INJURY UPDATE

*A Report to Oklahoma Injury Surveillance Participants**

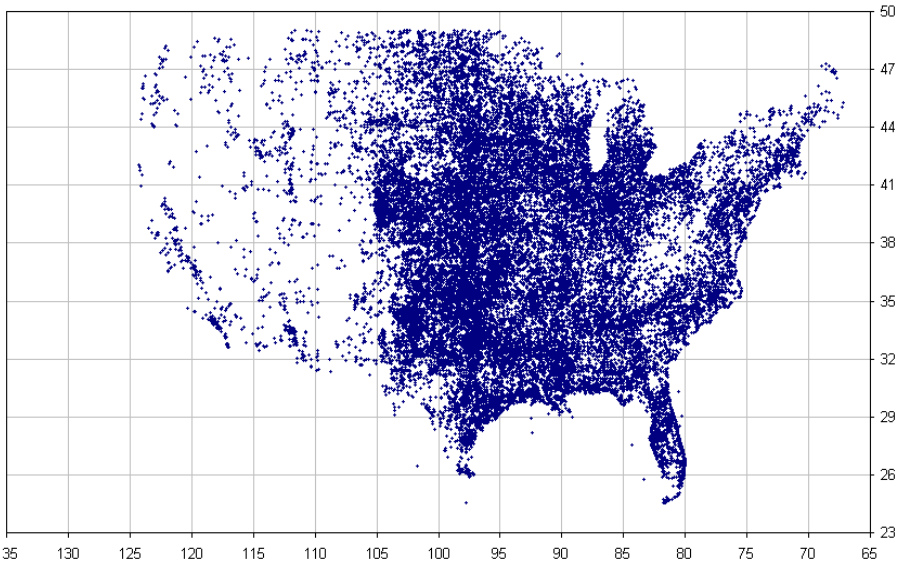
July 21, 2000

Investigation of Deaths and Injuries Resulting From the May 3, 1999 Tornadoes

BACKGROUND

In the United States, tornadoes are among the most violent and lethal of all natural disasters, occurring in every state (Figure 1). During 1950-1997, a yearly average of 787 tornadoes accounted for approximately 88 fatalities and 1,000 injuries per year. Though tornadoes occur in every month, the majority of tornadoes and resulting fatalities occur in April through July. During 1999, 30 killer tornadoes were reported in 13 states resulting in 96 fatalities; 45 fatalities occurred in Oklahoma.

Figure 1. Spatial Distribution of Tornado Touchdowns 1950-1997*



*Source: Computational Geosciences, Inc., Norman, Oklahoma

The Fujita Scale is used to rate the force of tornadoes. The most severe tornadoes are assigned a rating of F-5 and can produce wind speeds of 261-318 miles per hour (mph). An F-5 tornado is capable of completely destroying strong frame houses and removing them from their foundations. The risk of death and injury to people in the path of an F-5 tornado is extremely high. During 1990-1996, only five tornadoes in the U.S. were assigned an F-5 rating.

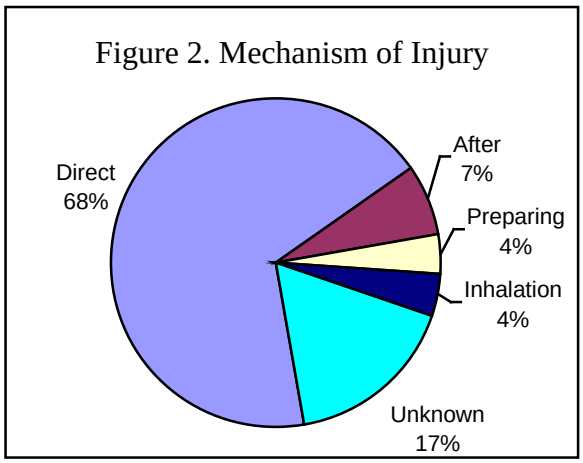
During the evening hours of May 3, 1999, multiple tornadoes occurred across Oklahoma and Kansas. According to the National Severe Storms Laboratory (NSSL) in Norman, Oklahoma, a total of 59 tornadoes occurred in Oklahoma that evening. A tornado reaching F-5 intensity left behind widespread destruction in the towns of Bridge Creek, Newcastle, south Oklahoma City, Moore, Del City, and Midwest City. Other communities that suffered damage, injuries, or deaths from tornadoes that touched down that evening included Dover, Shawnee, Perry, Stroud, and Sapulpa. The town of Mulhall was completely destroyed.

*The INJURY UPDATE is a report produced by the Injury Prevention Service, Oklahoma State Department of Health. Other issues of the INJURY UPDATE may be obtained from the Injury Prevention Service, Oklahoma State Department of Health, 1000 N.E. 10th Street, Oklahoma City, Oklahoma 73117-1299, 405/271-3430 or 1-800-522-0204 (in Oklahoma). INJURY UPDATES and other IPS information is also available at http://ips.health.ok.gov.

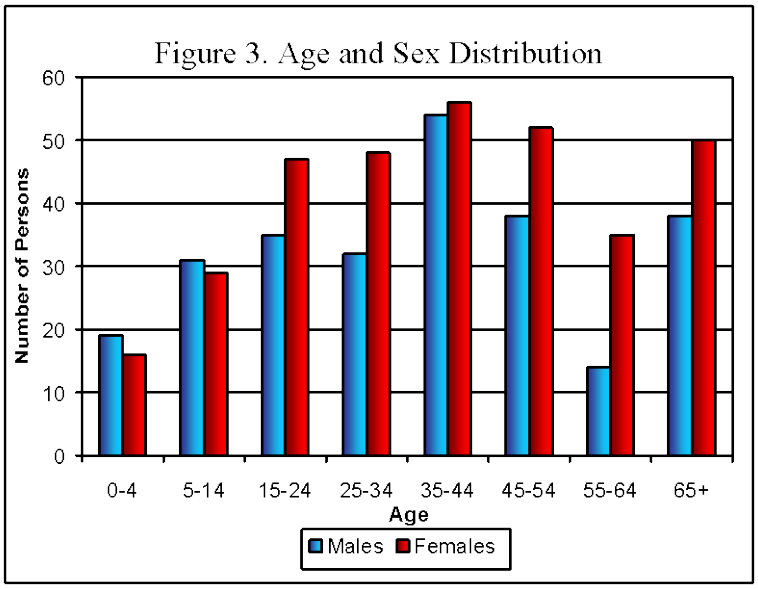
On May 4, 1999, Oklahoma Commissioner of Health, J.R. Nida, M.D., declared tornado deaths and injuries reportable conditions. State Epidemiologist, Dr. Mike Crutcher, M.D., requested assistance from the Centers for Disease Control and Prevention to aid with data collection. Medical records were reviewed for persons treated in hospital emergency departments or admitted as a result of the tornadoes. Medical Examiner reports were reviewed for persons who died. A community field survey was conducted in the heavily damaged areas of Bridge Creek, southwest Oklahoma City, Moore, and Del City. A follow-up survey was mailed to injured survivors to collect more details about their locations, the warnings they received, the protective actions they took, and the causes of their injuries. In addition, the Medical Examiner's office interviewed family members of persons who died to obtain similar data.

RESULTS

Forty-five persons were killed as a result of the tornadoes. Of those deaths, 40 persons died from direct tornado injuries, one person died from injuries preparing for the tornado, one person died from injuries following the tornado, and three persons died from heart attacks as a result of the tornado.



A total of 597 survivors were directly or indirectly injured in the tornadoes; 23% (137/597) of persons were hospitalized and 77% (460/597) were treated in emergency departments and released. Among injured survivors, 408/597 (68%) were injured directly by the tornado, 41/597 (7%) were injured after the tornado, 23/597 (4%) were injured preparing for the tornado, and 23/597 (4%) suffered inhalation injuries. The mechanism of injury was unknown for 102 persons (17%) (Figure 2). Another 32 individuals were not injured but were treated in hospitals for other medical conditions (e.g. premature labor, heart palpitations, or lost medications). These 32 individuals were not included in the injury data analysis.



Of the 642 persons killed or injured, 55% (352/642) were female and the average age was 39 years (range less than 1 year – 98 years). Almost one-third of persons injured were 35 to 54 years of age (Figure 3).

The most common types of injuries were soft tissue injuries (cuts, bruises, and scrapes), followed by fractures/dislocations, and brain injuries. Sixty-one percent of persons who were hospitalized suffered fractures/dislocations and 42% sustained brain injuries (Table 1). Some persons sustained very severe injuries caused by impalements of the body with wood debris such as 2x4 boards, and others suffered complex lacerations filled with dirt, debris, and foreign bodies requiring multiple debridements and surgeries. Thirty persons, including nine children, suffered serious traumatic brain injuries with a potential for long-term disabilities. The average length of stay for persons admitted to the hospital was 6 days (range 1-36 days). Sixty-six percent of hospitalized persons were discharged home, 23% were discharged to

rehabilitation centers, 6% to skilled or intermediate care facilities, 3% to other acute care facilities, and 2% with home health care services.

Sixty percent (27/45) of deaths and 55% (328/597) of injuries occurred in the Oklahoma City metropolitan area (Moore, Southwest Oklahoma City, Southeast Oklahoma City, Del City, and Midwest City). Twelve deaths (27%) occurred in Bridge Creek. Six deaths occurred near Guthrie (1), Shawnee (1), Dover (1), Newcastle (2), and Perry (1) (Table 2).

Table 1. Type of Injuries by Treatment Status*
May 3, 1999 Tornadoes, Oklahoma

Type of Injuries	Inpatient (n=137) Number (%)	Outpatient (n=460) Number (%)	Total (n=597) Number (%)
Soft Tissue Injuries	133 (97%)	348 (76%)	481 (81%)
Fractures/Dislocations	84 (61%)	67 (15%)	151 (25%)
Brain Injuries	58 (42%)	63 (14%)	121 (20%)
Sprains/Strains	20 (15%)	73 (16%)	93 (16%)
Foreign Body	29 (21%)	37 (8%)	66 (11%)
Eye Injuries	21 (15%)	39 (8%)	60 (10%)
Pulmonary Contusions	28 (20%)	2 (<1%)	30 (5%)
Smoke/Dust Inhalation	3 (2%)	27 (6%)	30 (5%)
Other Internal Injuries**	10 (7%)	0	10 (2%)

[1]Includes 597 survivors who were directly or indirectly injured in the tornadoes.
[2]Including ruptured bladder and spleen; severe contusions of liver, kidney, abdomen involving GI hemorrhages, and severe lacerations of external carotid artery.

Locations were known for 410/597 (69%) injured survivors. Of these, 63% were inside single-family houses; 11% were outdoors; 6% were in mobile homes; 6% in vehicles; 4% were in storm shelters; and 3% were in apartments, public buildings, or other locations (Figure 4). Among persons who died from injuries sustained in the tornado, 50% (21/42) were in single-family homes, 19% were in mobile homes, 17% were outdoors, 12% were in apartments or public buildings, and 2% were in vehicles.

Table 2. Geographic Location of Persons Who Died and Injured Survivors, May 3, 1999 Tornadoes, Oklahoma

Geographic Location	Died Number (%)	Survived Number (%)	Total Number (%)
Southeast OKC	5 (11%)	39 (7%)	44 (7%)
Southwest OKC/Moore	14 (31%)	202 (34%)	216 (34%)
Del City	5 (11%)	53 (9%)	58 (9%)
Midwest City	3 (7%)	34 (6%)	37 (6%)
Bridge Creek	12 (27%)	44 (7%)	56 (9%)
Unknown	0 (0%)	129 (22%)	129 (20%)
Other	6* (13%)	96 (16%)	102 (16%)
Total	45	597	642

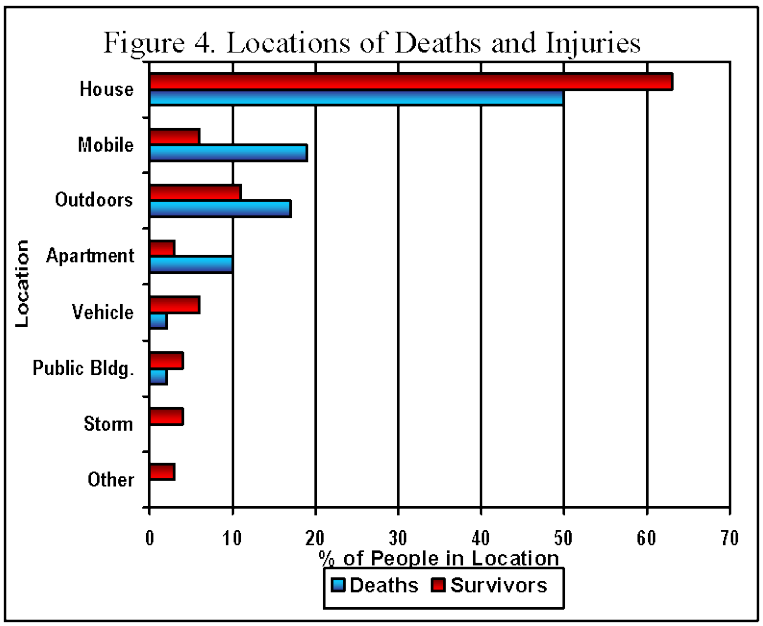
*Other locations where deaths occurred were in the areas of Guthrie (1), Shawnee (1), Dover (1), Newcastle (2), and Perry (1).

The specific interior locations of survivors inside residences (houses, mobile homes, and apartments) were known for 223 persons. The most common interior locations among survivors were closets (34%), followed by bathtubs (22%), bathrooms (other than tub) (15%), hallways (10%), and other rooms (19%) (Figure 5). Among persons who died inside residences, the specific interior locations were known for 67% (22/33). The most common interior locations were bathtubs (27%) and closets (27%), followed by living room/family room (14%), bathrooms (other than tubs) (9%), basement (5%), and other rooms (18%).

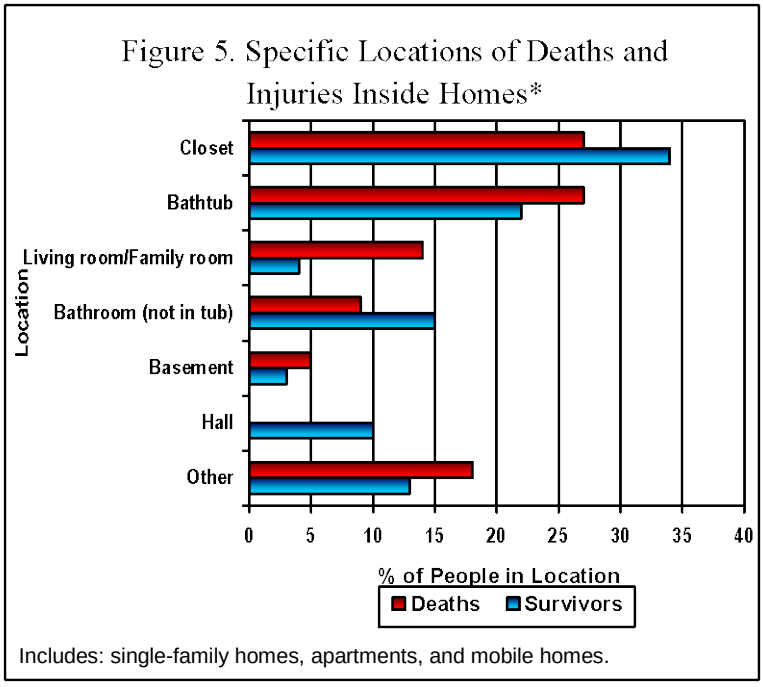
The most common causes of injuries among survivors were flying/falling debris (32%); being picked-up/blown by tornado (14%); collapsing walls, ceiling, roof (11%); flying/falling wood or boards (10%); glass (6%); fell/tripped (6%); and other causes (21%). Other causes included injuries from concrete, bricks, screws, nails, and motor vehicle crashes.

To determine risk factors associated with the communities affected by the tornadoes in general, and not just those killed or injured, Oklahoma State Department of Health and Centers for Disease Control and Prevention staff and volunteers conducted on-site community surveys in the severely damaged areas of Bridge Creek, Oklahoma City, Moore, and Del City three to five days following the tornadoes. A total of 614 persons were interviewed on-site in Bridge Creek (10%) and the Oklahoma City metropolitan area

(Oklahoma City, Moore, and Del City) (90%). Seventy-two percent (443/614) of those interviewed had been in the damaged areas when the tornado struck; 70% had not been injured and 30% suffered minor or moderate injuries. Fifty-eight percent of persons interviewed on-site said that television warnings caused them to take protective action. Other warnings that caused people to take protective action were seeing the tornado (12%), hearing sirens (8%), radio (5%), weather changes suggestive of tornado (4%), pager/phone (4%), word of mouth and other (9%). Only two persons said that they had no warning of the tornado.



Seventy-eight percent of persons interviewed in the community survey were inside homes when the tornado struck, 2% in motor vehicles, and 4% in public buildings, apartments, outdoors, or other locations. Only 16% of persons interviewed were in storm shelters. Sixty percent of persons interviewed "didn't know" or "weren't sure" where the nearest storm shelter was located, 36% could name a specific shelter site, and 4% had a general idea where the nearest storm shelter was located. Sixty percent of persons interviewed had pets in their home; 16% of households had pets that were killed or injured and 11% were missing.



PREVENTION

Though F-5 tornadoes are rare, tornadoes of lesser force are common during the spring and fall months in the midwestern U.S., especially in Oklahoma's tornado alley. The most important factor for tornado injury prevention is preparation. Every home, school, and place of business should have an effective tornado preparedness plan in advance of a tornado alert. Persons should heed the weather warnings and not wait until the last minute to activate the preparedness plan. Weather warning technology is excellent. Some reports stated that during the May 3 tornado, people had an average of 30 minutes warning time before the tornado struck.

Weather band radios, also called the National Oceanic and Atmospheric Administration (NOAA) radios, are effective in providing advance warning of severe weather conditions and have the advantage of providing a warning system at night while people are sleeping and in the event of power outages. The weather band radio receives a broadcast frequency for weather warnings including tornadoes within an average range of 40 miles. The National Weather Service recommends purchasing a radio that includes both a battery backup and

a tone-alert feature that automatically activates the radio when a watch or warning is issued. Weather band radios can be purchased from many local retailers for $39 to $59. The more expensive radios are programmable to insure only warnings issued for a desired county will activate the tone-alert feature.

The best protection is an underground storm shelter, however, the data show that only 16% of people interviewed in the community survey were in storm shelters. Communities should address the issues of storm shelters; whether community shelters need to be built, where they should be located, and how to notify and route people before a tornado. Sixty percent of persons interviewed in the damaged areas said that they did not know where the nearest shelter was located.

Persons who live in mobile homes should evacuate immediately and allow plenty of time to get to shelter. Persons who live in single-family homes should go to the lowest level, away from exterior walls, in an interior closet or bathroom, and cover the body with thick blankets or clothing to prevent injury from flying debris. The head can be protected with some type of helmet such as a bicycle or motorcycle helmet. Other helpful preparation steps can include putting car keys and wallet with money in a pocket, putting on shoes, and having a flashlight and battery-powered radio ready.

Underground storm shelters have long been the traditional form of shelter protection. However, the safe room industry has expanded rapidly as a result of the May 3 tornadoes. Safe rooms were first developed about 15 – 20 years ago at Texas Tech University. Tornado damage in over 90 towns and cities was investigated and in many instances, a small room in the central portion of the home was all that remained standing or undamaged. With this information, safe rooms were designed to be constructed inside homes, to have multiple uses, and be produced from readily available materials. The industry standard, the Texas Tech Safe Room, is capable of withstanding an impact of a 12-foot 2x4 board accelerated at speeds of 100 mph and wind speeds of 250 mph, which accounts for the majority of all tornadoes that occur in the U.S. Many private companies now manufacture and sell safe rooms as a result of the recent drive to place them in newly constructed homes. The costs of safe rooms vary, ranging from $3,000-$6,000, depending on size, type, and building material used. Modifying the walls or foundation of an existing structure adds to the cost of installation. Alternatives include an addition to an existing house or a separate structure close to the house. If constructed properly, safe rooms can provide life-saving shelter in a tornado. Persons building a safe room should request testing standards from the manufacturer prior to construction.

The strong winds produced from a tornado are capable of reducing a well-built home to rubble. Local building codes only require minimum design standards for winds. In a tornado, the wind speeds can easily exceed minimum design standards. The Federal Emergency Management Agency (FEMA) recommends some simple methods for increasing the strength of new and existing homes. To increase the roof's resistance to being uplifted by strong winds, specially designed metal connectors or metal strapping can be attached to the rafters and the wall plates. The installation of storm shutters over windows and other glass surfaces is an effective method to protect against flying glass and other debris. The doors in a home can be strengthened with a stronger bolt system and retrofit kits are available for the large two car garage doors. A local building supply retailer can provide information about the materials needed for these upgrades. The relatively inexpensive costs of these and other preventative measures could potentially save thousands of dollars, prevent injuries, and save lives in the high winds of a tornado.

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For more information about weather safety prevention measures mentioned in this report contact the following:

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Federal Emergency Management Agency
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