Cold Water Boot Camp/
Beyond Boot Camp

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Relevance to you as:
1) a potential victim
2) a rescuer
3) an educator
General Thermoregulation
Like a house climate control system

Skin Temperature Sensors → Thermostat → Hypothalamus (37 ± 0.5°C) → Core Temperature Sensors

To cool down:
- Lose Heat - Open Window
  - Vasodilation
  - Sweating

To warm up:
- Decrease Heat Loss - Close Window
  - Vasoconstriction
- Increase Heat Production - Furnace on
  - Shivering
Vasomotion occurs mainly in the hands, primarily in the fingertips.
Shivering Thermogenesis

- Inefficient muscle oscillations
- Metabolic heat production

**Goal:**
- Prevent hypothermia
- Slow onset of hypothermia
- Power rewarming
Shivering Thermogenesis
Heat production prevents, or slows the onset of hypothermia
Which drink do you give the cold patient?

- Only for mild hypothermia.
- Conscious, alert, won’t choke.

Hot/Warm Water?
Cool alcohol?
Cold Soft Drink?

BEST: Warm Chocolate
Heat Loss Mechanisms

- Evaporation
- Respiration
- Radiation
- Convection
- Conduction
- Muscular activity
- Conversion of food to heat

External Sources

How Heat Is Lost and Gained
Core Temperature depends on HEAT BALANCE
a) Normal conditions
b) Cold decreases surface blood flow (heat loss)
c) Exercise increases surface blood flow (heat loss)

Figure 4. Thermograms indicating relative skin temperatures (and therefore relative heat loss): (a) before immersion in 45.5°F (7.5°C) water, (b) after holding still in the water for fifteen minutes, and (c) after swimming for fifteen minutes. Lighter areas are warmer.
Question

* If you fall in ice water, with winter clothes on, how long do you think it will take to become hypothermic?
Estimated time to hypothermia

- 0 to 5%
- 6 to 10%
- 11 to 15%
- 16 to 20%
- 21 to 30%
- >30%

Beyond Cold Water Boot Camp
4 Phases of Cold Water Immersion

- Cold Shock (~ 1 min)
- Cold Incapacitation (5-15 min)
- Hypothermia (> 30 min)
- Circum Rescue Collapse
When and How You Can Die in Cold Water

1) Cold Shock Response
   (0-2 minutes)
   ↓
   Gasp → Drown
   ↓
   Hyperventilation → Faint → Drown
   ↓
   Cardiac Work → Cardiac Arrest

   Keep head out of water
   Enter slowly?
   Thermal protection
   Don’t panic, keep calm
   If existing heart problems
**Cardiac Work → Cardiac Arrest (If existing heart problems)**

**Frigid dip fatal**

Bruce MacIntosh, 74, gets emergency attention after collapsing on a Hamilton, Ont., beach yesterday following his annual Polar Bear Club dip in Lake Ontario. MacIntosh, who ran the icy swim for 30 years, died of heart failure. His doctor had suggested he quit the swim after he had a heart attack in 1992 and began taking nitroglycerine.
When and How You Can Die in Cold Water

2) Cold Incapacitation (2-15 minutes)

Local cooling of nerves and muscle fibers
Swim failure,
Can’t hold on,
Can’t perform survival tasks

If you can’t get out in 5-15 minutes, you might not get out on your own power!

If so, prepare to survive.

Widen window of opportunity for rescue.

Thrashing around will:
- increase heat loss
- cause exhaustion (Drowning)
When and How You Can Die in Cold Water

3) **Onset of Hypothermia**
   - Human body is a large mass
   - Thermally protected by VC and SHP
   - Mild Hypothermia (35°C) >30 minutes
   - Cooling to **UNCONSCIOUSNESS** (~30°C)
   - If head goes under
     - Drowning (within 30-120 minutes)
   - If head above water... (i.e., with floatation)
     - Cooling to **CARDIAC ARREST** (28-25°C)
     - Death (90-180 minutes)
When and How You Can Die in Cold Water

4) Circum-rescue collapse

Just before, during or after rescue
Collapse - ranging from faint to death
May be caused by:
- Mental relaxation, and
- Decreased output of stress hormones (epinephrine/adrenaline)
  - Drop in blood pressure (faint)
  - Extra cardiac work (cardiac arrest)
1 – 10 – 1 Principle

Refers to first three phases of cold water immersion
Lifesaving Message
1 Minute - 10 Minutes - 1 Hour

Cardiac Arrest
Control
Meaningful
Breathing Movement
Lose Consciousness

*(°C)*

Control Breathing
Meaningful Movement
Lose Consciousness
Cardiac Arrest

Temperature over time:
- Control Breathing
- Meaningful Movement
- Lose Consciousness
- Cardiac Arrest

(0 - 2 hours)
1 - 10 - 1 Principle

Regarding the Cold Shock Responses…
Consider the following:

* **DO NOT PANIC**
* If possible, enter the water slowly and try to keep your head from being submerged
* Focus on surviving the first minute by getting control of your breathing
You have 10 minutes of meaningful movement for self rescue

Once you start becoming weaker, prepare to wait for rescue
1 - 10 - 1 Principle

Regarding Hypothermia
Consider the following:

Delaysing the Onset of Hypothermia

- HELP position
- Groups of individuals (HUDDLE)
- Exit water as soon as possible
- If exit is not possible, get as far out of the water as possible
Lifesaving message

1 - 10 - 1 Principle

**DO NOT PANIC, because you have:**

- 1 minute **to get your breathing under control**
- 10 minutes **of meaningful movement**
- 1 hour **before you become unconscious due to hypothermia**
Survival in Cold Water
Survival in Cold Water

- Life jacket

- Behavior
  - Activity
  - HELP / Group HUDDLE
Survival in Cold Water

- Life jacket
- Behavior
  - Activity
  - HELP / Group HUDDLE
- Signals

Courtesy DFO
Survival in Cold Water

- Life jacket
- Behavior
  - Activity
  - HELP / Group HUDDLE
- Signals
- Thermal Protection
  - Clothing
  - PFD
  - Wet suits
  - Extended wear “paddling” dry suits
  - Low activity/short duration wear dry suits
    - Survival suits / Rescue personnel
Stay or Swim?
What to do?

- Your boat has capsized in the middle of the lake
- The water is cold
- There is little chance of rescue
- Should you “Stay with the boat no matter what?”
To swim... or not to swim?

Can you make it?

If you swim and are wrong...

- **Without a PFD**, the price is death
- **With a PFD**, the price is incapacitation but at least you’re still floating
What happens?

* Exercising in cold water:
  - Increases blood flow to muscles
  - Increases heat loss from skin
  - Increased convective heat loss as you move through water
  - Decrease in arm temperature
  - Difficulty in coordinating swimming and breathing
  - Fatigue or exhaustion

* Your judgment will be impaired as time goes on
Recent studies

* In 10-14°C water
* With a PFD
* Swimming distances for
  * Novices was ~800 m
  * Experts was ~1500 m
* Average swim time was ~45 min
* The evidence suggests swimming is possible . . .
  But still very risky
Decision making

In 2006 the Canadian Red Cross Society stated

“If rescue is unlikely, it may be preferable to swim to safety” only if you have a PFD on!
After you fall in cold water

* Don’t panic
* Get your breathing under control (~1 min)
* IF YOU HAVE NO PFD . . .
* STAY WITH THE BOAT!
After you fall in cold water

IF YOU DO HAVE A PFD:

★ Get breathing under control
★ Ask “Is rescue likely” within an hour or so
★ If yes – preserve energy and heat
★ If not - you may consider swimming
★ Once you make your decision, stick to it
After you fall in cold water

- Determine the closest/easiest destination
- Do you think you can make it?

or

- Can you get there within 45 minutes?
- If so, you can proceed
- Swim with a head out breast stroke at even and sustained pace
- NO guarantee! But you do have a PFD
Rescue
Treatment
Rescue

Safety

- Rescuer
  - Flotation
  - Thermal Protection
  - Don’t tip boat / fall in
  - Other?
- Others
- Victim
Rescue (extraction)

Care of victim

1) Gentle
2) Horizontal
   - Dehydration
   - Remove hydrostatic squeeze
   - Blood pooling in legs
   - Decrease in blood pressure and temp
3) Protect from environment
4) Dry / Insulate / Vapor barrier
General Care of the Hypothermic

- Handle victim gently
- Keep victim lying flat
- Dry/Insulate/Vapor barrier
- Fuel Shivering if practical
Treatment

Some important Issues:

- Emergency or Urgency???
- Active warming pre-hospital?
- Victim, physical activity?
- CPR?
- Fluid replacement?
Treatment

Main Priorities

★ Arrest fall in core temperature
★ Afterdrop
★ Maintain cardiovascular stability
★ Establish steady safe warming
Past Practice?

The lady in the picture has just been hauled out of the lake in the foreground - and the two doctors are gallantly reviving her by the expedient of blowing tobacco smoke up her bottom. (I understand that an important principle of this mode of therapy was that the physician should remember NOT TO INHALE)
Remove Wet Clothing

* Be very aware
* Mechanical Stimulation may trigger Ventricular Fibrillation!
* Use the "North Face Clothing Test"
Packaging and external heat
### Classification for Level of Hypothermia

<table>
<thead>
<tr>
<th>Core Temperature</th>
<th>Thermoregulatory Status</th>
<th>Signs and Symptoms</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 °C</td>
<td></td>
<td>Cold Sensation</td>
<td>Normal</td>
</tr>
<tr>
<td>&lt;37°C</td>
<td>Control and Responses Fully Active</td>
<td>Shivering</td>
<td></td>
</tr>
<tr>
<td>35-32°C</td>
<td>Control and Responses Fully Active</td>
<td>Physical Impairment Fine Motor Gross Motor Mental Impairment Complex Simple</td>
<td>Mild</td>
</tr>
<tr>
<td>32-28°C</td>
<td>Responses Attenuated/Extinguished</td>
<td>~30°C Shivering Stops Loss of Consciousness</td>
<td>Moderate</td>
</tr>
<tr>
<td>&lt;28°C</td>
<td>Responses Absent</td>
<td>Rigidity Vital Signs Reduced or Absent Risk of VF/CA (Rough Handling)</td>
<td>Severe</td>
</tr>
<tr>
<td>&lt;25°C</td>
<td></td>
<td>Spontaneous Ventricular Fibrillation Cardiac Arrest</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. First aid prehospital care of the hypothermic victim.
Some advanced treatment topics
CPR

Danger
- Chest compressions will fibrillate a cold functioning heart

NOTE: This is not a temporal emergency
- It took time to become hypothermic
- Delaying CPR a few minutes will not compromise patient
- Rushing to start CPR may be fatal

Extended attempt to determine perfusing activity
- Look, listen and feel (60 seconds by the clock)
CPR

- Ventilation (3 min) to increase oxygenation of heart
- Another attempt to determine perfusion (60 sec)
- Final judgment on perfusing cardiac activity
- CPR decision may depend on time to medical facility
You’re never cold and dead…
Unless you’re warm and dead…
Unless you’re cold and dead!
IV Fluids

* Dehydration
  - Cold induced diuresis,
  - Fluid shift
  - Hydrostatic squeeze

* Rapid cooling - some dehydration

* Slow cooling - larger effect

* IV Infusion

* Rapid infusion (250 ml boluses)

* Warm fluid (heat IV bag or tube)
SAR/EMS
With monitoring equipment

Hypothermia: EMS Prehospital Care

1. Responsive?
   - Yes
   - No
   - Shivering?
     - Yes
     - Spontaneous Rewarming (Insulate/Vapor Barrier)
     - Cardiac Monitor
     - Heat if Possible
     
     - Non-arrest Rhythm
     - Ventilate
     - Central Pulse
     - PEA
     - CPR
     
     - Heat if possible
     
     - HOSPITAL
   
   - No
   - Assume Cardiac Output
   
   - Ventilate 1-2 Minutes
   
   - Heart if Possible
   
   - Cardiac Monitor
   
   - Arrest Rhythm
   
   - HOSPITAL

2. Respiration?
   - Yes
   - Heat if Possible
   
   - Cardiac Monitor
   
   - HOSPITAL
   
   - No
   - CPR
   
   - HOSPITAL
Figure 8-13  Schematic illustration of the effectiveness of various rewarming techniques under shivering and nonshivering hypothermic conditions. Dashed line (at 30°C) indicates approximate core temperature at which shivering is spontaneously abolished. Ex. External rewarming.
# Warming efficiency/safety

<table>
<thead>
<tr>
<th>Power Source</th>
<th>Heat Source</th>
<th>Heat Level/Aggressive?</th>
<th>Treatment Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low-to-Moderate Heat</td>
<td>Hypothermia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-Aggressive</td>
<td>XX</td>
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<tr>
<td>Non-Electric</td>
<td>Fire</td>
<td>Low-to-Moderate Heat</td>
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<td></td>
<td>Chemical Pack</td>
<td>Low-to-Moderate Heat</td>
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<tr>
<td></td>
<td>IV Fluid</td>
<td>Low-to-Moderate Heat</td>
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<tr>
<td></td>
<td>Warm Sweet Drink</td>
<td>Non-Aggressive</td>
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<tr>
<td></td>
<td>Inhalation Warming</td>
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<tr>
<td></td>
<td>Warm Water Bottles</td>
<td>Non-Aggressive</td>
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<tr>
<td></td>
<td>Warm Body</td>
<td>Non-Aggressive</td>
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<tr>
<td></td>
<td>Charcoal HeatPac</td>
<td>Non-Aggressive</td>
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<tr>
<td>Electric</td>
<td>Electric Blanket</td>
<td>Low-to-Moderate Heat</td>
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</tr>
<tr>
<td>120 VAC</td>
<td>Water Blanket</td>
<td>Low-to-Moderate Heat</td>
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<tr>
<td></td>
<td>Forced Air Warming</td>
<td>Low-to-Moderate Heat</td>
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<td></td>
<td>Warm Shower</td>
<td>High Heat</td>
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<tr>
<td></td>
<td>Warm Bath</td>
<td>Aggressive</td>
<td>XXX</td>
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<tr>
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<td>Lavage</td>
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<tr>
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<tr>
<td></td>
<td>Fem-Fem</td>
<td>Aggressive</td>
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</tr>
<tr>
<td></td>
<td>Bypass</td>
<td>Aggressive</td>
<td>✓✓✓✓</td>
</tr>
</tbody>
</table>

✓, Effectiveness - , Not effective or applicable X, Harmful