2008 20th International Lightning Detection Conference
21-23 April • Tucson, Arizona, USA
2nd International Lightning Meteorology Conference
24-25 April • Tucson, Arizona, USA

RECENT UPDATES IN LIGHTNING SAFETY

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1. INTRODUCTION

Lightning is the second leading cause of storm related deaths in the United States, only floods kill more (NOAA, 2007). Lightning kills more than tornadoes or hurricanes (Figure 1). Lightning also inflicts life-long debilitating injury on many more than it kills (Cooper, 1995). Lightning is also a significant weather hazard outside of the U.S. (Holle and Lopez, 2003). Fortunately, most lightning casualties can be easily, quickly, and cheaply prevented. Public education is the key.

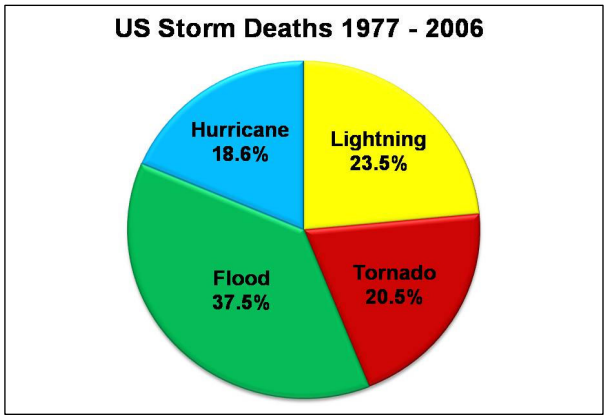

Figure 1. Weather causes of U.S. storm deaths (1977-2006) taken from NOAA Storm Reports (NOAA, 2007). This is not corrected for lightning under reporting, which has been significant in past years (Lopez et al., 1993).

Meteorologists can play a decisive and profound role in the battle against lightning casualties by increasing public awareness of the lightning threat and of the lightning safety guidelines. The author encourages the professional meteorological community, especially broadcast meteorologists with their ready access to large audiences, to join this vital public service to save lives and prevent crippling injuries. Those interested in teaching lightning safety will find a recommended approach at Roeder (2007a) and Lushine et al. (2005), which is briefly summarized in Table 1. Useful resources on lightning safety are at the National Weather Service website on this topic (www.lightningsafety.noaa.gov). In addition, useful slogans for teaching lightning safety are in Table 2. Interested parties may also contact the author for assistance (william.roeder@patrick.af.mil).

2. UPDATES IN LIGHTNING SAFETY

Lightning safety public education requires that meteorologists present consistent information. This paper will survey recent updates in lightning safety to help meteorologists maintain that consistency. Six topics will be covered: 1) upgrading the safety provided by vehicles with solid metal tops and solid metal sides, 2) cueing on hearing thunder to seek a safe place, rather than 30 seconds between lightning and its thunder, 3) lightning fatalities by age, 4) no longer teaching last minute outdoor lightning risk reduction to the general public, 5) adding Automatic External Defibrillator (AED) to lightning first aid, and 6) a review of common myths that continue to detract from lightning safety.

2.1 Upgraded Safety From Vehicles

Lightning casualty reports for people inside vehicles with solid metal roofs and solid metal sides shows no electrical deaths and much reduced frequency and intensity of electrical injuries (Holle, 2008). As a result, the working group for the NOAA Lightning Safety Awareness Week (LSAW) upgraded the safety provided by such vehicles from a '3', to just under a '9', just below large fully enclosed buildings with wiring and plumbing, on an arbitrary 10 point scale of safety. That 10 point scale varies from '0' for being exposed outside to '10' for being inside a proper building with lightning protection and surge protection installed and obeying the indoor lightning safety rules. While merely a subjective estimate of safety, this 10 point scale has proved useful in public education.

TABLE 1. Quick Reference For The Five Levels Of Lightning Safety

LEVEL (best to worst)	**BRIEF DESCRIPTION**
Fundamental Principle: **No** place outside is safe if a thunderstorm is in the area.	
1	Schedule outdoor activities to avoid lightning.
2	Know when and where to be in a safe place. When you hear thunder, go to a safe place. Stay there for 30 minutes or more after the last thunder. Safe places are a large fully enclosed building with wiring and plumbing, e.g. house, school, store, etc., or a vehicle with a solid metal top and solid metal, e.g. most cars, trucks, or buses.
3	Avoid dangerous locations/activities (elevated places, open areas, tall isolated objects, and water related activities (swimming, boating, near edge of bodies of water). Do **NOT** go under trees to keep dry in thunderstorms!
4	Last minute personal outdoor lightning risk reduction, including the 'lightning crouch' no longer advocated for general audiences (Roeder, 2008, 2007c).
5	First Aid: Immediately start CPR or rescue breathing, as needed. Call 9-1-1. Use an AED (do not delay CPR). Continue CPR/rescue breathing if AED won't activate or is not available.

TABLE 2. Lightning Safety Training Slogans

SLOGAN	**SOURCE**
When Thunder Roars, Go Indoors!	StruckByLightning.Org (originally by author)
Half An Hour Since Thunder Roars, Now Okay To Go Outdoors!	StruckByLightning.Org (originally by author)
Lightning Kills--Play It Safe!	National Weather Service
If You Can See It, Flee It!	National Lightning Safety Institute
If You Hear It, Clear It!	National Lightning Safety Institute
Don't Get Fried, Go Inside!	Author's
Don't Be A Fool, Get Out Of The Pool!	Author's
Don't Be Lame, End The Game!	Author's

2.2 Thunder As Cue

The lightning safety community now recommends seeking a safe place when you hear thunder, rather than the previous guidance of the first '30' of the '30-30 Rule'. The first '30' in the '30-30 Rule' advised people to already be in a safe place when the time between lightning and its thunder was 30 seconds or less. This 30 seconds corresponds to a distance of about 6 miles, which is close enough for lightning to be a danger. Unfortunately, many people were remembering this as 'go to a safe place at this time', not 'be in a safe place'. Some meteorologists even taught it that way. Therefore the LSAW working group built a reaction time into new guidance. It then became clear that the cue should be 'hearing thunder', especially for fast moving thunderstorms. The LSAW adopted the slogan 'When Thunder Roars, Go Indoors!' This slogan was developed by the author and used by 'StruckByLightning.Org', a non-profit lightning safety education organization. The slogan is especially useful for teaching children. A complementary phrase for the last '30' of the '30-30 Rule' is being finalized by the author and StruckByLightning.Org, 'Half An Hour Since Thunder Roars, Now Okay To Go Outdoors!'.

2.3 Lightning Fatalities By Age

Lightning fatalities by age in the U.S. were compiled for 1995-2006 from NOAA Storm Reports (www.weather.gov/os/hazstats.shtml) and are shown in Figure 2. The percent of total lightning fatalities for each age bracket is normalized by the percent of population from the 2000 U.S. census (www.census.gov) (Figure 3). The normalization produces a non-dimensional ratio, where '1' means the age bracket receives the number of fatalities expected from its population, and > 1 means the lightning fatalities are higher than expected from the population. Ages from 10-49 appear to be more at risk than expected from their population with a peak ratio of 1.55 in the 30-39 year old bracket. This increased risk is presumably due to more outdoor activities by younger ages. The largest jump in lightning fatality ratio is from 0-9 to 10-19 year olds with ratios of 0.25 to 1.20, respectively. Presumably this is due to older youths doing more outdoor activities unsupervised by adults, but without proper lightning safety education and/or with reckless judgment. This suggests the most effective lightning safety education would be done with children below the age of 10, so can develop good lightning safety behavior before their most at-risk years and before bad habits become ingrained, especially considering the "teachability" of children as compared to adolescents. These patterns are consistent with an earlier study by Lushine et al. (2005) in Florida, except that study found the largest peak was for the 10-19 year olds. This Florida study also found that the lightning fatalities by location or activity for youths was very different from adults. Youths had most fatalities in water activities, then organized outdoor sports, then school activities, etc. (Figure 4). This led to slogans for teaching youths such as 'Don't Be A Fool, Get Out Of The Pool!', 'Don't Be Lame, End The Game!', 'Don't Get Fried, Go Inside!', and others. The lightning fatality locations/activities for youths should be broadly applicable across the U.S., except perhaps for a smaller contribution from water related activities.

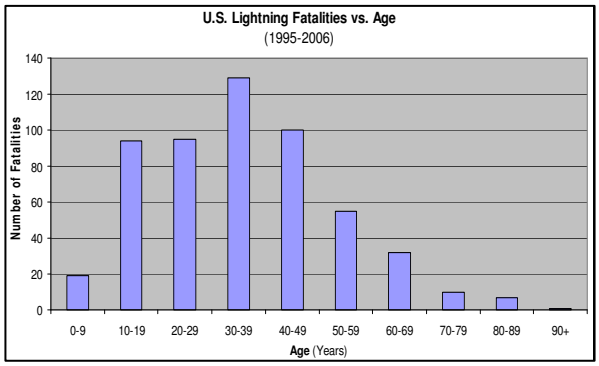

Figure 2. Lightning fatalities in the U.S. by age from NOAA Storm Reports.

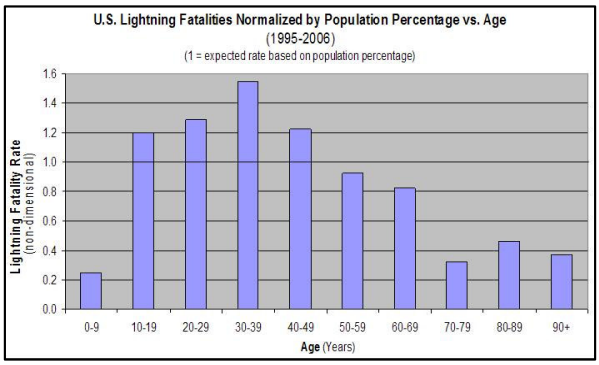

Figure 3. Normalized lightning fatalities in the U.S. by age. Lightning fatality data are as in Figure 1; population data from 2000 U.S. census.

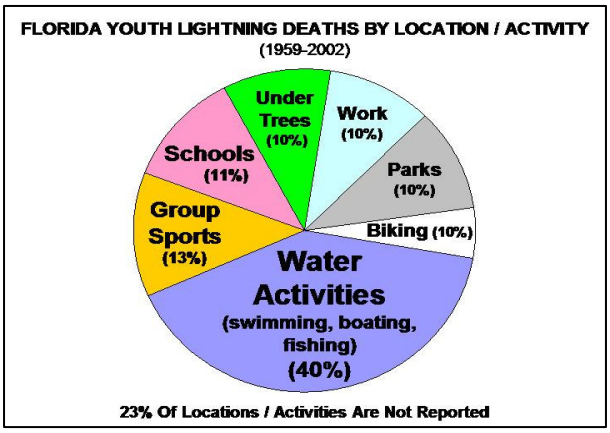

Figure 4. Location/activity of youth lightning fatalities in Florida.

2.4 Don't Teach Short-Notice Outdoor Lightning Risk Reduction To The General Public

The vast majority of lightning casualties in the U.S. occur close enough to a safe location that it was deemed not cost-effective to teach last minute outside lightning risk reduction to general audiences. First, this does not apply in well over 90% of the casualties, since they are better off running to the nearby safe location. Second, the instructions are complex and take a lot of time to teach, detracting from more cost-effective training. Third, many people were misremembering the details and many more would likely misapply them under the stress of an imminent lightning threat. Fourth, many people showed a large interest in this topic, which took time away from the primary message of lightning safety. Fifth and finally, this could undermine the main message of lightning safety – 'No Place Outdoors Is Safe When Thunderstorms Are In The Area!' It is important to note that this applies to short notice outdoor lightning risk reduction, when the threat of lightning is imminent and people are fleeing for safety. Avoiding risky locations should still be done by people that have to be outside when thunderstorms are in the area, but not immediately threatening. Also, short notice outdoor lightning risk reduction should still be taught to groups that spend a lot of time away from safe locations.

2.5 Automated External Defibrillators (AED) In First Aid

All lightning deaths are from cardiac arrest or stopped breathing from the cardiac arrest. An AED will work on many of these cases and is much more effective than CPR. Thus, AEDs have been added to the recommended lightning first aid procedures. If an AED is not available, or does not activate because it detects the heart is not fibrillating, then resume CPR or rescue breathing.

2.6 Pernicious Lightning Myths

Unfortunately, many myths that compromise lightning safety continue to persist. Indeed, 'myth busting' has proven to be one of the most useful techniques in lightning safety education. The most prevalent of these lightning myths are summarized in Table 3. Much of this information as been discussed in more detail at Roeder (2007b). Several of these myths mislead people into thinking that some places outside may be safe under some situations. But that violates the fundamental principle of lightning safety—'No place outside is safe with thunderstorms in the area!' (Roeder et al., 2001).

Table 3. (continued on next page) Prevalent lightning myths and their impact on lightning safety.

Lightning Myth	**Impact On Lightning Safety**
Rubber tires or rubber soled shoes protect you from lightning by insulating you from the ground	Can mislead people to not seek a safe place, or think that some unsafe locations are safe, e.g. convertibles, motorcycles, bicycles, etc.
Metal attracts lightning (variations include cell phones, i-pods, under wire bras, etc.)	Can mislead people to think wrongly that they are safe outside and thus avoid a safe place, or waste time shedding metal rather than rushing to safety. Cell phones and i-pods can interfere with people hearing thunder, a vital cue to seek safety.
Cell phones: - Attract lightning because they are metal - Attract lightning because the radio waves ionize the air and create a conducting path - Increase injuries because they are metal touching the skin, which channels more of the lightning current inside the body	Can mislead people to think that they are safe outside near thunderstorms if they don't have a cell phone. Can interfere with people hearing thunder, a vital cue to seek safety. Can mislead people outside not to use their cell phones to call for a ride when thunderstorms are threatening.
Lightning won't strike if it is not raining or cloudy	Can mislead people to think that they are safe outside when thunderstorms are in the area. About 1/3 of lighting strikes occur outside the rain.

Table 3. (continued) Prevalent lightning myths and their impact on lightning safety.

Lightning Myth	Impact On Lightning Safety
'Cone Of Protection'	Can mislead people to think they are safe outside. Can mislead people to move closer to tall isolated objects, where lightning is more likely going to strike, increasing their risk.
Lightning never strikes the same place twice	Sometimes leads to erroneous advice to run to where lightning has just struck, rather than an appropriate safe place
A person who was just struck by lightning can electrocute you if touched	Misleads people to delay or not provide life saving first aid
Lay flat on the ground if lightning is imminent*	Misleads people to stay outside longer than they should when thunderstorms are in the area. Also increases risk from step voltage and ground streamers, which cause more casualties than direct lighting strikes.
Lightning is 100% deadly	Can mislead people to not apply first-aid
Running decreases the chances that lightning will strike you	Can mislead people to stay outside and not seek a safe place
A person struck by lightning will be turned into a burnt corpse (aka the crispy critter myth)	Can mislead people to not apply potentially life-saving first-aid
It won't happen to me	Misleads people to avoid practicing lightning safety

* The 'lightning crouch' provides more risk reduction than laying flat on the ground. However, teaching last minute personal outdoor lightning risk reduction to the public is losing credibility (Roeder, 2008 and 2007c).

3. Summary

Six recent updates on lightning safety were discussed. The six updates are as follows: 1) upgrading the safety provided by vehicles with solid metal tops and solid metal sides, 2) cueing on hearing thunder to seek a safe place, rather than 30 seconds between lightning and its thunder, 3) lightning statistics for youths, 4) no longer teaching last minute outdoor lightning risk reduction to the general public, 5) adding Automatic External Defibrillator (AED) to lightning first aid, and 6) a review of common myths that continue to detract from lightning safety. These updates were presented to help meteorologists present a consist message in lightning safety education. In addition, persistent myths that detract from lightning safety were also presented.

4. Disclaimer

This paper is presented for informational purposes only and no guarantee of lightning safety is stated or implied by the recommended procedures.

5. Acknowledgements

This paper summarizes extensive discussions over 2006-2007 and consensus among the National Weather Service Lightning Safety Awareness Week Working Group (www.lightningsafety.noaa.gov) and the board of directors of StruckByLightning.Org, a non-profit lightning safety education organization (www.struckbylightning.org).

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