Retention of Chest Compression Performance of Medical Students

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ABSTRACT

Background and objectives: Chest compression (CC) performance is one of the most important parts in saving the lives of victims with cardiac arrest. The primary objective was to determine the retention of CC performance among last-year medical students (externs).

Methods: All externs were recorded for their CC performance at the end of their BLS workshop by the use of a CPR training manikin. The retention of BLS performance was evaluated by CC score (CCS) which is the percentages of correct CC during their internal medicine rotation. Detailed errors of chest compression performance including rate of compression, compression to ventilation ratio, incomplete release, too little, too much, and wrong hand position were also recorded.

Results: 223 externs had baseline data for a chest compression score (CCS1) and 118 with follow-up data (CCS2). The interval between CCS1 and CCS2 was 198 (range 119-266) days. CCS during the training course (CCS1) and CCS during the test (CCS2) were 89 (range 84-94) and 81 (range 68-89) respectively. CCS2 was significantly lower than CCS1 ($p < 0.001$). The percentages of externs who passed 80% decreased from 90.5% to 51.4% ($p < 0.001$). The independent predictors for a high CCS2 included male gender, grade point average, experience in CPR observation or participation - especially recent experience. The area of errors in CC included compression rate, compression: ventilation ratio, too little and too deep compressions.

Conclusion: CC performance significantly decreases after CPR training. Assessment of predictors for retention of CC performance and the area of errors may help to strengthen the CPR training program in the future.

Keywords: CPR, chest compression, training

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The current CPR guideline[1] suggests that effective cardiac compression is a very important part of CPR. CPR is always listed as an important teaching category for medical graduates since CPR is a life-saving procedure. In those with asystole or pulseless electrical activity (PEA), effective CPR is needed to increase the chance of survival.[2,3] CPR is also needed immediately after defibrillation. After 5 minutes of VF, the chance of successful resuscitation can be increased by a brief period of chest compression before defibrillation.[4,5]

The American Heart Association (AHA) Advanced Life Support (ALS) course is a multidisciplinary training course which aims to teach participants how to manage the resuscitation of a patient at risk of or in cardiac arrest.[6,7] Chest compression may be too little, too slow or the wrong hand position.[8,9] Research on recall showed that immediate recall is good but long-term recall was poor with approximately 60% of participants passing the assessment.[6] Skills on the automatic external defibrillator (AED) and ALS were also demonstrated to be significantly reduced after some time had passed since training.[10,11] CPR skills evaporate quickly after training.[12] Therefore, certain strategies to improve CPR training should be considered.

The primary objective was to determine retention of chest compression performance among externs after a full-course of training. Secondary objectives were 1) to determine factors that influence the retention of CPR performance such as the written examination score during CPR training, time after training, and CPR experience and 2) to determine pitfalls in methods and means of chest compression.

MATERIALS AND METHODS

Study population

All last-year medical students (externs) who started their year on March 2006 were included in this study.

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Study protocol

CPR training using the AHA standard is required for all last year medical students known as externs at the beginning of the year. Lectures were followed by many CPR workshops such as one-rescuer CPR, two-rescuer CPR and AED for BLS and advanced airway management, electrical therapy, algorithm for ALS, and a variety of CPR scenarios which provided the integration of BLS and ALS knowledge. All externs were evaluated by written examination at the end of the training. Chest compression performance was recorded as chest compression scores (CCS) at the end of the BLS workshop.

After the regular training program, all externs were arranged for CC examination within 1 year after their training. All externs were equally divided into 4 rotations over the year. Therefore we divided externs into 4 groups according to their rotation. Retention of CC performance of each group was evaluated during 3, 6, 9, and 12 months after training.

Data collection and outcome measures

CCS, which is the main outcome measurement in this study, was defined as percentages of correct chest compression over 5 cycles of 30 compressions or approximately 150 compressions according to the recommendation of the AHA.[1] Those who had more than 80% correct chest compressions had passing scores.

We also recorded CC rate, CC: ventilation ratio and errors of chest compression including incomplete release, too little, too much, and the wrong hand position. Reports of CCS and errors were printed from the Skillmeter Resusci Anne (Laerdal, Stavanger, Norway).

In order to evaluate factors that might influence the retention of CC performance, all externs were required to fill out a questionnaire. They had to provide their data on gender, and grade point average (GPA). CPR experience was collected as the number of CPR observations and participations and the interval of their last CPR observation or participation before the examination.

Sample size calculation

A sample size of 97 was needed to have 90% power to detect a difference in means of 10 (e.g. a first condition mean of 90 and a second condition mean of 80), assuming a standard deviation of differences of 30, using a paired sample calculation with a 0.05 two-sided significance level. Since the objective of this study was to evaluate the retention of CPR performance of the whole group of externs, this sample size calculation was to make sure that the approximately 220 externs in 2006 would be enough to serve the objectives of this study.

Statistical analysis

Continuous data were expressed as mean ± SD and median and interquartile range (25^{th} and 75^{th} percentile) for data with normal and non-normal distribution. Categorical data were expressed as frequency (percentages).

The comparison of baseline and follow-up data were made by the paired-samples t test or Wilcoxon signed rank test for continuous data with normal and non-normal distribution and the McNemar test for categorical data. Univariate analysis for predictors for a CCS of > 80% was made by univariate logistic regression analysis. Multivariable logistic regression analysis with a forward stepwise (likelihood ratio) method was used to determine independent predictors for a CCS > 80%. A p value of ± 0.05 was considered significant.

RESULTS

Among 223 externs who had baseline data, 118 completed the follow-up examination. Baseline characteristics of their personal data, written examination score, CCS at baseline, internal medicine rotation, time between training and follow-up examination and CPR experience are shown in Table 1. Comparisons between CC performance at baseline and follow-up examination are shown in Table 2. The median CCS significantly decreased from 89% to 81%. The number of externs with a passing score or CCS > 80% significantly decreased from 199 (90.5%) to 112 (51.4%). There was no significant difference in the number of externs having a correct CC rate, whereas the number of externs with a wrong CC: ventilation ratio significantly increased during the follow-up examination. For errors during CC, there was no significant increase in incomplete release, but a significant increase in too little and too deep CC and wrong hand position usage.

Univariate analysis of predictors for CCS > 80% during follow-up examination are shown in Table 3. Continuous variables were divided into 2 groups by the use of their median levels. The following parameters were not significant predictors: baseline written examination score, baseline CCS, time to follow-up examination (within 6 months or after 6 months). Significant predictors were male gender, high GPA, and CPR experience either observation or participation including recent experience.

Multivariable logistic regression analysis with a forward stepwise (likelihood ratio) method was performed to find the independent predictors for CCS >80% during follow-up examination. The results are shown in Table 4. Recent experience was the most important predictor among the 4 parameters which remained in the final step.

DISCUSSION

Results of our study showed that CPR experiences in the real situation especially recent experience are the

TABLE 1. Baseline characteristics of the study group.

	Mean ± SD or Frequency (%)
Age (years)	23.14 ± 0.61
	23 (23,23)
Male (%)	108 (48.4)
Written examination score (total score = 30)	25 (23,27)
Rotation group	
Group 1	53 (24.3)
Group 2	56 (25.7)
Group 3	56 (25.7)
Group 4	53 (24.3)
Number of CPR observation	5 (2.25,6)
Last CPR observation (month)	1 (0.5,2)
Number of CPR participation	4 (2,5)
Last CPR participation (month)	1 (0.5,1)
Correct CC at baseline (%)	89 (84,94)

TABLE 2. Comparison between baseline and follow-up CC performances.

Variables	Baseline	Follow-up	P values
CC score (% correct)	89 (84,94)	81 (68,89.25)	<0.001*
CC score >80%	199 (90.5)	112 (51.4)	<0.001***
Correct CC rate (91-110)	194 (88.2)	182 (83.9)	0.281***
CC:V ratio 30:2 (% correct)	172 (78.2)	127 (58.5)	<0.001***
Incomplete release (%)	0 (0,0.63)	0 (0,1)	0.078*
At least one CC with incomplete release	57 (25.9)	61 (28)	0.642***
Too little (%)	10 (4,19)	12 (4.75,32)	<0.001*
At least one CC with too little compression	205 (93.2)	205 (94)	0.695***
Too deep (%)	0.5 (0,2)	1 (0,7.25)	<0.001*
At least one CC with too deep compression	110 (50)	127 (58.3)	0.078***
Wrong hand position (%)	0 (0,1)	0 (0,3.25)	0.001*
At least one CC with wrong hand position	58 (26.4)	60 (30.7)	0.329***
At least one wrong CC	215 (97.7)	218 (100)	0.025***

*Wilcoxon signed rank test , ** = paired-samples t-test, *** = McNemar test

important factors determining retention of CPR performance after training in last year medical students.

Chest compression has been increasingly recognized to be a very important factor that determines immediate and long-term outcomes of victims with cardiac arrest. Recently, a multicenter study from Japan has shown that victims that had only chest compressions had better outcomes, including neurological outcomes, than conventional CPR in out-of-hospital cardiac

TABLE 3. Univariate predictors for corrected CC score >80% during follow-up.

Variables	Corrected CC > 80% (n = 112)	P Value
Male	1.75 (1.02-3.00)	0.041
Baseline written exam score > 25 (total score = 30)	1.23 (0.72-2.11)	0.443
Baseline CCS > 89%	1.29 (0.76-2.20)	0.345
GPA > 3.2	2.35 (1.36-4.05)	0.002
Number of CPR observation ≥ 5	2.67 (1.54-4.62)	<0.001
Last CPR observation < 1	6.70 (3.36-13.36)	<0.001
Number of CPR participation ≥ 4	2.58 (1.49-4.49)	0.001
Last CPR participation < 1	6.20 (3.15-12.19)	<0.001
Exam with 6 months	0.93 (0.55-1.58)	0.786

Values are expressed as Odd ratio (95% CI)
Continuous variables were divided into 2 groups by the use of their medians as a cut off.

TABLE 4. Independent predictors for corrected CC score >80% during follow-up.

Variables	Corrected CC > 80% (n = 112)	P Value
Last CPR observation < 1 month	5.58 (2.69-11.57)	<0.001
GPA > 3.2	2.41 (1.29-4.50)	0.006
Male	2.41 (1.27-4.54)	0.007
Number of CPR observation ≥ 5 times	2.21 (1.18-4.13)	0.013

arrests.[13] Recommendations by the AHA emphasizes adequate chest compression with minimized interruption of the chest compression.[1] They suggested an increased ratio of the number of chest compressions over ventilation which has been shown to result in a more effective chest compression[14] that also minimizes the hands off time.[15] Uninterrupted chest compression has been shown to have a better chest compression performance compared to standard CPR among medical students with a better retention of performance at 6 and 18 months after training with substantially more chest compressions being delivered.[16]

Testing for retention of CPR performance is required to make sure that after training, students can perform effective CPR. Data from undergraduate nurse students has shown that a significant number of these students still had inadequate CPR performance during and immediately after training, although the performance was better than their pre-training scores.[17] They also demonstrated that the skill significantly dropped 10 weeks after training.

Previous studies have shown various results for the predictors of retention of CPR performance after training. Riegel et al.,[10] have shown that more CPR practice especially in the emergency department as well as more intense retraining are important factors for the retention of CPR performance in the layperson. This finding together with a better CPR performance in the male gender agrees with the findings from our study. A previous study has demonstrated a significant decay in ALS skill 6 months after training[11] among residents and consultants. A passing performance decreased from 100% immediately after training to 64% at 6 months after training. This is similar to our findings which showed a decrease from 90.5% to 51.4% at an average of 6 months after training. We demonstrated that the decrease in chest compression performance does not depend on the time after training since CPR experience played an more important role in the maintenance of chest compression performance.

Recent CPR experience was the most important predictor for retention of CC performance in our study. The strategy to encourage medical students to observe real CPR situations should improve their CC performance after their training. Other independent predictors included male gender, and GPA which probably reflect that CC learning may be one part of their global learning. More focused CC training in female medical students may be considered. The most frequent errors during CC examation in our study were too little CC followed by too deep CC. Medical students should be informed that the force of CC is the key to success and inappropriate force is a common error. The feedback system may help to improve their performance.

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