Rapid Treatment of Hypothermia

Rebecca Carman, MSN, ACNP-BC

Nurse Practitioner, Trauma Services, Intermountain Medical Center,
Intermountain Healthcare; Salt Lake City, Utah

Objectives:

- Describe hypothermia and physiologic effects on trauma patients
- Discuss rapid rewarming methods
- Describe ongoing management of hypothermic patients
Rapid Treatment of Accidental Hypothermia

Rebecca Carman, MSN, ACNP-BC
Trauma NP
Intermountain Medical Center, SLC, UT
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Accidental Hypothermia

• Definition: Core Body Temperature below 35°C (95°F)
• Typically happens in areas of the world with severe winters but also happens in the U.S.
• Happens in the winter AND summer
• Incidence in Trauma Patients- 43% (n=359) only 1.9% severe hypothermia. In-hospital mortality of patients with moderate to severe accidental hypothermia have been reported at 40%.
• 1,500 patients/year have hypothermia on death certificate
• Inconsistent treatments between and within trauma centers.
  – One hospital- 84 cases of accidental hypothermia (14 different methods)
## Degree of Hypothermia

<table>
<thead>
<tr>
<th>Stages</th>
<th>Temperature</th>
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</thead>
<tbody>
<tr>
<td>Mild hypothermia</td>
<td>32°-35°C (89°-95°F)</td>
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<tr>
<td>Moderate hypothermia</td>
<td>30°-32°C (86°-89°F)</td>
</tr>
<tr>
<td>Severe hypothermia</td>
<td>&lt;30°C (&lt;86°F)</td>
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</table>
Pathophysiology

• Body temperature reflects balance between heat production and heat loss
• Hypothermia causes altered cell membrane function efflux of intracellular fluid (cold diuresis), enzymatic dysfunction and electrolyte imbalances (hyperkalemia)
• The hypothalamus attempts to stimulate heat production through shivering and increased thyroid, catecholamine and adrenal activity→ vasoconstriction
Trauma Triad of Death

- Deadly combination of hypothermia, coagulopathy and metabolic acidosis
- Seen in patients who have sustained severe **traumatic** injuries and it results in a significant rise in the mortality rate
Risk Factors

Environmental exposure
• Trauma (exposure, fluids, medications, paralytics)
• Elderly
• Children
• Homelessness
• Psychiatric disease
• Alcohol abuse
• Post operative and ICU patients

Medical Conditions
• Hypothyroidism
• Adrenal insufficiency
• Sepsis
• Neuromuscular disease
• Malnutrition
• Thiamine deficiency
• Hypoglycemia
Mild Hypothermia
Temperature 32°-35°C (89°-95°F)

Excitation phase
- Shivering
- Tachypnea (hyper-ventilation)
- Tachycardia
- Early CNS depression
Moderate Hypothermia-Temperature
30°-32°C (86°-89°F)

**Slowing phase**
- Hypoventilation
- Bradycardia
- Loss of shivering
- Further CNS depression (hyporeflexia, stupor and dilated pupils)
- Cardiac arrhythmias (sinus bradycardia, slow A fib)
Severe Hypothermia
Temperature < 30°C (< 86°F)

Cardiopulmonary failure
- Hypotension
- Pulmonary edema
- Apnea
- V. fib

Profound CNS depression
- Areflexia
- Dilated, unreactive pupils
- Coma
Resuscitation

“YOU ARE NOT DEAD UNTIL YOU ARE WARM AND DEAD”

• True in patients who suffer cardiac arrest as result of hypothermia
• Neuro and cardiac protection from hypothermia may allow recovery despite prolonged arrest
• End Point of resuscitation is to rewarm to temp of 32°C - 35°C
Exceptions to the Rule

1. Anoxic event while still normothermic who has no pulse or respiration. They really are DEAD!
2. Serum potassium level greater than 10 mmol/L Reflect cell lysis and predicts futile resuscitation
3. Signs of irreversible death
4. Frozen chest wall
5. Burial in avalanche > 35 min
6. Airway packed with snow and asystole
Therapeutic Hypothermia

• Goal for therapeutic hypothermia beyond the objectives of this lecture

• Despite physiologic changes induced by hypothermia and complications to the trauma patient, induced hypothermia has been noted to improve outcomes in animal studies and certain clinical situations
Primary Survey - Assessment

- **A**irway and Protection of Spinal Cord
- **B**reathing and Ventilation
- **C**irculation
- **D**isability
- **E**xposure and Control of the Environment

• Do not delay transfer to critical care setting or location for CPB or ECMO
TIPS

- Vital Signs- Don’t forget temperature! Often missed vital sign.
- Temperature preferably esophageal. Insert thermistor probe into the lower third of esophagus.
- Bladder temp can be falsely elevated with peritoneal lavage.
- Severe Depression of RR and HR-listen/feel at least 60 sec
- Avoid rough movements and activity → v. fib
Common EKG Abnormalities

Osborn Waves—prominent in V2-V5

Suggests hypothermia, but can be present in other conditions (SAH)

Misinterpreted as injury or infarct
Cardiovascular Interventions-Pearls

- Hypotension-IO and femoral venous catheters
- Treat hypotension with warmed crystalloids
- Dopamine if necessary. single inotropic agent that has some degree of action in hypothermia
- Arrhythmias may persist until rewarmed
- Ignore atrial arrhythmias with slow ventricular response
- Organized Cardiac Rhythm?? If present, sufficient circulation is present. CPR can lead to fibrillation.
- No rhythm → initiate CPR and continue until rewarmed
- Treat arrhythmia (ACLS guidelines), defibrillation and cardiac meds may be attempted but usually unsuccessful until core temp is > 28°–30°C
Lab studies

• Check CBC, CMP, electrolytes, BG, ETOH, toxins, amylase, TSH and blood cultures

• ABGs best interpreted “uncorrected” that is blood warmed to 37°C with the values used as guides for administering sodium bicarbonate and adjusting ventilation parameters
# Overview of Treatment

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<th>Hypothermia</th>
<th>Technique</th>
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<tr>
<td>Mild</td>
<td>Passive external rewarming</td>
</tr>
<tr>
<td>Moderate</td>
<td>Active external rewarming</td>
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Rapid Treatment-Mild Hypothermia

Passive External

• Remove from cold
• Remove wet clothing
• Cover with warm blankets
• Don’t delay transport
Rapid Treatment- Moderate Hypothermia

Active External Rewarming and Internal Rewarming

• Warmed humidified oxygen; warmed IV fluids
• Forced air warming systems
• Rewarm the trunk first to minimize risk of core temperature after drop*
• Increase temp at least 2°C/hr

*Paradoxical drop in core temperature due to return of cold blood from extremities to core
Rapid Treatment of Severe Hypothermia

- Warmed humidified oxygen; warmed IV fluids
- Pleural and peritoneal irrigation with warm saline
- Extracorporeal options: continuous intravascular rewarming, hemodialysis, continuous arteriovenous rewarming and cardiopulmonary bypass

*Avoid gastric and colonic irrigation due to fluid and electrolyte fluctuations. Surface area of bladder is too small to be of much benefit.
Continuous Intravascular Rewarming

- Central line placement
- Minimally invasive
- Available- quick (used for heating and cooling)
- Practical
- Portable
- \( \uparrow \) temp
  2-3°C/hr
Pleural and Peritoneal Lavage

Thoracic - two right sided CTs - anterior used to infuse warmed saline; posterior to drain fluid

Peritoneal - two catheters - infuse saline leave in cavity for 20 min.-drain
Cardiopulmonary Bypass (CPB)

Who is it for?

• Reserved for patients who are:
  1. Potentially salvageable
  2. HD instability or arrest
  3. Do not rewarm with less invasive rewarming

• Transthoracic cannulation in OR
• Used for hours NOT days
• 47% survival in pts with severe hypothermia and cardiac arrest
• Rewarm at 9.5°C/hr
Extracorporeal Membrane Oxygenation (ECMO)

- Preferred to CPB because it prolongs oxygenation and can treat noncardiogenic pulmonary edema
- Use it for days 3-10
- Cervical/femoral cannulation (preferred to transthoracic cannulation used in CPB)

*Consider that heparin is required with more invasive rewarming
Complications of Rewarming

• Patients may get worse before they get better!
• Arrhythmias—may persist until rewarmed
• Hypotension
• Rhabdomyolysis
• Bleeding
• Acid-Base Balance
• Hypoglycemia
• Paralytic ileus
• Electrolyte abnormalities (hyperkalemia, low phos)
Failure to Rewarm

Continue rewarming techniques!

- Sepsis- ABX broad spectrum – Urban pts with hypothermia, infection is major cause
- Adrenal Insufficiency – single dose of glucocorticoid (dexamethasone 4 mg IV not measured in cortisol assays when measuring adrenal function)
- Hypoglycemia – D₅W IV drip
- Severe Hypothyroidism – levothyroxine 250 mcg IV after labs are drawn for thyroid function
Case Study
Accidental hypothermia 13.7°C with circulatory arrest

History
• 29 y.o. female fell skiing down a waterfall gully. Wedged between ice with flowing icy water.
• Struggled under ice for 40 min.
• EMS assessment: clinically dead with dilated and unresponsive pupils
• CPR started immediately
• Flown to hospital, taken to the OR. Still NO signs of life.

Interventions and Outcome
• Cardiopulmonary bypass for 179 minutes
• Rewarmed-vfib, bleeding subclavian artery, cardiopulmonary insufficiency
• Started on ECMO
• 60 days later d/c to rehab
• 5 months later returned to work with normal neuro exam
• Residual pareses of upper and lower extremities but able to hike and ski
**Local injuries**

- Classifications range First-Fourth degree frostbite
- Risk factors same as systemic hypothermia
- Most frequently ears, nose, cheeks, chin, fingers and toes
Non-Freezing Cold Injuries (NFCI)

Wet

- Trenchfoot (described in WW1)
- Swollen, edematous, numb foot
- Initially red then becomes pale and cyanotic
- Increased sensitivity to pain and infections
- Nerve and vascular injuries
Non-Freezing Cold Injuries

Dry

- Chilblains or Pernio
- Bare skin exposed to dry or damp environment
- Edematous, red or purple, tender, swollen, itchy and painful
- After rewarming – inflamed, red and hot to the touch for hours
NFCI and Freezing Cold Injury Treatment

• RAPID rewarming
• Do not rub
• Remove wet clothes
• Immersion of limb into 37-39°C water bath
  – Water feels warm NOT hot
• Leave 15-30 minutes
  – Until area appears flushed with good circulation when circulation is re-established
NFCI and Freezing Cold Injury Treatment

- Tetanus Toxoid and IV antibiotics for potential infection. Avoid topical.
- Intra-arterial tPA for pts high risk for amputation
  - Within 24 hours of injury
  - Do not give to patients with contraindications
- Narcotic Pain Relief
  - Very painful!
- May need escharotomy or amputation 😞
Summary

• Remember ABCDEs
• You are not dead until you are warm and dead. A few exceptions.
• Hypotension-give warmed crystalloids- dopamine if necessary
• Avoid movements or procedures that can → v.fib
• CPR should continue until rewarmed; then renewed attempts at ACLS
• Attempts to actively rewarm should not delay transfer to a critical care setting
• Appropriate warming techniques depend on degree of hypothermia
• Resuscitation goal is 32-35°C
• Patient may get worse before they get better
• Local injuries: give tetanus, Abx and tPA (if no contraindications) rewarm in warm water bath

Thank you!
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