

## Submersion Injuries in Children Younger Than 5 Years in Urban Utah

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Submersion injuries of children younger than 5 years in 4 urban Utah counties from 1984 through 1988 were studied retrospectively to identify associated risk factors. Infants younger than 1 year had the highest rates of both submersion injuries and deaths. The incidence of bathtub drownings was 2 to 3 times higher than reported national rates. All bathtub drownings occurred while the victim was bathing with a young sibling (10 months to 7 years of age) without adult supervision. All drownings in pools and moving bodies of water (rivers, irrigation ditches) resulted from unintentional falls into the water rather than from swimming and wading activities. Drowning prevention strategies should focus on educating parents about the risk of young children bathing with siblings in the absence of adult supervision and fencing regulations for pools and open bodies of moving water.

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Injuries are the leading cause of death among children older than 9 months in the United States.<sup>1</sup> In many western states, including Utah, submersion injuries, which include both drowning and near-drowning, are one of the most common causes of injury-related deaths in children 14 years of age and younger.<sup>1</sup> Nationally, children younger than 2 years are overrepresented among the victims of submersion injury, accounting for as high as 38% of childhood drownings.<sup>2-4</sup>

Most studies have focused on submersion injuries associated with fatalities, yet submersion injuries also are an important cause of morbidity, with 5% to 20% of survivors left with permanent and severe neurologic sequelae resulting in both ongoing costly medical care and loss of productivity.<sup>5-7</sup> Also, most research has reported submersion injuries in coastal states such as Washington, Florida, and California, but in many noncoastal states submersion injuries are a leading cause of injury death to children.<sup>1</sup>

Previous research has helped identify some of the variables associated with submersion injuries. Bathtubs are the most frequent site of drowning for those younger than 1 year.<sup>2,8,9</sup> Pacific Coast and Rocky Mountain states have the highest mortality from bathtub-related drownings.<sup>10</sup> Swimming pools are the most frequent site of drowning for children 1 to 4 years of age.<sup>2,8,9</sup> In most cases of childhood submersion injury, there has been a lapse in adult supervision.<sup>8</sup>

Understanding the variables associated with childhood submersion injuries is the first step in developing an effective strategy to prevent this pediatric health problem. Our study was conducted to identify the factors associated with submersion injuries along the Wasatch Front, a four-county urban area in Utah. The area has four distinct seasons highlighted by a hot dry summer and a cold snowy winter. There are two

major lakes into which the rivers from this area drain, Great Salt Lake and Utah Lake. The hot dry summers and mountain snowpack lead to an extensive system of rivers, irrigation ditches, and canals.

### Cases and Methods

We did a retrospective medical records review to profile the circumstances and consequences of submersion injuries of children younger than 5 years from January 1, 1984, to December 31, 1988, in four urbanized counties in Utah—Davis, Salt Lake, Utah, and Weber—home of about 140,000 children during 1986 (the midpoint of our study period), or 77.6% of Utah's pediatric population younger than 5 years. Population data for the period under study were derived from interpolated estimates of the population of the four-county area for 1986 from the 1980 and 1990 US Census.

Cases that occurred in the four-county area during the period of study were obtained from the following sources: death certificates from the Bureau of Vital Records and Health Statistics, Utah Department of Health; records from the Office of the Medical Examiner, Utah Department of Health; and medical records reviews done at local community hospitals and at Primary Children's Medical Center (Salt Lake City), the regional children's hospital.\* Hospitals where the medical records were reviewed accounted for 83% of the total pediatric beds and 100% of the pediatric critical care beds in the four-county area. Cases were identified by computerized searches using the International Classification of Disease (ICD) code for drowning or near-drowning (994.1), the ICD-E (external cause) code for submersion (E910.8), or by the cause of death. Records were reviewed for data related to the submersion injury, including outcome,

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site, age, sex, race, date, and presubmersion activity. Cases included only submersion events that occurred within the four-county area and to residents of that same area. Submersion deaths included only those cases where the submersion event and death occurred during the study period.

## Results

### Outcome

Of the 119 submersion injuries identified during the five-year period, 29 (24%) resulted in death (Table 1). Of the initial 91 survivors, 6 suffered severe neurologic sequelae

TABLE 1.—Rates of Submersion Injuries, Fatalities, and Case-Fatality by Age for Urban Utah, 1984 to 1988

Age, years	Injury		Fatality		Case-Fatality Rate, %
	Rate* (No.)		Rate* (No.)		
<1.....	24.2 (33)		6.60 (9)		27
1-4.....	15.4 (86)		3.58 (20)		23
Total.....	17.1 (119)		4.17 (29)		24

\*Rate is in events/100,000 age-specific population/year.

that resulted in their transfer to an extended care facility. One of these six died during the study period and is therefore included as a submersion death.

### Age-Specific Rates

The highest rates of injuries, fatalities, and case-fatalities were observed in children younger than 1 year (Table 1). The rates were calculated using age-specific population estimates mentioned earlier.

Of the 119 submersion injuries in this study, 33 (28%) occurred to those younger than 1 year, with all but 1 of these involving infants between 6 and 11 months of age. This older group of infants also accounted for most of both submersion injuries (26/44, or 59%) and deaths (6/8, or 75%) occurring in the bathtub.

### Site of Injury Occurrence

Data related to injury site are presented in Table 2. The most frequent site of submersion injury varied with age. The bathtub was the most common site of submersion injury and death for those younger than 1 year. Also in infants younger than 1 year, four submersion events resulting in two deaths involved buckets that had been used for mopping or water storage.

Private pools were the most frequent site of submersion

injury for those between the ages of 1 and 4 years. The second most frequent site of submersion injury and the most frequent site of submersion deaths were open bodies of moving water, specifically, rivers, canals, and irrigation ditches.

The case-fatality rate varied with the victim's age and site of injury. The highest rate was observed for events occurring in open bodies of moving water where 11 of 23 (48%) of the injuries resulted in death. For children aged 24 to 35 months, such events resulted in a case-fatality rate of 71% (5/7).

### Presubmersion Activity

As expected, the presubmersion activity was site-related. All but one of the bathtub submersion injuries occurred while bathing. In 26 of the 44 bathtub submersion injuries (59%) and in 7 of the 8 bathtub fatalities (88%), the victim was 2 years of age or younger and was bathing with one or more young siblings (ages ranging from 10 months to 7 years) while the parent or babysitter was out of the room. A brief case-by-case description of the above-mentioned injuries is given in Table 3. The other bathtub death involved a 47-month-old boy with a known history of seizures who had a seizure while bathing with a twin in the absence of adult supervision.

Most of the injuries (42/67, or 63%) and all 19 of the deaths that occurred in pools and open, moving bodies of water resulted from unintentional falls into the water rather than during swimming or wading activities. No deaths at any site occurred during a swimming-related activity nor did any deaths occur at public pools.

### Race and Ethnicity

The majority of submersion injuries to children younger than 5 years occurred to whites (87%). In those younger than 1 year, however, 21% (7/33) occurred to children of Native American or Hispanic origin. These two ethnic groups represent 6.1% of the total 1990 four-county population.

### Season

As expected, the season with the most submersion events was summer. Nearly half (48%) of the events occurred from June 21 to September 21. This seasonal increase was observed even in those younger than 1 year, for whom the most frequent site of submersion injury was the bathtub.

### Sex

As expected, male children were involved in more submersion injuries than female children. Overall, there were

TABLE 2.—Submersion Injuries, Fatalities, and Case-Fatality Rates by Age and Site for Urban Utah, 1984 to 1988

Site	Age, years										Total				
	< 1					1-4									
	Injury		Fatality		Case-Fatality, %	Injury		Fatality		Case-Fatality, %	Injury		Fatality		Case-Fatality, %
No.	(%)	No.	(%)	No.		(%)	No.	(%)	No.		(%)	No.	(%)		
Bathtub.....	26	(79)	6	(67)	23	18	(21)	2	(10)	11	44	(37)	8	(28)	18
Private pool.....	1	(3)			0	31	(36)	8	(40)	26	32	(27)	8	(28)	25
Moving water....	1	(3)	1	(11)	100	22	(26)	10	(50)	45	23	(19)	11	(38)	48
Public pool.....	--	--	--	--	--	12	(14)	--	--	0	12	(10)	--	--	0
Lake.....	--	--	--	--	--	2	(2)	--	--	0	2	(2)	--	--	0
Bucket.....	4	(12)	2	(22)	50	1	(1)	--	--	0	5	(4)	2	(7)	40
Miscellaneous....	1	(3)	--	--	0	--	--	--	--	--	1	(1)	--	--	0
Total.....	33		9			86		20			119		29		

TABLE 3.—Cases of Submersion Injuries Where Victim Was 35 Months Old or Younger and Was Bathing With 1 or More Young Siblings While Parent or Sitter Was Out of the Room

Case	Age, mo	Sex	Age of Sibling	Supervision	Length of Hospital Stay, days	Comments
1	35	♂	18 mo	Mother	44*	Fell and hit head, witnessed by 7-year-old sibling
2	14	♀	3, 5, 9 yr	Mother	2	Mother called to phone
3	9	♂	2 yr	Mother	1	Empty tub, water running when mother returned
4	20	♂	2½ yr	Father	3†	Father left for "2 to 3 min"
5	9	♀	2 yr	Parents	2†	Mother left assuming father would remain
6	7	♂	20 mo	Mother	1	Left for "5 min"
7	8	♀	4 yr	Mother	2	Phone rang, mother left water running
8	15	♂	3 yr	Mother	3	Found with 3-year-old sibling sitting on patient
9	14	♂	3 yr	Mother	1	Mother left for "1 to 2 min" to answer phone
10	25	♂	4 yr	Father	ED	4-year-old sibling held patient under water
11	12	♀	3 yr	Mother	1	Mother vacuuming
12	10	♀	3 yr	Mother	1	Immersed by older sibling
13	9	♀	2 yr	Father	1	Found in "7 to 8 in" of water
14	11	♀	2 yr	Mother	1†	Mother left to answer phone, found in "4 in" of water
15	10	♀	2 yr	Father	1†	Left for "5 min"
16	10	♂	2, 4, 7 yr	Mother	2†	Found in "7 to 10 in" of water
17	10	♂	10 mo	11-yr-sib	1†	Sister left to get baby bottle, returned to find baby under water, ran to get help before pulling patient out
18	10	♂	2 yr	Father	6†	Found face down in tub
19	24	♂	4 yr	Parents	1	In tub with sib and 3-year-old friend who "pulled patient into tub and submerged his head"
20	11	♂	Preschool	Mother	1	Found face down in tub
21	18	♂	Preschool	Mother	110‡	Mother went to get towel, returned after "1 to 2 min"
22	25	♂	3 yr	Sitter	1	Left for "3 min"
23	8	♂	2½ yr	Mother	1	Found with sibling sitting on patient's head
24	11	♂	11, 26 mo	Mother	1	Mother left for "2 to 3 min"
25	9	♂	9 mo	Mother	ED	In tub with twin, left for "seconds," found cyanotic
26	9	♂	9 mo	Mother	ED	In tub with twin, left for "seconds," found cyanotic

ED = emergency department

\*Transferred to an extended-care facility.  
†Died.  
‡Transferred to an extended-care facility, died 10 months after injury, death occurring after study period.

2.7 injuries to boys for every 1 injury to a girl. The male-to-female ratio was 2.3 for those younger than 1 year and 3.0 for those between the ages of 1 and 4.

#### Miscellaneous

Other information related to the submersion injury, including socioeconomic status, response time of emergency personnel, length of submersion, the initiation of cardiopulmonary resuscitation, type of fencing for the body of water, water-related experience of the victim, and the suspicion of a nonaccidental injury, was collected. These data are not presented in our results because information available in the records was incomplete.

#### Discussion

This retrospective study has identified a number of factors associated with drownings and near-drownings among children younger than 5 years in urban Utah from 1984 through 1988. This report is the first to describe submersion injuries occurring at various sites in a noncoastal community. Two high-risk groups emerged from the data: infants or toddlers in bathtubs and preschool-aged children playing near private pools or open bodies of moving water. Although these two groups have distinct risk factors, a common contributing factor is a lapse or absence of supervision.

There is a trend of decreasing drowning rates among children younger than 14 years in the nation<sup>1</sup> and in Utah.<sup>11</sup> The

drowning rates obtained in our study for children 1 to 4 years of age are similar to those previously reported.<sup>1,2,5,8,9,11</sup> Yet the drowning rate of 6.6 drownings per 100,000 children per year obtained in our study for children younger than 1 year is two to three times higher than previously reported national rates<sup>1,5</sup> and also somewhat higher than other rates reported from areas in the western United States.<sup>1,2,5,8,9,11</sup> Of note is that most of these infant deaths occur in a bathtub and that children from minority ethnic groups may be overrepresented.

Submersion injury rates are not as well studied as drowning death rates, in part because of inconsistent inclusion criteria for near-drowning victims and in part because of the difficulty in identifying all eligible victims. Definitions of submersion injury victims have varied from all children seen by emergency response personnel to only those who were admitted to a hospital.<sup>5,7,8</sup> Our study included all children younger than 5 years seen in an emergency department, regardless of inpatient admission to the hospital. Our submersion injury rate of 17.1 injuries per 100,000 children per year for children younger than 5 years is considerably less than the estimated national rates of 76.0 injuries per 100,000 children per year for male children younger than 5 years and 44.0 per 100,000 per year for female children under 5 from Wintemute's study in which the definition of submersion injury included all emergency department visits.<sup>5</sup> This estimated national rate was generated by extrapolating regional data

from coastal states (California and Virginia) and may not be representative of the injury rate in a noncoastal area. Yet, the submersion injury rate obtained in our study is greater than that obtained by Quan and co-workers in King County, Washington, where the definition of submersion injury included only those requiring admission to a hospital.<sup>8</sup> They calculated submersion injury rates of 4.0 injuries per 100,000 per year for those younger than 1 year and 12.8 injuries per 100,000 per year for those aged 1 to 4 years.

The association between the lapse of adult supervision of a bathing child and the increased risk of submersion injury is well described.<sup>8</sup> Our study points to another important risk factor, unsupervised bathing with a sibling. All but one of the bathtub-related drownings and the majority (61%) of the injuries occurred in the absence of adult supervision, when a 6-month to 2-year-old child was bathing with a sibling or siblings ranging in age from 2 to 7 years. This likely reflects an overestimation of the sibling's ability to supervise a younger child.

The second risk group identified during this study was toddlers playing near private pools and open bodies of moving water. The association between submersion injuries and private pools is well described,<sup>2,3,5</sup> as is the correlation between pool fencing regulations and a decrease in childhood submersion injuries.<sup>2,5,8,12,13</sup> Bodies of moving water have also been shown to be dangerous, but little has been written regarding fencing regulations for them.<sup>5,8,9</sup> Our study showed that bodies of moving water were the most dangerous site of submersion injury and were especially hazardous for children aged 18 months to 3 years. Reasons for this finding may include the exploring nature of the toddler, the difficulty finding a small victim in moving water, and the distance of these sites from phone contact and medical help.

In Utah, mountain snowpack runoff and irrigated desert farming each result in an extensive system of open bodies of moving water such as streams, irrigation ditches, and canals. Many of these open bodies of moving water are on farmland that has been recently developed into housing subdivisions,

which tend to attract young families. This leads to a dangerous scenario: an increased number of young children with possibly inadequate supervision frequently playing near open bodies of moving water.

We recommend that greater emphasis be placed on educating parents that young children should never be left to bathe without adult supervision, even when an older sibling is in the bathtub. Perhaps permanent warning labels should be placed on all bathtubs reminding parents about the danger of leaving children in the tub without adequate supervision in the room. The efficacy of this strategy would need to be evaluated. We also recommend that parents be educated about the dangers of pools and bodies of moving water to preschoolers. A possible way of doing this is through the educational component of the well-child-care visits with a child's primary care provider. Mass education campaigns and stronger fencing regulations for property developers and owners may be more expensive but also more effective.

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