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The 4W Model of Drowning

Stathis Avramidis, Ronald Butterly, and David J. Llewellyn

The aim of the study was to develop a conceptual model of drowning incidents. The authors conducted qualitative content analysis of drowning-incident videos (*N* = 41) and semistructured interviews of those involved in drowning incidents (*N* = 34), followed by the measurement of frequencies and Boolean search with matrix intersection. Results confirmed that when there is human activity in, above, or around an aquatic environment, a drowning incident might occur to whomever, wherever, and under whatever circumstances. Factors that determined drowning outcome were, in order of importance, rescuer characteristics (Who 1), casualty characteristics (Who 2), location (Wherever), and general circumstances (Whatever). The interaction of the rescuer with the casualty largely determines the outcome of drowning. The 4W model is a promising tool in lifesaving and lifeguarding.

Key Words: lifeguarding, lifesaving, water safety, swimming, rescue

Participation in aquatic activities increases the likelihood of drowning-related incidents (Lifesaving Society, 2000). Petridou and Klimentopoulou (2006) have observed that drowning often occurs to healthy people during leisure time. In the year 2000, about 450,000 people drowned worldwide, making drowning the second leading cause of unintentional injury-related mortality globally, after traffic accidents (World Health Organization, 2003). This figure includes only reported accidental drownings and submersions, which means that the incidence of actual drownings from all causes might be much higher. Computer modeling also suggests that the effects of global warming might lead to an increase in drowning-related mortality (Epstein, 2000). Taken together these findings demonstrate that drowning is likely to remain a leading cause of death in the future and a key public health concern.

In the late 20th century it was thought that lifeguards were the key to drowning prevention and water safety (Griffiths, 2001). Previous improvements in lifeguard awareness have resulted from the development of domain-specific theoretical models and specific interventional suggestions. For example, the 5-minute scanning strategy (Griffiths, 2000) was developed based on the observation that after 15 minutes of performing a simple task, the quality of people's performance on that task tends to deteriorate. Based on Griffiths's strategy, lifeguards should therefore

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change posture and scanning technique every 5 minutes or so in an attempt to maintain high levels of effectiveness. The C zones (Connolly, 2004) are used to explain how a drowning casualty tends to progress through a number of worsening stages or zones (i.e., comfort, concern, crises, critical, and cardiopulmonary resuscitation). Similarly, Pia (1984) revolutionized thinking in lifeguarding by establishing the R.I.D. model to help explain why drowning can occur even when a lifeguard is present. He hypothesized that drowning can occur as a result of the failure to recognize the symptoms of drowning (R), intrusion (I), or distraction (D).

A broad-ranging conceptual model of drowning incidents occurring during engagement in aquatic and nonaquatic activities has not previously been available and would give greater insight into the drowning phenomenon. A conceptual model of drowning incidents should prove to be a useful tool for teaching lifeguarding skills, targeting those most vulnerable to drowning, and reducing the number of drowning-related deaths. Whether someone drowns deliberately or accidentally is of little concern to lifeguards, whose responsibility, simply put, is to prevent injury, drowning, and death regardless of cause (Isaacs, 2003). Of course drownings do not only occur when people are supervised by lifeguards. Improved understanding of the dynamics of drowning by the general public through water safety education might also lead to a reduction of drownings in alternative circumstances when lifeguards are not present.

Although the number of people dying each year confirms drowning as a major problem worldwide, most studies relate to preventive and forensic aspects without integrating them within an overarching theoretical model (Bierens, Knape, & Gelissen, 2002). Although the studies that have been conducted afford us some insight into the nature of drownings, a comprehensive conceptual model of drowning incidents is clearly needed. Questions remain about the characteristics of people who drown, the location of drowning incidents, the causes of drowning incidents, and characteristics of rescuers (if present) that might make drowning more or less likely (for example, see Table 1). The interaction of these factors can only be addressed by a model that integrates all these factors.

The purpose of this study was to develop a model of drowning incidents and to classify and rank risk factors (Petridou & Klimentopoulou, 2006) to establish a platform for effective education and intervention. An extensive review of the drowning-incident literature (Avramidis, 2004) revealed that drowning incidents can occur as a result of several factors that can be categorized into four discrete categories (Table 1). It was hypothesized that these factors are interrelated (see Figure 1), and given human activity in, on, and around an aquatic environment, a drowning incident might happen to whomever, wherever, and under whatever circumstances. We therefore undertook two studies to investigate the importance of these factors and their relationships.

Study 1

Participants

A criterion-sampling method (Patton, 1990) was used to obtain drowning-incident videos (N = 41) from a wide variety of sources (BBC1, 2000, 2001, 2002; ITV, 2001; Mega Channel, 2001, 2002a, 2002b; Pia, 1970; Royal National Lifeboat

Table 1 The Four Factors That Contribute to Drowning and Practical Examples

Rescuer characteristics	Casualty characteristics	Location	General circumstances
Training Current level of experience, expertise, physical strength, vision, health, swimming speed Knowledge of the particular dangers of the aquatic area Professionalism (adequate number of lifeguards, visible appearance, clothing, written operating procedures) Ability to do risk assessment, work as educator, recognize the instinctive drowning response, remain alert, and react ignoring the bystanders' lack of response	Physical water fitness Disability or medical problems Age Sex Ethnicity Socioeconomic background Area of residence Number and type of family members Occupation Casualty behaviors	The specific geographical characteristics of the country Size and the shape of the working area Lighting, heating, air quality, water clarity Weather and environmental conditions Social and emotional environment Ethical issues	Relationship between casualty and equipment Risk as physical demand of aquatic activity Presence of others Time, day, season of occurrence Rescue type Aquatic activity

Note. Adapted from Avramidis (2004).

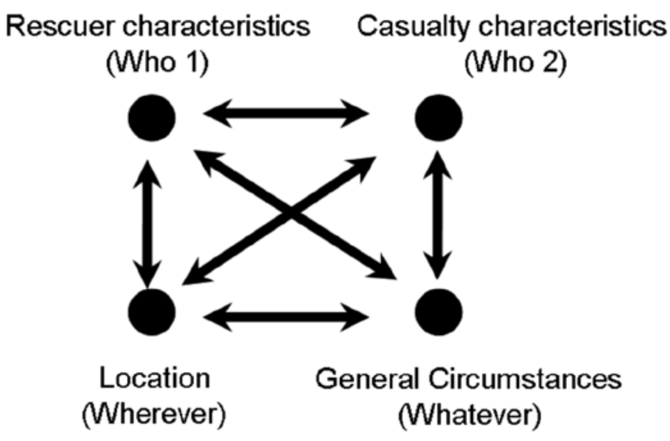

Figure 1 — The 4W model of drowning.

Institution, 1994; Twenty First Century Films Production, 1998; Waga News, 2001). This method facilitated the identification of variables and their relations that would not otherwise be available for fatal or traumatizing events. These visual narratives ranged in length from 30 to 720 s (M = 345.0, SD = 2.8).

Apparatus and Procedures

Videos were watched using a JVC television (CM31720-003) and a Panasonic videocassette recorder (AG-MD830). Videos were watched and data input into NVIVO software (QSR, 2002) for qualitative analysis. One of the first things to be established was the length of each video narrative, because the aquatic emergencies were usually on videocassettes that contained other audiovisual narratives. Therefore it was not always clear when each narrative started and ended. This had to be defined to guarantee reliable measurements during the test–retest. The reset time button of the VCR was pressed while the first visual or audio message that was related to the aquatic emergency was on the screen. For example, in some videos the audio narrative started before the actual visual portion, and in other cases, the visual video started before the audio narrative. In both cases the actual start point of the video was either the very first visual scene or the first audio narrative of the video. In cases in which the video was connected with transition effects with the next or preceding video segment on the tape, however (e.g., fade in), the starting and finishing points were when the whole scene could cover the whole TV screen.

As soon as the start and end points of the video were established, the videotapes were watched in real time like a movie, so that the researcher could get overall impressions of the aquatic emergency and take rough notes. The objective and subjective content of the video were then noted. Objective content was defined as the observations of audio or visual information on which every person watching the video would agree (e.g., what type of rescue a lifeguard did, in which aquatic environment the casualty was drowning, what they said). Unsupported assumptions and editorial comments were avoided. An example of an objective description is "Mr. L.H. was immersed in the river. Mrs. L.McD. was shouting to him to hold on to the collar of the dog that approached to rescue him." For objective description one would avoid reporting that Mr. L.H. could not hear Mrs. L.McD. because he was deaf or saying that the dog that rescued him was a Newfoundland until those things were confirmed as such in the video. Subjective content of records was defined as the responsive interpretations of the psychosocial dynamics of the scene. Subjective content should be the same regardless of the number of times that the same researcher observes the same video. An example of subjective content is the different interpretation of the same example: "After being saved by the dog, Mr. L.H. was very scared" or "After being saved by the dog, Mr. L.H. was very depressed." A researcher's observations would therefore be influenced by his or her own age, gender, personal experience, and so on. The researcher could therefore misunderstand what he or she is observing, resulting in mistaken interpretations of the situation (Gratton & Jones, 2004).

To minimize observer bias the videos were observed twice within a period of 3 months, and then information that was common to both observations was finally recorded and saved as the final narrative. During the test and retest each story had to be transcribed twice, first to analyze all the audio messages in the video and second to describe what could actually be seen. This ensured that enough information about each story would be available for analysis instead of relying completely on the narrator's comments. Finally, each aquatic-emergency narrative was divided into manageable sections (30 s long) so specific observations could be precisely located in the transcribed text. NVIVO also allowed the notation of the exact location of the coded text in the transcribed narrative by document number, paragraph, and line (Rich & Chalfen, 1999). Because the subjects of the current study were the casualties shown in the videos, they had no direct communication with the researcher, and therefore threats to reliability such as subject error and subject bias were not present (Gratton & Jones, 2004).

Observational content analysis of the video-recorded incidents enabled us to examine the drowning experience "from the inside out." The objective data that the videos captured were rich in information that other forms of data could not duplicate; an example of this was the audiovisual record of a girl being submerged under the water for 4 min, wheezing and gasping for breath with her hair caught in the water-suction valve of a whirlpool. Content analysis was dependent on the careful observation of the videos, the categorization of the frequency and nature of the verbal interactions, the data analysis, and the writing of a brief report with recommendations for future practice (Booth, 1998). Coding stripes and the node browser enabled the visual identification of differently coded sections and the internal comparison of all data that were similarly coded as tree nodes. Frequencies were measured, and Boolean search with matrix intersection identified the dominant linkages between the four variable factors thought to contribute to drowning incidents (Table 2).

Results

The analysis of the 115 tree nodes of the four factors resulted in 7,560 theoretically possible variable combinations. From this range of possible relationships, 1,425 (18.84%) were actually observed (see Table 2). A relationship was defined as every combination of one characteristic of one factor with another characteristic of another factor. For example, one relationship might be the ability to recognize (rescuer characteristic) the casualty's instinctive drowning response of a nonswimmer (casualty characteristic) or the presence of risk during an activity (circumstances of occurrence) in the deep water of the sea (place of occurrence). The casualty

Table 2 Frequency of Observed Relationships and Possible Matrix Relationships Between 115 Tree Nodes (in Parentheses) of the Four Key Drowning-Incident Factors in Drowning-Incident Videos (*N* = 41)

	Who 1 (casualty)	Who 2 (rescuer)	Whatever circumstances	Wherever
Who 1 (casualty)	—	303 (1,584)	104 (864)	237 (1,404)
Who 2 (rescuer)		—	359 (1,056)	230 (1,716)
Whatever circumstances			—	192 (936)
Wherever				—

(Who 1) related with the rescuer (Who 2) 303 times, with the place of occurrence (Wherever) 237 times, and with the circumstances under which the incident took place (Whatever circumstances) 104 times. The rescuer related with the place of occurrence 230 times and with the circumstances of the drowning 359 times. The place of occurrence and the circumstances under which the drowning occurred were related 192 times. Table 2 also shows that the rescuer and the circumstances under which each aquatic emergency took place played the biggest role in the outcome of the examined sample (359 relationships). The second most important combination of factors was the relationship between the casualty and the rescuer (303 relationships). The third important combination was between the casualty and the place where the incident occurred (237 relationships). The fourth-ranked combination was between the rescuer and the place of occurrence of the aquatic emergency (230 relationships). The fifth rank was the relationship between the place of occurrence and the circumstances of the incident (192 relationships). Finally, the sixth most frequent occurrence was the relationship between the casualty and the circumstances under which the incident occurred (104 relationships).

Study 2

Participants

With a snowball sampling method (Patton, 1990), we conducted semistructured interviews with 30 male (age 16–65 years, $M = 28.4$, $SD = 11.3$) and 4 female participants (age 19–65 years, $M = 37.5$, $SD = 19.5$) who were water safety or aquatic professionals (e.g., lifeguards, lifesavers, scuba divers, and athletes of aquatic sports) from Greece ($n = 25$, 71.4%), the United Kingdom ($n = 2$, 5.7%), the United States ($n = 1$, 2.8%), and Cyprus ($n = 6$, 17.1%). Participants were selected if they had witnessed and could describe a drowning-related incident above the surface of the sea ($n = 23$, 67.6%), under the surface of the sea ($n = 5$, 14.7%), in a lake ($n = 2$, 5.9%), or in swimming pool or water park ($n = 4$, 11.8%).

Apparatus and Procedures

A Sanyo M-1110C audiotape recorder and 2-hr Maxell cassettes were used to record the interviews. Institutional ethical approval was first obtained to conduct semistructured interviews investigating the factors involved in drowning incidents. The people interviewed were involved in the drowning incidents they described. A snowball or chain sampling method was used to locate information-rich key informants and critical cases who either viewed the footage or discussed their own experience (Patton, 1990). An information sheet was distributed to potential participants before the interviews explaining the nature and objectives of the study, and voluntary informed consent was obtained (Gratton & Jones, 2004).

Interviews were conducted using a semistructured interview outline, which included points relating to each of the four factors of interest (i.e., the rescuer, the casualty, the location, and the circumstances). Confidentiality and anonymity were maintained throughout, and individuals were not identifiable from the raw data (Patton, 1990). Data were transcribed and entered into NVIVO for indexing and qualitative content analysis (Wengraf, 2001). The procedures adopted were consistent with those used in Study 1. All hard copies were kept in a locked cabinet, and electronic data were password protected.

Results

The analysis of the four factors revealed 2,910 possible random factorial combinations (see Table 3). From this range of possible relationships 206 (7.8%) were observed. The interaction of the rescuer and the general circumstances appeared to play the biggest role in determining the outcome of aquatic emergencies (58 relationships), along with the way the casualty related with the rescuer (58 relationships). The third most important combination was between the casualty and the circumstances under which the incident occurred (36 relationships). The fourth combination was between the casualty and the place of occurrence of the aquatic emergency (27 relationships). The fifth was the relationship between the places of occurrence and the casualty (16 relationships). Finally, the sixth was the relationship between the place and the circumstances under which the incident occurred (11 relationships). When we compare the results from Studies 1 and 2 a similar pattern of relationships between the 4W factors is observed (Table 4).

Discussion

The results of these two studies showed that the rescuer, the casualty, the place, and the circumstances of occurrence determine the outcome of drowning incidents. The factors with the highest frequency and therefore potentially having the most importance for the outcome of the rescue are, in order of significance, the rescuer characteristics (Who 1), the casualty characteristics (Who 2), the drowning location (Wherever), and general circumstances (Whatever). It is now clear that although the rescuer is the most important factor, as was thought before, it is not the key to the prevention of drowning incidents; rather, the *interaction* between the rescuer and the casualty is. Thus, previous conceptual models appear to have neglected the role of important factors and oversimplified the complex interactions between them.

Our study represents the first attempt to provide a comprehensive model of drowning-related incidents and has a broad range of applications. By incorporating

Table 3 Frequency of Observed Relationships and Possible Matrix Relationships Between 115 Tree Nodes (in Parentheses) of the Four Factors Related to Drowning Incidents in Semistructured Interviews of Those Involved in Drowning Incidents (*N* = 34)

	Who (casualty)	Who (rescuer)	Whatever circumstances	Wherever
Who (casualty)	—	58 (420)	16 (320)	27 (416)
Who (rescuer)		—	36 (532)	58 (728)
Whatever circumstances			—	11 (494)
Wherever				—

Table 4 Single and Contributing Factors That Determine the Outcome of Drowning

Ranked factor combinations	Observed relationships (*n*)	Rescuer	Casualty	Wherever	Whatever
Videos (*n* = 41)					
rescuer—whatever	359	6	—	—	6
rescuer—casualty	303	5	5	—	—
casualty—wherever	237	—	4	4	—
rescuer—wherever	230	3	—	3	—
wherever—whatever	192	—	—	2	2
casualty—whatever	104	—	1	—	1
Subtotal	1,425	14	10	9	9
Interviews (*n* = 34)					
rescuer—wherever	58	6	—	6	—
rescuer—casualty	58	5	5	—	—
rescuer—whatever	36	4	—	—	4
casualty—wherever	27	—	3	3	—
casualty—whatever	16	—	2	—	2
wherever—whatever	11	—	—	1	1
Subtotal	206	15	10	10	7
Grand total	1,631	29	20	19	16

Note. The first column contains the ranked factor combinations, the second column the observed relationships, and the other four the number of times these factors were actually related. The more times two factors were interrelated, the higher their rank. The pair with the most relationships ranks 6, and the pair with the least ranks 1.

both observational and interview data, effectively a form of methodological triangulation, our findings and the 4W model itself are more likely to have construct validity (Gratton & Jones, 2004). This maximizes the likelihood that the 4W model will be generalizable, although further research is required to replicate the current findings and examine the utility of the 4W model in other drowning contexts.

A number of methodological points also need to be considered. The current findings are subject to a number of sources of potential bias. For example, those interviewed might struggle to remember specific details about the drowning incident, and their perceptions are likely to have been influenced by the stressful nature of the situation. Considerable time might also have passed between the drowning incident and the interview, although the in-depth interviews were designed to maximize recall. The degree to which the 4W model is generalizable to situations in which a lifeguard is not present is also a topic for future research.

The R.I.D. factor (Pia, 1984) and the 5-minute scanning strategy (Griffiths, 2000) are proposed to be useful to lifeguards, although they have limited application to nonlifeguard settings. The C-zones approach (Connolly, 2004) helps both lifeguards and the general public understand the drowning process, although in a relatively limited capacity. The 4W model, on the other hand, offers a far broader and more detailed model for describing and understanding drowning incidents. For example, the 4W factors provide insight into the antecedents of drowning incidents and the influences determining their outcomes. The 4W model applies to a wide range of human activities, including those that occur in, above, and around aquatic environments. Those involved in water safety education should therefore consider using the 4W model to educate others about the factors that lead to drowning incidents and determine their outcome.

These findings have important implications for the general public, because anyone engaged in activity in and around water should consider the risks that they are exposed to. The presence of lifeguards and their interaction with other factors is clearly important, and people should engage in aquatic activities that are supervised by lifeguards wherever and whenever possible. Our findings suggest the importance of professionalism in lifeguarding, structured training, and high certification standards. Local authorities have a responsibility to make funding available when possible for additional professional lifeguards to minimize the number of drowning incidents. When drowning incidents occur, the 4W model also provides a useful lens through which to examine the antecedent and situational factors that led to them. This process might help identify possible cases of negligence and teach valuable lessons to minimize the number of future drowning incidents.

Several questions were left unanswered, such as the way that the rescuer characteristics relate with the place and with the circumstances of occurrence of the drowning incidents. In contrast to the factor relationship "rescuer–casualty," these secondary factors and relationships could not be established as important contributing factors to the outcome of drowning incidents because they appeared to be important in one study but less important in the other. Given the fact that the rescuer plays the dominant role in all the linkages of the 4W model, a further examination of how the rescuer relates with the rest of the factors will enhance the understanding and the effectiveness of the rescue procedure for the benefit of both casualty and rescuer.

Conclusions

When there is human activity in, above, or around an aquatic environment a drowning incident might happen to whomever and under whatever circumstances. The factors that determine the outcome of drowning incidents are, in order of significance, rescuer characteristics (Who 1), casualty characteristics (Who 2), location (Wherever), and general circumstances (Whatever). Rescuer characteristics, and their interaction with other factors (mainly with casualty characteristics), appear to largely determine the outcome of drowning incidents. As a result of the two studies reported in this article, we conclude that the 4W model of drowning is a promising tool in lifesaving and lifeguarding training, as well as in understanding the dynamics of drowning for risk assessment, accident prevention, and safety promotion from water safety organizations, local authorities, and the general public.

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