INJURY UPDATE
A Report to Oklahoma Injury Surveillance Participants*

April 3, 2009

Why People Drown: A Look at Contributory and Protective Factors in a State with One of the Highest Shoreline Mileages in the Nation

INTRODUCTION

Fatal submersion injury, or drowning, is due to immersion in a liquid leading to anoxia (lack of oxygen), cardiac arrest, or spasm of the larynx. Opportunities to drown are almost limitless and include exposure to pools, natural waters, receptacles of any size, or a one-to-two inch collection of liquid anywhere. Oklahoma has 11,611 miles of lake shoreline, which is slightly less than the estimated combined general coastline of the Atlantic, Pacific and Arctic Coasts (12,383 miles). The state has 78,578 miles of rivers and streams with 1,120 square miles of water in the state's 909 lakes, and approximately 250,000 ponds. There are also an estimated 9,000 commercial and residential swimming pools, and almost every home has a bathtub. Given the potential for submersion injury, it is evident that many people normally either limit exposure to waters outside of their home environment, or are cautious or fortunate in avoiding submersion events.

Statewide surveillance of submersion injuries has been conducted by the Injury Prevention Service since 1988. An average of 110-120 persons are hospitalized or die each year from submersion injury; 72% of injuries are fatal. This report describes the occurrence of fatal submersion injuries among Oklahomans during 2000-2007. Epidemiologic characteristics, case descriptions, and contributory and protective factors related to death or survival are discussed based upon accumulated data, circumstantial evidence, and consideration of the effectiveness of strategies to prevent fatal submersion injuries.

DESCRIPTIVE EPIDEMIOLOGY

Surveillance data were cross-checked with all deaths due to submersion reported in Vital Statistics and the Office of the Chief Medical Examiner data during the years 2000-2007. A total of 585 Oklahomans suffered a fatal submersion injury during this period, an annual rate of 2.0 per 100,000 population. Mean age was 34 years (median 31 years) (Table 1).

Table 1. Epidemiologic Characteristics of Fatal Submersion Injuries, Oklahoma, 2000-2007 (N=585)

Characteristic	Number (%)	Rate per 100,000 Population
Age 0-97 Years		
Mean 34, Median 31		
Age group		
0-4	84 (14%)	4.2
5-14	48 (8%)	1.2
15-24	112 (19%)	2.7
25-34	67 (12%)	1.8
35-44	79 (14%)	2.1
45-54	77 (13%)	1.9
55-64	45 (8%)	1.5
65 +	73 (12%)	1.9
Gender		
Males	446 (76%)	3.2
Females	139 (24%)	1.0
Race		
White	441 (75%)	1.9
Black	60 (10%)	2.5
Native American	37 (6%)	1.4
Other	47 (9%)	--
Time submerged		
1-4 minutes	13 (2%)	--
5-14 minutes	84 (15%)	--
5-30 minutes	41 (7%)	--
> 30 minutes	348 (59%)	--
Unknown	99 (17%)	--

*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 are also available at http://ips.health.ok.gov.

The highest rate occurred among children 0-4 years (84 deaths, rate 4.2 per 100,000 population), and the lowest among persons 5-14 years (48 deaths, rate 1.2). Fatal injuries among males were three times higher than females. African Americans had the highest rate of submersion deaths (2.5 per 100,000 population) followed by Whites and Native Americans, rates 1.9 and 1.4 respectively. Submersion deaths included five homicides and 27 (5%) suicides. Nine percent of persons sustained accompanying head (5%), spine, fracture, or multiple injuries. Geographic distribution of death rates varied considerably with 34 counties (44%) experiencing no deaths or rates below the state rate of 2.0 per 100,000 population. The majority of counties with higher rates were located in eastern Oklahoma where natural and recreational waters are more abundant.

Figure 1. Location of Fatal Submersions, Oklahoma, 2000-2007 (N=585)

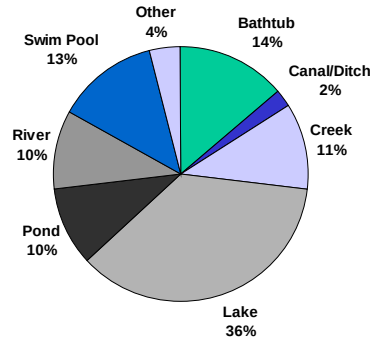
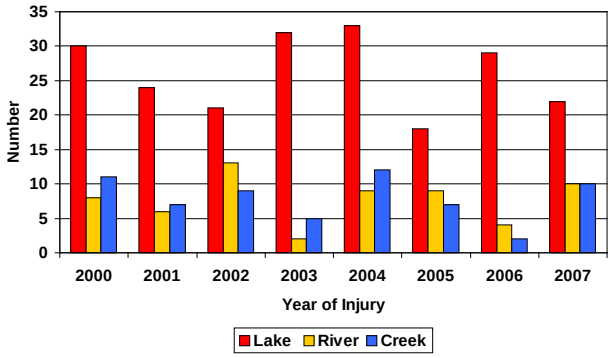


Figure 2. Trends in Fatal Submersions Occurring in Natural Waters, Oklahoma, 2000-2007 (N=333)



Circumstances such as solitariness of the event, if the deceased had medical problems or was intoxicated, if no one acted to prevent submersion, or environmental conditions (i.e., flooding (4%), wind (1%), strong currents) enhanced the risk of fatal submersion. Of the 358 submersions (61%) with reported time of injury, 45% occurred from 12 noon to 6 p.m. Among cases with reported time of submersion, nearly 60% were under water more than 30 minutes. Almost one-fourth of injuries occurred on a Saturday. In 41% of cases, no other person was present at time of submersion. Impaired mental status, including substance use, was likely a contributory factor in 24% of deaths.

Location of fatal injuries was associated with the body of water, ability to enter and exit easily, and the presence of others. The highest number of submersions occurred in lakes (36%), and rivers and creeks (21%) (Figure 1). The home environment accounted for 80 (14%) bathtub and 73 (13%) swimming pool deaths. A total of 333 fatal submersions took place in natural waters. Although the incidence of fatal submersions occurring in creeks, lakes and rivers varied across the years, there were no discernable trends. Lake deaths, however, were consistently higher (Figure 2). Among the 145 persons with documented alcohol use, 70% drowned in lakes. Fatal submersions took place in many other locations such as buckets, mining pits, stock ponds, roadways, storm cellars, and water tanks.

Activity prior to submersion is a major factor related to drowning, near drowning, or a simple/minor water incident. One-fourth of bathtub drownings occurred among children under five years of age who were either alone or with siblings when the caretaker left to answer the phone, perform a household activity, or was partying with friends. Persons in the older age groups were alone in the tub and often drowned due to conditions such as diabetes, seizures, weakness, and heart/chronic problems. Playing was the main activity prior to submersion for children 0-4 years (79%). These incidents occurred when children were close to a pool or lakeside and were considered safer than “being in the water;” however, they fell in the water, or decided to join a friend, catch a ball, or play with rings or floaties. Wading or walking prior to submersion was common in several age groups. In many of these instances, they slipped at the water’s edge, walked off a

rock ledge, stepped into a hole, or were carried down by the current. The decision to jump from bluffs or cliffs, or spontaneously take a swim in a cove, pond, or across a creek led to the demise of swimmers and nonswimmers. Fishing (5%), retrieving an object (2%), and work (1%) also preceded fatal submersion.

Persons 5-24 years of age were most likely to suffer fatal submersion injuries associated with swimming. Main activities leading to fatal submersion injuries among persons over 24 years of age were boating and driving/riding in motor vehicles. A total of 65 drownings (12%) involved boating. Incidents ranged from the boat overturning when a passenger stood up, people jumping from the boat to have a swim and not having the strength to swim to shore, or people attempting to retrieve a boat, to the boat being pulled by an undertow to a dam and capsizing. Alcohol use was reported in 48% of boating submersion deaths. The combination of motor vehicle crashes (MVCs) and submersion led to 78 deaths. Instances such as driving off a highway or narrow county road, veering from a slick road, losing control to avoid an obstacle in the road, or crashing through a guardrail into trees and landing upside down in ponds, creeks or lakes were typical scenarios of MVC-related fatal submersions (Table 2).

Table 2. Fatal Submersion Injuries by Major Activity and Age Group, Oklahoma, 2000-2007 (N=517)*

Age	Bathing Number (%)	Boating Number (%)	Drive/Ride Number (%)	Playing Number (%)	Wade/Walk Number (%)	Swimming Number (%)	Other Number (%)
0-4	16 (25%)	0 (0%)	2 (3%)	50 (80%)	10 (19%)	1 (0%)	3 (5%)
5-14	1 (1%)	3 (5%)	2 (3%)	8 (13%)	5 (9%)	24 (18%)	1 (2%)
15-24	3 (4%)	11 (16%)	14 (18%)	4 (6%)	12 (23%)	50 (39%)	13 (22%)
25-34	8 (12%)	6 (10%)	9 (11%)	0 (0%)	3 (6%)	17 (13%)	13 (22%)
35-44	8 (12%)	16 (25%)	12 (15%)	0 (0%)	5 (9%)	17 (13%)	7 (12%)
45-54	13 (20%)	11 (16%)	17 (22%)	0 (0%)	6 (11%)	16 (12%)	5 (8%)
55-64	7 (10%)	9 (14%)	9 (11%)	1 (1%)	3 (6%)	1 (0%)	7 (12%)
65+	11 (16%)	9 (14%)	13 (17%)	0 (0%)	9 (17%)	6 (5%)	10 (17%)
Total	67	65	78	63	53	132	59
*Activity unknown for 68 (12%) of fatal submersions.							

CASE BRIEFS

- A 17-year-old male was swimming with his family at a lake. They could not find him as they were leaving and thought he left with friends. When he did not come home, they called the local police. He was found in 12-14 feet of water.
- Two brothers fishing from a 16-foot boat near a dam were floating downstream and threw anchor to slow down. The anchor hung on a rock and pulled the back of the boat down, filling it with water. Both were wearing lifejackets, but the jacket of the deceased came off because it was not zipped. He got tangled in the lines and drowned.
- During a family reunion, a nine-year-old boy was swimming with another child near a large pipe. The water was turned on and the boys were carried downstream. One child was picked up by a person on a wave runner, but the other drowned.
- An eight-month-old baby was being bathed by her mother in five inches of water. The mother left to prepare food and when she returned, the baby was face down in the tub unresponsive. Emergency medical services personnel worked with full protocols, but the baby died while on a ventilator in the intensive care unit.

DISCUSSION

People who suffered fatal submersion injuries were engaged in the same activities at the same places where many Oklahomans spend their daily lives or recreational time. In studying the circumstances of each case and considering them collectively, it appears a peculiar combination of factors results in death. Parents placed a baby in a bath seat surmising they could leave for a few minutes and the child would be safe but on returning, they found the baby upside down in the seat; they attempted resuscitation and called emergency medical services, but the child did not survive. A belted motorist, obeying all driving rules, encountered a pothole, lost control, and the vehicle landed in a river upside down; the doors and windows could not be opened and he drowned. A strong swimmer decided to swim across a channel; he was alone, suffered a heart attack, and did not have the strength to reach shore. Young children cannot reason and are dependent on caretakers to protect or save them. Adolescents often took risks and did not recognize their limited swimming abilities. Alcohol use, jumping into water situations without forethought, inability to navigate boats, and not having the knowledge and skills to save a drowning person were significant factors in these drowning deaths. In recreational waters, the response of people seeing or hearing someone in trouble was often delayed, ignored, or inadequate, in part because they were not capable of negotiating the save. The following contributory and protective factors have been found to be associated with submersion injuries. When the appropriate protective/preventive factors are in place, there is less risk of fatal submersion.

Factors Associated with Submersion Deaths

Contributory	Protective
Person	**Person**
• Vulnerability of specific age groups • Physical, mental and behavioral limitations/disabilities • Not knowing dangers of a body of water • Not realizing self limitations in water • Lack skills to negotiate waters • Not using protection (life vests) • Risk-taker • Alcohol/drug use	• Has swimming and water survival skills. • Uses life vest • Recognizes risks if tired, intoxicated, over-extended • Has CPR, water-saving skills • Does not engage in water activities alone • Caretakers never leave child alone in or near water • Persons with disabilities are accompanied by an adult in any type of water (bathtub, pond, lake) • Motorists avoid speeding near bodies of water • Boaters are skilled in maintaining/handling boat • People educated and follow basic water rules (never swim alone, do not enter unknown waters)
Environment	**Environment**
• Safety standards not in place/enforced • Inadequate design/maintenance of docks, dams • Inclement weather (floods, currents, wind) • Treacherous bottoms (debris, roots, holes) • Lack of signs notifying people of water hazards • Bathtubs with slippery bottoms; lack grab bars	• Pools have four-sided fences, self-latching gates, and a life preserver and shepherd's hook on hand for emergencies • Regulations for pool/lake safety in place/enforced • Information on inclement weather and appropriate response communicated before and during event

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