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Final-year medical students' knowledge of cardiac arrest and CPR: We must do more!

Enrico Baldi [a, b, c, d, *], Enrico Contri [c, d, e], Alessandra Bailoni [f], Kristina Rendic [g], Valeria Turcan [h], Nikola Donchev [i], Ilia Nadareishvili [j, v], Ana-Maria Petrica [k], Irene Yerolemidou [l], Anastasiia Petrenko [m], Johannes Franke [n], Gabrielle Labbe [o], Redon Jashari [p], Alba Pérez Dalí [q], Jordy Borg [r], Niklas Hertenberger [s], Bernd W. Böttiger [t, u]

[a] Department of Molecular Medicine, Section of Cardiology, University of Pavia, Pavia, Italy
[b] Cardiac Intensive Care Unit, Arrhythmia and Electrophysiology and Experimental Cardiology, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy
[c] Pavia nel Cuore, Pavia, Italy
[d] Robbio nel Cuore, Robbio, Italy
[e] AREU Azienda Regionale Emergenza Urgenza—AAT Pavia c/o Fondazione IRCCS Policlinico San Matteo Hospital, Pavia, Italy
[f] Segretariato Italiano Studenti in Medicina – SISM, Pavia, Italy
[g] Srpska Medical Students' International Committee-SaMSIC, Banja Luka, Bosnia and Herzegovina
[h] Asociația Studenților și Rezidenților în Medicină-ASRM, Chișinău, Republic of Moldova
[i] Association of Medical Students in Bulgaria-AMSB, Sofia, Bulgaria
[j] Georgian Medical Students Association—GMSA, Tbilisi, Georgia
[k] Federația Asociațiilor Studenților în Medicină din România—FASMR, Bucharest, Romania
[l] Cyprus Medical Students' Association—CyMSA, Nicosia, Cyprus
[m] Ukrainian Medical Students' Association—UKRMSA, Kiev, Ukraine
[n] Austrian Medical Students' Associations—AMSA, Wien, Austria
[o] Association Nationale des Etudiants en Médecine de France—ANEMF, Montrouge, France
[p] Kosova's Organization of Medical Students—KOMS, Pristina, Kosovo
[q] Federación Española de Estudiantes de Medicina para la cooperación internacional—IFMSA Spain, Valladolid, Spain
[r] Malta Medical Students' Association—MMSA, Msida, Malta
[s] German Medical Students' Association—BVMD, Berlin, Germany
[t] Department of Anaesthesiology and Intensive Care Medicine, University Hospital of Cologne, Köln, Germany
[u] European Resuscitation Council, Niel, Belgium
[v] David Tvildiani Medical University, Tbilisi, Georgia

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ABSTRACT

Background: Students are an important part of the community response to an out-of-hospital cardiac arrest (OHCA). If even schoolchildren now know cardio-pulmonary resuscitation (CPR), even more the reason a young doctor should know how to treat an OHCA. The aim of our study was to assess medical students' knowledge of CPR and OHCA throughout Europe.
Methods: An online survey was given to final-year students by the Medical Student Associations of different countries.
Results: 1012 medical students from 99 different universities and 14 different countries completed the questionnaire. A total of 82.2% attended a BLS or BLS/AED course, provided by the University in only 69.7% of cases. In 84.3% it was a mandatory part of their degree. A total of 78.6% felt able to rescue a person in OHCA. Only 49.3% knew that 'unresponsiveness' and 'absence of normal breathing' are sufficient for lay people to identify an OHCA, and less than half of those interviewed knew the incidence of OHCA in Europe and the decrease in chance of survival if CPR is not performed. The correct compression:ventilation ratio was known by 90.2%, the correct compression depth by 69.7%, whilst only 57.8% knew the right compression rate. In total, 69.7% knew that an AED must be used immediately when available, and only 57.2% recognized the AED symbol.

* Corresponding author at: Via Sauro 34, 27038 Robbio, PV, Italy.
E-mail address: enrico.baldi@unipv.it (E. Baldi).

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Conclusions: Medical students' knowledge of cardiac arrest and CPR needs to be improved throughout Europe and we believe that BLS/AED training should be mandatory in all European Universities.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) is one of the leading causes of death in industrialized countries [1]. In Europe, the EuReCa-One survey reported an OHCA incidence rate of 84.0 per 100,000 population with an overall survival rate, evaluated as patient discharged from hospital alive or alive at least 30 days after event, of 10.3% [2]. Literature frequently reports, and the 2015 ERC Guidelines also highlight, that community response is a key factor for improving the survival of OHCA victims [3,4], and regions where this approach has been implemented appreciate a greater survival rate than those where it has not [5,6]. Students in particular are an important part of the community response, and there is a lot of proof showing that teaching Cardio-Pulmonary Resuscitation (CPR) in schools saves lives [7]. For this reason, the European Resuscitation Council has promoted a strategy which has received the endorsement of the World Health Organization: to promote resuscitation education in schoolchildren from the age of 12, 2 h a year, in all European countries [8]. If even schoolchildren know CPR, all the more reason a young doctor should know how to treat a cardiac arrest. However, we recently demonstrated that among medical students in Italy, nearing graduation, there is a considerable lack of knowledge regarding lifesaving techniques [9]. The aim of our study, therefore, was to verify whether this problem of scarce knowledge of cardiac arrest and CPR is solely an Italian problem or whether it spans throughout Europe.

2. Material and methods

We designed an anonymous online survey in agreement with ERC Research NET, which was then given to final-year European students by the Medical Student Associations of the different countries. The questionnaire was divided into three different parts: the first concerned general information about the respondents, the second consisted of questions regarding their previous participation in Basic Life Support (BLS) or Basic Life Support and Automated External Defibrillation (BLS/AED) courses, and the third focused on knowledge of Cardiac Arrest and CPR. Only questionnaires with all the three parts fully completed were considered valid for analysis.

The survey was carried out between May 2018 and October 2018 in order to verify students' knowledge just prior to graduation, and a specific online system was used to administer the questionnaire (www.surveymonkey.com, Surveymonkey Inc., San Mateo, CA, USA). The questionnaire (English version as supplementary file) was translated into different languages by the chair of each Medical Association in order to ensure it was understood by all. It was also validated by an English mother tongue. The online system calculated that the mean time taken to complete the questionnaire was 6 min, and the uniqueness of the response was confirmed by the IP address of the respondent.

2.1. Ethics approval and informed consent

The study is considered exempt from ethical evaluation because, in accordance with Italian law, the study did not include the use of drugs or medical devices and it was not directly related to the health of the participants. Moreover, formal consent is not required for this type of study, and no personal data were collected.

2.2. Statistical analysis

All data were entered in anonymous form into a database (Microsoft Excel 2017) and then analyzed with MedCalc Ver. 12.5.0.0 Windows version (MedCalc Software bvba, Ostend, Belgium). The main descriptive statistics as mean and standard deviation or median and interquartile range were used to describe all variables collected during the study.

3. Results

All three parts of the questionnaire were completed by 1012 final-year students from 99 universities in 14 countries. Additional 109 students did not fill out their questionnaires completely so these were not considered for the analysis. In total, 36.6% of the participants were male and the mean age was 25.45 ± 2.69. The mean time for each student to complete the survey, recorded by the dedicated online platform, was 5 min and 25 s. Participants' general information is given in Table 1.

Regarding the students' previous participation in BLS or BLS/AED courses, participation ranged from 38.5% to 100%, and the course was organized by the University in 69.7% of cases. Participation was equally distributed over the six years of the degree course and, in most cases (95.9%), it was both theoretical and practical. The compulsoriness of the course varied from country to country; from 14.3% in Bulgarian universities to 100% in Austrian, Georgian and Kosovo universities. About half of the respondents considered the course had prepared them sufficiently and were subsequently able to intervene in the case of a cardiac arrest. Regarding courses not organized by universities, 94% were both theoretical and practical. The same proportion of respondents as those who participated in a course as a part of the degree programme, considered it sufficient to be able to intervene in case of a cardiac arrest. In general, 78.6% of the European final-year medical students felt they were able to rescue a person experiencing cardiac arrest outside of a health-care setting (Table 2).

Concerning final-year medical students' knowledge of cardiac arrest and CPR, 46.4% knew the correct incidence of OHCA in Europe and 35.4% knew that the chance of survival of a person in cardiac arrest drops by about 7%–10% every minute if cardiopulmonary resuscitation is not carried out. Regarding practical skills, 90.2%, 69.7% and 57.8% knew the correct compression:ventilation ratio, the correct compression depth and the correct compression rate, respectively. Moreover, the fact that unresponsiveness and absence of normal breathing are the signs by which lay rescuers can identify an OHCA is known by 49.3%, whilst 34.9% know that if a person who is choking and is coughing vigorously calls for help, you must simply tell him to cough, and observe without intervening. A total of 91.3% of respondents knew that myocardial infarction is the common cause of OHCA in adults, and 88.8% correctly identified VF as a shockable rhythm. Regarding knowledge of AED, 69.7% knew that it has to been used immediately when available, and 57.2% correctly identified the international symbol recommended by ILCOR to indicate its presence. Answers varied greatly between countries (Table 3).

4. Discussion

Our study clearly demonstrates, for the first time, that final-year medical students' knowledge of cardiac arrest and CPR is scarce and needs to see improvement throughout Europe. It has been widely demonstrated that involving the community in emergency response is the main way to improve survival following an OHCA [3–6]. There are a number of effective ways to involve the community: carrying out public campaigns to increase OHCA awareness [10,11], teaching lay people high-quality CPR using modern

Table 1
General information about the students who answered the survey.

Nation	Total	Austria	Bosnia	Bulgaria	Cyprus	France	Georgia	Germany	Italy	Kosovo	Malta	Moldova	Romania	Spain	Ukraine
n (%)	1012 (100)	31 (3.1)	27 (2.7)	30 (3.0)	3 (0.3)	94 (9.3)	10 (1.0)	138 (13.6)	285 (28.2)	13 (1.3)	10 (1.0)	54 (5.3)	134 (13.2)	99 (9.8)	84 (8.3)
Age (mean ± SD)	25.45 ± 2.69	25.06 ± 1.58	25.75 ± 1.87	25.33 ± 1.89	23.96 ± 1.03	24.39 ± 1.86	24.54 ± 0.6	26.64 ± 3.68	26.02 ± 2.60	25.55 ± 4.65	25.13 ± 1.96	25.39 ± 1.54	25.43 ± 2.15	24.32 ± 1.26	24.11 ± 3.65
Male (%)	36.8	38.7	70.4	33.3	33.3	43.6	30.0	30.4	44.2	53.8	70.0	31.5	17.2	35.4	34.5
University (n)	99	4	2	3	2	12	1	21	17	1	1	1	8	14	12

technologies [12], alerting CPR-trained citizens if an OHCA occurs in their vicinity [13–15], and teaching students CPR. Regarding this last point, there is a lot of evidence to show that schoolchildren learn CPR better and more quickly than adults, retain good practical and theoretical skills months after their training, and play a key role in improving out-of-hospital cardiac arrest survival, as highlighted by the ERC with its "KIDS SAVE LIVES" statement and initiatives [1,16–18]. All the evidence has led several countries to make CPR training in schools compulsory [19].

If almost all European nations have passed a law or promoted teaching students CPR, it is reasonable to expect that final-year medical students, just before their graduation, to have a comprehensive understanding of cardiac arrest problems and CPR, especially since they are the doctors of the near future.

Thanks to the help of the Medical Student Associations of 14 different countries, we have been able to involve 1012 students from 99 universities. The results of our survey report that not all the medical students did a BLS or BLS/AED course during their degree and, in some countries, the percentage of students who did do such a course was well below 50%. Moreover, respondents reported that courses were organized by the universities themselves in only 69.7% of cases, and they were not always compulsory. These results are consistent with data found in literature, reporting on both western countries and other parts of the world [9,20–22]. This highlights that the lack of mandatory BLS/AED training during medical school is probably a worldwide problem. Furthermore, the percentage of students that considered their course sufficiently instructive for them to be able to rescue a person in cardiac arrest was only slightly above 50%. This result was similar regardless of whether they did their course via their university or externally (57.9% and 56%, respectively).

Despite this, the percentage of students who considered themselves able to rescue a person in OHCA is quite high; from 53.3% to 100% depending on the country, with a median of 78.6%. Although this figure is higher than those previously reported both in Europe and in the United States [23,24], the actual knowledge of cardiac arrest and CPR is quite disarming. This also suggests that students have an inaccurate perception of their "rescuing abilities".

As far as theory is concerned, less than 50% of future doctors know that the incidence of OHCA is 1 in 1000 inhabitants and that a person's chance of surviving cardiac arrest drops by about 7%–10% every minute that cardio-pulmonary resuscitation is not carried out. Knowledge of the treatment algorithm is no better; despite about 90% knowing that 30:2 is the correct compression:ventilation ratio, only 69.7% (range, 50%–81.5%) know that at least 5 cm (no more than 6 cm) is the correct compression depth, and only 57.8% (range, 7.7%–77.5%) know that the correct compression rate is between 100 and 120 compressions per minute. This lack of knowledge regarding CPR practical skills was seen in our previous report on Italian medical students and also in other single-center or single-nation surveys carried out in other parts of the world [9,20–22,25–27], which, however, have included students of different years and/or students of different health sciences, making the population more heterogeneous than our study, which is focused only on final year medical students just before their graduation.

The most common cause of cardiac arrest in adult was better understood and was correctly identified as myocardial infarction by 91.3% of the respondents. They were also well aware that ventricular fibrillation is the only shockable rhythm compared to asystole, PEA and sinus tachycardia. This suggests that perhaps medical students are more prepared on the pathophysiological aspects of cardiac arrest than on how to actually intervene with CPR manoeuvres. In fact, what a lay rescuer has to check in order to identify a cardiac arrest was known only by about 50% of the students and the results were even worse with regard to foreign-body-airway

Table 2
Answers to the questions related to the previous participation of the students in a BLS or BLS/AED course and to what extent they feel able to rescue a person in cardiac arrest. The results are presented as a percentage of students who answered correctly to each question. In the first column, the results refer to the students of all countries whilst in the subsequent columns, the results refer to each single country.

Nation	Total	Austria	Bosnia	Bulgaria	Cyprus	France	Georgia	Germany	Italy	Kosovo	Malta	Moldova	Romania	Spain	Ukraine
Previous course (%)	82.2	100.0	48.1	43.3	100.0	97.9	90.0	100.0	79.3	38.5	90.0	72.2	82.8	89.9	64.3
Course organized by University (%)	69.7	93.5	92.3	53.8	100.0	98.9	88.9	96.4	43.4	40.0	22.2	87.2	70.3	68.5	40.7
During 1st year (%)	12.9	62.1	8.3	0.0	33.3	1.1	0.0	27.8	0.0	0.0	0.0	26.5	10.3	0.0	0.0
During 2nd year (%)	11.2	13.8	66.7	0.0	66.7	22.0	12.5	6.0	8.2	0.0	0.0	2.9	3.8	8.2	22.7
During 3rd year (%)	16.6	6.9	0.0	0.0	0.0	41.8	50.0	15.0	9.2	0.0	0.0	0.0	5.1	27.9	9.1
During 4th year (%)	19.0	10.3	0.0	14.3	0.0	23.1	37.5	18.8	10.2	100.0	0.0	2.9	38.5	16.4	18.2
During 5th year (%)	18.4	6.9	0.0	28.6	0.0	9.9	0.0	30.1	6.1	0.0	100.0	50.0	15.4	14.8	36.4
During 6th year (%)	21.9	0.0	25.0	57.1	0.0	2.2	0.0	2.3	66.3	0.0	0.0	17.6	26.9	32.8	13.6
Course theoretical and practical (%)	95.9	100.0	83.3	42.9	100.0	94.5	37.5	99.2	96.9	100.0	100.0	91.2	91.0	96.7	95.5
Course mandatory (%)	84.3	100.0	83.3	14.3	33.3	96.7	100.0	97.7	62.2	100.0	50.0	76.5	88.5	78.7	68.2
Sufficient to be prepared to rescue? (%)	57.9	86.2	25.0	71.4	100.0	45.1	50.0	80.5	50.0	50.0	50.0	35.3	48.7	59.0	50.0
Course NOT organized by University (%)	30.3	6.5	7.7	46.2	0.0	1.1	11.1	3.6	56.6	60.0	77.8	12.8	29.7	31.5	59.3
Course theoretical and practical (%)	94.0	100.0	100.0	83.3	N.A.	100.0	100.0	100.0	97.7	33.3	0.0	80.0	93.9	92.9	87.5
Sufficient to be prepared to rescue? (%)	56.0	100.0	100.0	83.3	N.A.	100.0	100.0	100.0	52.3	33.3	71.4	40.0	45.5	75.0	46.9
Are you ready to rescue? (%)	78.6	96.8	66.7	53.3	100.0	77.7	80.0	94.9	76.5	84.6	80.0	85.2	69.4	79.8	72.6

Table 3
Answers to the questions related to cardiac arrest and CPR knowledge. The results are presented as a percentage of students who answered correctly to each question. In the first column, the results refer to the students of all countries whilst in the subsequent columns, the results refer to each single country.

Nation	Total	Austria	Bosnia	Bulgaria	Cyprus	France	Georgia	Germany	Italy	Kosovo	Malta	Moldova	Romania	Spain	Ukraine
Correct incidence of OHCA	46.4	45.2	33.3	53.3	66.7	50.0	50.0	42.8	50.2	30.8	50.0	38.9	52.2	43.4	38.1
Decrease of chance of survival during OHCA without CPR	35.4	32.3	22.2	10.0	33.3	18.1	10.0	34.1	53.3	30.8	20.0	25.9	35.8	37.4	19.0
Correct compression:ventilations ratio	90.2	100.0	81.5	70.0	100.0	91.5	40.0	97.1	88.8	61.5	100.0	83.3	94.0	97.0	88.1
Correct compression depth	69.7	71.0	81.5	56.7	66.7	59.6	70.0	73.2	71.2	69.2	50.0	61.1	72.4	75.8	66.7
Correct compression rate	57.8	77.4	14.8	30.0	66.7	66.0	20.0	77.5	52.3	7.7	40.0	66.7	49.3	62.6	67.9
Unresponsiveness + no normal breath to identify OHCA by layrescuers	49.3	90.3	14.8	6.7	100.0	60.6	0.0	90.6	42.1	7.7	60.0	16.7	32.1	78.8	27.4
Common cause of cardiac arrest in adults	91.3	100.0	100.0	83.3	66.7	91.5	80.0	93.5	91.2	100.0	100.0	83.3	91.8	91.9	88.1
What to do with a person is chocking and coughing vigorously	34.9	45.2	3.7	10.0	100.0	60.6	20.0	23.9	31.6	30.8	20.0	51.9	28.4	58.6	23.8
When to use an AED	69.7	93.5	44.4	60.0	66.7	71.3	0.0	91.3	78.2	30.8	70.0	31.5	56.0	83.8	50.0
ILCOR sign to indicate the presence of an AED	57.2	83.9	29.6	26.7	33.3	62.8	20.0	84.8	61.1	23.1	50.0	24.1	39.6	77.8	39.3
Which is a shockable rhythm (VF)?	88.8	96.8	81.5	56.7	100.0	93.6	60.0	97.1	87.0	76.9	100.0	75.9	90.3	91.9	92.9

obstruction; only 34.9% knew that if a patient can cough and speak, you just need to observe and not do anything. This shows that medical students are not totally sure how to deal with choking, as recently highlighted in a mono-centric study in Egypt [27].

Concerning the use of an AED, which is something that every citizen should know, 69.7% (range, 0%–93.5%) answered that the AED must be used immediately when available and, even more worrying, only 57.2% (range, 20%–84.8%) correctly identified the AED international symbol recommended by ILCOR. It is not surprising, per se, that the international AED sign is not universally recognized, especially if one considers that Aagaard et al. reported that only 39% of passengers (of 42 nationalities) in an airport correctly identified it [28]. It is nothing short of alarming that the future doctors of tomorrow are not familiar with it.

The main reason for this scarce knowledge of cardiac arrest and associated lifesaving techniques seems to be that, in many countries, there is a considerable proportion of students who, at the end of their medical degree, have not done a BLS course. In fact, knowledge is higher in countries where students attended a course than in those where they did not. However, this alone cannot explain the issue; knowledge of practical skills also appears lacking (especially for the compression rate) in the countries where almost all the respondents previously participated in a BLS course. There are many possible explanations for this. Firstly, the courses are not standardized and not follow the international recommendations; there is a fairly significant percentage of students who attended a theory-only BLS course. Such courses are not the best option for teaching the practical skills necessary to carry out a real resuscitation. Courses should be standardized and be in line with European Resuscitation Council recommendations. Feedback systems and high-fidelity simulation should also be used as they have been proved to effectively increase the quality of CPR training [29,30]. Secondly, many students attend a BLS course in the first years of their degree course; practical skills of CPR rapidly deteriorate in just a few months [31], so medical students should refresh their knowledge on several occasions during their degree. “Knowledge refreshing” can be achieved via short retraining courses or by involving students in teaching BLS to their younger colleagues or people out in the community which, in so doing, also fulfills the social responsibility of universities [30,32].

In summary, our survey reports a significant lack of knowledge regarding cardiac arrest and lifesaving techniques among final-year medical students in the period of their graduation throughout Europe. This is all the more serious if we consider that the respondents of our survey are the doctors of the future; they should be the first to spread cardiac arrest and CPR awareness throughout the population. This appears to be a long-standing problem; evidence suggests that the BLS and Advance Cardiac Life Support (ACLS) knowledge of doctors currently operating is sub-optimal, if not poor, in different parts of the world [33–37]. We strongly suggest that BLS/AED courses and practical training should be mandatory during medical school of every university – at least for 2 h per year–and we hope that our study will be a stimulus to do so.

4.1. Limitations

The first limitation of our study is that it is based on an online survey. This means that some students could have looked up some answers rather than responding using their own knowledge. However, the mean response time suggested that respondents concentrated on answering the questionnaire without wasting time looking for answers elsewhere. Anyway, a copying problem by respondents, should lead to an underestimation of the real lack of knowledge present among the students.

The second limitation is that our sample does not include all students throughout Europe in the final year of a medical degree. However, as far as we know, including students from roughly 100 universities in 14 different countries, this is the most spread survey to have been carried out to date.

5. Conclusions

Cardiac arrest and CPR knowledge of medical students throughout Europe in the period leading up to their graduation is scarce and must be improved. We believe that BLS/AED training (at least 2 h a year) should be a mandatory part of all medical degrees, in every university, and we hope that this study could encourage such a practice.

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Conflict of interest

Bernd W. Böttiger is European Resuscitation Council (ERC) Board Director Science and Research; Associated Editor, European Journal of Anaesthesiology (EJA); Speakers honorarium from Medupdate, FoMF, Baxalta, Bayer Vital, Bard; Chairman, German Resuscitation Council (GRC); Board Member, German Society of Interdisciplinary

Intensive Care and Emergency Medicine (DIVI); Associated Editor, Resuscitation.

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Appendix A. Supplementary data

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