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

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Harbingers of summer, the first rays of 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, right up to sunstroke or heatstroke**. In case of high temperatures, the body is not capable of giving off heat to the outside anymore and thus **cannot protect itself from overheating**. Increased sweating causes a **loss of liquid and electrolytes**. Physical exercise additionally worsens the situation.

Heat syncope/heat exhaustion

If in **standing position for a long time**, heat can cause **orthostatic dysregulation** with short unconsciousness (heat syncope) or blackouts (heat

exhaustion). This is caused by vasodilation due to heat; blood flows into the periphery, which results in a temporary insufficient supply of the brain. **Shock symptoms are clinically visible** (tachycardia, hypotension, cold sweat), theskin temperature is not elevated. They also present with headache, irritability, and extreme thirst.Treatment of heat syncope/heat exhaustion occurs through (intravenous) administration of fluid, shock positioning and cooling. Especially **older patients should be hospitalized for clarifying 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 done corresponding to the interventions in case of heat syncope. However, a stationary clarification is usually not necessary.

Heatstroke and sunstroke

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

- **Exertional heat stroke** that 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 **always must be treated in a hospital** since it can be lethal. Besides cooling, shock positioning and fluid replacement, intubation and anticonvulsive therapy might be necessary.

Sunstroke can be dangerous as well. It **results from overheating of the brain**, usually due to intensive sun exposure. **Besides symptoms of meningeal irritation, cerebral edemas are also possible**. Patients suffering from sunstroke show similar symptoms as patients suffering from heatstroke: hyperthermia of the head, drowsiness, vomiting and, additionally, symptoms of meningeal irritation up to **cerebral seizures**. If these severe symptoms are present, a 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,** e.g., through fire, hot liquids (scalds) but also through lightning or electric shocks.

The danger of burns for the organism 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**. Furthermore, intravascular activation of blood coagulation (disseminated intravascular coagulation) can occur as a possible complication and may cause multiple-organ failure by damaging organs. All complications together are called burn disease and

can be associated with additional **inhalation injury and smoke intoxication** depending on the cause of the burn.

Characterizing burns

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

Degree of burn	Characteristics	Symptoms	Healing
1st degree	limited to the epidermis, no destruction of skin, hyperemia, edema	from itching to pain	flawless spontaneous recovery
2nddegree superficial burns 2nd degree deep 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 have been destroyed	skin regeneration no longer possible
4th degree	involves 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 easily 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 one arm equal 9 %.
- One leg 2 times 9 % (front side = 9 %, back side = 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 give the severity level of the burn.** We always speak of severe burns if

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

Severe burns should always be treated in a **burn unit**.

Therapy of burns

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

- Stabilization of the patient by **securing of the airway** (if necessary through

intubation), ventilation with 100 % oxygen, fluid replacement as per the parklands 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 burns unit or a normal hospital depending on the severity of the burn.

General management of burns takes a general layout of:

- Resuscitation and saving the patient's life in the **first 48hrs**.
- Prevention of **complications from 48 hours to six months.**
- Reconstructive surgery, Rehabilitation, 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 <1000V = domestic electricity, high voltage > 1000V, 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 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 against burns. Additionally, possible cardiac arrhythmias have to be treated (CPR), and potential other injuries (e.g., fractures) have to be attended appropriately (bone setting, splint).

In electrical burns aim for 100ml /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 evidence of haemoglobinuria hence flush the kidney with increased fluids and mannitol.

References

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Notes