AN ASSESSMENT OF THE EFFECTIVENESS OF VARIOUS VARIANTS OF WATER RESCUE

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Abstract:

Water rescue is an area in which, unfortunately, many myths persist and intuitive actions are allowed. The aim of the study was to verify the empirically selected ways of carrying out rescues, in particular: a) to determine the effectiveness of direct rescue with or without the use of rescue equipment, b) to demonstrate the danger for the lifeguard, and thus for the victim, during a rescue without equipment, c) to determine the algorithms of automatic reactions of a lifeguard in rescue conditions. The study involved performing simulated rescues of an active victim by three lifeguards, one by one, directly in the water. The study was carried out in an indoor swimming pool and the material was filmed by cameras (under and over water) and photographs were taken. Additionally, fourteen lifeguards attempted to tow a victim using four techniques, with the towing times measured. The most important results indicate clearly that a rescue of an active victim without equipment is a great hazard for the lives of the lifeguards and the victim. The best technique of using a rescue canister and the best technique of towing were determined, as well as the algorithm of proceeding with an active victim during the rescue. The timing of the rescue with the use of equipment showed that reaching a victim with a rescue canister takes slightly longer, but significantly increases the effectiveness of the rescue and the lifeguard's safety.

Key words: *lifeguards, a rescue canister, towing techniques, an active victim, rescue*

Introduction

Water rescue, despite being a public service similar to the fire fighting department or the police, has not yet developed definite algorithms of proceeding in various situations occurring during rescuing lives in the water. Scientific and methodological literature on water rescue varies widely in terms of the approach to the methods of rescue execution and does not present any clear, unambiguous models of rescues.

A rescue can be performed from a boat or from the shore, pier, the edge of a pool or the water. This study is devoted to a rescue in the water during which a lifeguard swims to the victim.

During rescues lifeguards use rescue canisters, similar to those known from the U.S. television series *Baywatch*. However, in professional literature one cannot find studies concerning the ways of using this apparatus during specific rescues with various courses of events. Lifeguards use a rescue canister in a more intuitive way, based on observation rather than on empirically developed rules tested for effectiveness.

On the other hand, in the mind of lifeguards and society in general, the image of a lifeguard as a brave (Avramidou, Avramidis, & Polman, 2004) and heroic person has become well established. Selected personality traits of lifeguards have been studied by Parnicki and Turosz (2002) who showed that some traits, e.g. temper, aggression and fear, are directly related to the pattern of behaviour in dangerous situations. Their results showed that, in comparison with subjects who are not lifeguards, the lifeguards displayed a lower level of a momentary and constant tendency to react with fear in a situation of danger. In the summary of their results Parnicki and Turosz noted that a low level of fear is a predisposition which enables a person to use his or her knowledge and abilities more effectively in lifesaving. This article also indicates that researchers seem to overemphasize personality traits of lifeguards, rather than the pragmatics of rescue activities.

The subject of a direct rescue in water based on the intensity of effort of the lifeguards – students of physical education - was dealt with by Parnicki, Długołęcka and Siłakiewicz (1999). This study indicated that the execution of a rescue was an enormous physical effort, the peak of which was reached in the final stage of the rescue. The research in this area was continued by determining the time structure of a rescue in direct contact with the victim (Parnicki & Siłakiewicz, 2004). The authors carried out tests involving timing of a rescue performed with and without the use of flippers. Their results indicated that a better time was achieved by a lifeguard wearing flippers. The study did not reveal any novel factors which could have an influence on the actual effectiveness or safety of the lifeguard. A simple assumption that a rescue with the use of flippers would be quicker is a truism and basically does not require scientific confirmation.

A lifeguard often does not behave in a well-thought out way, according to the carefully developed algorithms of lifesaving procedures, but undertakes a spectacular rescue based on bravery and physical fitness (Dahl & Miller, 1979; Griffiths, Steel, Vogelsong, & Werts, 1996). A consequence of such thinking, combined with the fact that lifeguards are usually young people with tendencies to show off and overestimate their abilities, may be an ineffective rescue, resulting very likely with drowning of both, the victim and the lifeguard. Sometimes outdated ways of training lifeguards favour this situation. During the courses preparing young people to work in water rescue a great deal of time is devoted to teaching how to carry out a rescue without the use of rescue equipment. The emphasis is, among other things, on freeing oneself from the victim's grasp and the lifeguard's swimming fitness over long distances (*Programy Szkolenia WOPR*, 2000). Modern water rescue is, however, sufficiently supplied with rescue equipment and the emphasis in lifeguard training should be shifted from the lifeguard's physical fitness and bravery to his/her abilities to use state-of-the-art rescue equipment.

This problem was examined by Dahl and Miller (1979) in their study of a group of approximately 500 lifeguards trained by various American rescue organizations. The results of the study showed that only 35% of the lifeguards avoided being grabbed by the victim in a rescue without equipment. This is very significant information from the standpoint of rescue safety and effectiveness. Although the study was carried out in 1979, it is still a source of extensive knowledge. The results were collected in the form of the descriptions of rescues carried out by the participating lifeguards in real situations of danger.

Very often a lifeguard deals with a victim who becomes dangerous for the rescuer, i.e. the so called *active victim*. American sources (Pia, 1974, 1999; *On the Guard II*, 2001; *Lifesaving Rescue and Water Safety*, 1977) use two terms to describe an aggressive drowning person. The first one is an *active victim* – a conscious, struggling person unable to swim, described as throwing him or herself about, showing signs of panic or fear, very dangerous for the lifeguard. He or she may continue to fight against the rescuer even after submerging, until a loss of consciousness. Such a victim maintains a characteristic vertical position in the water, without a visible leg kick. The victim's outstretched arms move up and down in the water in order to remain on the water surface. The victim's head is tilted back. Such victims do not usually call for help as their respiratory system is being flooded with water and breathing is for them more important than speaking. On the other hand *a distressed swimmer* is a person able to swim, who for some reason cannot return to safety. Such a swimmer remains in enormous physical and mental stress in the water. He or she can call for help by body or arm signals and shouting. A drowning distressed swimmer is able to catch the piece of rescue equipment pushed out to him/her. If at this stage the lifeguard fails to begin the rescue, the victim will enter the stage of active drowning. Pia (1974) carried out a unique study which involved filming the movements of drowning people with a camera placed on a lifeguard stand in Orchard Beach in Long Island Sound in New York. The material collected in this way was used for the analysis of the entire drowning accident, from the first signals to the completion of the rescue. A 17-minute film includes close-ups of the actual 'near' drownings and rescues. The study contributed a plethora of interesting information which was later used by a number of rescue organizations all over the world. On the basis of this footage Pia (1974) formulated a pioneering statement that previous beliefs related to the behaviour of a drowning person and the rescue techniques were simply wrong.

In most cases an active victim gets into panic. Panic is an uncontrollable fear which overwhelms a person who finds himself or herself losing control of his or her safety. The state of panic ruins the person's sense of logic. Self-defense (self-preservation instinct) becomes a priority, even at the cost of friends or loved ones (*On the Guard II*, 2001). The authors of this article, on the basis of the collected information and their own rescue experience, oppose the statement that the swimming skills, physical fitness and bravery of a lifeguard are sufficient to guarantee a successful rescue, in particular, in the case of helping an active victim.

In formulating the objectives of this study it was assumed that rescuing an active victim may be very dangerous for a lifeguard, and thus ineffective, and that such a rescue should always be executed with the use of rescue equipment. The time devoted to putting on a rescue canister or other equipment cannot be treated as a waste of time, but the only way to an effective and safe rescue.

The basic aim of the study was to verify the empirically selected ways of carrying out a rescue without equipment, in particular:

a) to demonstrate the danger for the lifeguard and thus for the victim during a rescue without equipment,
b) to determine the effectiveness of a rescue with or without the use of rescue equipment,
c) to select the best elements of a rescue which should constitute the whole of the rescue in the water.

Methods

In order to carry out the tests three lifeguards were selected for the study, who were marked as LG1, LG2 and LG3. The lifeguards had lifeguard certificates issued by the Polish Voluntary Lifeguards Association (VLA) (Polish: Wodne Ochotnicze Pogotowie Ratunkowe – WOPR), which fully authorize working as an independent lifeguard in Poland. All three lifeguards were university students. They had experience as lifeguards at the sea or lake beaches. Each of them took part in real rescues of men, women and children. The majority of victims rescued by them were active victims, i.e. dangerous for the lifeguard.

A person acting as an active victim was also a VLA lifeguard. He was a university teacher with work experience at a sea beach and at an indoor swimming pool, where he also took part in real rescues, rescuing both conscious and unconscious victims.

Table 1 presents the basic information about the lifeguards participating in the study as well as the lifeguard acting as the active victim.

Table 1. Characteristics of the participants of rescues

Lifeguard's symbol	Age (years)	Weight (kg)	Height (cm)	Experience as a lifeguard (years)
Participants acting as lifeguards				
LG1	20	75	181	3
LG2	20	79	180	3
LG3	22	90	182	5
Participant acting as the active victim				
AV	33	97	177	14

The selection of people for the rescue was deliberate, closely related to the assumptions of the study. The chosen lifeguards were of great body height and weight, with age and experience guaranteeing the lifeguard's high fitness level. The choice of an active victim of heavy body weight was also deliberate, as rescuing a small and light person is not such a great problem. Problems with effectiveness of a rescue and lifeguard safety become more pronounced when a victim is heavy.

All the four lifeguards as well as ten others took part in a complementary test T14 (described in the following chapter). All of them were full members of the VLA (Voluntary Lifeguards Association) and except for one, who had only worked in a waterpark, all had experience in working as lifeguards at sea or in a lake. Seven, including one woman, took part in the actual rescues.

Procedure

The material for the analysis comprised simulated rescues in the water. The tests were carried out in an indoor swimming pool in order to facilitate the filming over and under the water; however, the structure of the rescue was identical to an open water situation. On the basis of the footage the events were observed and the rescue activities were timed.

The water was 3.90 metres deep in the deepest place, the swimming pool was 25 metres long and 12.5 metres wide. In all the tests the lifeguards reached the victim by the heads-up crawl. It is the front crawl in which the lifeguard does not submerge his/her face in order to be able to see the victim while swimming. The arm strokes are shorter but stronger and the kick is wider than in the competitive front crawl.

In tests with rescue equipment a rescue canister was used. It comes with shoulder straps to fit a lifeguard's body and a tow rope approximately 3 metres long (Karpiński, 2005; Stanula, 2005).

The technique of the start was uniform throughout the test (the place of the start, the way of giving the start command, the place of picking up the canister by each lifeguard were always the same). The technique of entering the water consisted of the stride jump.

The first part of the study included three timed swimming tests (T1, T2, T3) over a distance of 50 metres. The choice of a 50 metres distance in these and the following tests was determined by the fact that it was the maximum possible distance which a lifeguard would cover during a rescue. This is justified by the most typical design of an organized beach, based on the Polish legal regulations, where the distance from the shoreline to the end of the swimming area is maximum 50 metres. If the drowning accident takes place further afield, a boat is used for the rescue.

The first test (T1) involved swimming the distance without the equipment (Table 2). In the second test (T2) a lifeguard put on a rescue canister (Figure 1) with a strap over his/her shoulder by his/her choice. The third test (T3) differed from the second one only by the way of putting on the canister strap: it was put on with two shoulder straps, like a rucksack (Figure 2).

The time of putting on the canister strap over the shoulder and putting on two shoulder straps was measured from the starting signal through picking the canister up from the floor, from either the right or the left side, putting the canister strap/straps on the body, completing the activities with the canister, covering the distance of 2 m to the edge of the pool, to the bending of the body as a preparation to perform a dive.

The start time was measured from the moment of bending the lifeguard's body to dive to the emergence of the first arm from water in order to start swimming.

The swimming time is from the moment of the emergence of the first arm from the water in order to start swimming to completing swimming over 50 metres.

In other tests (T4 to T13) (Table 4) the distance to the victim to be covered by the lifeguards was 48 metres. The aim of the tests involving simulated rescues without the equipment (T4) and with various variants of the rescue canister use (T5-T13) was to demonstrate that the time devoted to putting on a rescue canister must not be treated as a loss of time but as a benefit to a rescue.

In the first test (T4) the lifeguard had no rescue equipment. The lifeguard's task was to swim to the victim, take control of him/her using any known technique and tow him/her to the shore using a stroke of the lifeguard's choice.

We define taking control of the victim as getting hold of the victim (before the towing is started), either by holding the victim so that he or she cannot pull the lifeguard under water or successfully passing the equipment to the victim.

Because the results of the study had shown that the swimming time with the canister strap put on both shoulders in test T3 was the longest, this way of putting on the rescue canister was abandoned. In

Table 2. Results of timed swimming tests (seconds)

T1 - 50m without a rescue canister				
	start time		swimming time	total time
LG1	2.7		34.7	37.4
LG2	2.7		37.0	39.7
LG3	2.4		38.9	41.3
T2 - 50m, one canister strap over one shoulder				
	time of putting on a strap	start time	swimming time	total time
LG1	4.4	1.9	33.8	40.1
LG2	5.1	2.2	41.1	48.4
LG3	3.5	2.0	39.6	45.1
T3 - 50m , two canister straps over both shoulders				
	time of putting on two straps	start time	swimming time	total time
LG1	6.8	2.5	35.5	44.8
LG2	6.8	3.1	40.6	50.5
LG3	5.7	2.8	39.5	47.9

Figure 1. Putting a rescue canister on one shoulder

Figure 2. Putting a rescue canister on both shoulders

the following rescues, T5 to T13, the lifeguards put the strap over one shoulder, like in test T2.

In the nine tests (T5 - T13) a rescue canister was used. The nine rescues differed from each other in the ways the canister was passed to the victim and the victim was towed to the shore:

T5 – any technique of taking control of the victim, passing the rescue canister to the victim, any technique of towing the victim to the shore.

In the following four rescues (T6 to T9) the lifeguard pushed out the rescue canister to the victim's hand. During the towing the victim was on his/her chest holding the rescue canister with his/her both hands:

T6 – the lifeguard held the rescue canister with his/her both hands; while towing the victim, the lifeguard performed inverted breaststrokes, whereas the victim was still on his/her chest (Figure 3);

T7 – the lifeguard held the rescue canister in one hand while towing; the lifeguard performed the rescue stroke - one-arm pull (swimming on his/her side, holding the canister by its middle handle with his/her top hand, and paddling with his/her other, bottom, arm under the water; the legs perform scissors kicks: spreading and joining the legs in a horizontal plane; the head above the water turned towards the victim in order to watch him/her; the victim was on his/her chest) (Figure 4);

T8 – the lifeguard passed the rescue canister to the victim, then swam away from the victim and towed him/her on a long rope doing the rescue stroke; the victim was on his/her chest (Figure 5);

T9 – only after the active victim gripped firmly the rescue canisters the lifeguard proceeded with grabbing the victim's armpits, towing him/her to the shore, doing an inverted breaststroke, with the victim on his/her back. The rescue canister was on the chest of the victim (Figure 6).

The following four rescues (T10 to T13) differed from the four described previously (T6-T9) only by the manner of passing the rescue canister to the victim: it was pushed out with a slide on the water surface towards the victim. The lifeguard did not swim very close to the victim. He/she remained at a distance from which he/she could push out the canister to the victim without being grabbed by the latter. In tests T10-T13 the same four ways of towing were used in the same order.

At the end, an extra T14 test was carried out. The participants were fourteen lifeguards, including one woman. They performed four tests of towing the victim at a distance of 25 metres, each test with a canister used in a different way (Figures 3-6). Their starting heart rate and post-exercise heart rate were calculated as well as the towing time.

Figure 3. Towing with inverted breaststroke, the victim on his/her chest

Figure 4. Rescue stroke

Figure 5. Towing on a long rope

Figure 6. Inverted breaststroke with an armpit tow

The active victim behaved in a way characteristic for a drowning person who can swim, was conscious, aggressive and dangerous for a lifeguard.

It was accepted that the key element of the rescue of an active victim is taking control of him/her by the lifeguard. Taking control of the victim is, after approaching the victim, the ability to prevent the victim from grabbing the lifeguard and successful transition to towing. The lifeguard must not get close to the victim's hands in order to avoid being grabbed. If the lifeguard does not have any equipment, he or she must grasp the victim firmly from the back, and then start towing. If the lifeguard carries the equipment, he or she has to pass it skillfully to the victim and start towing. During the tests a successful rescue was one in which the lifeguard managed to take control of the victim, which made it possible to continue the rescue, that is, to start towing.

The researcher stopped the tests and considered them failed if there was any danger for the lifeguard's life (victim's grabbing, climbing on the lifeguard, trying to free himself/herself from the lifeguard's hold) in direct contact between the lifeguard and the active victim. A rescue was also stopped when the victim was not able to get hold of the canister, see it because of water in his/her eyes or if the canister slipped from the victim's hands.

Variables

In all the tests (T1 - T14), the total rescue time was measured. In tests T1 - T13 the time of rescue components was also measured; the times were presented in tables. Also, in all the rescues the lifeguards' starting and post-exercise heart rate was measured on the carotid artery. The initial pulse was taken for one minute and the post-exercise pulse for 10 seconds immediately after the completion of the exercise. The latter result was multiplied by six to obtain the number of heartbeats in one minute. In all the tests with the simulating victim (T4 - T13), the success of the rescue was established on the basis of whether the lifeguard took control of the victim, i.e. successful rescue, or whether the lifeguard did not take control of the victim, i.e. unsuccessful rescue.

Results

In tests T1, T2 and T3 the time was measured to assess how much time was spent on putting on a rescue canister, diving and swimming with the canister.

Putting on the rescue canister with a strap over the shoulder in test T2 took the lifeguards from 3.5 to 5.1 seconds (Figure 1) (Table 2). Putting on the canister strap on both shoulders (T3) took more time, i.e. 5.7 to 6.8 seconds. The time of swimming with the rescue canister, irrespective of the way of putting it on, can be considered similar, but for two subjects it was slightly longer than in the tests without the canister. The total time of the entire test was clearly the shortest without the equipment (T1) and the longest when the lifeguard swam with two shoulder straps (T3) (Figure 2) (Table 3).

Table 3. Differences in total time of three swimming tests

	time T2 - T1	time T3 - T1	time T3 - T2
LG1	2.7	7.4	4.7
LG2	8.7	10.8	2.1
LG3	3.8	6.6	2.8

The differences between the times of the tests were up to 10.8 seconds. This was in the case of a conscious victim, for whom even several seconds were not crucial for survival. The loss of consciousness occurred 95 to 165 seconds after the first signs of the victim's panic, choking or momentary swallowing of water (*WOPR*, 1993). According to *On the Guard II* (2001) this time should be 70 to 150 seconds. Therefore, spending a few seconds putting on a rescue canister is a disproportionately small loss compared to the benefit of safety for the victim and lifeguard, that is, to the rescue effectiveness. It would look different in the case of a passive victim (unconscious victim) for whom each second of brain hypoxia is crucial.

In tests T4 and T5 all three participating lifeguards decided to dive vertically before the active victim, swam underneath the victim and surfaced behind the victim's back. This is what they had been taught at lifeguard courses. It was to prevent being grabbed by the active victim. Test T4 turned out to be completely ineffective because none of the three lifeguards managed to take control of the victim (Table 4).

In test T5 the lifeguards decided to pass the rescue canister to the active victim by tightening the rope. After the victim had got hold of the canister, the lifeguards grabbed the victim's armpits from the back and started the tow (Figure 6). Teat T5 performed by all three participants was effective. The footage showed that during the dive under the victim there was a danger of the lifeguard being kicked by the active victim. In the case of less clear water the eye contact between the lifeguard and the victim could also be lost. In the author's opinion, diving under the victim is justified in the case of rescue without equipment. The point is to avoid being grabbed by the victim. When the lifeguard holds a rescue canister is his/her hand (T5), the possibility of being grabbed by the victim is insignificant, thus diving seems pointless. Besides, it is time consuming andexhausting. However, as the T5 test showed, having a choice all the lifeguards used this unnecessary manoeuvre. In this way, it can be a proof that unpractical rescue reactions are deeply rooted in a lifeguard's awareness.

All tests from T6 to T9 were effective. Their effectiveness must be attributed to the way of passing the rescue canister to the victim's hand. After taking control of the victim the lifeguards used four different ways of towing presented in Figures 3-6.

A high percentage of 75% of the tests T10-T13 were ineffective. The lifeguard was not significant here. The reason was the failure to get hold of the rescue canister by the victim. In spite of accurate passing the rescue canister by the lifeguard the victim could not get hold of the apparatus, because his/her arm movements generated waves which carried away a weakly pushed canister. Water in the eyes and the victim's panic (Pia, 1974) render an effective co-operation with the lifeguard ineffective. Valuable seconds are wasted. It should be emphasized that the tests were performed in a swimming pool, which is free from such factors as wind, waves or murky water, which may interfere with a rescue.

The shortest and longest times of the rescue activities are presented in Table 4. The total times do not add up as their component times were obtained by various lifeguards.

The obtained results suggest that methods of rescue which are less effective or completely ineffective should be abandoned for rescue methods which lead to successful rescues. These include rescues in tests T5 to T9. Among the presented variants of rescues the ones to be completely abandoned are rescues without equipment and rescues with passing the rescue canister on the surface of the water.

The study showed which components of the rescue are most effective and the safest, both for the lifeguard and the victim. All elements which significantly affect the success of the rescue and rescue time should be taken into account: a unique, long distance to the victim (48 metres), a stride jump and a lifesaving approach stroke to reach the victim (much slower than competition strokes), the victim's weight (approximately 100 kg), a large chest circumference, very muscular – difficult to encircle and hold by the lifeguard.

The results of the study allowed choosing the variants of the rescue in terms of their effectiveness. Another problem is the lifeguard's fatigue, who after taking control of the victim has to tow him or her to the shore. Sometimes in the meantime, another lifeguard comes to help, or a boat arrives at the place of the rescue; however, a situation in which a lifeguard cannot expect such help should be also examined. Then the degree of a lifeguard's fatigue is important and it may determine his or her abilities to tow the victim to the shore.

The heart rate of the studied lifeguards before the rescue, but after a swimming warm-up, ranged from 72 to 96 heart beats per second. The highest value obtained after towing the victim to the shore was 180 beats per minute (measured for 10 seconds immediately after the completion of the rescue and then multiplied by six). It is, however, difficult to separate what effects the individual parts of the rescue had on the lifeguard's fatigue, in particular the towing which is considered to be a great strain. Parnicki et al. (1999) measured a lifeguard's exertion during the individual stages of a rescue. They noted a heart rate of 169 beats per minute during towing the victim on his/her back holding his/her arms under his back over a distance of 25 metres. Assuming, as confirmed by earlier tests, that carrying out a rescue without equipment is too dangerous and of little effectiveness, the authors of this study carried out an extra partial rescue test (T14). The aim of this test was to assess the fatigue of the lifeguards during towing and to compare the towing times using various methods (Figures 3-6) (Table 5).

The relation between the towing time in seconds and the post-exercise heart rate presented in Table 5 was analysed statistically using Spearman's rank correlation test. The correlation between the towing time and the post-exercise heart rate was sta-

Table 4. Minimum and maximum times of individual rescue activities in various types of rescues (in seconds)

Rescue activities	T4	T5	T6–T9	T10–T13
Putting on a canister	a rescue without a can	3.6 – 5.3	3.1 – 5.8	2.6 – 7.4
Start	2.6 – 3.3	1.9 – 2.4	1.7 – 2.2	1.5 – 2.3
Swimming to the victim	35.4 – 39.6	37.1 – 42.5	36.2 – 43.9	37.1 – 40.6
Taking control of the victim	all three failed	6.7 – 11.2	5.0 – 13.2	nine tests failed, three tests successful in 4.1 – 12.5
Time from start of rescue to successfully taking control of the victim		50.7 – 61.4	47.5 – 60.5	46.8-56.2
Towing	all three failed	78.5 – 104.8	76.2 – 125.7	84.4 – 98.2
Total for the whole rescue	all three failed	130.6 – 166.1	127.2 – 182.5	140.1 – 153.0
Effectiveness	all three failed	all three successful	all three successful	nine tests failed, three tests successful

Table 5. Arithmetic means of heart rate at rest, post-exercise heart rate and towing time in 13 men and 1 woman.

T14 starting	heart rate	post-exercise heart rate	towing time
Towing method 13 men			
Inverted breaststroke (a canister in both hands)	76.6	159.7	53.2
Rescue stroke (a canister in one hand)	79.8	160.6	51.4
Rescue stroke with towing on a long rope	80.8	156.9	53.1
Armpit towing	80.3	155.1	47.2
1 woman			
Inverted breaststroke (a canister held in both hands)	78	168	47.2
Rescue stroke (a canister in one hand)	84	162	52.7
Rescue stroke with towing on a long rope	84	150	57.3
Armpit towing	78	156	41.3

tistically significant (Spearman's R = .31, p=.0262). A small significance of this correlation indicates that there are other factors different than the heart rate, e.g. the efficiency of the circulatory system, but probably also the movement technique, that affect the towing time. The most useful from the standpoint of low exercise heart rate in men and towing time was the armpit tow (Figure 6).

The times of towing in four different ways were compared with the use of Mann-Whitney U test. The time of armpit towing differed significantly from the time of towing in inverted breaststroke and with a rescue stroke with towing on a long rope (z=1.97, p=.048). For the only female lifeguard participating in the study this way was also the quickest, although her strain was the least after towing with a rescue stroke with the victim on a long rope.

Discussion and conclusions

The results of the study clearly indicate that the probability of effective performance of a rescue in the water without any equipment is negligible, and a lifeguard's safety in such conditions is at risk due to the direct contact with an active victim. The observations of American authors (*On the Guard II*, 2001) that the use of the equipment significantly reduces the risk of loss of lifeguard's and victim's lives were fully confirmed. Towing is facilitated and energy is saved during a rescue in the water.

The key for a successful rescue is taking control of the victim. After it is executed the greatest danger of life loss for the victim and lifeguard is over. The successful taking control of the victim ensures that the loss of consciousness and brain damage are prevented. It turned out that even in very unfavourable conditions of the rescue described above, with the assumption that the lifeguard notices the victim in the earliest stage of drowning, the time of rescue with equipment does not extend to the beginnings of loss of consciousness by the victim (according to various sources the earliest time it occurs is 70-95 seconds). The longest simulated rescue with such a long distance to cover to reach the victim and with the large dimensions of his/her body took 61.4 seconds before taking control of the victim. Thus, there was even a time margin in the case that a drowning accident was not immediately noticed.

A critical moment for the success or failure of a rescue was, as assumed in the study, taking control of an aggressive victim. If the lifeguard manages this, he/she is also able to carry out the rescue to the end. No rescue was stopped at a stage earlier or later than taking control of the victim.

The results of the study show that a lifeguard can start the rescue of an active victim with a large time margin even in unfavourable conditions (long distance to the victim, victim's heavy body weight, stride jump and swimming using a lifesaving approach stroke). Any positive changes of these factors will be reflected in a better outcome of the rescue.

Thus, the rescue proposed by the authors after the study should include the following elements: putting on the rescue canister strap on one shoulder, stride jump and swimming to the victim using a lifesaving approach stroke, passing the rescue canister to the victim's hand, and armpit towing the victim who holds the canister.

Of the often used components of the rescue, diving under the victim should be abandoned. It should be replaced by a safe form of passing the apparatus to the victim. In rescues without equipment a lifeguard dives when he or she is about two metres from the victim. The aim of this dive is to avoid being grabbed by the victim. Pia (1974) criticises this technique as a manoeuvre which causes the lifeguard's fatigue, spatial disorientation and waste of time. The analysis of the footage also shows that with this way of approaching the victim there is a great probability of the lifeguard being kicked by the victim. This risk increases greatly in water of little clarity. In spite of the disadvantages of this technique a great deal of time is, unfortunately, devoted during rescue courses to teaching it and fixing it in the awareness of the trainees of water rescue. Diving took place in two tests: T4 and T5, in which the lifeguards themselves made decisions in which way to take control of the victim. The shortest diving time was 4.1 seconds and the longest 8.0 seconds. In a rescue with the use of a safe and effective way of passing the equipment to the victim, diving can be abandoned and a few seconds can be gained. It gives another guarantee before approaching the time of the victim's loss of consciousness.

To sum up, it has to be stated that a lifeguard should always have a rescue canister close by. In this way, if there is a need to carry out a rescue he/she will not lose time getting to the rescue canister and putting it on. This definitely improves the chance of an effective rescue and increases the lifeguard's safety. The rescue canister should be even treated as a personal piece of rescue equipment in which the lifeguard adjusts the length of the strap to his or her own size and takes care of its technical condition.

At the same time the results of the study question some systems of lifeguard training, because carrying out an effective rescue with an active victim without equipment often turns out to be impossible. Training programmes at rescue courses treat such techniques as a significant element of examinations and course credits. This confirms the rescue trainees' faulty thinking about the practicability of performing rescues without any equipment.

The rescue canister selected for the above study is not the only useful apparatus in water rescue. Wiesner (2001) attempted to show the effectiveness of a rescue with such rescue equipment as a rescue tube, ring buoy, rescue canister, safety line on a winch and rescue line and ball. He demonstrated the advantages and disadvantages of the use of individual rescue devices. He specified the time needed to swim and tow the victim with the use of the above equipment over a distance of 20 metres. The use of a rescue tube, a ring buoy and a line on a winch also has many advantages. The authors suggest that changes should be made in the training of lifeguards, which then should lead to course participants getting to know the techniques of using various equipment and choosing one most suitable for themselves. Each lifeguard has a slightly different predisposition, different strengths (for example, depending on the swimming stroke he or she practiced competitively earlier) and may prefer different techniques of swimming and towing with the use of rescue equipment.

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PROCJENA UČINKOVITOSTI RAZLIČITIH NAČINA SPAŠAVANJA OD UTAPLJANJA

Sažetak

Uz spašavanje od utapljanja, nažalost, vezuju se mnogi mitovi. Vrlo se malo spasilačke opreme koristi pri spašavanju, a ona koja se koristi rijetko ima unaprijed određene i testirane algoritme spašavanja. Stavovi spasilaca o ovom problemu su podijeljeni. Oni, često bez dubljeg razmišljanja, koriste tehnike spašavanja koje su naučili tijekom spasilačke obuke ili uvježbavanja, a koje nisu uvijek učinkovite i sigurne ni spasioca ni za žrtvu. Spasioci koriste spasilačke bove koje su postale popularne nakon emitiranja TV serije *Spasilačka služba*. Tehnike koje se koriste za manipuliranje tim bovama utemeljene su na promatranju spašavanja, a ne na znanstveno dokazanim principima.

Cilj je ovog istraživanja bio empirijski utvrditi učinkovitost izabranih načina spašavanja utopljenika. Konkretno, autori su nastojali odrediti učinkovitost spašavanja primjenom spasilačke opreme i bez nje.

Studija je uključivala pokušaje priležanja žrtvi različitim načinima plivanja, simulirane različite načine spašavanja i pokušaje da se utopljenik izvuče na suho. Provedena je u zatvorenom bazenu zbog sigurnosnih razloga te zbog lakšeg podvodnog i nadvodnog snimanja spašavanja. Ipak, cjelokupna studija odnosi se na spašavanje od utapljanja na otvorenom moru ili jezeru.

Prvih trinaest testova (T1-T13) provela su trojica spasilaca koji su kvalificirani za samostalnu spasilačku službu (LG[1]1, LG2 i LG3). Instruktor spasilačke službe, snažan i visok muškarac, bio je angažiran kao aktivna žrtva (AV[2]).

Istraživanje je započelo mjerenjem vremena potrebnoga za preplivavanje 50 metara trima različitim plivačkim tehnikama. Prvi je test uključivao plivanje zadane dionice bez spasilačke opreme. Drugi i treći test uključivali su plivanje dionice sa spasilačkom bovom – u 2. testu vrpca bove bila je prebačena preko jednog ramena, a u 3. testu bovu je spasilac nosio na leđima poput naprtnjače (vrpce preko oba ramena) (tablica 2). Postavljenje trake bove za spašavanje na rame trajalo je 3,5 do 5,1 sekundu. Postavljenje trake bove na oba ramena trajalo je još i više – od 5,7 do 6,8 sekunda.

Razlike u ukupnim vremenima tri testa iznosile su i do 10,8 sekunda (tablica 3). Ovakva razlika u vremenima može se tolerirati u slučaju da je žrtva pri svijesti za koju nekoliko sekunda nije ključno u spašavanju. Gubljenje svijesti događa se od 70 do 165 sekunda od trenutka prvih znakova panike kod žrtve, gušenja ili kratkotrajnog gutanja vode (WOPR 1993; *On the Guard II* 2001). Zbog toga, nekoliko sekunda koje se izgube na stavljanje spasilačke opreme nesrazmjerno je mali gubitak u odnosu na povećanje sigurnosti i žrtve i spasioca, odnosno na povećanje učinkovitosti samog spašavanja.

Drugi dio istraživanja uključivao je 10 simuliranih načina spašavanja na dužini od 48 metara (tablica 4). U sklopu individualnih testova, nakon uspostavljanja kontrole nad žrtvom, koristile su se različite tehnike vučenja do ruba bazena (crteži 3, 4, 5 i 6).

Kod spasilaca uključenih u ovo istraživanje je frekvencija srca u mirovanju, ali nakon plivačkog zagrijavanja, iznosila 72 do 96 otkucaja u minuti. Najviša izmjerena vrijednost FS otk/min nakon vučenja žrtve do ruba bazena iznosila je 180. Vučenje se smatra fazom najvećeg napora za vrijeme spašavanja. Korelacije između vremena vučenja i frekvencije srca nakon odrađene vježbe spašavanja bile su statistički značajne (Spearman's R = 0,31, P=,0262). Niska statistička značajnost navedenih korelacija pokazuje da postoje i drugi faktori koji utječu na vrijeme vučenja žrtve do ruba bazena, a ne samo djelotvornost krvožilnog sustava. Vjerojatno je jedan od važnijih faktora i tehnika kretanja pri vučenju.

Vrijeme vučenja tehnikom koja predviđa da je žrtva pod pazuhom spasioca značajno se statistički razlikovala od vremena koje je bilo potrebno za spašavanje tehnikom okrenutog prsnog povlačenja ili tehnikom povlačenja dugim užetima ($z = 1{,}97$, $p = 0{,}048$). Najkorisnija metoda vučenja, kod koje su bile zabilježene najniže frekvencije srca, bila je vučenje žrtve pod pazuhom (slika 6).

Rezultati ovog istraživanja jasno pokazuju da je vjerojatnost bržeg i učinkovitog spašavanja bez uporabe spasilačke opreme zanemarivo veća, ali je u takvim uvjetima sigurnost spasioca ugrožena zbog direktnog kontakta s žrtvom.

Ključ uspješnog spašavanja jest uspostavljanje kontrole nad utopljenikom. Nakon toga najveća je opasnost i za žrtvu i za spasioca otklonjena. Uspješno kontroliranje utopljenika osigurava da neće doći do gubljenja svijesti žrtve ni do oštećenja mozga. Kontrolu nad žrtvom definiramo kao takvo prihvaćanje žrtve u kojemu ona ne može povući spasioca pod vodu ili kao situaciju u kojoj se žrtvi uspješno doda spasilačka oprema.

Preporučena tehnika spašavanja, najučinkovitija u ovom istraživanju, uključuje sljedeće elemente: stavljanje trake spasilačke bove preko jednog ramena, skok dugim korakom na noge i plivanje prema žrtvi spasilačkom plivačkom tehnikom s glavom iznad vode, pružanje bove u ruke utopljenika te, nakon što je utopljenik kvalitetno primio bovu, odvlačenje na obalu tehnikom ispod pazuha. Ronjenje ispod utopljenika trebalo bi napustiti.

[1] LG – engl. lifeguard - spasilac

[2] AV – engl. active victime aktivna - žrtva