Arthur A. Ellis, MA
Roger B. Trent, PhD

Both authors are with the Injury Surveillance and Epidemiology Section, Emergency Preparedness and Injury Control Branch, California Department of Health Services. Mr. Ellis is a Research Scientist, and Dr. Trent is a Research Scientist and Chief of the Section.

Swimming Pool Drownings and Near-Drownings Among California Preschoolers

SYNOPSIS

Objective. To describe a significant but poorly understood public health problem, the authors compiled data on swimming pool drownings and near-drownings requiring hospitalization for California children ages 1 to 4.
Methods. Data from death certificates were used to analyze swimming pool drownings, and hospital discharge data were used to analyze near-drownings.
Results. Among California preschoolers in 1993, pool immersion incidents were the leading cause of injury death and the eighth leading cause of injuries leading to hospitalization. Rates per 100,000 population were 3.2 for fatalities and 11.2 for nonfatal incidents, with a fatality-to-case ratio of 1:3.5. Total charges for initial hospital stays (excluding physicians' fees) were $5.2 million for 1227 hospital days.
Conclusions. Swimming pools remain a serious hazard for young children. Primary prevention continues to be an important public health goal. Public health officials should support the adoption of laws designed to protect children from drowning and near-drownings.

Drowning is the third most common cause of injury death among children younger than 4 years old in the United States and the leading cause of death in children younger than age 5 in California, Arizona, and Florida.[1,2] Studies have found between two and 20 near-drownings for every drowning.[3-6]

Research has revealed some correlates of risk for drowning and near-drowning. For example, risks are higher for preschool children and teenagers than for other children and adults,[2,4,6,7] for males than for females,[4,6] for blacks (except preschoolers) than for whites and Hispanics,[6] and for residents of Alaska, Hawaii, the Gulf Coast, and Florida than for residents of other states or regions.[1] High drowning rates in residential swimming pools have been documented for preschoolers in the United States.[1,2,4,6,8] Pool drownings may increase with socioeconomic status because of a link between income and pool ownership.[6]

The costs of nearly drowning can be high, according to the limited information available. In California, 75 near-drowning patients with severe anoxic brain damage are permanently hospitalized in state developmental centers at an

Address correspondence to Mr. Ellis, EPIC, 601 N. 7th St., P.O. Box 942732, Sacramento CA 94234-7320; tel. 916-323-3611; fax 916-323-3682; e-mail <aellis@hw1.cahwnet.gov>.

annual cost of $120,000 each.[9] The mean acute care charge for eight near-drowning patients was $78,875 in a California children's hospital between 1984 and 1986.[10] Hospitalization charges for near-drowning patients in California in 1991 ranged from $266 to $690,940, with a mean of $13,215. Most patients were admitted for observation; only 2% of patients (n=19) had initial hospitalization charges exceeding $100,000, indicating severe consequences such as brain damage. Of $11.4 million in total charges, $6.6 million was for pool near-drownings for which children were hospitalized. Nearly 73% of the costs associated with these incidents for drownings and near-drownings were for children younger than age 6.[4]

Although swimming pool drownings and near-drownings among preschoolers are a significant public health problem in California, few researchers have looked closely at this phenomenon. This population-based study addresses the incidences of and risk factors for swimming pool immersions among California residents ages 1 through 4. For near-drownings, we examine the costs of and expected sources of payment for hospitalizations.

Methods

This study used 1993 mortality data for swimming pool drownings and 1993 hospital discharge data for near-drownings. The *International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM)*, external cause of injury (E-code) E910.8[11] identifies swimming pool

drownings and near-drownings in both datasets. *Total* drownings are encompassed by the E-code series E910.0 to E910.9. In addition to pool immersions (E910.8), these unintentional incidents involve water-skiing (E910.0), other sports (E910.1-E910.2), nonrecreational swimming or diving (E910.3), the bathtub (E910.4), and unspecified immersions (E910.9).

Drownings are documented in the death records maintained by the California Department of Health Services (CDHS). Death records are nearly 100% complete because a death certificate must be filed before a burial or cremation permit is issued. CDHS's merged death file—an aggregation of annual death record files—was used for drowning trend data.

For this study, we defined near-drownings as cases in which victims were admitted to—and discharged alive from—non-Federal acute care hospitals, as documented in hospital discharge summaries. State law requires these hospitals to send discharge summaries to the California Office of Statewide Health Planning and Development (OSHPD). A total of 589 of 612 hospitals (96%) reported 3.7 million discharges to OSHPD for 1993. California law requires hospitals to include cause of injury codes (*ICD-9-CM* E-codes) for each injured patient's first hospitalization for a given injury. Therefore, E-codes can be used to calculate the incidence of injuries for which patients were hospitalized. In addition to pool immersion incidents, we used E-codes to determine other leading causes of injury death and hospitalization.

Swimming pool drowning and near-drowning rates for California children ages 1 to 4 by sex, age, and race/ethnicity, 1993

	Swimming pool drownings				Swimming pool near-drownings requiring hospitalization			
	Number	Percent	Rate	95% CI	Number	Percent	Rate	95% CI
Total	71	100	3.2	2.4,3.9	250	100	11.2	9.8,12.6
Sex								
Males	41	58	3.6	2.5,4.7	163	65	14.3	12.1,16.5
Females	30	42	2.7	1.8,3.7	87	35	8.0	6.3,9.6
Age								
1	27	38	4.5	2.8,6.2	108	43	18.0	14.6,21.4
2	26	37	4.4	2.7,6.1	82	33	13.8	10.8,16.8
3	14	20	...	...	35	14	6.5	4.3,8.7
4	4	6	...	...	25	10	5.0	3.0,6.9
Race/Ethnicity								
White	39	55	4.3	2.9,5.6	137	55	15.0	12.5,17.6
Black	3	4	...	...	22	9	12.3	7.2,17.4
Hispanic	17	24	...	...	63	25	6.8	5.2,8.5
Asian/Other	12	17	...	...	25	10	11.1	6.8,15.5
Unknown	0	0	NA	NA	3	1	...	...

NOTE: Rates were not computed for fewer than 20 cases.
CI = Confidence interval
NA = Not applicable
SOURCES: California Department of Health Services, Death Records, and California Office of Statewide Health Planning and Development, Hospital Discharge Data Program

In 1993, of the 291 children ages 1 to 4 admitted to inpatient care with an E-code of 910.8, 41 died in hospitals. We did not include them in the analysis of incidence rates to preclude duplication, but their hospital charges were included in the cost analysis. Hospital discharge data are generally reliable, as demonstrated by OSHPD's reabstraction studies of hospital records. In these periodic studies, OSHPD staff abstract data from a predetermined sample of case records and compare the results with the originally abstracted data. E-codes have not been subject to a reabstraction study, but coding edits are performed on every case.

California Department of Finance population projections served as denominators for computing injury rates. The race/ethnic categories are white, black, Hispanic, and Asian/others. Since "Asians" cannot be separated from "others" in these census estimates, we report a combined "Asian/others" category.

We define costs, or hospital charges, as charges billed for all services rendered (except physicians' fees) during the first year of the initial hospitalization. Not all billed charges are paid, so we refer to "*expected* sources of payment" rather than "sources of payment." Kaiser Permanente (a large health maintenance organization [HMO]) and the Shriner hospitals are exempt from reporting hospital charges to OSHPD. Therefore, we imputed costs for 26 cases (9%) with unreported or unknown charges (primarily from these institutions) using mean charges for HMO cases ($17,530) to obtain an approximation of total charges.

30% of all injury deaths among children ages 1 to 4. Immersion incidents at pools and other sites were the eighth leading cause of injuries leading to hospitalization (n=326, or 2% of all hospitalizations in this age group) after, in order: falls; unintentional poisoning; being hit by a car; burns; being injured as a motor vehicle occupant; foreign body in respiratory tract, eye, or elsewhere; and being struck by an object.

Trend data demonstrate the continuing importance of swimming pool drownings and near-drownings for preschool children. Between 1985 and 1993, the proportion of swimming pool drownings grew from 47% of all drownings to 64%. The actual number of swimming pool drownings of children ages 1 to 4 climbed from 53 in 1985 to 71 in 1993, a 34% increase. In contrast, near-drownings requiring hospitalization declined over the three calendar years for which E-codes are available, from 352 in 1991 to 291 in 1993, a decrease of 17%.

For 1993, the incidence rate for drownings was 3.2 per 100,000, the rate for near-drownings requiring hospitalization was 11.2 per 100,000. The fatality-to-case ratio for both combined (71/250) was 1:3.5. The hospital fatality rate (41/291) was 14.1 per 100 hospitalized cases.

The characteristics of victims appear in the Table. Fifty-eight percent of the children who died as a result of pool drownings were boys, as were nearly two-thirds (65%) of those involved in pool near-drownings for which children were hospitalized. The ratios of boys to girls were 1.4:1 for

Definitions. The fatality-to-case ratio is the number of patients discharged alive from the hospital divided by the number of drowning deaths.

The hospital fatality rate is the number of patients who died in the hospital divided by the number of discharges.

Length of stay is the number of days between admission and discharge. Since both costs and length of stay are strongly skewed, with many low values but some very high outliers, medians are an appropriate measure of central tendency to characterize these patients. Means are also presented to permit comparisons with other studies.
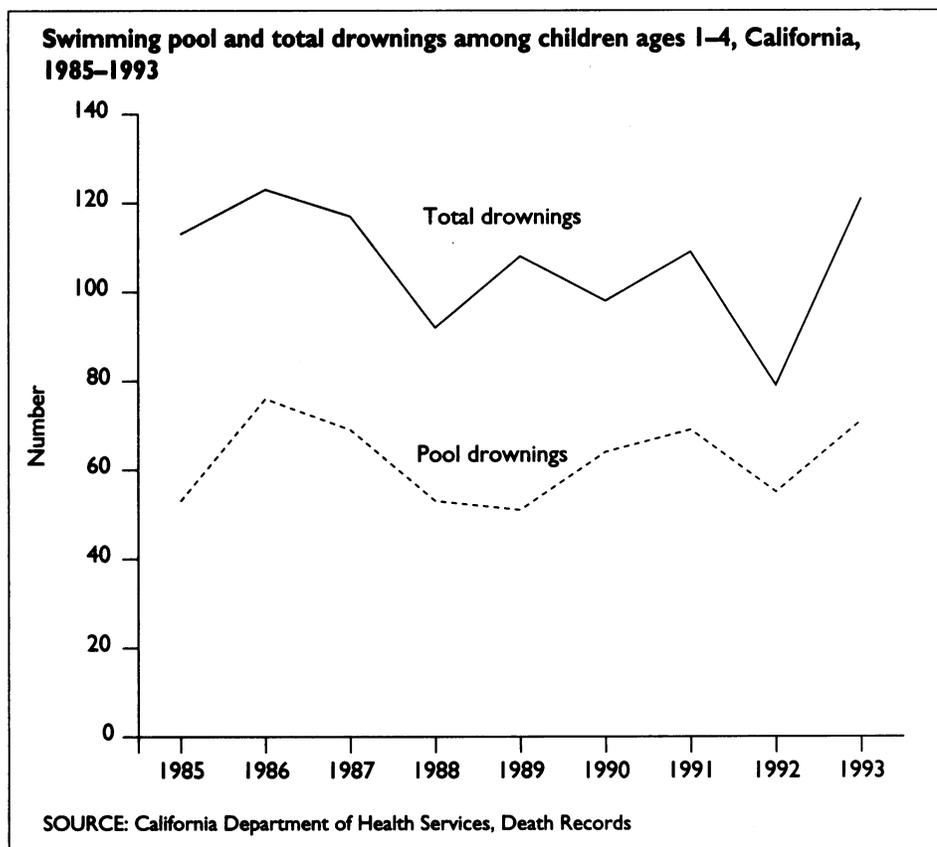
Results

In 1993, drowning was the leading cause of injury death among children ages 1 to 4 in California, with 121 deaths, or

Swimming pool and total drownings among children ages 1–4, California, 1985–1993

SOURCE: California Department of Health Services, Death Records

drownings and 1.9:1 for near-drownings. The modal age group for both fatal and nonfatal immersion incidents was 1-year-olds, with numbers declining with each additional year of age. White children ages 1 to 4 had the largest rate of nonfatal near-drownings in swimming pools (15.0), followed by black children (12.3), "Asian/other" children (11.1), and Hispanic children (6.8).

Immersion incidents in California peak in the summertime. In 1993, nearly half the hospitalizations for swimming pool near-drownings (46%) occurred during June, July, and August, with 18% in August alone. Drownings followed a similar pattern.

For all 291 hospitalizations in 1993 (250 discharged alive plus 41 who died in the hospital), hospital charges amounted to $5,217,957, with a mean of $17,931 and a median of $4020. The 4.5-fold difference between mean and median reflects the influence of a small number of cases with very high charges and, thus, a highly skewed distribution. The range extends from $560 for an HMO patient who was admitted and discharged on the same day to $558,013 for a Medi-Cal patient with a hospital stay of 157 days, averaging $3554 per day. Total charges billed to expected payment sources were $2.3 million to Medi-Cal, $1.6 million to HMOs, and $1.0 million to private insurance companies. Mean and median charges are $22,782 and $3958 for Medi-Cal, $17,530 and $5100 for HMOs, and $15,728 and $4093 for private insurance. Medi-Cal was the expected source of payment for the largest share of costs (34%), followed by HMOs (31%) and private insurance (22%). But private payers were the expected payment source for 64% of total cases, compared to 36% for government payers.

Victims of near-drownings in 1993 spent a total of 1227 days in the hospital, with a mean stay of 4.2 days and a median stay of one day. For children covered by Medi-Cal, the mean stay was 6.0 days and the median stay one day, with a total of 595 hospital days.

A total of 41 victims (14%) died in the hospital, and 229 (79%) had a routine discharge to their homes. Twelve (4%) were discharged to another short-term acute care hospital, indicative of a poor outcome.

Discussion

Swimming pools are dangerous places. Given rates of 3.2 per 100,000 for drownings and 11.2 per 100,000 for near-drownings, primary prevention is an important public health goal. This goal is particularly pertinent to states such as California, Arizona, and Florida with long, warm summers and large numbers of swimming pools. A private pool at a single family home is the site for most swimming pool drownings and near-drownings.[6] Since children in higher income families probably have more exposure to private pools,[6] our finding that private payers were the expected source of payment for 64% of near-drowning cases among children ages 1 to 4 is not surprising. (Private payers were the expected source of payment for 42% of all injury-related hospitalizations of children of this age group.) The public use California mortality and hospital discharge datasets do not list individual identifiers and do not permit the review of individual cases for additional details. However, the literature is clear that approximately one-half to two-thirds of all immersion incidents occur in the child's own home pool, with the remainder occurring at the residence of a friend, relative, or neighbor.[12-16]

Trend data are not encouraging because they show no decline in incidence. Drownings in swimming pools show no increase from 1985 through 1993; however, they have increased as a proportion of all immersion incidents during this period. Hospitalizations for nonfatal incidents declined during the 1991–1993 period, suggesting that an increasing proportion of young children are either dying at the scene or being treated as outpatients rather than being admitted to the hospital.

Our data indicate that the rates of drownings and near-drownings were higher among boys than girls, higher among white children than nonwhite children, and higher among 1-year-olds than other age groups studied. The ratio of males to females was 1.4:1 for fatal and 1.9:1 for nonfatal incidents. One earlier nationwide study reported a male-to-female ratio of 1.8:1 for both fatal and nonfatal immersions at pools and other sites.[6] A more recent study of drownings among children younger than age 5 found a male-to-female ratio of 1.6:1, similar to our ratio of 1.4:1.[17] Previous research has invariably found young children to be most at risk compared to all other age groups.[2-4,6] Our earlier study found the 1 to 5 age group to have near-drowning rates higher than any other age group.[4] In contrast to other study findings that black children ages 1 to 5[7,17] had the highest nationwide drowning rates and that black children ages 1 to 5 had the highest near-drowning rates in California,[4] our finding for children 1–4 years old was consistent with data cited by Wintemute for children 1–3 years old: white children had a higher rate than black children.[6] The fact that our study looked only at swimming pool incidents may explain why white children had higher rates than black children.

> Drowning is the third most common cause of injury death among children younger than four in the United States.

In this study, the fatality-to-case ratio was 1:3.5, which falls within the range of the ratios found in other studies (1:2.9 through 1:7.2).[1,6,18]

Isolation pool fencing, as defined by safety standards in the Uniform Building Code, has been shown to be effective in preventing drowning.[7] Isolation pool fences separate the home from the pool, are built to be unclimbable, and have self-closing and self-latching gates. Their purpose is to stop children from passing unnoticed from the home to the pool. Such fencing has been found to reduce swimming pool drownings and near-drownings by as much as 50% to 80%, according to studies in Australia and New Zealand.[6,19]

Consistent with the recommendation of the American Medical Association, the American Academy of Pediatrics, and many other national organizations to fence residential pools, some US jurisdictions have adopted regulations requiring fencing. Maricopa County, Arizona, found that 51% of its 137 drownings and near-drownings in 1988–1989 could have been prevented by pool fencing with safety gates and latches and now has a mandatory fencing requirement.[20] A recent report indicates that swimming pool drowning and near-drowning incidents among children ages 4 and younger dropped from 102 in 1988 to 44 in 1994 following the adoption of barrier legislation.[13]

In 1996, California adopted a statewide barrier code based on Appendix Chapter 12, Division 111, of the Uniform Building Code. This new code stipulates that, effective January 1, 1998, a new or refurbished pool cannot receive an approved building permit without an isolation fence or other device to protect children. This law should reduce child drowning rates in the long run, but its effect will be muted because existing and unrenovated pools are not covered.

In addition to legal measures, an educational strategy is important to diminish the effects of immersion incidents that are not prevented. Caretakers of children should be taught resuscitation techniques, which, if administered immediately following immersions, are associated with better neurological outcomes.[21]

References

1. Hazinski MF, Francescutti LH, Lapidus GD, Micik S, Rivara FP. Pediatric injury prevention. Ann Emerg Med 1993;22(pt2);456–467.
2. Fields AI. Near-drowning in the pediatric population. Crit Care Clin 1992;8:113–129.
3. Olshaker JS. Near drowning. Emerg Med Clin North Am 1992;10:339–350.
4. Ellis AA, Trent RB. Hospitalizations for near drowning in California: incidence and cost. Am J Public Health 1995;85:1115–1118.
5. Consumer Product Safety Commission [US]. Briefing package on pool safety. Washington DC: Consumer Product Safety Commission; 1988.
6. Wintemute GJ. Childhood drowning and near-drowning in the United States. AM J DIS CHILD 1990;144:663–669.
7. Wintemute GJ. Evaluation of methods to prevent childhood drowning in residential swimming pools. Calif Morbidity 1992;27–28.
8. Flood TJ, Porter RS. Water-related incidents in 1993 in Maricopa County. Phoenix: Office of Chronic Disease Epidemiology, Arizona Department of Health Services; 1994.
9. California Network for Drowning Prevention. Policy statement: the need for four-sided pool fencing: a look at the uniform building code appendix for swimming pool barriers. Pleasant Hill (CA): California Network for Drowning Prevention; 1992 Oct.
10. Brill D. The cost of drowning. In: Brill D, Micik S, Yuwiler J, editors. Childhood drownings: current issues and strategies for prevention. Newport Beach (CA): Consumer Product Safety Commission, 1987:45.
11. World Health Organization. International classification of diseases: manual of the international statistical classification of diseases, injuries, and causes of death. 9th rev. clinical modification. Geneva: WHO; 1977.
12. Wintemute GJ. Drowning in early childhood. Pediatr Ann 1992;21: 417–421.
13. Flood TJ, Porter RS. Water-related incidents in 1994 in Maricopa County. Phoenix: Office of Chronic Disease Epidemiology, Arizona Department of Health Services; 1995.
14. Hassall IB. Thirty-six consecutive under 5 year old domestic swimming pool drownings. Aust Paediatr J 1989;25:143–146.
15. Present P. Child drowning study: a report on the edpidemiology of drownings in residential pools to children under age five. Washington DC: U.S. Consumer Product Safety Commission; 1987.
16. Meyers H, Dale A, Bolton S. Immersion surveillance summary, 1991 and 1992. Santa Ana (CA): County of Orange Health Care Agency; 1993.
17. Injury mortality: national summary of injury mortality data, 1986–1992. National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, February 1995.
18. Levin DL, Morriss FC, Toro LO, Turner GR. Drowning and near-drowning. Pediatr Clin North Am 1993;40:321–336.
19. National Center for Environmental Health and Injury Control [US]. Proceedings of the Setting the National Agenda for Injury Control in the 1990s, the Third National Injury Control Conference; 1991 April 22–25; Denver, CO.
20. Flood TJ, Aaickin M, Englender SJ, Tucjer D. Child drownings and near drownings associated with swimming pools, Maricopa County, Arizona, 1988 and 1989. MMWR Morbid Mortal Wkly Rep 1990:39:441–442.
21. Kyrlacou DN, Arcinue EL, Peek C, Kraus IF. Effect of immediate resuscitation on children with submersion injury. Pediatrics 1994;94:137–142.

In 1993, swimming pool drownings and near-drownings were the leading cause of injury death among California children ages 1 to 4.