Drowning
Cold Injuries &
Hypothermia

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# Drowning Cold Injuries & Hypothermia

## Objectives

- **Drowning**
  - Definition & Terms
  - Mechanisms
  - Complications
  - Statistics
  - Pre-hospital treatment
  - Pre-hospital Considerations
  - Case #1

- **Cold Injuries & Hypothermia**
  - Case #2
  - Definition
  - Stages
  - Treatment & General Management
  - Hypothermia Cardiac Arrest Protocol
Drowning
Definition (ref 8)

• There are >20 accepted definitions referring to this drowning

• At the 2002 World Congress on Drowning, a group of experts suggested a new definition for drowning

• They felt this would allow, more accurate analysis, comparison of studies, more meaningful conclusions from pooled data
Drowning
Definition

“Drowning is a process resulting in primary respiratory impairment from submersion in a liquid medium.”
Drowning

Discarded Terms

- Wet drowning
- Dry drowning
- Active or passive drowning
- Near-drowning
- Secondary drowning
- Silent drowning

Are all terms that have now been discarded
Drowning

New Accepted Terms

• “Submersion Injury” and “Drowning” are interchangeable

• All patients are submersion victims until they die or live
  • If they live = submersion victim
  • If they die = drowning
Drowning
Mechanisms

- Hypoxemia and acidosis are the principle mechanisms of injury in drowning. (ref 7, 8)

  - Submersion in water results in cessation of normal respiration and a sudden reduction in alveolar concentration of oxygen.
  
  - Causes the victim to gasp with a subsequent intake of water.
  
  - Immersion stimulates hyperventilation, followed by voluntary apnea
  
  - There may be violent laryngospasm and bronchospasm, preventing ingress of water into the lower airway
Drowning

Mechanisms

- As hypoxemia supervenes, the vocal cords relax and water enters the lungs, exaggerating the hypoxia. (previously referred to as “wet drowning”)

- Most victims aspirate less than 4 ml/kg of fluid

- Approximately 10 – 20% of individuals maintain tight laryngospasm until cardiac arrest occurs and inspiratory efforts have ceased

- These victims do not aspirate any appreciable fluid (previously referred to as “dry drowning”)

- Aspiration leads to changes in pulmonary surfactant, and there is a difference between saltwater and freshwater

Saltwater Drowning:  Saltwater is 3-4 times more hypertonic than blood. Because of this, theoretically the salt water will pull protein rich fluid out of the blood and into the lungs. This process could take minutes or even hours to manifest.

Freshwater Drowning:  Freshwater quickly and easily passes the alveolar wall and acts as a barrier between the pulmonary circulation and the alveoli.
Drowning
Diving reflex (ref 7)

Children suddenly immersed in cold water (≤20°C) may have

• Apnea
• Bradycardia
• Vasoconstriction of vascular beds.

This redistributes blood to the coronary and cerebral circulation

This is called the Diving Reflex
Drowning
Complications (ref 8)

Complication of Drowning Include

• Aspiration pneumonitis
• Non-cardiogenic pulmonary edema
• Rhabdomyolysis
• Multi Organ Dysfunction Syndrome

Primarily seen in the hospital setting.
• In Canada During 1991–2000
  - 5,900 water–related deaths
  - in comparison with over 400,000 world wide. ref (2)

• In addition, there were 3,289 hospitalizations
  - many of which resulted in brain damage. ref (2)
Drowning
Statistics

Drownings happen

• 2/3 of the time in the summer months
• 40% occur on Saturday and Sunday
• 90% occur in fresh water

Leading Causes

• Boating
• Swimming
• Playing near unprotected water and swimming pools
Drowning
Statistics

**Drowning injuries by age with leading causes**

- **Infants (< 1 yo)**
  - bathtubs and buckets

- **Toddlers (1–4)**
  - swimming pools

- **Children (5–14)**
  - Lakes, ponds, rivers and oceans

- **Adolescents and Adults**
  - Anywhere involving alcohol & drugs
Drowning
Statistics

• One-quarter to one-third of drowning victims have swimming lessons. ref(3)

• Males have a rate three times higher than females because of increased reckless behavior and use of alcohol ref(3)
Drowning
Survival Factors

Factors associated with survival without permanent brain and lung damage:

• Length of submersion (shorter submersion time has better outcome)
• Water temp (cold water accidents can have a better outcome)
• Patients age (children are more likely to have a better outcome)
• Speed in which resuscitation begins.
• Absence of alcohol before drowning (less likely to die or develop brain or lung damage).
Drowning
Survival Factors

Factors associated with survival without permanent brain and lung damage:

• Survival is possible after submersion for as long as 40 minutes.
• Almost all people who are alert and conscious upon their arrival at the hospital recover fully.
• Many people who need CPR can also recover fully.
Drowning
Pre-hospital Treatment

- BLS Patient Care Standards Section: 4–14

- Assume life/limb/function threats:
  - Asphyxia, aspiration, pulmonary edema
  - Hypothermia
  - Scuba Diving related disorder
  - Concurrent trauma
  - Underlying disorders which may have precipitated the event
    - E.g.: Drug or alcohol consumption, hypoglycemia, cardiac dysrhythmias

- C-spine precautions if spine injury is obvious, suspect, or can not be ruled out.
Drowning
Pre-hospital Treatment

• Attempt to ascertain water temperature and duration of submersion/immersion.

• Treat as per Medical Cardiac Arrest General Protocol if VSA

• Consider Ventolin if Broncho-constriction present
Drowning
Pre-hospital Considerations

• Underlying disorders which may have contributed to the event:
  • Drug or alcohol consumption
  • Hypoglycemia
  • Cardiac dysrhythmia

• Water contains known or obvious chemicals, pollutants or other debris

• Accident related to diving
Drowning
Pre-hospital Considerations

• Submersion victims may complain of ongoing SOB or be asymptomatic after a drowning event

• Symptoms may occur hours after the initial event.

• All submersion victims should be transported to the most appropriate hospital for continued care.
Case #1

• During a free swim with his classmates, a 12 year old male was splashing around but appeared “OK”.

• Within minutes, he was seen by an instructor motionless on the bottom of the pool in 8–feet of water.

Points from audio:
• Caller did not know the address of the pool when he called 911
• Caller did not know if the victim was conscious or unconscious
• Caller did not know if the victim was breathing
• Called from cell phone with poor reception (should have been a land line phone near the pool)
• Caller stopped relaying information to 911 dispatch to help with extrication. 911 dispatch did not know if the cell phone lost connection.
Scenario Outcome

• The patient was in the pool for no more than six minutes total

• The patient remained VSA until enroute to the hospital

• The patient died five days later in hospital

• The Medical Examiner's office labelled his cause of death "complications of near drowning."
Drowning

Summary

• “Drowning” is becoming more commonly referred to a “Submersion Injury”

• It affects all ages and sexes with multiple co-factors

• There are multiple co-morbid factors that will affect the patients outcome

• The priority’s in pre hospital treatment should be
  • Rapid Transport
  • Assume trauma is a co factor
  • All Submersion victims should be assessed in hospital
Cold Injuries & Hypothermia
What would you do?

• In Dec. 2008 a 10 year old boy fell through the ice at a park pond while trying to retrieve a remote control airplane. His 7 year-old brother grabbed a cellular phone to dial 911 for help

Points from Audio
• Caller was not clear of address. “at the pond on Washburn.....”
• Caller did not know name of park
• No parents around
• Poor cell phone reception. Kept cutting off when caller spoke.
Hypothermia

Definition

- Hypothermia is a condition in which the body temperature drops below that required for normal metabolism and bodily functions.
Hypothermia

Definition

- Normal body temperature is 36.8°C (98.6°F).

- The core body temperature is maintained near a constant level through biologic homeostasis.

- When the body is exposed to cold, its internal mechanisms may be unable to replenish the heat that is being lost to the surroundings.

Normal body temp is around 36.8 °C. It is different for everyone.
Hypothermia
Can be divided in three stages of severity

**Stage 1**
- Body temperature drops by 1–2°C below normal temperature
- Shivering begins
- The victim is unable to perform complex tasks with the hands
- Breathing becomes quick and shallow
- Goose bumps form
- Victim may feel sick to their stomach, and very tired
- Often, a person will experience a warm sensation but they are in fact heading into Stage 2

1 – no comments
2 – no comments
3 – the hands become numb. Blood vessels in the outer extremities constrict, lessening heat loss to the outside air.
4 – no comments
5 – raises body hair on end in an attempt to create an insulating layer of air around the body
6 – no comments
7 – victim may think that they have recovered
Hypothermia
Can be divided in three stages of severity

**Stage 2**
- Body temperature drops 2–4°C below normal temperature
- Shivering becomes more violent
- Muscle un-coordination becomes apparent
- Movements are slow and labored
- Peripheral blood vessels contract
- The victim becomes pale
- Cyanosis will appear

1 – no comment
2 – no comment
3 – no comment
4 – maybe accompanied by a stumbling pace and mild confusion
5 - the body focuses circulation on keeping the central organs warm
6 – no comment
7 – noticeable in the lips, ears, fingers and toes
Hypothermia
Definition

**Stage 3**

- Body temperature drops below approximately 32 °C
- Shivering usually stops
- Difficulty speaking, sluggish thinking, and amnesia start to appear
- Inability to use hands and stumbling is also usually present.

Sluggish thinking and amnesia start to appear due to decreased cerebral perfusion
Hypothermia
Stage 3 continued

Stage 3 continued

- Cellular metabolic processes shut down

- Below 30 °C, the exposed skin becomes blue and puffy, muscle coordination becomes very poor, walking becomes almost impossible, and the victim exhibits incoherent/irrational behavior including terminal burrowing or even a stupor

- Pulse and respiration rates decrease significantly, but fast heart rates (ventricular tachycardia, atrial fibrillation) can occur
Hypothermia
Stage 3 continued

Stage 3 continued

• Major organs fail

• Clinical death occurs

• Because of decreased cellular activity in stage 3 hypothermia, the body will actually take longer to undergo brain death
Hypothermia
Treatment (ref. 6)

- BLS Patient Care Standards Section 4-11
- Remove from cold ASAP. Remove any wet clothing and cover with blanket (including head)
- Assume life/limb/function threats:
  - Severe hypothermia/frostbite
  - Concurrent trauma
  - Drowning, if cold injury is secondary to immersion or submersion
  - Underlying disorders /Precipitating factors
    - E.g., Alcohol/drug ingestion (especially barbiturates or other sedatives), hypoglycemia or trauma
Hypothermia

Treatment

• Check pulse and respirations for at least 45 seconds if severe hypothermia is suspect or obvious
• Initiate cardiac monitoring

Incident History
• Duration/type of exposure (wet, dry, or both)
• Approx. air/water temp. and wind chill
• Any re-warming attempted prior to EMS arrival and if any Pt. response
Hypothermia

Key Points

Important!!!

- Recall that the presence or absence of shivering is an important indicator of the severity of hypothermia. If shivering is minimal or absent and LOC is decreased or LOA is markedly altered, assume core temperature is below 32°C

This may not always be the case. This logic can be used to help support your critical thinking and decision making on scene.
Hypothermia

Key Points

• Hypothermic patients should be managed supine
  • Variations in body position may provoke dysrhythmias in the severely hypothermic victim.
  • The cardiovascular system cannot cope with fluid shift changes.
    • Example: moving from vertical to supine position
Hypothermia
General management for cold injuries (mild to moderate hypothermia)

- Passive re-warming
  - Remove pt. from the cold and blanket (including head)
  - Insure C-spine protection if injury is obvious, suspect, or cannot be ruled out
  - Attempt to remove wet or constrictive clothing (including jewelry and shoes); if jewelry is frozen to the skin, leave until thawing occurs; wrap body/affected parts in blanket or foil rescue blanket.
  - Maintain comfortable temperature in the patient compartment, at or around room temperature.
  - Overheating may redistribute cold, acidotic blood from the extremities to the core, possibly leading to cardiac dysrhythmias, death

Passive re-warming vs. Active re-warming

Peripheral vasodilation in skin causes increased blood flow to return to core. While superficially temp may be increased, overall the extremity will be cooler than core. This increased flow of cooler blood to the heart may trigger V-Fib
Hypothermia
General management for cold injuries (mild to moderate hypothermia)

- Active re-warming
  - Pre-Hospital
    - Provide external re-warming as available. E.g., Hot packs, hot water bottles, heating pads to axillae, groin, neck and head.
    - Provide slow, gentle re-warming especially if transport time is long i.e., > 30 minutes
  - In Hospital
    - Warm IV solution, warm resus. bay, “Bear” hugger, Foley irrigation, chest tube, peritoneal lavage, cardiopulmonary bypass, thermo-couplers

We do not carry the necessary equipment for active re-warming in the pre-hospital setting. However, this comes from the BLS Standards of Patient Care.
Hypothermia
General management for cold injuries (severe hypothermia)

- Unconscious pt. with cold, stiff body/limbs, no shivering, pulse and respirations slow/absent and no other signs of “obvious death”
  - Handle as gently as possible
  - If no pulse is detected after 45 seconds, initiate hypothermic cardiac arrest protocol
  - If no or inadequate respirations are detected but a pulse is present, begin assisted ventilations without compressions and initiate rapid transport
  - Do not perform vigorous or excessive suctioning or airway manipulation (may trigger ventricular fibrillation)

Vigorous or excessive suction or airway manipulation may trigger a vagal response and induce VF
Hypothermia
General management for cold injuries (severe hypothermia)

• Administer/ventilate using high concentration humidified oxygen. Protect the cylinder from cold whenever possible

• Employ passive re-warming measures

• Do not employ active re-warming. (May shunt cold, acidic blood from the extremities to the core, possibly leading to cardiac dysrhythmias, death)

The measures that we implement in the pre-hospital setting do not “warming” as much as the are helping to prevent further heat loss
Hypothermia
Management of Frostbite

- Initiate passive re-warming of the affected part
- Cover and protect the area
- Do not rub or massage the skin
- Leave blisters intact
- Bandage digits separately
- Elevate and splint the affected extremity
Hypothermia
Management guidelines

• If transport is delayed or transport time is prolonged, consider contacting a BHP for advice regarding active re-warming
• Enroute: monitor, re-evaluate, and manage as required. Prepare for expected problems:
  • Emesis
  • Problems related to concurrent injury/illness
  • Respiratory/cardiac arrest (if severe hypothermia)

Again, we do not have any means of actively re-warming in the pre-hospital setting.
Hypothermia
where you least expect it...

- Hypoglycemia
- CVA
- Hypothyroid
- Economics
- Geriatrics
- Falls
- Sepsis
Hypothermic Arrest Protocol

Hypothermic Cardiac Arrest General Protocol Adult & Pediatric

• When a patient is found to be in cardiac arrest (vital signs absent – VSA) and convincing evidence exists that the patient is severely hypothermic, the Paramedic will treat the patient according to the following protocol.
Hypothermic Arrest

Indications

Patient who is in cardiac arrest (VSA) with severe hypothermia. Severe hypothermia suspected by:

- History indicating that the patient has suffered prolonged exposure to a cold environment.
- Central body temperature is cold to the touch (chest, abdomen, and under arms).
- Skin appears to be white/waxy in nature.
- May have stiff limbs.
**Hypothermic Arrest**

**Procedure**

- Confirm cardiac arrest by the absence of spontaneous respirations and palpable central pulses. A **45 second pulse check** should be performed.

- Initiate chest compressions and ventilations for approximately 2 minutes.

- Attach AED or defibrillator while performing CPR.

The ROC procedures will supersede the BLS Standards of Patient Care where/if applicable for up front CPR (30 sec vs. 3 min)
Hypothermic Arrest

Procedure

4. Initiate therapy according to the PCP or ACP Cardiac Arrest General Protocol. Continue until the first AED analysis or manual rhythm check has been performed and CPR has been re-initiated if necessary.

5. Transport should be initiated quickly. No further defibrillation efforts enroute. Update receiving facility enroute.

6. Establish IV access enroute (if certified). No IV drugs will be administered.

If the heart does not respond to the first attempt at defibrillation, then it probably won’t without warming the victim’s core. This is the reason for only one analysis on scene, (Semi-automatic or manual) then load and go.
Scenario Outcome

• The victim was rescued and successfully treated at a hospital.
Hypothermia

Summary

• Hypothermia is a dynamic process that may not be easily identifiable in the pre-hospital environment
• Gentle, gradual, and minimally invasive therapies should be implemented
• Remove wet and/or cold clothing and cover with blanket (including head) ASAP
• Pre-hospital treatment is focused on rapid transport with minimal treatment on scene

1 – Shivering may or may not be present. Interpret sign’s and symptoms and scene info and choose the most appropriate therapy.
2 – Do not overheat. Avoid aggressive suctioning or airway management. Keep movement to a minimum.
3 – Even if relatively short transport time.
Drowning, Cold Injuries & Hypothermia

Any Questions?
References

(1) Final Recommendations of the World Congress on Drowning (Amsterdam 26—28 June 2002)

(2) http://www.redcross.ca/cmslib/general/10drwn_english.pdf

(3) http://www.emedicinehealth.com/drowning/article_em.htm

(4) http://en.wikipedia.org/wiki/Drowning


(6) BLS Standard of Patient Care


(8) Drowning, Near Drowning and Immersion Syndrome; SR Lord, PR Davis, 2005