

Injuries caused by heat, cold, electric current, drowning

2018 version

Injuries caused by heat

- **Burns**
- **Overheating of the organism**

BURNS

- Specific type of injury, where tissue damage (most often the skin) **is a result of high temperatures (above 45 degrees)**
- **Dry burns** – burns caused by a flame, *radiation, direct contact with a hot object, friction*
- **Wet burns** – burns caused by scalding liquids, or steam

- **Most often affected age group:** *18 - 30* years of age and small children *1 - 3* years
- **incidence:** home injuries (60%), automotive accidents, industry
- **Severity of burns - depth** (so called degree), **extensity, localization** of the burned area

Damage to the organism

- **Direct damage** – damage to cell membranes – necrosis or carbonification
- **Indirect damage** – edema, ischemia

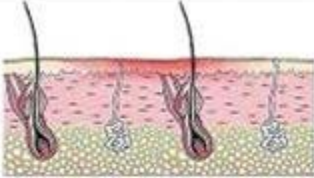







The genesis of edema

- Damage to capillaries – increase in their permeability – leakage of proteins and liquids from the veins to the intercellular space – formation of a so called **interstitial edema**
- Edema – formed practically immediately, formation is maximized within 12 hours after scorching

- severe burns – generalized edema – acute loss of circulating liquid – **hypovolemic shock**
- Proinflammatory components from the damaged tissues act negatively on the activity of the myocardium – **cardiogenic shock**, they also cause generalized vasodilation- **distributive shock**
- **Infectious complications**
- **Loss of warmth**- hypothermia (especially in small children)
- **Inhalatory trauma** (thermal damage to the lungs, poisoning)

Symptoms - depth

- I. Degree – **redness** of skin (damage to the epidermis)
- II. Degree – **blisters** (damage to the *dermis*)
- III. Degree – **necrosis** (damage to all layers of the skin)
- IV. Degree – **carbonification** (damage to the *deep structures* – muscles, bones)

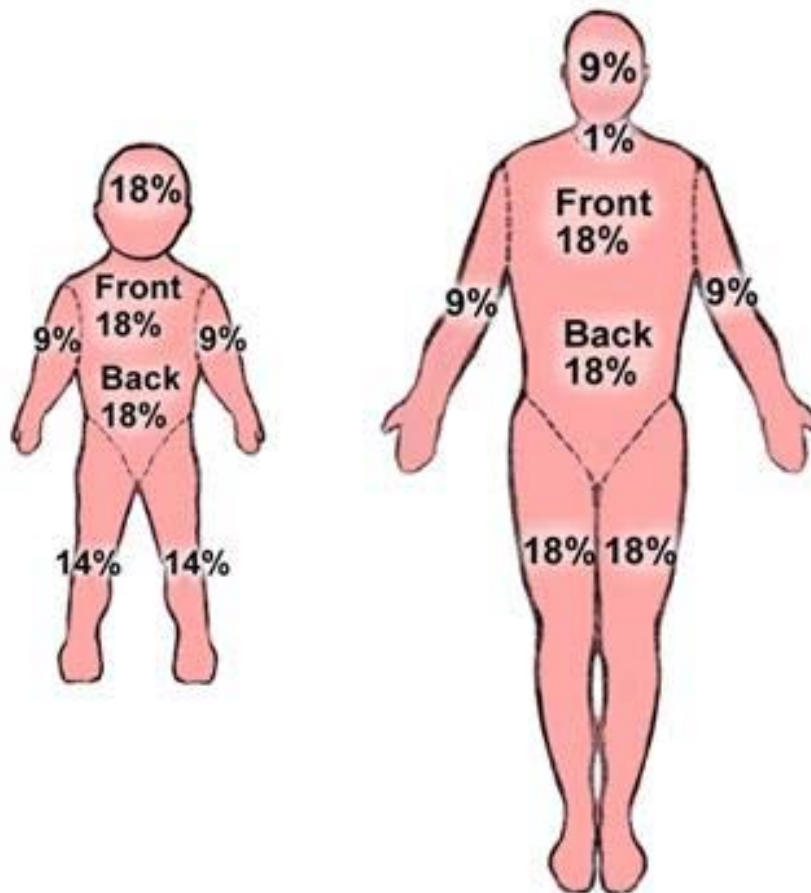
Degree	Anatomic correlate	Schematic aspect	Clinical aspect
I	Reddening, swelling, pain (epidermis)		
IIa	Reddening, blistering, pain (superficial dermis)		
IIb	Pallor, blister, pain (partial dermis)		
III	Greyish white or black necrosis, analgesia (complete dermis)		
IV	Carbonization (may extend to the bones and joints)		



Symptoms - extensivity

- Wallaces rule of 9

- Head and neck – 9 % (in children up to 3 years old its 15%)
- Upper limbs – 2 x 9 %
- Lower limbs – 2 x 18 %
- Chest – 18 % front, 18 % back
- Abdomen – 18 % front, 18 % back
- Genitals – 1 %



- Note: the size of the palm of the patient (with fingers) is approximately **1%** of their body area

- **Severe burns** – in adults it is about **30 %** of skin surface, in children up to 3 years only **5 %** (if located on the face, neck, hands, flat of the foot, the genitals, even with smaller areas)
- Heavy burns – primary priority is a transport by ES to a **burns center**, not to the nearest hospital

First Aid

- **Technical first aid** – prevent further trauma (turn off or put away sources of heat, extraction, extinguishing burning clothes)
- **By-stander first aid** – primary treatment should be tailored to the severity of the burns and the overall state of the patient

- **Burns of lower severity** (I. and II. Degree burns, roughly 7 cm in diameter) – can be treated just locally
- Immediate cooling **using water** with a temperature of roughly 8 °C, for as long as it brings relief to the patient
- Loosen all articles of clothing that could eventually **strangulate** the given body part in the resulting edema (rings, chains, circlets, cuffs, tight fitting clothing)

- Remove large foreign objects, (a burn is not to be disinfected – only the surrounding area and no local agents are to be applied)
- Do not puncture the blisters
- Cover it with sterile mull and the free hydrophilic bandage, if you dont have any, cover with clean preferably freshly ironed cloth
- Liquids and common analgesics (i.e.. ibuprofen, paracetamol)

Severe burns

- Call professional aid, early transport to the burns centre
- **Do not cool** (a threat of hypothermia to the patient)
- Do not remove charred clothing from the burns
- Sterile covering
- Basic life support, nothing per os.

OVERHEATING

- Overheating of the organism (hypertermia) – state in which the **temperature of the body core raises above 39 °C**
- Cause
 - excessive thermal generation
 - excessive surrounding temperature and humidity
 - the organism cannot cool down fast enough
 - ❖ radiation, conduction, convection and sweating

Reaction of the organism

- **Vasodilatation** – greater loss of heat through excessively perfused skin and sweating – loss of water and salts, lowering of blood pressure (collapse)
- A possibility of development of hypovolemic shock → vasoconstriction → lower ability of thermoregulation → vicious circle → rapid raise in temperature

Symptoms

Heat stroke (hypertermia, siriasis) – caused by a hot, often humid environment (mass transit, or excessive physical strain in a hot environment)

- Manifestations – headaches, nausea, vomiting, thirst, tachycardia and hypotension

Sun stroke (insolatio, heliasis) – prolonged exposition of the uncovered head and neck to the sun

- Affected functions of the CNS – headaches, hyperreflexia, spasms and stupor of the nape of the neck as in meningitis (pseudomeningital symptoms)
- Derangement of the circulatory system- hypotension or heart arrhythmia

First aid

- Transfer the patient to a **cool shaded and well ventilated area** and check the basic vital functions
- Recuperating position in case of unconsciousness
- Release tight clothing and actively **cool** (icepack, ventilation)
- Liquids per o. – if not unconscious
 - mineral water, sweetened tea

HYPOTHERMIA INJURIES

- Frostbite
- Hypothermia of the organism

FROSTBITE

Frostbite (congelationes) – damage to the tissues cause by **the cold**

- Most often afflicted is the **skin** (but can extend to the inner tissues – subcutaneous areas, muscles, tendons, bones and joints)
- Highest threat of frostbite – peripheral areas of the body – fingers of the upper and lower limbs, nose, chin and ears

Mechanisms of the frostbite

- The formation of the **ice crystals** interstitially – transfer of water outside of the cells – damage to the structure and function of the cell membranes, vasoconstriction and damage to the perfusion of the peripheral tissues
- Damage to the endothelium of arteries – aggregation of platelets – **formation of thrombus**

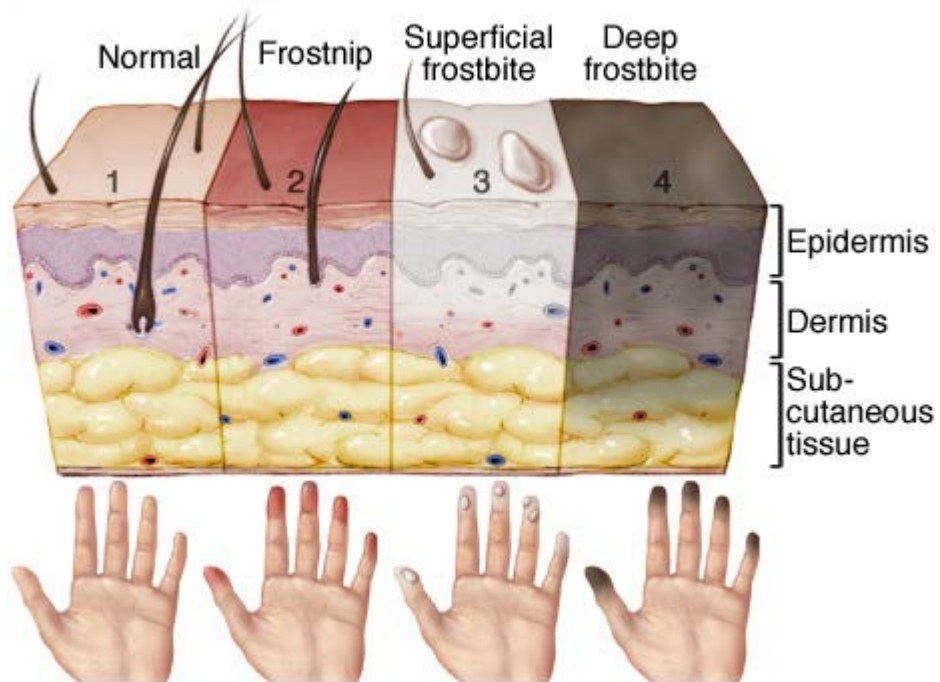
- After warming – vasodilatation – loss of liquid and proteins out of damaged blood vessels – **edema** – further deterioration of perfusion
 - edema usually just local
- Usually does not devolve into a shock state

Frostbite- risk factors

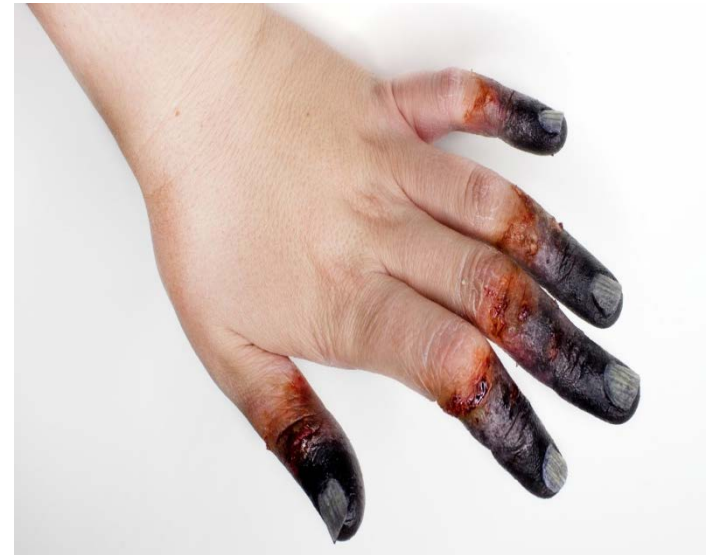
- Climatic conditions (severe frost, wind, humidity, high altitude)
- Dehydration, hunger, exhaustion
- Wet or sweaty clothing
- Restricted movement (injuries, broken bones, exhaustion, drunkenness)
- Restricted perfusion (tight shoes and clothing, rings, watches, backpack straps)
- Previous frostbite
- Venous ailments (atherosclerosis, diabetes mellitus)
- Smoking
- Sex (men are affected 10x more often)

Symptoms

- **Pale, cool and insensitive** skin, at first looks the same in all degrees of frostbite
- After warming – gradual development (often over several weeks)
- **4 degrees** as in burns
- From a practical point of view – **surface and deep** according to the level of the damage - if deeper tissues are afflicted (arteries, nerves, tendons, muscles, bones, joints) – a surgical solution is necessary



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Prevention

- Sufficient liquids, food and rest, high altitudes require acclimatization
- Quality and sufficient equipment, especially shoes and gloves, reserve clothing
- Do not wear tight clothing or shoes, exchange wet clothing for dry at earliest possible moment
- Unprotected areas of the body (face) should be anointed with a protective layer
- Do not smoke
- Actively search for first signs (loss of tactility), especially in children. The earlier frostbite is treated, the better the final result
- Protect especially previously frostbitten areas

First aid

- Transport the afflicted to a safe area leeward protected from the wind
- Until then do not remove even wet pieces of clothing
- In an improvised shelter – dry clothing, warm liquids
- Warm the afflicted areas by body warmth (armpits, hands, groin area), possible to use aid of the afflicted
- Frostbitten area should not be massaged – bruising of tissues
- If a return of sensation is not returned within 10 minutes, immediately transport to a safe warm location (Mountain Rescue service house)

Definitive treatment

- Remove wet shoes, clothing, rings, bracelets and watches
- Sufficient amount of **warm sweetened liquids** (if the afflicted is not unconscious)
- **Water bath** - 40°C best also with the addition of disinfection (Jodisol, Betadine)
- Constant temperature until the restoration of normal color of the skin (30 – 60 min.)
- Afterwards dry the frostbitten area, cover with sterile covers and bind loosely
- Elevate the limb above the level of the heart to reduce swelling

- Do not use radiative heat – it incurs a risk of burns
- Do not puncture blisters
- **acetylsalicylic acid** (Acylpyrin or Aspirin 500 mg) – inhibits aggregation of platelets or **ibuprofen** (example Ibalgin 400 – 600 mg) – has an anti-inflammatory and analgetic effect



Warning

- Always consider that the patient can have **hypothermia** and therefore do not concentrate only on the afflicted area, but the **overall state of the patient, mainly their basic life functions**

HYPOTHERMIA

- A state in which the temperature of the body core falls under 35 °C
- **primarily** – caused by long action of severe frost
- **secondarily** – a restricted ability of the organism to produce warmth (impossibility of active movement – uncousiousness, injury, exhaustion)
- **Regulation** - **autonomous** (vasoconstriction on the periphery), **motoric** (shivering, more warmth production)

- Temperature under 28 °C – the heart is in danger of **ventricular fibrillation** – most common cause of death of hypothermia
- Temperature under 34 °C – disruption of function of coagulation factors

Symptoms



UNCONTROLLED
BREATHING



INTENSE
SHIVERING



MENTAL
CONFUSION



LOSS OF
COORDINATION



COLD AND
BLUE SKIN



IRREGULAR
HEARTBEAT



WEAK PULSE



ENLARGED
PUPILS

Symptoms

- SWISS SCORING SYSTEM

- Stage I

- Core temperature 32-35 st.C
 - Shivering, fully conscious

- Stadium II

- Core temperature 28-32 st.C
 - Various degrees of consciousness impaired, can be qualitative(paradoxical undressing),beware- patient is not shivering in this stage

- Stadium III

- Core temperature 24-28 st.C
 - Unconsciousness, other vital functions present, but diminished

Symptoms

- SWISS SCORING SYSTÉM
 - Stage IV
 - Core temperature <24 st.C
 - Cardiac arrest, or minimal flow state
 - Stadium V
 - Core temperature $<13,7$ st. C
 - Death resulting from hypothermia

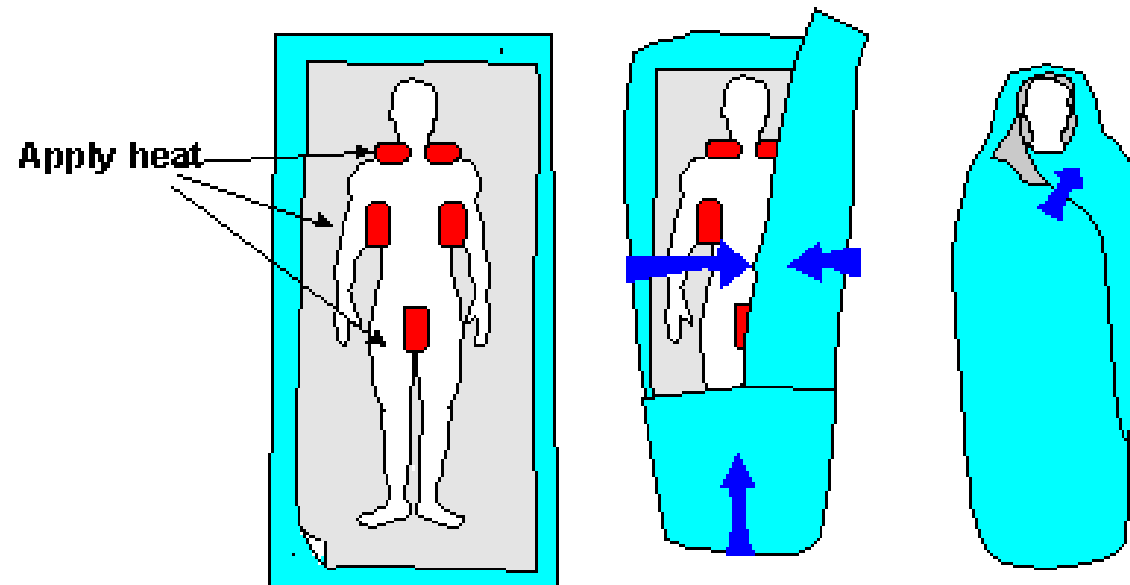
Hypothermia and CPR

- *Hypothermia is brain's best friend during cardiac arrest*
- In core temperature of 18 dg.C brain can tolerate cardiac arrest 10 times longer than in 37 dg. C
- Therefore, we follow general: „no one is dead, unless warm and dead“ (direct quote from CPR guidelines 2015)
- Temperature should be taken in lower third of oesophagus(heart temperature)
 - TT<28 st.C- 5 minutes resuscitation, 5 minutes transport
 - TT <20 st.C- 5 minut resuscitace, 10 minutes trasnport

First aid

- Safe and warm place
- Prevent further loss of warmth
- Do NOT give any alcohol
- Do not rub arms and legs, do not try to warm up the limbs –we don't want the vasodilation- loss of heat
- If the afflicted is apathetic, **immobile** and there is reason to believe there was no movement for a longer period of time, **do not force movement** (risk of ventricular fibrillation)
- Warm liquids (if conscious)
- Hot pack

Hypothermia Wrap



INJURIES BY ELECTRIC CURRENT

- Threat to both the victim and the rescuer
- **Most common** – injuries caused by low voltage (at home or normal workplaces)
- **Less common** – injuries caused by a contact with a source of high voltage

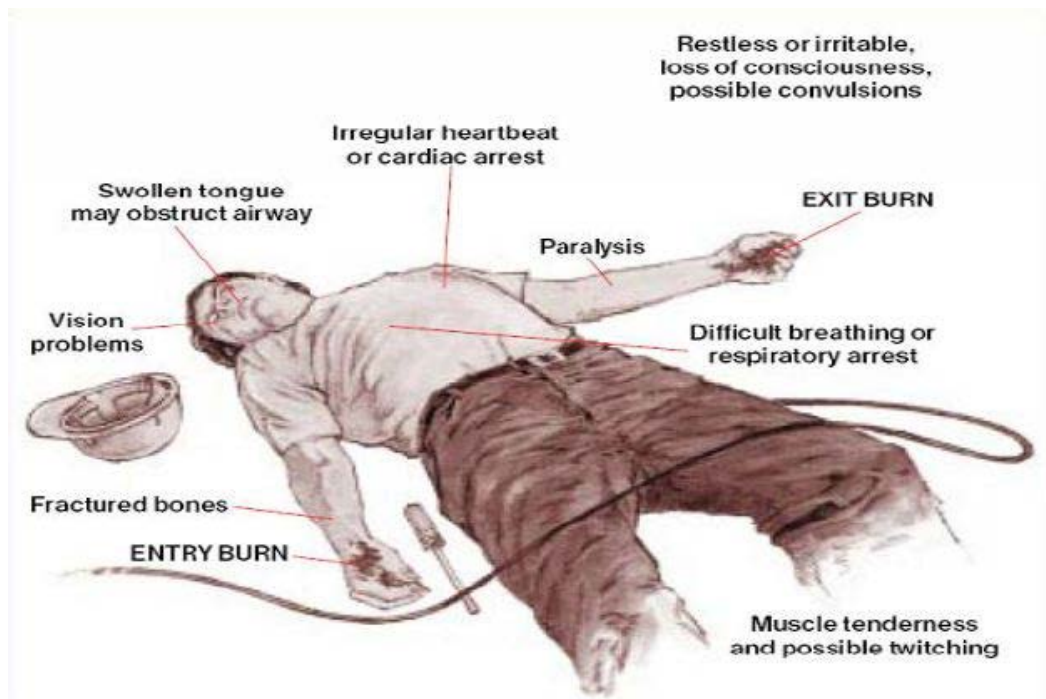
Mechanism of damage

- Thermal damage to the tissues
- Derangement of normal electric potentials of the organism
- **Low voltage** – electrical damage more pronounced
- **High voltage** – the overall damage to the tissues is *thermal* – burns

- Electrical current passes through the body through the path of least resistance and causes **thermal necrosis along this path**
- Most afflicted are usually veins, nerve bundles and muscle tissue
- Most of the electric resistance of the body are centered around the properties of the skin
- Often only a minimal skin burns are present at the zone of electrical contact, with severe internal burns
- Heart arrhythmias
- Tetanic spasms of skeletal muscles (inability to release the source, fractures of vertebrae)

Symptoms of electricity caused injuries

- **Red, swollen, burned or charred skin** at the point of entry and egress of electric current
- Possible **derangements of consciousness**;
- Possible **signs of shock**;
- Possible **failure of vital functions**
(unconsciousness, sudden circulatory arrest – asystoly, fibrillation of ventricles, apneusis).



Arm with third degree burn from high-voltage line.

First aid

- **Remember: YOUR SAFETY FIRST!!!!**
- **Prevent further damage if it is safe for you** (preferably turn off or short circuit the source, if not possible move the afflicted from the area of the source).
- **DO NOT DIRECTLY TOUCH THE VICTIM !!!!!**
- **Check vital life functions**, in case of their failure begin **CPR**
- In case of derangement of vital functions signs of shock and significant burns call the **rescue services**
- Provide basic life support and anti-shock treatment
- Treatment of burned areas



CAVE!

Current with a high voltage

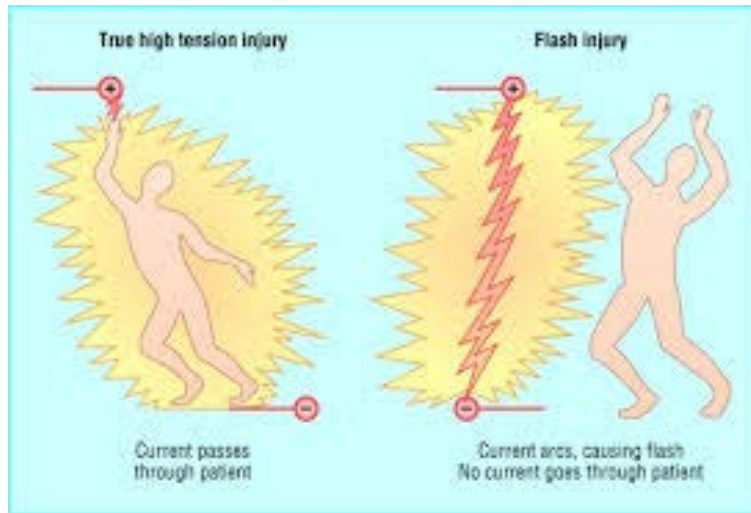
- usually ends with death
- The rescuer **should not attempt to approach the victim** (electrical arc can jump a distance of **up to 20 meters**) **unless the source of electricity is shut down**
 - Call authorities (police, ES) and approach the victim only after receiving the call or notification that the electrical source has been turned off.

Lightning strike

- Lightning – a discharge of cumulated electrical energy of **very high voltage** (up to 1 million kilovolts), which takes place between clouds or between a cloud and earth
- The duration of this discharge is short (about 0,001 s), which is why the energy transferred to the body is small
- Thanks to the high resistance of skin and the short duration, lightning strikes tend to pass along the surface of the body, victim often survives

Symptoms

- Surface burns
- Unconsciousness
- Tossed up to several meters– associated wounds
- Arrhythmias



Prevention

- In case of storm find safe shelter (not a cave, or a tent or a tree). On the other hand cars are relatively safe.
- Immediately before the storm find a hollow in the ground and hide there
- If in the mountains get off the peaks, try to get as low as possible
- Get rid of any metal objects, mobile phone and electrical gadgets
- In the middle of the storm its tricky. Upright moving object is very attractive to the pesky lightning bolts. Stay where you are even if you are on a peak in the mountains or near a tree, squat down on a sufficient isolation layer...and pray

First aid

- Safe and if possible dry area (can be tricky in the middle of nowhere during a storm)
- Check vital life functions (start CPR)
- Call first aid – hospitalization is necessary
- Take care of burns

DROWNING

- Suffocation as a result of submerging in the water or another liquid
- Drowning – if this is a direct cause of death

- When submerged in the water → reflexive breathing arrest → hypoxia, hypercapnia → stimulation of the breathing center – unwilling inspiration
- **Wet drowning** – water enters the lungs
- **Dry drowning** – reflex causes laryngospasmus – water does not enter distally into the lungs (30%)

Fresh water

- hypoosmolar → water enters bloodstream → **osmotic haemolysis**

Salt water

- hyperosmolar → attracts water from bloodstream → **lung edema**

Symptoms

- Panicked fear
- Labored sporadic breathing
- Hypothermia
- Spasms
- Impaired consciousness to unconsciousness, lung edema (coughing up of pink froth), cyanosis
- Breathing and circulatory arrest

What Drowning Really Looks Like



Many people think that this is what drowning looks like, but thrashing in the water is actually a sign of aquatic distress. The person is in trouble but can still take part in their own rescue by grabbing onto something. After this point the Instinctive Drowning Response sets in. The person's mouth bobs above and below the water and they press down on the water laterally to try to stay above it, and thus they cannot wave or yell for help. So be sure to look for these 10 quieter signs of drowning instead.



Head low in the water,
mouth at water level



Head tilted back
with mouth open



Eyes glassy and
empty, unable to focus



Eyes closed



Hair over forehead
or eyes



Not using legs –
Vertical



Hyperventilating
or gasping



Trying to swim in a
particular direction
but not making
headway



Trying to roll over
on the back



Appear to be climbing
an invisible ladder

First aid

- Save the drowning individual. It is hard and sometimes impossible. Panicked drowning person can pull you under
- Think about the possibility of *injury to the head and spinal column*
- Check for vital signs, start CPR if necessary
- If unconscious but breathing place in the recovery position, prevent thermal loss
- If conscious, place the afflicted in a comfortable position, give him/her warm clothes, call an ambulance

- In case of sudden circulatory arrest caused by drowning **begin CPR by 2 – 5 breaths** notwithstanding the age of the afflicted.
- **Alone rescuer calls ES after about one minute of providing CPR.** In case of several rescuers call first aid and begin CPR simultaneously.

- How to save a drowning person video:

<https://www.youtube.com/watch?v=edNQV0c2PAg>

That's all Folks!