Executive Summary
Bibliographic Study on Lifeguard Vigilance

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Introduction

Drownings are a significant cause of mortality, particularly among young children and especially among children under the age of five years. It is estimated that there are 140,000 fatal drowning accidents per year throughout the world. Near-drownings occur five to 10 times more frequently, and 10% of these incidents have serious neurological consequences.

Within the context of public swimming pools, lifeguards are the people most involved in the surveillance and maintenance of user safety. Their mission requires a high level of vigilance maintained constantly when they are on duty, but the nature of the job and the environment, as well as the length of the on-duty periods, make this very difficult.

The bibliographic study done by A.COBLENTZ, R.MOLLARD and Ph. CABON, (Applied Anthropology Laboratory, University of Paris V René Descartes), summarizes the work done specifically on lifeguards, mainly in the U.S. and Australia. It also presents results from laboratory work and from other professional fields in which vigilance is a key factor in performance and safety and which can be applied to lifeguards: aircraft pilots, automobile drivers, industrial machine operators, etc. The implications for lifeguard vigilance are highlighted.

1. Some Basic Information

Historically, the first vigilance study was developed by Mackworth in 1950, at the request of the Royal Navy, which was concerned with the weakening performance of sonar operators called on to detect the presence of enemy submarines. The results indicated that the percentage of non-detection of critical signals during the two hour experiment increased rapidly to 15% during the first 30 minutes, and was close to 30% during the next 30 minute period. This study, subsequently confirmed by many other studies, was the first to prove that vigilance capacity ***cannot be maintained at an optimum level for more than 30 minutes and that the detection of critical signals in this type of task is never 100%.***

The performance in tasks of this type is also affected by the subject's physiological state. This physiological state or "*activation*" describes "*the excitability of the central nervous system*". Activation states are in a continuum ranging from deep sleep to states of strong emotion. Each level is characterized by specific electro-physiological manifestations, particularly on an electroencephalogram (EEG). Each of these physiological states has a corresponding performance level. To attain an optimum vigilance level, an optimum activation level is required: this is referred to as "attentive alert". ***Either below or above this state, the vigilance is degraded.*** If the lifeguard is at a high alertness level (favorable time of day, consumption of caffeine), environmental factors (e.g.: noise) can increase his/her alertness level beyond the optimum, which can result in weaker performance. This weakened performance will occur quickly in a complex situation (e.g.: many swimmers in the pool, high noise level, etc.).

The biological clock which regulates all of the physiological and psychological functions induces temporal variations in lifeguard performance. This notably results in a ***strong decrease in performance in the early afternoon, commonly known as the "post-prandial slump", aggravated by various factors such as lack of sleep the preceding night, heat and low motivation***. Contrary to a widely-held belief, this lower performance is not related to consuming food. Moreover, there are significant individual differences in the scope and phase of these biological rhythms. Such data must be considered when planning lifeguard rotations. (Fenner and coll. (1999))

2. Characteristics of The Task

Laboratory studies indicate that the level of vigilance is higher when the pertinent signals are numerous and the non-pertinent information is rare. The presence of numerous non-pertinent stimulations (non-critical signals), visual or aural, is a factor which contributes to reducing lifeguard vigilance. Inversely, the pertinent signals for drowning are rare and arrive haphazardly. ***The signal-noise ratio in pool environments is thus very unfavorable to maintaining of lifeguard vigilance.***

More recent studies have sought to highlight the impact of attention type processes on the performance of a vigilance task. According to the level of learning of the subject or the task's difficulty, two types of processes are used: controlled processes for tasks requiring great attention and automatic processes for tasks requiring little attention or for those for which intensive learning was obtained beforehand. The works of Fisk and Schneider (1981) showed that the use of controlled processes resulted in greater degradation of performance over time than was the case with automatic processes. ***Training, which contributes to "automating" the attention, can be a favorable element for maintaining the vigilance level of lifeguards.***

The experiments carried out by Cabon (1992) also show that alternating between automatic and controlled attention processes helps to maintain performance. ***These results show the value of alternating activities (for example: surveillance, lessons, maintenance operations) rather than a continuous pool vigilance activity***. However, the positive effects of this alternating are only seen when there is a satisfactory level of physiological activation. In unfavorable physiological conditions (fatigue, low level of alertness, etc.), performance decreases despite the alteration of automatic and controlled processes.

The lifeguards' main activity during surveillance is visual sweeping (scanning) of areas where people are swimming. ***The quality of this visual scanning is a key factor in detection performance.*** This scanning must allow a quick movement from one zone to another, as a drowning can occur in 20 to 60 seconds. The lifeguard's attention must also be able to detect a critical signal (start of a drowning) from amongst a series of non-critical signals (swimmers on or below the water's surface). The optimum detection performance is located in the central vision. This difference between central vision and peripheral vision implies that the lifeguard must rotate his/her head in order to visually scan all of the areas of the pool using the central vision. The studies by Harell (1999) show that the visual scanning is of a better quality when the lifeguard is located above the level of the pool, and that ***the visual scanning decreases during the day, probably due to fatigue***.

The monotony of the lifeguard's activity, combined with the need to remain vigilant, can result in a high level of frustration and stress, which has a negative impact on performance (Perkins and Hill, 1985). This decreased performance results primarily in an increase in the response time within the central vision (Williams and Andersen, 1997). One of the possibilities for overcoming this monotony is to alternate tasks requiring different attentional processes.

3. Environmental Factors

Among the ambient factors, noise has a complex effect on vigilance. It improves performance when the alertness level is low (fatigue, sleep deprivation, early afternoon, etc.) but degrades it when the alertness level is high. Moreover, noise hinders the ability to share one's attention and tends to focus one's attention on the signals present in the central vision, to the detriment of those signals present in the peripheral vision. ***Noise, one of the major environmental factors at a pool, generally has an unfavorable effect on lifeguard vigilance.***

Heat, as of 30°C, significantly reduces vigilance (by about 45% with respect to optimal performance). (Studies by Mackworth (1950) and Pepler (1953)).

Harell also demonstrated that ***the number of children in the pool reduced the number of visual scans of the pool***, due to the higher number of incidents and of rule breaking identified around the pool. Another particular aspect of the lifeguard's activity relates to his/her attention being distracted by the pool environment, notably by children running along the side of the pool, questions from swimmers, etc., while a drowning can take place in 20 seconds.

4. Temporal Factors for the Activity

Breaks have a very positive effect on the vigilance level, whatever their content. The improved performance is thus primarily attributable to a change in activities. However, the effect of break times varies according to the time of day and the person's degree of alertness. For optimum benefit, the frequency and duration of the breaks must be adapted: breaks should be more frequent and shorter when the alertness level is low, in the early afternoon, for example.

Conclusion

The results of the studies cited in this document demonstrate that ***the maintaining of lifeguard vigilance at a high and constant level throughout the surveillance period is particularly difficult due to the nature of the task***: the low number of critical signals and high number of non-critical signals, the monotony, the unfavorable physical conditions (noise, temperature, etc.), and the organization of the activity over time, which may not be ideal.

In this context, automatic systems such as Poseidon to help detect drowning accidents provide essential assistance and are a determining factor in improving safety. For such systems, it is important to take into account and to optimize the functioning of the human/system team in order to maximize the overall performance.

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