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ORIGINAL RESEARCH

Retention of Basic-Life-Support Knowledge and Skills in Second-Year Medical Students

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Purpose: Basic life support (BLS) training is crucial in improvement of cardiopulmonary resuscitation (CPR) outcomes. Many studies have demonstrated improvement of skills after BLS training but the skills significantly decrease over time. Our study aimed to evaluate the retention of knowledge and skills after training following 2010 BLS guidelines in second year medical students at Faculty of Medicine, Thammasat University.

Materials and Methods: One hundred and forty-nine second-year medical students were enrolled in the prospective cohort study. Participants were tested for knowledge and skills of BLS prior to training (pre-test), immediately after training (post-test) and six months after training (retention test).

Results: The mean scores of pre-test, immediate post-test and retention-test were 8.52 (SD 1.88), 12.12 (SD 1.52) and 10.83 (SD 1.95), respectively. Improvement in knowledge score post-test and retention test were 3.60 (95% CI 3.22,3.99 $P<0.001$) and 2.31 (95% CI 1.92,2.70 $P<0.001$) respectively, compared with pre-test score. In post-test, detection skill, activation skill and compression skill were improved 1.67 (95% CI 1.28,2.19 $P<0.001$), 5.15 (95% CI 3.41,7.77 $P<0.001$) and 3.88 times (95% CI 2.24,6.71 $P<0.001$) compared with pre-test evaluation. Comparison between retention test and pre-test was improved detection skill 1.72 (95% CI 1.31,2.26 $P<0.001$), activation skill 4.4 (95% CI 2.93,6.75 $P<0.001$) and compression skill 2.56 (95% CI 1.44,4.57 $P=0.001$). Knowledge decreased 1.29 times in retention test compared with post-test (95% CI −1.67,0.92 $P<0.001$). In retention test, detection skill increased 1.03 times (95% CI 0.81,1.29 P = 0.810), activation skill decreased 0.86 times (95% CI 0.98,1.10 $P=0.24$) and compression skill decreased 0.66 times (95% CI 0.45,0.98 $P=0.04$) compared with post-test.

Conclusion: Knowledge and skills of BLS significantly improved after training in second year medical students. However, the knowledge decreased at 6 months after training although the BLS skills still remained.

Keywords: basic life support, medical student, retention, skill, knowledge

Introduction

Cardiac arrest was considered the major cause of disabilities and death.[1] It was defined as the condition in which the heart abruptly stopped functioning, hence the blood failed to circulate to the rest of the body.[2] The lack of oxygenated blood to the brain could cause sudden loss of consciousness. If the patients were not properly rescued, they eventually died.

Sudden cardiac arrest often occurred while the patients were outside the hospital or far from medical services. As a result, there were no healthcare professionals promptly rescuing the patients. Although the patient could get help from medical

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staff in the hospital, the survival rate in Thailand was still low. The study at Thammasat University Hospital revealed that 22.5% of the patients with cardiac arrest were successfully rescued and admitted to the hospital, while only 5.6% survived.[3]

According to the American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiovascular Care (ECC), the Chain of Survival consisted of an immediate recognition of cardiac arrest and activation of the emergency response system, an early BLS and an Advanced-Cardiac-Life-Support (ACLS) with hospital care.[4] Several studies showed higher survival rates when the patients with cardiac arrest outside the hospital had BLS with chest compressions before the ambulance and ACLS arrival compared with those without chest compressions.[5]

There is an emergency medical service (EMS) provided for the general public in Thailand. In case of emergency, the hotline 1669 can be dialed for initial advice and ambulance call. However, BLS and EMS knowledge among the general public were still insufficient. They did not know how to properly respond to the cardiac arrest patients and thus treatment, particularly chest compressions was delayed.[6,7]

Toner et al[8] studied in 25,000 school children aged 10–12 years and found a significant increase in BLS knowledge after BLS training. Naqvi et al,[9] also showed an increase in both BLS knowledge and skills of 11–15 years-old school children and retention of the knowledge and skills at 3 months after training. Connolly et al[10] found BLS knowledge and skill retention at even 6 months after training in 10–12 years-old children.

Pande et al[11] demonstrated BLS knowledge average score improvement from 3.42 to 7.42 one week after the BLS training in first year medical students and skill retention but it decreased to 5.38 when the students moved to the second year. A study by Riegel et al[12] found a gradual decline in BLS skills in the general public at 3–5, 6–11, and 12–17 months respectively after the training. Spooner et al[13] showed a decrease in check response skill, call for help skill, chest compression skill and overall assessment at 6 weeks after BLS training in first year health science students. Ruijter et al[14] also reported a decline in BLS skills of medical students a year after the training.

A study conducted in Thammasat University, Thailand by Srivilaithon et al[15] in 250 students aged 18 year and over revealed a significant increase in the BLS knowledge after the training. Other research among nursing students showed that BLS training was effective immediately after the course but the knowledge and skills declined after 3 months. Still, they were more than those before the training.[16]

This study aimed to evaluate the retention of the BLS knowledge and skills of second year medical students after the training program.

Materials and Methods

Study Population

In this prospective cohort study, we included second-year medical students who participated in the BLS training program of the Department of Emergency Medicine, Faculty of Medicine, Thammasat University from November 2015 to October 2016.

We enrolled the second year medical students, aged ≥18 years-old who completed the BLS training program and agreed to participate in the study. We excluded participants who had medical condition that restricted their full BLS training. Medical students who could not complete the BLS test after the training or disincline to participate in this study were also excluded.

Sample Size Calculation

Sample size formula as there is no definite population number recorded

$$n = \frac{Z^2}{4e^2}$$

where: Z = 1.96 (95% CI), e = 0.1 (tolerable error 10% or = 0.1)

$$n = \frac{1.96\text{x}1.96}{4(0.1\text{x}0.1)}$$

$$n = 97$$

As there were 149 participants during the period of data collection, all of them were used as the study population.

Data Collection

The demographic data, and the knowledge/experience in BLS and emergency medical service of all participants were recorded. The BLS knowledge was evaluated before, immediately after training, and 6 months after training in all participants by the pre-test, post-test and retention test, respectively. The test with 15 items (supplement: BLS test) had been previously used to evaluate the BLS training program for university students.[15] The BLS practical

section was evaluated immediately and 6 months after the training and was recorded in the data record forms.

Part 1

Detection skill: consciousness and response assessment by tapping the victim on the shoulder and shouting at the victim

Activation skill: calling for help and an automated external defibrillator (AED)

Part 2

Chest compression skill: hand position, compression rate, compression depth and compression efficacy, which was defined as a proportion of the correct chest compression to total chest compression determined by the BLS training manikins.

Data Analysis

All data were recorded in the computer and analyzed using STATA 12 (StataCorp LP, College Station, TX). Categorical data were presented as frequency and percentage, while continuous data were displayed as mean and standard deviation (SD). The association between the test scores before and after the BLS training was reported as mean difference using an analysis of repeated response. The multi-level model multivariable analysis was used to control variables that might affect the results. The association between the BLS skills before and after the training was determined as risk ratios of passing the evaluation. For all statistical analyses a p-value of <0.05 was considered significant.

Results

One hundred and forty-nine second year medical students at the Faculty of Medicine Thammasat University were enrolled in this study. Seventy-one (47.6%) and 78 (52.35%) participants were respectively male and female with an average age of 19.15 years (Table 1).

According to the questionnaire, 37 participants (24.83%) had known the emergency medical service system in the country, 11 (7.38%) had used the service, and 48 (32.21%) had attended the BLS training.

The mean scores (SD) of the BLS knowledge test were 8.52 (1.88), 12.12 (1.52) and 10.83 (1.95) from the pre-test, post-test and retention test, respectively (Table 2).

The scores were respectively improved by 3.6 points (95% CI 3.22–3.99, p-value <0.001) and 2.31 points (95% CI 1.92–2.70, p-value <0.001) immediately and at 6 months after the training compared with the pre-test scores.

Table 1 Gender and Experience in BLS of Second-Year Medical Students

Characteristics	n	Percentage (N= 149)
Female gender	78	52.35
Age (year); n (%)	19.15 (0.54)	
Knowledge of emergency medical service	37	24.83
Experienced in emergency medical service	11	7.38
Trained in basic-life-support program	48	32.21
Experienced in basic-life-support situation	1	0.67

Eighty-three participants (55.70%) passed the detection skill pre-test, while 139 (93.29) and 143 (95.97%) were able to pass the post-test and retention test, respectively (Table 3).

Twenty-seven (18.12%), 139 (93.29%) and 120 (80.54%) participants were subsequently found to have proper activation skill in the pre-test, post-test and retention test.

Regarding the chest compression skill, 16 (10.74%), 62 (41.61%) and 41 (27.52%) participants passed the pre-test, post-test and retention test, respectively.

The number of participants passing the detection skill post-test and retention test were respectively 1.67 (95% CI 1.28–2.19, p-value <0.001) and 1.72-fold (95% CI 1.31–-2.26, p-value <0.001) greater than those of the pre-test.

As compared with the pre-test, a proper activation skill was improved by 5.15 (95% CI 3.41–7.77, p-value

Table 2 BLS Knowledge Before, Immediately After and 6 Months After the Training

Test Score	Before Training (N=149)	After Training	
		Immediate (N=149)	6 Months (N=149)
Mean (SD)	8.52 (1.88)	12.12 (1.52)	10.83 (1.95)
Mean difference[a] 95% CI p-value		3.60 3.22, 3.99 <0.001	2.31 1.92, 2.70 <0.001

Note: [a]After adjusted with gender, age, knowledge and experienced in emergency medical service, and trained and experienced in basic-life-support

Table 3 Detection, Activation and Chest Compression Skills Before, Immediately After and 6 Months After the Training

Skill Test Passing	Before Training (N=149)	After Training	
		Immediate (N=149)	6 Months (N=149)
Detection skill; *n* (%) Activation skill; *n* (%) Compression skill; *n* (%)	83 (55.70) 27 (18.12) 16 (10.74)	139 (93.29) 139 (93.29) 62 (41.61)	143 (95.97) 120 (80.54) 41 (27.52)
Risk ratio of passing[a] Detection skill 95% CI *p*-value		 1.67 1.28, 2.19 <0.001	 1.72 1.31, 2.26 <0.001
Activation skill 95% CI *p*-value		5.15 3.41, 7.77 <0.001	4.44 2.93, 6.75 <0.001
Compression skill 95% CI *p*-value		3.88 2.24, 6.71 <0.001	2.56 1.44, 4.57 0.001

Note: [a]After adjusted with gender, age, knowledge and experienced in emergency medical service, and trained and experienced in basic-life-support

Table 4 BLS Skills at 6 Months After Training Compared with Immediately After Training

Knowledge and Skill Testing	6 Months After Training (N=149)
Mean testing score difference[a] 95% CI *p*-value	−1.29 −1.67, −0.92 <0.001
Risk ratio of passing[a] Detection skill 95% CI *p*-value	 1.03 0.81, 1.29 0.81
Activation skill 95% CI *p*-value	0.86 0.68, 1.10 0.24
Compression skill 95% CI *p*-value	0.66 0.45, 0.98 0.04

Note: [a]After adjusted with gender, age, knowledge and experienced in emergency medical service, and trained and experienced in basic-life-support.

<0.001) and 4.44-fold (95% CI 2.93–6.75, *p*-value <0.001) in the post-test and retention test, respectively.

For the compression skill, the number of participants who passed the post-test and retention test were subsequently increased by 3.88 (95% CI 2.24–6.71, *p*-value <0.001) and 2.56-fold compared to the pre-test (95% CI 1.44–4.57, *p*-value 0.001).

Table 4 demonstrates a reduction in the BLS knowledge score in the retention test by 1.29 fold compared with the post-test (95% CI −1.67 to −0.92, *p*-value <0.001).

The detection skill at the retention test period was improved by 1.03 times (95% CI 0.81–1.29, *p*-value 0.81) but activation skill and chest compression decreased by 0.86 (95% CI 0.98–1.10, *p*-value 0.24) and 0.66 times (95% CI 0.45–0.98, *p*-value 0.04) compared with the post-test period, respectively.

There were 48 participants (32.21%) who trained in a BLS course before they were included in the study (Table 5). The pre-test mean scores of the trained group was 9.23 (1.69) while the non-trained group was 8.18 (1.05). The mean difference was 1.05 (95% CI 0.42–1.68, *p*-value 0.01). The immediate test mean scores in trained and non-trained group were 12.5 (1.59) and 11.94 (1.45), respectively. The immediate post-test mean difference was 1.05 (95% CI 0.04–1.08, p-value 0.03). The retention test mean scores in trained group (11.21 (2.01)) were slightly more than the non-trained group (10.64 (1.91)).

Comparison of the detection skill, activation skill and chest compression skill between trained and non-trained participants is shown in Table 6.

Thirty-one (64.58%) participants in trained group passed the pre-test detection skill while fifty-two (51.49%) of the untrained group passed the pre-test skill (OR 1.72 (0.85,3.49) *p*-value 0.13). Forty-five (93.75%) trained participants passed post-test compared to the non-trained (93.07%) (OR 0.45, 95% CI 0.28,4.52 *p*-value 0.87). About the retention test, forty-five (93.75%) trained participants passed the test

Table 5 Comparison of Test Score Between Trained and Not-Trained BLS Before Training, Immediately After Training, and Six Months After Training

	Trained (n=48)	Not-Trained (n=101)	Mean Difference (95% CI)	*P*-value
Test score mean (SD) Before training	9.23 (1.69)	8.18 (1.88)	1.05 (0.42, 1.68)	0.001
Immediately after training	12.5 (1.59)	11.94 (1.45)	0.56 (0.04, 1.08)	0.03
Six months after training	11.21 (2.01)	10.64 (1.91)	0.57 (−0.1, 1.24)	0.09

Table 6 Comparison of Detection Skill, Activation Skill, and Compression Skill Between Trained and Not-Trained BLS Before Training, Immediately After Training, and Six Months After Training

	Trained (n=48)	Not-Trained (n=101)	Odds Ratio (95% CI)	*P*-value
Detection skill n (%)				
Before training	31 (64.58)	52 (51.49)	1.72 (0.85, 3.49)	0.13
Immediately after training	45 (93.75)	94 (93.07)	1.12 (0.28, 4.52)	0.87
Six months after training	45 (93.75)	98 (97.03)	0.46 (0.09, 2.36)	0.35
Activation skill n (%)				
Before training	11 (27.92)	16 (15.84)	1.58 (0.67, 3.73)	0.29
Immediately after training	45 (93.75)	94 (93.07)	1.12 (0.28, 4.52)	0.87
Six months after training	38 (79.17)	82 (81.19)	0.88 (0.37, 2.07)	0.77
Compression skill n (%)				
Immediately after training	5 (10.42)	11 (10.89)	0.95 (0.31, 2.91)	0.93
Immediately after training	20 (41.67)	42 (41.58)	1.00 (0.49, 2.01)	0.99
Six months after training	17 (35.42)	24 (23.76)	1.76 (0.83, 3.72)	0.14

and ninety-eight (97.03%) untrained passed the test (OR 0.46, 95% CI 0.09, *p*-value 0.35).

Regarding the activation skill, the number of participants passing the pre-test in the trained group were 11 (27.92%) and the non-trained group were 16 (15.84%) (OR 1.58, 95% CI 0.67,3.73 *p*-value 0.29). The trained group who passed the post-test were 45 (93.75%) when the non-trained group were 94 (93.07%), (OR 1.12, 95% CI 0.28,4.52 *p*-value 0.87). The retention test was performed in both group. Thirty-eight (79.17%) participants in the trained group passed the retention test and 82 (81.19%) untrained participants passed the retention test (OR 0.88, 95% CI 0.37,2.07 *p*-value 0.77).

Participants who passed pre-test compression skill were 5 (10.42%) and 11 (10.89%) in the trained and non-trained group, respectively (OR 0.95, 95% CI 0.31,2.91 *p*-value 0.93). There were 20 (41.67%) in the trained group passed the post-test and 42 (41.58%) in the non-trained group (OR 1.00, 95% CI 0.49,2.01 *p*-value 0.99). Seventeen (35.42%) in the trained group and 24 (23.76%) of the untrained participants passed the retention test (OR 1.76, 95% CI 0.83,3.72, *p*-value 0.14).

Discussion

This study evaluated the retention of knowledge and skills in BLS of 149 preclinical medical students. They were tested for the knowledge and skills before, immediately after and 6 months after the BLS training. Only 24% of the students had been aware of the emergency medical service and its hotline, while 32.21% of them had attended the BLS training before this study.

Insufficient BLS knowledge and skills of untrained medical students were reflected in low pre-test scores. Freund et al[7] demonstrated that third year medical students still had a low level of the BLS knowledge, though they had started working in the clinic. Businger et al[17] found that not only medical students, but the general public also had a poor level of the BLS knowledge. A study among Thammasat University students, Thailand by Srivilaithon et al[15] showed that the level of BLS knowledge was low before the training. Moreover, Ghanem et al[18] found BLS awareness among medical students was low.

We demonstrated an improvement of the BLS knowledge after the training. Though it declined with time, a statistically significant improvement was determined compared with the pre-test knowledge. Partiprajak et al[16] revealed similar results. Their participants' knowledge of the BLS also improved after the training. A hundred percent of the participants passed the exam after the BLS training compared with only 10% before the training, though after 3 months the number decreased to 30%. Pande et al[11] found that first year medical students had better BLS knowledge scores at one week after the training (from 3.42 to 7.42). Their scores dropped to 5.38 when they moved to the second year, though it was better than before the BLS training. Srivilaithon et al[15] determined a statistically significant improvement of the BLS knowledge test scores in university students from 8.66 to 12.34. Madden et al[19] also found similar results in nursing students.

Our study showed a low level of BLS skills before the training, but with the training, the skill level was clearly increased and sustained for up to 6 months.

We demonstrated significantly improved detection, activation and chest compression skills after the BLS training. A study among second year nursing students by Madden, et al,[19] showed marked skill improvement after the BLS training. Even though the BLS skills declined 10 weeks after the training, they were still better than before.

Detection skill in this study was raised with statistical significance after the BLS training and remained 6 months later. In contrast, Avisar, et al,[20] found a fall in the skill of speaking with the patient and tapping the mannequin to check response among medical students fell when retested at 12 months. One possible explanation for an increased detection skill at 6 months after the BLS training in our study is that the participants were probably aware of being tested for detection of a cardiac arrest victim.

We found a statistically significant increase in activation skill immediately after the BLS training and a significant decrease at 6 months afterwards.

Riegel et al[12] revealed a decline in BLS skills over time. Their participants could perform correctly at a rate of 79.6%, 76.170.4% at 3–5, 6–11 and 12–17 months, respectively, with a p-value of <0.001. A study in first year health science students by Spooner et al[13] showed a decline in the skills to check response, call for help and do the chest compression as well as an overall assessment at 6 months after the BLS training. De Ruijter et al[14] also showed BLS skill reduction a year after the training.

Our data revealed a statistically significant increase in chest compression skill after the BLS training but it declined after 6 months. Behrend et al[21] found that chest compression skill of medical students dropped after 1 year. Spooner et al[13] tested the BLS skills in health science students and found that they were reduced in only 6 weeks. Another study among general public volunteers[12] showed a decrease in chest compression skill as well.

The retention of BLS knowledge at a significantly high level in this study reflects effective BLS training. The students still had BLS knowledge and skills even at 6 months after the training.

Participants in the trained group had higher statistically significant knowledge scores in BLS than the non-trained group. Ghanem et al[18] also demonstrated that overall score in trained group was statistically significant higher than in non-trained group. Moreover, Nambiar et al[22] found participants in life support group had higher statistically significant score.

The post-test and retention test scores were not different. For detection skill, activation skill and compression skill, there was not statistically difference in both groups after training although the trained group had done better in the pre-test.

BLS training for all levels of the students and general public is essential. Bystander CPR could lead to a better survival of sudden cardiac arrest victims. The BLS knowledge and skills of participants often declined over time; therefore, the training courses should be periodically held in order to maintain the knowledge and skills. BLS teaching in Thailand is still limited to healthcare providers, while it should be provided for everyone to improve the survival rate of the victims with cardiac arrest outside the hospital.

Our study had several limitations. Participants were second-year medical students. They tended to pay more attention to learning the BLS compared with the general public, though in a pre-clinical year, as they were aware that they need to be capable of the ACLS. Some of the students might have recorded a high score since they had attended BLS training before this study. The retention test at 6 months after the training was well announced; therefore, our participants might have reviewed BLS knowledge before taking the test. This possibly led to higher scores particularly in the detection and activation skills. The participants had already known that the patient was unconscious in the skill test. As a result, the detection skill became better in the retention test, while the chest compression skill declined.

Conclusion

The BLS training for medical students led to proper knowledge and skills. Even though the retention of the BLS knowledge and skills declined at 6 months after training, they were still better than before. Periodic BLS training is essential to maintain proper knowledge and skills.

Suggestions

It is advisable to provide BLS training for all students and the general public. We encourage further studies in the future, as BLS training is mostly performed by demonstration and practice. With an increasing number of participants, the number of instructors may not be sufficient. Currently, the results from various BLS training methods are still conflicting. Development of new teaching techniques suitable for each country's socioeconomic conditions to supplement or replace the conventional methods is anticipating.

Ethical Considerations

This research only evaluated the BLS knowledge before and after the training; and hence there were no negative physical effects on the participants. The training instructors were specialized in patient resuscitation, thus the BLS knowledge was correct, evidence-based and applicable. The data of all participants were kept confidential. The study was approved by the Human Research Ethics Committee of Thammasat University, Faculty of Medicine.

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Disclosure

The authors report no conflicts of interest in this work.

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