

---

# INJURY UPDATE

*A Report to Oklahoma Injury Surveillance Participants\**

---

May 30, 2001

## **Hazards Related to Nature, Environment, and Human Behavior Leading to Flood-Related Submersion Injuries in Oklahoma**

### **Introduction**

Floods are the primary natural disaster in the United States indicated by the loss of many lives and destruction of homes and businesses in all 50 states during the past two years. The history of floods is grim: accounts of tidal waves, torrential rains and rampant rivers were recorded in past civilizations. A dam break in Pennsylvania in 1889 resulted in a 36-40 foot wall of water that killed 2,200 people. A river in Texas crested after 17 inches of rain, killing 15 people and costing \$100,000,000. Flash floods in Wyoming resulted in 12 deaths and property costs of \$61,000,000. In Ohio, after raining 4 inches in two hours, a 30-foot wall of water caused 26 deaths and \$4,000,000 damage. A unique factor with flooding is that entire regions or areas downstream are affected by the combination of excess waters, high winds, and intense low pressure systems.

Flooding relates to the amount of excess water overflow onto normally dry land and involves varying factors such as terrain (flat/mountainous), the number of streams, creeks and lakes, whether the deluge is torrential or steady rainfall, and the absorption capacity of the soil. Flooding along rivers is a natural and inevitable part of life; some is seasonal with winter or spring rain or melting snows that fill rivers with too much water too quickly. Flooding also is considered a longer term event and may last a week or more. Flash flooding occurs within 6 hours of the rain event and can strike anywhere. Oklahoma has clay soils and intense rainfalls, increasing the risk of flash floods. Certain areas are considered flood risks by assessment of the records of river flow, stem tides and rainfall, and floodplain topographic surveys. A floodplain is a plain bordering a river subject to flooding. Floodplain mapping examines the size of the water shed (the region draining into a river, river system, or body of water), dimensions of the topography, and the soil. The development of cities with cement tabletops and watershed development increases the hazard of severe flooding. Floodplain management involves flood hazard mitigation and flood preparedness, warning, recovery – including hydrologic (properties, distribution, and effects of water in the atmosphere, earth's surface, and in soil and rocks), and emergency response.

The risk of flooding and flash floods is high for Oklahomans because of the severe storms that occur sporadically during the year, especially in the spring months. This report describes the occurrence and risks of flood-related submersion injuries in Oklahoma. Specific recommendations are made based on data, case history briefs, and suggestions from agencies involved in the study, prevention, and control of floods and loss of life and property.

\*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. 10<sup>th</sup> 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 [www.health.state.ok.us/program/injury](http://www.health.state.ok.us/program/injury).

## Descriptive Epidemiology

A total of 75 flood-related hospitalized or fatal submersion injuries (5% of all submersions) occurred in Oklahoma from 1988-2000; 87% (65/75) of persons died. The 0-4 (17%) and 25-34 (24%) year age groups sustained nearly half of the injuries (Table 1). The male to female ratio was 2:1. The rate of injury was highest for whites (.18 per 100,000 population) followed by other races (.16), Native Americans (.12), and African Americans (.09). Forty-eight percent of injuries were suffered by motor vehicle occupants; others were involved in various activities (Figure 1). Eighty-five percent of motor vehicle flood-related submersions were fatal. Three percent of injuries were homicide.

Thirty-one percent of injuries occurred in April and May. Seventy-one percent of injuries occurred on Thursday, Saturday, or Sunday. High winds contributed to 10% of injuries. Although floods occur across the state, lakes and rivers predominate in the east section where 57% of injuries occurred (37% in the northeast which averages 30-34 inches annually). Location of injury was a major factor in injury occurrence with creeks accounting for more than half of submersions.

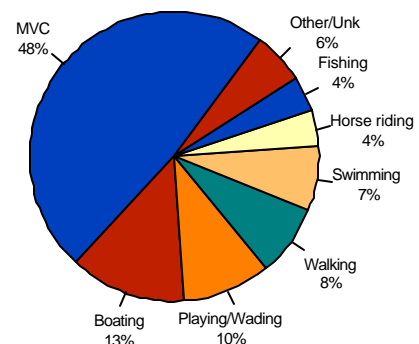
**Table 1. Characteristics of Flood-Related Submersion Injuries in Oklahoma, 1988-2000 (N=75)**

Characteristic	Number	Percent
Age group		
0-4	13	17%
5-14	9	12%
15-24	10	13%
25-34	18	24%
35-44	10	13%
45-54	5	7%
55-64	4	5%
65 +	6	8%
Location		
Creek	39	52%
River	12	16%
Drain/ditch	9	12%
Lake	8	11%
Pond	1	0%
Other	6	8%
Survival Factors		
Known to be swimmers	6	8%
Time submerged		
1-4 minutes	5	7%
5-9 minutes	3	12%
15-30 minutes	1	1%
Over 30 minutes	58	77%
Unknown	8	3%
Resuscitation attempted	17	23%
Substance Use (14 years & older)		
Alcohol	20	38%
Drugs	1	2%
Time of Injury		
2:00 am – 8:00 am	9	12%
8:00 am – 2:00 pm	17	23%
2:00 pm – 8:00 pm	26	35%
8:00 pm – 2:00 am	16	21%
Unknown time	7	9%
High winds a contributing factor	7	10%

## Case Briefs

- A homeless man was apparently sleeping in a drainage canal that became rain swollen. The water engulfed him. A passerby could not reach him, and his body was found 30 hours later.
- A mother was driving three children to daycare across a low water bridge after a 7 inch rain. The vehicle stalled, and she tried to move the children to a higher place. The van was swept off the road into a creek, rolled over breaking the windows and was swept down the stream. The mother and three children died.
- A man rode his horse into 3-5 feet of water flowing across a road after a downpour. The horse lost its footing and the man didn't know how to swim. The current swept them into a drop off creek with high waters and swift current where they drowned.

**Figure 1. Flood-Related Injuries by Type of Activity Oklahoma, 1988-2000**



- Three young men in a canoe approached an old concrete dam on a creek and attempted to go over it. They capsized and were pulled under by the current in frigid water. Two of the men drowned.
- A man drove around looking for his cattle after a rainfall that lasted 24 hours. He became stranded after driving into the creek crossing and got out of the vehicle. He was swept downstream by the force of the water.

## **Discussion**

The natural, environmental, and human behavioral factors involved in the hazards of flooding and flash floods causing death and destruction require a broad and multidisciplinary approach to prevention and control. On the national/international level, the focus of prevention is on disaster reduction through engineering, design, and planning. The goal for national, state and local entities is to reduce injuries/deaths and property damage, and to promote and protect the environment. Government agencies, tribal agencies, emergency management (FEMA), and the general public seek to ensure energy and water supplies, and encourage warning systems and predictions. Diminished land surface due to building, roadways, and so forth, loses the ability to absorb rainfall; urbanization increases runoff 2-6 times the natural runoff. With flooding, streets can become swift moving rivers. Water-carved gullies or creek beds can fill with fast moving water within a minute; ice can also block normal flow of water.

Key human factors leading to submersion injury with flood conditions are: 1) lack of knowledge concerning the risks and hazards of the rapid accumulation and passage of waters; 2) not knowing what actions to take in a flash flood situation; and 3) having limited opportunities to get out of the situation safely and in time. Recommended actions to take in a flood situation such as getting out of a car to get to a safer place are not always successful, as illustrated in the case briefs. Whenever possible, avoiding the situation in the first place is more likely to mean survival.

## **Recommended Prevention Measures**

The following basic precautions and preventive measures should be followed for flooding and flash floods. Specific recommendations are made related to motor vehicles as well as other strategies for prevention. (Compiled from several sources including the Oklahoma Water Resources Board and the American Red Cross.)

### ***Long-Term Preparedness***

- Assess flood risk and elevation above flood stage in your area beforehand to allow you to plan evacuation routes.
- Learn which local streams or rivers flood easily and avoid them during heavy rains.
- Know the dangers of downed cables or wires and report broken utility lines to the appropriate authorities.
- Know your community's existing flood warning system and evacuation plans.
- Families should plan ahead where to meet, how to contact EMS/911, and know how to turn off water, gas, and electricity.
- A stock of food should be prepared and drinking water stored in containers.
- A disaster supplies kit should be kept on hand including first aid materials, rubber boots, a radio, emergency cooking equipment, and flashlights.

***Before Flood***

- Listen for flash flood or flood water watch/warning, the urban and small stream advisory, and flood follow-up information.
  - Move to a safe area while it is still accessible.
- Remember that, with a flood warning, you may have only seconds to save yourself and others.
- Look for signs of flash flooding and be ready to evacuate immediately.

***During Flood***

- Keep out of areas subject to flooding such as dips, low spots, canyons, creeks, and ditches.
- Avoid already flooded areas. If you come to a flowing stream with water above your ankles, stop, turn around, and go another way.

***After Flood***

- Avoid disaster areas that could hamper rescue and emergency operations.
- Check electrical equipment before returning to service.
- Use flashlights to examine buildings since flammables may be present.
- Throw out any food that came in contact with flood water and boil drinking water.
- Pump out wells and test for purity.

***Recommendations Specific to Motor Vehicles***

- Nearly half of all flash flood submersions are motor vehicle-related. Occupants should look out for flooding at highway dips, bridges, low areas, creeks and streams that proximate roads.
- Look out for rapidly rising water.
- Don't camp or park your vehicle along streams and washes, especially during threatening weather conditions.
- Don't attempt to drive over a flooded road; depth of water is not always obvious and the roadbed can be washed out, leaving you stranded or trapped. Instead, turn around and go another way.
- If the vehicle stalls, leave it immediately and seek higher ground. Rapidly rising water may engulf the vehicle and its occupants and sweep them away.
- Be especially cautious at night when it is harder to recognize flood dangers.
- Relate what you know about flooding as you drive through other states/regions.

***General Recommendations***

- Children should be taught not to play, bike or swim around high water, storm drains, ditches, viaducts or creeks, and should be supervised and guarded from these places.
- Youth and adults should not attempt to swim or boat in flooded waters.
- Any obvious accumulation of water on road surfaces should be approached with caution or avoided altogether because of the possibility of washed out roads and treacherous currents.