Heat, Burn and Electric Shock – How to Safely Master Thermic Emergencies

Harbingers of summer, the first rays of the sun are tempting us to go outside. Temperatures are still moderate but with a rising thermometer value, one should keep in mind the dangers that result from heat exposure over a long time. Thermic emergencies are often underestimated; however, they can be lethal. Burns and electric shocks also damage the tissue through heat. Learn more about these three types of thermic injury and how to act in case of an emergency.

Heat Emergency

These are crises induced by prolonged exposure to heat and necessitate immediate medical attention. Heat can cause many emergencies that range from circulatory problems, heat cramps, and heat exhaustion, up to sunstroke or heatstroke. In case of high temperatures, the body is not capable of giving off heat anymore and thus cannot protect itself from overheating. Increased sweating causes a loss of liquid and electrolytes. Physical exercise worsens the situation.

Heat syncope/heat exhaustion

If in the standing position for a long time, heat can cause orthostatic dysregulation with brief unconsciousness (heat syncope) or blackouts (heat exhaustion). This is caused by vasodilation due to heat; blood flows into the periphery,
which results in temporarily insufficient blood supply to the brain. **Shock symptoms are clinically visible** (tachycardia, hypotension, cold sweat), and the skin temperature is not elevated. Shock symptoms also include headache, irritability, and extreme thirst. Treatment of heat syncope/heat exhaustion occurs through the (intravenous) administration of fluid, shock positioning, and cooling. In particular, **older patients should be hospitalized to clarify possible differential diagnoses.**

**Heat exhaustion**

Heat exhaustion caused by long and heavy sweating is also a mild form of heat emergency. Too little fluid can cause **dehydration with headache, physical exhaustion, and drowsiness.** A disturbed electrolyte balance (loss of sodium) promotes **muscle cramps.** Therapy is offered alongside any interventions in case of heat syncope. However, hospitalization for clarification is usually not necessary.

**Heatstroke and sunstroke**

Severe heat emergencies are **heatstroke** and **sunstroke.** Heatstroke occurs if heat production or supply exceeds the heat emission of the body. There are 2 types of heatstroke:

- **Exertional heatstroke** is evident in young individuals that engage in physical exercises in a hot environment.
- **Non-exertional heat stroke** in case of young children, chronically ill, and elderly people.

Heatstroke causes hyperthermia with dry, warm skin, drowsiness, nausea and vomiting, tachycardia, hypotension, and **cerebral seizures,** as well as organ failure. Heatstroke **must always be treated in a hospital** since it can be lethal. Besides cooling, shock positioning, and fluid replacement, intubation and anti-convulsive therapy might be necessary.

**Sunstroke** can also be dangerous. It **results from the overheating of the brain,** usually due to intensive sun exposure. **Besides symptoms of meningeal irritation,** **cerebral edema is also possible.** Patients suffering from sunstroke show similar symptoms as patients suffering from heatstroke. Symptoms include hyperthermia of the head, drowsiness, vomiting and, additionally, symptoms of meningeal irritation up to **cerebral seizures.** If these severe symptoms are present, hospitalization and further treatment are indicated along with the above-mentioned interventions.

**Burns**

Burns are **tissue injuries caused by local heat exposure and heating of the respective tissue over 45°C (113°F),** via fire, hot liquids (scalds), lightning, or electric shocks.

The danger of burns lies within the destruction of the vessel barrier (endothelial cells and endothelial surface layer) and the resulting **movement of fluid into the interstitial space.** This leads to **hypovolemia resulting in hypovolemic shock.** Further, intravascular activation of **blood coagulation** (disseminated intravascular coagulation) can occur as a possible complication and may cause multiple-organ failure by damaging organs. Combined, all complications are called burn disease and can be associated with additional **inhalation injury and smoke intoxication** depending on the cause of the
Characterizing burns

Generally, burns can be differentiated by their extent and degree. The degrees of burn describe the depth of burn wounds (see table).

<table>
<thead>
<tr>
<th>Degree of burn</th>
<th>Characteristics</th>
<th>Symptoms</th>
<th>Healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st degree</td>
<td>limited to the epidermis, no destruction of skin, hyperemia, edema</td>
<td>from itching to pain</td>
<td>unscarred spontaneous recovery</td>
</tr>
</tbody>
</table>
| 2nd degree, superficial burns | a: superficial, limited to the epidermis, hyperemia, blistering, wet wound bed, intact sensibility  
b: deep, epidermis and dermis are damaged, blistering, dry wound bed, bright and reddened areas | severe pain                     | a: usually unscarred spontaneous recovery   
b: partial recovery with scar formation |
| 3rd degree     | damage of all skin layers including the superficial fascia, greyish-white discoloration of the skin | painless since the nerve endings are destroyed | skin regeneration no longer possible         |
| 4th degree     | involve muscles, tendons or bones, charring of tissue                           | painless                        | skin regeneration no longer possible         |

The extent of a burn describes the affected body surface, which can be estimated using certain rules. The size of the palm of an adult is equal to 1% of the body surface area (BSA). The Wallace rule of nine is used to divide the body surface area into regions, each equaling 9% of the total BSA:

- Head, neck, and 1 arm equal 9%
- One leg 2 times 9% (front side = 9%, backside = 9%)
- The trunk is divided into 4 regions of 9%
  - Front side of the thorax = 9%
  - Back side of the thorax = 9%
  - Front side of the abdomen = 9%
  - Lumbar region = 9%
- The genital region equals 1% of the BSA.

For children, this classification is shifted due to different proportions.

The combination of burnt body surface area and degree of burn gives the severity level of the burn. A burn is severe if:

- The head, hands, or feet and genital region are affected
- 25% of the BSA shows 2nd-degree burns (20% for children)
- 10% of the BSA shows 3rd-degree burns

Severe burns should always be treated in a burn unit.

Therapy for burns

Besides maintaining self-protection, the first measures in case of burns should be:

- Stabilization of the patient by securing the airway (if necessary through intubation), ventilation with 100% oxygen, fluid replacement as per the
Parkland formula

- Adequate analgesia, prophylactic antibiotics, and antitetanus toxin administration
- Removing of clothing and sterile covering of the wound
- Further treatments can be carried out in a burn unit or a normal hospital depending on the severity of the burn

General management of burns involves:

- Resuscitation and saving of the patient’s life in the first 48 hrs
- Prevention of complications from 48 hrs to 6 months
- Reconstructive surgery, rehabilitation, and training in the period after 6 months

Electric Shock

In case of electrical accidents, a mix of symptoms of thermic (local burns) and electrical injuries (cardiac arrhythmia) can be seen. The severity of the injury depends on the voltage (low voltage < 1000 V = domestic electricity, high voltage > 1000 V, lightning), current strength, duration of exposure, contact area, and other general factors such as moisture and conductivity of the skin. Possible consequences are:

- Burns
- Cardiac arrhythmia (ventricular fibrillation) and cardiac arrest
- Muscle injuries leading to muscle contractions
- CNS injuries with disturbances of consciousness

Additionally, secondary injuries due to falls (e.g., fractures, internal injuries) often occur. Current brands are injuries of the skin caused by entry and exit of current. In the case of lightning strikes, a so-called lightning figure in the form of a fern-like branching can often be seen on the skin.

Therapy

Self-protection is of top priority when treating patients in case of electric accidents. Before the patient can be rescued from the danger zone, the electric circuit has to be broken off. In cases of high voltage accidents, this has to be done by qualified personnel. The measures that would follow are similar to those for burns. Additionally, possible cardiac arrhythmias have to be treated (CPR), and other potential injuries (e.g., fractures) have to be attended appropriately (bone setting, splint).

In electrical burns aim for 100 mL/hr of urine to flush the kidney. Alkalization of the urine by adding sodium bicarbonate to the IV fluid increases the solubility and clearance rate of myoglobin from muscle breakdown in the urine. This can be suggested by the evidence of hemoglobinuria, which indicates the need to flush the kidney with increased fluids and mannitol.

References


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