

International Congress of Mountain Medicine François-Xavier Bagnoud

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ABSTRACT BOOK

LIGHTNING INJURIES:

Incidence, Pathophysiology and Prevention

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INCIDENCE OF LIGHTNING INJURIES IN MOUNTAINS

Craig /1986/ stated, that in the USA 300-600 persons die yearly after lightning stroke and several thousand injured people survive. This number is larger than the toll of any other type of natural catastrophe .

Holle /1995/ summarized the data since 1972. Lightning is reported to have killed an average of 80 people a year, second only to 146 flood-related deaths. Tornados, which rank third, kill an average of 69 persons year; hurricanes are fourth, with 17 deaths per year.

During the period of 1951-1981 there were 3109 injuries reported in mountaineering activity in USA and Canada. 36 /1.16%/ had been caused by lightning, but there were no fatal lightning injuries among 178 mortal casualties.

In 1979-1984 the German Alpine Union reported 1112 injuries, of which 9 /0.8%/ had been due to lightning.

In the High Tatras /former Czechoslovakia/ altogether 814 fatal casualties were recorded among all visitors over a long span of time /1650-1986/. Only 12 cases /1.47%/ of these deaths were after lightning stroke.

Dürer stated , that in the period 1991-1993 there were 3438 people rescued in the Swiss Alps. Only 23 of them /0.7%/ were caused by lightning. 40% of lightning injured were hikers, 35% mixed climbers, and 25% rock climbers. All lightning injuries occurred during July and August and 30% of them died.

Burtscher described 12 fatal accidents /0.65%/ among all 1833 alpine fatalities in Austria during the period 1986-92

In Czech Mountaineering Association there were 265 fatal casualties during the period 1958-1987. In 4 of them /1.51%/ the lightning stroke was confirmed as a cause of death, and in 10 others /3.78%/ was lightning as a main pathomechanism suspected.

EPIDEMIOLOGY OF LIGHTNING INJURIES

/after Holle, USA, 1995/

1. Outdoor activities /27%/

- climbing, camping, picknicking, fishing, riding, hiking
- locations: Summit or ridge of mountains, lake, on horse, near river, inside tent

2. Sports /15%/

- golf, bicycling, playing football or baseball, riding
- locations: Park, fairground, on bicycle, playground, on motorcycle, amusement park, country club

3. Work /7%/

- working, filling oil tank
- locations: Near plane, construction camp, scaffolding, in/near truck, trailer

4. Farm and ranch /7%/

- farming
- locations: Ranch, on tractor, in wagon

5. Urban /7%/

- gardening, using telephone, housework
- locations: Yard, in house, telephone, near wall, telephone pole

6. Others /37%/

- standing, walking, sitting, wedding rehearsal, watching thunderstorm, hiding from rain
- locations: Under tree, near car, on ground, near monument, beneath power line, in car

LIGHTNING:

DEVELOPMENT: Specific atmospheric conditions required

CHARACTERISTICS:

Lightning channel : diameter 3-30mm

Temperature : 10 000-30 000 C

Explosive character

Voltage : up to 8 MV

Current intensity : 100-200 kA

Energy : 10-1 000 kWh

Duration : up to 0.6 usec

TYPES OF LIGHTNING:

"Cold lightning" / discharge of short duration without thunder/

"Incidentary lightning" / discharge of short duration with relatively low intensity of current/

"Common lightning" / high voltage and intensity of current/

"Phenomenons of induction" / "fire of Elias" , buzzing of ice-axe, electrization of clothes/

LIGHTNING STROKES:

Leader stroke / slow, pioneers the lightning channel/

Main stroke / retrograde in direction, 100 times faster/

Afterdischarges / several and weaker strokes/

THE EFFECTS OF LIGHTNING ON THE HUMAN ORGANISM.

20-30% of the victims die and 75% of the survivors have some permanent sequelae.

MODE OF STROKE:

"Direct stroke" -can cause severe sequelae or death/80%/

"Forked flash" - means a thunderbolt, the channel of which branches in the air and strikes plural points on the ground.

"Side stroke" - is an indirect stroke with the discharge conducted to the man from immediate neighbourhood- from a tree,a rock,or man

"Stride potential"- can injure to a distance of a few hundred metres from the place of discharge.

"Indoor incidence" - injuries caused on persons inside houses.

"Flash-over-phenomenon"- can injure the eyes and superficial layers of the skin, whereas the inner organ are relatively preserved/ wet outfit, rain, sweat-through clothes/.

THE ETIOPATHOGENESIS OF VARIOUS LIGHTNING INJURIES:

1. Effects of heating / internal and external /
2. The direct effects of electrical current on the conductive tissues.
3. The effects of pressure ,or blast, resulting from acoustic shock wave accompanying stroke.
4. Secondary changes /after falls,convulsions,lesions of bones and muscles/
5. Damage of skin by metallic parts of outfit, magnetization

ORGAN INJURIES CAUSED BY LIGHTNING / EARLY AND LATE LESIONS/

Neurologic: Loss of consciousness, cerebral edema,
keraunoparalysis, seizures, respiratory arrest

Cutaneous: Burns and abrasions

Musculoskeletal: Swelling and rupture of muscles and tendons

Renal: Renal failure /myoglobine/

Gastrointestinal: GI bleeding, gastric atony

Ocular: Lid burns, corneal lesions, lens dislocation, retinal
injuries, cataracts

Cardiovascular: Dysrhythmias, myocardial injury, vasomotor
spasm, hypertension

Auditory: Tympanic membrane rupture, tinnitus,
hearing loss

Psychiatric: Personality and hysterical changes, phobias.

FATAL CASUALTIES

CARDIAL: Heart arrest
Arrhythmias

NEUROLOGIC: "Direct stroke" to the head
Breathing paralysis /central or peripheral/
Brain edema
Haemorrhages

"LATE DEATH": Renal failure /myoglobinuria/
Brain / subdural haematoma, etc./
Spinal / demyelinating neuropathy/

PREVENTIVE MEASURES OF LIGHTNING INJURIES.

PROACTIVE PLAN:

1. Days before activity - listen to weather forecasts, observe the weather to decide on rules whether to postpone the hike, when to start the hike, or where take the shelter
2. Day of activity - at all stages of the hike, be aware of where shelter is and how long it will take to reach it. Observe the weather or designate a spotter.
3. When thunderstorms develop - estimate distance to lightning using the flash-to-bang method. Determine whether the storm is approaching your position. Reach a proper shelter.
4. Lightning nearby - go inside an occupied building, do not touch anything connected to the power. Go inside a vehicle. Do not be a highest object. Do not be connected with anything taller than its surroundings. In a forest seek a thick grove of small trees.
5. Last minute - crouch on the balls of your feet with your head down and don't touch the ground with your hands.

The second best space is the corner space formed by the top point of a tall object keeping 2 m distance from the object/picture/. In case the object is a tree, keep the distance from all twigs and leaves and lower yourself. Leave the objects not higher than 4 m. In small caves and under small overhangs don't stay at the entrance and keep 2 m distance from behind and from the roof /picture/. After having reached the depression in the flat terrain as a shelter don't keep your head in the same level with terrain - ground currents /picture/. If there is a group of people in the forest during the storm, keep at least 3 m apart and do not walk in pairs or in closely packed groups /picture/.

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