Drowning

Epidemiology and Prevention

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Accidental drownings were analyzed to determine their relationship to age, race, alcohol, preexisting disease, and other factors. A number of preventive measures are suggested.

Introduction

Approximately 6,500 persons drown in the United States each year.[1] Drowning is the fourth leading cause of accidental death, and for ages 5 to 24 is second only to death due to motor vehicles. Widespread programs of swimming and water safety instruction may account for the decreased drowning rates observed in recent decades, an encouraging achievement in light of the increased popularity of boating and water sports. Nonetheless, continued substantial loss of life suggests that, as in other areas of injury control,[2] education is not the complete solution. Furthermore, there may be important segments of the population that receive little education relevant to their water safety needs.

Two epidemiological studies have suggested that alcoholic intoxication is a factor in at least 12 to 14 per cent of all accidental drownings.[3,4] In other investigations designed to evaluate the role of alcohol directly, blood tests for alcohol were positive in five of 17 adult drownings in California,[5] in 34 per cent of adults who drowned in Finland,[6] and in 36 per cent of adults who drowned in the Australian city of Geelong.[7]

The present study was undertaken in order to determine (1) the population groups most in need of water safety instruction, (2) the prevalence of alcoholic intoxication in drowning deaths, in relation to characteristics of the person and circumstances of death, and (3) the possibilities for injury control through environmental modifications.

The study was conducted in Maryland, where climate and geography encourage water sports. Few of the state's 3.9 million inhabitants live more than 10 miles from a tidewater or freshwater river. Private swimming pools are common, and during the hot summer months thousands of people swim daily at the ocean beaches. Sailing in the Chesapeake Bay is popular; Marylanders own an estimated 12,000 sailboats.

Material and Methods

Records at the Office of the Chief Medical Examiner of Maryland were reviewed for all drownings that occurred in Maryland in 1972. Available records varied in completeness. All drownings occurring in Baltimore City had been investigated by the Office of the Chief Medical Examiner. The files on Baltimore City cases contained investigator's reports and, in most cases, autopsy, toxicology, and police reports. Drownings occurring in the 23 counties had initially been investigated by Deputy Medical Examiners,

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and in all cases their reports were available. Autopsies and toxicology studies were rarely conducted for county cases, except when the bodies were transported to Baltimore for study (approximately one-fifth of the county cases).

A total of 133 drownings occurring in 1972 were officially ruled to be accidental. Of these, 16 occurred during the flooding associated with Tropical Storm Agnes. Major flooding and flood fatalities are so rare in Maryland that flood deaths are analyzed separately, leaving a Primary Study Group of 117 cases.

Tests for blood alcohol were performed for only 28 drownings in 1972. Adult drownings occurring within Baltimore City comprised the only group for which blood alcohol concentrations were known in all cases. Therefore, in order to obtain a study group of adequate size, city cases from 1968 to 1971 were added to form a secondary group for the study of alcohol in drownings. A total of 45 cases from 1968 to 1972 met the following criteria for inclusion in the Alcohol Study Group: (1) drowned in Baltimore City; (2) age 15 years or older; (3) no land vehicle involved; and (4) body submerged less than 12 hr.*

Results

Primary Study Group

DEMOGRAPHIC DATA

As shown in Table 1, the frequency of accidental drownings varied with age, the greatest frequency being in the age group 15 to 24. The median age for the Primary Study Group was 21 years, 6 years younger than the median age for the population of Maryland. Only 21 per cent were less than 15 years of age.

Seventy-five persons who drowned were whites and 42 were blacks. Figure 1 shows drowning rates per 100,000 population by age for both racial groups. The overall drowning rate for whites was 2.3 deaths per 100,000, while for blacks the rate was 5.8 deaths per 100,000. Drowning rates were higher for blacks in all age groups except the youngest. The similarity of drowning rates by race in the youngest ages was associated with an absence of swimming pool deaths in black children under age 9. The drowning rate for males was 5.2 per 100,000, and for females was 0.85 per 100,000.

SEASON

As expected, drownings occurred primarily in the warmer months of the year: 62 per cent occurred in the 3 months June—August; 90 per cent in the 6 months April—September. The greatest number of cases occurred in July (39), followed by June (17), August (16), and May (15). From October through April, almost all persons who drowned were age 18 and over, and the majority were hunting or fishing.

TABLE 1—Frequency of Drowning by Age, Sex, and Race

	Male		Female		
Age	White	Black	White	Black	Total
0–4	5	2	2	0	9
5–9	3	1	2	1	7
10–14	6	2	0	1	9
15–19	16	8	3	0	27
20–24	9	7	2	2	20
25–29	2	2	0	1	5
30–34	3	4	0	0	7
35–39	6	2	0	0	8
40–49	6	6	0	0	12
50–59	4	1	1	0	6
60–89	4	1	1	1	7
Total	64	36	11	6	117

BODY OF WATER

Table 2 shows that the greatest number of drownings (61, or 52 per cent) occurred in creeks and rivers. The 13 swimming pool deaths included nine children with an age range of 16 months to 9 years. Thirty-six per cent (n = 9) of the persons age 14 or younger drowned in swimming pools, as compared to 4 per cent (n = 4) of those age 15 or older. Maryland's popular ocean beaches were associated with not more than one case of drowning, a 55-year-old man who was found floating in the Atlantic Ocean in early September.

ACTIVITY PRIOR TO DROWNING

Immediately prior to their deaths, 40 persons (34 per cent) were swimming. Thirty-four (29 per cent) were in boats, 14 of them while fishing or hunting. In addition to these two groups, which will be considered in greater detail, 10 children were playing in or near water without actually swimming, five people were fishing from piers or the shore, four were walking near water, four were wading, and three young nonswimmers were "showing off" in deep water. Two boys were drinking alcohol near streams and apparently fell in fully clothed. Three persons were taking baths. One was driving a truck; one was riding in a car. An adult hospitalized for an organic brain syndrome and a severely retarded child wandered away or escaped from their respective institutions and were found drowned. A 14-year-

* I.e., removed prior to the fermentative production of alcohol associated with putrefaction and decomposition. The physiological alterations associated with drowning have not been shown to increase postmortem blood alcohol concentrations. On the contrary, it has been demonstrated in experimental animals that a decrease on the order of 10 per cent may be expected.[8] Thus, any such changes in alcohol levels would tend to decrease the apparent contribution of alcoholic intoxication to drowning.

old boy fell through the ice covering a pond while testing its stability for skating. In seven cases, the person's final activity was unclear or unknown.

Witnesses described the drownings of the swimmers as follows: 11 were seen to lose control and cough, panic, and/or call for help; 10 were swimming without apparent difficulty before suddenly disappearing below the surface; eight were said to be poor swimmers who jumped into the water or went too far from shore; four purposely dove beneath the surface but did not emerge; two drowned while attempting to rescue companions; and one was struck by a motorboat. Drownings of four swimmers were unwitnessed.

The types of watercraft involved in the drowning of boaters are shown in Table 3. Sinking or capsizing led to 19 drownings, 16 per cent of the Primary Study Group. Twenty-three (68 per cent) of the boats involved in drownings were rowboats or small boats with outboard motors. Only one was a sailboat.

Sixty-two per cent of boating deaths occurred on weekends, while swimming deaths were distributed more evenly throughout the week. Swimming deaths occurred predominantly in the afternoon, while drownings associated with boating more frequently occurred in the morning and evening hours ($\chi_2^2 = 31.9$, $p < 0.001$). Of the nighttime deaths, only one person, a swimmer, drowned between midnight and 6 a.m.

Twenty-three (68 per cent) of the boaters who drowned were age 25 or over, as compared to nine (23 per cent) of the swimmers ($\chi_1^2 = 13.5$, $p < 0.001$).

Although blacks comprised only 36 per cent of the sample, 67 per cent (n = 8) of the persons who fell from boats were black ($\chi_1^2 = 3.9$, $p < 0.05$).

PREEXISTING ILLNESS

Table 4 summarizes seven cases in which preexisting illness is believed to have played a role. In these seven cases there is a plausible relationship between organic disease and drowning; five involved seizure disorders, mental retardation, or both. In another six cases, preexisting illness appeared to be incidental to drowning, involving, for example, a vague history of gastrointestinal distress or an autopsy finding of fatty metamorphosis of the liver.

HEAD TRAUMA

Two persons apparently sustained severe head trauma just prior to drowning and may reasonably be presumed to have drowned secondary to unconsciousness while immersed: one, a swimmer, sustained severe head injuries when struck by a motorboat; the other person was found face-down in a stream with his head against a large rock, and had a fresh, traumatic subarachnoid hemorrhage.

The external appearance of the body was described in detail in seven cases of pool drowning. Four of the seven had various abrasions and contusions of the forehead and face; no intracranial lesions were found. The external lesions might have been incurred when the body was removed from the pool, but it is noteworthy that in only one case did the pattern of injuries on the extremities and trunk suggest that the body had been dragged over the pool edge. The possibility that a significant number of pool drownings occur when a diver strikes his head and is rendered unconscious cannot be excluded, since concussion and spinal cord injuries may be undetected at autopsy.

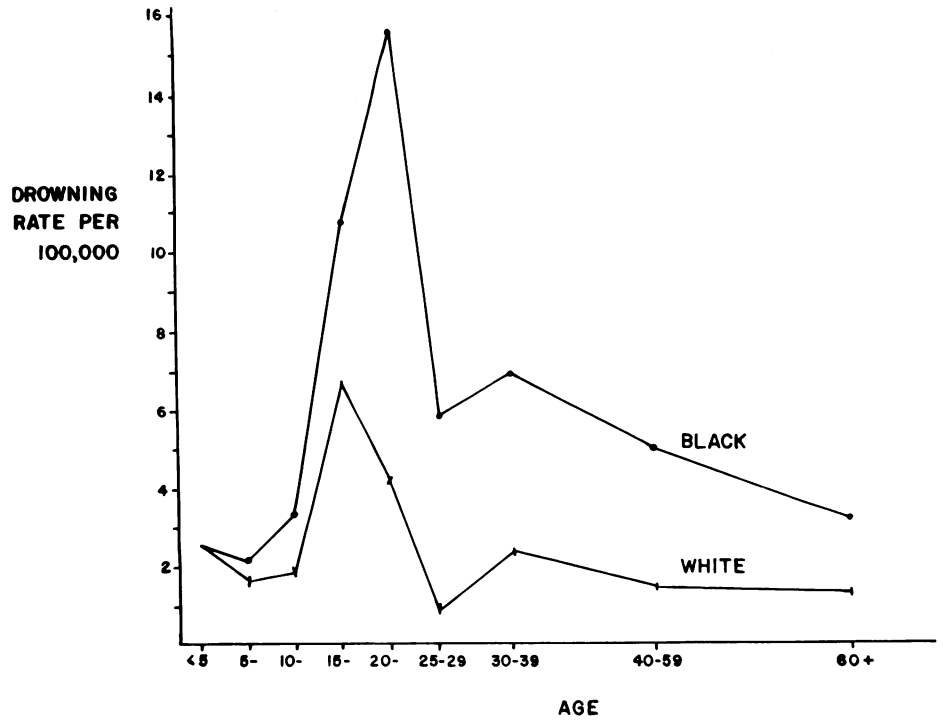

FIGURE 1 Drowning rates by age and race, based on Maryland population (1970 census).

TABLE 2—Frequency of Drowning by Activity and Location

Body of Water	Swimming	Boating*	Fell or Stepped into Deep Water	Child Playing near Water	Other or Unknown	Total
Ocean	0	1	0	0	1	2
Bay, harbor	5	5	4	0	2	16
River, creek	19	23	15	2	2	61
Lake, reservoir, quarry, pond	12	5	3	0	0	20
Swimming pool	4	0	0	7	2	13
Ditch, hole	0	0	0	1	1	2
Bathtub	0	0	0	0	3	3
Total	40	34	22	10	11	117

*Includes 12 persons who fell from boats.

TABLE 3—Watercraft Involved in Drownings

Type of Boat	Boat Sank or Capsized	Person Fell from Boat	Boat Collided with Other Object	Total
Raft, surfmat	1	2	0	3
Canoe	5	0	0	5
Sailboat	1	0	0	1
Rowboat	0	2	0	2
"Small boat" (rowboat or outboard)	4	5	0	9
Outboard motorboat	8	1	3	12
Inboard watercraft	0	2	0	2
Total	19	12	3	34

RESCUE AND RESUSCITATION

A common belief is that a drowning person will surface three times and then disappear. Among 34 cases for which information was available, none surfaced three times; one surfaced twice; three surfaced once; and 30 not at all. Despite immediate rescue attempts, recovery of the body from murky or deep water was often possible only with the aid of scuba divers or of special equipment available to police and fire departments.*

Eighty-eight drownings were witnessed, usually by friends or relatives of the deceased, and even in unwitnessed cases the body was frequently discovered by friends or relatives.

Resuscitation of some kind, often unspecified, was attempted in at least 19 cases, but in many instances it was not possible to determine whether such efforts had been made. The duration of submersion for recipients of resuscitative efforts ranged from 10 min to 2 hr. Visible decomposition when discovered accounted for lack of resuscitative efforts in eight cases.

Resuscitation was attempted on five or six of six persons known by their discoverers to have been submerged less than 15 min. However, resuscitation was attempted on only seven to nine of 15 persons discovered by adults in circumstances offering no indication of the duration of submersion.

SURVIVORS OF BOATING MISHAPS

Seventeen incidents in which drowning followed the capsizing or sinking of a boat resulted in the loss of 19 lives. An additional 24 passengers survived these same 17 incidents, in each case by successfully swimming to shore. In no case did fellow passengers survive as a result of having remained with the boat, perhaps because no drownings occurred when entire groups followed this rule of water safety.

Information was seldom obtainable concerning life jacket availability or use by survivors. In two instances, however, misallocation of available equipment was evident: too few jackets were available, and these were worn by people said to be able to swim, while the nonswimmer had no life jacket and drowned.

Alcohol Study Group

As explained above, a secondary study group was used to investigate the role of alcohol in drownings. The 45 cases meeting the criteria for inclusion in this group did not differ significantly from the 117 cases in the Primary Study Group as to race or sex. They differed, of course, as a result of the criteria by which they were selected: all were age 15 or older, drowned in Baltimore City, were not immersed during a car or truck collision, and were submerged less than 12 hr.

Twenty-one (47 per cent) of these 45 cases had positive blood alcohol concentrations (BACs), ranging from 0.03 to 0.26 per cent by weight, with median and mean values of 0.19 and 0.18 per cent by weight, respectively. All but four of the positive alcohol determinations were 0.10

* The "dead man's float" is a phenomenon peculiar to those who are alive and those who have been dead long enough for putrefactive gas formation to have raised the body to the surface.

per cent or higher, concentrations almost universally recognized as indicating significant intoxication.

Persons age 20 to 44 years more frequently had been drinking alcohol than those older or younger, but the numbers were too small for the difference to be statistically significant. All but one of the persons age 25 or over with positive BACs had concentrations greater than 0.10 per cent by weight. There was no difference between races or sexes in the proportion with positive alcohol determinations.

The time of drowning was known in 28 cases. Twelve of the 21 drownings occurring between noon and 1:00 a.m. involved alcohol, while alcohol was involved in none of the seven drownings occurring before noon.

Table 5 shows alcohol in relation to the circumstances of drowning. Alcohol was present in 11 of the 14 swimming deaths (78 per cent); in seven the concentration was greater than 0.15 per cent by weight.

Alcohol was involved in only two bathtub drownings. One person with a BAC of 0.26 per cent drowned in a partially filled bathtub, apparently having been rendered unconscious by striking her head as she fell into the tub; another with a history of seizures and a BAC of 0.24 per cent drowned while bathing. Eight other bathtub drownings were apparently related to seizure disorders (five cases) or other preexisting illness, but not to alcohol.

Five of six males who drowned while at work had negative alcohol determinations. One was knocked from a barge into the harbor by malfunctioning construction equipment; another fell from a crane located on a barge. An 18-year-old crewman was painting a freighter and fell from the scaffolding. Two men drowned while working in sewers: one slipped from a ladder, the other was washed away by an unexpected rain storm. The sixth had a blood alcohol concentration of 0.20 per cent by weight and fell from a pier at the shipyard where he worked.

Five floodwater drownings met the criteria for the Alcohol Study Group. Three were positive for alcohol: two who abandoned their cars and a third who left a roadside diner "to help the flood victims" and was last seen alive clinging to a telephone pole.

Tropical Storm Agnes Flood

Sixteen drownings occurred in June, 1972, in flood waters associated with Tropical Storm Agnes. Six adult motorists drowned in their cars or soon after abandoning them. Two of these cases were of particular interest because they suggest needed modifications of vehicles or environment: in one case a man was trapped in his car, allegedly as a result of electrical short-circuiting which prevented release of the power windows and door-locks; in the other, a woman was walking through floodwaters, after abandoning her car, and fell through one of several storm drains that were exposed when rising water displaced their protective coverings.

Three children drowned in a stalled car after the driver had been swept away by the flood; the family had just been evacuated from its home in the flood plain and could not find a road to safety. One man drowned when he and a friend explored a flooded swamp in a canoe, which became entangled in the wreckage of an overturned high voltage tower; another was attempting to cross a flooded river on a raft.

Three pedestrians drowned when caught in floodwaters, and one man drowned while attempting to rescue others. A woman fell into floodwaters during an attempted helicopter rescue from a tree in which she had taken refuge.

Discussion

From an epidemiological perspective, drowning may be viewed as an interaction between host (person) and agent

TABLE 4—Drownings in Which Preexisting Organic Disease May Have Played a Part

Age	Sex	Circumstances of Drowning	History of Disease	Autopsy Findings
Years				
7	M	Set himself adrift in family rowboat; fell or jumped overboard	Mental retardation, epilepsy, hemophilia	Not performed
8	M	Fishing from pier; fell off during witnessed seizure	Epilepsy	Not performed
9	M	Escaped from institution for retarded children; drowned in swimming pool	Severe mental retardation, congenital encephalopathy	Polygyria of parietal and temporal lobes
23	M	Drowned in bathtub while bathing	Epilepsy; 1–4 seizures/week	Sclerosis of amygdala, Ammon's horn, and cerebellar tonsils; old cerebral contusions
39	M	Drowned while cleaning leaves from bottom of pool	Myocardial infarction; diabetes mellitus; narcotic and amphetamine abuse	Myocarditis, including sinoatrial node
47	M	Disappeared from group of institutionalized patients; fell or jumped into river	Organic brain syndrome; seizure disorder	No pathological diagnoses other than drowning
65	F	Drowned in bathtub while bathing	No known history	Advanced arteriosclerotic cardiovascular disease; 90% coronary occlusion

TABLE 5—Frequency of Drowning by Activity and Blood Alcohol Concentration

Blood Alcohol	Swimming	Boating*	Fell or Stepped into Deep Water	Other	Total
Per Cent by Weight					
0.00	3	3	8	10	24
0.01–0.04	0	1	0	0	1
0.05–0.09	2	0	0	1	3
0.10–0.14	2	0	0	0	2
0.15–0.19	2	2	0	1	5
0.20 or over	5	1	3	1	10
Total	14	7	11	13	45

* Includes four persons who fell from boats.

(water), occurring with or without the intervention of a vector or vehicle (most often a boat, in the present case) in a variety of environmental settings. This view of drowning emphasizes the similarity not only between drowning and disease but also between drowning and other types of injury-producing interactions between man and his environment. Drowning and highway death, for example, share certain etiological factors such as alcohol intoxication and suggest common preventive measures such as better emergency systems. The two phenomena are also similar in regard to some of the circumstances surrounding the events: for instance, fatal crashes are not usually associated with high density rush hour traffic, and drowning (at least in Maryland) is rare at crowded beaches.

The similarity between drowning and highway death is further emphasized by the aptness of a single basic model[9] for categorizing both phenomena. Countermeasures that would have been effective in preventing the drownings in this study are categorized in Figure 2, which is adapted from the framework developed by Haddon[9] and used to categorize highway safety measures. In place of "pre-event," "event," and "postevent" phases, preventive measures are categorized as those that would prevent an involuntary or hazardous immersion ("preimmersion" phase); those that prevent drowning once immersion occurs ("immersion" phase); and those relating to reversal of potentially fatal events by retrieval and resuscitation ("postimmersion" phase). Measures relevant to host, agent, vehicle, and environment are suggested for each of these phases.

It is important to recognize that although many drownings in this study were the result of a combination of several factors—such as intoxication *and* working above water—the presence of a single preventive measure such as a lifeline would have been sufficient to avert death. Furthermore, preventive measures do not need to be directly related to contributing causes[10]: the alcoholic can be saved by a life jacket or a railing even if the problem (alcoholism) that places him in a high risk group is not solved.

Host Factors

PREIMMERSION

Preventive measures in this category consist mainly of education and training.

The problem of identifying segments of the population with the greatest exposure to the hazard of drowning has not yet been surmounted in drowning research. While this limitation impedes identification of etiological factors, it does not affect the implications for educational programs. For example, even if one group were shown to have greater exposure and/or more deaths than a second group, higher drowning *rates* among the second group would indicate that they are most in need of water safety instruction.

The current trend seems to be to expand existing programs of swimming instruction at YMCAs, public pools, camps, etc., while establishing new programs through public schools. One of the drownings in our study population, for example, prompted the organization of a "Learn to Swim" program that offers beginning instruction to over 500 sixth graders annually. In this program, instruction is given at available pools during school time, and only children in need of beginning instruction are permitted to attend. If public schools are to become the administrative agencies of swimming programs, such programs will exist primarily where funding is available. One potential contribution of epidemiological data is the directing of federal or state funds to those schools with the greatest enrollment of groups known to have high drowning *rates.* The high rates among males and among blacks suggest that black males are the group most in need of water safety instruction.

Lack of adult supervision was an important factor in 10 of the 16 drownings in the age group 0 to 9 years, i.e., in 9 per cent of the Primary Study Group. None of these children drowned while being bathed, although other investigators have reported that slightly over 20 per cent of drownings in the 0 to 4 age groups occur during baths.[3,4] Seven of the 10 unattended children found their way into swimming pools, comprising over half of the pool drownings in the primary series. Webster[11] found that this 0 to 9 age group accounted for over half of 484 pool drownings in 1965. These data suggest that educational efforts directed toward parents should concentrate on families living in areas where swimming pools, including the portable, above ground type, are common.

Preexisting illness which may have contributed to drowning was identified in 6 per cent of the Primary Study Group. The finding of preexisting illness in a greater proportion (20 per cent) of the Alcohol Study Group is related to an increased frequency of bathtub drownings in

	PREIMMERSION PHASE	IMMERSION PHASE	POSTIMMERSION PHASE
HOST (PERSON)	Alcohol education	Life jackets	Visible swimwear
AGENT (WATER)	No swimming pool	Shallow baths	Underwater lights
VEHICLE (BOAT)	Stable watercraft	Adequate flotation	Lights on boats
ENVIRONMENT	Barriers	Lifelines	Rescue systems

FIGURE 2 A framework for categorizing countermeasures with examples of measures that might have prevented Maryland deaths (adapted from Haddon[9]).

the city population (all of the city drownings in which illness was identified occurred in bathtubs). Adams found preexisting illness in 22 per cent of 163 drownings in Australia.[4] Of 20 persons in the combined Primary and Alcohol Study Groups in whom illness was identified, eight were known to suffer from seizure disorders. Drowning has previously been reported to account for 2 to 15 per cent of deaths among epileptics,[12,13] and was the second most common immediate cause of death in a series of 66 male epileptics.[13] Counseling for every patient who experiences periodic lapse of consciousness due to seizure activity, transient ischemic attacks, or any other cause should emphasize the special hazards posed by aquatic environments. In particular, such patients should be advised to bathe in the smallest possible amount of water, for it is in the bathtub that exposure is most frequent and the danger least evident.

The role of alcohol in drowning has been neglected in both the popular press and the public health and medical literature. This is explained, in part, by the failure of most studies to utilize adequate sampling techniques. Few medicolegal facilities determine blood alcohol concentration for all persons who drown, and those selected for alcohol determinations are chosen on a nonrandom basis. A test for alcohol may be made, for example, primarily when there is a history of alcohol use or if the drowning is unwitnessed or otherwise suspicious. In any case, unless tests are performed on an appropriate sample or in 100 per cent of cases, it is impossible to be confident that the sample is representative of all drowning deaths.* Working under such a handicap, other investigators have implicated alcohol in 7 per cent (United Kingdom)[14] to 21 per cent (Norway)[15] of all drownings, in 34 per cent of drowned persons age 15 and over (Finland),[6] and in 35 per cent of drowned persons age 20 and over (British Columbian Indians).[16] None of these studies controlled for submersion time or indicated the proportion in whom decomposition may have permitted endogenous alcohol production through fermentation.

Two previously published studies, on the other hand, have used series of consecutive adult drownings and have controlled for decomposition. Waller,[5] working in Sacramento, California, included only cases known to have been submerged less than 6 hr, and BACs were known in all or almost all cases. Positive BACs were found in five of 17 cases (29 per cent); four (24 per cent) had BACs of 0.10 per cent or higher. Analysis of Plueckhahn's data on drowning in Geelong, Australia, reveals that, for a sample comparable to that reported in the present paper, BACs were positive in eight of 18 cases (44 per cent); seven (39 per cent) had BACs of 0.10 per cent or higher.

The present study reveals the highest proportion of positive blood alcohol concentrations known to have been reported in persons who drowned in the United States: 21 (47 per cent) of the 45 persons age 15 and over had been drinking, and 17 (38 per cent) had BACs of 0.10 per cent or higher.

Although it is possible that these high figures reflect factors unique to the city of Baltimore, our impression based on limited data available from the Maryland counties is that alcohol is a widespread concomitant of adult drownings. The results of Waller and of Plueckhahn, based on smaller numbers, do not differ significantly from ours. Inasmuch as alcohol is now widely recognized as an important etiological agent in highway fatalities,[17] it is interesting to note that a study of fatally injured drivers in Baltimore[18] revealed a proportion of positive BACs (58 per cent) and a mean positive BAC (0.16 per cent) that do not differ significantly from figures from the present study.

That alcohol is important in the *etiology* of drowning seems to us to be established beyond dispute, for it is inconceivable that 47 per cent of all persons age 15 and over who are exposed to the possibility of drowning have been drinking alcoholic beverages. More especially, the frequency with which alcohol was observed among drowned adult swimmers (11 of 14, or 78 per cent) speaks for itself. Shakespeare seems to have been wise beyond his time when he wrote:

> What is a drunken man like? Like a drown'd man, a fool, and a madman: one draught above heat makes him a fool; the second mads him; and a third drowns him.—*Twelfth Night* (I; v; 140).

In response to the need for public awareness, swimming and boating courses should emphasize the increased hazard of aquatic sports for persons who have been drinking. Safety Councils could attempt to inform the general public in this regard and might also sponsor public announcements and distribute stickers displaying a phrase

* Routine testing for alcohol should include children age 12 and over: a 13-year-old boy in the Primary Study Group had a blood alcohol concentration of 0.18 per cent.

such as "Drinking like a fish doesn't make you one." Also, commercial advertising practices should be changed, for alcoholic beverages are frequently shown in association with such activities as swimming, boating, and fishing.

IMMERSION

For either the nonswimmer or the trained swimmer faced with unusually challenging situations, a life jacket can mean survival. There was no evidence to suggest that anyone in the present study had been wearing a life jacket. The rarity of fatal sailing accidents, despite the great popularity of sailing in Maryland and the tendency of small sailboats to tip over, may reflect both swimming ability and life jacket usage among sailing enthusiasts. The absence of water skiing fatalities in our study population may also reflect the common practice among water skiers of wearing life belts, even though Maryland is not yet among the states that require them by law.

POSTIMMERSION

In the present series, 75 per cent of drownings were witnessed, in most cases by persons old enough to have learned lifesaving and resuscitation techniques. The frequency with which persons slipped rapidly out of view, and the failure of recovery efforts even in the first few minutes, suggest that a major obstacle to successful drowning control is delay in retrieval due to inability to locate a body underwater.

It is therefore suggested that clothing manufacturers take it upon themselves to develop clearly visible swimwear, possibly incorporating phosphorescent material.* If luminescent materials prove impractical, certainly swimwear could be colored yellow (as is much scuba equipment) or orange (the traditional color for life jackets).

Agent (Water)

PREIMMERSION

Haddon[10] points out that one of the many available options for reducing drownings would be not to collect water in a quantity adequate for drowning, e.g., not to build swimming pools. Although this option may be unacceptable to many people, it is worthy of note that of the seven children age 5 or younger who drowned in swimming pools, none was black. The fact that blacks in Maryland are far less likely than whites to be able to afford swimming pool ownership or membership thus serves to pinpoint a hazard that could be avoided.

On a larger scale, flood control programs are also concerned with preventing the accumulation of water in hazardous quantities. One factor often pointed to in connection with Maryland's unprecedented 1972 flood was the reduction in absorptive capacity of the land due to extensive paving and building during recent decades.

IMMERSION

Once in the water, whether a person drowns may depend both on the quantity or depth of the water and on such qualities as turbulence or temperature. The importance of shallow baths for the epileptic, as discussed above, could also apply to persons with other disabilities. In addition, 10 drownings occurred in natural bodies of water when people stepped into unexpectedly deep areas. Wherever possible, holes, depressions, or cliffs should be eliminated or clearly marked in frequented swimming areas.

Although it was not possible to evaluate the importance of water temperature in the present series, immersion hypothermia[21] is sometimes the principal cause of death while immersed in water (for example, after shipwrecks).†

POSTIMMERSION

Increasing the transparency of a body of water could be influential in retrieval efforts. Some of the nightime swimming pool deaths in the present study might have been prevented by underwater lighting.

Vehicle (Watercraft)

PREIMMERSION

One of the boats that tipped over (and the only sailboat in the study) was a small, styrofoam sailboat. Although the person who thus drowned was 23 years old, the incident raises the question of whether the least stable sailboats are being manufactured for a market consisting primarily of our least experienced sailing population.

IMMERSION

Current regulations requiring flotation devices in canoes, rowboats, etc., are a response to the need for a boat to stay afloat, even when it has tipped over or is full of water. At least one rowboat in the study did not have flotation adequate to provide buoyancy for all of its occupants once it had filled with water.

POSTIMMERSION

Spotlights on boats that are used at night are not only important in averting collision (preimmersion phase) but can be of assistance in locating persons who would

* Bioluminescent materials which merit consideration for this purpose include extracts of the "marine firefly," *Cypridina hilgendorfi,* and the jellyfish *Aequorea aequorea.* The former retains its power to luminesce for years whenever moistened,[19] while the latter represents an especially simple reaction, requiring only calcium ions and water for in vitro luminescence.[20]

† It has been suggested that alcohol may contribute to drowning by dilating cutaneous blood vessels, thereby hastening heat loss. Keatinge[22] has demonstrated experimentally, however, that drinking moderate amounts of alcohol does not significantly increase mean fall in rectal temperature during immersion in water at 15° C.

otherwise drown (for example, the several persons who drowned following falls from boats at night, when their fellow passengers were unable to find them).

The Environment

PREIMMERSION

More than a fourth of the drownings in the Primary Study Group occurred in the course of activities not normally thought of as imposing a danger of drowning. Wading, fishing from docks, bridges, or the shore, and playing, walking, or driving near water result in drowning primarily when structural characteristics of the environment permit excessive interaction between host and agent. At least 23 of the 117 drownings in the Primary Study Group could have been prevented by modifications in the physical environment: adequate railings along riverbanks (6), bridges (2), and wharfs (4); adequate barriers around swimming pools (9); and adequate guardrails along roads bordering ditches and waterways (2).

The failure of many of the popular types of fences built around swimming pools to exclude children has been well documented.[11] One child in the present series drowned in a pool which was unfenced, yet complied with the local building code in being located the requisite distance from the nearest property line.

IMMERSION

All six of the men who died while at work—both those who drowned in sewers and those who fell into the water—might have been saved if a lifeline had been attached to them and to a fixed structure.

POSTIMMERSION

Only one drowning in the study was known to have occurred where a lifeguard was on duty, and in that instance the lifeguard was pulling weeds nearby. The absence of drownings at Maryland's popular beach resorts may be due in part to the presence of lifeguards, who can be effective not only in retrieval and resuscitation, but also in encouraging disciplined, less hazardous water activity.

Although comparable data are not available for nonfatal near-drownings, our observation that fatalities occurred in circumstances in which the first persons on the scene were likely to be laymen (friends or relatives of the deceased) emphasizes the importance of training a substantial portion of the population in techniques of mouth-to-mouth resuscitation. Obviously, this must be backed up with emergency systems that can respond with both appropriate equipment and trained personnel to crises such as drowning.[23]

The above examples do not include all possible preventive measures. Rather, drawing on evidence from the present investigation, they suggest the wide variety of approaches that must be undertaken in order to substantially reduce the extensive loss of life due to drowning.

Regional differences in climate and geography will produce differences in drowning rates and circumstances. Scuba and skin-diving fatalities, for instance, are common in Florida and California,[24] and hundreds of persons die each year in the treacherous surf at Rio de Janeiro's attractive beaches. However, many of the preventive measures suggested by these Maryland deaths are applicable throughout the world and under a variety of conditions.

Summary

Three groups of accidental drownings in Maryland were investigated: 16 deaths during Tropical Storm Agnes; 117 other Maryland deaths in 1972; and 45 adults who drowned in Baltimore City in 1968—1972. Statewide, 34 per cent of the drownings involved swimming and 29 per cent resulted from boating mishaps. Drowning was rarely associated with swimming in the ocean or with sailing, two popular Maryland sports. Drowning rates were higher for males, especially those age 15 to 24, and were 2.6 times as high for blacks as for whites. Bathtub drownings were usually associated with preexisting disease, primarily seizure disorders. Blood tests for alcohol were positive in 47 per cent of the adults who drowned in Baltimore; positive tests were especially common in swimming deaths. Possibilities for prevention include water safety instruction for high risk groups, development of highly visible swimwear, and environmental modifications.

Health professionals who wish to direct their efforts toward a major cause of death can give effective leadership to communitywide campaigns to prevent drownings. When counseling patients, physicians have an opportunity to emphasize that alcohol increases the hazard of water sports just as it adds to the hazard of driving. The words "or drinking" must be added to the well known dictum, "never swim after eating."

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UNIVERSITY OF COLORADO TO HOLD POPULATION SEMINARS

The University of Colorado, in cooperation with Planned Parenthood/World Population, is presenting a series of seminars regarding population problems and their possible solution. The object of the seminars is to increase physician awareness regarding the seriousness of the population problem, to give physicians an exposure to its potential solutions, and to motivate them to find one or more areas where they can apply their efforts in an attempt to help solve this problem.

The seminars are open to any physician from the developing nations, regardless of his field of specialization, who is in the U.S., if he intends to return to work in a developing country within 1 year following completion of the course or to any missionary physician who is in the U.S. on furlough, but will be returning overseas. The Institute is also inviting participation by English-speaking Mexican physicians who are working in Mexico.

Funds have been obtained to pay round trip transportation expenses from the applicant's address and living expenses while at the seminar. Sixty applicants will be accepted for each session.

The seminars will be 1 week in duration and will run from Monday through Saturday noon. The dates for the next two sessions are May 20—25 and June 17—22, 1974.

Topics for presentation include: demographic background, contraceptive background, contraceptive technology, common diseases encountered in family planning programs, and the social and political background of family planning programs in the developing nations.

For additional information concerning the seminars contact: Thomas Moulding, MD, University of Colorado Medical Center, 4200 E. Ninth Ave., Denver, CO 80220.