**ARTYKUŁ ORYGINALNY/ORIGINAL PAPER**
Otrzymano/Submitted: 15.02.2010 • Poprawiono/Corrected: 07.04.2010 • Zaakceptowano/Accepted: 28.05.2010


# *The European Guidelines of 2005 have not simplified the teaching and learning skills of adult CPR to medical students*

**Małgorzata Grześkowiak**
The Department of Teaching Anaesthesiology and Intensive Therapy University of Medical Sciences in Poznan, Poland

## Summary

***Introduction***. The European Resuscitation Council Guidelines of 2005 have made changes to the BLS algorithm. The aim of the study was to assess medical students' skills of performing adult cardiopulmonary resuscitation (CPR) according to the guidelines of 2005 and 2000, and then eventually to accept or reject the hypothesis that the guidelines of 2005 have simplified teaching skills of adult CPR. ***Material and methods***. The representative group of 200 medical students [100 first (F) year and 100 sixth (S) year] were recruited. One group was tested in 2003 according to the guidelines of 2000, the other in 2007 according to the guidelines of 2005. Each participant performed adult BLS algorithm. All the data was automatically recorded from the sensored resuscitation manikin (Ambu®Man). The quality of performance was assessed by a grading number system. Data was compared using the Mann-Whitney U Test. Qualitative variables were expressed as means and standard deviations (±S.D.). ***Results.*** The difference between mean tidal volume delivered by mouth-to-mouth ventilation by the F2000 (0.69±0.44) versus F2005 (0.32±0.24) was statistically significant (p=0.000), the same as the volume delivered by facemask and self-inflating bag by the S2000 (0.70±0.30) versus S2005 (0.16±0.22). The difference between mean compression rates achieved by S2000 (101.0±14.8) versus S2005 (89.20±16.14) was statistically significant (p=0.000), same as the mean compression depth achieved by F2000 (4.07±1.07) versus F2005 (3.64±0.64). There was no statistical difference between the groups, when mouth-to-mouth ventilation and chest compressions were scored. ***Conclusions.*** The European Guidelines of 2005 did not simplify teaching and learning skills of adult CPR to medical students. *Anestezjologia i Ratownictwo 2010; 4: 293-300*

*Keywords: basic life support (BLS), cardiopulmonary resuscitation (CPR), European Resuscitation Council Guidelines, medical students, manikin study*

## Introduction

The current European Resuscitation Council Guidelines for Resuscitation were updated and published in November 2005 [1]. The most important changes made in adult resuscitation are: a single compression-ventilation ratio of 30:2, smaller tidal volumes of approximately 500-600 ml (equals 6-7 ml/kg), shorter inflation time of 1 second and the centre of the chest as the place for chest compressions. The rate for chest compressions 100/min as well as a depth (4-5 cm) has not changed. The previous guidelines of 2000 were published in 2001 [2-3]. Single compression-ventilation ratio of 30:2 was introduced to simplify the instructions for teaching, promote skill retention and increase the effectiveness of chest compressions as well as reduce hyperventilation. The guidelines of 2000 have recommended performing chest compressions by placing one finger on the lower end of sternum and sliding the other hand down to it, but the guidelines of

2005 have simplified this technique by positioning the hand in the centre of the chest. It's of course important to update the clinical guidelines regularly to make the rescuers aware of the best practice.

The aim of the study was to assess medical students' skills of performing adult cardiopulmonary resuscitation (CPR) according to the European Guidelines of 2005 and to compare their usefulness according to the guidelines of 2000, and eventually to accept or reject the hypothesis that the European Guidelines of 2005 have simplified the teaching and learning skills of adult CPR.

## Material and methods

The research was undertaken on a representative group of 200 medical students (100 first year students and 100 sixth year students) recruited among approximately 750 students in one of the Universities of Medical Sciences. One group consisting of 50 first and 50 sixth year students were tested in 2003 according to the European Guidelines of 2000. The second group consisting of 50 first and 50 sixth year students were tested in 2007 according to the European Guidelines of 2005. All the students agreed to participate in this research.

The assessment of medical students' skills of performing adult cardiopulmonary resuscitation was dichotomous. Sensored manikins (Ambu®Man) connected to a computer (Ambu®Mega Code Simulation Software) captured the following data: volume of ventilations, rate and depth of chest compressions and hand placement. At the same time an examiner who is a professional BLS/AED and ALS instructor of the ERC, assessed the performance of these skills on a scoring sheet. During this research manikins were placed on the floor. The following skills were assessed: opening the airway, checking breathing, mouth to mouth ventilation volumes, chest compression's rate and depth (the manikin was in the "max" setting during the study) and ventilation with the use of self inflating bag with volumes (checked only among sixth year students). Each skill (except opening the airway) was estimated in two categories: quality of performance and overall performance.

The quality of performance was estimated by a grading number system from 0 to 3 (0 meaning inadequate performance and 3 meaning that all the elements of the procedure were done correctly). This assessment included the estimation of all the elements of the performed procedure. When assessing breathing, opening the airway and the position of the rescuer's head were scored. When mouth-to-mouth ventilation was assessed, opening the airway, volume of each breathes and the presence or absence of stomach inflation was scored. When chest compressions were assessed, finding a proper place for chest compressions, position of the rescuer, position of his hands, depth and rate of the compressions were scored. When ventilation with the use of self-inflating bag was assessed, opening the airway, position and holding of a facemask, volume of each breathe and also the absence or presence of stomach inflation were scored. Nevertheless, the objective data was being recorded from the sensored manikin, and the examiner assessed the skills. On the other hand the overall performance was graded from 0 to 1, 0 meaning "inadequate" and 1 meaning "adequate" performance.

Both first and sixth year students participating in this research attended the same mandatory CPR classes during their study at the university. To assess the effectiveness of the teaching skills of adult CPR, first year students were tested just after the classes of CPR in contrast to sixth year students who were tested at the beginning of their classes. In this way it was also possible to find the retention of skills in the group of sixth year students. The performance of both groups of medical students tested in 2003 and 2007 was evaluated using the identical manikins and process of dichotomous assessment.

The statistical analysis was performed using specific software (StatSoft, Inc. 2005 Statistica, version 7.1.). Qualitative variables were expressed as means and standard deviations (±S.D.). The non-parametric Mann-Whitney U rank sum test was used to determine any differences between the groups. P values $<0.05$ were considered statistically significant.

## Results

**Recorded on the sensored manikins**

The group of first year students tested in 2003 were taught the guidelines of 2000 and was marked as F2000, and sixth year students as S2000. The group tested in 2007 was taught the guidelines of 2005 marked as F2005 (first year students) and S2005 (sixth year students).

Table 1 shows the percentage of students who

delivered mouth-to-mouth ventilation with different volumes, chest compressions with different depth and rate and ventilation with the use of self-inflating bag measured by the sensored manikins. The group of first and sixth year students tested in 2003 performing mouth-to-mouth mostly delivered 0.7-1.0 l as the adequate volume (42% of F2000, 58% of S2000), while the group tested in 2007 mostly delivered 0.69-0.4 l (48% of F2005, 50% of S2005) (Diagram 1, Diagram 2). The recommended volume of breath delivered with the use of self-inflating bag with oxygen (0.69-0.4 l) was achieved by 22% of S2000 and 30% of S2005. The chest compressions delivered with adequate depth was achieved by 68% of F2000, 64% of F2005, 74% of S2000 and 86% of S2005 while the adequate rates achieved was 66%, 72%, 74%, 52% respectively.

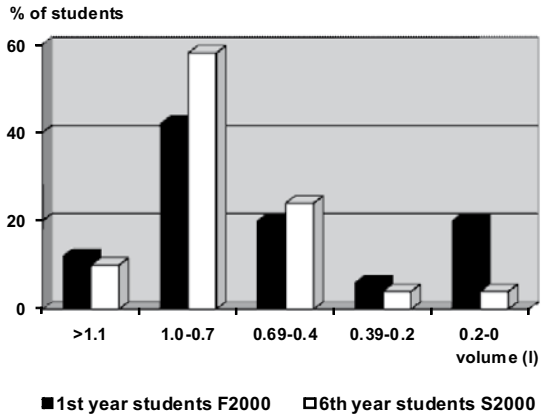


Diagram 1. Mouth to mouth ventilation – according to the guidelines of 2000

Table 1. Percentage of students performing different procedures evaluated based on the values recorded by the manikins – comparison between 1st year students (F) and 6th year students (S) according to the guidelines of 2000 and 2005

| | 1st year students (F 2000) | 1st year students (F 2005) | 6th year students (S 2000) | 6th year students (S 2005) |
|---|---|---|---|---|
| **Mouth-to-mouth ventilation** | | | | |
| Volume of each breath (l) | | | | |
| >1.0 | 12% | 0% | 10% | 18% |
| 1.0 – 0.7 | 42% | 0% | 58% | 14% |
| 0.69 – 0.4 | 20% | 48% | 24% | 50% |
| 0.39 – 0.2 | 6% | 22% | 4% | 2% |
| 0.2 - 0 | 20% | 30% | 4% | 16% |
| **Chest compressions** | | | | |
| Depth (cm) | | | | |
| >5.5 | 2% | 0% | 0% | 0% |
| 3.5 – 5.5 | 68% | 64% | 74% | 86% |
| <3.5 | 30% | 36% | 26% | 14% |
| Rate ($min^{-1}$) | | | | |
| >120 | 4% | 0% | 2% | 0% |
| 111 – 120 | 4% | 4% | 12% | 4% |
| 90 - 110 | 66% | 72% | 74% | 52% |
| 80 - 89 | 10% | 10% | 8% | 2% |
| <80 | 16% | 14% | 4% | 42% |
| **Ventilation with the use of self inflating bag** | | | | |
| Volume of each breath (l) | | | | |
| >1.0 | ---------- | ---------- | 8% | 0% |
| 1.0 – 0.7 | ---------- | ---------- | 42% | 2% |
| 0.69 – 0.4 | ---------- | ---------- | 22% | 30% |
| 0.39 – 0.2 | ---------- | ---------- | 0% | 2% |
| 0.2 - 0 | ---------- | ---------- | 0% | 0% |

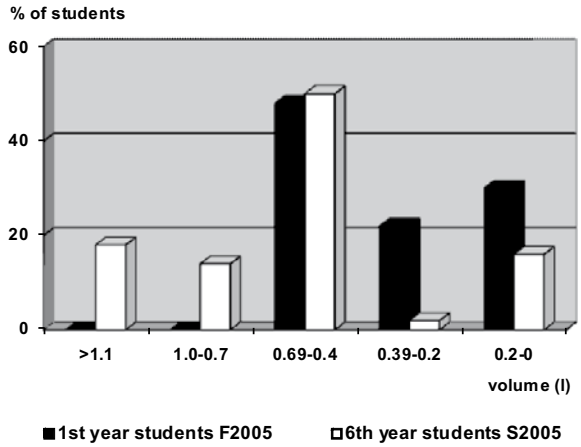


Diagram 2. Mouth to mouth ventilation – according to the guidelines of 2005

Comparison between first and sixth year students according to the guidelines of 2000 and 2005 using recorded manikin data is presented in Table 2. The difference between mean tidal volume delivered by mouth-to-mouth ventilation by the F2000 (0.69±0.44) versus F2005 (0.32±0.24) was statistically significant (p=0.000). The difference between mean tidal volume delivered by facemask and self-inflating bag ventilation by the S2000 (0.70±0.30) versus S2005 (0.16±0.22) was also statistically significant (p=0.000). The difference between mean compression rates achieved by S2000 (101.0±14.8) versus S2005 (89.20±16.14) was statistically significant (p=0.000) and the mean compression depth achieved by F2000 (4.07±1.07) versus F2005 (3.64±0.64) was also statistically significant (p=0.006).

Table 2. Comparison between 1st year students (F) and 6th year students (S) estimated with the use of the data recorded by the manikin documenting the performance of basic cardiopulmonary resuscitation (mean ±S.D.) according to the guidelines of 2000 and 2005

| | 1st year students | | | 6th year students | | |
|---|---|---|---|---|---|---|
| | F 2000 (n=50) | F 2005 (n=50) | p-value | S 2000 (n=50) | S 2005 (n=50) | p-value |
| Mean tidal volume (liters) (mouth-to-mouth ventilation) | 0.69±0.44 | 0.32±0.24 | 0.000 | 0.76±0.31 | 0.64±0.41 | 0.047 |
| Mean tidal volume (liters) (face mask, self inflating bag ventilation) | ---------- | ---------- | ------- | 0.70±0.30 | 0.16±0.22 | 0.000 |
| Mean compression rate ($min^{-1}$) | 93.60±19.64 | 96.10±10.11 | 0.99 | 101.0±14.8 | 89.20±16.14 | 0.000 |
| Mean compression depth (cm) | 4.07±1.07 | 3.64±0.64 | 0.006 | 4.09±0.79 | 4.30±0.72 | 0.197 |

Table 3. Comparison between 1st year students (F) and 6th year students (S) performing basic cardiopulmonary resuscitation according to the guidelines of 2000 and 2005 estimated by the scoring system

| | F 2000 vs. S 2000 p-value* | F 2000 vs. F 2005 p-value | S 2000 vs. S 2005 p-value | S 2005 vs. F 2005 p-value |
|---|---|---|---|---|
| Opening the airway | 0.103435 | 0.000469 | 0.103435 | 0.000469 |
| Checking breathing<br>QP<br>OP | <br>0.013907<br>0.012866 | <br>0.000605<br>0.000574 | <br>0.004699<br>0.012866 | <br>0.000159<br>0.000574 |
| Mouth-to-mouth ventilation<br>QP<br>OP | <br>0.233313<br>0.144224 | <br>0.199017<br>0.302811 | <br>0.940559<br>0.518664 | <br>0.893026<br>0.832416 |
| Self inflating bag ventilation<br>QP<br>OP | <br>----------<br>---------- | <br>----------<br>---------- | <br>0.031218<br>0.000337 | <br>----------<br>---------- |
| Chest compressions<br>QP<br>OP | <br>0.530117<br>0.222995 | <br>0.313240<br>0.426038 | <br>0.110542<br>0.045022 | <br>0.913158<br>1.000000 |

*p-value<0.05 –statistically significant is underlined

QP-Quality of performance, OP-Overall performance - meant "inadequate" or "adequate"

Table 4. Percentage of students who performed procedures correctly (estimated by the sensored manikins as well as scoring system) – comparison between 1st year students (F) and 6th year students (S) according to the guidelines of 2000 and 2005

| The estimated procedure | 1st year students (F 2000) | 1st year students (F 2005) | 6th year students (S 2000) | 6th year students (S 2005) |
|---|---|---|---|---|
| Opening the airway | 78% | 100% | 90% | 78% |
| Checking breathing | 70% | 96% | 90% | 70% |
| Mouth to mouth ventilation | 58% | 68% | 72% | 66% |
| Ventilation with the use of self inflating bag | - | - | 70% | 34% |
| Chest compressions | 54% | 46% | 66% | 46% |

**Recorded by scoring system**

Comparison between the first and sixth year students according to the guidelines of 2000 and 2005 estimated by scoring system is presented in Table 3. There was a significant difference between F2000 versus F2005 (p=0.0004) and S2005 versus F2005 (p=0.0004) while assessing opening of the airway procedure. There were significant differences between all the groups F versus S (p=0.01 – p=0.0001) and 2000 versus 2005 (p=0.01 – p=0.0005) when assessing breathing as a quality of performance as well as overall performance. There was a significant difference between S2000 and S2005 in the quality of performance (p=0.03) and overall performance (p=0.0003) when ventilation with the use of self-inflating bag was compared. There was no statistical difference between the groups when mouth-to-mouth ventilation and chest compressions were scored.

The percent of students who performed procedures correctly assessed by the sensored manikins as well as scoring system is presented in Table 4.

## Discussion

This study was conducted to assess medical students' skills of performing adult CPR according to the European Guidelines of 2005 and 2000 and to determine whether the European Guidelines of 2005 simplified teaching and learning skills of adult CPR.

The group of first and sixth year students according to the guidelines of 2000 when ventilated mouth-to-mouth mostly delivered 0.7-1.0 liters as the adequate volume (42% of F2000 and 58% of S2000), but the group according to the guidelines of 2005 mostly delivered 0.4-0.69 l as the adequate volume (48% of F2005 and 50% of S2005). The effectiveness of teaching mouth-to-mouth ventilation to these groups of students based on the recommended tidal volume was similar. So the change of decreasing the tidal volume did not influence the improvement of teaching and learning this skill. Einspruch et al. assessed the percentage of adequate ventilations delivered by adults just after training (40% in one group, 61% in the other one) and two month after the training (it dropped to 36% and 41% respectively) by a sensored manikin. Comparing this results with my research, I could say that, the effectiveness of teaching students was better because more than 42% first year students just after their classes, ventilated adequately and more than 50% sixth year students ventilated adequately when tested after longer break. The difference between mean tidal volume delivered by mouth-to-mouth ventilation was statistically significant (p=0.000) only among first year students F2000 (0.69±0.44) versus F2005 (0.32±0.24), which was obvious because different recommendations were compared. The mean tidal volume delivered by F2005 was smaller comparing with F2000 because these students according to the guidelines of 2005 wanted to ventilate smaller volume and nobody exceeded 0.69. They rather hypoventilated, 22% delivered 0.2l-0.39 and 30% delivered <0.2 l. This statistical correlation was not found among sixth year students, both S2000 and S2005 delivered mean tidal volume 0.76 and 0.64 respectively. These groups of sixth year students were tested at the beginning of their classes so the lack of knowledge and skills were observed. The S2005 did not remember to deliver smaller volume. The statistical correlation between the first versus sixth year students and the guidelines of 2000 versus 2005 based on the scoring system was not found because the tested students ventilated in the same manner, some of them too much, some of them too small and they did the same errors like: not opening the airway while ventilating, not adequate seal and the presence of stomach inflation.

The ventilation with the use of self-inflating bag was assessed only among sixth year students. The recommended volume of breath (0.4-0.69) delivered with the use of self inflating bag with more then 40% of oxygen has not changed by the guidelines of 2005 and was achieved by 22% of S2000 and 30% of S2005. The S2000 rather hyperventilated (42% delivered 0.7-1.0) similar to mouth-to-mouth at the basic level (58% delivered 0.7-1.0). The S2005 rather hypoventilated, only 2% delivered >0.7-1.0 and 2% delivered 0.2-0.39. The S2005 had more problems with ventilation comparing with S2000 (34% performed adequate ventilations versus 70% among S2000). The statistical correlation between S2000 and S2005 was found when quality of performance and overall performance (p=0.0003) was assessed based on the scoring system. This factor was not related with the guidelines of 2005 and did not influence the simplicity of teaching and learning skills.

The rate of chest compressions 100 $min^{-1}$ as well as a depth (4-5 cm) of them has not changed according to the guidelines of 2005. The only change that has simplified is the technique of finding a place for chest compressions by immediate placement of the hand in the centre of the chest. Adequate chest compression rates and depths were achieved by 66% and 68% of F2000, 72% and 64% of F2005, 74% and 74% of S2000 and 52% and 86% of S2005. The adequate depth achieved in my research was much higher than in those conducted by Einspruch et al. (38-48% in two different groups just after the training and 48-49% two month later) [4]. The mean compression rate ($min^{-1}$) was 93.60±19.64 in F2000 versus 96.10±10.11 in F2005 (not statistically significant p=0.99) and 101.0±14.8 in S2000 versus 89.20±16.14 in S2005 (statistically significant p=0.000). Deschilder et al. assessed hospital personnel while performing chest compressions on the same Ambu®Man manikin as used in my study and their compression rate was 115-118 $min^{-1}$ and depth 4.05-4.1 cm [5]. In my research the mean compression depth was 4.07±1.07 in F2000 versus 3.64±0.64 in F2005 (statistically significant p=0.006) and 4.09±0.79 in S2000 versus 4.30±0.72 in S2005 (not statistically significant p=0.197). The statistical correlation between the first versus sixth year students and the guidelines of 2000 versus 2005 based on the scoring system was not found because the students performed chest compressions in the same manner, not at the recommended depth <3.5 cm (30% F2000, 36% F2005, 26% S2000, 14% S2005), too fast >111 $min^{-1}$ (8% F2000, 4% F2005, 14% S2000, 4% S2005), too slowly <90 $min^{-1}$ (26% F2000, 24% F2005, 12% S2000, 44% S2005) and the same errors were observed: not proper position of hands, not adequate position of the rescuer, not adequate depth and rate. Even if the students according to the guidelines of 2005 put their hands immediately in the centre of the chest, this did not influence the improvement of chest compressions performance. Isbye et al. checked skill retention in adults according to the guidelines of 2000 and they wrote about simplified hand position in the centre of the chest introduced by Handley in his research [6-7]. Unfortunately this simpler hand position did not improve skill acquisition and even retention, which is similar to my research.

When opening of the airway was assessed by the grading system more than 78% students both first and sixth year opened the airway correctly. Based on this scoring system statistical correlation was found only in F2000 versus F2005 (p=0.000) and S2005 versus F2005 (p=0.000). The main errors included: bad position of the fingers on the jaw and not tilting the head. The errors related to the opening of the airway are not new. M.C. Smith et al. indicated that 1.1% first year medical, nursing and physiotherapy students after 8-hour training in basic resuscitation did not open the airways correctly [8].

When assessing breathing, opening of the airway as well as the position of the rescuer's head was scored. More than 70% of students assessed breathing properly. Surprisingly the statistical correlation between first versus sixth year students and the guidelines of 2000 versus 2005 based on the scoring system (quality of performance and overall performance) was found at each level. The main errors included: bad position of the student's head (looking not at the chest) and not opening the airway. S. Gabor et al. indicated that 60% volunteers three month after their 4-hour training in basic resuscitation did not open the airway while checking breathing [9]. The techniques of opening the airway and checking breathing have not changed according to the guidelines of 2005 and has not influenced the simplicity of teaching and learning skills.

In my research the results of sixth year students in few cases were worse when compared to the first year students, which is not surprising as its due to the loss of skills, caused by the retention process. Other authors have written about the retention of skills even after 2 weeks after initial training [10-12]. The Utstein guidelines recommended 6 months as a retesting interval [13].

Some other authors have undertaken the researches trying to compare the usefulness of the guidelines of 2000 with 2005. Roessler et al. analysed the practical impact of BLS algorithm of 2005 among 59 volunteers between 18-80 years of age. They were randomised and allocated in two groups according to the guidelines of 2000 and 2005. Significantly more volunteers managed the BLS algorithm of 2005 correctly compared to the guidelines of 2000. The results analysed from the manikin model showed higher quality in CPR according to the guidelines of 2005 and faster onset of chest compressions. The final conclusion was that the 2005 BLS sequence seemed to be easier to learn and to retain [14] and this stands in contrast to my research. Of course the guidelines of 2005 recommended faster onset of chest compressions and thus they were initiated faster. As in my study I analysed the quality of the procedures performed during CPR and not the speed of their initiation, the result showed no changes between the real groups taught according to the guidelines of 2000 and 2005. Jäntti et al. undertook a research on a group of 12 paramedic students and 22 licensed paramedics who were randomise according to the guidelines of 2000 and 2005. Although they were managing the scenarios with ventricular fibrillation, the quality of CPR did not differ between the groups [15], which was similar to my research.

I could not find any articles comparing the guidelines of 2000 and 2005 among medical students. To support my research the chosen group of medical students was representative (similar age ±1 year, 68% female, 32% male), large (200 students) and real to check their factual CPR performance according to different guidelines. These groups were not randomised which is an advantage of this research because the students attended the same classes during their study and one group was taught the guidelines of 2000 and the other the guidelines of 2005, so they represented the final result of teaching based on the different guidelines.

## Conclusion

In general the skills of adult CPR were performed best by the first year students according to the guidelines 2005 if opening the airway and checking breathing were assessed (100% and 96% respectively) and by sixth year students according to the guidelines 2000 if mouth to mouth ventilation, ventilation with the use of self inflating bag and chest compressions were assessed (72%, 70% and 66% respectively). Thus the specific changes between the groups were not noticed and the students assessed according to the guidelines of 2005 have not presented higher level of skills than the group assessed according to the guidelines of 2000. The same errors connected with opening the airway, checking breathing, ventilation and chest compressions were observed both among first and sixth year students and both according to the guidelines of 2005 and 2000. On the basis of the research it can be concluded that the European Guidelines of 2005 did not simplify the teaching and learning skills of adult CPR to medical students. The effectiveness of teaching and learning skills depend on the quality of teaching and repeatable periods of practice rather than the changes in the guidelines. Further research is needed in this matter of concern.

Correspondence address:
Małgorzata Grześkowiak
Zakład Dydaktyki Anestezjologii i Intensywnej Terapii
ul. Św. Marii Magdaleny 14
61-861 Poznań
Phone: (+48 61) 668-78-36
E-mail: mgrzesko@ump.edu.pl

### References

1. European Resuscitation Council Guidelines for Resuscitation 2005. Resuscitation 2005;67S:1-189.
2. Guidelines 2000 for cardiopulmonary resuscitation and emergency cardiovascular care. The American Heart Association in collaboration with International Liaison Committee on Resuscitation. Resuscitation 2000;46:1-447.
3. Handley AJ, Koenraad GM, Bossaert LL. European Resuscitation Council Guidelines 2000 for Adult Basic Life Support. Resuscitation 2001;48:199-205.
4. Einspruch EL, Lynch B, Aufderheide TP, Nichol G, Becker L. Retention of CPR skills learned in a traditional AHA Heartsaver course versus 30-min video self-training: A controlled randomized study. Resuscitation 2007;74:476-86.

5. Deschilder K, De Vos R, Stockman W. The effect on quality of chest compressions and exhaustion of a compression-ventilation ratio of 30:2 versus 15:2 during cardiopulmonary resuscitation-A randomised trial. Resuscitation 2007;74:113-8.
6. Isbye DL, Meyhoff CS, Lippert FK, Rasmusssen LS. Resuscitation 2007;74:296-302.
7. Handley AJ. Teaching hand placement for chest compression-a simpler technique. Resuscitation 2002;53:29-36.
8. Smith MC, Christensen C, Stephenson BTF, Hulme J, Perkins GD. A systematic analysis of common errors in basic life support. Resuscitation 2004;62:338.
9. Gabor S, Domonkos K, Andorka M, Voros P, Dioszeghy C. Most frequent mistakes during layperson and in-hospital basic life support. Resuscitation 2004;62:368.
10. Fossel M, Kiskaddon Rt, Sternbach GL. Retention of cardiopulmonary resuscitation skills by medical students. J Med Educ 1983;58:568-75.
11. Moser DK, Dracup K, Guzy PM, Taylor SE, Breu C. Cardiopulmonary resuscitation skills retention in family members of cardiac patients. Am J Emerg Med 1990;8:498-503.
12. Wenzel V, Lehmkuhl P, Kubilis PS, Idris AH, Pichlmayr I. Poor correlation of mouth-to-mouth ventilation skills after basic life support training and 6 month later. Resuscitation 1997;35:129-34.
13. Chamberlain DA, Hazinski MF. Education in resuscitation: an ILCOR symposium: Utstein Abbey: Stavanger, Norway: June 22-24, 2001. Circulation 2003;108:2575-94.
14. Roessler B, Fleischhackl R, Losert H, et al. Practical impact of the European Resuscitation Council's BLS algorithm 2005. Resuscitation 2007;74:102-7.
15. Jäntti H, Kuisma M, Uusaro A. The effects of changes to the ERC resuscitation guidelines on no flow time and cardiopulmonary resuscitation quality: A randomised controlled study on manikins. Resuscitation 2007;74:338-44.