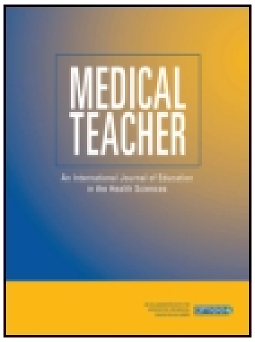

Medical Teacher

Taylor & Francis
Taylor & Francis Group

ISSN: 0142-159X (Print) 1466-187X (Online) Journal homepage: informahealthcare.com/journals/imte20

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To cite this article: Enrique Carrero, Carmen Gomar, Wilma Penzo, Neus Fábregas, Ricard Valero & Gerard Sánchez-Etayo (2009) Teaching basic life support algorithms by either multimedia presentations or case based discussion equally improves the level of cognitive skills of undergraduate medical students, Medical Teacher, 31:5, e189-e195, DOI: 10.1080/01421590802512896

To link to this article: https://doi.org/10.1080/01421590802512896

2009; 31: e189–e195 MEDICAL TEACHER

WEB PAPER

Teaching basic life support algorithms by either multimedia presentations or case based discussion equally improves the level of cognitive skills of undergraduate medical students

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Abstract

Background: There is no evidence on the best method for teaching Basic Life Support (BLS).

Aims: To compare two methods for teaching BLS, assessing the level of cognitive skills.

Methods: Randomized, prospective study including 68 medical students. BLS algorithms were taught for 60 minutes using either a multimedia presentation (Group I, $n = 34$) or case based discussion (Group II, $n = 34$). Assessments included a scenario-based quiz test and an error-pinpointing video, which the students completed before (T1) and after (T2) teaching. Comparisons between both groups were made on scores of the assessments, actual increases in scores (final value – initial value) and score gains (actual increase/potential increase).

Results: No significant differences were found between the groups in any of the recorded scores. Both groups improved their T2 scores (p values <0.001). The actual increases in scores and the score gains were similar in both groups. Test scores improved in 55.9% of students in Group I and 58.8% in Group II; video scores improved in 85.3% of Group I and in 82.3% of Group II.

Conclusions: BLS teaching by either multimedia presentations or case based discussion equally improves the level of cognitive skills among medical students.

Introduction

The primary objectives of teaching basic life support (BLS) are learning the sequence of action according to international guidelines and acquiring the necessary skills for its proper application (Handley et al. 2005; Baskett et al. 2005).

Despite efforts to prepare and update BLS guidelines, recommendations on the best instructional method are still needed (Jordan & Bradley 2000; Philips & Nolan 2001); a few models have been proposed recently for training non-healthcare professionals (Hoke & Handley 2006). In order to establish significant levels of evidence, the International Liaison Committee on Resuscitation (ILCOR) has adopted the goal of designing randomized controlled studies in educational research to compare standard teacher-based instructional methods versus newer methods focused on the student's participation process (Chamberlain & Hazinski 2003).

In our Medical School, BLS teaching is included in the curriculum as a 2.5-hour-long professor-led station. Action algorithms are taught for one hour using an instructional home-made videotape plus a Power Point presentation; for the remaining hour and a half, students use manikins to practice the BLS sequence of action, airway management, ventilation, external chest compression and automated external defibrillation. The students' assessment is theoretical and is included as multiple-choice test questions in the final examination of the course. Following the ILCOR's recommendations, we have included the discussion of case scenarios in this one-hour session and we have focused the assessment on aspects related to the application of knowledge.

The aim of this study was to assess if the teaching method based on discussion of case scenarios simulated on manikins

Practice points

- Instructional methodology in BLS should be based on evidence.
- The best method to teach Universal BLS Algorithms is not defined.
- BLS teaching by either multimedia or case based discussion equally improved cognitive skills among medical students.
- An objective method to assess BLS instruction efficacy is described.
- Blind studies with sufficient samples in the field are difficult.

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ISSN 0142–159X print/ISSN 1466–187X online/09/050189–7 © 2009 Informa Healthcare Ltd.
DOI: 10.1080/01421590802512896

by the teacher improves the students capacity to apply acquired knowledge on BLS compared to our traditional teaching method based on multimedia of BLS.

Methods

Subjects

To determine the sample size, the average efficacy was estimated at 60%; we considered a difference in scoring to be relevant at 25%; we established an α risk = 0.05, a statistical power $(1 - \beta) = 0.8$ and we estimated a case loss of about 5%. The resulting sample size was 35 students in each study group. The study population included 70 students in their third year of Medical School at the University of Barcelona, Spain, who attended four consecutive stations on BLS. Participation in the study was voluntary and confidential and had no influence on the academic scoring. All students included in the final analysis (Figure 1) signed the informed consent form. We recorded the students' previous CPR training experience. We excluded those students who did not complete all the phases of the study. Figure 2 shows a schematic representation of the study protocol.

Teaching

The station dealt with BLS according to the European Resuscitation Council (ERC) guidelines (Handley et al. 2005). The two participating professors were certified ERC BLS instructors with more than 5 years of BLS teaching experience and agreed upon the aims of the station before the study. All the students were taught BLS algorithms in a 60-minute session.

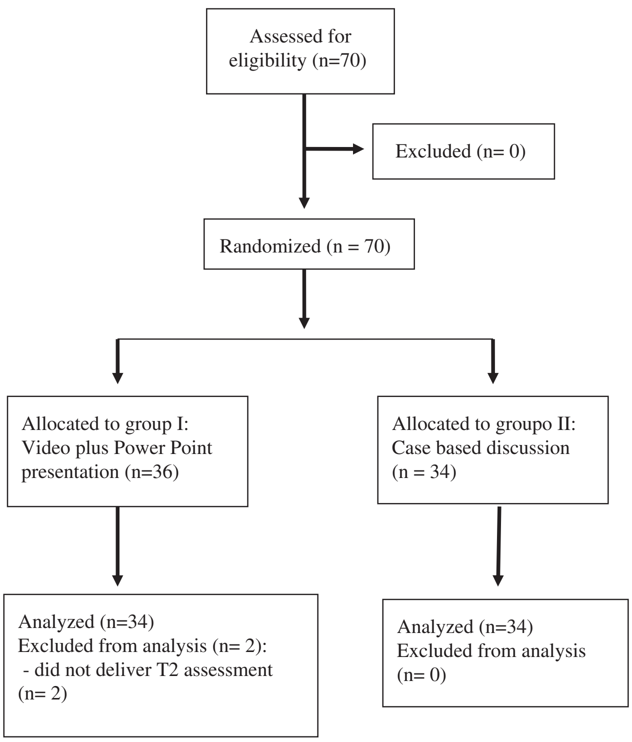

Figure 1. Flow chart showing the medical students' progress in the study.

Closed envelopes containing a number between 1 and 70 were randomly distributed among medical students (Figures 1 and 2). Students were randomized by a computer-generated procedure (two blocking restriction). Medical students and instructors were not blinded to the educational method applied.

Students in Group I received the content on a non-interactive multimedia format: 20 minutes home-made videotape on BLS, plus 25 minutes of a Power Point presentation and 15 minutes for questions and answers. The videotape and Power Point presentation contents were complementary. The videotape included simulated BLS outside the hospital performed by one or two rescuers with all the ILCOR algorithms steps: victim detection, both victim and rescuer safety, consciousness assessment, help request, upper airway patency, phone call to 112, chest compressions, sequence chest compressions/ventilations and victim reassessment. The Power Point presentation included the epidemiology, etiology and pathophysiology of the cardiac arrest, available evidences on effectiveness of BLS maneuvers, airway devices, ventilation with bag-valve-mask, safety lateral position and performance in front foreign-body airway obstruction. Four work stations were organized with 8–10 students participating in each one. Teaching resources was a computer for all students in each station and the constant presence of the teacher.

Students in Group II directly started with three case-scenario discussions: (1) a victim with non-traumatic cardio respiratory arrest; (2) an unconscious victim with effective and non-effective spontaneous respiration; and (3) a victim with

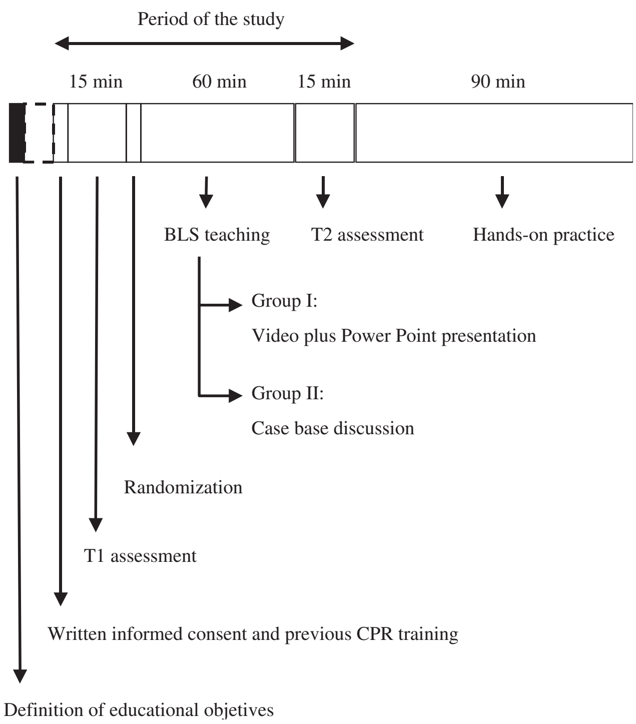

Figure 2. Outline of the methodology followed in the study. T1 assessment: test and video recording before teaching the basic life support (BLS) algorithms; T2 assessment: after teaching the BLS algorithms; CPR: cardiopulmonary resuscitation.

foreign-body airway obstruction. Four work stations were organized with 8–10 students participating in each one. Students did not receive the cases in advance to prepare them. The teacher performed the actions on the manikin during the case scenarios simulation, interacting with the students. The discussion was led by the teacher who detected and corrected the gaps and misunderstandings. The teacher was a subject-matter expert and had experienced the cases in reality. Resources included one Resusci®Anne SkillReporter™ manikin of BLS (Laerdal®), barrier devices for mouth-to-mouth ventilation, oropharyngeal cannulae, and one bag–valve–mask system. To simulate safety lateral position and maneuvers for foreign body airway obstruction, the teacher asked for voluntary collaboration of one student. The teaching objectives for both groups in all the stations were the same.

Following the multimedia presentation in Group I and case based discussion in Group II, the station was completed in both groups with a 90-minute hands-on practice on manikins using the BLS equipment. The teachers redressed the students during the hands-on practice. The study objective did not include the effect from the hands-on practice on cognitive skills because this teaching session could have result in a ceiling effect, eliminating the potential differences between the two teaching methods.

Assessments

Assessments included a test and a home-made videotape (Appendix 1). The test included three open-answer questions about three clinical scenarios. The students were asked to answer which BLS maneuver was indicated in each case. The video footage showed four wrong actions in the execution of the BLS sequence on a cardiorespiratory arrest performed by one rescuer on an adult manikin (Resusci® Anne). The students were asked to identify the incorrect actions and list them on a template. Assessments did not include hands-on skills.

A pilot trial was performed 6 months earlier for the design of this study. Twenty-nine students at 2 stations on BLS completed the assessments, the test and the video, and were scored by the same two evaluators who would later score the participants in our study. The evaluators confirmed that the assessments were understandable and could be completed within 15 minutes. This pilot trial was used to exclude the test and video data that led to disagreement between the evaluators and to prepare the final design for the test and the video.

Assessments were completed before (T1) and immediately after (T2) the application of the two methods for teaching BLS algorithms (Figure 2). T2 assessment was completed before the 90 min hands-on practice to avoid the possible influence of the latter in the results. Students were given no more than 15 minutes to complete the assessments and were not allowed to make comments on the assessments until finishing T2 assessment.

The primary endpoints assessed were two different fields of cognitive skills in BLS: field 1 'decisions based on BLS sequence' (test) and field 2 'detection of errors on BLS performance' (video recording). We counted the total number of correct answers at T1 and T2 assessments. Each correct answer scored 1 point, whereas wrong answers or unanswered questions scored 0 points. Assessments were scored by two evaluators (blinded to group allocation) different from the two instructors. We used the kappa statistic to analyze the agreement between evaluators (Altman 1991).

Secondary endpoints were the actual increase in the score between the different times of each assessment (final value – initial value) and the score gain (Δ), defined as the ratio between the actual increase in the score and the potential increase:

$$\Delta\text{Test} = 100 \cdot [(\text{final value} - \text{initial value})/(3 - \text{initial value})]$$
$$\Delta\text{Video} = 100 \cdot [(\text{final value} - \text{initial value})/(4 - \text{initial value})]$$

Finally, the number of students who improved their T2 scores from T1 was counted; we considered a percentage of over 50% to be relevant.

Statistics

Statistical calculations were performed using the SPSS 13.0 package (SPSS Inc., Chicago IL, USA). Qualitative variables were expressed as numbers (percentage) and were compared using the chi-square test. Fisher's exact test was used for a 2×2 frequency table with a number of observed frequencies less than 5. Quantitative variables were not normally distributed. Data were expressed as medians and 25th–75th percentiles. Non-parametric testing was used to assess differences between groups (unpaired two-tailed Mann–Whitney U-test) and within groups (Wilcoxon signed rank sum test for related samples). Statistical significance was defined as $p < 0.05$.

Results

Sixty-eight medical students completed the study, 34 in each group. Two participants in Group I were excluded because they did not complete T2 assessments (Figure 1). Previous BLS training experience was similar in both groups (Table 1).

Table 2 summarizes the results of the assessments. The kappa index of inter-evaluator agreement was higher than 0.8 for all assessments. We found no significant differences between the groups in any of the recorded scores. In both

Table 1. Personal characteristics and pre-study training experience in cardiopulmonary resuscitation (CPR) of the students. Data are shown as (a) number of students (% in each group) or as (b) median (25th–75th percentiles).

	Group I ($n = 34$)	Group II ($n = 34$)	p
Females/males[(a)]	27/7 (79.4/20.6)	26/8 (76.5/23.5)	0.77
Age[(b)]	20 (20–21)	20 (20–21)	0.65
Students who had received previous CPR training			
• lectures plus hands-on[(a)]	8 (23.5)	11 (32.4)	0.42
• hands-on[(a)]	1 (2.9)	2 (5.9)	1
Students who had performed CPR on a patient or manikin[(a)]	10 (29.4)	13 (38.2)	0.44
• Number of CPRs performed[(b)]	0 (0–0.75)	0 (0–1)	0.43

Table 2. Scores obtained at the assessments before (T1) and after (T2) teaching the BLS algorithms. Values are expressed as medians and 25th–75th percentiles. (#) $p < 0.001$ versus T1 within the group.

Assessment	Group	T1	T2
Test	Group I	1.5 (1–2)	2 (2–3)#
	Group II	1 (1–2)	2 (2–3)#
	p (between groups)	0.71	0.75
Video recording	Group I	1 (0–1)	2 (2–3)#
	Group II	1 (0–1)	2 (1.75–3)#
	p (between groups)	0.72	0.43

Table 3. Actual increase in the score and gain of score (Δ) at the assessments; T1: score obtained before teaching the BLS algorithms; T2: score obtained after teaching the BLS algorithms. Data are expressed as median and 25th–75th percentiles.

Score	Group I ($n = 34$)	Group II ($n = 34$)	*p*
Test T2 – Test T1	1 (0–1)	1 (0–1.25)	0.52
Δ (Test T2 – Test T1)	50 (0–58.33)	50 (0–83.33)	0.31
Video T2 – Video T1	1.5 (1–2)	1 (1–2)	0.25
Δ (Video T2 – Video T1)	50 (25–66.66)	50 (0–83.33)	0.33

Table 4. Number of students who achieved better scores (positive ranks), worse scores (negative ranks) or the same scores (tie ranks) at the assessments (Wilcoxon rank test). Values are expressed as number of cases (percentage within the group). (a) $p = 0.012$ within group.

Score differences	*Ranks*	Group I ($n = 34$)	Group II ($n = 34$)	*p*
Test T2 – Test T1	Positive	19 (55.9)[a]	20 (58.8)	0.8
	Negative	2 (5.9)	4 (11.8)	0.39
	Tie	13 (38.2)	10 (29.4)	0.44
Video T2 – Video T1	Positive	29 (85.3)[a]	28 (82.3)	0.74
	Negative	2 (5.9)	0 (0.0)	0.15
	Tie	3 (8.8)	6 (17.6)	0.28

groups, T2 scores improved significantly both on the test and on the video (*p* values <0.001).

The analysis of the actual increases of scores and the gains of scores on the test and on the video did not reveal any significant differences between the groups (Table 3).

We found no differences between the groups in the numbers of students who improved their T2 scores for either assessment (Table 4). In both groups, the percentages of students who improved their scores were relevant. In Group I, the number of students who improved their scores on the video was significantly higher than those who improved their scores on the test.

Discussion

In this study, the new instructional method based on the discussion of simulated case scenarios of non-traumatic cardiac arrest did not show any advantages versus the traditional method based on the multimedia presentation for the evaluated fields of knowledge. Our findings are consistent with two previous publications of our group in the fields of internship and residency and continuous medical education in which case discussion method did not demonstrate to be superior (Carrero et al. 2007, 2008). Randomized controlled studies have shown similar results in undergraduate medical education (Koles et al. 2005; Wahlgren et al. 2006).

Case discussion method and problem based learning are not the same. Reliance on teacher-directed versus self-directed learning remains the most obvious difference between the case method and problem based learning (Tärnvik 2007). In the present study we applied the case discussion method because we considered it more suitable to our scheduled teaching program. Moreover due to a more teacher-dependent approach to learning, the case based discussion method is less susceptible to group dysfunction, a well recognized problem inherent in problem based learning (Tärnvik 2007).

Case-based teaching designs are widely variable and we cannot rule out that the case-based discussion method could have obtained better results if it had been applied to a different context or if other parameters had been analysed. In this regard, several papers show the efficacy of problem based scenarios for improving non-technical skills and clinical judgment (Yee et al. 2005; Tiwari et al. 2006).

The important aspect of our study lies in the fact that both methods can be used to achieve equally good results and therefore these two methods are equally valid instructional alternatives. Cost-benefit balance of teaching methods, such as those used in this study, is difficult to assess since depends on the already established organization and available infrastructure of the different centers. In our case, both methods were equally affordable in our organization.

The high rates of agreement between evaluators found in our study are a measure of validation and reproducibility for the assessments used, which could lead to their more widespread of them. Unlike multiple-choice tests, designing the assessments with open answers allowed us to better understand the construction of the response by the student and the analysis of cognitive skills beyond simple recognition.

There were common factors to the two teaching methods used in this study that could explain our equally good results: both methods showed the BLS sequence of action in a realistic setting, either filmed or simulated, which approximated teaching to reality. Moreover, both, video recordings and simulation are instructional tools that particularly motivate students, as they consider these tools to be very effective (Lee et al. 2006; Morgan et al. 2006).

A higher percentage of students in both groups improved their error-pinpointing scores to a higher extent than their right-decision making scores. Perhaps, the video recording used for assessment could have had a visual retention effect on the students, helping them to self-redress their mistakes. It is also possible that we may have put stronger emphasis in teaching BLS maneuvers, chest compressions and ventilation, than in the lateral safety position or the management of the airway, which is a common bias in such courses (Durak et al. 2006).

Interestingly, we found that most students did not reach the maximum score at any of the post-instructional assessments. Our results reflect the difficulty in achieving BLS teaching objectives with one workshop only. This fact has already been reported in the literature (Madden 2006; Reder et al. 2006) and reinforces the recommendation that BLS education should be continuous (Chamberlain et al. 2002; Chamberlain & Hazinski 2003; Madden 2006).

Our study presents several drawbacks. This study deals with a narrow topic (only cognitive skills on BLS algorithm) in a limited setting (one 60 min session, with 70 students). Institutional limitations in both, available timetable and resources, restricted the study design to that carried out. A design including the effects of the teaching methods on both type of skills, cognitive and practical, would have given a more approximate assessment of the student's performance in the clinical setting. The lack of differences in cognitive skills with both teaching methods used does not exclude the possibility of differences in practical skills.

It is possible that there were differences between both methods that we could not detect because we aimed at a difference in scoring of at least 25%. We would have had to include many more students to detect smaller differences but it was not possible since the sample size was determined by the number of students doing the course in our Medical School. Including students of several years would have increased the variability of the sample, making the interpretation of the results difficult. Sample size is difficult to increase in medical education research since student numbers are determined by the scheduled teaching program.

The assessment method was basic, with simple questions and limited score range. This simplicity might cause a bias affecting validity and prevents us from generalizing our results. The simplicity of the questions could have conditioned the fact that no differences were detected between the groups but we do not consider it a main factor since the assessment method gave low pre-study scores and detected scoring differences in both groups after BLS algorithm instruction. Universal BLS algorithms are intentionally simple and easy to facilitate learning and application in the majority of circumstances of cardiac arrest (Nolan 2005). Simple questions did not imply simple responses; in our design the students' response reflected the students' capacity to integrate and apply the cognitive skills. We did not compare global scores of the whole assessment because we believe that different fields scoring are not comparable.

One of the difficulties in instructional research studies such as ours is harmonizing the curriculum across the analysed groups but the absence of differences between groups in their BLS training background is an indicator of homogeneity for our student sample. However, since it is impossible to have a double-blind design, we believe it is extremely difficult to exclude the professor effect on the results or a better student's performance due to observation.

One differential aspect between the two instructional methods used was the nature of the students' participation during the instruction–passive (multimedia) as opposed to active (case based discussion). However, in the light of our results, we cannot rule out that some factors may have contributed to the similarity between the methods. One factor could have been the 15-minute question-and-answer session in the Group I although we think that such a short time could have only minimal influence in the ability to cognitive skills and improve learning of students with such a little previous experience in BLS.

Other limitations of the study were logistics that impeded to assess retention of learning over time and the clinical competence on cognitive skills in clinical practice: important goals of the teaching efforts.

The applicability of our methodology is to be confirmed in further studies in order to compare our results and contrast them in different populations of students. In addition, the potential correlation of our assessments to multiple-choice question tests and evaluation of skills needs to be defined. It would be equally interesting to compare new methods for assessing BLS knowledge, extending the analysis of different cognitive abilities and determining the effect of several instructional methodologies. Long-term studies are required to establish whether the improvement in decision making and error pinpointing enhances, in turn, the students' competence in BLS.

Instructional research in BLS should be based on evidence. In this regard, this study provides a methodological design that can be used to objectively assess the efficacy of instruction in the analysed fields of knowledge. Nevertheless, we have to be humble when interpreting our results considering the flaws of this study.

In conclusion, teaching universal BLS algorithms using either an instructional videotape plus Power-Point presentation or case-based discussion equally improves the level of cognitive BLS skills among medical students.

Acknowledgements

The authors thank Erika Sierra for her statistical advice and Dr J Fontanals and Dr J Tercero for their collaboration.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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References

Altman DG. 1991. Practical statistics for medical research. New York: Chapman & Hall/CRC.

Baskett PJF, Nolan JP, Handley A, Soar J, Biarent D, Richmond S. 2005. European Resuscitation Council Guidelines for Resuscitation 2005: Section 9. Principles of training in resuscitation. Resuscitation 67S1:S181–S189.

Carrero E, Gomar C, Penzo W, Rull M. 2007. Comparison between lecture-based approach and case/problem-based learning discussion for teaching pre-anaesthetic assessment. Eur J Anaesthesiol 24:1008–1015.

Carrero EJ, Gomar C, Fábregas N, Penzo W, Castillo J, Villalonga A. 2008. Clase magistral versus aprendizaje basado en caso/problema para la enseñanza del embolismo aéreo en formación médica continuada. Rev Esp Anestesiol Reanim 55:202–209.

Chamberlain D, Hazinski MF. 2003. European Resuscitation Council, American Heart Association, Heart and Stroke Foundation of Canada, Resuscitation Council of Southern Africa, Australia and New Zealand resuscitation council, Consejo Latino-Americano de resucitación. Education in resuscitation: An ILCOR symposium: Utstein Abbey: Stavanger, Norway: June 22–24, 2001. Circulation 108:2575–2594.

Chamberlain D, Smith A, Woollard M, Colquhoun M, Handley AJ, Leaves S, Kern KB. 2002. Trials of teaching methods in basic life support (3): Comparison of simulated CPR performance after first training and at 6 months, with a note on the value of re-training. Resuscitation 53:179–187.

Durak HI, Certug A, Caliskan A, van Dalen J. 2006. Basic life support skills training in a first year medical curriculum: Six years' experience with two cognitive-constructivist designs. Med Teach 28:e49–58.

Handley AJ, Koster R, Monsieurs K, Perkins GD, Davies S, Bossaert L. 2005. European Resuscitation Council Guidelines for Resuscitation 2005. Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 67S1:S7–S23.

Hoke RS, Handley AJ. 2006. A reference basic life support provider course for Europe. Resuscitation 69:413–419.

Jordan T, Bradley P. 2000. A survey of basic life support training in various undergraduate health care professions. Resuscitation 47:321–323.

Koles P, Nelson S, Stolfi A, Parmelee D, Destephen D. 2005. Active learning in a Year 2 pathology curriculum. Med Educ 39:1045–1055.

Lee MT, Jacobs JL, Kamin CS. 2006. Video-enhanced problem-based learning to teach clinical skills. Med Educ 40:473–474.

Madden C. 2006. Undergraduate nursing students' acquisition and retention of CPR knowledge and skills. Nurse Educ Today 26:218–227.

Morgan PJ, Cleave-Hogg D, Desousa S, Lam-McCulloch J. 2006. Applying theory to practice in undergraduate education using high fidelity simulation. Med Teach 28:e10–15.

Nolan J. 2005. European Resuscitation Council guidelines for resuscitation 2005. Section 1. Introduction. Resuscitation 67S1:S3–S6.

Philips PS, Nolan JP. 2001. Training in basic and advanced life support in UK medical schools: Questionnaire survey. Br Med J 323:22–23.

Reder S, Cummings P, Quan L. 2006. Comparison of three instructional methods for teaching cardiopulmonary resuscitation and use of an automatic external defibrillator to high school students. Resuscitation 69:443–453.

Tärnvik A. 2007. Revival of the case method: A way to retain student-centred learning in a post-PBL era. Med Teach 29:e32–e36.

Tiwari A, Lai P, So M, Yuen K. 2006. A comparison of the effects of problem-based learning and lecturing on the development of students' critical thinking. Med Educ 40:547–554.

Wahlgren CF, Edelbring S, Fors U, Hindbeck H, Ståhle M. 2006. Evaluation of an interactive case simulation system in dermatology and venereology for medical students. BMC Med Educ 14:6–40.

Yee B, Naik VN, Joo HS, Savoldelli GL, Chung DY, Houston PL, Karatzoglou BJ, Hamstra SJ. 2005. Nontechnical skills in anesthesia crisis management with repeated exposure to simulation-based education. Anesthesiology 103:241–248.

Appendix 1. Assessments: questions, fields of knowledge measured, correct answers and scoring criteria

Test

Questions

(1) On the BLS sequence, which maneuvers should be performed for an adult victim lying on the floor onto his back, unresponsive when you check him, who is breathing normally. You are alone and nobody arrives after your shout for help.

(2) On the BLS sequence, which maneuvers should be performed for an adult victim lying on the floor onto his back, unresponsive when you check him. You are alone and nobody arrives after your shout for help.

(3) On the BLS sequence, which maneuvers should be performed for an adult victim lying on the floor onto his back, unresponsive when you check him, who is making agonal gasps. You are alone and nobody arrives after your shout for help and you call 112.

Field measured

(1) Decision based on BLS sequence.

Correct answers

(1) Turn him into the recovery position
(2) Open the airway
(3) Chest compressions

Score system. One point for each correct answer. Score range: 0–3

Video recording

Question. You are about to see a video recording about the adult BLS sequence with one rescuer. The BLS sequence seen in the footage may contain maneuvers performed incorrectly or not. Please indicate which wrong actions, if any, you can identify.

BLS Step:	*Video:*
Safety	Victim and rescuer safe
Check responsiveness	Shake and shout: unresponsive
Shout for help	Help!!
Open airway	Head tilt and chin lift
Check breathing	Keeping the airway open, look, listen, and feel: not breathing
Call 112	Call 112
Chest compressions:	Heel of left hand located on victim's upper abdomen, fingers of both hands interlocked, rescuer's position vertical, arms straight, pressure down 4–5 cm, release pressure without losing contact between rescuer hands and victim.
	Chest compression rate 50 times per minute.
Compression to ventilation ratio	5 : 2
Stop to recheck the victim	After 5 compressions and 2 breaths

Field measured

(2) Detection of errors on BLS performance

Correct answers (errors correctly detected)

(1) Heel of left hand located on victim's upper abdomen. (ERC guidelines: in the center of the victim chest).
(2) Chest compression rate 50 times a minute. (ERC guidelines: rate of approximately 100 min^{-1}).
(3) Compression to ventilation ratio 5 : 2. (ERC guidelines: ratio of 30 : 2).
(4) Stop to recheck the victim after 5 compressions and 2 breaths. (ERC guidelines: only if he starts breathing normally).

Scoring system. One point for each correct answer. Score range: 0–4.