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The knowledge of the potential reversible causes (4H, 4T) in cardiac arrest and applying them while performing a successful resuscitation - a comparative study

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Summary

Background and objective. Potential reversible causes of cardiac arrest (classified into two groups: 4 H's and 4T's) should be found and treated while performing a successful resuscitation. The aim of the study was to prove if medical students and graduate medical doctors knew the potential reversible causes and whether they were able to find them while resuscitating a victim. ***Methods***. A group of 50 fourth year medical students was compared with a group of 50 graduate medical doctors. The knowledge about the reversible causes was assessed by a written test containing free response questions. The tested groups had to go through a practical session where they had to manage a victim and had to find one of the reversible causes. To increase the effectiveness of teaching, a special method comprising of positive and negative motivations were used. For statistical analysis Kruskal-Wallis and Mann–Whitney tests were used. ***Results***. In the written test nearly 90% of fourth year students tested just after receiving the course knew the reversible causes, but only less than 50% could find them solving two scenarios. Among the graduate doctors who were tested 5 month after graduation only a few could list the causes, more than 25% could effectively manage the victim with hypovolemia and only 2% could find tension pneumothorax. The effectiveness of teaching of graduated doctors increased significantly just after the course same as their management of reversible causes of cardiac arrest (more then 90%). The graduate doctors achieved a huge percentage gain in successful resuscitations in practical tests when "motivational" methods were used. ***Conclusions.*** The test groups even though knew most of the potential reversible causes of cardiac arrest, were unable to find them while managing the victim in real case scenario. The special method of teaching, which incorporated the positive and negative motivations, resulted in substantial increase in successful resuscitations. *Anestezjologia i Ratownictwo 2011; 5: 23-27*

Keywords: cardiopulmonary resuscitation (CPR), cardiac arrest, potential reversible causes of cardiac arrest, pulseless electrical activity, medical students, graduate doctors, manikin study

Introduction

The potential reversible causes of cardiac arrest should be considered while performing cardiopulmonary resuscitation (CPR). They are classified into two groups, 4H's and 4T's which are: 1. Hypoxia, 2. Hypovolaemia, 3. Hyperkalaemia, hypokalaemia, hypocalcaemia, acidaemia and other metabolic disorders, 4. Hypothermia and 1.Tension pneumothorax, 2. Tamponade cardiac, 3. Toxins, 4. Thrombosis (coronary/pulmonary) [1]. They have been published in the European Resuscitation Council Guidelines of 2000 and 2005 [1-2], hence they are not new and should be known to anybody familiar with cardiopulmonary

resuscitation. Providing CPR, in each algorithm, does not matter if it is VF/VT (Ventricular Fibrillation / Ventricular Tachycardia without the pulse) or non VF/VT [Asystole or Pulseless Electrical Activity (PEA)], if the victim is not responding to recommended treatment (drugs or defibrillation), potential reversible causes of cardiac arrest should be looked for. In particular, it is important while treating a victim with PEA, where these causes are crucial and should be found early enough while performing resuscitation.

The aim of the study was to assess if medical students and graduate medical doctors are aware of 4 H's and 4 T's and whether they are able to find the potential reversible causes while providing resuscitation in real case scenario on a manikin.

Methods

The study group comprises of a group of 50 fourth year medical students and 50 graduate medical doctors. All participants agreed to be tested. They were evaluated in Poznan University of Medical Sciences in Poland in 2005. In this University the advanced cardiopulmonary resuscitation curriculum was incorporated into fourth year and later at sixth year level. To have the best correlation of knowledge and skills, I compared fourth year medical students (just after receiving the course) with graduate medical doctors who were tested 5 month after graduation at the beginning of a refresher course and at the end of this course. These two courses addressed to fourth year students and graduate medical doctors were similar. The idea behind comparing these groups was to assess the effectiveness of teaching and the decrease of knowledge in graduate doctors.

Quantitative methods were used to analyse the study. The knowledge about the reversible causes of cardiac arrest was assessed by a written test. This test (called free response) contained only questions with no multiple choices and the test groups had to write their answers to each questions. This test has been constructed based on B.S. Bloom taxonomy [3], which was transformed by B. Niemierko into ABC taxonomy [4]. Based on this taxonomy it is possible to check four levels of knowledge, in the increasing order of difficulty, they are: 1. Retention of knowledge (i.e. remembering, which is a passive knowledge), 2. Understanding the knowledge, 3. Using the knowledge in typical situations (e.g. in simple algorithms) and 4. Using the knowledge in difficult situations (e.g. if the algorithm is more complicated). In my study I used two kinds of questions, to assess extreme levels of knowledge, the easiest (to assess the retention of knowledge) and the hardest (to assess the use of knowledge in difficult situations). In the test, each group was to list the potential reversible causes (4 H's, 4 T's) of cardiac arrest (this question checked the easiest level of knowledge) and to solve two different clinical scenarios with PEA (these questions checked the hardest level of knowledge). These questions were incorporated into the test among other questions, which were looking for something else.

These fourth year medical students and graduate medical doctors were also involved in the practical management of a victim with PEA. They had to find one of the potential reversible causes included in the scenario demonstrating the performance of cardiopulmonary resuscitation on the manikin.

Based on the rather poor results achieved by fourth year students to increase the effectiveness of resuscitation performed on the manikins, a special method of teaching was used. This method was done during the refresher course for graduate doctors, to increase rescuer's chance to find the reversible causes of cardiac arrest. The rescuers performing resuscitation on the manikin were motivated positively, if they thought about and if they were looking for the potential reversible causes of cardiac arrest. They were motivated negatively, if they forgot about 4 H's, 4 T's and did not look for them. In positively motivated group the victim always survived and while in the other group the victim always died. After each practical part of the course with the use of different scenarios, all the pitfalls in the management of the victim were discussed. All the participants knew the fact that during resuscitation, if they did not see any improvement in the condition of the victim they had to think about 4 H's, 4 T's and that they had to find them. For each scenario the Sensored ALS Skill Master Interactive Training Manikin Laerdal® connected to a computer with HeartSim 4000 Laerdal® software were used. A continuous ECG monitoring allowed the Zoll M Series® biphasic defibrillator. The ALS manikin allowed to simulate scenarios in realistic way.

When analysing the results, the formula of the effectiveness of teaching was used. The formula divided the received number of points by the maximum number of points in the written test and showed it in percentage. The statistical analysis was performed using specific software (StatSoft, Inc. 2005 Statistica, version 7.1.). For statistical analysis Kruskal-Wallis

Table 1. The effectiveness of teaching (%) – received in the written test

Levels of knowledge	The easiest level – the retention of knowledge	The hardest level – the use of knowledge in difficult situations	
Questions	If they knew 4 H's, 4 T's	If they solved clinical problem (PEA) – Hypovolaemia	If they solved clinical problem (PEA) – Tension pneumothorax
Fourth year medical students assessed just after receiving the course	89.5%	40%	44%
Graduate medical doctors assessed at the beginning of a refresher course	8%	28%	2%
Statistical correlation between above two groups	P<0.05	P<0.05	P<0.05
Graduate medical doctors assessed at the end of a refresher course (motivation method)	92%	94%	90%

test was used to estimate the written test and Mann-Whitney test to estimate the practical procedures. P values <0.05 were considered statistically significant.

Results

The results presented below are: (1) from the written test and (2) from the practical test.

1. The results from the written test were estimated with the use of the effectiveness of teaching formula and are presented in Table 1.

Fourth year medical students knew and could list 4 H's, 4 T's in the written test. The graduate medical doctors, a few months after their graduation, did not remember the potential reversible causes of cardiac arrest. This question evaluated the easiest level of knowledge, which was the "retention of knowledge" (remembering).

To assess the hardest level of knowledge, the tested groups had to solve two different clinical scenarios with PEA in a written test. In the first case scenario, hypovolemia and in the second case, tension pneumothorax was the reversible cause of cardiac arrest.

When two levels of knowledge were compared, the relationship between them was not observed (statistically significant).

If two tested groups were compared, a very huge decrease in knowledge was observed in the graduate doctors group. These tested groups were studied at the same University of Medical Sciences and were taught by the same teachers using the same methods. Hence forgetting the knowledge was responsible for the worse results received by the graduate doctors.

This is in contrast to the results achieved by graduate medical doctors tested just at the end of the refresher course. More then 90% correct answers were given as well at the easiest as at the hardest level of knowledge.

2. The results achieved in the practical test are presented below in Table 2.

Table 2. The number of participants who found one of 4 H's, 4 T's during CPR on the manikin (showed in %)

Clinical scenarios	Hypovolaemia as a potential reversible cause of cardiac arrest	Tension pneumothorax as a potential reversible cause of cardiac arrest
Fourth year medical students assessed during the course	10%	2%
Fourth year medical students assessed just after receiving the course	44%*	46%*
Statistical correlation between two above groups	P<0.05	P<0.05
Graduate medical doctors assessed at the beginning of the refresher course	25 %	0 %
Graduate medical doctors assessed at the end of the refresher course	98 %	92 %
Statistical correlation between two above groups	P<0.05	P<0.05

*The positive and negative motivation method was not used.

Discussion

The results achieved in the written test by graduate doctors were not surprising. At the easiest level of knowledge [4], nearly 90% of fourth year medical students could list potential reversible causes of cardiac arrest as they remembered them well compared to only 8% of graduate doctors tested 5 month after the graduation. The decrease in knowledge found in the graduate doctors group, can be explained by them forgetting what was taught and it indicates the need of a refresher course. Similar results in the decrease of knowledge in cardiopulmonary resuscitation after graduation, have been reported by other authors [5-10].

At the hardest level of knowledge [4], even though nearly 90% of these students knew the 4 H's and 4 T's, only 40% and 44% of fourth year medical students were able to solve the first and the second PEA clinical case scenarios respectively. This indicates that the medical students were unable to apply their knowledge in a real life scenario. This shows that there was no connection between the easiest level of knowledge and the hardest level. I can also find the same problem in the graduate doctors group, 28% of the doctors could solve the first PEA scenario and only 2% could solve the second. Despite the lack of knowledge about the potential reversible causes, the unusual increase of positive answers found in the first PEA scenario, was because I think that, it is not difficult for graduate doctors to treat hypovolemic victims. In the second clinical scenario not surprisingly, most of the graduate doctors were unable to save the victim.

The written test prepared for this research has been constructed with the use of B.S. Bloom taxonomy [3], which was transformed by B. Niemierko into ABC taxonomy [4]. D. Krathwohl in his article revised Bloom's taxonomy consisting of four dimensions: factual knowledge (the basic elements to know), conceptual knowledge (the inter-relationship among the basic elements), procedural knowledge (how to do something), and meta-cognitive knowledge (knowledge of cognition) [11]. Transformation of Bloom's taxonomy made by B. Niemierko also contains four levels of knowledge: the retention of knowledge, the understanding of knowledge, the use of knowledge in typical and problem situations [4]. It does not matter what the ranges of knowledge are, as long as there are two important educational goals: retention of knowledge and transfer of knowledge. Retention means remembering, but the transfer of knowledge means the ability to apply the knowledge e.g. when solving new problems [12].

In this study, based on current revisions of taxonomy, to achieve the best correlation between remembering and transferring of knowledge, the test groups were involved in a practical session where they had to demonstrate how they solved clinical scenarios of PEA. The results presented by fourth year students were better compared with graduate doctors tested at the beginning of the refresher course. The graduate doctors were tested a few months after the attendance of resuscitation classes. To improve finding potential reversible causes of cardiac arrest while resuscitation, a special method of teaching based on motivation was used. Despite other factors this method influenced the good results achieved by graduate doctors after the refresher course. The positive motivation indicated that all the victims survived when the graduate doctors thought about and looked for the potential reversible causes during resuscitation. The negative motivation indicated that all the victims died, because the rescuers never thought about the 4 H's and 4 T's and they never found them. In my opinion, "the negative" rather than "positive motivation" will stimulate the students (the rescuers) involved in the management of cardiac arrest. If resuscitation is not successful they will always think about the potential reversible causes of cardiac arrest as they were used to practice it during the refresher course.

The results achieved by fourth year students are very poor even they were tested after the course. Among graduate medical doctors the results are encouraging and I have noticed a very huge increase in percentage of successful resuscitations, where potential reversible causes of cardiac arrest were found. Statistical correlation ($p<0.05$) in each case scenario was significant, hence I recommend this motivational method of teaching.

The graduate doctors after each clinical case (different scenarios) had an opportunity to discuss all the problems related with the management of the victim (same as fourth year students). I quote P. Pintrich from his article "If the knowledge is never shared through discussion, modelling, or explicit instruction it is difficult for students to learn" [13]. Thus I can add to make use of this idea while teaching cardiopulmonary resuscitation.

Conclusion

In my study I have found the fact that fourth year medical students and graduate doctors had known the potential reversible causes of cardiac arrest, but they were unable to use this knowledge in managing the PEA victim in real case scenarios. The use of a special method of teaching based on positive and negative motivation resulted in a very huge increase of successful resuscitations, hence I recommend this method of teaching. Thus teaching with the use of simulation techniques and methods of motivation is a goal.

To achieve the best effectiveness of successful resuscitation, the rescuers should be well trained. During their education the main emphasis has to be on teaching them according to taxonomy to receive the connection between remembering and transferring of knowledge.

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Appendix

- Scenario No 1:

You are a doctor in an ambulance driving to 25 years old man who had an accident at work. His left extremity was amputated below a knee. He was bleeding seriously. The co-workers put a gauze on the wound trying to stop bleeding. Just before you came the man had lost consciousness.

Vital signs: unconscious, breathless, pulseless, pale skin, ECG-50/min.

These vital signs should be checked and treated according to ERC guidelines.

- Scenario No 2:

60 years old man has suffered from asthma for many years. Today he had severe breathing difficulties and used inhaled medications. Unfortunately, the drugs did not help him. He called the EMS and was transported to Emergency Department. After few minutes he lost consciousness. You are a doctor working in Emergency Department just called to him.

Vital signs: unconscious, breathless, pulseless, blue skin. ECG- 30/min.

These vital signs should be checked and treated according to ERC guidelines.

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