

Lightning Injuries in Sports Situations to Avoid

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Abstract

There is no absolute protection against lightning because of its random and capricious nature. However, the risk of being struck by lightning can be substantially reduced.

There are general safety rules that apply to all athletic and recreational events. The athlete should have a proactive plan that can be instituted when storms approach. He/she should go to a safe shelter before the storm arrives and stay there until the danger is gone. Because the location, climate, terrain and playing site vary with different sporting activities, safety plans may have distinct elements for different recreational activities.

Mountain climbers should know the weather patterns of their locale. The highest frequency of lightning strikes in the Rocky Mountains occurs between 11am and 9pm during the months of April to September. There is less chance of a hiker encountering lightning during the early morning hours. Many tourists are unaware of this pattern, which may possibly explain the finding that most lightning victims are visitors from other states.

The bicyclist is as vulnerable as anyone in the open. In the event of lightning he/she should seek safe shelter and get off the bike. Rubber tires do not provide protection from lightning.

Golfers continue to make the same mistakes year after year. Golfers should know to seek safe shelter (clubhouse or closed metal vehicle) before the storm arrives and not return prematurely to the golf course. They should avoid isolated trees, open fields, unsafe sheds and metal poles. They should separate from each other rather than gather together.

Swimmers should get out of the pool and find a safe shelter. Safe areas do not include poolsides, under awnings or under trees. A nearby closed automobile may be the safest place until the danger is gone.

Applying precautions when engaging in these sporting or recreational activities will help to minimise the risk of casualties or fatalities caused by lightning.

Before the middle of the 20th century, most lightning casualties were people engaged in work (farmers, ranchers, construction workers, etc.). By the end of the century the great majority of lightning casualties involved people engaging in sports and recreational activities.^[1] Victims of lightning strikes occurring during sporting or leisure activities are usually young and healthy. Furthermore, many of these misfortunes can be prevented. Too often, the victim did not use common sense and ignored the warning signs of an approaching thunderstorm.

Lightning originates in clouds and develops with negative charge regions at one end and positive charge regions at the other end.^[2] Cloud-to-ground (CG) lightning is less frequent and less extensive than intracloud lightning. However, CG lightning is more likely to confront the outdoor sports enthusiast. Most CG lightning begins in the cloud as a downward propagating negatively charged channel.^[3] A minority of CG discharges are positively charged. Positive flashes often have very large peak currents and charge transfers and are especially dangerous. However, the more common negative flashes are powerful enough to cause death, damage and injury. Positive flashes are more common in winter months and can travel large distances. A positive flash can strike the ground miles away from the cloud where it originated. Thus, it often appears to come out of a clear blue sky. These 'bolt from the blue' situations, are especially tragic because the victim has no warning or reason to seek shelter.^[4] Each year in the US there are about 100 fatalities and 1000 casualties.^[5]

The sports and recreational activities with the largest numbers of lightning fatalities and injuries are: mountain activities (hiking, biking, camping), golf, ball field games and water sports (swimming, fishing, boating).^[5] The major determinants of lightning casualties are: (i) the weather patterns in the location of the activity; and (ii) the numbers of people in locations where lightning density is high. For example, Florida has both the largest number of thunderstorm days per year and has large numbers of outdoor enthusiasts. Not surprisingly, lightning

casualties are high among boaters, fishermen and golfers in Florida.^[6] In the Rocky Mountains, another high lightning density region, campers, hikers, bikers, as well as golfers make up a large number of those struck by lightning. Most lightning flashes on earth occur in tropical climates and mountain terrain. Hot and humid regions of central South America and Africa have about 180 thunderstorm days per year. Java has 223 and The Gulf of Thailand has had as many as 310.^[7,8] In the US, Tampa, Florida leads with 80. Castle Rock, Colorado is next with 75.

The rules for lightning safety apply to the population in general, as well as to outdoor sports and recreational enthusiasts. I urge all those at risk to learn the lightning safety recommendations developed at the 1998 American Meteorological Society meeting by the Lightning Safety Group committee.^[9,10] The participants and active collaborators of the Lightning Safety Group include contributors from countries on 3 continents (USA, France and Australia). Two paramount rules are: (i) have a proactive plan that has been considered before undertaking the sports activity; and (ii) seek and stay in a safe shelter until the lightning risk is gone. A safe shelter has been defined as any sturdy building that has metal plumbing or wiring, or both, to electrically ground the structure.^[11] Many sheds or shacks in fields and golf courses do not meet these conditions of a safe shelter. In the absence of a sturdy building, a closed metal vehicle (automobile or bus) is often the next best place to be during a thunderstorm.

Although many of the lightning safety guidelines are common sense, there are distinct situations for athletes to consider. They should be armed with knowledge specific to their particular location and activity. Such knowledge is critical to developing a comprehensive strategy to lower the risk of becoming a lightning casualty. For example, Rocky Mountain hikers should know to start their descent from the mountain top before 11am because the lightning threat increases after that hour.

What are the medical aspects of being struck by lightning? According to recent data from Colorado,

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1 out of 10 lightning strike victims dies.^[12] This data includes outpatient as well as inpatient lightning casualties. Prior to this study data collected in the US was based largely on newspaper clippings, and did not include many outpatients. As a result, the numbers of casualties were under-reported by as much as 50%. Interestingly, the ratio of fatalities to injuries in Australia is identical to the Colorado ratio (1 : 10).^[13] By contrast, the fatality to injury ratio in the British Isles is about 1 in 20.^[14]

Cardiac arrest is the usual cause of lightning fatality.^[15] Neurological damage is the next most common cause of death or serious permanent disability.^[16] Neurological sequelae that are most devastating include; hypoxic encephalopathy, cerebral infarction, intracerebral haemorrhage and myelopathy. Infrequent consequences include cerebellar syndromes and involuntary movement disorders. By contrast, chronic epilepsy is not a common long term complication of lightning strikes.

I shall discuss the following sports and recreational settings in more detail:

- Mountain sports – analysis of the Rocky Mountain experience
- Golf – the sport with the largest number of lightning fatalities in the US
- Ball field casualties – common in children and young adults
- Water sports (swimming and boating)

If the participant has a prudent safety plan and remains alert to weather patterns, he/she can lower his/her risk of becoming a lightning statistic.

1. Mountain Lightning Risks: The Rocky Mountains Experience

An increasing number of people select the mountains as the place to spend their leisure time. Unfortunately hazards accompany many of these outdoor activities. According to 1 analysis of deaths from sports and recreational activities, mountaineering is much more dangerous than either ball games or water sports.^[17] Lightning is one of the hazards confronting the mountain visitor.

The Rocky Mountain area is a magnet for millions of vacationers because of the spectacular

beauty and recreational opportunities. Unfortunately, this area is also a high lightning flash density region. A consequence of this combination of large numbers of visitors and high lightning frequency is too many lightning casualties each year.

We at the Lightning Data Center have collected data on 39 lightning-related casualties that occurred in the Rocky Mountains. These cases are the sum of our own experience with 15 lightning victims plus an additional 24 Rocky Mountain lightning victims during the years 1989 to 1995 as reported in Colorado front range newspapers.^[18] Approximately a third of these mountain lightning casualties were fatal. Of the 39 victims, 21 were from states remote to the Rocky Mountain region.

Based on the data from these 39 individuals, we provide a profile of the people and activities likely to be at risk of a lightning strike. In addition there is important data on the time of year, time of day and location of the accident. The information gleaned from this data, could be important to visitors to the Rocky Mountains in helping them to take proactive measures to lower their risk of being struck by lightning.

The typical victim is a healthy male in his mid-30s who is a visitor to the Rocky Mountains (table I). Male victims outnumber female victims by about 4.5 : 1. He is most likely engaged in mountain hiking, climbing or camping and is more likely to be struck during the months of July and August and during late morning to early evening hours. The most surprising finding in this study was that 4 people were struck by lightning as early as 11am.

Table I. Individuals injured or killed by lightning while in Rocky Mountains^[19]

Total number	39
Male	32
Female	7
Male/female ratio	4.5 : 1
Age range (years)	8-79
Average age (years)	37.6
Number who were visitors from other states (%)	21 (54)
Number of fatalities (%)	16 (41)
Number known to be above timberline	11
Number of fatalities above timberline (%)	7 (64)

The conventional wisdom for hikers is to get off the mountain top by noon. Now based on this new information, I recommend that hikers and climbers get off the mountain by 11am. Fatality rates are high for those individuals who are caught above the timberline when lightning strikes. There are few, if any, sanctuaries from the lightning for those on mountain peaks.

The largest numbers of mountain casualties caused by lightning are in hikers and climbers, followed by campers (fig. 1).^[19] Lightning has struck people in their tents. In choosing a location for their tent, campers should avoid high terrain or sites under a single tree. A metal pole should not be used, it can act as an upward streamer and therefore increase the risk of attracting a lightning strike. If a car or truck is nearby, it might be wise to vacate the tent and move to the inside of a closed vehicle until the danger has passed.

Bicyclists are just as vulnerable as hikers. They should be aware that the rubber tires provide no protection from lightning. The bicyclist struck by lightning also has the potential of head, neck and limb trauma resulting from being thrown from the bike.^[19] Mountain visitors should understand the dangers of lightning and learn safety tips that could reduce their risks. Armed with such knowledge, they can plan their activity accordingly.

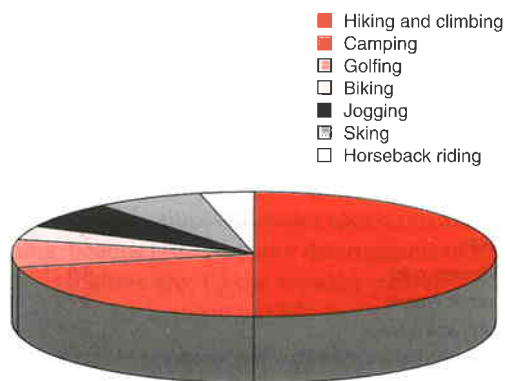


Fig. 1. Activities performed by victims of mountain lightning (known for 28 of 39 individuals).^[19]

The data presented here conform closely with the Colorado demographic observations of Lopez and Holle.^[1] They point out that lightning-related accidents in the mountains are likely to involve individuals engaged in sports and recreational activities, whereas lightning-related accidents on the plains are more likely to involve farmers, ranchers.

It is interesting to note how similar the Colorado data are to demographic data from Sweden. An analysis of 18 lightning fatalities in Sweden yielded an identical male/female ratio (4.5 to 1) to the Colorado ratio.^[20] The age range of the victims in Sweden was 12 to 79 years; the Colorado age range is 8 to 79. The Swedish fatalities, like the Colorado injuries and fatalities occurred in people who were young and active and who were struck performing various outdoor activities during summer months.^[20]

It is not generally well known that snow skiers in the Rocky Mountains are also at risk of being killed or injured by lightning. Thunderstorms with snow tend to produce fewer lightning strikes than thunderstorms with rain. Thundersnow is a term used to define lightning and thunder occurring during snowstorms.^[21] The thundersnow season in the US is the cool season from October to May.

Although lightning storms are less common during winter-like conditions, they do happen. The visual summertime clues of approaching ominous clouds are often not available to the skier because the clouds do not appear distinct in a blue sky, but are buried in the grey, cloud-filled sky. Furthermore, snow absorbs more sound and more light than rain, reducing the likelihood of reports of audible thunder or visible lightning. Nevertheless, the sound of thunder should warn the skier of potential danger. Another clue that should alert the skier to the possibility of lightning is the appearance of graupel.^[22] Graupel is a type of frozen precipitation that is sometimes referred to as snow pellets or soft hail. It is smaller (typically <1cm) and more spongy than hail.

In many cases, these accidents could have been prevented if the proactive measures outlined below had been taken: