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ORIGINAL ARTICLE

Comparison of resuscitation techniques using pocket-mask in tactical medicine

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ABSTRACT

INTRODUCTION: The technique of resuscitating or supporting inefficient breathing on the battlefield can be carried out using the soldier's mask. However, carrying out this activity by one rescuer requires the use of the appropriate techniques. The study aims to assess the effectiveness of selected resuscitation methods using mouth-mask ventilation.

MATERIAL AND METHODS: The research tool was a Pocket Mask type artificial respiration kit. The study covered the resuscitation technique from behind the patient's head and from the side of the patient, performed by one soldier. The study group underwent standardized training on the application of the package. The parameters were evaluated before the training, immediately after the training and three days after the completed instruction. The statistical T-Student test and Mann-Whitney U test were used to analyze statistical results. All results were considered significant at $p < 0.05$.

RESULTS: Significantly higher quality of ventilation from behind the head was shown compared to ventilation from the side of the patient (minute volume: p=0.000; inspiration rate: p=0.015; breath volume: p=0.017) in the long-term assessment. A brief instruction on tactical rescuers can be an effective way to teach ventilation using the Pocket Mask package.

CONCLUSIONS: Cardiopulmonary resuscitation conducted by one person from the head method guarantees a higher quality of rescue operations compared to the technique from the side. A brief briefing of soldiers on how to use a ventilation mask can be effective. The Pocket Mask package that is included in the tactical lifeguard is an effective tool for conducting ventilation using the mouth-mask method in battlefield conditions.

KEYWORDS: Pocket mask, resuscitation, ventilation, battlefield medicine, tactical rescue.

INTRODUCTION

Every day, while conducting military operations, fatal events occur on the battlefield. A significant proportion of deaths are deaths that can be avoided [1]. The success of the rescue operation in the conditions of tactical medicine is determined by the fast help of the rescuer and the availability of medical equipment. Rescuers on the battlefield must conduct actions in a way other than actions in safe conditions of the civil environment [2].

Medical rescue on the battlefield - or tactical rescue - are all actions carried out to help victims during combat operations that directly threaten fighting soldiers and rescuers who help them [3]. Such assistance is most often provided in the case of life-threatening conditions, when the simplest rescue operations are used, but not always in line with the assumptions of civil rescue. In such cases, rescuers often improvise rescue equipment and rescue operations until the threat begins to diminish. Then they are just starting to use other elements of emergency medical services to adequately protect the injured person [1]. Artificial respiration masks are elementary equipment used in emergency medical services. The Pocket Mask rescue mask has been designed to provide safe replacement breathing for adults, children, and babies. This is a specialized method that is used to perform mouth-mask ventilation. The mask includes a pneumatic sealing cuff, mouthpiece with a bacterial filter and an additional port for connecting the oxygen tube to enrich the breathing mixture with 100% oxygen. The silicone coating, which is the highest quality, gives the possibility of the complete matching of the mask to the victim's face. Stored in a plastic box, it combines the functions of a one-way valve with low flow resistance with a high-quality hydrophobic bacterial filter, giving rescuers conducting artificial ventilation with its maximum protection and high comfort of work (Figure 1).

The technique of resuscitation or supporting inefficient breathing on the battlefield can be carried out using the soldier's mask [4]. However, due to the frequent need for tactical rescuers to work alone, resuscitation using Pocket Mask requires adaptation of the appropriate technique. Performing one rescuer chest compressions and patient's ventilation using the mouth-mask technique is a challenging activity, due to problems with maintaining tightness during ventilation and minimizing interruptions in pressure. The authors of the study attempted to assess the effectiveness of two cardiopulmonary resuscitations (CPR) techniques using Pocket Mask by one rescuer.

Figure 1. "Pocket Mask" rescue mask

MATERIAL AND METHODS

The research tool was the Pocket Mask artificial respiration mask (Figure 1) and the phantom with the Ambu CPR Software computer program used to record specific resuscitation activities. The main parameters that were noted during a 2-minute resuscitation using Pocket Mask are:

- minute volume of ventilation;
- inspiration rate per minute;
- breathing volume;
- depth of compressions;
- correct pressure sites;
- relaxation;
- frequency of compressions.

The study included two resuscitation techniques: "from behind the head" (Figure 2) and "from the side" (Figure 3). The study group underwent regular uniform training in the use of Pocket Mask. The parameters were evaluated before the training, immediately after the training and three days after the completed instruction.

Figure 2. "From behind the head" ventilation technique.

Figure 2. "From the side" ventilation technique.

The survey was conducted in 2018 at the Military Unit in Poland. The study group consisted of forty-eight professionally active soldiers. The results were expressed as arithmetic means and average standard errors. The statistical T-Student test and Mann-Whitney U test were used to analyze statistical results. All results were considered significant at $p < 0.05$.

RESULTS

Participants in the study

Forty-eight soldiers participated in the study, including four women and 44 men. The average age was M=34.02 years (SD=7.87). All subjects already had knowledge and skills in the field of basic resuscitation procedures.

Assessment of resuscitation quality

In order to check if there are differences in CPR parameters using Pocket Mask (i.e. minute volume of ventilation, frequency of inspirations per minute, volume of breaths, depth of compressions, correct places of pressure, relaxation, frequency of compressions) "from the side" and "behind the head" , a number of Student's t-tests were carried out for dependent samples, separately - before the training, immediately after the training and 3 days after the training. The lists are presented in Table 1 and Table 2.

The above tables show the seven tested parameters measured before and immediately after the training. In both cases, a comparison was also made between the lateral resuscitation group and the head resuscitation group. There were no statistically significant intergroup differences.

Three days after the training, the quality of resuscitation was again measured using Pocket Mask to attempt to assess long-term effectiveness. The differences turned out to be statistically significant in the parameters of the minute ventilation volume (from the side: 1.07 liters vs. from behind the head: 1.45 liters), the frequency of inspirations (from the side: 3.54 / min vs. from behind the head: 4.21 / min) and inspiration volumes (from the side: 0.30 liters vs. from behind the head: 0.34 liters), as shown in Table 3.

Table 1. Comparison of CPR "from the side" and "from behind the head" before training (T-student test for dependent samples).

Lp.	CPR parameters	Resuscitation "from the side"	Resuscitation "from behind the head"	Materiality level
1	Minute ventilation volume:	0,50 (± 0,91) [l/min]	0,48 (± 0,80) [l/min]	p=0,875
2	Inhale frequency:	1,69 (±3,14) [l/min]	1,83 (± 2,41) [l/min]	p=0,671
3	Breath volume:	0,13 (± 0,16) [l/min]	0,12 (± 0,15) [l/min]	p=0,894
4	Compression depth:	49,04 (± 5,02) [l/min]	48,58 (± 5,42) [l/min]	p=0,477
5	The number of correct locations for the compression site	125,60 (± 35,39) [l/min]	135,98 (± 47,15) [l/min]	p=0,188
6	The amount of compressions with proper relaxation	51,60 (± 44,85) [l/min]	54,98 (± 40,21) [l/min]	p=0,628
7	Compression Rate:	96,58 (± 23,50) [l/min]	103,00 (± 29,45) [l/min]	p=0,099

Table 2. Comparison of CPR „from the side" and „behind the head" after training (student T-test for dependent samples).

Lp.	CPR parameters	Resuscitation "from the side"	Resuscitation "from behind the head"	Materiality level
1	Minute ventilation volume:	1,44 (± 0,93) [l/min]	1,28 (± 0,81) [l/min]	p=0,306
2	Inhale frequency:	3,94 (±2,29) [l/min]	4,40 (± 2,21) [l/min]	p=0,242
3	Breath volume:	0,33 (± 0,16) [l/min]	0,29 (± 0,12) [l/min]	p=0,096
4	Compression depth:	48,83 (± 5,54) [l/min]	47,98 (± 5,39) [l/min]	p=0,148
5	The number of correct locations for the compression site	130,4 (± 27,83) [l/min]	133,52 (± 28,28) [l/min]	p=0,437
6	The amount of compressions with proper relaxation	48,79 (± 34,58) [l/min]	50,67 (± 32,45) [l/min]	p=0,781
7	Compression Rate:	97,98 (± 22,50) [l/min]	95,81 (± 22,10) [l/min]	p=0,493

leTable 3. Comparison of CPR "from the side" and "from behind the head" 3 days after the training (student's T-test for dependent samples).

Lp.	CPR parameters	Resuscitation "from the side"	Resuscitation "from behind the head"	Materiality level
1	Minute ventilation volume:	1,07 (± 0,57) [l/min]	1,45 (± 0,77) [l/min]	**p=0,000**
2	Inhale frequency:	3,54 (±1,46) [l/min]]	4,21 (± 1,93) [l/min]	**p=0,015**
3	Breath volume:	0,30 (± 0,11) [l/min]	0,34 (± 0,12) [l/min]	**p=0,017**
4	Compression depth:	48,00 (± 4,36) [l/min]	48,48 (± 5,24) [l/min]	p=0,457
5	The number of correct locations for the compression site	135,48 (± 19,25) [l/min]	131,15 (± 31,65) [l/min]	p=0,290
6	The amount of compressions with proper relaxation	48,17 (± 27,38) [l/min]	41,54 (± 33,84) [l/min]	p=0,145
7	Compression Rate:	102,96 (± 22,35) [l/min]	96,42 (± 19,86) [l/min]	p=0,062

Training effectiveness

Additionally, in order to demonstrate the effectiveness of training in "from the side" and „behind the head" ventilation techniques using Pocket Mask, the results were compared before and immediately after the training using the Mann-Whitney U test. These data are presented in Table 4 and Table 5.

Based on the analysis, it was found that brief instruction statistically significantly improved the results in both "side" and "behind the head" ventilation. Substantive instructional errors that could distort the results were therefore excluded.

Table 4. Demonstration of the effectiveness "from the side" ventilation training (Mann-Whitney U test).

Lp.	CPR parameters	Before training	After training	Result of the test
1	Minute ventilation volume:	0,50 [l/min]	1,44 [l/min]	Mann-Whitney U test: 4,395**; p=0,000**
2	Inhale frequency:	1,69 [l/min]	3,94 [l/min]	Mann-Whitney U test: 5,137; **p=0,000**
3	Breath volume:	0,13 [l/min]	0,33 [l/min]	Mann-Whitney U test: 2,404; **p=0,016**

Table 5. Demonstration of the effectiveness of training „behind the head" ventilation technique (Mann-Whitney U test).

Lp.	CPR parameters	Before training	After training	Result of the test
1	Minute ventilation volume:	0,48 [l/min]	1,28 [l/min]	Mann-Whitney U test: 3,807; **p=0,000**
2	Inhale frequency:	1,83 [l/min]	4,40 [l/min]	Mann-Whitney U test: 4,964; **p=0,000**
3	Breath volume:	0,12 [l/min]	0,29 [l/min]	Mann-Whitney U test: 2,252; **p=0,024**

DISCUSSION

The effectiveness of resuscitation procedures depends mainly on the combination of basic resuscitation procedures and advanced resuscitation procedures [5]. Ventilation from behind the patient's head using a self-inflating bag with a face mask is a method recommended by many authors. The professional experience of people working in resuscitation teams indicates that the use of a self-inflating

bag requires ventilation from behind the head, which also prevents simultaneous pressure on the side of the patient if CPR is performed by one rescuer. In the conducted research it was found that resuscitation carried out with the use of the Pocket Mask method from behind the head gives better results than resuscitation carried out using the method from the side, which was confirmed only in the long-term assessment. A comparison of the effectiveness of training in the field of ventilation showed that the training instructor both from the head and from the side proved to be effective, as the study group statistically significantly improved their skills in every aspect. Thanks to this analysis, a factor that distorts the results in the form of substantive errors of training can be excluded.

The borderline result at the level of p=0.062 was obtained in the measurement of the differences in compression rates (from the side: 102.96 / min vs. from the head: 96.42 / min). The effectiveness of chest compressions during resuscitation using Pocket Mask is comparable, regardless of the ventilation technique. However, special attention should be paid to the rate of chest compressions during ventilation from behind the head, as the result obtained is borderline for statistical significance. In tactical rescue of battlefield medicine, first aid is provided to a wounded soldier by a colleague, for whom a short training provided by a medical rescuer is an effective form of teaching professionally active soldiers to use the Pocket Mask kit. Proper ventilation ensures PaO2 at a level of approx. 100 mmHg, and PaCO2: 35 - 45 mmHg. A leak between the mask and face can reduce the volume delivered by 40% or more.

The Pocket Mask, based on better materials and a more accurate "fit" to the face anatomy, proved to be the best in terms of tightness and convenience of use during replacement ventilation conducted in this study. Both before and immediately after the training, no statistically significant differences were found between resuscitation (both ventilation and pressure) from behind the head and from the side. After three days, however, it turned out that the ventilation group from behind the head was much better. In the long term, ventilation through the Pocket Mask from behind the head seems more practical. However, remember to pay attention to maintaining the appropriate rate of pressure then, because the results show that the ventilation group from the side did it a bit better (although there were no statistically significant differences).

Proper ventilation of the injured is one of the basic skills of a rescuer. Ventilation using a self-inflating bag with a face mask requires the use of an appropriate technique [6]. Cardiopulmonary

resuscitation techniques are continually evolving. However, it does not always bring the expected results, because it is performed too late, by people not always properly trained, using the wrong equipment or not in accordance with the recommended methods. Therefore, the universality of training in this area, modernization of equipment, use of the latest methods and shortening to a minimum the time from the occurrence of the event to the start of resuscitation, which results in human life, is necessary.

CONCLUSIONS

Cardiopulmonary resuscitation conducted by one person from the head method guarantees a higher quality of rescue operations compared to the technique from the side. An brief abridged briefing of soldiers on how to use a ventilation mask can be effective adequate. The Pocket Mask package that is included in the tactical lifeguard is an effective tool for conducting ventilation using the mouth-mask method in battlefield conditions.

Disclosure statement

The authors did not report any potential conflict of interest

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