Activities Associated with Drownings in Imperial County, CA, 1980–90: Implications for Prevention

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Synopsis

Statewide surveillance in California determined that the highest drowning rate from 1980 through 1989 was for the rural, desert county of Imperial (21.9 drownings per 100,000 population). To identify activities associated with drowning in this county, the authors abstracted data from the county sheriff-coroner's reports.

From 1980 through 1990, there were 317 unintentional drownings; 85 percent occurred in irrigation canals. The activity prior to drowning was known for 262 persons (83 percent), and the most common activity was illegal entry into the United States. Overall, 140 persons (53 percent) were illegal entrants.

Ninety-three percent of illegal entrants drowned in the All American Canal; the monthly drowning rate increased as the monthly average water velocity in the canal increased ($r = 0.36$; $P<0.001$). *Forty-eight persons (18 percent) drowned while riding in or on a land vehicle (automobile, pick-up truck, motorcycle, dune buggy, or tractor), the second most common activity associated with drowning. Seventy percent of the 23 drivers had an alcohol concentration of 100 milligrams per deciliter or more, California's limit for intoxication. To reduce drownings in Imperial County, prevention strategies should target persons engaged in at-risk activities near bodies of water. These strategies should include the identification and use of effective canal safety devices.*

THE LARGEST NUMBER of drownings ocurring in the United States each year from 1980 through 1989 was reported for California, with an average of 669 drownings per year. California had an annual rate of 2.5 drownings per 100,000 population, approximately the median among all 50 States (*1*).

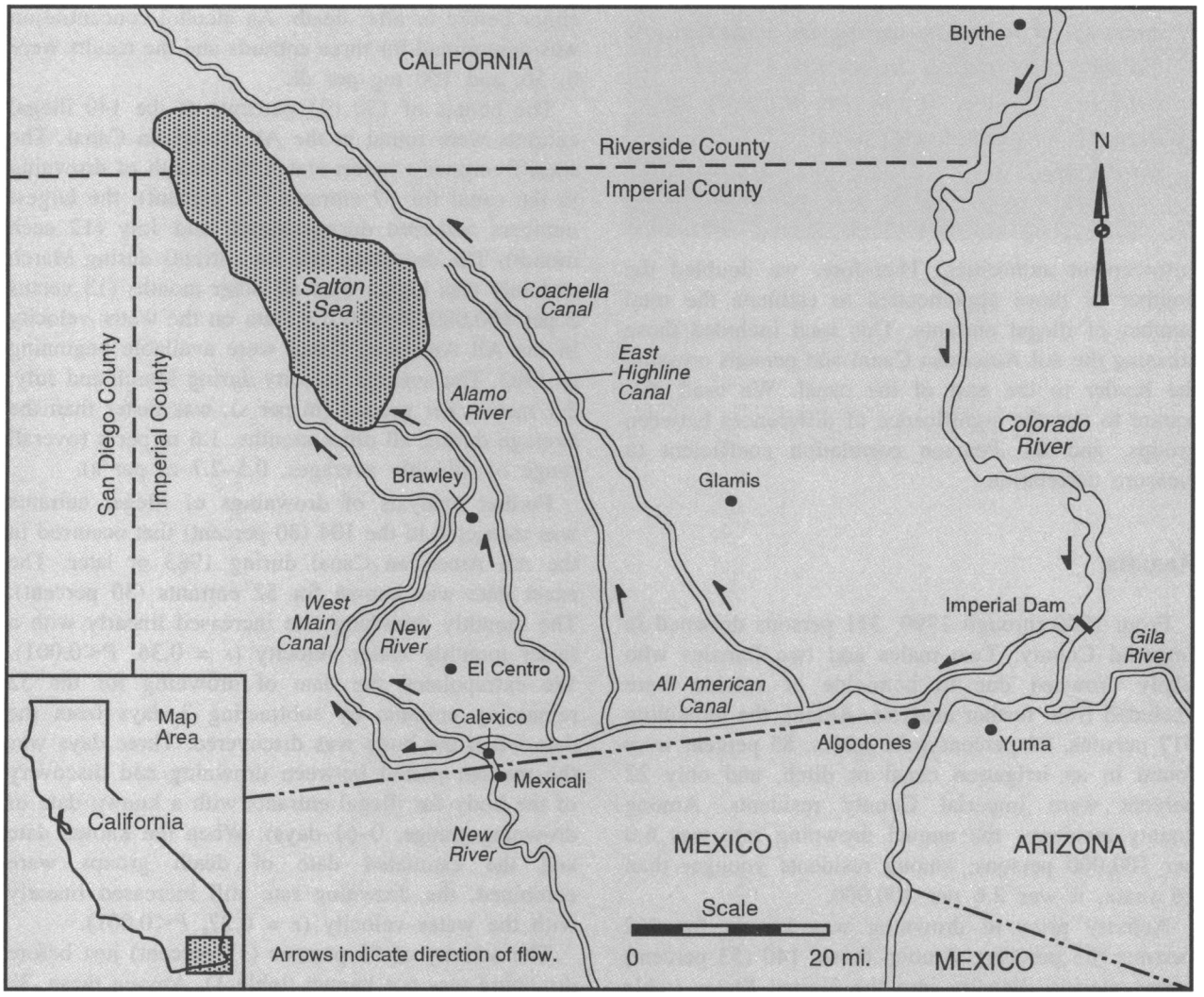
To characterize these deaths better, the California Department of Health Services undertook statewide surveillance of drownings based on death certificate files. These data revealed that among California's 58 counties from 1980 through 1989, the highest rate of drowning, measured by the event's location divided by the resident population, occurred in Imperial County (21.9 per 100,000 persons; 8.8 times the State average) (*2*).

Imperial County occupies 6,719 square kilometers (km^2) of California's southeast corner; it is bordered by San Diego County to the west, Mexico to the south, and the Colorado River to the east (see map). Much of the county is desert basin lying below sea level. It is sparsely populated (1985 population of 106,001 persons and density of 16 persons per km^2), and it contains a 923-km^2 lake, two perennial rivers, and approximately 4,800 kilometers (km) of agricultural irrigation canals and ditches.

Water from the Colorado River supplies the irrigation system and initially travels through the All American Canal within Imperial County. The canal is approximately 60 meters (m) wide, 5 m deep, and closely parallels the United States-Mexico border for about 130 km. Irrigation canals branch from the All American Canal and supply numerous smaller canals.

We undertook this investigation to characterize persons who drowned in Imperial County and to

Network of canals in Imperial County, CA



identify possible interventions to prevent these deaths.

Methods

In Imperial County, deaths due to an injury or an unknown cause are investigated by the sheriff-coroner's office. We reviewed their records of all investigations conducted between January 1, 1980, and December 31, 1990, and abstracted data on all drownings. A drowning incident was a death attributed to drowning or asphyxia due to drowning according to the sheriff-coroner's office. Data gathered included demographic characteristics of the decedent, place of residence, date of injury, cause of death, autopsy results, and a description of the circumstances surrounding death. Decedents were classified as illegal entrants into the United States if so stated in the sheriff-coroner's report. The date of drowning for illegal entrants was known if other entrants witnessed and reported the death to officials, or if the sheriff-coroner's office estimated the date. Decedents with an alcohol concentration of 100 milligrams per deciliter (mg per dl) or more, the current legal definition of intoxication for a California motor vehicle driver, were considered intoxicated.

Data on the water velocity in the All American Canal were obtained from the Imperial Irrigation District. The number of persons apprehended monthly in the All American Canal area while attempting illegal entry into the United States was provided by the U.S. Border Patrol, Yuma Station. According to this Border Patrol Station, approximately 50 percent of all illegal entrants are apprehended by law

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enforcement authorities. Therefore, we doubled the number of those apprehended to estimate the total number of illegal entrants. This total included those crossing the All American Canal and persons crossing the border to the east of the canal. We used chi-square to test the significance of differences between groups, and the Pearson correlation coefficient to measure correlation.

Results

From 1980 through 1990, 321 persons drowned in Imperial County. Two males and two females who likely drowned due to homicide or suicide were excluded from further analysis. Among the remaining 317 persons, 94 percent were males, 85 percent were found in an irrigation canal or ditch, and only 22 percent were Imperial County residents. Among county residents, the annual drowning rate was 6.0 per 100,000 persons; among residents younger than 16 years, it was 2.6 per 100,000.

Activity prior to drowning was known for 262 persons (83 percent). Among those, 140 (53 percent) were entering illegally into the United States (table 1). All but one of the illegal entrants were white males, and all with known ethnicity were Hispanic (table 2). The age or approximate age was known for 114 entrants (81 percent); their median age was 24 years (range 15–58 years). Among the entrants, at least 33 percent wore pants into the water, 23 percent wore shoes, and 6 percent carried a bag of belongings.

The decedents' residence was known for 86 persons (61 percent). Of these, 81 percent lived in Mexico, 14 percent in the United States, and 2 percent each in Guatemala and Honduras. Reportedly, several persons who lived in the United States had returned to Mexico to visit relatives. None of the entrants resided in Imperial County. The estimated average annual illegal entrant drowning rate was 12.6 per 100,000 entrants (annual range 7.5–20.9 per 100,000).

Fifty-two entrants (37 percent) were autopsied. One person had a skull fracture—possibly an intentional injury. However, this injury could have occurred either before or after death. An alcohol concentration was determined for three entrants and the results were 0, 50, and 100 mg per dl.

The bodies of 130 (93 percent) of the 140 illegal entrants were found in the All American Canal. The sheriff-coroner's report stated the month of drowning in the canal for 67 entrants (52 percent); the largest numbers occurred during March and July (12 each month). The drowning rate for entrants during March and July was higher than all other months (13 versus 5 per 100,000; $P<0.001$). Data on the water velocity in the All American Canal were available beginning in 1983. The average velocity during March and July, 2.1 meters per second (m per s), was faster than the average during all other months, 1.6 m per s (overall range of monthly averages, 0.5–2.7 m per s).

Further analysis of drownings of illegal entrants was restricted to the 104 (80 percent) that occurred in the All American Canal during 1983 or later. The exact date was known for 52 entrants (50 percent). The monthly drowning rate increased linearly with a faster monthly water velocity ($r = 0.36$, $P<0.001$). We extrapolated the date of drowning for the 52 remaining entrants by subtracting 3 days from the date when the body was discovered. Three days was the median period between drowning and discovery of the body for illegal entrants with a known date of drowning (range, 0–61 days). When the known date and the estimated date of death groups were combined, the drowning rate still increased linearly with the water velocity ($r = 0.27$, $P<0.001$).

The activity of 55 persons (17 percent) just before drowning was not known (table 1). Among these, 38 persons (69 percent) were found in the All American Canal. As with known illegal entrants, all 38 were male, their median age was 25 years (range, 18–35 years), and all those with known race (97 percent) and ethnicity (87 percent) were white Hispanics. Because post-mortem decomposition may falsely elevate the alcohol concentration (*3*), we limited alcohol concentration data among the group of 55 to the 5 persons deceased 1 day or less at the time of tissue sampling. All were intoxicated.

Forty-eight persons drowned in 37 land (automobile, pick-up truck, motorcycle, dune buggy, or tractor) vehicle crashes. In six crashes (16 percent), more than one person in the vehicle drowned (range, 2–5 persons). Overall, most were white, male, and resided in the county (table 2).

Among the 47 persons (98 percent) known to be the driver or passenger, 30 (64 percent) were drivers.

Drivers were more likely than passengers to be male (87 versus 71 percent) and older (medians, 29 versus 21 years; ranges, 16–63 and 2–63 years, respectively). Two motor vehicle victims were not autopsied due to decomposition. Among those autopsied, 17 (37 percent) sustained injuries that possibly caused unconsciousness before drowning.

An alcohol concentration was determined for 28 drivers (93 percent) and 13 of the 14 passengers 16 years or older. We did not analyze alcohol concentrations obtained from 8 persons deceased for more than 1 day (*3*). Sixteen (70 percent) of 23 drivers and 5 (45 percent) of 11 passengers were intoxicated.

These land vehicle-related drownings occurred in an irrigation canal or ditch in 33 cases (89 percent) and a river in 4 (11 percent). The location of the vehicle was described for 36 crashes (97 percent). The vehicle entered the water, in 35 cases, including a tractor driven into a canal in a work-related incident. The circumstances of the vehicle's entering the water were noted for 27 incidents (73 percent). Among these, a curve was unsuccessfully negotiated in nine; the vehicle drifted off a straight road in nine; the vehicle struck an object and rebounded into water in four; the vehicle ran through a T-intersection in three; and the driver lost control due to mechanical failure in two.

Among the 74 other decedents whose activities prior to drowning were known (table 1), the majority were white, male, and non-Hispanic (table 2). Their median age was 22 years (range, 1-77 years), and 77 percent drowned from May through August. Most (57 percent) drowned in an irrigation canal or ditch. Twenty-four percent drowned in a pond or lake, 11 percent in a river, 5 percent in a pool, and 1 percent each in a bathtub and a 5-gallon bucket.

Among these 74 decedents involved in a known activity, an alcohol concentration was determined for 24 persons deceased 1 day or less; 11 (46 percent) were intoxicated. Thirteen of the 74 persons (18 percent) were younger than 16 years. Of these, 46 percent drowned while swimming, and 54 percent drowned after falling into the water.

Table 1. Activity before drowning of 317 persons, Imperial County, CA, 1980-90

Activity	*Number*	*Percent*
Illegal entry into the United States....	140	44
Riding in or on a motor vehicle	48	15
Swimming	28	9
Unintentional water entry[1]	23	7
Boating.....	12	4
Fishing, frogging, hunting.....	8	3
Scuba diving, jet skiing	2	1
Bathing.....	1	<1
Unknown activity.....	55	17
Total.....	317	100

[1]Fell or slipped into water while standing, walking, or sitting near the water.

Discussion

Statewide surveillance of drownings in California identified the excess rate in Imperial County and prompted this investigation. State-based surveillance systems that gather data describing injuries or diseases can provide useful information to characterize regional health problems. Subsequent investigations that are planned using the surveillance data can be more effectively targeted to identify persons and the risk factors associated with injury or disease.

In Imperial County, CA, during the 1980-90 period, the most common activity associated with drowning was attempted crossing of the All American Canal after illegal entry into the United States. However, the number of entrants who drowned was likely underreported. Most persons whose activity prior to drowning was unknown were similar to entrants both demographically and in the location of the drowning (that is, the All American Canal). Thus, most were probably illegal entrants.

In the future, drownings of illegal entrants are likely to increase. Most crossed the All American Canal, and their rate of drowning increased as the water's velocity increased. The All American Canal is currently earthen, but it will likely be lined with concrete to prevent water loss due to ground seepage. Lining a canal decreases the drag on the water and increases the average water velocity. Thus, the illegal entrant drowning rate can be expected to rise as the water velocity increases. Additionally, more illegal entrants may attempt to cross the canal because the growing Mexican population in the United States (12 million in 1988) is likely to increase the number of illegal border crossings (*4*).

We found that the swiftness of the water flow contributed to the drownings in the All American Canal. The flow was not a likely marker for another factor contributing to drowning, such as water depth or width, because the canal is so large (5 m deep and 60 m wide.) However, many other factors possibly contributed to these deaths, such as the entrants' inability to swim, crossing in the dark, wearing clothing and shoes, and carrying objects. The contribution of alcohol is unknown, because an alcohol concentration was only determined for three illegal entrants.

We estimated the denominator of the illegal entrant

Table 2. Activity before drowning by race, sex, ethnicity, and residence of 317 persons, Imperial County, CA, 1980-90

Category	Illegal entry (N=140)		Vehicle travel (N=48)		Other[1] (N=74)		Unknown (N=55)		Total (N=317)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Race:										
White	140	100	42	88	65	88	51	93	298	94
Black	. . .	. . .	2	4	8	11	3	5	13	4
Asian	. . .	. . .	1	2	. . .	. . .	. . .	. . .	1	<1
American Indian	. . .	. . .	3	6	1	1	. . .	. . .	4	1
Unknown	. . .	. . .	. . .	. . .	. . .	. . .	1	2	1	<1
Sex:										
Male	139	99	39	81	67	91	54	98	299	94
Female	1	1	9	19	7	9	1	2	18	6
Ethnicity:										
Hispanic	138	99	21	44	35	47	41	75	235	74
Non-Hispanic	. . .	. . .	26	54	39	53	8	15	73	23
Unknown	2	1	1	2	. . .	. . .	6	11	9	3
Residence:										
Imperial County	. . .	. . .	40	83	27	36	5	9	72	23
Other	54	39	8	17	44	59	15	27	121	38
Unknown	86	61	. . .	. . .	3	4	35	64	124	39

[1]Includes swimming, falling, boating, fishing, frogging, hunting, scuba diving, jet skiing, and bathing.

'Imperial County residents younger than 16 years who drowned in the county were either swimming, in a vehicle crash, or fell into the water. Their annual drowning rate was 2.6 per 100,000 persons.'

drowning rate using data from the U.S. Border Patrol. A systematic bias may exist in this number if, for example, the Border Patrol consistently over or underestimated the percent of entrants who were apprehended. However, this would not affect the magnitude of the association with the water flow (*5*). Nevertheless, these data should be cautiously interpreted.

Prevention of both illegal entry and drownings will continue to be difficult, particularly while economic opportunities in the United States are much greater than in Mexico. Illegal entry has not been stopped by fences. However, drownings may be decreased by installing signs with universal symbols warning of the drowning hazard [many illegal entrants are illiterate (*4*)]. Also, public service announcements broadcast in Spanish in border towns may have an impact.

The second most common activity associated with drowning in Imperial County was riding in or on a land vehicle. Like Wintemute and coworkers (*6*), we found the majority of drivers who drowned were intoxicated. In Imperial County, roads are often located next to irrigation canals and ditches. Drunk drivers who drift off the road have a good chance of entering water and putting themselves and their passengers at risk of drowning. Intoxication may also contribute to motor vehicle-related drownings by hindering escape both from the car and the water.

In Imperial County, at least one-third of vehicle-related drownings were associated with a curve in the road. Wintemute and coworkers found a road curve of 20 degrees or greater was associated with vehicle-related drownings in Sacramento County, CA (*6*). Many rural roads lack clearly visible center and edge stripping, which can assist a driver in anticipating road alignment changes. Drownings due to motor vehicle incidents therefore may be decreased if roads along waterways had conspicuous markings, barriers, and reflective signs at T-intersections.

Imperial County residents younger than 16 years who drowned in the county were either swimming, in a vehicle crash, or fell into the water. Their annual drowning rate was 2.6 per 100,000 persons—no higher than the 5 per 100,000 rate for 0–19-year-olds in Sacramento County, CA (*7*) and 2.6 per 100,000 for King County, WA (*8*); 5 per 100,000 for 0–14-year-olds in New Mexico (*9*); and 3 per 100,000 for 0–15-year-olds in Honolulu, HI (*10*). Imperial County's relatively low rate may be due to the scarcity of pools and an extensive school-based canal safety program in which a health educator teaches canal safety programs in each county classroom every year.

Irrigation canals, found in many arid areas of the United States, pose a potential drowning risk. Canals

in many populated areas are fenced to prevent access (*11*). Shallow, unlined canals and ditches are thought to offer danger predominately to small children. However, concrete lined canals pose a greater threat because their steeply sloping sides hinder escape and increase the water's velocity (*11*). Safety features in lined canals include ladders placed at 500-foot intervals on alternate sides; flotation cables and safety nets upstream from a siphon or water check (a turbulent area where the water level drops); and grates across siphons, pipe chutes, and pipe drops (*11,12*).

Lined canals can be built with sides configured as steps rather than a straight incline. These steps were designed to allow deer to enter and exit safely from canals. We were unable to locate data describing the efficacy of any canal safety device in preventing human drownings. We believe that such devices should be designed so that persons in the middle of a canal, anecdotally a common place for drowning, can reach them.

In Imperial County, the two most common activities associated with drowning were crossing the All American Canal after illegal United States entry or traveling in a land vehicle. Irrigation canals and ditches were associated with 85 percent of drownings. To prevent drownings in the county, persons participating in these activities must be alerted to the hazards of the canals, and effective safety features to assist escape from canals must be identified and used.

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