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Paulina Buca[1], Kamil Krzyzanowski[2], Przemyslaw Zuratynski[2], Pawel Jastrzebski[3], Adam Gorgol[4], Klaudiusz Nadolny[5, 6], *Daniel Slezak[2]

Cardiac arrest – factors affecting the effectiveness of resuscitation

Zatrzymanie krążenia – czynniki wpływające na skuteczność resuscytacji

[1]Paramedic, PhD Student, Faculty of Health Sciences with Subfaculty of Nursing and Institute of Maritime and Tropical Medicine, Medical University of Gdansk, Poland
[2]Paramedic, Faculty of Health Sciences with Subfaculty of Nursing and Institute of Maritime and Tropical Medicine, Medical University of Gdansk, Poland
[3]Paramedic, Faculty of Health Sciences, University of Warmia and Mazury in Olsztyn, Poland
[4]Department of Emergency Medicine, Faculty of Health Sciences, Medical University of Lublin, Poland
[5]Department of Emergency Medicine, Medical University of Bialystok, Poland
[6]University of Strategic Planning in Dabrowa Gornicza, Poland

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Słowa kluczowe
nagłe zatrzymanie krążenia, ratownik medyczny, resuscytacja

Summary

Introduction. According to the statistics by the European Resuscitation Council, 700 000 deaths per year are caused by a lack of treatment in sudden cardiac arrest (SCA). Early initiated resuscitation activities significantly increase the chances of return of spontaneous circulation (ROSC). SCA treatment means a high-quality Basic Life Support (BLS), defibrillation, securing airway patency, venous access, pharmacotherapy, and an exclusion of reversible SCA causes. Every stage of treatment requires a constant monitoring of the elements affecting the effectiveness of actions.

Aim. The objectives of the research were an analysis of factors affecting ROSC chances during advanced life support and an identification of the most frequent mistakes made by the members of the emergency medical teams (EMT) in SCA cases.

Material and methods. The study involved advanced manikins which enabled participants a proper observation and analysis of the procedures and equipment that met the expectations of EMT equipment. Standardized scenarios ensured the observation of paramedics in repeatable and similar conditions, and the obtained data was archived in the prepared evaluation forms.

Results. The most frequent mistakes include a lack of adequate care of the quality of ventilation and chest compression.

Conclusions. It needs to be mentioned that advanced techniques must be accompanied by the fundamental BLS activities. Drugs, defibrillation, and intubation alone are not going to improve a patient's condition when there is no effective ventilation and no heart massage.

Streszczenie

Wstęp. Według statystyk Europejskiej Rady Resuscytacji 700 000 zgonów rocznie jest spowodowanych nagłym zatrzymaniem krążenia. Wczesne wdrożenie działań resuscytacyjnych znacząco zwiększa szanse na powrót spontanicznego krążenia. Leczenie zatrzymania krążenia oznacza prowadzenie wysokiej jakości podstawowych zabiegów resuscytacyjnych, defibrylacji, zabezpieczenia drożności dróg oddechowych, dostępu żylnego, farmakoterapii i wykluczenia odwracalnych przyczyn nagłego zatrzymania krążenia. Każdy etap leczenia wymaga stałego monitorowania elementów wpływających na efektywność działań.

Cel pracy. Celem badań była analiza czynników wpływających na powrót spontanicznego krążenia podczas zatrzymania krążenia oraz identyfikacja najczęstszych błędów popełnianych przez członków zespołów ratownictwa medycznego.

Materiał i metody. W badaniu wykorzystano zaawansowane manekiny, które umożliwiły uczestnikom prawidłową obserwację, analizę procedur i sprzętu, które spełniły oczekiwania. Standaryzowane scenariusze zapewniły obserwację ratowników w warunkach powtarzalnych i podobnych, a uzyskane dane archiwizowano w przygotowanych formularzach oceny.

Wyniki. Najczęstsze błędy to brak odpowiedniej dbałości o jakość wentylacji i kompresji klatki piersiowej.

Wnioski. Należy wspomnieć, że zaawansowanym technikom muszą towarzyszyć podstawowe działania resuscytacyjne. Leki, defibrylacja i sama intubacja nie poprawią stanu pacjenta, gdy nie ma skutecznej wentylacji i nie ma masażu serca.

Conflict of interest
Konflikt interesów
None
Brak konfliktu interesów

Address/adres:
*Daniel Slezak
Faculty of Health Sciences with Subfaculty of Nursing and Institute of Maritime and Tropical Medicine
Medical University of Gdansk
17 Smoluchowskiego Str., 80-214 Gdansk, Poland
Phone: +48 (58) 3493780
E-mail: ratownictwo@gumed.edu.pl

INTRODUCTION

The most frequent cause of SCA in adults is the coronary artery disease and its complications (85%) (1, 2). The first analysis of the rhythm in most injured indicates ventricular fibrillation (VF) or ventricular tachycardia (VT) (76%) (3). In both cases, the diagnosis should lead to a decision to initiate an immediate defibrillation and, subsequently, a prompt chest compression and ventilation (4). If defibrillation is performed within the first minute following the SCA diagnosis, there are up to 75% chances of an effective resuscitation (1). Every minute of delay in the procedure increases the probability of conversion of ventricular fibrillation into asystole, which decreases the chances of ROSC (1). In the case of shockable rhythms, pharmacotherapy is applied in further stages of the treatment procedure, i.e. after the third ineffective discharge (5). Asystole and pulseless electrical activity (PEA) are ruled by a different procedure which recommends a high-quality BLS and the application of adrenaline, and does not recommend defibrillation (6). It needs to be remembered that, instead of pharmacotherapy, venous access, and intubation, it is a high-quality BLS that is the crucial element of any resuscitation case (7). A proper flow of blood through the most significant organs, especially the brain, is conditioned only by a proper chest compression. According to the current ERC and AHA (American Heart Association) guidelines, chest compression in adults should be performed with the frequency of 100-120/min, the depth of 5-6 cm (7), and pauses in compression not longer than 10 s (1). Due to a rapidly increasing tiredness of the rescuer and a decreased effectiveness of action, it is recommended to change the person performing massage every 2 min (8). After 5 min of SCA, irreversible changes occur in the brain (9, 10), and therefore it is extremely important to initiate an effective ventilation. A breathing mixture enriched with oxygen should be applied in a frequency of 10-12/min using 6-7 ml/kg of the optimal body weight (11).

There are numerous factors affecting the effectiveness of resuscitation. There is a limited time to prevent an irreversible loss of brain cells, and therefore, the condition of the injured should be assessed as soon as possible, the quality of the implemented procedures should be monitored and based on the up-to-date knowledge of advanced life support (ALS).

AIM

1. An analysis of factors affecting ROSC chances in advanced life support (ALS) in adults.
2. An identification of the most frequent mistakes in the treatment of SCA patients.

MATERIAL AND METHODS

The research was conducted in groups of professionally active paramedics (40 teams) and based on standardized ALS-oriented scenarios. In a random selection, each team was expected to select one scenario representing the shockable rhythms and one scenario related to asystole or PEA. The paramedics were not informed about the aim of the selection. They were equipped according to the standards of a basic emergency medical team. All teams had time to verify the equipment and, if needed, reorganize their bags. There were three defibrillator models available for the purpose of selection. All teams performed their actions on identical manikins, with an identical system evaluating chest compression, ventilation, and time, using identical assessment forms in equal light, space and temperature conditions. The participants of the research were advised to proceed according to their everyday professional tasks. No types of behavior were suggested. Based on the analysis of the assessment forms and computer evaluation of BLS, the most frequent mistakes and the actions performed properly were identified.

Examples of scenarios used during the research are presented below:

Scenario 1

Information for the team: The case concerns an unconscious woman aged 65 and is reported by her family. The medical history includes diabetes and hypertension. Before the arrival of the team, the woman was found by the family in the toilet. She was in sweat, mumbling and not able to communicate verbally.

Information for the leader: Unconscious, A – patent, B – 0, C – 0. The first analysis of the rhythm indicates PEA with a frequency of 40/min remaining stable throughout the action. Glucose 12 mg/dl.

Scenario 2

Information for the team: The case concerns a 55-year old man who fainted in a hotel room and is reported by the hotel service indicating acute pain in the chest and dyspnea. The medical history includes hypertension, coronary artery disease, obesity, and nicotine addiction.

Information for the leader: Unconscious, A – patent, B – 0, C – 0. The first analysis of the rhythm indicates VF remaining stable throughout the action.

RESULTS

1. The procedure of the initial assessment of the condition of the injured was applied in 81% of cases. Some teams (14%) initiated a simultaneous assessment of breathing and pulse, which is accepted and compliant with the ALS standards. It is alarming that, in most cases, the paramedics were unable to evaluate the time spent on the assessment of life functions. The average time of breathing assessment amounted to 7 s and the average time of pulse assessment was 6 s (fig. 1).
2. In a majority of cases, the frequency of chest compression was in compliance with the guidelines provided by scientific associations. However, 73% of teams did not maintain the optimal (5-6 cm) compression depth (fig. 2).
3. Ventilation was effective in only 9% of cases (fig. 3).

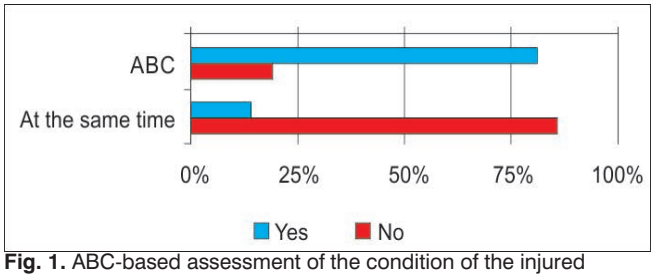

Fig. 1. ABC-based assessment of the condition of the injured

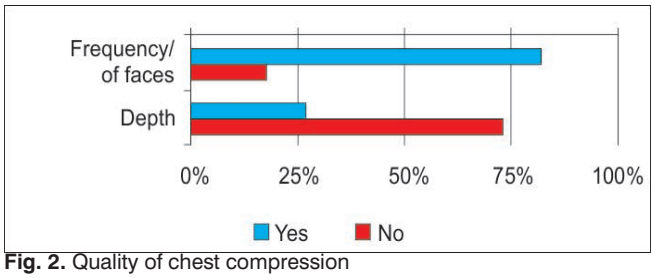

Fig. 2. Quality of chest compression

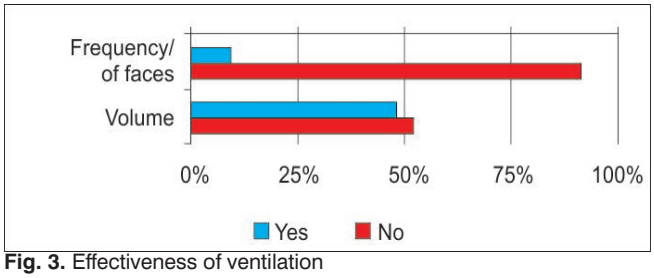

Fig. 3. Effectiveness of ventilation

4. The greatest difficulty during attempts to ventilate was the ability to maintain airway patency with no devices. This aspect was correct in only 45% of cases.
5. Oxygen, a crucial element of ALS, was applied in 50% of cases.
6. Supralaryngeal techniques were applied first in 95% of cases. The I-GEL laryngeal mask was most frequently selected (90%).
7. Endotracheal intubation was applied first in only one case. In most situations (90%) this type of intubation was selected as a further step after providing patency by means of the supraglottic methods.
8. In 70% of teams, proper chest auscultation was involved to confirm the right location of the tube/mask. Nevertheless, the values are equal in the case of supralaryngeal methods and endotracheal intubation. The use of capnography is alarmingly low and has been presented in figure 4.
9. An immediate discharge in the reported shockable rhythms was performed in 18% of cases. In other cases, the discharge was significantly delayed (fig. 5).

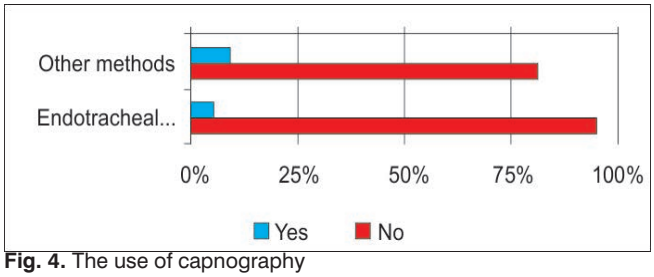

Fig. 4. The use of capnography

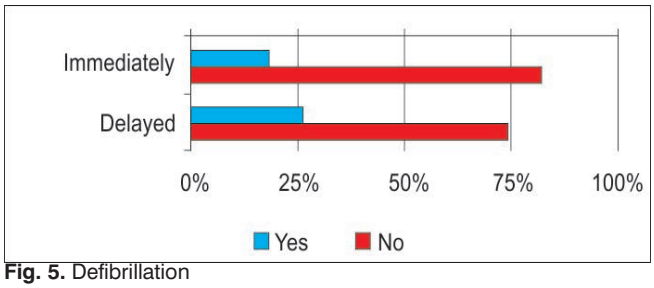

Fig. 5. Defibrillation

10. The effectiveness of defibrillation can be improved by the application of an electrically conductive gel. Such gel was used in the research in 10% of cases.
11. A proper selection of the algorithm in the treatment of shockable and non-shockable rhythms is illustrated in figure 6. The most problematic issues that the teams found difficult to manage were the ECG analysis and a proper selection of drugs.

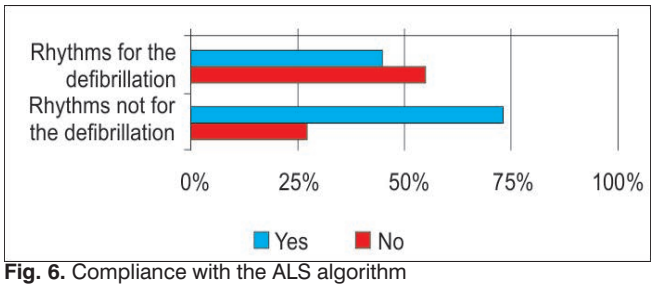

Fig. 6. Compliance with the ALS algorithm

CONCLUSIONS

1. The training designed for paramedics should focus more on basic activities. It might seem obvious that the ABC examination is very simple and can be performed by every professional paramedic. In fact, it is not as obvious as it seems. On the one hand, when the examination time is not long enough, the examination is not going to reflect the real life parameters. On the other hand, when the time is too long, the examination is going to cause a delay in resuscitation. In this way, examination time may affect the chances of ROSC (12).
2. The research illustrates that the participants of the study were frequently focused on the advanced techniques, determining drug doses, managing the equipment etc. Simultaneously, they failed to remember about the basic activities that condition the chances of survival. It is the high-quality BLS combined with defibrillation (if recommended) that is the core of resuscitation (1). A computer analysis clearly indicated that compression depth and ventilation quality should be improved.
3. Pharmacotherapy in SCA treatment does not only mean the application of Adrenaline and

Amiodarone. Oxygen is one of the most important elements in the process. Unfortunately, while using the ventilation bag with a reservoir, paramedics very frequently failed to remember to connect the device to the source of oxygen.

4. It is worth noticing that paramedics frequently favor supralaryngeal methods. Providing airway patency is a challenging task. Endotracheal intubation requires experience and confidence (13). Moreover, this type of intubation involves the risk of severe complications, e.g. unrecognized esophageal intubation (14). Owing to the simple techniques, it is possible to maintain an optimal ventilation level in a comfortable, easy and effective manner (15).
5. After providing airway patency by means of airway device methods, an effective ventilation can be performed only when the device has been properly situated. Chest auscultation is a proper technique to verify the location of the tube/mask but it is not the only one that is possible (12). An optimal solution is the use of a capnometer, a device that can be used to measure the concentration of carbon dioxide in the exhaled air (16, 17).
6. Ventricular fibrillation (the rhythm frequently observed in cardiac arrest in complications of a coronary event) is less shockable with every second of delay in treatment. There is a constant risk of immediate conversion of VF into asystole, which definitely implies a negative outcome. Immediate defibrillation may affect a prompt return of spontaneous circulation (18).
7. Although a defibrillation gel, a proper pressure of defibrillator paddles, the use of multifunction electrodes, and the selection of optimal energy increase the effectiveness of electrotherapy, they were often neglected by the participants of the study (6).

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