Hypothermia

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1 Credit Course Approved for the Following Levels:
First Responder
EMT Basic
EMT Intermediate
EMT Paramedic
Objectives

- Explain the basic physiology of thermoregulation
- Define the basic metabolic rate
- Explain common measurements of core temperature and the mechanisms by which heat is lost from the body
- Explain the various heat conserving and heat producing mechanisms
- List the causes and ranges of hypothermia
- List the signs, symptoms and treatments of hypothermia
Temperature Regulation

- Humans are warm-blooded mammals who maintain a constant body temperature (euthermia).
Temperature regulation is controlled by the hypothalamus in the base of the brain.
Temperature Regulation

- The hypothalamus functions as a thermostat for the body.
- Temperature receptors (thermoreceptors) are located in the skin, certain mucous membranes, and in the deeper tissues of the body.
Temperature Regulation

- When an increase in body temperature is detected, the hypothalamus shuts off body mechanisms that generate heat (for example, shivering).

- When a decrease in body temperature is detected, the hypothalamus shuts off body mechanisms designed to cool the body (for example, sweating).
Temperature Regulation

- Body Temperature = Thermogenesis–Heat Loss
Temperature Regulation

Basal Metabolic Rate:
- The metabolism that occurs when the body is completely at rest.
Temperature Regulation

Metabolic Rate:

- The body continuously adjusts the metabolic rate in order to maintain a constant CORE temperature.
Temperature Regulation

Normal body temperature is approximately 37° C (98.6° F).
- However, what is normal for an individual may vary somewhat.
Definition of Hypothermia:

- CLASSIC DEFINITION: A state of low body temperature, specifically a low CORE temperature (< 35º C or < 95º F).

- ALTERNATIVE DEFINITION: It is best defined as the unintentional decrease of around 2º C (3.6º F) from the “normal” CORE temperature.
What is the CORE temperature?

- The deep internal temperature of normothermic humans
How is the CORE temperature measured?

- There is little variance in CORE temperature because of perfusion.

- Esophageal and tympanic temperatures are essentially the same as the temperature of the pulmonary artery.
In steady-state conditions, the rectal temperature is a good index of CORE temperature.
Hypothermia

- Oral temperature is an excellent index of CORE temperature, provided the mouth is kept closed.
Hypothermia

- The type of temperature measurement utilized is less important than using the same device and measurement site to detect trends.

- Thermometer must be able to read low temperatures.
Hypothermia

Heat loss results from:

- Conduction
- Convection
- Radiation
- Evaporation
- Respiration
Hypothermia

Conduction:
- Heat loss occurs due to direct contact of the body with a cooler object.
- Heat flows from higher temperature matter to lower temperature matter.
Hypothermia

Convection:

- Heat loss occurs due to air currents passing over the body.
- Heat must first be conducted to the air before convection can occur.
Hypothermia

Evaporation:
- Heat loss occurs as water evaporates from the skin.
- Heat loss occurs as water evaporates from the lungs during respiration.
Hypothermia

Respiration:

- Respiration combines the heat loss mechanisms of convection, radiation, and evaporation.

- Expired air is normally 98.6 degrees F. and 100% humidified.
Hypothermia

Heat-conserving Mechanisms

Vasoconstriction of blood vessels in the skin.

- Stimulated through activation of the sympathetic nervous system.
- Causes pale, cool skin.
Heat-conserving Mechanisms

- Piloerection is more commonly called “goose bumps” or “goose flesh.”

- Evolutionary remnant.

- Caused by sympathetic stimulation of arrector pili muscles.
Hypothermia

Increased heat production:

- Shivering
- Activation of futile cycles (chemical thermogenesis)
- Increased thyroxine release
Hypothermia

When the core temperature of the body drops below 95º F, an individual is considered to be hypothermic.
Clinically, hypothermia results from:

- Inadequate heat generation by the body (thermogenesis).
- Excessive cold stress.
- A combination of both.
Hypothermia

Normal Range:

Mild Hypothermia 90-95°F

Severe Hypothermia < 90°F
Hypothermia

Predisposing Factors to Hypothermia:

- Patient Age
- Patient Health
- Medications
- Prolonged or Intense Exposure
- Co-existing Weather Conditions
Hypothermia

Patient Age:

- Pediatric and geriatric patients cannot tolerate cold environments and have less capacity for heat generation.

- Older patients often become hypothermic in environments that seem only mildly cool to others.
Hypothermia

Patient Health:

- Hypothyroidism (suppresses metabolic rate)

- Malnutrition, hypoglycemia, Parkinson’s disease, fatigue, and other medical conditions can interfere with the body’s ability to combat cold exposure.
Hypothermia

Medications:

- Some drugs interfere with the body’s heat-generating mechanisms.
- These include:
  - narcotics,
  - alcohol,
  - antihistamines,
  - antipsychotics,
  - antidepressants,
  - and many others.
Hypothermia

Prolonged or Intense Exposure:

- The length and severity of cold exposure have a direct effect on morbidity and mortality.

- The Wind Chill Index (WCI) must be taken into consideration.
### Hypothermia

#### Wind Chill Chart

<table>
<thead>
<tr>
<th>Wind (mph)</th>
<th>Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calm</td>
<td>40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45</td>
</tr>
<tr>
<td>5</td>
<td>36 31 25 19 13 7 1 5 11 16 22 28 34 40 46 52 57 63</td>
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<tr>
<td>10</td>
<td>34 27 21 15 9 3 -4 -10 -16 -22 -28 -35 -41 -47 -53 -59 -66 -72</td>
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<tr>
<td>25</td>
<td>29 23 16 9 3 -4 -11 -17 -24 -31 -37 -44 -51 -58 -64 -71 -78 -84</td>
</tr>
<tr>
<td>35</td>
<td>27 21 14 7 0 -7 -14 -21 -27 -34 -41 -48 -55 -62 -69 -76 -82 -89</td>
</tr>
<tr>
<td>40</td>
<td>26 20 13 6 -1 -8 -15 -22 -29 -36 -43 -50 -57 -64 -71 -78 -84 -91</td>
</tr>
<tr>
<td>50</td>
<td>24 18 11 4 -3 -10 -17 -24 -31 -38 -45 -52 -60 -67 -74 -81 -88 -95</td>
</tr>
<tr>
<td>55</td>
<td>23 17 10 3 -4 -11 -18 -25 -32 -39 -46 -54 -61 -68 -75 -82 -89 -97</td>
</tr>
<tr>
<td>60</td>
<td>22 15 8 -1 -8 -15 -22 -29 -36 -43 -50 -57 -64 -71 -78 -84 -91 -98</td>
</tr>
</tbody>
</table>

**Frostbite Times**

- 30 minutes
- 10 minutes
- 5 minutes

**Wind Chill (°F) = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275V^{0.16}**

Where, T = Air Temperature (°F), V = Wind Speed (mph)

*Effective 11/2/09*

[MedicEd.com](http://MedicEd.com)
Coexisting Weather Conditions:
- High humidity, brisk winds, and accompanying rain can all magnify the effect of cold exposure on the body by accelerating heat loss from the skin.
Hypothermia

Degrees of Hypothermia:

Mild—Core temperature > 90 degrees F
   (32 degrees C)

Severe—Core temperature < 90 degrees F
   (32 degrees C)
Hypothermia

MILD Hypothermia:

- Lethargy
- Shivering
- Lack of Coordination
- Pale, cold, dry skin
- Early rise in blood pressure, heart, and respiratory rates.
Prevention

Preventive Measures:
- Warm dress
- Plenty of rest
- Adequate diet
- Limit Exposure
Treatment for Hypothermia:

1. Remove wet garments
2. Protect against further heat loss and wind chill.
Hypothermia

Treatment

Treatment for Hypothermia:

1. Remove wet garments
2. Protect against further heat loss and wind chill.
4. Avoid rough handling.
5. Monitor the core temperature.
6. Monitor the cardiac rhythm.
Hypothermia

Treatment

ECG changes seen in hypothermia:

- Prolongation of first the PR interval, then the QRS, then the QTc interval.
- J waves (also called Osborne waves) can occur at any temperature < 32.3°C (90°F).
- Most frequently seen in Leads II and V6.
- The size of the J waves increase with temperature depression.
Hypothermia

Treatment

“J” or Osborne Waves
Treatment

“J” or Osborne Waves
Hypothermia

Treatment

“J” or Osborne Waves
Re-warming

Methods of Rewarming:

- Active External Rewarming
- Active Internal Rewarming
Active Rewarming of MILD Hypothermia:

- **Active external methods:**
  - Warm blankets
  - Heat packs
  - Warm water immersion (with caution)

- **Active internal methods:**
  - Warmed IV fluids
Re-warming

Active Rewarming of SEVERE Hypothermia:

- **Active external methods:**
  - Warm blankets
  - Heat packs
  - Warm water immersion (with caution)

- **Active internal methods:**
  - Warmed IV fluids
  - Warmed, humidified oxygen
Re-warming

- Rewarming of the SEVERE hypothermia patient is best carried out in the Emergency Department using a pre-defined protocol, unless travel time exceeds 15 minutes.

- Most patients who die during active rewarming die from ventricular fibrillation.
Re-warming

- Application of external heat in the prehospital setting is usually not effective and not recommended because:
  - More heat transferrence is required than generally possible in the prehospital setting.

- Application of external heat may cause “rewarming shock.”
Re-warming

- **Rewarming Shock:**
  - Occurs due to peripheral reflex vasodilation.
  - Causes the return of cooled blood and metabolic acids from the extremities.
  - May cause a paradoxical afterdrop in the core temperature further worsening hypothermia.
Re-warming

- **Rewarming Shock:**
  - Can be prevented in the prehospital setting by using warmed IV fluids during active rewarming.
Re-warming

- Portable IV fluid heaters are available in the United States and Canada.
- Devices fit in-line and are powered by DC power sources.
The device is single-use and remains with the patient in the hospital (both the ED and on the floor).
Re-warming

- The HOT IV is powered from a Physio-Control battery or from a DC converter plugged in to an AC outlet.
Issues in Hypothermia

- **Benefits of IV Fluid Warming:**
  - Maintains euthermia
  - Increases patient comfort
  - Prevents shivering
Benefits of IV Fluid Warming:

- Prevents cold-induced dysrhythmias
- Decreases hemorrhage in abdominal trauma patients
- Decreases the incidence of infectious complications in abdominal trauma patients
Benefits of IV Fluid Warming:

- Allows active internal rewarming to begin in the prehospital setting.
- Less labor-intensive, freeing emergency personnel to manage other, more pressing care needs.
Hypothermia

Issues in Hypothermia - Cardiac Arrest

- **Other Clinical Concerns:**
  - Resuscitation of cardiac arrest due to hypothermia is only successful when the patient is being re-warmed.
  - The hypothermic cardiac arrest patient is not DEAD until he is WARM and DEAD!
Survival from Hypothermia

- **48.2° F (9° C)** - Lowest reported survivor from therapeutic exposure.

- **59.2° F (15.2° C)** – Lowest reported infant survival from accidental exposure.

- **60.8° F (16° C)** – Lowest reported adult survival from accidental exposure.
Survival from Hypothermia

- 64.4°F (18°C) – Asystole.
- 66.2°F (19°C) – Flat EEG.
- 71.6°F (22°C) – Maximum risk for ventricular fibrillation.
- 77°F (25°C) – Cerebral blood flow decreased by 66%.
- 78.8°F (26°C) – No reflexes or response to painful stimuli.
Survival from Hypothermia

Initial therapy for all patients:
- Remove wet garments
- Protect against heat loss and wind chill (use blankets and insulating equipment)
- Maintain horizontal position
- Avoid rough movement and excess activity
- Monitor core temperature
- Monitor cardiac rhythm

Assess responsiveness, breathing, and pulse

Pulse and breathing present

What is core temperature?

34 C to 36 C (mild hypothermia)
- Passive rewarming
- Active external rewarming

30 C to 34 C (moderate hypothermia)
- Passive rewarming
- Active external rewarming of truncal areas only

<30 C (severe hypothermia)
- Active internal rewarming sequence (see below)

Active internal rewarming:
- Warm IV fluids (43 C)
- Warm, humid oxygen (42 C to 46 C)
- Peritoneal lavage (KCl-free fluid)
- Extracorporeal rewarming
- Esophageal rewarming tubes

Continue internal rewarming until:
- Core temperature >35 C
- Return of spontaneous circulation
- Resuscitative efforts cease

Pulse or breathing absent

What is core temperature?

<30 C
- Continue CPR
- Withhold IV medications
- Limit shocks for VF/VT to maximum of 3
- Transport to hospital

>30 C
- Continue CPR
- Give IV medications as indicated (but space at longer than standard intervals)
- Repeat defibrillation for VF/VT as core temperature rises

Notes:
1. This may require needle electrodes through the skin.
2. May experience that these interventions should be done only in hospital, though practice varies.
3. Methods include electric or charcoal warming devices, hot water bottles, heating pads, radiant heat sources, and warming beds.
4. Esophageal rewarming tubes are used internationally and are expected to become available in the United States.
Hypothermia

Issues with Hypothermia

Other Clinical Concerns:

- Hypothermia is common, even in persons with minor trauma.
- Hypothermia can worsen infectious complications of abdominal trauma.
- Hypothermic trauma patients suffer increased blood loss compared to their normothermic cohorts.
Issues with Hypothermia

Considerations in Emergency Care:

“Most traditional methods of maintaining trauma patient temperature during prehospital transport appear to be inadequate.”

From: Watts DD, Roche M, et al. The utility of traditional prehospital interventions in maintaining thermostasis. Prehosp Emerg Care 1999;3(2)115-122
Considerations in Emergency Care:

“Based upon our findings, accidental hypothermia poses a relevant problem in the prehospital treatment of trauma patients. It is not limited to a special season of the year.”

Issues with Hypothermia

Considerations in Emergency Care:

“Thus, hypothermia is common in patients undergoing a laparotomy for trauma. Hypothermic patients with similar injury severity have greater blood loss.”

Issues with Hypothermia

Considerations in Emergency Care:

“Thus, hypothermia is common in patients undergoing a laparotomy for trauma. Hypothermic patients with similar injury severity have greater blood loss.”