A report is presented on a five-state study of 1,201 drownings during a 12-month period ending June 30, 1966. More than a score of variables involved were analyzed and the findings are discussed. The need for more valid information and for further studies along various lines is emphasized.

AN INTERSTATE DROWNING STUDY

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OVER a hundred persons accidentally drown in an average week in the United States and there is currently no systematic recording of the major causes or factors leading to their demise.

In an effort to cast light on the potential causes and other factors associated with drownings and hence to formulate more refined, expanded, and specific safety precautions to prevent these tragedies, a study of the drownings in five states in the United States for a twelve month period was undertaken.

Drowning Incidence in Illinois and the United States

With the rapid increase in aquatic activities such as boating, fishing, swimming, water skiing, scuba diving, etc., plus the increase in the number of residential, public, and quasi-public swimming pools, plus the increase in population and the greater amount of leisure time available for water recreational activities, it seemed almost certain that the number and rate of accidental drownings would increase. This assumption, however, did *not* appear to be borne out by the figures from the National Office of Vital Statistics. Although in 1949 the definitions and codings of drownings were changed to give more specific information on water transport accidents—that is to separate drownings that occurred in small boats from those that occurred in larger ferries and ocean liners—the combined total did *not* increase as one might have anticipated in view of the increasing population and increasing exposure. The total number of drownings from all causes remained relatively constant from 1939 to 1965. It fluctuated from 6,537 in 1939 to 6,799 in 1965, with a low of 6,131 in 1950 and a high of 7,482 in 1958. The rate (drownings per hundred thousand general population), however, decreased from about 4.2 in 1939 to 2.8 in 1965 for general drowning. For water transport accidents (i.e., accidents in large and small boats resulting in drownings) the rate remained at about 0.6 to 0.8 during these years.

Whether this reflects the result of rather extensive water safety activities during the past two or three decades—such as those in the programs of the national and local Red Cross, Safety Councils, YMCA's, Coast Guard, state and local public health agencies, and the United States Public Health Service—is not known. It does, however, seem reasonable to believe that these programs may have had a salutory effect.

However, regardless of whether or not the decreasing drowning rate is about to reverse itself, because there are still well over 6,000 drownings annually in the USA, intensified efforts to reduce these are well warranted. Moreover, detailed analysis of the drowning deaths in Illinois during each of the last three summers appears to reveal a clear-cut, progressive increase.

Arrangements were made to analyze all of the drownings that occurred for the twelve month period ending on June 30, 1966, in five states (Illinois, Colorado, Florida, North Carolina, and New York). With the exception of New York State, information was obtained on all, or nearly all, drownings that occurred in each of these states; questionnaries were returned on 100 per cent of the drownings that had been reported in Illinois and North Carolina; on 414 out of 440 of the drownings that had occurred in Florida; on 79 of the 121 drownings that had occurred in Colorado. However, New York State, because of the inability to get the cooperation of many of its coroners, was able to give information regarding only 153 out of 492 drownings.

Design of Study

In addition to ability to swim, presence of lifeguards, type of activity (i.e. bathing, boating, fishing, scuba diving, etc.), site, age, and sex, other factors such as very low water temperature, ingestion of alcohol or food, type and timing of resuscitation attempts, use of life preserver, and the like, were included. These items were set up on the questionnaire so that the answers could be recorded through the use of linear pencil marks on paper forms; these forms could be scanned by optical instruments that automatically punched cards. A detailed type of optical screening form is used.* (This form is partially reproduced in Figure 1.)

The forms were checked when received and, if necessary, letters or telephone calls were made to query incomplete forms or forms where there were questions.

In each of the participating states, one or more members of the Department of Public Health acted as the chief liaison person to facilitate the obtaining of the information, the querying of results, and the relaying of the various data obtained. Without the assistance of these individuals and the endorsement and sanction of the study by the state health officer in each of these states, the study would not have been possible. We give grateful acknowledgment for the assistance of those individuals, who are listed at the conclusion of this study.

Results

Seasonal Incidence

Table 1 tabulated the number of drownings by state for each of the twelve months. This shows that even in Florida, where a large proportion of the state has swimming and boating weather throughout the entire year, a seasonal peak of drownings occurred during the summer months. For example, the July and August drownings in Florida were 54 and 45, respectively, compared with 18 and 16 for the months of January and February. The analogous figures for Illinois were 58 and 40, versus 12 and 2, for North Carolina 50 and 36 versus 7 and 5, and for Colorado 20 and 19 versus 1 and 2. It is felt that this reflects the fact that a much larger number of persons are on or in the water during the summer months. In other words, the chance of drowning increases in a warmer climate and also increases during the summer, when so many people take their annual vacations and therefore have time to indulge in bathing and other aquatic sports.

* A limited number of sample forms is available from the author.

Figure 1

DROWNING STUDY

NAME OF STATE

1. NAME OF DECEASED

2. AGE OF DECEASED

3. SEX M F

4. DATE OF DEATH MO DAY

5. DEATH CERTIFICATE NUMBER

6. PLACE OF OCCURRENCE

7. STATE CODE (01–50)

8. DROWNING SITE ..... River | Quarry | Lake | Pond | Public Swim. pool | PVT. Fence Swim. pool | PVT. Unfence Swim. pool | Bath Tub | Ocean | Other

9. Was lifegaurd on duty at time of drowning? ..... Y N Unk.

10. Any history of injury associated with drowning? ..... Y N Unk.

11. Were any others drowned in same accident? ..... Y N Unk.

12. Were any others present at time of drowning? ..... Y N Unk.

Table 1—Number of drownings, by state and month

	Total	Colorado	Florida	Illinois	North Carolina	New York
Total	1,201	79	414	322	233	153
July, 1965	219	20	54	58	50	37
August, 1965	170	19	45	40	36	30
September, 1965	98	9	34	28	18	9
October, 1965	68	3	37	21	5	2
November, 1965	47	1	23	11	6	6
December, 1965	52	0	23	14	7	8
January, 1966	47	1	18	12	7	9
February, 1966	31	2	16	2	5	6
March, 1966	54	3	21	14	9	7
April, 1966	98	6	44	18	21	9
May, 1966	115	5	45	38	21	6
June, 1966	202	10	54	66	48	24

Age

Table 2 summarizes the number of drownings by site, age group, and sex. It is obvious that the "teenager"—that is those between 10 and 19 years of age, where 292 of the 1,201 drownings occurred—is the age group that is chiefly involved. Of persons between 50 and 64, a 15- rather than a 10-year age span, only 154 died. Of persons between 20 and 29 there were 144 drownings. This may also reflect the degree of exposure, inasmuch as—particularly from the standpoint of swimming and boating—the teen-age group and the young adults up to 30 years of age would probably be exposed to drowning more frequently and for longer periods of time than the other age groups.

Difference Between States

The proportion of drownings in each of the age groups varies slightly from state to state but these differences do not appear to be significant. The same major clustering in the 10-19-year age group was noted in each of the states.

Separate tabulations were run for each of the variables studied in each state to see if any significant differences would be noted. The states participating: Florida, New York, Illinois, Colorado, and North Carolina represent a diversity of climatic conditions and considerable variety in the number and types of bodies of water. The states range from Florida that has year-round swimming weather in the southern part and over 1,000 miles of shore line, to the inland states of Colorado and Illinois. Some of the factors studied obviously differed from state to state. For example, the relative number of drownings in the ocean, lakes, rivers and quarries differed significantly as their incidence depended on the number of such bodies of water. The number of persons drowned while scuba diving was, as might be expected, concentrated largely in Florida. However, most of the other variables showed about the same proportions and same relationships in each of the states. Although separate state-by-state breakdowns were run and furnished to state officials for their own use and analysis, the totals from all five states were pooled for the

Table 2—Number of drownings by site, age group and per cent male in Colorado, Florida, Illinois, New York, and North Carolina: July 1, 1965-June 30, 1966

Site	All ages		Age Groups																	
			0–4		5–9		10–19		20–29		30–39		40–49		50–64		65+		NR	
	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male
Total	1,201	84.9	126	76.2	100	82.0	292	88.4	144	88.2	90	86.7	122	86.9	154	85.1	98	80.6	75	84.0
River	298	86.6	9	55.6	15	80.0	52	86.5	40	92.5	41	87.8	43	86.0	51	92.2	29	75.9	18	94.4
Quarry	31	96.8	2	100.0	2	100.0	16	93.8	3	100.0	1	100.0	4	100.0	—	–0–	—	–0–	3	100.0
Lake	275	89.1	15	93.3	19	84.2	84	91.7	49	85.7	20	85.0	26	96.2	34	88.2	15	93.3	13	76.9
Pond	130	88.5	11	81.8	18	88.9	50	94.0	11	100.0	5	80.0	8	87.5	12	75.0	5	100.0	10	70.0
Public swimming pool	30	83.3	3	33.3	4	100.0	14	78.6	2	100.0	—	–0–	1	100.0	1	100.0	4	100.0	1	100.0
Private fenced pool	24	83.3	13	84.6	2	100.0	5	60.0	—	–0–	1	100.0	—	–0–	1	100.0	1	100.0	1	100.0
Private unfenced pool	17	58.8	8	62.5	1	100.0	3	33.3	—	–0–	—	–0–	—	–0–	2	100.0	2	50.0	1	0.0
Bathtub	62	58.1	27	70.4	1	100.0	2	50.0	3	33.3	3	66.7	6	16.7	7	42.9	8	50.0	5	80.0
Ocean	85	87.1	—	–0–	7	85.7	16	93.8	13	84.6	6	83.3	8	87.5	12	91.7	14	78.6	9	88.9
Other	210	83.8	31	77.4	28	75.0	43	83.7	18	88.9	11	90.9	21	95.2	28	82.1	18	88.9	12	83.3
Gulf*	4	75.0	—	–0–	—	–0–	2	100.0	2	50.0	—	–0–	—	–0–	—	–0–	—	–0–	—	–0–
Canal*	35	80.0	7	85.7	3	33.3	5	100.0	3	100.0	2	100.0	5	80.0	6	66.7	2	50.0	2	100.0

* Category used for Florida incidents only.

purposes of most of this discussion and presentation.

Sites

The most frequent sites recorded (the places where the largest numbers of drownings occurred) for the five-state group as noted in Table 2 were rivers, lakes, ponds, and oceans, in that order. This may reflect simply where the largest number of unsupervised exposures occur. In Illinois, for example (as anticipated, with no ocean and Lake Michigan in a densely populated area) the lakes exceeded the rivers in frequency of drowning site. In Florida the combination of rivers and canals exceeded the lakes, with the ocean in third place. Perhaps this reflects the more frequent supervision by lifeguards on ocean beaches. In North Carolina the order was river, pond, lake; in New York it was river, lake, ocean; while in Colorado it was lake, river, and pond. The most frequent place for infants and children to drown was—as one might anticipate—in the bath tub or in swimming pools. A similar preponderance of drowning in bath tubs was noted for the elderly. This may merely reflect the fact that the very young and the very old are less likely to be engaged in relatively strenuous aquatic sports or recreational activities or it may indicate that the infants and children need more supervision in the bath tub and that the elderly are more prone to heart attacks, strokes or falls and if this occurs in a bath tub, "drowning" could be reported as the cause.

With the great increase in the construction of public and private swimming pools, special pains were taken to determine the probable role of these pools in accidental drownings. Private residential pools were distinguished from the public pools because public pools are utilized by a larger number of persons and are more likely to employ a lifeguard or attendant. The protective factor of an enclosure or fencing around private residential pools, to help avoid the accidental drowning by children from neighboring residences, was also included. It can be seen that the 41 drownings in fenced and unfenced private pools exceeded the 30 in the public pools. As might be expected, the victims in the private pools were concentrated in the age group under five years. This emphasizes the need for supervision and protective enclosures for these children.

Surprisingly, a large number of the drownings in private pools occurred where the pool was fenced (24 versus 17). Unfortunately it is not known whether this merely reflects the possibility that most private pools have a fence or other enclosure to keep stray dogs, squirrels, children, and other visitors out, and hence only relatively few pools have no enclosure; or whether the enclosure fails in its protective aspects. However, according to Robert M. Hoffman[2] in 1965 only 32.6 per cent of all residential pools and 26 per cent of nonresidential pools had fencing included as part of their original construction contract. Many pool owners nevertheless furnished fences under a separate contract, but the number of these is unknown, and thus it is difficult to evaluate this factor. We feel, however, that proper protective enclosures are valuable and desirable safeguards. Possibly some of the fenced pools where drownings occurred had fences designed primarily as a screen for privacy, and these fences were either unlocked or easily broached; hence, the fence might prevent persons from the outside from observing a child drowning.

A study by Webster[3] of 484 swimming pool fatalities in 1965 in the USA revealed that 230 occurred in private residential pools, 335 in hotel, motel, and apartment house pools, and 129 in nonresidential pools such as clubs, YMCA's, schools, and the like. In our study, as noted above, 41 of the 71 pool drown-

ings occurred in private residential pools. Webster found that in 249 of the 484 drownings a fence or other enclosure was absent or inadequate (i.e. one that could readily be scaled or penetrated by children). He also found that in 144 of 190 drownings that occurred in private residential pools, there was a lack of, or inadequate, protection by proper fencing or enclosures.

One of the factors that makes it difficult to assess the significance of the increasing number of pools as a potential drowning hazard is the difficulty in obtaining estimates of the number of persons using pools without drowning. In other words, the total number of persons at risk (e.g. "person-hours" or "person-days" in a pool) is difficult to determine. While there are reliable estimates of the number of pools, it is difficult to obtain similar information on the number of persons using a pool per day. It is likely that a much larger number of persons per pool use public pools rather than residential pools; this should be considered in assessing the relative risk. Of the 725,000 pools that were in use, as estimated by the 1967 Swimming Pool Industry Market Report, 514,100 were residential pools. The remainder included public pools such as those associated with hotels and motels, clubs, municipalities, schools, Y's, and so on. Most of the drownings in private pools reported in our study occurred among the youngest age group made up of children under the age of 5 (21 out of a total of 41), whereas in the public pools, it was the teen-age group from 10 to 19 where most of the drownings occurred (14 out of 30).

The category of "gulf" and "canals" in the tables refers only to the state of Florida. This is the Gulf of Mexico and the network of canals that parallel many roads in Florida. The preponderance of children under five years of age that drowned in canals in that state (7 of 35) suggests that they may have been playing on the banks of these canals. The older persons drowning there can be attributed to automobile accidents where control of the automobile was lost and the car became submerged in the canal, or to fishing mishaps.

Sex

It is clear that there is an unmistakable preponderance of males over females with 1,020, or 84.9 per cent of the total 1,201 drownings occurring in males. This preponderance as noted in Tables 2 and 3 extends to all age groups but is most clear-cut in the teen and the young adult age group. This disproportion between male and female drownings is less marked in the very young (0-4 age group) and in those over 65 years of age. This may reflect the larger exposure of males to aquatic sports and recreational activities, as well as the fact that they are usually more venturesome.

Activity

The most frequent single activity mentioned was, as one might expect, swimming, and—as summarized in Table 3—293 of the 1,201 deaths recorded this as the activity at the time of drowning. Swimming was followed by playing, power boating, and fishing, in that order.

Most of those who drowned while swimming were in the teen-age group (that is 10 to 19 years of age); 157 of the total of 293 persons who drowned while swimming were in this age group. As would be expected, those who succumbed while playing in the water were primarily children under 10 years of age, 96 of 132; curiously enough, those who succumbed while wading were primarily over 10 years of age, chiefly in the 10 to 19 year old age group. Power boating affected older individuals, rather than teenagers; this may reflect the fact that it requires a certain amount of afflu-

Table 3—Number of drownings by activity, age groups, and per cent male in Colorado, Florida, Illinois, New York, and North Carolina: July 1, 1965-1966

Activity	Age Groups																			
	All ages		0–4		5–9		10–19		20–29		30–39		40–49		50–64		65+		NR	
	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male	Total	% Male
Total	1,201	84.9	126	76.2	100	82.0	292	88.4	144	88.2	90	86.7	122	86.9	154	85.1	98	80.6	75	84.0
Swimming	293	92.2	—	–0–	20	90.0	157	93.0	50	90.0	14	92.9	17	94.1	13	92.3	12	91.7	10	90.0
Fishing	79	88.6	1	100.0	3	66.7	15	93.3	7	100.0	4	100.0	12	91.7	20	85.0	11	90.9	6	66.7
Power boating	105	86.7	4	50.0	4	100.0	8	100.0	20	90.0	21	90.5	20	85.0	18	88.9	7	100.0	3	0.0
Row boating	44	95.5	—	–0–	1	100.0	9	100.0	6	100.0	8	87.5	8	87.5	7	100.0	2	100.0	3	100.0
Canoeing	10	80.0	—	–0–	—	–0–	5	80.0	2	100.0	1	100.0	1	100.0	—	–0–	—	–0–	1	0.0
Sailing	7	100.0	1	100.0	—	–0–	1	100.0	2	100.0	1	100.0	1	100.0	1	100.0	—	–0–	—	–0–
Playing	132	74.2	55	70.9	41	73.2	20	70.0	2	50.0	—	–0–	—	–0–	—	–0–	—	–0–	14	100.0
Wading	58	75.9	6	100.0	8	87.5	22	63.6	4	75.0	4	50.0	1	100.0	5	100.0	4	75.0	4	75.0
Scuba diving	16	100.0	—	–0–	—	–0–	6	100.0	7	100.0	1	100.0	1	100.0	—	–0–	—	–0–	1	100.0
Skin diving	3	100.0	—	–0–	—	–0–	—	–0–	2	100.0	—	–0–	1	100.0	—	–0–	—	–0–	—	–0–
Surfing	1	100.0	—	–0–	—	–0–	1	100.0	—	–0–	—	–0–	—	–0–	—	–0–	—	–0–	—	–0–
Other water	76	77.6	12	83.3	7	85.7	13	92.3	10	80.0	5	80.0	10	60.0	9	66.7	7	57.1	3	100.0
Other nonwater	130	76.9	24	66.7	12	83.3	15	80.0	7	57.1	12	91.7	16	75.0	22	81.8	13	76.9	9	77.8
Unknown	247	85.4	23	91.3	4	100.0	20	85.0	25	88.0	19	78.9	34	94.1	59	83.1	42	76.2	21	90.5

ence to be able to purchase a power boat. The drownings in this activity were rather evenly distributed between those in each of the age groups between 20 and 65.

The sex differential as related to differences in activities is somewhat similar to that related to differences in site of drowning. In other words, a strong preponderance of males is present not only in activities like fishing, swimming, power boating, and sailing (where one would expect it) but also present, though to a lesser degree, in such activities as playing, wading, and row boating.

Ability to Swim

Table 4 summarizes the number of drownings by type of swimmer and activity. Although the value of this table is impaired by the fact that in over half of the instances (649 of 1,201), information as to the swimming ability was not known; nevertheless, of the remaining 552 who drowned, 121 were classed as good swimmers; almost half (56) of these good swimmers drowned while they were swimming. An additional 117 of the 552 were classed as average swimmers. It can thus be seen that *over-confidence or poor judgment* is a definite factor in a significant number of drownings! Table 4 also indicates that 19 persons who were non-swimmers died while they ostensibly were swimming. In checking these reports, it was noted that these persons were actually bathing or playing in the water rather than swimming in the customary sense.

Use of Life Preservers

The use of a life preserver as an essential adjunct to boating has been frequently recommended. Tabulations were run to determine whether staying with the overturned boat and the use of a life

Table 4—Number of drownings by type of swimmer and activity in Colorado, Florida, Illinois, New York, and North Carolina: July 1, 1965-June 30, 1966

Activity	Total	Type of swimmer				
		Good	Average	Poor	Non-swimmer	Unknown
Total	1,201	121	117	62	252	649
Swimming	293	56	72	37	19*	109
Fishing	79	3	6	4	18	48
Power boating	105	16	14	0	19	56
Row boating	44	5	3	5	9	22
Canoeing	10	7	1	0	0	2
Sailing	7	3	0	0	1	3
Playing	132	3	3	1	80	45
Wading	58	4	1	6	30	17
Scuba diving	16	8	4	0	0	4
Skin diving	3	2	0	0	0	1
Surfing	1	0	0	0	0	1
Other water activity	76	2	5	1	15	53
Nonwater activity	130	3	3	2	29	93
Unknown	247	9	5	6	32	195

* "Bathing" rather than swimming.

preserver while awaiting rescue was, in fact, beneficial.

They revealed that only 5 of the 166 that drowned while boating had used a life preserver *and* stayed with the boat. Although this is a rather small percentage, it was felt that it should be further explored. In reviewing individual case histories among these five, it was determined that in at least two instances, the life preserver had not been securely fastened to the victim. In one of these cases, the preserver was a seat cushion that had slipped from the victim's hand, and in the other the victim had lost the preserver while he was drifting in the water. A third instance illustrates the necessity for not only securely attaching the life preserver but for attaching it properly so that no loose straps with loops, or other possibilities of entanglement, might occur. In this instance a six year old boy who was wearing a life preserver was trapped under the boat by the loose loop of a strap on the life preserver jacket. In several instances persons held onto the boat at first, but later lost their hold, became separated from the boat, and drowned. The possibility of recommending handles or grips on the bottom of all boats to facilitate using the overturned boat itself as a life preserver is, therefore, raised.

Only 14, or less than 10 per cent, of those who drowned in association with boating accidents used life preservers, and as indicated above, even among those who used life preservers many of them either used them improperly or they did not securely fasten them. This emphasized the point that properly designed and fastened life preservers are a very important factor in boating safety.

Being a good swimmer of itself does not necessarily protect one from drowning during boating accidents. At least 31 of 112 boaters who drowned and whose swimming ability was recorded were good swimmers.

An effort was made to see whether injuries such as striking one's head while diving were responsible for many drownings. Although this factor was unknown in 206 of the 1,201 instances, it was reported as a contributing factor in 51 drownings.

Supervised swimming, i.e., having a lifeguard on duty, is obviously an added safety factor. However, complete reliance on this, to the exclusion of close supervision by parents or companions, is undesirable. This fact appears to be underlined by the finding that in 61 out of 1,071 cases where the presence or absence of a lifeguard was recorded, one *was* on duty.

Necropsies to Identify Homicide, Heart Attack, or Stroke as Causative Factors

Although the great majority (1,017 of 1,065) of the drownings were accidental, 48 were intentional (44 suicides and 4 homicides). In the total series of 1,201 there were 136 cases in which the above factors were undetermined. It is quite possible that in a significant number of undetermined cases, drowning was intentional rather than accidental. Many of these victims were found floating in the water, sometimes days or weeks after death.

In many, if not most, instances of drownings there are no witnesses who see the individual "go under." Where there are no direct witnesses, the possibility of foul play exists and a necropsy should be performed to determine whether or not poisoning from such chemicals as "knock-out" drops (chloral hydrate) or opiates had occurred, or whether there are evidences of not readily observable injury. A postmortem pathological examination can also be helpful in identifying stroke or heart attack as causative factors. In spite of this, in 704 of the 1,201 cases no autopsy was performed, and in 98 additional instances it was not known whether or not a necropsy was

performed. Similarly, inquests were not held in 613 cases, and in 237 it was not known whether or not inquests were held. Illinois had the largest percentage of cases in which necropsies were performed (173 out of 322), and Florida was next with 135 out of 414.

Artificial Respiration

Artificial respiration was definitely attempted in only 275 of 884 cases; in 317 of the 1,201 it was not known whether or not this was used. In the remaining 609, presumably the body had been in the water too long to make it desirable or feasible to attempt artificial respiration. However, of the 275 cases where it was attempted, resuscitation efforts had been started less than five minutes after the apparent drowning for 37 of the victims. In view of the fact that when properly performed by mouth-to-mouth methods, resuscitation is often effective in reviving a victim, further study was undertaken of those cases in which the attempt was unsuccessful, even though it was started in less than five minutes. In several of these it was learned that although resuscitation was started within five minutes after the body was recovered, the body had been under water far longer than five minutes. It is felt that either this time factor or improper use of the mouth-to-mouth method probably contributed to the lack of success in resuscitation where efforts were started in less than five minutes elapsed time.

Fatal Attempts to Save Others

Frequently a single drowning accident is turned into a double or triple one by unskilled or inadequate efforts of incompletely trained individuals to save drowning persons. In an effort to learn more about this factor, the circumstances surrounding the drowning of persons who had been trying to save others were studied. In 42 of the 1,024 victims, this was the activity that led to the drowning. Of the 42 that perished while trying to save others, 12 were classed as good swimmers, seven as average swimmers, four as poor swimmers, and three attempted to save others in spite of the fact that they were not swimmers themselves. In 16 instances the swimming ability was unknown. It appears that the lesson to be learned here is that unless one is a good swimmer, in excellent physical condition, and has special training in life-saving, efforts to save others should be concentrated on throwing floating objects to them or attempting to get competent help as soon as possible. Even good swimmers could profit by special instruction and practice in saving others as 12 good swimmers had turned a single drowning into a double one by unsuccessful attempts to save others.

Alcoholic Intoxication as a Factor in Drowning

Because intoxication by alcohol could affect one's judgment and thus make boating, water skiing, swimming, and other aquatic activities more hazardous, it was felt that this factor should be included in the study. Thus correlations were sought between the ingestion of alcohol, the type of activity, e.g., swimming, fishing, power boating, sailing, etc., swimming ability, whether or not an effort to rescue others was made, and whether the water was very cold. In addition, tests for blood alcohol made on drowning victims were tabulated by age.

Of the total of 1,201, a history of ingestion of alcohol was obtained in 149 cases, of no ingestion in 679, and in the remaining 373 instances this factor was unknown. Of the 149 individuals where there was a history of alcohol ingestion prior to drowning, the type of activity in which they engaged was unknown for 52, was swimming for 22, non-water activities for 19, power boating for 15, and other water activities for the re-

mainder. Of the 42 persons who drowned attempting to rescue others, four had a history of ingestion of alcohol. Of those who perished swimming in water that was very cold, 53 out of a total of 116 in which this factor was known succumbed after they had been drinking alcohol. This raises the question of whether the "pseudo-warmth" or numbing effect of the alcohol may have encouraged fatal over-exposure to the hypothermic hazards of very cold water.

Unfortunately in order to determine whether or not alcohol ingestion was a significant factor in drowning, it would be necessary to know what the number and percentage was of those who had consumed alcohol and engaged in similar activities without drowning. This information obviously would not be available in the study of drownings only, and would require a special study. However, some of the case histories, such as those describing obviously intoxicated individuals going swimming at night when the boat was moored in deep water or jumping off a bridge when intoxicated to win a wager, appeared to indicate that this is a factor in at least some instances.

Effect of Cold Water

There has been much speculation on the role of decreased body temperatures in drowning. There is no question that persons submerged in water in arctic climates (regardless of how good swimmers they are, or how well equipped with life preservers) can survive only a brief time in these extremely cold waters. It is also known that decreasing the body temperature decreases both the metabolic activity and the demand for oxygen by the brain, and when the brain metabolism is decreased sufficiently, unconsciousness and, finally, death occur.

Sigal and Mitchell[4] believe that in certain persons cold water triggers the release of a histamine-like substance that causes unconsciousness; also, Keating[5] concluded, from findings in the MRC Body Temperature Research Unit and on a study of the survivors from the sinking of the liner Lakonia in December 1963 (loss of 124 lives), that decreased body temperature from submersion in cold water was a significant factor in causing death. Keating states that cold water immersion causes a delirium first, then unconsciousness, and finally death. He found in laboratory experiments that exercise accelerated and conventional clothing retarded a fall in body temperature of volunteers who remained immersed, for 20 minutes or more, in water too cold for them to achieve thermal balance. He also found that some of the victims of the sinking of the Lakonia were recovered in life jackets that had kept their mouths and noses above water, but were found dead after having spent several hours in the water at a temperature of 17.9° centrigrade (64.2° F). Others have felt that the chilling and shivering associated with cold water might facilitate the onset of "cramps" and that eating meals shortly before going into water might have a similar "cramp" precipitating effect. Accordingly, the relationship between whether or not the water was very cold and whether a meal was eaten within the hour preceding entry into water was investigated in the drowning study.

Table 5 summarizes these results (plus the relationship of the ingestion of alcohol and swimming ability to drowning in cold water).

It can be seen that in 874 out of 1,201 drownings the water temperature was known, and in 299 (or about 34 per cent) of the 874, the water was reported as being very cold. One of the difficulties faced in assessing the importance of this factor is similar to the problem earlier discussed about assessing the alcohol factor—we do not know the total number of individuals who were exposed to the drowning hazards caused by low

water temperatures. In other words the population base at risk—that is the number of persons swimming in cold water that did not drown—is not known. In view of the fact that far larger numbers of persons are likely to be in the water when the water is not very cold, it is probably significant that in a third of the drownings where the temperature of the water was known the water temperature was very cold.

In addition, a much higher per cent of those succumbing in very cold water did so in spite of being good swimmers. The relative figures were 44 good swimmers drowning in cold water, and a combined total of 46 average and poor swimmers drowning in cold water. In water that was not very cold (about 70° F or above) the ratio was nearly reversed, with 61 good swimmers drowning compared to 116 average and poor swimmers drowning. This contrast could be interpreted to mean that the good swimmer is more vulnerable to cold water. If Keating's theory is correct, the good swimmer may stay in cold water longer, swim and exercise more, and therefore risk hypothermia and unconsciousness to a greater extent. However, no conclusion can be reached without more specific studies—preferably controlled ones—in which the temperature of warm and cold water is measured as one of the variables and equated with both the time immersed and the amount of swimming or other exercise.

Such a controlled study should include persons of approximately the same swimming ability and degree of exercise; efforts should be made to determine the difference in time required—with and without protective clothing—for the onset of signs and symptoms.

Discussion

Certain facts and certain gaps in information are clearly revealed in this study of 1,201 drownings in five states for the twelve month period ending on June 30, 1966. It is obvious that

Table 5—Type of swimmer by water temperature, alcohol, meal, trying to save others in Colorado, Florida, Illinois, New York, and North Carolina: July 1, 1965-June 30, 1966

			Type of swimmer				
		Total	Good	Average	Poor	Non-swimmer	Unknown
Total		1,201	121	117	62	252	649
Water cold:	Yes	299	44	30	16	45	164
	No	575	61	79	37	151	247
	Unknown	327	16	8	9	56	238
Alcohol:	Yes	149	17	18	7	16	91
	No	679	82	75	49	216	257
	Unknown	373	22	24	6	20	301
Meal:	Yes	78	17	8	13	26	14
	No	346	52	62	24	109	99
	Unknown	777	52	47	25	117	536
Trying to save others:	Yes	42	12	7	4	3	16
	No	982	99	107	54	233	489
	Unknown	177	10	3	4	16	144

whether or not the rate and number of drownings is increasing, a substantial number of such fatalities (averaging between 6,000 and 7,000) still occur annually in the United States, and efforts to prevent these should be intensified. The summer months represent peak period for drowning regardless of whether the state is located in latitudes where swimming is a year-round sport; this probably reflects the increase in exposure during the summer months. The site of drowning in all likelihood reflects to a considerable extent the site where the greatest unsupervised exposures occur.

In order to interpret the facts obtained in this and other similar studies[6-9] as fully as possible, it is essential that additional data be obtained about the number of potential exposures in various sites, in different water activities, and under various physiologic conditions. In other words, a more specific denominator than general population is required in the epidemiologic equation in order to properly assess the importance of the different factors. For example, the number of exposures to bathing, fishing, boating, etc., per drowning, should be obtained; this can only be done through some organized method of objective reporting through a scientifically devised sampling basis. Basic incidence figures should be obtained for such factors as the number of persons that ingest alcohol and then go swimming, bathing, or fishing without drowning or the number of persons of various age groups and swimming ability who are exposed to different types of drowning hazards without drowning, in order to more accurately interpret any future findings.

Good swimming ability, although obviously helpful and desirable, by no means completely protects one from the risk of drowning. Indeed, in some instances overconfidence, poor judgment, or excessive risk-taking while engaging in aquatic sports that are not adequately protected and safeguarded, may trigger drownings among good swimmers. At least 121 of the drowning casualties studied were classed as good swimmers; they succumbed in spite of this. Thus, overestimating one's swimming ability or one's life-saving ability (42 persons succumbed trying to save others) can result in a fatality.

Whenever one engages in water sports, life preservers, buoys, or other types of rescue devices should be available—and used—whenever needed. From the information obtained it appears obvious that increased emphasis should be placed on the desirability of using life preservers and remaining with the boat when boating accidents occur. As more and more boats are equipped with more powerful motors that leave stronger wakes, the likelihood of boat accidents increases, as does the importance of both wearing life preservers and remaining with the boat in case of an accident.

The age group most vulnerable to drowning is that of the young adult and the teen-aged males. One should concentrate on giving safety messages and safety precautions to these groups.

Further information is needed on the many relatively unexplained instances where persons in apparent good health and good physical condition succumb to "fatigue," "panic," "cramps," and the like. A continued analysis of the role that hypothermia (lowered body temperature) plays in these cases should be pursued.

The relative infrequency of necropsies or other detailed scientific investigations into the causes of death in persons who drowned when no witnesses were present suggests that this is an area where further study and increased activity would be desirable. It is quite possible that many deaths currently attributed to accidental drownings may have resulted from heart attacks, strokes, intentional or unintentional overdoses of alcohol or drugs, or actual physical foul play. Autopsies were not performed on 704 of the 1,201 drowning cases, and inquests were not held in 613 instances.

In many of these it may have seemed obvious that the death was an accidental drowning one. On the other hand, the absence of signs of exterior violence in unwitnessed drowning cases can not, and should not, be construed as proof that accidental asphyxiation by drowning was the cause of death.

The lack of supervision or swimming alone, whether in a natural bathing or recreational area or in a swimming pool, presents a serious risk and deserves special precautionary measures. Finally, in only a relatively small per cent of the drowning cases was mouth-to-mouth rescue breathing used very shortly after the victim was drowned; thus, further efforts to encourage this type of artificial respiration as soon as possible—in cases where this is feasible—should be made.

Summary

A five-state study of 1,201 drownings that occurred during the 12 months ending on June 30, 1966, was done. The study analyzed more than a score of variables that included ability to swim, type of water activity, site, roles of very cold water and of ingestion of food or alcohol, use of life preservers in boating accidents, age, and sex of victims.

Teen-aged males were found to be among those most vulnerable. Overconfidence in one's swimming ability and range, especially in very cold water, led to many of the fatalities. The importance of wearing life preservers and staying with overturned boats was underscored. Additional facts related to the importance of supervision of bathers and of protective enclosures for swimming pools were also obtained.

Finally, the need for obtaining further facts and making additional studies that take into account the number of persons at risk in the varying types of drowning exposures was emphasized.

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