5.4 LIGHTNING-CAUSED DEATHS AND INJURIES IN THE VICINITY OF VEHICLES

Ronald L. Holle
Holle Meteorology & Photography
Oro Valley, Arizona 85737

1. INTRODUCTION

The goal of this study is to examine the types of lightning-caused injuries in the vicinity of vehicles. This category accounted for a sizable number of lightning deaths and injuries in the U.S. and elsewhere in recent years. The present report focuses on vehicles, and uses some of the approaches that were used in several similar previous studies of soccer, baseball, golf, and camping (Holle 2005a), hiking and climbing (Holle 2005b), motorcycles (Cooper and Holle 2007), and running (Holle et al. 2007).

The cases in the following sections were randomly collected through newspapers, web reports, broadcast media, published papers, and other publications and sources. Some of the events were from the NOAA Publication *Storm Data* whose information is compiled by local National Weather Service offices. The reports in this study are mainly from the last 20 years.

Events are paraphrased from the news source. The indicated dates are when the case occurred, or the first date of a news report after the event. It must be noted that the reports may be affected by preconceived ideas about lightning and its effects by reporters, casualties, and witnesses. The random nature of the dataset precludes the conversion to an absolute rate for each scenario. Nevertheless, relative values generally indicate which types of events are more common than others.

2. BACKGROUND

The category of "Near vehicles" accounted for 3.3% of U.S. lightning deaths and 3.5% of injuries from 1991 to 1994 in the Outdoor category in Holle et al. (2005) summarizing data from NOAA's *Storm Data*. Additional vehicle cases are spread among other categories in Holle et al. (2001). The total is 4.1% of deaths and 5.0% of injuries related to vehicles in that publication.

The general situations under which people have become victims of lightning in the vicinity of vehicles are listed in Table 1. A total of 212 events related to vehicles are included; the cases had 42 deaths and 288 injuries.

The rate of 6.9 injuries to each death approaches the rate of 10 injuries requiring medical treatment for each death in Colorado (Cherington et al. 1999). Note that the specific category of motorcycles and other small exposed vehicles is studied separately in Cooper and Holle (2007); 27 events accounted for 19 deaths and 20 injuries in that study.

Corresponding author address: Ronald L. Holle, Oro Valley, AZ 85737; e-mail: rholle@earthlink.net.

TABLE 1. Summary of type and number of vehicle-related events, deaths, and injuries. Details by type are provided in the indicated tables.

Type of vehicle event	Events	Deaths-	Injuries	Tables
Inside fully enclosed metal-topped vehicles	76	4	77	2, 3, 4
Direct contact	36	9	37	5, 6
On or near non-enclosed vehicles	29	7	67	7
Parking lots	24	8	30	8
Other casualties related to vehicles	47	14	77	9
Total	212	42	288	

3. PEOPLE INSIDE FULLY-ENCLOSED METAL-TOPPED VEHICLES STRUCK BY LIGHTNING

Table 2 provides details of 76 events that involved people who were inside fully-enclosed metal-topped vehicles when struck by lightning. This group is described in detail since lightning safety often emphasizes that being inside a fully-enclosed metal-topped vehicle is a place to be safe from lightning (Holle et al. (1999).

During the 76 events, there were 4 deaths and 77 injuries. However, it is noteworthy that in more than half of the events (40), the people inside the vehicles described themselves as uninjured. In the injury cases, a person was identified as injured if taken to a hospital, or suffered burns, numbness, or other direct wounds. Since more than half of the direct strike events involved no injuries, and the rest were typically minor impacts, the recommended lightning safety precaution (such as Holle et al. 1999) to seek safety inside a fully-enclosed vehicle appears to be well supported.

The four events in Table 2 involving deaths require further discussion. Note that one case involved people being safe inside a vehicle, while those leaning on the vehicle outside were killed. The first three reports are from the NOAA publication *Storm Data*, an excellent source of lightning event data (Curran et al. 2000; Holle et al. 2005; Lopez et al. 1995 and others). Nevertheless the cases are sometimes described so briefly that critical elements of the situation appear to be missing, and many questions remain. The four cases involving fatalities are described in details as follows:

- 5 September 1995, Florida: Several people were inside a vehicle when lightning struck at a construction site. The exact location of the strike is not specified. Those inside were uninjured, but two men were killed and another injured who were leaning on the vehicle at the time. This case indicates the value of being inside compared to outside the vehicle. The event is also included in the list of direct contact events in the next section.
- 27 April 1994, South Carolina: This report states that a man was killed when lightning passed from a tree through the ground to his office, a converted bus without wheels. This is a difficult case to clarify, since there was likely to have been power and/or phone lines into the bus if it was used as an office, and there may have been a downward flash from the tree to the bus.
- 15 May 1994, Tennessee: This report states that a man was killed as he was parking his tractor-semi-trailer near his home. It is an ambiguous description, since the driver may have been outside checking its position, unloading cargo, or in another location outside the vehicle, so the report is of limited value.
- 10 March 2001, California: Based on two newspaper reports, a 74-year-old woman started a crash when lightning struck very near her vehicle. She and another driver were killed; there were two injuries. Witnesses described the situation as being initiated by the lightning, then the driver's reaction that led to the crash. Two similar situations occurred on 04 July 2000 (Maine) and 24 May 2001 (Georgia) when drivers swerved to avoid lightning strikes and slammed into utility poles (Table 2).

There are two multiple-injury events of particular interest:

- A school bus with 30 people flipped into a ditch (29 May 2001, Ontario). The circumstance was thought to involve a dog scared by lightning that ran into the road, causing a van to stop suddenly, then the bus stopped quickly behind the van.
- Six people inside a van sought safety as a heavy thunderstorm hit during a funeral; injuries were minor (13 August 2001, Tennessee).

Table 3 summarizes the injuries during these cases. The most common injury in the 76 events inside vehicles of Table 2 involved the arm or elbow (7 events). The next most common reported injury involved the ear (4), or being shaken, jolted, or dizzy (4). A number of other impacts are also in Table 2. However, no significant injuries appear to have resulted specifically from direct contact with metal in the vehicle, with the exception of an earplug attached by a power cord to the dashboard (27 August 2003, Tennessee). As a result, less emphasis may be made in safety recommendations about avoiding contact with metal, since this situation did not apparently lead in a direct way to serious injuries in the 76 events in Table 2.

TABLE 2. Descriptions of 76 events of people inside fully enclosed metal-topped vehicles when struck by lightning.

Date of event or report	Location	Deaths-Injuries	Description
1980	Lenox, Pennsylvania	0-1	Man injured on left side while driving tractor-trailer; antenna struck by lightning; laid up for 3 to 4 weeks.
20 August 1987	La Salle, Illinois	0-1	Highway maintenance man inside truck when electrical system was destroyed and cab filled with smoke; he went to a hospital due to elevated heart rate, and had ringing in his ears 13 years later.
17 September 1991	Herndon, Virginia	0-0	Two occupants of car were traveling on multilane highway when flash struck antenna causing extensive damage to electrical system.
27 April 1994	Tigerville, South Carolina	1-0	Man killed when lightning passed from a tree through the ground to his office, which was a converted bus without wheels.
15 May 1994	Pleasant View, Tennessee	1-0	Man killed by lightning as he was parking his tractor-semi-trailer near his home.
22 October 1994	Tuscaloosa, Alabama	0-1	Driver of ABC-TV truck kept at hospital after flash struck in stadium area in second quarter of football game; cameraman also injured.
August 1995	Jacksboro, Texas	0-0	Male storm chaser's car struck traveling down road; car stalled, amateur radio and battery blown, antenna melted, and hole burned in trunk.
05 September 1995	North Naples, Florida	0-0	Several people in vehicle uninjured; two men killed and one man injured while leaning against a car at a construction site (also Table 6).
06 July 1997	Missing	0-0	Two people driving in heavy rain when direct strike caused sound like bomb going off in car; car stopped but came back after short time; radio and air conditioner not working; check gauge lights came on; 3 flat tires; antenna missing.
19 August 1998	Orlando, Florida	0-0	Father and son traveling in minivan struck, resulting in loss of antenna, major electrical system damage, and flattened left front tire.
05 October 1998	Muskogee, Oklahoma	0-0	Woman driving on turnpike when struck antenna became red hot and flew onto back glass; radio destroyed and flat tire under antenna.
23 January 1999	Asheville, North Carolina	0-0	Man driving SUV on highway when flash struck behind driver's side above cargo area window; luggage rack melted, paint scorched, hole burned in trim, all 4 tires burst.
03 March 1999	Central Minnesota	0-0	Woman driving on Interstate 74 when lightning struck car that filled with smoke after antenna hit; electrical components destroyed.
Summer 1999	Canada	0-1	Man took electrical charge resulting in tingling sensation for several hours down right side of body after car struck.
26 April 2000	Vancouver, British Columbia	0-1	43-year-old man struck in head by chunk of wood from tree exploded by lightning; wood flew through window of van waiting at intersection.
07 May 2000	Nebraska Panhandle	0-0	Male storm chaser driving in rain when flash vaporized two-meter amateur radio antenna; 3 flat tires, weld marks on tire rims, interior filled with smoke from burst cable connecting antenna to radio.
17 May 2000	Big Timber, Montana	0-0	Engine blown on pickup truck driven by man on Interstate 90; flash charred antenna and nearby pavement.
19 June 2000	Collingswood, New Jersey	0-3	Children between 5 months and 5 years old treated for minor cuts due to flying glass when lightning struck a power pole and knocked utility box onto car while at stop sign.
22 June 2000	Poughkeepsie, New York	0-0	Lightning struck pickup truck driven on highway by 37-year-old man, radio antenna destroyed and burn mark left on hood.
30 June 2000	Wakefield, Rhode Island	0-1	16-year-old girl passenger struck in left arm by current after flash hit ground next to car and bounced into it; she was taken to a hospital.
04 July 2000	Augusta, Maine	0-1	63-year-old woman crashed into a utility pole while driving after being blinded by lightning in front of her.
July 2000	New Brunswick	0-0	Man driving on bridge when car was struck, resulting in malfunction of electronic system and causing engine to stop.
July 2000	Belle Vernon, Pennsylvania	0-1	Woman driving on route 51 when lightning hit car and stopped; two tires went flat that day, and the other two 3 weeks later.
12 July 2000	Columbus, N. Carolina	0-1	Woman's arms became numb after lightning hit another car in front of her vehicle.
16 July 2000	Chippewa Falls, Wisconsin	0-1	Man injured when lightning hit his car while waiting at intersection; his arm was numb from current traveling through steering wheel.
03 August 2000	Cedar Springs, Michigan	0-1	Woman had hearing loss after lightning hit car antenna, blew out tires, and destroyed radio.
03 August 2000	Chatham, Ontario	0-1	29 year-old male truck driver hit the cab's roof when lightning hit the top on Highway 401; all gauges and electrical system disabled.
09 August 2000	Clifton, Arizona	0-0	Female and son not injured when lightning struck car antenna while driving on Highway 70; CD, cruise control, and speedometer stopped.
19 August 2000	Cumberland, N. Carolina	0-1	23-year old man knocked unconscious when lightning hit his truck while driving on N.C. 24.

20 August 2000	Tuscaloosa, Ala.	0-1	Driver treated by paramedics after vehicle struck.
01 September 2000	Grand Forks, N. Dakota	0-2	24- and 25-year old men had ringing in their ears after their SUV was struck while driving on Interstate 29.
11 September 2000	Battle Creek, Michigan	0-0	Antenna and trunk struck on car while woman driving on Interstate 94; motor died and a one-inch hole made in pavement.
17 October 2000	Snyder, Texas	0-0	Male truck driver uninjured when flatbed trailer with roofing insulation struck and caught fire; engine stopped then electrical system restarted.
30 October 2000	Oakdale, California	0-0	Three men shaken after lightning left burn streaks on roof and right door of car whose ignition was just turned; it started shaking.
10 March 2001	Casa de Fruta, California	2-2	37-year old man killed, as well as 74-year-old woman who started crash when flash struck very near vehicle on highway 152; 2 injured.
18 April 2001	Abeline, Kansas	0-0	Woman driving car on Interstate 70; antenna demolished, radio failure, smoke from dashboard, flat tire, stuck horn, and racing engine.
15 May 2001	Brookfield, Wisconsin	0-0	Man driving car during torrential downpour when lightning destroyed electrical system and antenna, shattered window, blew out rear tires, and left two gashes in pavement 3 feet wide and 6 inches deep.
24 May 2001	Cumming, Georgia	0-0	18-year-old male driver swerved to avoid a lightning strike and slammed into a utility pole.
29 May 2001	Aylmer, Ontario	0-30	30 high school students injured when bus flipped into ditch at low speed after bus driver slammed on brakes behind van that stopped suddenly for dog crossing road after being frightened by thunder and lightning.
07 June 2001	Alliance, Nebraska	0-0	Man driving car on highway stopped immediately as electrical system destroyed, smoke from dashboard, small black hole in roof, windshield and rear window etched, and scorched tire rim; car total loss.
28 June 2001	Carmel, New York	0-0	Man and woman driving on Route 301 when SUV was hit in antenna; paint burned, filled with smoke, windshield cracked, two tires exploded, and airbags deployed. The highway was damaged.
29 June 2001	Venice, Florida	0-1	54-year-old mailman driving on street taken to hospital after truck was struck, as well as nearby transformer.
12 July 2001	Denver, Colorado	0-1	One person slightly injured when lightning struck car traveling on highway C-470.
17 July 2001	Irvington, New Jersey	0-0	61-year-old man and woman of 67 sitting in truck during pounding rain when lightning hit a large tree that fell on the truck cab, trapping them inside; minor injuries.
13 August 2001	Dresden, Tennessee	0-6	Lightning struck van where shelter was sought shortly after a funeral; they were taken to the hospital but injuries weren't serious.
18 March 2003	Waukesha, Wisconsin	0-0	64-year-old man driving on street when lightning strike caused power loss, demolished antenna, shattered rear window, and shredded rear tires; two 6-inch-deep potholes left in pavement.
31 May 2003	Novi, Michigan	0-1	70-year-old female passenger in car on Interstate 96 injured when flash struck car and set off air bag, injuring her arm; ignition died.
July 2003	Peoria, Illinois	0-0	Woman and grandchildren not injured inside car struck by lightning; the vehicle had multiple difficult-to-repair damages.
06 August 2003	Topeka, Kansas	0-0	Two male drivers uninjured when lightning hit first car driving on highway 75, then bounced to car behind it; the second car was not drivable due to electrical damage.
22 August 2003	South Carolina	0-2	Two women waiting in parking lot during storm when lightning struck between cars, resulting in skin marks and nightmares.
27 August 2003	Nashville, Tennessee	0-1	Man driving on street when lightning struck pickup truck with detachable 8- and 28-inch antennae on roof. One antenna was connected to cell phone and vehicle power source had an earpiece in his ear; headache and burns dissipated after 3 days.
27 April 2004	Baxter, Arkansas	0-0	17-year-old male on Highway 5 when pickup struck; the impact through metal gear shift left red mark on palm. Truck shut off, white smoke from under hood, left fender wall caught fire, windows blown out; truck destroyed by fire.
12 December 2004	Louisiana area	0-1	Parent and daughter driving on highway when lightning hit next to tire well; blinding light followed by pressure in chest and tickling on arms, as well as dizziness. Bad back pain for last 9 years was gone.
15 May 2005	West Valley City, Utah	0-0	Woman shaken when car struck driving on Highway 201; windshield half gone, side mirror blown off, road damaged, air bag deployed.
15 June 2005	Cochrane, Alberta	0-0	Driver uninjured when car struck while traveling on Highway 22; car lost power, smoke from dashboard, and caught fire.
07 September 2005	South Florida	0-0	Woman and child uninjured when flash struck car driving on Florida Turnpike; hole in rear window near child's car seat.
30 September 2005	Santa Fe, New Mexico	0-0	Male sheriff deputy driving on State Road 14 when lightning disintegrated antenna and knocked out electronics.
10 November 2005	Hunter Valley, Australia	0-0	Person in car struck by lightning was not injured.

May 2006	Texas	0-0	Storm chaser van struck while driving on road when flash struck field one km away; tire simultaneously blew on van; no other damage.
05 June 2006	Moscow, Russia	0-0	A tram packed with passengers was damaged when struck by lightning while traveling in northern Moscow.
23 June 2006	Whitehouse, Ohio	0-1	Flash struck just outside bus; man inside holding metal rail had current travel through hand, arm, chest, neck, and back. He was treated at a hospital and released to work later in day.
18 July 2006	Riverview, Florida	0-1	50-year-old man had lightning hit car as arm was propped on window; both elbows and car had burn marks; stayed overnight at hospital.
18 July 2006	E. Wenatchee, Washington	0-1	44-year-old man in stationary car knocked out when flash struck; he was treated at a hospital and released. Electrical service at nearby house was disrupted.
27 July 2006	Wolcott, Indiana	0-0	Man and woman driving on Interstate 65 when car struck antenna, car stopped running, antenna melted to half its original size, and a tire blew. No hair was standing on end prior to strike.
25 August 2006	Naperville, Illinois	0-0	22- and 19-year-old men sitting in truck when lightning struck and left dents and scorch marks on ceiling; engine started 10 minutes later.
18 September 2006	South Florida	0-0	Male driving tractor-trailer on Interstate 75 when struck on cab; truck became engulfed in flames.
28 December 2006	Port Arthur, Texas	0-0	Male driving car when struck; engine and brakes died, smoke filled inside, back passenger window blown out, metal frame around window twisted, and electrical system destroyed.
2 April 2007	Opelousas, Louisiana	0-0	36-year-old man driving on Interstate 49 when lightning blew hole in truck, burn mark cracked windshield, and blew out tire.
19 June 2007	Dover, Ohio	0-0	Two people inside car pulling into rest stop off Interstate 77; unharmed but trapped inside car for over an hour due to power door locks and windows being disabled; arc and small indentation on top of car.
21 June 2007	Walworth County, South Dakota	0-0	Deputy sheriff driving on US 83 when lightning hit patrol car at 7 am; sparks on road behind vehicle as engine stopped; electronics and police radio destroyed.
28 June 2007	Greenfield, New Hampshire	0-6	Family of 6 driving on Route 31 jolted and shaken when lightning shattered windshield, warped antenna, and gave driver jolt through steering wheel.
16 August 2007	Albert Lea, Minnesota	0-1	Driver taken to hospital after vehicle was struck by lightning at 4:45 am on Interstate 35.
19 August 2007	Edison, New Jersey	0-1	Man in car in parking lot when lightning struck car; complained of headache and stuttering from the shock.
09 September 2007	Keenansville, Florida	0-1	Woman taken to hospital after car was struck while driving on turnpike.
08 October 2007	Orlando, Florida	0-1	Man not seriously injured when lightning hit as he waited at traffic light; flash hit nearby power pole and sent debris from pole smashing through back car window and nearly hit him.
09 December 2007	Mitchell, Queensland, Australia	0-0	Three police officers unscathed after lightning struck 4-wheel-drive patrol vehicle traveling on road; sparks under hood; current passed through aerial; cracked windshield; lights, horn, and siren could not be disconnected until reaching station.
Total		4-77	

TABLE 3. Injuries reported to people inside fully-enclosed metal-topped vehicles, summarized from Table 2. Some events had more than one symptom.

Symptom	Events
Arms or elbows tingling, tickling, burned, struck, or numb	7
Ears ringing, hearing loss, or earphone damage	4
Shaken, jolted, or dizzy	4
Skin marks	2
Headache	1
Knocked unconscious	1
Left side injured	1
Minor cuts by flying glass	1
Nightmares	1
Pressure in chest	1
Struck in head by wood from exploded tree	1
Stuttering	1

Table 4 describes the damages to the vehicles in the 76 cases in Table 2. The most common impact was for the antenna to be hit (20 of 76 events). The next most common report was of the electrical system being destroyed or damaged (17). Flat tires were reported 14 times, glass damage 13 times, a stopped engine in 13 events, burn marks 10 times, as well as smoke in nine cases. In seven events, the pavement beneath the vehicles was damaged. During another seven events, radios or CD players were severely impacted. Four vehicles caught fire, and two were declared a total loss. A tree hit by lightning fell onto a truck in one case, and a utility box fell onto a car in another. Several other effects were noted less often.

TABLE 4. Damages to fully-enclosed metal-topped vehicles with people inside them, summarized from Table 2. Some events had more than one type of damage.

Damage	Events
Antenna	**20**
--Destroyed	*9*
--Hit	*7*
--Damaged	*4*
Electrical System	**17**
--Destroyed	*9*
--Damaged	*8*
Tire(s) flat	14
Broken, flying, or etched glass	13
Engine stopped or racing	13
Burn marks on exterior	10
Smoke inside vehicle's passenger cabin	9
Pavement damaged	7
Radio/CD player destroyed/damaged	7
Caught fire	4
Airbags deployed	3
Tree or utility box fell on vehicle	3
Stuck horn	2
Total loss of vehicle	2
Air conditioner stopped	1
Battery failed	1
Brakes died	1
Cruise control and speedometer stopped	1
Luggage rack melted	1
Power locks and windows disabled	1
Side mirror blown off	1
Stuck siren	1
Weld marks on tire rim	1

Most vehicles were in motion when struck by lightning. Fifteen vehicles were waiting at a stop sign, intersection, parking lot, football game, or for the storm to end. Of those on the road, at least 11 were on Interstate or other divided highways. A few events did not have their status reported. Two-thirds of the people inside the vehicles were male.

In summary, there were 76 reports of fully-enclosed metal-topped vehicles being struck by lightning when people were inside them. One case involved people being safe inside a vehicle, while those leaning on the vehicle outside were killed. Three cases involved deaths with people inside the vehicles, most notably an elderly driver who started a crash when lightning struck very nearby; descriptions of the two other fatality cases were ambiguous. More than half of the events resulted in no injuries. Most injuries were minor impacts on arms or hearing. Damages consistently involved hits to the antenna, electrical system, flat tires, and broken windows. Most vehicles were traveling on a road or highway.

In view of the commonality of many of the damages and injuries, such events do not appear to be especially unusual. Nevertheless, several police, medical, insurance, and car repair staff involved in the Table 2 events were quoted as saying that they could not understand how lightning could produce such damages, and suspicion was cast on people involved in the events.

4. PEOPLE IN DIRECT CONTACT WITH VEHICLES STRUCK BY LIGHTNING

Table 5 summarizes the major activity categories during 36 events that involved people who were in contact with the outside of vehicles at the time of a strike; details are in Table 6. This step voltage category involves people at two potentials (Cooper et al. 2007). It is difficult in some events to know where the flash struck.

The most common direct-contact event involves step voltage when a person is entering or exiting a vehicle. This is very dangerous, as indicated by 5 of the 9 direct-contact deaths resulting from this posture. An unexpected category was that 8 events occurred when people were working on vehicles, usually beneath them, when current from a nearby flash traveled to them while in contact with the ground. When gender was identified, 37 of the 41 casualties were male; this 90% rate is higher than most previously-published categories.

Seventeen events in Table 6 involved cars, 9 were trucks, 3 were vans, and there was one each camper, crane, motorhome, and trailer.

TABLE 5. Situations of people in direct contact with vehicles when struck by lightning, based on detailed narratives in Table 6.

Activity	Events	Deaths-Injuries
Entering/exiting vehicle	11	5 7
Working under or on vehicle	8	0 14
Leaning on vehicle	4	2 4
Rolling up windows	3	2 2
Other	10	0 10

TABLE 6. Descriptions of 36 events of people in direct contact with vehicles when struck by lightning.

Date of event or report	Location	Deaths-Injuries	Description
1986	Columbia, South Carolina	0-1	39-year-old man with foot on ground while reaching for object on car's rear seat. Hole blown in concrete; foot was smoking.
June 1987	Cherry Hill, Pennsylvania	1-0	17-year-old man killed as he hurried to put up his car windows at a shopping center.
16 June 1992	Tampa, Florida	0-3	Man and two youths injured while working on a car in a wooded area.
27 July 1992	Pace, Florida	0-4	Injured while working on a car; all were hospitalized.
03 June 1993	Bear Creek, North Carolina	0-1	Man under truck changing oil pan when lightning stunned and burned him; effects lasted several weeks.
28 August 1993	Galveston Island, Texas	1-0	Man killed as he was entering his car.
24 May 1994	Danville, Illinois	1-0	Man struck and killed as he exited his car.
06 September 1994	Alamogordo, New Mexico	1-0	19-year-old man killed by lightning as he exited his car in a shopping center parking lot.
05 September 1995	North Naples, Florida	2-1	Two men killed and one man injured while leaning against a car at a construction site; several people in vehicle were uninjured (also Table 2).
27 May 1999	San Antonio, Texas	1-1	46-year-old man killed and man of 43 injured while putting up windows on a station wagon.
13 May 2000	Troy, Pennsylvania	0-1	60-year-old man struck while rolling up truck window; later pain and muscle aches.
17 May 2000	Wallaceburg, Ontario	0-1	18-year-old man working underneath pickup truck in farm shop; spark passed from him into truck frame; knocked unconscious.
23 May 2000	Dexter, Michigan	0-2	Two 18-year-old men injured while entering car that was struck by lightning; one revived by nurse using CPR.
27 July 2000	Blackfoot, Idaho	0-1	Man injured while opening pickup door after fixing windshield wipers alongside highway during rainstorm.
10 August 2000	Catskill, New York	0-1	Man knocked off feet using metal rod to unravel canvas overhang on camper side; flash may have hit nearby utility pole.
10 August 2000	Sicklerville, New Jersey	0-1	43-year-old man injured when depositing mail at a drive-up mailbox outside post office.
28 September 2000	Tucson, Arizona	0-1	47-year-old woman entering minivan at school office.
26 January 2001	Petaluma, California	0-1	High school girl entering mother's car when flash hit and sent a shock through her; weak and tingly sensations, and erratic heartbeat.
31 May 2001	Kamloops, British Columbia	0-1	45-year-old man knocked over while working on motorhome; flash hit tree 20m away, then through dirt to him.
03 June 2001	Jacksonville, Fla.	0-1	Man burned when his vehicle was struck while touching it.
12 June 2001	Mason, Ohio	0-1	Lightning struck car that man was touching in parking lot of amusement park; brain damage.
27 June 2001	Charlotte, North Carolina	0-1	23-year-old man fixing truck outside rental agency, resulting in broken collarbone and partial paralysis.
27 June 2001	Paris, Illinois	0-1	Lightning hit fueling tank canopy, through tank, to man holding nozzle.
23 November 2004	Al Ain, United Arab Emirates	1-0	21-year-old man killed when he exited car that broke down; he was on trip to watch unusual heavy rains.
27 May 2005	Vanceburg, Kentucky	0-1	Man injured while under vehicle working on brake lines; unconscious for a short time.
09 June 2005	Royal Oak, Michigan	0-1	30-year-old man went into shock when flash hit neighbor's car while clearing branches off it.
13 July 2005	Wilkes-Barre, Pennsylvania	0-1	61-year-old man treated at hospital after flash struck concrete truck while he was holding the chute that distributes concrete.
25 May 2006	Jackson, Missouri	0-1	Man leaning on metal trailer when flash hit utility pole, bounced off tree, and up through ground; treated at hospital.
26 July 2006	New Rochelle, New York	0-1	Man had one hand touching a truck and the other holding a pole in a masonry yard; thrown several feet and had burns.
25 August 2006	Tutbury, U.K.	0-1	Man stepping out of van; swollen arm several hours later.
31 August 2006	Lake Wylie, South Carolina	1-0	36-year-old man killed when he stepped out of a truck.
14 May 2007	Jasper, Tennessee	0-2	Father and son stunned while working on truck inside garage when flash hit in back of house and followed water to them.
23 July 2007	Weatherford, Texas	0-1	Firefighter had tingling in right arm after flash struck nearby ground while leaning on crashed car and speaking with driver.
06 August 2007	Pompano Beach, Florida	0-1	54-year-old man injured on left arm while leaning against a crane when lightning struck it.
14 September 2007	Savannah, Georgia	0-1	Woman holding onto a car when flash traveled from nearby tree to car in restaurant parking lot.

01 October 2007	Boise, Idaho	0-1	39-year-old woman was struck in head after she decided to go back into a car.
Total		9-37	

5. NON-ENCLOSED VEHICLES

Specific mention was made in 29 events of people who were casualties of lightning while on non-enclosed vehicles (Table 7). These cases are in contrast to cases of people inside fully-enclosed metal-topped vehicles listed in Tables 2, 3, and 4. During the 29 events, 7 people were killed and 67 were injured; one case involved 36 injuries. The most common event was when people were under an awning or screened porch near a trailer used for recreation. In these cases there was no protection provided by any structure surrounding the people, in contrast to the cases of people inside fully-enclosed metal-topped vehicle. There are three cases with one death each on tractors, and four other situations where people on or near vehicles were outside and not protected from the threat of lightning. There were also four events that involved people outside near cranes that resulted in 43 injuries (Table 7).

TABLE 7. Events with people on or near non-enclosed vehicles when lightning struck.

Location	Events	Deaths-Injuries
Under awning or screened porch of trailer	4	0 7
On tractor	3	3 0
Standing/working near crane	3	0 6
Standing/riding in back of trailer/pickup truck	2	1 1
Unloading cars off trailer	2	1 1
On/near golf cart	2	0 2
On road grader/bulldozer	2	0 2
Fixing leak on camper roof	1	1 0
Pushing wheelbarrow with drinks for sale	1	1 0
Crane hit during fireworks display	1	0 36
Soccer players near struck crane	1	0 5
Driving open-top recreational vehicle	1	0 1
Fixing back of construction truck	1	0 1
Loading groceries into car	1	0 1
On fertilizer spreader in field	1	0 1
On top of military vehicle	1	0 1
Pouring concrete near cement mixer	1	0 1
TV cameraman on boom at football game	1	0 1
Total	29	7 67

6. PARKING LOTS

Specific mention was made in 24 events of people who were casualties of lightning while in parking lots. These casualties were not inside a vehicle, or in direct contact with a vehicle. During the 24 events, 8 people were killed and 30 were injured; some cases involved up to 7 injuries in one event. Table 8 lists the most common locations of these events. People in these cases were usually in the process of crossing a parking lot to or from a vehicle, or under a tree at the lot. The most common locations relating to parking lots were at a shopping center, store, amusement park and grocery.

TABLE 8. Events with people in parking lots when lightning struck at or near the person, but not inside or in direct contact with a vehicle.

Parking lot location	Events	Deaths-Injuries
Shopping center/Store	5	1 4
Amusement park	4	1 9
Grocery	3	0 2
Motor sports race track	2	0 7
Hockey rink	1	1 2
Manufacturing plant	1	1 1
Flea market	1	1 0
National park	1	1 0
Reservoir	1	1 0
Restaurant	1	1 0
Church	1	0 2
Historical site	1	0 1
Hospital	1	0 1
School	1	0 1
Total	24	8 30

7. OTHER CASUALTIES RELATED TO VEHICLES

Other cases when people were near vehicles when killed or injured by lightning are listed in Table 9. None of these events were in previous tables. In these 47 events, 14 people were killed and 77 were injured. The most common event occurred when people were outside waiting for a bus or other type of transportation. Others involved being near a truck, standing near a disabled or crashed car along a highway, and law enforcement officials outside during the course of duty; some of the eight injuries in these five cases were also bystanders. All other cases included people outside a vehicle where no protection was provided.

TABLE 9. Other events related to vehicles when lightning struck.

Activity	Events	Deaths-Injuries
Bus/transportation	**10**	**6 32**
--Waiting for school bus/transportation	*3*	2 21
--Standing at/near bus shelter	*3*	0 9
--Stepped off/walking away from school bus	*2*	0 2
--Lightning hit pole, power line dropped onto bus as people stepped off bus into water	*1*	3 0
--Under tree waiting for bus	*1*	*1 0*
Standing/walking/near truck	6	2 5
Standing near disabled car/crash near/on highway	5	1 10
Law enforcement	**5**	**0 8**
--Helping at crash	*1*	*0 2*
--Helping stranded vehicles	*1*	*0 2*
--Routine traffic stop	*1*	*0 2*
--Directing traffic at crash	*1*	*0 1*
--Outside squad car	*1*	*0 1*
Walking from beach/swimming spot to vehicle	3	2 1
Running/walking from school to car	3	1 2
Working on highway	2	0 4
Moving car closer to house when flash hit tree	1	1 0
Walking from mobile home to house	1	1 0
Loading truck outside home	1	0 3
Trying to reach van from plant nursery	1	0 3
Closing gate in truck yard	1	0 1
Driving school instructor	1	0 1
Exiting car when flash hit nearby tree; traveled to umbrella	1	0 1
Leaving baseball practice for van	1	0 1
Near car during pouring rain and holding umbrella	1	0 1
Running from tractor to truck	1	0 1
Soccer coach running to close car windows	1	0 1
Storm chaser near car	1	0 1
Walking between church and vehicle; holding umbrella	1	0 1
Total	47	14 77

8. SUMMARY OF VEHICLE CASUALTIES

A total of 212 events was analyzed where lightning resulted in a casualty in the vicinity of vehicles. There were 42 deaths and 288 injuries during these events.

The most common type of vehicle impact was a strike to a fully-enclosed metal-topped vehicle with people inside. There were no injuries in more than half of these events. There were three cases with a reported death, however, two of the situations were very ambiguous (section 3). In the third case, two fatalities resulted when a driver apparently reacted to a nearby flash by driving into oncoming traffic. With the exception of that case, very few of the other events involved major injuries. Vehicles with people inside most often had the antenna as a point of entry. In addition, electrical and other systems were affected, tires went flat, glass was damaged, engines were affected, the outside was burned, and smoke or fire sometimes resulted. Nevertheless, it is concluded that being inside a metal-topped vehicle is a safe place to be from the danger of lightning, as stated in safety recommendations, compared to remaining outside at the same time and place.

The next most common category occurred when people were in direct contact with a vehicle at the time of lightning. In this situation, there was a fairly high rate of deaths and serious injuries, most often at the time when a person was entering or exiting a vehicle (step voltage). Another group involved people working on a vehicle during a thunderstorm.

Cranes, tractors, golf carts, and other non-enclosed vehicles were another source of significant impacts on people. A consistent situation occurred in four cases when people were under an awning or screened porch of a trailer; while they provide rain protection they provide no safety from lightning.

In other situations, parking lots were a source of many events, most often at a store or amusement park. People waiting for buses or other transportation often became casualties, and were sometimes killed. Additional cases occurred near trucks, as well as to law enforcement and other people near disabled vehicles. Additional cases involved people running or walking to or from a vehicle in a variety of situations. In all of these, no safety was provided unless inside fully-enclosed metal-topped vehicles.

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