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## **The quality of chest compressions performed by the staff employed in selected units cooperating with the state emergency medical services system**

### SUMMARY

The purpose of our research was to compare the quality of chest compressions performed by firefighters, lifeguards, and police officers and to identify any weak points they may have so as to prevent them in the future. Participants of the research were asked to compress the chest of a training phantom for four minutes, and the results were measured separately after the first two and consecutive two minutes. Based on the results, lifeguards have the biggest problem with maintaining the correct depth of compressions, firefighters with upholding the adequate rate, and police officers strain after two minutes, which influences the quality of chest compressions. The conclusion of the research is that all these groups should receive more obligatory practical training, so that people, who may sooner or later be confronted with a situation in which they have to sustain blood circulation between vital organs, can do it as flawlessly as possible.

**Key words:** compressions, emergency medical services system, qualified first aid, cardiopulmonary resuscitation.

## **Background**

High-quality chest compressions are crucial to sustain vital functions until the possibility of using electric devices which are intended to restore regular heart rhythm become available [6, 7]. Furthermore, there are documented cases of restoring proper heart functions with just chest compressions. Compressions must be performed with diligence and maximum efficiency as soon as possible. Following this line of thought, all possible witnesses should be trained in first aid, especially in chest compressions and using an Automated External Defibrillator (AED). Due to the limited number of ambulances and extended travel time to the victim other services are first at the scene where help is needed. So, it is crucial that all people and mentioned services are properly trained and their quality of chest compressions is indeed at its highest. While lifeguards and firefighters in active service must have completed the Qualified First Aid course and passed the examination in its scope, police officers are not legally obliged to attend the first aid course or pass knowledge of life-saving activities.

According to the guidelines, when someone is not breathing or is breathing incorrectly, you should start cardiopulmonary resuscitation as fast as you can after calling for help [1, 3]. This is what chain of survival (Figure 2) says– the first thing a person should do is to recognise cardiac arrest and call for help. There is no doubt about the importance of this act – a non-qualified person cannot do much at the scene to help the victim, or even a qualified person can do much less without the equipment or resources to transport a victim to the hospital. The second chain link calls for starting cardiopulmonary resuscitation as soon as possible, to buy time, to maintain blood circulation through vital organs: heart, lungs, and brain, to stop the blood clotting process and keep the flow, among other things, of oxygen to the brain. The next link requires a defibrillator be used right away to restore heart rhythm if the victim's heart is working in ventricular fibrillation or ventricular tachycardia. There is a great chance for a patient to survive cardiac arrest if a witness uses an AED (automated external defibrillator) in the first minutes. The last link indicates post-resuscitation care – it happens in the hospital with qualified medical personnel involved as well as special procedures that are to restore the best possible quality of life – nothing that can be done by a witness in the field. Nevertheless, let's focus on what they can do, because they can do a lot. The chest should be compressed in the middle, with enough force to compress the chest to a depth of five to six centimeters. The compressions rate should fall between 100 and 120 compressions per minute, which gives us an average little less than two every seconds. In literature, there is still a discussion about the influence of inhalations in cardiopulmonary resuscitation and using the 30:2 algorithm. The vast majority agrees that chest compressions are more important than inhalations and using the 30:2 algorithm instead of just chest compressions does not show a significant difference in survivability of people with cardiac arrest. With each subsequent guideline of the European Resuscitation Council, more attention is paid to the lack of interruptions in chest compressions and their best possible quality [1].

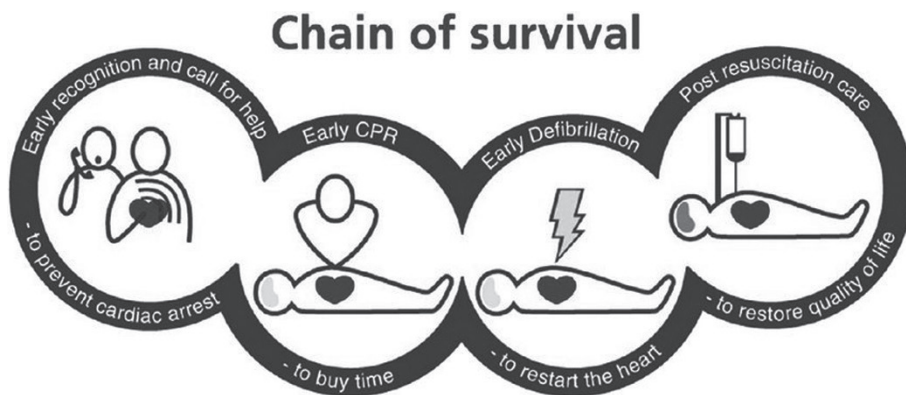


Figure 1. Chain of survival

Source: European Resuscitation Council Guidelines (ERC).

### Material and methods

The study group included 55 firefighters working at Rescue and Fire Units number one and two in Pila, 42 police officers working in many units in the district police in Poznan and 37 lifeguards working at Aquapark in Pila. Every one of them is currently working in their profession. All the study participants agreed to take part in the research, and at the time of joining, had no contraindications to participate in the study as their health conditions allowed it. Measurements were collected July 17<sup>th</sup>-19<sup>th</sup>. Good quality chest compressions are those with a rate of 100-120 compressions per minute, depth of 50-60 millimetres and with preserved relaxation (from European Resuscitation Council Guidelines 2021) [1, 3, 8, 9, 11, 14].

Parameters have been collected by training phantom AmbuMan Advanced. Participants performed chest compressions for four minutes continuously without giving rescue breaths and using the AED machine. During the testing, there were no disruptions, like music or crowds of people standing around the person being tested. During this time there were two results taken after every two minutes. The following parameters were considered during the study: chest compressions rate, depth, and whether relaxation levels were maintained. The results show the arithmetic mean of people who maintained correct depth, rate, or relaxation against the background of all study participants in the first two and consecutive two minutes.



Figure 2. AmbuMan Advanced

Source: AmbuMan Advanced Startseite (anatomie-modelle.de).

## Results

Not many can maintain chest compressions at a good level for a long time. Research shows that in the first two minutes 14,46% of firefighters, 22,73% of lifeguards and only 7,98% of police officers did not maintain adequate chest relaxation. In the third- and fourth-minutes firefighters got better at 9,10%, lifeguards at 21,90%, but police officers got worse results, 25,53% of whom did not relax the chest.

On average, within four minutes, the number of firefighters who did not maintain chest relaxation during chest compressions was 11,78%, lifeguards 22,31%, and police officers 16,25%. If we consider the rate of chest compressions, the worst results were achieved by people employed in the State Fire Brigade.

Only 49,09% of them maintained the average correct compression rate for the first two minutes, and only 38,18% of them in the third and fourth minutes.

The lifeguards did better, maintaining an average pace of 62,16% in the first two minutes and 64,86% in the next two minutes. Despite this, the best results were achieved by police officers; as many as 82,93% of them maintained the appropriate average pace throughout the first two minutes of the research and 73,17% throughout the next two minutes. In the first stage of the examination, the appropriate depth of compressions was better than in the second stage in all study groups. In the first two minutes, 73,17% of police officers maintained deepness at the highest level, not much less 70,91% of firefighters and only 59,46% of lifeguards. In the second stage efficiency of all people taking part in the research decreased. Only 48,78% of police officers maintained suitable depth, 69,09% of firefighters and 54,05% of lifeguards.

Table 1. Research results

	First two minutes			Next two minutes		
	Correct chest relaxation	Correct compression rate	Correct compression depth	Correct chest relaxation	Correct compression rate	Correct compression depth
Firefighters	85,54%	49,09%	70,91%	90,90%	38,18%	69,09%
Lifeguards	77,27%	62,16%	59,46%	78,10%	64,86%	54,05%
Police officers	92,02%	82,93%	73,17%	74,47%	73,17%	48,78%

Source: own elaboration.

## Discussion

Even though the results do not look good at first glance, most of the irregularities and shortcomings are minor when compared to the ideal chest compressions. Nevertheless, the percentage of people whose chest compressions are just not effective is higher than it could be with proper training.

To work in the profession, lifeguards must have a certificate verifying completion of a 66-hour Qualified First Aid course and pass the theoretical and practical exam.

The mentioned certificate is valid for three years, then lifeguards must refresh their knowledge and pass the exam again.

Throughout the course, there should be a proper amount of time devoted to practicing chest compressions. However, even if lifeguards do chest compression for an hour, it would only happen once in a lifetime, as they only need to do them for around two minutes during the exam once every three years.

This amount of training is not enough for people who we expect to save our life in case of an emergency.

Of course, lifeguards, like everyone else, can expand their competencies in basic life support and attend several different courses available on the market. As a refresher, they can also take the Qualified First Aid course again, but are not required to and therefore, according to results, most do not.

Some organisations, such as WOPR have their own equipment such as training AED<sup>2</sup>s or training phantoms for chest compressions and can conduct courses for their members [13]. You can clearly see a lack of training when you look at the results of the exam. The quality of chest compression by currently employed lifeguards is the lowest, both during the first two minutes and during the second part of the exam. The most difficult thing for lifeguards is to maintain is correct depth; not much more than 50% of them tackled the challenge. Most of them are using too much strength, their chest compressions are deeper than 60 millimetres, and their rate is higher than 120 beats per minute. Old schools say that chest compressions should be “fast and hard” and lifeguards are taking it too seriously. Nevertheless, according to the latest research and both AHA (American Heart Association) and ERC (European Resuscitation Council) guidelines the old school rule is not in the best of interest of the patient [1, 3, 14].

Firefighters on duty must also have a current Qualified First Aid certificate, just like lifeguards. There is nothing that legally obligates them to practice first aid, but still, lots of their calls do involve medical knowledge, and a lack of available ambulances brings about situations like the Fire Department having to send their people and vehicles to only medical occurrences. Therefore, the job of firefighters includes a lot of medical practice. There are not many training opportunities for them, but there should be if you take into consideration that plenty of them may have to give you medical care someday [10, 12].

If the rate is too high, cells cannot take in oxygen from the blood. If the rate is too low – there is not enough pressure to pump the blood through the vessels. Firefighters’ weak point is maintaining the correct rate of 100-120 beats per minute. The majority of them (little more than half through the first two minutes and more than 60% of them through the rest of the exam) could not maintain the strongly advised guidelines rate. Only a few firefighters compressed the chest too slowly, most of them did it too fast. The studies were conducted in a controlled environment without stress factors resulting from the situation when someone does not breathe.

There is no legal state document that obligates police officers to take any first aid courses, but some provinces have their internal regulations about the number of hours spent at first aid courses by each police officer depending on strengths and resources [5]. At the police academy there is a subject focusing on first aid, chest compressions etc., although this knowledge should be properly refreshed and updated according to the newest guidelines. Furthermore, a skill set should be practiced, not simply learned and hoped to be remembered once the time comes. Frequently police cars are first at the scene, where the help is needed, because they do patrol the streets unlike lifeguards or even firefighters, so they should be obligated to train their abilities more often than once in a lifetime.

Looking at the results police officers fared very well in the studies and courses. Their relaxation was almost always preserved, and both rate and depth were at a high level. However, their results dropped after two minutes much more than other study groups. According to a great deal of research and studies, the quality of chest compressions drops after two minutes, so it is not a surprise, although the quality of this study group dropped much more radically than the others. Despite the quality drop the result may be considered as very good if they take turns at appropriate times for chest compressions.

It is difficult to point out one direct cause of aberrations in all the groups. The shortcomings are not just a place-of-work problem but an individual issue, and extra training will help make muscle memory and prepare the professional for when someone needs help. Only the internal courses would make a difference. If needed, the time will be found and resources should too. Everyone should have access to a high quality of life-saving procedure, especially authorities. Speaking directly about firefighters and lifeguards and their obligation of having a current Qualified First Aid certificate, the problem may be in the amount of time between recertifications. Three years is plenty of time to forget learned abilities, and even then, they only have to pass the exam; which takes less than an hour. A more effective option may be to take one-day refresher course before the exam and to be recertified every two years or even every year to make it more efficient.



Figure 3. Lucas 3

Source: own elaboration.

Good quality chest compressions are crucial to give to the victim for the best chance of survival and as good as a probability of a having good quality of life, it is sure, but what about mechanical devices, which can replace people in chest compression? Some of the organisations or Fire Departments have these devices in their equipment, so they can use them if needed. There are a few types of these devices: Lucas 1, Lucas 2, AutoPulse, Life-Stat, Thumper, etc., although all of them have the same purpose, there are some differences in their operation [19].

For example, Lucas 2 is easy to put on the patient, but the plastic is on both sides of the patient, which reduces the risk of the device moving from side to side as its connected to a curved piece of plastic, and consequently the quality of compressions may drop, but it can only do mechanical chest compressions. Aside from chest compressions, Life-Stat can also be a transport respirator, but it is only on one side of the patient, which increases the risk of moving. These devices can help if there is not enough hands, especially in the mass



accidents, where all resources are needed to help as many people as possible, or when you have to transport the patient from an unsafe or cold place to a safe zone or even just to the hospital. To help the victim, every known method must be utilized. Although there are many benefits of using these types of equipment, they are rarely used as a first choice; because of possible severe damages, such as holes in the stomach caused by blowout injuries, which can lead to death even after successful resuscitation [20]. There is much research about the difference in quality of mechanical and manual chest compressions and just as many results show, some say that manual chest compressions are better quality, another one says mechanical chest compressions are easier to provide in difficult circumstances, others say there is no difference at all [2, 4, 15, 16, 17, 18, 21]. One thing is sure – mechanical devices are just mechanical devices that can be broken or lost and are too expensive to be bought in the first place, but nevertheless, a good quality manual chest compression is always needed.

### Summary

The quality of chest compressions is a matter of life and death. Lifeguards, firefighters and police officers are consistent at it, but could and should have been better with more obligatory practice. For people who have direct contact with medical incidents at their jobs should be introduced to a separate law that regulates the number of hours of courses and practical work.

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## STRESZCZENIE

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### **Jakość uciśnień klatki piersiowej przez osoby zatrudnione w wybranych jednostkach współpracujących z państwowym systemem ratownictwa medycznego**

Celem naszego badania było porównanie jakości uciśnień klatki piersiowej pomiędzy strażakami, ratownikami i policjantami oraz poszukiwanie słabych punktów, którym być może będą musieli zapobiegać w przyszłości. Uczestnicy badań zostali poproszeni o uciskanie klatki piersiowej fantomu treningowego przez cztery minuty, a wyniki pobierano oddzielnie po pierwszych dwóch i kolejnych dwóch minutach. Z wyników wynika, że największy problem z utrzymaniem prawidłowej głębokości uciśnień mają ratownicy, strażacy z utrzymaniem odpowiedniej częstości uciśnień, a policjanci obciążają się już po dwóch minutach, co wpływa na jakość uciśnień klatki piersiowej. Wniosek jest taki, że dla wszystkich tych grup powinno być więcej obowiązkowych ćwiczeń, aby ludzie, którzy prędzej czy później mogą znaleźć się w sytuacji, w której będą musieli utrzymać przepływ krwi między ważnymi narządami, mogli to zrobić możliwie bezbłędnie.

**Słowa kluczowe:** uciski, system ratownictwa medycznego, kwalifikowana pierwsza pomoc, resuscytacja krążeniowo-oddechowa.

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