

WARNINGS: WHEN DO THEY HELP, WHEN DO THEY HURT?

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PREFACE

This paper is required reading in my RAND Graduate School class entitled *Risk and Uncertainty In Public Policy Decisions*.

Within this graduate course, it is part of a broader set of discussions addressing:

- potential risks from accidental causes;
- risk taking and risk adverse behavior; and
- latent and patent risks.

This paper is funded by a grant from the National Swimming Pool Foundation (NSPF). The NSPF is a non-profit foundation whose goal is to foster and support programs of education and research in the swimming pool industry. Two earlier papers supported by NSPF and contrasting potential risks in and around swimming pools with other potential risks encountered by people in their every day lives are:

- Kenneth A. Solomon and Mario Juncosa, *Issues in Swimming Pool Design and Diving Safety*,
RAND, November 1987 P-7370
- Kenneth A. Solomon, *Swimming Pool Risks: How Do They Compare To Other Accidental Risks?*,
RAND, November 1993 P-7841

CONTENTS

PREFACE.....	iii
CONTENTS.....	v
FIGURES.....	vii
TABLES.....	ix
ABSTRACT.....	xi
ACKNOWLEDGEMENTS.....	xiii
Section	
1. BACKGROUND.....	1
To Warn.....	1
Warnings Come In Many Forms And Can Be Expressed In Varied Ways.....	1
Warnings Are Sometimes Beneficial And Are Sometimes Harmful.....	5
Purpose of this Paper.....	5
What Have We Learned?.....	6
2. WHEN IS IT APPROPRIATE TO WARN?.....	7
To Inform.....	7
To Reinforce Positive Behavior.....	7
Criteria for Helpful Warnings and Features of Bad Warnings.....	8
What Have We Learned ?.....	9
3. EXAMPLES OF GOOD AND BAD WARNINGS.....	10
What Have We Learned?.....	10
4. A CASE STUDY: NO DIVING IN SHALLOW WATER.....	12
Risks in the Aquatic Environment.....	12
Can Diving Risks be Reduced? - Role of No Diving Sinage.....	17
Does a No Diving Sign Meet the Criteria for an Effective Warning?.....	18
What Have We Learned?.....	19

FIGURES

Figure 1.1. Forms of Warning by Example	2.
Figure 1.2. Pictograph Warnings	4.
Figure 4.1. Drowning by Cause	13.
Figure 4.2. Most Diving Injuries Occur in the Shallow End of a Pool.....	16.

TABLES

Table 4.1 Estimates of Deaths Due to Drowning in Residential
Pools 14.

ABSTRACT

The intent of a warning is both to advise of a future, potential danger as well as to offer advice on how best to reduce one's exposure to that danger. While it is reasonable to advise of certain specific dangers, it would be highly unreasonable to warn against every potential danger. Hence, there are some circumstances where warning is merited and other circumstances where it is not.

What determines when you should warn and when you should not is simply determined by whether the warning is likely to do more good than harm.

Warnings are good when they alert people to something latent or not obvious. For example, the fact that aluminum dust can explode under some circumstances, is not generally obvious and should be warned against. The fact that a knife is very sharp and requires some degree of caution when being used is generally well understood by adults and is taught to children at a very young age. Warning people that knives are sharp may be more harmful than beneficial. People could become acclimated to warnings.

There is a proper balance of when warnings are helpful and when they are a hindrance.

ACKNOWLEDGMENTS

This paper is funded by grants from the National Swimming Pool Foundation (NSPF) and The Institute of Risk and Safety Analyses (IRSA). The NSPF is a non-profit foundation whose goal is to foster and support programs of education and research in the swimming pool industry. The goal of the IRSA is to foster and support programs intended to effectively communicate risk analyses to the general public.

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1. BACKGROUND

To warn

According to The New Merriam-Webster Dictionary (1989 edition) **to warn is** ... "(1) to put on guard; caution; also: admonish, counsel; (2) to notify (especially in advance); inform; (3) to order to go or keep away..."

In essence, to warn is to place someone on advance notice of a danger or a potential danger. To warn requires that the person or people giving the warning have a superior knowledge of the harm or potential harm compared to the person or people exposed. Further, the person or the people warning must also have a superior knowledge of the means of reducing either the likelihood and/or the magnitude of the harm or potential harm as compared with the person or people exposed.

Warnings come in many forms and can be expressed in varied ways

Warnings can take many forms as depicted in the taxonomy displayed in Figure 1.1. Warnings can be visual such as the label on a can of hair spray warning that the contents of the can are flammable. Warnings can be audible such as a backup alarm on the rear of a trash truck warning pedestrians that the large truck is backing up. Warnings could be an odor. The odorant added to natural gas and to propane warns the consumer of the presence of the otherwise invisible and yet flammable gas.

Warnings could stimulate more than one human sense. Some walk and don't walk pedestrian crosswalk signs not only flash a colored pictograph of a person walking or a hand telling you not to walk, they may also signal walk and don't walk by distinctive buzzer sounds. For example, the City of Santa Monica, California advises the pedestrian through the use of audible alarms and buzzers. An audible alarm would, for example, allow a blind person or a seeing

eye dog not to have to depend upon the sound of traffic to signal them to proceed.

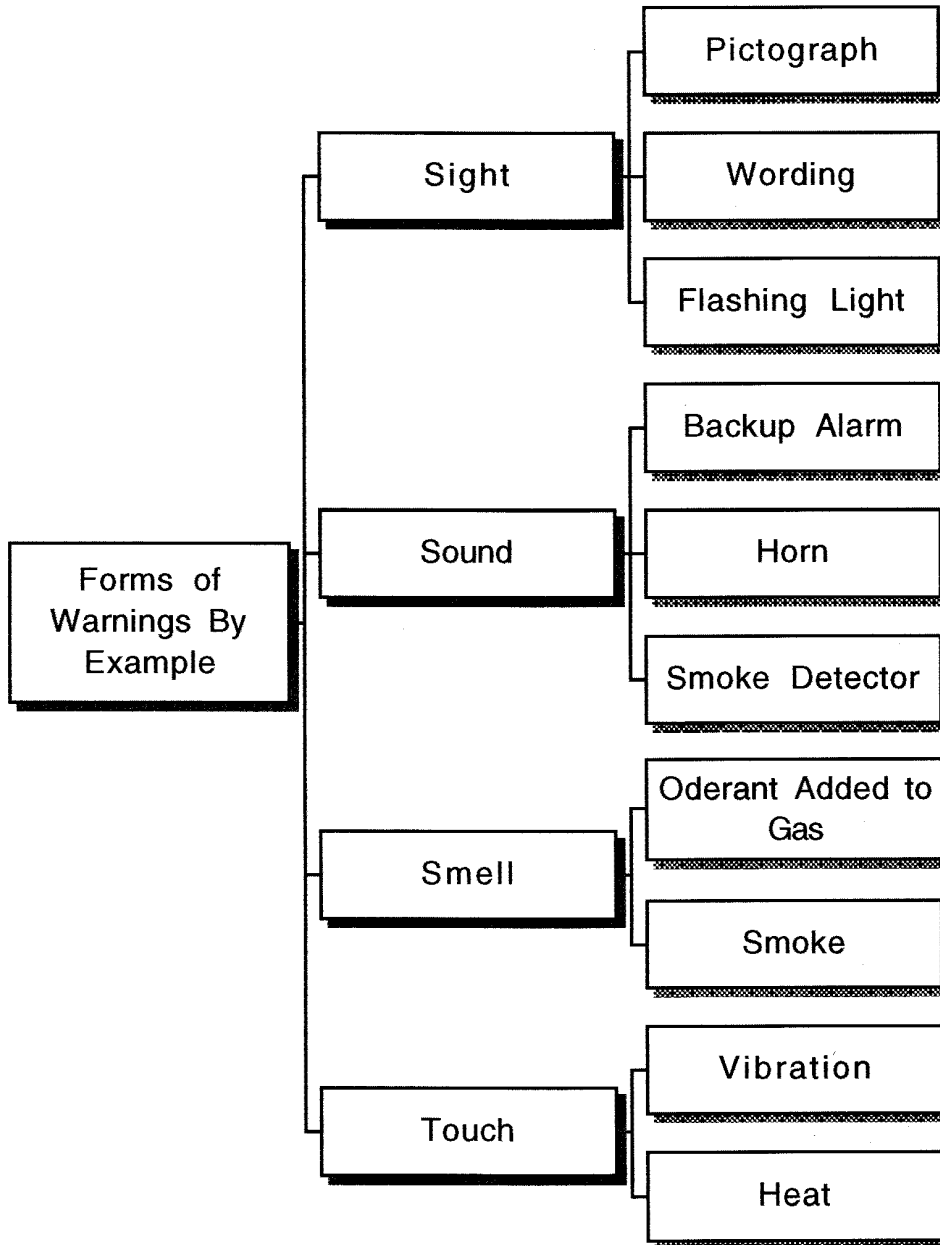


Figure 1.1.—Forms of Warning by Example

Visual warnings can be expressed in a number of ways; as a pictograph, as a written instruction, or even as a flashing light.

Figure 1.2. illustrates three warning pictographs. Each of these pictographs depict an activity and then indicate that the activity is not permitted. Specifically, the pictographs state:

Figure 2a. No Stepping (This warning is used on sections of aircraft wings.)

Figure 2b. No Running (This warning might be used in a classroom or around the deck of swimming pool.)

Figure 2c. No Skiing (This warning might be used on dangerous slopes.)

Visual warnings may be limited to words. For example, a traffic stop sign is a one word warning. A 100 word warning on a can of insecticide qualifies as a warning as well.

A flashing light indicating that you should not enter the core area of a nuclear reactor warns against radiation exposure.

Sounds are a common form of warning. Backup alarms on trash trucks, horns on cars, and buzzers on smoke detectors are all different means of warning with sound.



Figure 2a: No Stepping

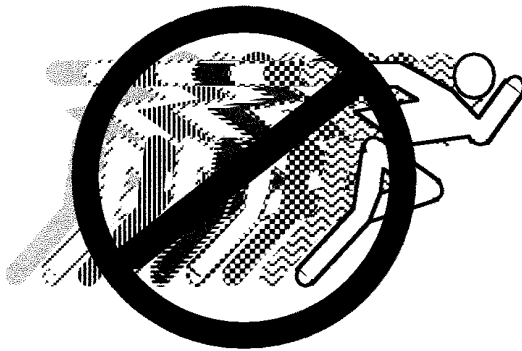


Figure 2b: No Running



Figure 2a: No Skiing

Figure 1.2. - Pictograph Warnings

Warnings are sometimes beneficial and are sometimes harmful

The examples just discussed demonstrate that warnings provide an important function - to advise people of a potential harm or danger and/or to instruct them on things they should (or should not) do in order to either eliminate their exposure to the potential harm or to minimize their exposure as much as practicable.

There must be a proper balance of what is warned against and what is not. For example, while it is reasonable to advise people that propane gas is both heavier than air and is flammable, it is not necessary to warn somebody not to stick their hand into a propane flame.

Clearly, some risks are obvious and need not be warned against. In fact, warning all people about *all* risks (obvious and not obvious) would have the tendency to both over saturate these people with information and as well acclimate them to this information. So bad (or excessive) warnings may cause people to ignore good (or meaningful) warnings.

PURPOSE OF THIS PAPER

In this paper, we will:

- distinguish between when it is appropriate to warn and when it is not (Section 2);
- identify the characteristics of good warnings and bad warnings across a broad range of environments (Section 2);
- offer examples of good and bad warnings in many applications (Section 3); and
- apply the criteria defining good and bad warnings to circumstances in the aquatic environment (Section 4);

What have we learned?

Warnings come in varied forms. Warnings are most effective when they warn of a potential danger that is not generally obvious. And, warnings could be harmful if they over advise.

2. WHEN IS IT APPROPRIATE TO WARN?

To inform

A warning is appropriate when it informs. To inform means to convey useful information that is otherwise not obvious. The information might either suggest that a person should abstain from an activity (e.g., do not dive into shallow water) or should proceed with caution (e.g., drive carefully; road is slippery when wet).

A risk may not be obvious, for at least three reasons; when the

- sequence of events is inadequately understood (e.g., propane gas can pool in a room instead of venting out of a window or a chimney)
- magnitude of the danger is under appreciated (e.g., the rupture of a large dam could drown many thousands of people downstream)
- likelihood of the risk is under stated (e.g., the chance of an average driver driving a midsize car dying per year in a car crash is one in four thousand, and the chance of a driver who drives perhaps forty or fifty thousand miles per year in a subcompact car might be as high as one in a few hundred per year or perhaps a few percent over his or her lifetime)

To reinforce positive behavior

A warning is also appropriate when it reinforces good behavior (e.g., remember to always wear your seatbelt).

Criteria for helpful warnings and features of bad warnings

It is not always obvious deciding when warnings would be helpful since the helpfulness of warnings will clearly depend on many environmental factors including:

- nature of the potential threat or harm;
- magnitude of the potential threat or harm;
- recognition of the potential for harm by the person facing the threat;
- alternative manners in which to address the potential threat; and
- value and effectiveness of the warning

Warnings are most effective when:

- they are unambiguous (e.g., a stop sign at an intersection);
- they advise of non obvious potential harms or threats (e.g. specific parts of copying machines may be hot to the touch);
- human perception of the potential harm is either impracticable or inaccurate (e.g., people cannot see radiation);
- they don't saturate with too much or too complex information (e.g., a red blinking light with a sign that says "do not enter");
- they are simple and easy to understand;

- they use pictorials and not word (e.g., see the pictographs in Figure 2); and
- they demonstrate risk or harm, clearly and memorably (e.g. a pictograph of a person diving in shallow water with an indication that the diver hit his or her head).

Warnings are least effective when:

- they are already obvious, reasonable, and/or intuitive (e.g., people already know that an open flame can burn or a sharp knife can cut);
- they convey too much information; they saturate (e.g., a fine print, multi-paragraph warning label written on the side of a hair spray can);
- when human perception is best (e.g., you do not need to warn adults not to run across a freeway).
- the observer tends to acclimate to warning (e.g., multiple and contradictory parking signs).
- instructions are too complex
- on a relative basis, the risk is already immeasurably small (e.g., you do not need to warn people about the dangers of being hit by meteorites).

What have we learned?

A warning is appropriate when it informs in a clear; concise; and unambiguous manner. Warnings that over inform may tend to do more harm than good.

3. EXAMPLES OF GOOD AND BAD WARNINGS

Based on the criteria distinguishing good from bad warnings, we offer a few examples of good and bad warnings.

A short lived light and/or buzzer on automobile's dashboard display advising the driver and the passengers to remember to use their seatbelts is not a worthwhile warning. People would quickly acclimate to the buzzer and light and eventually ignore them.

A sign on an aluminum sanding machine warning that hot aluminum dust in the presence of oxygen creates a severe fire hazard is a good warning. The potential hazard is not obvious to most people and the information provided in the warning would be useful.

Stall indicators on aircraft provide a useful warning since pilots are often not able to sense climb angle.

Gauges on cars indicating the temperature on of the fluid in the car's radiator is again an example of a good warning. The driver is typically not accurate at predicting when the radiator will boil over.

A backup alarm on a truck or a forklift operating in a yard with other trucks and or forklifts with backup alarms is typically a bad warning. Many alarms going off simultaneously would be confusing. They could over saturate the environment with noise. With many alarms sounding, it would difficult to identify direction. People would quickly acclimate to the sound of backup alarms. Backup alarms may provide a false sense of security to both the driver and to pedestrians potentially at risk. A signal man directing the driver would be superior to a backup alarm.

The warning message on thin plastic bags stating that plastic bags may suffocate children is a good warning message. The potential risk of suffocation is not obvious to all people.

What have we learned?

Some warnings in common use today may not be classified as useful warnings. In fact, some could be damaging if they provide a false sense of security or if they are confusing. A good rule of thumb is that warnings are best when they provide new information in a clear and direct fashion.

4. A CASE STUDY: NO DIVING IN SHALLOW WATER

People are exposed to many potential risks in their day to day activities. Automotive accidents present the highest potential risk to individuals. Falls present a significant risk as well. Diving into shallow water also presents a lesser but still a considerable potential risk.

In this section, we will look at the effectiveness of warning signs to prevent diving accidents. However, before evaluating the effectiveness of signage, some of the risks in the aquatic environment will be reviewed.

Risks in the Aquatic Environment

There are about 100,000 fatalities and millions of injuries per year in the United States from all accidental causes.

The aquatic environment is responsible for several thousand fatalities per year.¹ Essentially all of these are from drowning. Most drownings are submersions; typically swimmers who over extend themselves or non swimmers in a water situation they cannot handle properly. The next most common form of drowning is a result of sporting accidents (e.g., boating and water skiing). A couple of hundred drownings per year are due to suicide and almost as many due to homicide. About 200 drownings per year happen in bathtubs and are usually a result of small children left unattended.

Figure 4.1. depicts these findings.²

¹Derived from Accident Facts, 1992 Edition by The National Safety Council, Washington, D.C. and The Universal Almanacs, averaged from 1988 to 1993, Universal Press, New York.

²This information is drawn from Accident Facts, 1992 Edition by The National Safety Council, Washington, D.C.

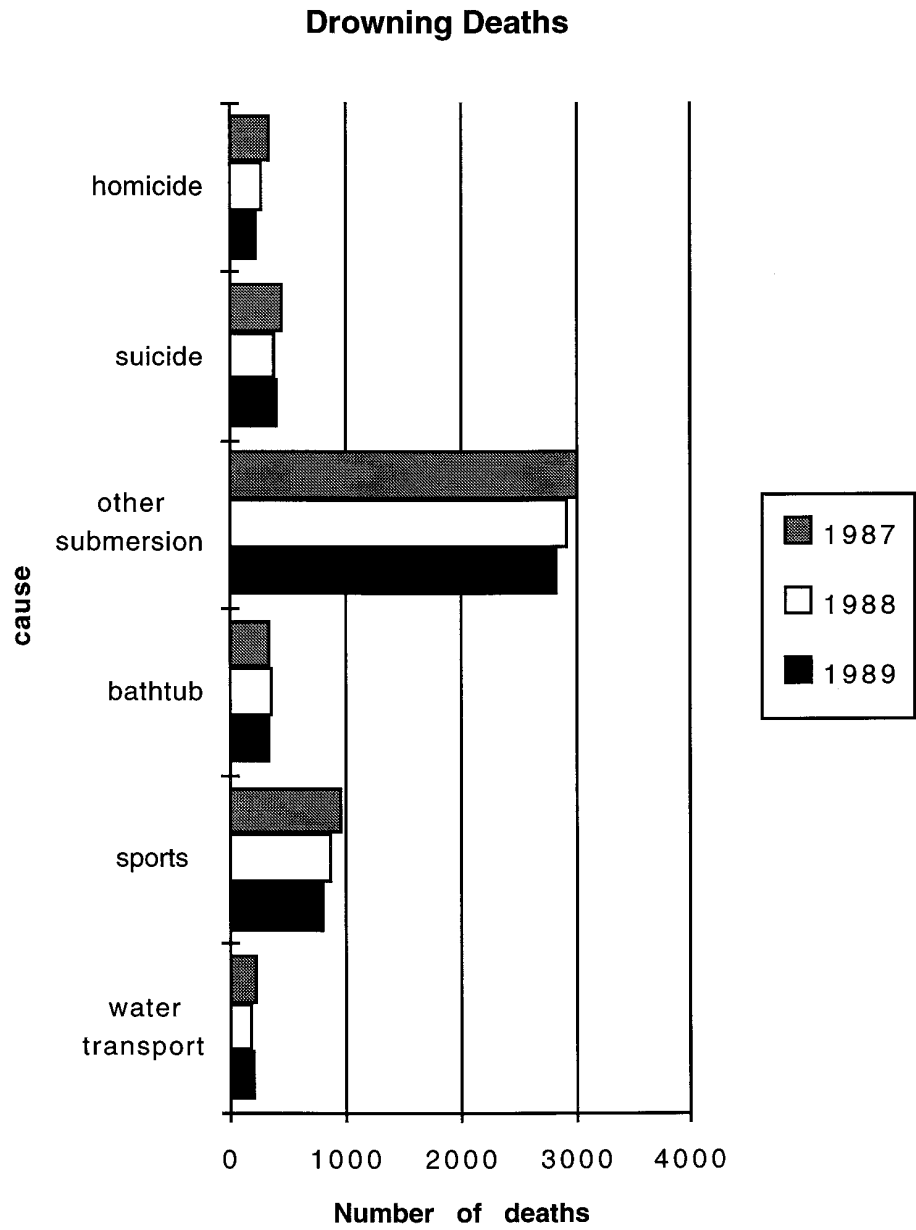


Figure 4.1.—Drowning By Cause

Most aquatic fatalities result from swimmers that drown and a lesser number result from drowning subsequent to boating accidents. Of the approximately 7,000 drowning fatalities in the United States in 1981, for example, 315 of the victims were children under the age of five that drowned in pools and spas. In 1981 there were another nearly 2,000 near drowning of children under age five. Of these, approximately 1,500 were hospitalized for some length.³ More recent data shows a similar trend with regard to drowning accidents. During the past five years there were about 300 drownings per year in pools by children five years of age (see Table 4.1) and under even though the number of swimming pools (and thus the exposure rate) has increased somewhat over the past decade.

Table 4.1.
Estimates of Deaths Due to Drowning in Residential Pools⁴

Age (years)	1987	1986	1985	1984
under 5	310	330	280	260
5 - 14	70	70	40	60
15 -24	50	50	50	40
25 - 64	110	110	80	130
over 65	60	70	60	50
Total	600	630	510	540

³See Table 4 of: Solomon, Kenneth A. and Mario L. Juncosa, "Altering Pool Upslope Angles To Improve Deep End Diving Safety, and Related Safe Water Issues", RAND P-7370, November 1987.

⁴Memo From Jacqueline Elder, Project Manger, Household Structural Products Program to The Commission of the United States Consumer Product Commission, dated May 8, 1991.

The aquatic environment (swimming in pools, lakes, rivers, and oceans, boating, and water skiing) is also responsible for several hundred quadriplegic and paraplegic injuries per year and several thousand less serious injuries per year. In the pool, more injuries - of any magnitude - are caused by diving than by any other single cause.

About 25% of injuries in and around the swimming pool environment are a direct result of diving accidents and about 15% are a result of swimming accidents. Said differently, if diving were completely eliminated (and, clearly, it could not be), then the total number of injuries in and around the pool would decline by one fourth. Jumping, "playing", running, sliding, stunts, and fence climbing account collectively for another about 30% of injuries. With the exception of swimming and walking and with the possible exception of diving, most injuries in and around the pool could be eliminated without ever effecting the perceived benefits of the pool.

As we have discussed thus far, most of these accidents are a result of human behavior or misbehavior.

Those accidents resulting in more serious injury (specifically quadriplegia and paraplegia) result from diving into water that is too shallow. Of 174 such injuries studied in a specific examination by Gabrielsen,⁵ more than 160 occurred in water depths under 6 feet and about 150 occurred in depths less than 5 feet. (See Figure 4.2.) The diver can most certainly control for this by electing not to dive into shallow water.

As another proof of shallow water diving risks consider an analysis by J. Neil Robinson, Ph.D.⁶ Dr. Robinson's study reveals that of 14 international studies assessing the risk of diving (conducted from 1975 through 1982) the total number of severe diving

⁵See M. Alexander Gabrielsen and Mary Spivey, "Diving Injuries: The Etiology of 486 Case Studies with Recommendations for Needed Action," Nova University Press, 3301 College Avenue, Ft. Lauderdale, FL. The Gabrielsen and Spivey data rely on and are interpreted from data extracted from litigation cases that have been filed in the court systems. As such, the Gabrielsen and Spivey data may have a natural bias.

⁶Failure Analysis Associates Letter (number FaAA-PA-R-89-04-02) to Mr. D.J. Hunsaker, of Councilman/Hunsaker and Associates, St. Louis, Missouri.

accidents reported from three meter boards was zero and the total number reported not from three meter boards was 556. Another 169 were from a platform of unknown height.

Of 174 Quadraplegia and Paraplegia Injuries, Most Happen In The Shallow End

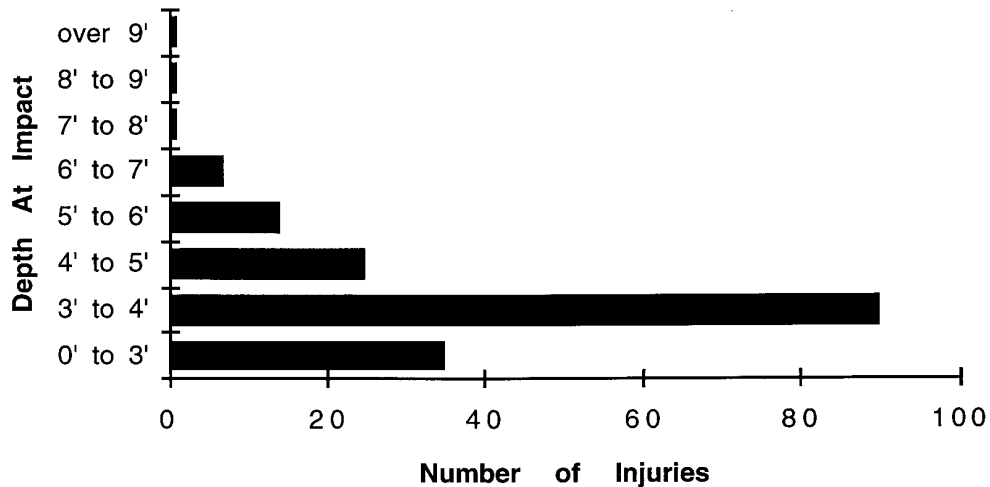


Figure 4.2.—Most Diving Injuries Occur In The Shallow End of a Pool

Of 486 paraplegic and quadriplegia pool related injuries studied by Gabrielsen,⁷ most of the injured parties were determined to have consumed alcohol and/or drugs.

The message here, as is true with automotive accidents resulting in serious injury or fatality, is that human misbehavior is correlated significantly with accidents of serious consequence.

There are perhaps 5 to 10 million swimming pools in the United States suggesting perhaps as many as 25 to 50 to more million individuals exposed to pools on a regular basis. In the data sample

⁷See M. Alexander Gabrielsen and Mary Spivey, "Diving Injuries: The Etiology of 486 Case Studies with Recommendations for Needed Action," Nova University Press, 3301 College Avenue, Ft. Lauderdale, FL.

examined, only 5% of the paraplegic injuries resulted from accidents in and around the pool and 95% resulted from all other recreational activities. Of the those other recreation activities, mountain climbing and horseback riding account for nearly 40% of the total. Both horseback riding and mountain climbing do not themselves collectively expose 25 million individuals. So, on a comparative basis and when considering paraplegic injuries only, the pool environment is a safe environment relative to other recreational activities.

Quadriplegic injuries occur in a number of recreational activities. About 25% of them occur in an aquatic environment (such as swimming pools, rivers, lakes, ponds, and oceans). Of those injuries that do occur in an aquatic environment, most do not occur in swimming pools. And, of those that do occur in swimming pools, the vast majority occur in water depths under 6 feet.

Some divers are risk takers. Supervised diving has very few injuries (only two deaths worldwide in the past ten years and those were off ten meter platforms). Further, under supervised diving, there have been no recorded paralysis resulting from diving off of three meter and one meter boards. However, many unsupervised divers are risk takers. Of 233 households interviewed by the Boston University School of Public Health,⁸ 30% of those interviewed were willing to dive into water less than or equal to four feet in depth, and 8% dove where no diving signs were posted. Only 95% of those interviewed believed it was dangerous to dive in shallow water; 5% do not believe it is risky.

Can diving risks be reduced? – Role of No Diving signage

Diving risks could be reduced. First, individuals should not dive into a pool while under the influence of drugs or alcohol, and second, individuals should never dive into shallow water.

⁸Reported in Mangione T. W., J. Howland, and D. Yob, "Summary of 1992 National Pool Owners Survey" Boston University and JSI Research and Training Institute, Boston Massachusetts, June 1992.

According to the Boston University study 95% of those people surveyed believed it was dangerous to dive into shallow water yet 30% of those interviewed were willing to dive into shallow water and 8% dove even where no diving signs were posted.

The results of this survey support the following conclusions:

- Even when aware of the danger, a significant percentage of the population is still willing to dive into shallow water. Those people willing to dive into shallow water are risk takers.
- Yet, risk taking behavior appears to be strongly influenced by the presence of a no diving sign.
- A no diving sign that is read by individuals will reduce the risks associated with diving but will not eliminate the risk.

Does a No Diving sign meet the criteria for an effective warning?

While diving into shallow water is an obvious risk to a majority of the population, a finite percent of the population would benefit from no diving signage. The signage would even be more effective in aquatic environments other than pools

The dangers associated with diving into a shallow pool is a more obvious risk than the dangers of diving into a shallow stream or lake, since the depth of a pool could be perceived more accurately than the depth of a stream or lake.

Typically, human perception of the potential risks from diving into shallow water is accurate. However, the potential risk of diving into shallow water is apparently not obvious to all people. Hence, some of the population needs advisement of the potential harm.

Simple, no diving signs do not saturate with too much information and are simple and easy to understand. They are especially simple, if the signage uses pictorials and not words. Pictorial signage demonstrating the impact of violating the warning are most effective.

What have we learned?

No diving signs in and around shallow water are effective warnings against potential risks. These signs are most effective as pictorials that demonstrate the impact of violating the warning. A head injury depicted in a pictorial warning demonstrates the impact of violating the warning. No diving signs are even more effective in aquatic environments outside of the pool environment.

WHAT HAVE WE LEARNED?

We have observed several important points:

- Accidental and drowning in and around the swimming pool are due primarily to human behavior (or misbehavior).
- Alcohol intoxication and recreational drug use is associated with a substantial number of serious injuries.
- The pool industry accounts for a relatively small portion of serious injuries compared to other activities.
- People react to information. In particular, activities have become safer primarily because people have become more aware of safety through both signage and media campaigns.
- The pool industry has done a good job in educating the public. Greater public awareness of how to more safely behave in an adequate environment may give added benefit. This role of further educating the public is the responsibility of many parties, not just the pool industry.

These findings, are, to varying extent, applicable to a broader set of activities.

