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Simulation and education

Cost minimization analysis for basic life support

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Abstract

Background: The use of online teaching methodology for basic life support (BLS) courses is progressively increasing.

Objective: The objective of this study was to verify whether the blended-learning methodology (virtual course with a short face-to-face complement) was more efficient than a course that followed the classical or face-to-face methodology in our university.

Materials and methods: A cost minimization analysis was performed for two BLS and automatic external defibrillation (AED) courses, one of which was conducted face-to-face (Control Group) and the second of which was conducted via blended-learning (Experimental Group). The courses had the same duration and content according to the European Resuscitation Council (ERC) recommendations. In the face-to-face course, direct costs were considered those generated by the faculty and derived from the academic activity. Other costs were those generated by the use of classrooms and the amortization of manikins and AED training. The perspective of the analysis was that of the provider, the academic, and a time horizon of six months. The costs are expressed in € 2017.

Results: The savings of a course in BLS-AED based on the blended-learning methodology calculated for a total of 160 university nursing and medical students were € 2328.8 for the first year of its implementation and € 9048.8 for its second edition compared with the same course using a face-to-face methodology.

Conclusions: The blended-learning methodology supposes a cost savings for BLS-AED courses, mainly due to the reduction of expenses of the teaching staff. The blended-learning methodology seems to be more efficient than the face-to-face methodology.

Keywords: CPR education, Online CPR training, Blended-learning, Education technology, Virtual learning, Cost minimization, Efficiency

Background

The latest European Resuscitation Council (ERC) guidelines for cardiopulmonary resuscitation (CPR)[1] continue to highlight the need for universal teaching in basic life support and automatic external defibrillation (BLS-AED) to improve the survival of patients who have suffered cardiac arrest. One way to achieve maximum dissemination of this teaching is through the introduction of virtual systems to facilitate autonomous learning[2]. Due to recent technological and computer developments, teaching methodology based on blended-learning, E-learning, or on-line

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courses for BLS-AED has increased exponentially. The acceptance by students seems very good[3].

Although some authors have doubts about the usefulness of individual learning[4,5], in general, courses and self-training programmes in CPR (e.g., video, DVD, online training, or use of computer feedback) are considered an equal alternative that is as effective as courses led by a physically present instructor teaching BLS-AED skills to healthcare professionals and all citizens[1]. The advantages of this approach favour the student's autonomy and the facilitation of training in more remote and isolated territories[6]. Another potential advantage of online training is the reduction of costs, although the evidence is not conclusive for BLS-AED.

The objective of this study was to evaluate the efficiency of a BLS-AED course conducted with a blended-learning methodology similar to a course based on a traditional face-to-face methodology with the same training effectiveness after the course and 6 months after concluding[7].

Materials and methods

We performed a cost minimization analysis of two similar BLS-AED courses whose content and development were adapted to the 2010 ERC recommendations. The study was designed in 2011–2012 and conducted in 2014. The control group (CG) received traditional official face-to-face training, and the experimental group (EG) received all training with virtual methodology except the last 45 min of the course, in which the presence of an instructor was introduced (Fig. 1). In both groups, the same assessment of knowledge and practical skills was conducted through a simulated case on QCPR Resusci Anne SkillReporter manikns (Laerdal®) and a check-list type grid completed by the instructor. This approach justified the use of a cost minimization analysis for the economic evaluation because the effectiveness of the intervention was the same as that of its comparison. The assessment was done using an MCQ test consisting of 11 questions on CPR knowledge used by the Consell Català de Resuscitació (CCR), the scientific society qualified to accredit these courses in Catalonia bounded to the ERC. The overall results of theoretical knowledge (5 points were needed to pass it) were not statistically significant between the two groups [$\bar{x}$ -Mean- 8.36 (SD-standard deviation- 1.23) in CG vs $\bar{x}$ 8.44 (SD 1.27) in EG (p = 0.41)]. Practical skills were assessed at the end of the course, by instructor's rubric (similar by the CCR): EG had higher scores in practical skill evaluated by than control group (7.44, SD 1.85 vs. 6.10, SD 2.6; P = 0.01)[7]. Satisfaction scores, using a survey of 10 questions, was $\bar{x}$ 8.6 (SD 0.65) vs $\bar{x}$ 8.6 (SD 0.77) (p = 0.093), respectively.

The sample consisted of first-year students in health sciences (medicine and nursing) from the University of Catalonia during the 2014–2015 academic years. The study was conducted after obtaining the approval of the Research Ethics Committee and the informed consent from the students.

After applying the inclusion criteria to the 178 enrolled students, the students that had completed an official BLS-AED course in the previous 3 years were excluded. As shown in Fig. 2, 68 students were included in the CG and 61 in the EG, which corresponded to the sample size needed to ensure the validity of the study of blended-learning vs traditional learning for BLS-AED. The results of the study showed that the groups were homogeneous in the degree year, sex, and previous course or previous performance in CPR (Table 1). Additionally, the group that used the virtual methodology obtained results in the BLS-AED that were similar to or even better than those of the group that used the traditional face-to-face methodology[7].

Analysis

The perspective of the economic analysis was that of the provider, the academic, and a time horizon of six months. From an economical point

<table>
<tr><th colspan="2"></th><th colspan="2">CONTROL GROUP: FACE TO FACE</th><th colspan="2">EXPERIMENTAL GROUP: BLENDED-LEARNING</th></tr>
<tr><td>SCHEDULE</td><td colspan="5">PROGRAM</td></tr>
<tr><td>10 min</td><td>Welcome. Presentation. Objectives of the course.</td><td colspan="2" rowspan="3">1 hour (Instructor 1 CG)</td><td colspan="2" rowspan="3">1 virtual hour (Instructor 1 EG)</td></tr>
<tr><td>10 min</td><td>Initial evaluation</td></tr>
<tr><td>40 min</td><td>Theory: Basic Life Support</td></tr>
<tr><td></td><td colspan="5">BREAK</td></tr>
<tr><td>120 min</td><td>BLS Practices, "step by step" skills</td><td rowspan="3">4.5 hours (Instructor 1 CG)</td><td rowspan="3">4.5 hours (Instructor 2 CG)</td><td colspan="2" rowspan="2">3.75 virtual hours (Instructor 1 EG)</td></tr>
<tr><td>30 min</td><td>BLS Practices, "step by step" defibrillation skills</td></tr>
<tr><td>75 min
45 min</td><td>Integrated simulation</td><td>0.75 hours (Instructor 1 EG)</td><td>0.75 hours (Instructor 2 EG)</td></tr>
<tr><td>30 min</td><td>Evaluation. Satisfaction survey.</td><td colspan="2">0,5 hours (Instructor 1 GC)</td><td colspan="2">0.5 hours (Instructor 1 EG)</td></tr>
<tr><td>SUBTOTAL</td><td colspan="3">6 hours Instructor 1 CG + 4.5 hours Instructor 2 CG</td><td colspan="2">1.25 hours (Instructor 1 EG) face-to-face
0.75 hours (Instructor 2 EG) face-to-face
4.75 hours (Instructor 1 EG)</td></tr>
<tr><td>TOTAL HOURS</td><td colspan="3">10.5 contact hours</td><td colspan="2">2 contact hours/4.75 virtual hours</td></tr>
</table>

CG: Control Group/EG: Experimental Group. The student-teacher ratio for the master classes is 1/16 and for the practices 1/8, which is why the instructors must be Doubled. In bold virtual hours.

Fig. 1 – Schedule of the BLS-AED (6 h) face-to-face and virtual courses. In-person and virtual hours of the instructor according to the teaching methodology.

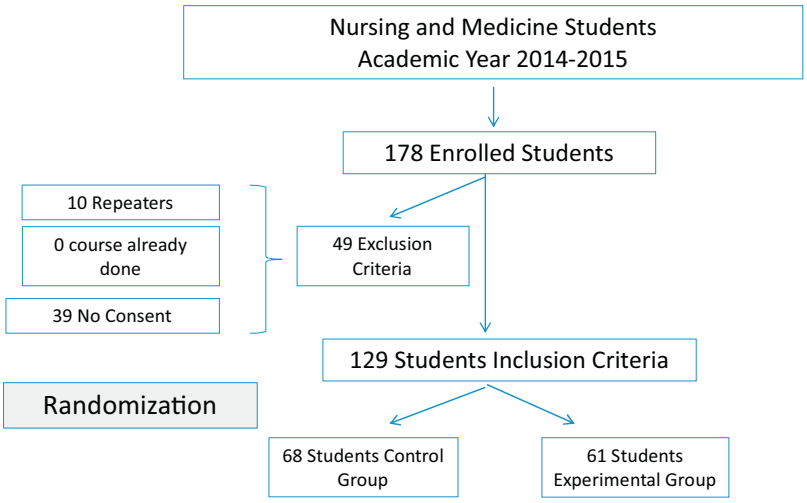

Fig. 2 – Flow chart of the population and sample size of the study.

Table 1 – Demographic characteristics, previous knowledge and skills of the population before the study.

		Face-to-face (N = 68)	Blended (N = 61)	Total (N = 129)	P
Degree*	Nursing	35 (51.5%)	28 (45.9%)	63 (48.8%)	0.59
	Medicine	33 (48.5%)	32 (52.4%)	65 (50.4%)	
	n/a	0 (0%)	1 (1.7%)	1 (0.77%)	
Sex*	Male	15 (22%)	17 (27.8%)	32 (24.8%)	0.41
	Female	52 (76.4%)	42 (68.6%)	94 (72.9%)	
	n/a	1 (1.5%)	2 (3.3%)	3 (2.3%)	
CPR previous participation		5 (7.6%)	5 (8.5%)	10 (8%)	0.85
Age (years)		19.31 (3.17)	21.31 (6.4)	20.25 (5.05)	**0.03**

Qualitative variables (degree, sex, previous training and participation in CPR) are expressed in absolute frequency (N) and %, and statistically analyzed with χ^2 test. Age variable is expressed in mean and SD and statistically analyzed with Student's *t*-test p-values<0.05 are considered statistically significant. n/a = no answer. Significant values are highlighted in bold.[7]
There is one case lost in the blended degree column, one case in the face-to-face sex column and two in the blended sex column.

of view, a balanced budget must always have a net result to be sustainable, which means that for preparation of any university budget, the expected income and expenses must have a net result of at least € 0. To meet this goal, the minimum number of students was 16.

Income

Course revenues were calculated based on the European Credit Transfer and Accumulation System (ECTS) price attributed to face-to-face training, which was modified based on the expenses generated by the course. Although the duration of this course was six contact hours, the institution considered this course to constitute one ECTS credit for the student because the rest of the ECTS hours were attributed to reading the manual and their autonomous work. The same price per credit was attributed to the blended-learning teaching methodology to enable comparison of their costs.

Costs

Direct costs

- Teacher hours: We consider that a model course of 16 students requires the participation of 2 instructors whose distributions of functions and schedules according to the study groups are shown in Fig. 1.

In the face-to-face course, the two instructors conducted 10.5 teaching hours overall (1 h theoretical + 9 h practicums + 0.5 h evaluation). The ECTS price that degreed faculty in private universities charge for their teaching is € 1100 (10 direct teaching hours, the content preparation, and the course evaluation).

In the virtual course, the two instructors taught a total of 2 classroom hours (45 min of practical training each and 30 min for practical evaluations) for groups of 16 students. During other hours without the instructor's physical presence, the teacher was connected online with the students to answer questions and doubts generated by the students through the blog. We differentiated a total of 4.75 h that had different costs as virtual hours (Fig. 1). Regarding virtual training, the cost generated by a teacher who performs virtual training at the university is subject to the following formula: € 560 per ECTS multiplied by a correction factor (0.02) and the number of total students.

- Academic Activity:

This activity included a BLS-AED manual edited by the CCR, which is the official agency of Catalonia that is dependent upon the ERC. The manual was distributed 15 days before the training[8], and the book and the official accreditation had a price and a cost of € 10/student.

Other academic expenses were considered for the amortization of 30 manikin (Little Anne de Laerdal®), 4 Resusci Anne QCPR® torsos, 4 AED training sessions, 4 Guedel airways, and 4 self-inflating bags. The amortization of the material corresponded to an internal equation of the university that was stipulated in this training at € 125 per group of 16 students (Table 2). The equipment costs were exactly the same in both groups because the students in the EG group used the same material without instructor, but following the videos during the practice the duration was exactly the same.

In the virtual group, the cost of generating the pedagogical material with video editing was included in this item, as was the creation of the web page with all the audiovisual material. The cost for generating the realization of the videos and their editing (€ 750) and half-day rental of a set (€ 250), among other costs (Table 2 section 3), could reach € 1920. In addition to creation of the web page from predesigned templates, the page was developed by a computer technician for 3 weeks full time (8 h a day). The hourly price was € 40 per hour for the technician, so de budget cost was € 4800. The remaining expenses for the creation of the material reach € 6720 and are detailed in Table 2.

- Similar to other services, a minimum insurance cost was considered for the students. It was stipulated by the faculty at € 53 per group of 16 students. Similarly, both groups were within the same university and using the same spaces and material, so the insurance was the same for both groups.

Indirect costs

- The use of classrooms for training at the university has a stipulated price with the hourly rent taken into account, including the use of campus facilities (i.e., toilets and library). The price was contemplated for both

Table 2 – Simulation of the economic costs of face-to-face training and blended-learning in a BLS-AED training course (6 h).

Training Course in BLS-AED (6 hours)

	FACE TO FACE EDUCATION			BLENDED LEARNING		
	BUDGET REFERENCE = 0	CONTROL GROUP	ANNUAL APPROXIMATES	FACE-TO-FACE COMPARISON	EXPERIMENTAL GROUP	ANNUAL APPROXIMATES
Number of participants	16	68	160	16	61	160
Total income	1920	8160	19,200	1920	7320	19200
Total expenses (1 + 2+3 + 4 +5)	1920	8160	19,200	7735.12	10,590.18	16871.2
(1) Teaching staff	1210	5142.5	12,100	305.12	1163.27	3051.2
(2) Academic activity	285	1211.25	2850	285	1086.56	2850
(2.1) Books and accreditations	160	680	1600	160	610	1600
(2.2) Other academic expenses	125	531.25	1250	125	476.56	1250
(3) Creation of pedagogical material (3.1+ . . . +3.10)	0	0	0	6720	6720	6720
(3.1) Rental location	0	0	0	250	250	250
(3.2) SONY cameras	0	0	0	90	90	90
(3.3) Study completion	0	0	0	200	200	200
(3.4) Micro HF	0	0	0	30	30	30
(3.5) Lighting rack	0	0	0	100	100	100
(3.6) A/V production room	0	0	0	200	200	200
(3.7) Technician	0	0	0	150	150	150
(3.8)Teleprompter	0	0	0	150	150	150
(3.9) Publication	0	0	0	750	750	750
(3.10) Webpage creation technician	0	0	0	4800	4800	4800
(4) Other Services	53	225.25	530	53	202.1	530
(4.1) Miscellaneous expenses - Insurance	53	225.25	530	53	202.1	530
(5) Indirect expenses (5.1 + 5.2)	372	1581	3720	372	1418.25	3720
(5.1) Occupancy expenses	180	765	1800	180	686.25	1800
(5.2) University general expenses (10% revenue)	192	816	1920	192	732	1920
a) Net result from the 1 st year	0	0	0	−5815.12	−3270.18	2328.8
b) Annual net result from the 2nd year	0	0	0	1015.12	3450	9048.8
c) Net result over 5 years	0	0	0	−1754.64	10,530	38,524

The first year in the blended methodology operates at a significant loss due to the material cost. 120 students are required for savings to accrue; this is the number of students at which the courses break-even. b) Annual net result from the 2nd year were calculate without cost of creation of pedagogical material (3); c) Net result over 5 years were calculate c= (bx4)-a.

teaching methodologies at € 30 per class hour for the 16 students as expenses for occupation of the classrooms (Table 2).
- General expenses (i.e., secretary and promotion) are also contemplated as a fee that the University includes for the teaching activity stipulated in 10% of the generated income.

All economic data are shown in euros (€ year 2017).

Results

The face-to-face training in BLS-AED budgeted at the University had a final price of € 120/credit/student. This price included direct and indirect costs for a total of 16 students with a net result of € 0. To be sustainable, teaching must not operate at a net loss for the institution. The total sum is the price marked to be paid by the student. Thus, a price/credit value was obtained (Table 2).

This baseline calculation allowed us to calculate the costs of the training of the presented study (61 and 68 students) as well as those generated for the training of 160 students in one of the two methodologies (the approximate annual number of trained students).

For the blended-learning modality, the costs derived from the academic activity and the other services or indirect expenses were not modified because the course was conducted in the same university. However, the expenses attributed to teachers and the pedagogical material did vary. The costs of the courses were as follows:

- The expenses attributed to the teaching staff.
  - As shown in Fig. 1, instructor 1 CG in the classroom methodology taught 5 h and 30 min for the classroom-based teaching (of 16 students) and practice (of 8 students) and 30 min for the evaluations (of 16 students), which were attributed to 0.6 ECTS of teaching. Instructor 2 CG received 0.45 credits for the 4 h and 30 min of teaching because he only took charge of the practical part of a group of 8 students. Thus, the expense generated by the two professors in the classroom course after completing 10 h and 30 min of training for a group of 16 students was € 1210 (€ 1.05 x € 1100) (Table 2).
  - For the blended-learning course (Fig. 1), for a total of 16 students and using 2 instructors, the total face-to-face hours were 2 hours or 0.2 ECTS (which would have a teacher expense of € 220 compared to € 1100 ECTS face-to-face) and 4 h with 45 virtual minutes (multiplied by 0.475 [ECTS] * 0.02 [virtual ECTS correction factor stipulated by the university] * 16 [number of students] * € 560 [ECTS face-to-face] for a cost of € 85.12). The cost attributed to the teachers of the blended-learning training for a group of 16 students was € 305.12 (Table 2).

A total of € 192 per 16-student course was taken into account as an indirect cost, which represented 10% of the university profits.

The costs were calculated for 160 students because 160 is the approximate number of students trained annually in BLS-AED at the university. As shown in Table 2, the final cost of both teaching methodologies for these students was obtained by multiplying all of the values obtained by 10.

The net benefit obtained in the blended-learning training was € 2328.8 for the first year for a group of 160 students and € 9048.8 for the second year. The training would be deficient (€ -5815.12) in the first year for a group of 16 students in the blended-learning methodology compared to the face-to-face methodology. The benefits for groups of 16 were € 1015.12 per year.

In blended-learning if we perform the cost calculation for the 61 students in the EG, a negative balance can be observed in the first year but positive of € 10,530 at 5 years even when the blended-learning methodology is used.

Discussion

To compare the efficiency between two delivery systems for a training program, the effectiveness of the programmes and the costs related to them should be known. This study has shown that in terms of costs, the blended-learning programme is dominant and as a result saves costs for the university. Although the cost minimization analysis does not need to contribute the income generated, we believe that its presence is essential for reading and understanding the article.

Few studies have compared two identical courses that are equally effective with different teaching methodologies in BLS-AED similar to those described in our study. De Vries et al.[9] compared a three-hour in-person refresher course for hospital nurses (costing €59) with a self-training course based on a poster and manikins (costing €12).

Thorne et al.[6] observed a considerable reduction in costs if the knowledge part of advanced life support (ALS) courses was conducted using virtual methodology. Although we have studied the costs of a BLS course, they may not be identical. Perkins et al.[10] compared a classroom ALS course with a course with blended-learning methodology and found that the knowledge and skills were similar at the end of the course but that the cost of the course with blended-learning methodology was lower ($ 438) than that of the face-to-face course ($ 936). Their conclusions are consistent with our results. Our study also used this methodology for the majority of the learning of practical skills, and thus, the price of the course decreased even further.

In an economic evaluation, we believe that the inclusion of items that are equal in both groups facilitates understanding of the expenses generated by any university education. The budget items of the two types of teaching approaches are detailed in this paper because, although there are items that do not influence the cost analyses, their inclusion would facilitate understanding of the type of expenses generated at any university delivering similar programs. There are two budget items that promote savings for blended-learning compared to the face-to-face approach: the remuneration of teachers (the price per hour in the blended group is cheaper) and the development of teaching materials (digital videos, website, Moodle page) only spent the first year.

We cannot compare the parameters used by our university to calculate the costs of a face-to-face or virtual training activity with those of other institutions because this information is not available. Therefore, we have applied the scales used by a specific university for the two types of training and used them to calculate the difference in costs and the possible savings of online training. However, the calculation of the cost of face-to-face training was based on the real cost, whereas that of the on-line training was based on a budget simulation. In addition, the cost of editing ITC materials was calculated based on the working hours of the principal investigator. Despite these limitations, which can subtract strict accuracy from the calculations,

the approximation made in this article is based on the costs of the same institution and in our opinion is sufficiently demonstrative of the cost difference.

The price attributed to teacher remuneration decreases in online training not only because the price per ECTS is approximately half that of the face-to-face credit but also because it is multiplied by a very small correction factor. The correction factor corresponds to the standards of our university, and we believe that its attribution is understandable depending on the number of students tutored.

The cost attributed to the elaboration of the teaching material in non-face-to-face modalities must be carefully taken into account because it can increase the price of traditional training up to 24 times[11]. The cost of this material is very high for small or specific groups, making this methodology ineffective. However, if the training is designed for a larger population and this material can be used for future training, it becomes an economically very profitable method provided that both methodologies show similar efficacy (as in this case). In addition, because the guidelines are modified every 5 years, this material can be used during this period of time. Thus, for an annual training of 160 students in this methodology and with a profit of € 2328.8 for the first year and € 9048.8 for each of the following four years, a total benefit of € 38,524 would be obtained. The savings experienced after a course in BLS-AED with blended-learning methodology can be invested in research of new technologies in BLS-AED or be applied toward lowering the price of ECTS or training a larger number of students.

To reach the maximum population, the costs of this training must decrease exponentially; therefore, online training in BLS-AED in schools is a reality[12]. This saving costs policy should be studied in other populations.

The international guidelines also join efforts to simplify the algorithms of action to the maximum not only so that the quality of the CPR is greater and the retention of skills is more durable but also to reduce the hours of training and the costs of the courses[13]. This simplification can also make online training easier.

The organisation and budgeting of BLS-AED training is widely variable among institutions or organisations, and so the direct extrapolation of any cost analysis is not feasible; nevertheless, this was not the goal of our study. For the same content, duration, and training effectiveness of a BLS-AED course, the online methodology, in conjunction with 45 min of instructor time, allows a significant cost savings compared to the face-to-face methodology. This benefit, observed in a large population, can help to universalise training in BLS-AED.

In conclusion, for training with the same content, duration, and training effectiveness, the on-line methodology with 45 min of instructor time is dominant and allows a significant cost savings compared to the face-to-face methodology. This benefit is observed if the groups are numerous and is an especially beneficial method to universalize training in BLS-AED.

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Conflict of interest

We have no conflict of interest.

REFERENCES

1. Greif R, Lockey AS, Conaghan P, Lippert A, De Vries W, Monsieurs KG on behalf of the Education and Implementation of Resuscitation Section Collaborators. European Resuscitation Council Guidelines for Resuscitation 2015. Section 10. Education and implementation of resuscitation. Resuscitation 2015;288–301.
2. Cook D, Levinson A, Garside S, Dupras D, Erwin P, Montori V. Internet-based learning in the health professions: a meta-analysis. JAMA 2008;300:1181–96.
3. Perkins G, Fullerton JN, Davis-Gomez N, et al. The effect of pre-course e-learning prior to advanced life support training: a randomized controlled trial. Resuscitation 2010;81:877–81.
4. Finn J. E-learning in resuscitation training – students say they like it, but is there evidence that it works? Resuscitation 2010;81:790–1.
5. Finn J. Education, implementation and team worksheets. Available at:. . http://www.americanheart.org/presenter.jhtml?identifier=3060113.
6. Thorne C, Lockey A, Bullock I, et al. E-learning in advanced life-suport-an evaluation by the Resuscitation Council (UK). Resuscitation 2015;90:79–84.
7. Castillo J, Gallart A, Rodriguez E, Castillo-Monsegur J, Gomar C. Basic life support and external defibrillation competences after instruction and at 6months comparing face-to-face and blended training. Randomised trial. Nurse Educ Today 2018;232–8.
8. Bossaert L, Daviles S, De Vries W, et al. Ressuscitació Cardiopulmonar amb Desfibril.lador Extern Automàtic. Manual de l'alumne. CPR/AED Provider manual Catalan translation. 2011. [Internet]. Consult: 10/10/14. Available at:. https://my.erc.edu/en/webshop/item/13.
9. De Vries W, Schelvis M, Rustemeijer I, Bierens JJ. Self-training in the use of automated external defibrillators: the same results for less money. Resuscitation 2008;76:76–82.
10. Perkins GD, Kimani PK, Bullock I, et al. Improving the efficiency of advanced life support training: a randomized, controlled trial. Ann Intern Med 2012;157:19–28.
11. Drummond D, Arnaud C, Thouvenin G, et al. An innovative pedagogic course combining video and simulation to teach medical students about pediatric cardiopulmonary arrest: a prospective controlled study. Eur J Pediatr 2016;175:767–74.
12. Hoyme D, Atkins D. Implementing cardiopulmonary resuscitation training programs in high schools: Iowa's experience. J Pediatr 2017;181:172–6.
13. Bouland AJ, Risko N, Lawner BJ, Seaman KG, Godar CM, Levy MJ. The price of helping hand: modeling the outcomes and costs of bystander CPR. Prehosp Emerg Care 2015;19:524–34.