

# The significance of pre-existing knowledge of the latest guidelines for cardiopulmonary resuscitation in successful basic life support education of Belgrade sixth year medical students

SLAĐANA ANĐELIĆ (✉)  
Belgrade Emergency Medical Services  
Street Franše d`Eperea 5  
11000 Belgrade, Serbia  
Phone: +381113615015  
E-mail: novizivot@ptt.rs

DIMITRA KALIMANOVSKA-OŠTRIĆ  
School of Medicine  
University of Belgrade, Serbia

ZORAN RADOJIČIĆ  
Faculty of Organizational Sciences  
Belgrade, Serbia

SLAĐANA ANĐELIĆ • DIMITRA KALIMANOVSKA-OŠTRIĆ • ZORAN RADOJIČIĆ

## ABSTRACT

*Introduction.* The latest Guidelines for cardiopulmonary resuscitation (CPR) were published in 2010. The aim of the implementation of basic life support (BLS) guidelines is the introduction of uniform criteria within the domain of cardiac arrest diagnostics and treatment both for lay rescuers and first line lifesavers without formal medical education as well as for medical personnel who happen to be in the role of the event witness but without medical equipment and outside of their working place.

*Objective.* The goal of this study was to investigate the significance of pre-existing knowledge of the latest 2010 Guidelines for CPR for achieving successful training in BLS among 6th year students of the Belgrade School of Medicine.

*Methods.* In a five-month prospective study of 6th year medical students doing a clinical internship at the Belgrade Emergency Medical Services (EMS) were in a peer training on the application of BLS. At the beginning and at the end of the training program, the students had to pass entrance (E) and final (F) tests composed of 25 identical questions. Using the E test, the students' knowledge of the latest CPR Guidelines was tested; they were classified into groups with pre-existing knowledge (group I) and groups without pre-existing knowledge (group II). By comparing data from E and F tests we analyzed the influence of training on the improvement of pre-existing knowledge or gaining new knowledge in BLS and first aid.

*Results.* A total of 423 students were tested. The analysis of obtained data showed that in group I there was a statistically significant difference between correct and incorrect responses to eleven questions on the F and E tests. In group II there was a statistically significant difference between test responses in the E and F tests to 17 questions. In group II, knowledge additionally improved after training so that in the F test, a statistical significance in correct answers was achieved with regard to 8 questions in relation to the E test ( $p < 0.05$ ). There was a statistically significant difference between correct and inaccurate answers in tests F and E with regard to 10 questions. In the entire group of students, a total statistical significance ( $p < 0.05$ ) was achieved in answers to as much as 25 questions.

*Conclusion.* Among 6th year medical students without pre-existing knowledge of the latest 2010 CPR Guidelines, BLS training considerably improved their previously acquired knowledge. Also, students with good pre-existing knowledge, showed a considerably higher level of acquired knowledge after implemented training. A future study with a longer follow-up period to estimate the effect on long-term retention of learning outcomes is needed.

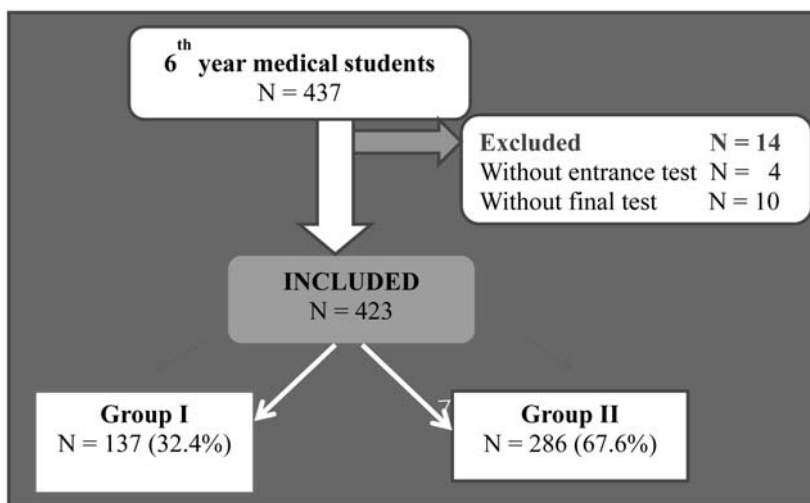
**Key words:** latest CPR Guidelines, knowledge, BLS, education, students

## Introduction

Survival after acute cardiac arrest (ACA) is determined by the quality of scientific, evidence-based cardiopulmonary resuscitation (CPR), training quality and financial funds invested in the implementation of the Guidelines. (1) Saving a person in cardiac arrest should be a high-priority task in the healthcare system of any country. According to the Law on Healthcare Insurance ("Sl. Glasnik RS", Official Gazette of the Republic of Serbia, 57/2011), the Law on Road Traffic Safety and the Law on Occupational and Health Safety at Work, each citizen of Serbia is obligated to provide aid to a sick or injured person anywhere and at any time.

Knowledge of basic life support (BLS) is a part of each person's healthcare culture. The latest CPR Guidelines were published in 2010. The aim of their implementation is the introduction of uniform criteria in the diagnostics and treatment of ACA. Section 9, Principles of Education in Resuscitation, (2) states that all citizens should gain skills in BLS, regardless of whether they are layperson rescuers or first-line life-savers (firefighters, police officers, swimmer rescuers, security guards, etc.) without formal medical education or medical personnel who happened to be in the role of a bystander witnessing an ACA without medical equipment and outside their working place. (3)

In the literature there are reports of successful achievements related to educational curricula for postgraduate medical students, (4) but also in curricula involving undergraduate medical students, school children (5) and teachers. (6) Also, many countries have introduced teaching CPR skills to children aged 10-12 years, (7) as well as using e-learning (video/computer self-instruction) for family members of high-risk patients (at risk of sudden cardiac death). (8) Up-to-date international studies point out that early bystander CPR is essential for survival after out-of-hospital ACA.



**Figure 1. Flow of participants through trial.**

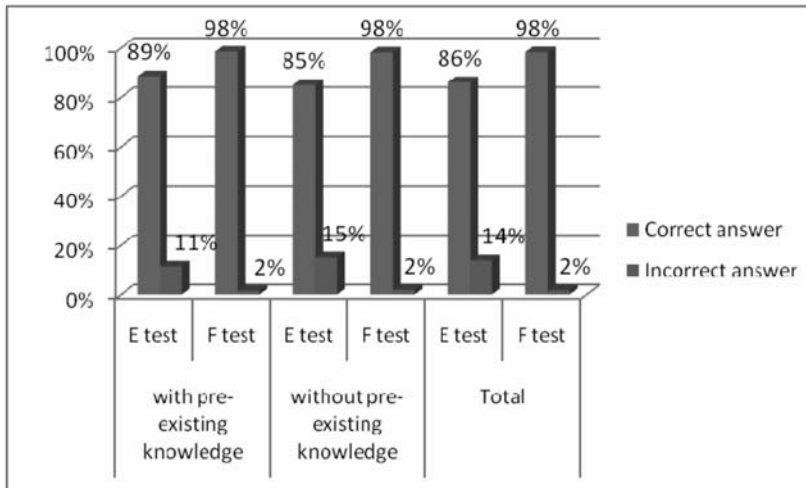
Students can become significant bystander CPR providers if BLS training, according to CPR Guidelines, is implemented as a compulsory part of medical student education. Educated students could strengthen the first three links of the Chain of Survival by a series of interventions that represent early recognition of ACA, calling the EMS, usage of early CPR and early defibrillation. (9) Obligatory training of medical students in resuscitation is important for at least two reasons: as future physicians they should be capable of performing resuscitation on any patient under any situation, and they should also be capable of transferring acquired knowledge to medical personnel with a lower level of qualifications (nurses, ambulance drivers) or laypersons. It has been confirmed that being trained in the application of resuscitation procedures cannot be achieved by reading or listening to theoretical concepts only, but that practical training is of essential significance. The number of participants in the practical curriculum should be limited so as to achieve uniform and qualitative knowledge of the necessary BLS skills. The best results are achieved by training small groups of students (4-8) and in a larger number of workshops. (6,7)

Objective. To indicate the significance of pre-existing knowledge of the latest

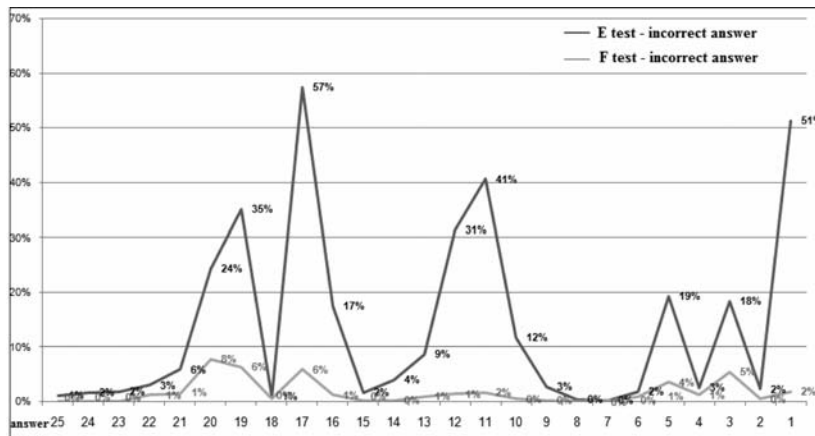
2010 CPR Guidelines for successful BLS training amongst 6th year students of the Belgrade School of Medicine (BMS).

## Methods

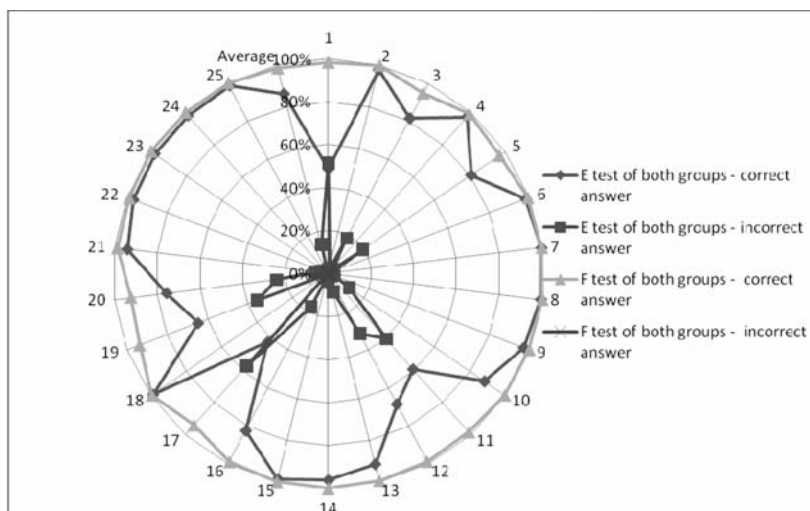
From February 1st to June 30th 2012 a prospective study was conducted involving 6th year medical students that spent a four-day clinical internship at the Belgrade Emergency Medical Services (EMS). During this period, the students first attended a two-day curriculum involving theory and practice, according to a specially designed plan and program, at the Centre for Education (Appendix 1). The aim of the theoretical curriculum was to educate students in the latest 2010 BLS Guidelines and first aid measures for adults. Practical training was carried out in small groups of 4-6 students. After a demonstration, in order to obtain skills, the students took part in workshop training in the presence of demonstrators utilizing dummy simulation of ACA (Little Anne™ CPR Manikin, Laerdal Corporation, Rorarco GmbH, Vienna, Austria), training defibrillator (Laerdal Forerunner Trainer™, Laerdal Corporation, Rorarco GmbH, Vienna Austria), medical equipment and auxiliary sanitary material according to an exactly determined time-table.



**Graph 1. Mean rate of correctly and incorrectly answered questions in both questionnaires. E test, entrance test; F test, final test; group I, with pre-existing knowledge; group II, without pre-existing knowledge; summarized knowledge.**



**Graph 2. Percentage of students in the entire group, regardless of pre-existing knowledge, who incorrectly answered every single question in the entrance (E) and final (F) tests.**



**Graph 3. Analysis of correct and incorrect answers to each question of the entrance (E) and final (F) test in the entire group.**

The curriculum involved BLS (sternal compression and artificial ventilation, management of airways obstruction, coma position), usage of an automatic external defibrillator (AED) and first aid measures (hemostasis, bandaging, immobilization). After completing the practical curriculum, the students participated in two-days of EMS team field activities. As the fourth team member, each student participated in the care of severely injured and critically ill patients, thus contributing to a shortened duration of intervention. The need for continuing medical education was explained as well as the renewal of pre-existing knowledge of practical skills at least every fifth year (after the publication of the latest CPR Guidelines), regardless of the healthcare institution that will employ them. Thus, students were motivated to select, as their future professional choice, employment in a modern EMS such as the Belgrade EMS.

As an integral part of the curriculum, at the beginning and at the end of the clinical internship, the students were required to solve a test composed of 25 questions (Appendix 2). The test consisted of multiple choice questions or a short written add-on to the required text. It was composed of 25 questions, each rated one point. The maximal number of points was 25. Two tests were categorized as: entrance – E test and final - F test. In the E test, each student was required to state whether he was acquainted with the 2010 Guidelines for CPR or not; on this basis the students were divided into groups with pre-existing knowledge (I) or groups without pre-existing knowledge (II). The F test contained identical questions as the E test, but it also demonstrated the level of students' acquired knowledge after completing the theoretical and practical curricula.

By comparing the results of tests E and F, we analyzed the influence of theoretical lectures and practical training, as a part of a clinical internship, on the improvement of pre-existing knowledge or new knowledge acquisition within the area of CPR and first aid. Analysis of both student groups in relation to

Table 1. Numerical and percentual results of correctly and incorrectly solved questions of E and F tests; difference and mean rate.

Question	Students												N = 423													
	Entrance test						Total						Pre-existing knowledge						Final test							
	Pre-existing knowledge			NO			+			-			YES			NO			+			-				
	137		286		68%		286		68%		137		32%		286		68%		137		32%		286		68%	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1	79	58%	58	42%	127	44%	159	56%	206	49%	217	51%	133	97%	4	3%	282	99%	4	1%	415	98%	8	2%		
2	135	99%	2	1%	278	97%	8	3%	413	98%	10	2%	137	100%	0	0%	284	99%	2	1%	421	100%	2	0%		
3	117	85%	20	15%	228	80%	58	20%	345	82%	78	18%	134	98%	3	2%	266	93%	20	7%	400	95%	23	5%		
4	136	99%	1	1%	276	97%	10	3%	412	97%	11	3%	137	100%	0	0%	281	98%	5	2%	418	99%	5	1%		
5	107	78%	30	22%	234	82%	52	18%	341	81%	82	19%	131	96%	6	4%	277	97%	9	3%	408	96%	15	4%		
6	137	100%	0	0%	278	97%	8	3%	415	98%	8	2%	136	99%	1	1%	283	99%	3	1%	419	99%	4	1%		
7	137	100%	0	0%	285	100%	1	0%	422	100%	1	0%	136	99%	1	1%	286	100%	0	0%	422	100%	1	0%		
8	136	99%	1	1%	285	100%	1	0%	421	100%	2	0%	137	100%	0	0%	286	100%	0	0%	423	100%	0	0%		
9	134	98%	3	2%	277	97%	9	3%	411	97%	12	3%	136	99%	1	1%	286	100%	0	0%	422	100%	1	0%		
10	130	95%	7	5%	243	85%	43	15%	373	88%	50	12%	135	99%	2	1%	286	100%	0	0%	421	100%	2	0%		
11	90	66%	47	34%	161	56%	125	44%	251	59%	172	41%	135	99%	2	1%	281	98%	5	2%	416	98%	7	2%		
12	107	78%	30	22%	183	64%	103	36%	290	69%	133	31%	135	99%	2	1%	282	99%	4	1%	417	99%	6	1%		
13	130	95%	7	5%	256	90%	30	10%	386	91%	37	9%	135	99%	2	1%	284	99%	2	1%	419	99%	4	1%		
14	132	96%	5	4%	274	96%	12	4%	406	96%	17	4%	137	100%	0	0%	285	100%	1	0%	422	100%	1	0%		
15	135	99%	2	1%	281	98%	5	2%	416	98%	7	2%	136	99%	1	1%	286	100%	0	0%	422	100%	1	0%		
16	115	84%	22	16%	234	82%	52	18%	349	83%	74	17%	136	99%	1	1%	282	99%	4	1%	418	99%	5	1%		
17	65	47%	72	53%	115	40%	171	60%	180	43%	243	57%	132	96%	5	4%	266	93%	20	7%	398	94%	25	6%		
18	134	98%	3	2%	285	100%	1	0%	419	99%	4	1%	135	99%	2	1%	286	100%	0	0%	421	100%	2	0%		
19	98	72%	39	28%	176	62%	110	38%	274	65%	149	35%	132	96%	5	4%	264	92%	22	8%	396	94%	27	6%		
20	110	80%	27	20%	210	73%	76	27%	320	76%	103	24%	125	91%	12	9%	265	93%	21	7%	390	92%	33	8%		
21	133	97%	4	3%	265	93%	21	7%	398	94%	25	6%	135	99%	2	1%	282	99%	4	1%	417	99%	6	1%		
22	132	96%	5	4%	278	97%	8	3%	410	97%	13	3%	137	100%	0	0%	281	98%	5	2%	418	99%	5	1%		
23	135	99%	2	1%	280	98%	6	2%	415	98%	8	2%	137	100%	0	0%	286	100%	0	0%	423	100%	0	0%		
24	134	98%	3	2%	282	99%	4	1%	416	98%	7	2%	137	100%	0	0%	286	100%	0	0%	423	100%	0	0%		
25	135	99%	2	1%	283	99%	3	1%	418	99%	5	1%	137	100%	0	0%	286	100%	0	0%	423	100%	0	0%		
Mean	121	89%	16	11%	243	85%	43	15%	364	86%	59	14%	135	98%	2	2%	281	98%	5	2%	416	98%	7	2%		

N (%) Questions answered correctly by all students

N (%) Questions answered incorrectly by most students

N (%) Questions resulting in significant improvement

**Table 2. Statistical analysis of results.**

Question	Difference YES	Difference NO	YES Z	YES p	NO Z	NO P	Total Z	Total P	Difference Z	Difference P
1	39,42%	54,20%	7,797	0,000	14,357	0,000	16,263	0,000	3,493	0,000
2	1,46%	2,10%	1,419	0,156	1,914	0,056	2,326	0,020	0,634	0,526
3	12,41%	13,29%	3,704	0,000	4,630	0,000	5,832	0,000	0,337	0,736
4	0,73%	1,75%	1,002	0,316	1,308	0,191	1,514	0,130	1,168	0,243
5	17,52%	15,03%	4,292	0,000	5,825	0,000	7,230	0,000	0,867	0,386
6	-0,73%	1,75%	1,002	0,316	1,522	0,128	1,163	0,245	3,486	0,000
7	-0,73%	0,35%	1,002	0,316	1,001	0,317	0,000	1,000	69,120	0,000
8	0,73%	0,35%	1,002	0,316	1,001	0,317	1,416	0,157	0,754	0,451
9	1,46%	3,15%	1,007	0,314	3,024	0,002	3,075	0,002	1,432	0,152
10	3,65%	15,03%	1,695	0,090	6,819	0,000	6,871	0,000	4,790	0,000
11	32,85%	41,96%	7,094	0,000	11,973	0,000	13,889	0,000	2,282	0,022
12	20,44%	34,62%	5,267	0,000	10,615	0,000	11,783	0,000	3,912	0,000
13	3,65%	9,79%	1,695	0,090	5,094	0,000	5,283	0,000	3,059	0,002
14	3,65%	3,85%	2,257	0,024	3,086	0,002	3,812	0,000	0,139	0,890
15	0,73%	1,75%	0,581	0,562	2,246	0,025	2,131	0,033	1,166	0,244
16	15,33%	16,78%	4,575	0,000	6,753	0,000	8,153	0,000	0,512	0,609
17	48,91%	52,80%	9,005	0,000	13,387	0,000	16,111	0,000	0,887	0,375
18	0,73%	0,35%	0,451	0,652	1,001	0,317	0,819	0,413	0,751	0,453
19	24,82%	30,77%	5,595	0,000	8,733	0,000	10,334	0,000	1,617	0,106
20	10,95%	19,23%	2,594	0,009	6,128	0,000	6,552	0,000	2,798	0,005
21	1,46%	5,94%	0,826	0,409	3,477	0,001	3,477	0,001	2,910	0,004
22	3,65%	1,05%	2,257	0,024	0,842	0,400	1,906	0,057	2,571	0,010
23	1,46%	2,10%	1,419	0,156	2,462	0,014	2,842	0,004	0,635	0,525
24	2,19%	1,40%	1,742	0,082	2,007	0,045	2,657	0,008	0,840	0,401
25	1,46%	1,05%	1,419	0,156	1,737	0,082	2,243	0,025	0,516	0,606

E/F, entrance/final test; NO, without pre-existing knowledge; p, P value ( $\chi^2$  test); YES, with pre-existing knowledge; Z, zet score.

pre-existing knowledge of CPR was made. Also, both groups were statistically analyzed.

The answers to each test were entered into the SPSS database (V.12.01, SPSS Inc., Chicago, IL, USA). Descriptive values of variables were expressed as average, standard deviation and in percentages. Chi-squared test was used to analyze the difference of the accurate rate of 25 questions during post-training evaluation between the two groups. The significance level was defined as  $p < 0.05$ .

## Results

The study involved 437 students, 241 female (55%) and 196 male (45%),

of average age 23.5 (SD=0.8) years. One hundred and thirty-seven (32.4%) students had pre-existing knowledge. Of the total number of students, 423 solved both E and F test, while 14 did neither the E nor F test (4 without E test and 10 without F test), and were thus not included in the final statistical data analysis (figure 1).

We analyzed each question in tests E and F for both groups (I and II) (table 1). Results showing correct and incorrect answers for all questions are presented in relation to the total number of students in the group solving the tests. The difference between correct responses to questions is presented for both students groups. At the bottom of the

tables, the mean number of students with correct/incorrect answers to E and F test questions is presented. At the end, the mean number and percentage of students who had a larger number of correct answers to all questions on the F test in comparison to the E test was determined. The obtained result was the predictor of the mean increase for students after the completed theoretical and practical curriculum.

## Results analysis

Table 1 summarizes results for all students who solved questions in the E and F tests (for both groups in total and E/F tests differences). The following were set apart: questions answered correctly

by all students, questions answered incorrectly by all students, and questions which indicated a considerable improvement achieved by all students (difference between F and E tests).

E test: all students in group I answered questions 6 and 7 correctly, and all students in group II answered questions 7, 8 and 18 correctly.

F test: all students, depending on pre-existing knowledge, answered the following questions correctly: Group I - 2, 4, 8, 14, 22, 23, 24 and 25, and group II - 7, 8, 9, 10, 15, 18, 23, 24 and 25.

Regardless of pre-existing knowledge, all students answered correctly question 7 in the E test and questions 8, 23, 24 and 25 in the F test.

It was observed that in the E test most students in both groups answered questions 1, 11, 12, 17 and 19 incorrectly. The rate of incorrect answers ranged from 31-57%. The highest number of students from both groups answered questions 3, 5, 17, 19 and 20 incorrectly in the F test. The rate of incorrectly solved questions decreased from 4-8%.

In the entire group, a considerable improvement was achieved (difference in correctly solved answers between F and E tests) in regard to questions 1, 11, 12, 17 and 19, which ranged from 29-52%.

Table 2 shows statistical analysis of obtained data evidencing that:

in group I there was a statistical significance ( $p < 0.05$ ) in the difference between correct and incorrect answers to 11 questions (1, 3, 5, 11, 12, 14, 16, 17, 19-21) in tests F and E, in group II there was a statistical significance ( $p < 0.05$ ) in the difference between correct and incorrect answers to 17 questions (1, 3, 5, 9-17, 19-21, 23, 14) in tests F and E, group II additionally showed knowledge improvement after completing training, thus statistical significance ( $p < 0.05$ ) was achieved in the number of correct answers in the F test to 8 questions in comparison to the E test (9, 10, 13, 15, 21-24) ( $p < 0.05$ ).

In regard to the difference between groups I and II, statistical significance ( $p < 0.05$ ) was obtained in the disparity between correct and incorrect answers

to 10 questions (1, 6, 7, 10-13, 20-22) in tests F and E,

a total statistical significance ( $p < 0.05$ ) was achieved by the entire group of students regarding answers to as many as 20 questions (1-3, 5, 9-17, 19-21, 23-25),

Graph 1 shows the mean number of correct, i.e. incorrect answers for tests E and F, and the total results for both groups of students. A significant rate increase of correct answers was observed in regard to the F test.

Graph 2 illustrates the rate of the entire group of students who incorrectly answered some questions in tests E and F, with a lower rate of incorrect answers in the F test.

Graph 3 shows the analysis of correct and incorrect answers regarding each question in tests E and F for the entire group.

## Limitations

Our study has some limitations.

The main problem is the lack of translation into the Serbian language of the latest CPR Guidelines; as most students have poor knowledge of foreign languages current changes in the CPR Guidelines reach them with delay.

Besides, although there is a Croatian translation of the CPR Guidelines on the web site of the Croatian Resuscitation Council ([www.crorc.org](http://www.crorc.org)), accessible since October 18th 2010, it is unavailable to students without Internet connection at home, and hence without information on the latest changes in CPR Guidelines.

In sporadic cases (2/423) students showed no interest in this type of training and thus no need for CPR in their future choice of professional (one student was interested in microbiology and the other in biochemistry). Only one student stated that the presence of blood, vomit and secretions of other persons caused negative sensations (fainting).

Our study involved neither the duration of acquired knowledge after completing training over a short-term and/or long-term period, nor the determination of variables that could influence better

memorizing or faster forgetting of the BLS protocol.

Despite existing European CPR courses also involving medical students as target groups, there is still no clear consensus or general standard for this exceptionally significant aspect of education.

Regarding theoretical knowledge of BLS, our students had the opportunity to apply it during the practical curriculum when they joined the EMS team on field, but they were handicapped by the protocol course on advanced life support (ALS) that should have involved the application of medications and medical equipment. Their practical participation proved useful as a form of help in the management of injured patients.

It was not possible to confirm whether the students who mastered BLS skills or first aid measures after completing their training had a chance to apply medical first aid as event witnesses.

## Discussion

The results of similar studies are non-homogenous in relation to demographic characteristics of subjects. There are differences in the studied groups of medical students in relation to gender and age, which is directly dependent on the curriculum of Schools of Medicine of different states. As in a Maribor study, (10) our study involved more female than male subjects (55%: 45%), but they were of mean age 23.5 (SD=0.8) years, since in Belgrade, BLS is part of the 6<sup>th</sup> year curriculum for medical studies. Compared to other reports, the total sample of 437 subjects makes our study sufficiently valid for drawing adequate conclusions. Fourteen of our students did not participate in solving either E or F test, and they were excluded from the statistical data analysis. Robak et al. (11) reported that in their statistical analysis they had to exclude a certain number of tests due to omitted questions, i.e. questions without filled-in answers.

The introduction of continuing BLS training during studies and immediately before employment is suggested as a long-term strategy of training within a

wider community. The goal should be directed toward the renewal of pre-existing CPR knowledge and acceptance of the latest guidelines and protocols that are published every fifth year. Based on our study, as well as other papers, it is evident that students were prepared and highly motivated, even if without sufficient theoretical knowledge, to implement the latest CPR Guidelines based on the theoretical curriculum and practical training in BLS skills. (8,9,11) A minor number (2/423) of our students did not show interest in pursuing this type of education with an explanation that there would be no need for CPR in their future profession of choice (one student was interested in microbiology and another one in biochemistry). In accordance with the results by Perkins et al., (12) indicating that the care of acutely ill persons is often inadequate, BLS training should aim at becoming a gold standard in the education of 6<sup>th</sup> year medical students in Belgrade, regardless of their future postgraduate choice of specialization. Based on this requirement, the number of skilled individuals with the capability of providing adequate first aid until the arrival of the EMS team, will increase. Our research suggests that an obligatory curriculum involving theoretical knowledge and practical experience in the implementation of the latest CPR Guidelines, will lead to guidelines being more rapidly acquired. Implementing such training, regardless of whether the students have pre-existing knowledge within the area of first aid, can lead to a statistically significant difference between F and E tests with regard to the number of correctly solved questions.

The question remains: What should be the duration of such training? The Medical Reform Curriculum Aachen from Germany (13) has suggested the introduction of a three-week practical curriculum in the field of first aid and emergency medicine. It is also the opinion of our students, obtained by an anonymous questionnaire, that such training is highly significant and that it should last for at least two weeks. From the presented results it could be noted that some questions were incorrectly solved by most students. Probable reasons are imprecisely formulated questions, short duration of theoretical and practical curriculum, a large amount of (frequently previously unknown) information and decreased attention and memorization. (14) In order to avoid confusion, in students tests for the following school-year imprecise questions should be replaced with those that can be clearly understood. For example, questions 15 and 19 should be reformulated, and instead of short text additions, circling a correct answer should be offered. Other authors also suggest a change of text after observed shortcomings. (15)

Filling-out the E test before the beginning of the course informs us of the student's pre-existing knowledge, and the F test shows the level of acquired knowledge and adopted BLS skills. By comparing these two tests, the efficacy of the course can be evaluated. Soar et al. (16) consider that, with the objective to evaluate the course efficacy, it is preferable to make a test consisting of 20 instead of 10 questions. Our test with 25 questions is quite a reliable indicator of the course quality. During

the training only one student stated that he could not apply first aid to the ill or injured person because of the presence of blood, vomit and secretions which triggered feelings of negative sensations (fainting). In a New Zealand study (17) as well, several students with a negative attitude towards training in skills for a first line saver stated that they did not want to apply BLS measures to unknown persons. It is possible that in our student the media or a negative life experience created a barrier in his BLS skills training, which also the explanation is given in reports by other authors. At the state level, it is necessary to find a 'modus operandi' in securing financial funds from the healthcare system for investment into passing "reanimation standards for clinical practice and training in BLS" like those in the Resuscitation Council (United Kingdom) (18) and standardization of education curriculum in BLS for medical students.

## Conclusion

Among 6<sup>th</sup> year medical students without pre-existing knowledge of the latest 2010 Guidelines for CPR, theoretical and practical BLS training considerably improved their performance in the application of their acquired knowledge. Even students who were thought to have pre-existing knowledge showed a considerably higher level of acquired knowledge after the implemented training. A future study with longer follow-up periods to estimate the effect on long-term retention of learning outcomes is needed. Also, factors that contribute to negative students' attitudes towards BLS training require further investigation.

## Appendix 1



### THEORETICAL AND PRACTICAL CURRICULUM AT THE BELGRADE EMERGENCY MEDICAL SERVICES

#### DAY 1

08:30 - 09:15	Registration and entrance test
09:15 - 09:30	Introduction to cardiopulmonary resuscitation (CPR) – lecture
09:30 - 10:30	Basic life support in adults (BLS) – lectures and demonstration
10:30 – 11:15	BLS training: chest compression, artificial ventilation with self-expanding balloon and mask, coma position, Heimlich maneuver
11:15 – 11:30	Pause
11:30 – 12:15	Use of automated external defibrillator (AED) – lecture and demonstration
12:15 – 13:00	AED training.

#### DAY 2

09:00 – 09:45	Wounds, bleeding, hemostasis – lecture and demonstration
09:45 - 10:30	Immobilization - lecture and demonstration
10:30 – 10:45	Pause
10:45 – 12:00	Skill stations: primary hemostasis and immobilization
12:00 – 12:30	Final test
12:30 – 13:00	Feedback and close

DAY 3 AND DAY 4: FIELD TRAINING WITH EMS TEAM

## Appendix 2 BLS questionnaire

TEST	NAME AND SURNAME .....	Gender M F Age (y)	Points
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- Are you acquainted with the latest 2010 CPR Guidelines?  
YES    b.) NO
1. Number of links in the Chain of Survival?  
a) three  
b) seven  
c) five  
d) four
2. The most important signs for the recognition of cardiac arrest are:  
a) altered state of consciousness  
b) widening and narrowing of the pupil  
c) sudden loss of consciousness, absent breathing, absent carotid pulses
3. Assessment of level of consciousness is done by using the following technique:  
a) look, listen, feel  
b) shake and call loudly  
c) Heimlich maneuver
4. Assessment of an unconscious person breathing should be done by using the following technique:  
a) shake and call loudly  
b) Heimlich maneuver  
c) look, listen, feel  
d) backward head, chin lift
5. Assessment of an unconscious person breathing should last up to:  
a) 10 min
- b) 30 sec  
c) 10 sec  
d) 2 min
6. The most adequate position for an untraumatized, unconscious but breathing person is:  
a) in a comfortable position, cushion under head  
b) placed on back and on hard surface  
c) kept in position as found  
d) flank, coma position
7. The phone number for the Belgrade EMS is:  
a) 193  
b) 991  
c) 122  
d) 194



8. During resuscitation, the victim should be placed in the following position:
- flank, on side, coma position
  - high, half-sitting position
  - on the ground, hard surface, in horizontal position on the back
  - in position as found
9. Chest compression in resuscitation of adults is performed:
- on the upper third of the sternum
  - in the center of the sternum
  - below the sternum
  - below the left rib vault
10. Relationship between compression and ventilation in adult resuscitation?
- 30:2
  - 15:2
  - 2:15
  - 2:30
11. Compression of sternum in adults is performed at the rate of:
- 40-60/min
  - 100-140/min
  - 100-120/min
  - 60-80/min
12. In adult resuscitation pressure on the chest wall toward the spine must be at a depth of:
- 5 - 6 cm
  - 1 - 2 cm
  - 10 cm
  - 8 - 10 cm
13. When is the TRIPLE MANEUVER utilized?
- in trauma to open airway
  - diabetic coma
  - epileptic seizure
14. Most reliable method for opening the airway is:
- place the victim in sitting position
  - pull out the tongue manually
  - backward head, lift chin
15. When do we apply the Heimlich maneuver?
- in airway obstruction due to the tongue falling back
  - in partial airway obstruction
  - in foreign body airway obstruction
16. State three types of artificial ventilation utilized in BLS:
- \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
17. Duration of air insufflation in artificial ventilation?
- 4 sec
  - 1 min
  - 1-1.5 sec
  - 3 sec
18. Which are the indicators for successful CPR?
- pupil width
  - body temperature
  - capillary refill
  - spontaneous circulation and breathing
19. How long does it take for a layperson to implement BLS measures?
- \_\_\_\_\_
  - \_\_\_\_\_
  - \_\_\_\_\_
20. Is it true that breathing stops soon after cardiac arrest?
- YES
  - NO
21. Method of temporary hemostasis is: (three correct answers)
- digital compression
  - tie off the bleeding vessel
  - hyperflexion of extremities
  - wound tamponade
  - blood vessel suture
  - blood vessel bypass
22. According to the site of blood escape, bleeding can be: (two correct answers)
- arterial
  - external
  - venous
  - capillary
  - internal
23. According to the type of vessel damage, bleeding can be: (three correct answers)
- arterial
  - external
  - venous
  - internal
  - capillary
24. Foreign bodies (knife, projectile..) and bone fragments, while providing first aid on field:
- must not be extracted
  - must be immediately extracted
  - may be extracted only if the foreign body is contaminated
25. Vulnus punctum means:
- laceration
  - puncture wound
  - crush wound
  - penetration wound

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## ACKNOWLEDGEMENTS

We would like to express our gratitude to Dr. Snežana Bogunović for her contribution to statistical analysis.

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