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RESEARCH

Scan Time Goals With Analysis of Scan Times From Aquatic Facilities

John Hunsucker and Scott Davison

This paper aims to understand the challenges associated with establishing a time goal for scanning a lifeguard's area of responsibility and identifying critical incidents requiring a response. It analyzed the results of 289 lifeguard inspections from aquatic facilities with management emphasis on scanning. Those scanning summaries from the inspections covered 15,737 lifeguard observations where lifeguards were trained using two different scanning goals: (1) scan their area of responsibility within 15 s with an emphasis on using visual recognition signals to identify an incident and (2) recognize victims within 10 s in their area of responsibility. Analysis showed an average scan time of 22.65 s with 41.86% of responses within 0–15 s and 37.03% of responses within 16–30 s. The 10 s goal averaged 25.96 s while the 15 s goal had an average 21.96 s scan time. The weak implication was that if guards were trained using the goal of a scan taking 15 s or less, there was a reasonable chance that a large percentage of their scans will be completed within 30 s or less. Additional research is needed to discover whether there are other goals or methods that might produce even more effective scanning and times.

Keywords: lifeguarding; scanning; water safety

One of the most important jobs of the lifeguard is identifying an incident. The military and private industries have produced a significant amount of research literature on vigilance tasks and on signal detection theory. Unfortunately for the aquatic community, little of this literature has related directly to lifeguarding. For example, N.H. Mackworth (1948) had described a sophisticated technique for signal detection research directed toward airborne radar operators on antisubmarine patrol and noted that vigilance is a useful word for "describing a psychological readiness to perceive and respond" (Mackworth, 1948) which is definitely similar to the psychological state we want lifeguards to achieve. Other than an analysis of self-reported evaluations of working lifeguards (Griffiths, Steel, & Vogelsong, 1996), we have found very little evidence-based information in the literature relating to the question of scan times for lifeguards. The intent of this paper is to present data that are related to the amount of time trained lifeguards actually took to scan their zone of responsibility.

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Drowning is one of the leading causes of accidental death, particularly among children (CDC, 2012). One of the major incentives for this study was to develop information on scanning that could be used to address this issue in guarded aquatic facilities. Of course, scanning by itself will not prevent drowning in swimming pools with lifeguards. Many conditions can affect vigilance and the effectiveness of a scan: lack of skill in how to recognize or identify a drowning, physiological or psychological fatigue on the part of the lifeguard, water turbidity, swimmer density, and environmental factors such as heat and noise (National Aquatic Safety Company, 2012b, pp. 48–49). One paper on "inattentional blindness" remarked that "the most influential factor affecting noticing is a person's own attentional goals" (Most, Scholl, Clifford, & Simons, 2005, p. 217). To further emphasize our position, if a lifeguard does not scan their zone effectively, then the chance they will find a victim is diminished. Said another way, if they don't look, they won't find.

It may be pertinent here to make several statements concerning the limitations of this paper and to discuss the development of how the inspection evolved. As one unidentified aquatic expert was quoted as saying, "Most of the current rescue techniques have evolved by trial and error, with little scientific investigation" (World Congress on Drowning, 2002, p. 3). This was also true of the early development of scanning and lifeguard inspections. Many of the first scanning techniques were the result of aquatic professionals collecting what they felt were the best practices of the guards who managed and guarded what the aquatic professionals believed were among the safest aquatic facilities. It should be noted that there is some overlap between the authors and the designers of the inspections, so we have personal experience in this development. The inspections evolved over time to give the aquatic managers a way to evaluate the effectiveness of their safety systems and were not developed with future research data collection as a goal.

In this paper, data are presented from facilities which used two different scanning goals that led to two different groups that had been trained in two different ways. This was a result of the facility choosing one or another of the aquatic organizations that did their lifeguard certifications—not because of a blind study being done on the lifeguards or the swimmers. We simply mined data that had been collected as part of the facility's normal operations. One group of facilities had the guards trained using a stated goal of recognizing a drowning victim within 10 s and the other group of facilities was trained on a goal of being able to scan their zone within 15 s using a formal emphasis on signal recognition to recognize a drowning victim. Note that these two goals are different not only in the time interval, but in the focus they use to scan. The 15 s goal refers directly to the length of time it takes to scan your zone while the 10 s focus is more intuitive in that it does not speak directly to scan times, but to finding a drowning victim within 10 s. There is research that supports the concept that the effectiveness of vigilance is contingent on how the information on a target is presented, in addition to other factors (Szalma, Hancock, Dember, & Warm, 2006). The research is technically sophisticated and does not directly address lifeguard scanning, but does provide some indication of a theoretical basis for training a lifeguard to look for particular visual cues when scanning to find a drowning victim.

The decision was also made by the inspection's designers to stop timing the guard's scan at 60 s. Since poorly trained or managed lifeguards may never scan their zone, their actual time has to be truncated. One reason for choosing 60 s is that

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this was approximately twice the fastest drowning time that any of the inspection designers had been able to verify. The fastest recorded drowning the authors have analyzed (i.e., time elapsed between the victim's head going under water and CPR being started immediately without the victim recovering) is 38 s (Hunsucker & Davison, 2010). At 60 s, it was felt that the scan had become ineffective due to the fact that the time was well beyond how long it takes for a fast drowning.

When the decision was made to evaluate how well the scanning was being done, we had to ask a number of questions. Some were as follows: (1) What is the purpose of the goal? (2) What actions make up the task? (3) How can one tell if those actions are being correctly performed? and (4) How can one tell if the task has been successfully completed? (Welty, 2007). While these questions have been addressed in prior papers (Hunsucker & Davison, 2008; 2010), an in-depth study of lifeguard scan times had to wait until there were enough data to provide sufficient statistical power to detect meaningful differences if they exist.

One key to telling if a task has achieved its purpose is to identify an appropriate measure. To put it in other words, as Lord Kelvin (2011) said, "If you cannot measure it, you cannot improve it" (Kelvin, 2011). Our study is based on observations taken from inspections that are usually done twice per 100 day season for each waterpark because " . . . in general the more frequently the study is rated, the more accurate the evaluation of the operator's demonstrated performance will be" (Niebel, 1976, p. 349).

In our opinion, the goal for the lifeguard ought to be to prevent any incident where someone could get hurt and to react if someone is in a hazardous situation. One of their tasks is to identify the signal event or events that precede or precipitate an incident. The activities they should perform to achieve this task include scanning their zone of responsibility, recognizing the signals that indicate an event taking place, and taking appropriate action upon recognizing an event.

To define the issue a bit more clearly, there were several factors that affected the choice of an appropriate scan time when the current scanning practice was evolving. The lifeguard must not only be able to locate or identify the signals that indicate an event is taking place, but must also be able to do so in a manner that allows for timely intervention. We are defining a signal as an event in their zone, or area of responsibility, that would indicate or predict their need to intervene. Other factors such as the size of the zone, the user density within the zone, and the number of activities within the zone are also important, but not addressed in this paper. They have been presented elsewhere (Hunsucker & Davison, 2011).

It also may be instructive to point out another reason why a desired scanning time should be described as a goal rather than a standard or rule. If you make scanning a hard and fast rule such as, "A Lifeguard Should Scan Their Zone in 'X' Seconds" there is a high probability that it will be violated at some point or an error will be made. This is because "human beings by their very nature make errors" (Shappell & Wiegmann, 2000, p. 3), which are "the mental or physical activities of individuals that fail to achieve their intended outcome" (Shappell & Wiegmann, 2000, p. 3). In contrast to an error, a violation is a "willful disregard for the rules and regulations" (Shappell & Wiegmann, 2000, p. 3). Even commercial airline pilots, whose experience will often entail hundreds of hours of training plus thousands of hours of airtime (Oliver, 2006) will continue to commit both errors and violations (Shappell & Wiegmann, 2000). Admittedly, lifeguards and airline pilots have very different job descriptions; however, there are certain similarities between them. Two of the most important aspects of a lifeguard's job are vigilance and scanning (National Aquatic Safety Company, 2012b, p. 35). Pilots also have a job that is heavily dependent on vigilance and scanning for aviation safety (Lavine, Sibert, Gokturk, & Dickens, 2002). Because lifeguard training will often be only 22–31 hr total (American Red Cross, 2012; Ellis & Associates, 2012, National Aquatic Safety Company, 2012a) instead of the hundreds of hours that pilots spend training, it is possible that the potential for errors and violations will be higher in lifeguards. This has particular implications in litigation. James Kozlowski (1996) described a number of cases involving standards violations by lifeguards, so setting a standard that may be frequently violated by lifeguards has the potential to open the litigation door even wider than it is now.

The determination of what constitutes an effective scan time goal is an important issue not only because of the lifeguard's task of identifying a signal event, but also because it will impact staffing levels, zone sizes, and other decisions affecting surveillance. Without a scan time goal, it will, in our opinion, be difficult to manage a safe and effective surveillance system that protects the users of an aquatic facility. The intent of this paper is to initiate a process of understanding the challenges and factors associated with establishing a goal for lifeguard scan times.

Method

Participants

The data were taken from 6 years of observations which included 289 inspections with 15,737 lifeguard observations. All of the data were taken primarily from water parks together with a few standalone flat-water pools and did not include any open water facilities. The authors were never given the individual scanning times. Instead, the scanning times received were already grouped into five categories: 0–15 s, 16–30 s, 31–45 s, 45–59 s, and 60 or more s, with the number of observations in each group for each inspection, the total number of observations and the average scan time for the facility. This fact mitigated any confidentiality concerns by keeping individual results anonymous, but prevented any more precise ungrouped quantification of scan times.

These data were collected during scheduled inspections of aquatic facilities that had strong managerial support for scanning. Each inspection was made of the aquatic facility's lifeguards by a trained inspector. The inspectors were individuals who not only had extensive backgrounds in lifeguarding and lifeguard management but who were also trained in classical industrial engineering work measurement procedures, though not in sophisticated statistical analysis.

Procedures

The inspection consisted of the inspector going through the facility to each lifeguard station and recording the scan times. Then the inspector would make another circuit covering each position and record the scan times. Each circuit would include all of the positions where scanning was part of the lifeguard function. Circuits were continued until the inspector felt enough data were obtained to reflect typical opera-

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tions. The determination of normal or usual scanning times was one of the major objectives of the inspection. Small parks with a small number of positions would require at least half a day to acquire 25 or more observations. Large parks would take most of a day and could result in 100 or more observations.

Because of the time required to make a circuit and because of the fact that all facilities required their guards to rotate positions, rarely, if ever, was the same guard observed in the same position on adjacent circuits. Since turnover in lifeguards is relatively high, the lifeguards observed on one inspection were not always the people who were observed on previous inspections. This is particularly true of inspections done in different years. Nevertheless, not all observations can be considered statistically independent as required by most parametric statistical analyses.

The inspector would then compile the data in the grouped form that was given to the authors. The results would then be presented to management at both the upper level and to the on-deck managers. To repeat a point that was made before, the data were not collected as part of any research study being done on the lifeguards or the swimmers. We simply mined data that had been collected as part of the facility's normal operations. Thus the data would be classified as "existing data" and anonymous so it would typically fall under an exempt category by institutional review boards.

Data Analysis

While the authors cannot state that these were 15,000+ completely independent observations, we can state that there were a high number of observations of different individual lifeguards throughout the six years of data. It may bear repeating that when this data collection and presentation methodology was designed, it was not for use in a rigorous statistical analysis, but was designed for ease of understanding and use by the aquatic facility management. In all of the parks, the managers and the lifeguards were aware of the goal of 15 s for scanning a particular zone regardless of which system they were trained under. In addition, they were aware of the overall goals for the facility of reducing the average scan time to 17 s or less and reducing the percentage of scan times which were a minute or more to be 3% or less. Note that 17 s was a management goal used for the overall facility since it was felt that there would be cases were the guard's scan time should exceed 15 s for various reasons. The choices of 17 s and 3% were relatively arbitrary, but the experience of the inspectors and managers at the facilities have shown them to be attainable goals while still meeting the goal of being able to recognize the signals. Again, the origins of these scanning and inspection procedures evolved from aquatic professionals adopting and adapting what they felt were the best practices of the lifeguards and aquatic facility they observed, not research projects on vigilance and signal recognition.

Results

Table 1 and Figure 1 show all the data in a compiled form. In Table 2 and Figure 2, the data were subdivided into two different categories. It can be noted that the data in the tables and the figures are identical. The reason for including two different ways of presenting the same data are that while it is easier to see the distribution of the scanning times using the figures, the reader might still want to see the actual numbers in the tables. In Table 1, the number of observations is divided into 15 s intervals. For example, during the 2009 inspections, 986 lifeguards took between 16–30 s to scan their zone. Please note how the scanning times in Figure 1 modally cluster in the 0–15 s and the 16–30 s times. Also note the similarity of the tracks of the scanning times for the 10 s and 15 s goals in Figure 2. The average scan time was calculated by summing all of the scan times and dividing by the number of observations for a particular year.

As previously mentioned the data were presented to the authors in a grouped form and truncated at 60 s. This precluded calculating mean and standard deviations of the probability distribution of individual times because of the 15 s grouping. By using standard group data statistical methods the mean and standard deviation of the grouped and truncated data could be calculated. Using median category

Table 1 Compiled Scan Times Data

Year	0–15 s	16–30 s	31–45 s	45–59 s	60+ s	Average Scan Time	Number Of Observations
2010	1,555	1,074	186	82	96	19.18	2,993
2009	1,268	986	270	116	169	21.89	2,809
2008	1,231	1,136	298	117	259	23.34	3,041
2007	1,105	1,107	304	155	310	24.2	2,981
2006	882	928	258	127	222	24.44	2,417
2005	547	597	165	76	111	23.68	1,496
Total	6,588	5,828	1,481	673	1,167	22.65	15,737
%	41.86%	37.03%	9.41%	4.28%	7.42%	——	100%

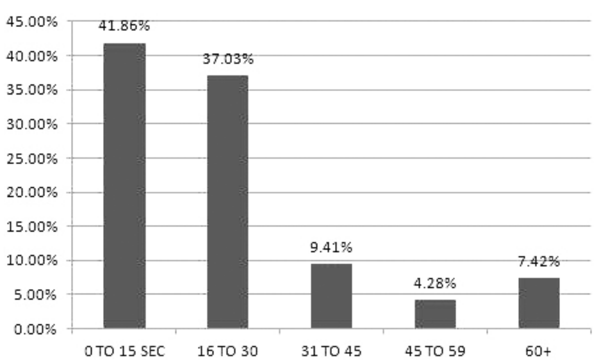

Figure 1 — Compiled scan time data histogram.

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Table 2 Comparison of Scanning Goals

Training	0–15 s	16–30 s	31–45 s	46–59 s	60+ s	Average Scan Time	Number of Observations
10 s	922	988	348	184	306	25.96	2,748
%	33.55%	35.95%	12.66%	6.70%	11.14%	—	100%
15 s	5,666	4,840	1,133	489	861	21.96	12,989
%	43.62%	37.26%	8.72%	3.76%	6.63%	—	99.96%

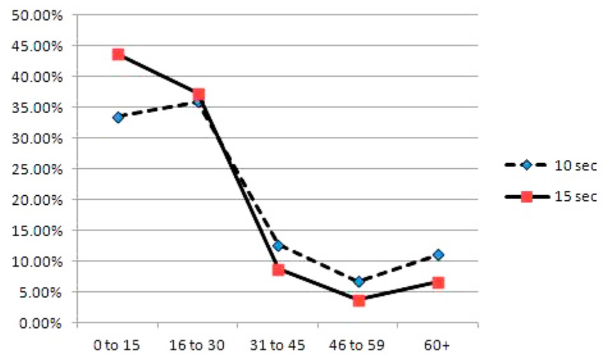

Figure 2 — Comparison of scanning goals plot.

times of 7.5 s, 22.5 s, 37.5 s, 52.5 s, and 60 s with the frequency data from Table 1 for the compiled results we arrived at an overall frequency mean of 21.7 s and a standard deviation of 16.05 s

When the data were given to us, included was the average scan time for the facility along with the total number of observations. This allowed for the determination of a calculated facility mean across the data of 22.65 s. Note that the frequency mean of 21.7 s is fairly close to the calculated mean of 22.65 s, which we believe implies that the calculated standard deviation might be close to the “real” standard deviation. For all these data, the standard deviation was rather large. Truncating the data at 60 s may well have limited the size of the standard deviation from being even larger. Unfortunately, we gained little else from looking at the statistics alone at this point.

The data in Table 1 show that almost 80% of the guards scanned their zones in 30 s or less. About 7% of the guards were in the “60+” second category and the vast majority of those were, based on the inspector’s direct observation, either not scanning or were scanning ineffectively. About 14% were in the middle range of 31–59 s and represented the guards who, based on the inspector’s direct observation, were scanning according to their training, but slowly compared with the goal.

Notice that the scan time distribution is clustered around the 0–15 s and the 16–30 s groups. The clustering around the 60+ sec. group might best be considered an artifact because of the way the data were truncated at 60 s. Since the data were presented in a grouped and truncated format, the frequency average scan time of 21.7 s when calculated from the data should be considered as a relatively weak descriptor. Nevertheless, the average as calculated is useful for comparative purposes. A calculated scan time could be derived because the average scan time for each facility along with the total number of observations was given to us. The calculated average scan time across all of the data were 22.65 s. This also should be considered a relatively weak descriptor because the data were truncated at 60 s

Discussion

This paper represents our initial attempt to determine a reasonable goal for effective scan times. We deduced several weak implications from these descriptive data.

Implication One

When guards are trained on a goal of a scan taking 15 s or less, there is a reasonable chance that a large percentage of their scans will last 30 s or less. Both tables support this implication with Table 1 showing almost 80% of scans taking less than 30 s.

Implication Two

When a scan time is set as a hard and fast rule or standard and not a goal, and the standard is less than a minute, there will be a percentage of guards who will violate the standard. Our data showed a large number of guards did not achieve the 15 s goal. This emphasized the issue that occurs when you make a predetermined scanning time a hard and fast rule. We again refer the reader to James Kozlowski's article for a sampling of litigation cases involving standards violations by lifeguards (Kozlowski, 1996).The experience of the airline industry, which shares important characteristics with lifeguarding with regard to scanning and vigilance, suggested that violations will occur in spite of everything management can do (Shappell & Wiegmann, 2000),

Implication Three

The more specific you are in defining the task of scanning, then the more likely your guards will perform this task effectively. This is very weakly implied by the differences shown in Table 2. The 15 s training process was felt to be more specific about scanning and signal detection and realized a better average scan time and a smaller percentage of guards over 60 s. This finding could be associated with vigilance and how information on a target is presented, as referenced previously (Szalma et al., 2006). Of course, many other factors could be at play here, not the least of which is an aggressive on deck management system that emphasizes scanning and signal recognition.

One reason that evaluating the effectiveness of lifeguarding procedures is difficult is because a successful procedure is only one part of the overall lifeguarding

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protocol at a facility. A common way to evaluate effectiveness is to compare the results from your research with the results from related research. A portion of the facilities that provided the scanning data used in this paper also provided rescue data for a prior research paper (Hunsucker & Davison, 2010). Scanning was part of the rescue protocol even though the research paper did not specifically address scanning times as such. That previous paper indicated that the drowning rate for guarded aquatic facilities where this protocol is in effect is only 1.02% of the drowning rate for all U.S. pools in 2000 (Hunsucker & Davison, 2010). Obviously, there are a large number of factors that influence any fatality figures. These include incomplete data on drowning (Idris et al., 2003), the effectiveness of resuscitation efforts, the pool conditions, the swimmer density, and the different demographics of the swimmer populations, among others. The authors can only say that, based on our experience and the data we have collected, that we believe that emphasizing effective scanning has a beneficial effect on the overall effectiveness of lifeguarding.

Future Research

The determination of a scan time goal is just one issue in lifeguarding research that is required to determine effective methodology for scanning. Finding additional methodologies to train lifeguards in incident detection and victim identification using signal detection theory would seem to present one fruitful line of inquiry. A major area where research is needed is that of the relationship of scanning to actual victim recognition. Research also could focus on issues and questions such as relating head movement to eye movement in scanning, the impact of user density, zone size, client/guest distribution throughout the facility, time on task and the impact of supervision.

Conclusions

One should be careful about drawing too strong a conclusion from the data presented in our study. These data do give some indication about what can be accomplished with lifeguards who are trained and managed with the intent of accomplishing a goal for scanning. With the establishment of a scan time goal, the scanning by lifeguards may be more effectively managed and the goal of seeing an incident before a fatality occurs may have a better chance of occurring. To repeat our paraphrase of Lord Kelvin, "If you can't measure it, you can't improve it" (Kelvin, 2011). Unfortunately, due to the absence of large sample studies, such as the data found in this paper, it is difficult, if not impossible, to draw conclusions based on comparisons of methods described in this paper to other methods. As a minimal indicator of effectiveness and one which should be considered such, the facilities which furnished the data for this paper had a drowning rate of 1.02% of that for all U.S. pools in 2000 (Hunsucker & Davison, 2010).

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