can be used to combat shivering, with serum levels up to 4-5 mg/dl



Physiological Parameters

Maintain

Maintain the following physiological parameters:

- MAP > 80 mm Hg
- HR 36-100 BPM
- Sedation: Ramsay score 4-5; Sedation-agitation scale 2-3; Motor activity assessment scale 0-1
- PO₂ corrected for temperature: > 90 mmHg
- PCO₂ corrected for temperature: 32-40 mmHg
- K >4.0 mEq/l; Mg > 2.0 mEq/l; P >3.0 mg/dl; Glucose 80-200 mg/dL; Hb>9.0 g/dl; Platelets > 30 X 10⁹/L

Consider these monitors

- Continuous EEG
- Esophageal Doppler
- CVP monitoring



Resuscitation Following Cardiac Arrest

Temperature management for patients resuscitated from cardiac arrest

Resuscitation following Cardiac Arrest:

A patient who remains comatose following return of spontaneous circulation following cardiac arrest may benefit from induced hypothermia. All comatose patients should receive temperature management. This protocol addresses the initiation of hypothermia for such patients. This protocol does not address the standard ACLS protocols for cardiac resuscitation.

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Rewarming

Warming the patient to euthermia

After 24 hours of cooling, begin re-warming.

- Duration of re-warming phase usually 12-24 hours.
- Warming speed 0.1-0.3°C /hour. Absolute maximum 0.5 °C /hour; preferably lower. Avoid more rapid warming.
- Perform controlled re-warming using a cooling device with a feedback mechanism.
- Points of attention: beware of hyperkalemia (in particular in case of rapid warming or renal failure); hypoglycemia (due to increase in insulin sensitivity during re-warming).
- Hypotension may occur during re-warming, usually due to hypovolemia

Checklist during rewarming:

- Monitor blood pressure and heart rhythm
- Lab: ABG, K, glucose every 3 hours; Mg, phosphate every 6 hours
- Target electrolyte levels: (normal/high normal) K > 4.0 mEq/l, Mg > 2.0 mg/dl (1.0 mmol/l), Phos > 3.0 mg/dl



Set Goal Temperature 32°C-33°C or 36°C

Establish target temperature and method

Contraindications for TTM and TH range from minor to absolute. Eligible patients should not have any absolute contraindications.

Absolute contraindications:

- DNR/POLST indicating they would not want this level of treatment
- Following commands

If no absolute contraindications, consider the following minor contraindications when determining what temperature to target in each individual patient:

TTM at 36°C is preferred in case of:

- Active bleeding with the cause not (yet) under control
- Greatly increased risk of bleeding (e.g. injury of the spleen or liver)
- Cardiac arrest more than 12 hours ago (apply targeted temperature management at 36°C rather than hypothermia)

If known presence of cold agglutinins (usually only if temp < 31°C), consider using endovascular cooling as the preferred method for temperature maintenance.

After considering risks and benefits:

- Set Target Temperature to 32-33°C or 36.0°C



Shivering Protocol

Methods to stop shivering

Shivering can be suppressed by several techniques:

- Consider skin counter warming during all phases of temperature control (induction, maintenance and re-warming), with special attention to warming of the hands, feet and face of the patient.

During Induction:

- Check ventilator settings such that sedation or chemical paralysis will not worsen P_aCO_2
- Propofol infusion 20-50 mcg/kg/min IV (as BP tolerates)
- Then add Fentanyl infusion 25-100 μ g /hour
- If not successful, add Diazepam 10-20 mg IVP
- Consider magnesium sulfate 4 gm IV over 15 minutes and single dose vecuronium 0.1 mg/kg IVP for induction

Maintenance:

- See above and consider midazolam 2-6 mg/hour

See ENLS protocol [Pharmacotherapy-Shivering Protocol](#)



Side Effects

Hypothermia induced complications

Most important side effects:

- Bradycardia: usually no treatment necessary. Normal heart rate at a core temperature of 32°C is 34-40 BPM. If treatment is deemed necessary, use isoproterenol or dopamine infusion. Atropine is INEFFECTIVE for hypothermia-induced bradycardia.
- Shivering: Fentanyl 50-100 mcg; Mg Sulfate 2-4 grams; Skin counter warming, especially of hands, feet and face.
- Cold diuresis: replace lost fluids.
- Electrolyte disorders: replace, target normal levels, high Mg levels.
- Arrhythmias. Arrhythmias due to hypothermia occur ONLY if core temperature decreases below 30°C. If this occurs re-warm rapidly to temp > 30°C, and then slowly to target temp. If core temp is > 30°C arrhythmias do NOT require any change in cooling therapy. Treat arrhythmias with standard antiarrhythmic medications. Beware of possible decrease in clearance of amiodarone during hypothermia. Beware of decubiti due to skin vasoconstriction and immobilization.



Start TTM/TH

Make sure of the following before TTM/TH induction

Before induction, make sure:

- Patient is intubated
- Patient is comatose and/or sedated.
- Patient does not meet any exclusion criteria
- A probe for core temperature measurement is in place (in order of preference): endovascular, esophageal, bladder, rectal. Peripheral temperature measurements including axillary measurements during hypothermia are unreliable. Many patients are mildly hypothermic after resuscitation and only require maintenance at temperature.

Also address the following:

- Sedation: start propofol if patient is hemodynamically stable; use midazolam if hemodynamically unstable
- Analgesia: start fentanyl or remifentanyl infusion
- Avoid continuous paralysis unless EEG is in place

Induction phase

Start hypothermia induction; normal duration of induction phase is 60-120 minutes.

- Start infusion of cold fluids (4°C) WITH A PRESSURE BAG as rapidly as possible. Type of fluid: saline 0.9%. Volume required may be up to 30cc/kg. Consider the volume of cold-fluid administration pre-hospital (if given) because of the risk of pulmonary edema.
- In case of cardiogenic shock/left ventricle failure: reduce bolus infusion to 1,000 ml per hour.
- Options to control shivering: fentanyl 1 mcg/kg/hour IV; remifentanyl continuous infusion; midazolam 2-5 mg IV; propofol infusion; diazepam 10-20mg IV; magnesium 2-4 grams IV (up to a serum level of 7.3 mg/dl (3 mmol/l); ondansetron 8 mg IV; consider single-dose paralysis in case of refractory shivering. See the shivering protocol in ENLS reference [Pharmacotherapy](#).
- In general: avoid hypotension during hypothermia treatment. Target MAP 80 ≥ mmHg