Original Article

Knowledge and Skills of Lay Participants Training with Basic Life Support Program in Case of Cardiac Arrest

Chatkane Pearkao, PhD[1], Thanat Tangpaisarn, MD[2], Donwiwat Saensom, PhD[1], Jeerawan Ek-u, MSc[1], Orathai Suebkinorn, MNS[1]

[1] Department of Adult Nursing, Faculty of Nursing, Khon Kaen University, Khon Kaen, Thailand
[2] Department of Emergency Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

Background: Out-of-hospital cardiac arrest is an important cause that leads to hospital admission and death. Improving lay people's knowledge and skills in basic life support (BLS) may lead to reduced death associated with out-of-hospital cardiac arrest. "BLS NU KKU" is a BLS training program developed from up-to-date literature as a smartphone application used to train lay people in the community.

Objective: To evaluate BLS-related knowledge and skills of participants before and after BLS training.

Materials and Methods: A one group pretest-posttest design was used to implement the present study in Khon Kaen, Thailand. Participants were 350 individuals age 18 and older. An 8-hour BLS training session was offered to 10 groups of 35 participants over the period of 10 months between November 2018 and August 2019. Self-administered questionnaires were used to assess BLS knowledge and Cardiopulmonary resuscitation (CPR) skills.

Results: The mean score for BLS-related knowledge significantly increased after the BLS training (mean = 15.05, SD = 2.51) compared to the scores before the training (mean = 10.47, SD = 3.43) ($p<0.05$). BLS skills improved from 0% to 100% ($p<0.001$) will all skills rated with mostly "excellent" and "good". Satisfaction with the training program was also rated mostly with "excellent" and "good".

Conclusion: The BLS training program effectively improved participants' knowledge and skills for basic life support. This program should be disseminated to train lay people in other settings.

Keywords: Basic life support, Cardiac arrest, Mobile application

Out-of-hospital cardiac arrest is one of the leading cause of death and hospital admission. When cardiac arrest develops, blood circulation stops and organ dysfunction begins. Individuals with cardiac arrest are unconscious with no pulse and not breathing and will die if cardiopulmonary resuscitation (CPR) is not immediately applied[1]. Insufficient circulation or obstruction of heart vessels are major causes of a heart attack and acute coronary syndrome. Airway obstruction, thromboembolism, neurological system dysfunction, respiratory failure, medicine overdose, electric shock, smoke inhalation, and traumatic injuries are other causes that may lead to cardiac arrest[2].

The American Heart Association reported that out-of-hospital cardiac arrest occurs about 420,000 cases/ year and the number is increasing every year. Approximately 80% of these cases were caused by ischemic heart disease[2,3]. On the other hand, the incidence of out-of-hospital cardiac arrest in Thailand is unclear however, it is also believed to be in an increasing trend[4].

According to the chain of survival concepts in providing continuing care for people who have heart attack, CPR is the third step after recognizing the event and calling for professional help. As a result, bystanders who meet the event will be key persons to help the victim and contact emergency medical systems (EMS)[1]. Once cardiac arrest is detected, the victim must receive cardiac massage immediately until an automated external defibrillator (AED) can be applied. The CPR must continue until medical staff arrive at the scene and provide professional CPR. Evidence supported that effective continuous CPR could lead to a survival rate of up to 50% survival for the victims[5].

In Thailand, most BLS training campaigns typically consist of education program and cardiac massage practice. Most BLS programs were offered to health professionals, public health volunteers, nursing students, and high school students. Knowledge and CPR skills were measured using experimental methods to compare results before and after the training[7]. In other countries with similar context to Thailand, knowledge after BLS training was measured at 3

and 6 months after training and not surprisingly that BLS-related knowledge decreased at 6 months after training[8,9].

None of the studies were conducted among lay people in the community. However, contemporary Thai households especially in rural communities are characterized as skipped-generation households where grandparents live with their grandchildren while the children's parents are away working in the cities[6]. Subsequently, if heart attack should occur to someone in the household or in the community, these community members might possibly be the first responders to contact EMS as well as provide CPR. As a result, it is crucial for health providers to disseminate BLS campaign in a way that could reach lay people as much as possible. Such innovative approach for BLS training had been developed based on the ACLS 2015 guideline as a smartphone application entitled "BLS NU KKU" that users can update their knowledge as well as use it to contact the EMS. The purpose of this study was to study effects of BLS training program using BLS NU KKU application by comparing BLS-related knowledge and practice scores before and after the training session as well as users' satisfaction with the training program and application.

Materials and Methods

A one group pretest-posttest design was adopted for this study. Participants were 350 community dwellers who never had a BLS training, recruited from various locations in Muang District of Khon Kaen Province, Thailand. The sample size was from the overall pass rate before intervention of 0.5 (70%) and post intervention overall pass rate of 0.7 (70%)[10] which yielded 334 subjects. Rounding the total number to accommodate potential attrition and the final sample size was 350 participants. BLS training was offer to a group of 35 participants at a time over the period from November 2018 to July 2019. A total of 10 BLS training sessions were completed. Protection of human subject was reviewed by the Khon Kaen University Ethical Committee with reference number HE 622033.

Research instruments included the followings
1) Data collection tools
1.1) Demographic data form that collected information on participants' age, gender, education, number of family members, age of each family member, history of illness in the family, experience in encountering cardiac arrest victim and helping the victim using BLS concept.
1.2) BLS knowledge questionnaire. A 20-item with multiple choices (4 alternatives) questionnaire was designed by the researchers to measure BLS knowledge which was the study's main outcome before and after the training session. Scoring correctly 60% or more (12 questions or more) is considered "pass".
1.3) BLS skills evaluation form. Developed from the American Heart Association's 2015 BLS guideline, this form evaluates participants' skills and actions in detecting the situation needing BLS, EMS contact number, hand position when providing CPR, depth and rhythm of chest compression, and overall BLS skills.

2) BLS training program, developed from literature review and based on Gagne's model of instructional design consisted of the following components.
2.1) BLS handbook for the researchers which delineated the training program outline, training objectives, learning media and evaluation forms.
2.2) Picture media which consisted of 3 parts: 1) 6 pictures of cardiac arrest victims, 2) cardiac arrest incidence, and 3) BLS knowledge test questions with answer keys to check participants' knowledge before and after the training.
2.3) A 10-minute video clip that displays the following content related to cardiac arrest; definition, causes, impact on health, risk factors, signs and symptoms, first aid steps for BLS, cardiac massage method, and demonstration on how to operate the automated external defibrillator (AED).
2.4) Pictures and words displaying cardiac arrest sign and symptoms for participants to choose during the training session.
2.5) BLS handbook for participants. This booklet consists of 1) a worksheet to check for risk of cardiac arrest by participants and their family members, 2) sign and symptoms for cardiac arrest and steps to perform BLS, 3) information about the BLS NU KKU smartphone application and how to download it for participants to review BLS knowledge after the training.
2.6) BLS training course which contains 3 topics of 8 activities for practicing BLS skills. Performing each activity will be rated by a score 1 to 4 (4 = excellent, 3 = good, 2 = average, 1 = poor). Participants are judged to pass the BLS skills when their combined score is 80% or more (20 score or more).
2.7) Resuscitation doll for BLS skill practice and demonstration of AED operation during the training session. All instruments were verified by 5 experts in cardiac arrest care and basic life support. The knowledge questionnaire had indexes of item-objective congruence of 0.6 to 1.0 with a test-retest reliability coefficient of 0.786. The BLS training program had a content validity index of 1.0.

BLS program training process

The BLS training session comprised of 6 steps to implement over the period of 8 hours as shown in Figure 1.

Data analysis

Descriptive statistics were used to analyzed demographic data to obtain frequencies, percent, means and standard deviations. BLS knowledge score was analyzed for mean, standard deviation and tested for normality using Kolmogorov-Smirnov statistics. Paired t-test was used to compare the knowledge score before and after BLS training.

Results

A total of 350 participants completed the BLS training program and provided both pretest and posttest assessments. The majority of participants was female (n = 207, 59.14%) with the mean age of 29 years old.

Basic life support knowledge

Using the 60% passing criteria, 337 participants (96.29%) passed the posttest assessment on BLS knowledge. In addition, a paired t-test confirmed that participants had significantly increased knowledge scores from the mean score of 10.07 (SD = 3.43) in the pretest to 15.05 (SD = 2.51) in the posttest ($p<0.001$). As shown in Table 1.

Basic life support skills

All participants passed the BLS skills after the training as shown in Table 2. Most participants passed all BLS skills at an "excellent" level (87% or higher). When comparing the BLS skills before and after the training, McNemar test indicated that participants significantly correctly perform all BLS steps after the training (100%) compared to the time before the training (0%) ($p<0.05$) as shown in Table 3.

Satisfaction with BLS program

After completing the BLS training program most participants rated their satisfaction with the BLS program at
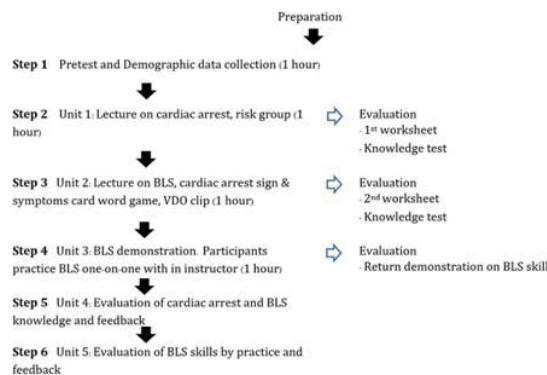

Figure 1. The research method.

an "excellent" and "good" levels. Program usefulness and BLS knowledge gained from the training were particularly rated highly as shown in Table 4.

Discussion

Results of the study indicated the effectiveness of BLS program implemented in the present study in improving participants' BLS knowledge and skills. This success may due to the application of Gagne's model of instructional design in developing the BLS program. According to the Gagne's model, adults learn better when they are presented with multiple stimuli, focused on learning outcomes and use various specific instructional activities to achieve those outcomes, all were key characteristics of this BLS training program. In the present study, the training program was carried out in 6 steps (Figure 1) to assist participants in understanding the program content, performing necessary skills with real-time feedback from instructors, and proving the smartphone application (BLS NU KKU) for participants to review their knowledge at their convenience after the training. Similar results were observed in other studies. For instance, a BLS training utilizing multiple-component program was successfully implemented for the general public in Nongkhai Province[11]. After the training participant had with significantly improved BLS performance scores compared to their score before the intervention ($p<0.001$). On the other hand, when BLS program consisted of a single method for training its effectiveness is compromised. Tippayanate et al[7] compared CPR knowledge and skill of high school

Table 1. BLS knowledge score

BLS knowledge	n	Mean	SD	df	p-value
Pretest	350	10.07	3.43	349	<0.001*
Posttest	350	15.05	2.51		

* p-value significant at <0.05

Table 2. Percent of basic life support skill after training in participants group

Basic life support skill	Excellent (%)	Good (%)	Average (%)	Poor (%)
Practices steps:				
Scene safety	87.43	10.28	2.28	-
Responsive assessment of victim	90.57	8.28	1.14	-
EMS calling (1669)	91.43	7.70	0.87	-
Cardiac Massage technique				
Hands position	89.72	9.14	1.14	-
Cardiac compression	88.00	10.86	0.86	-
Cardiac compress rhythm	88.29	10.57	1.14	-
Cardiac deep compress	90.00	8.29	1.71	-
AED practices	89.14	10.57	0.29	-

Table 3. Basic life support skill of participants comparative before and after training

Skill	Before training		After training		p-value
	n	Percent	n	Percent	
Practices	0	0.00	350	100	0.000*
No Practices	350	100	0	0.00	

* p-value <0.05

Table 4. Satisfaction with BLS training program

Satisfaction item	Excellent n (%)	Good n (%)	Average n (%)	Poor n (%)
Completeness of BLS content	207 (59.14)	122 (34.86)	19 (5.43)	2 (0.57)
Program usefulness	271 (77.43)	72 (20.57)	7 (2.00)	-
BLS knowledge	248 (70.85)	94 (26.86)	6 (1.72)	2 (0.57)
Confidence to apply BLS to help victim	216 (61.71)	121 (34.57)	11 (3.15)	2 (0.57)
Confidence to teach BLS to others	196 (56.00)	134 (38.29)	18 (5.14)	2 (0.57)

students after watching a brief VDO training or traditional training and found both groups had increased knowledge score but the VDO training group did not have scores high enough to pass the preset goal of 60%. In contrast, besides significant increase of knowledge, results from our study showed improved BLS skills with most participants scored at excellent level at all skills. This reflects another advantages of implementing a multi-component intervention. Lastly, the level of satisfaction with our BLS training program was very high with over 90% of participants rated their satisfaction at good and excellent. This high level of satisfaction corresponds with the improvement in participants' knowledge and skills which is consistent with the high level of satisfaction found in other study that also implement a multi-component BLS training program[11].

Conclusion
BLS training program that was developed to consist of multiple methods and strategies had proven effective in improving knowledge and skills among participants. Implementing the program in six steps among a small group of participants over the period of 8 hours allowed for in-depth learning and hands-on practice with real-time feedback. This led to desirable outcome with high level of program satisfaction particularly in terms of program usefulness and knowledge gained.

Limitation[12-16]
Due to the nature of participants that resided throughout the Province, we were unable to randomize subjects into intervention and control groups. The one group with pretest-posttest design limits our external validity and

prove of causal relationship that might have been possible with a true experimental design. In addition, participants were quite diverse and required different approach in each training session. Therefore, the internal validity might be compromised.

What is already known on this topic?
Out-of-hospital cardiac arrest is a leading cause of death and hospital admission.

What this study adds?
Multi-component BLS training program is effective in improving BLS knowledge and skills.

Conflicts of interest
The authors declare no conflict of interest.

References
1. American Heart Association. 2015 AHA Guidelines update for CPR and ECC [Internet]. 2015 [cited 2016 Jan 2]. Available from: https://www.cercp.org/images/stories/recursos/Guias%202015/Guidelines-RCPAHA-2015-Full.pdf.
2. American Heart Association. Heart Disease and Stroke Statistics-2015 Update [Internet]. 2015 [cited 2016 Jan 20]. Available from: https://www.ahajournals.org/doi/epub/10.1161/CIR.0000000000000152.
3. Cardiopulmonary Resuscitation Unit Srinagarind

Hospital. Basic life support. n.p.: n.p.; 2006.

4. Department of Disease Control, Ministry of Public Health. Data of non-communicable diseases [Internet]. 2015 [cited 2016 Jan 20]. Available from: http://www.thaincd.com/information-statistic/non-communicabledisease-data.php?pn=1.

5. Daya MR, Schmicker RH, Zive DM, Rea TD, Nichol G, Buick JE, et al. Out-of-hospital cardiac arrest survival improving over time: Results from the Resuscitation Outcomes Consortium (ROC). Resuscitation 2015;91: 108-15.

6. Podhisita Chai. What happen about "Thai family"? [Internet]. 2009 [cited 2016 Jan 20]. Available from: http://www.ipsr.mahidol.ac.th/IPSR/Annual Conference/ConferenceV/Download/Article_Files/ Article_Intro.pdf.

7. Tippayanate N, Chaiyaporm K, Chanabutr W. Comparison of the effectiveness of CPR training between the brief VDO training and traditional training in the group of secondary school student in Mahasarakham province [Internet]. 2017 [cited 2020 Sep 28]. Available from: http://journal.msu.ac.th/upload/articles/article 2183_31552.pdf.

8. Lovell RB. Adult learning. New York: John Wiley & Sons; 1980.

9. Nakpetch K, Apaijirarat J, Yaisum S. Developmental psychology for nurse. 2nd ed. Bangkok: Supa Printing House; 2005.

10. Naipat O. Quantitative and qualitative research methodologies in behavioral and social science. 2nd ed. Bangkok: Samladda Priniting; 2006.

11. Janrat S, Baunoo W. Effectiveness of basic life support training workshop for the general public in NongKhai. Udonthani Hosp Med J 2019;27:199-210.

12. Apiratwarakul K, Jumroenketpratheep K, Ienghong K, Ruttanaseeha W, Buranasakda M, Bhudhisawasdi V. Hand Hygiene of Emergency Medical Service Healthcare Providers. J Med Assoc Thai 2020;103:8-10.

13. Apiratwarakul K, Ienghong K, Gaysonsiri D, Buranasakda M, Bhudhisawasdi V, Tiamkao S. Role of motorcycle-based ambulance (Motorlance) in major sporting events. J Med Assoc Thai 2020;103:15-7.

14. Ienghong K, Kulsutcharit K, Apiratwarakul K, Gaysonsiri D, Mitsungnern T, hudhisawasdi V. Characteristics and mortality in high-, intermediate-, and low-risk acute pulmonary embolism patients in the emergency department. J Med Assoc Thai 2020; 103:42-6.

15. Apiratwarakul K, Pumiyoch P, Ienghong K, Phungoen P, Gaysonsiri D, Bhudhisawasdi V. Endotracheal intubation on a stationary vs. moving ambulance. J Med Assoc Thai 2020;103:18-21.

16. Ienghong K, Srikumpa P, Apiratwarakul K, Phungoen P, Gaysonsiri D, Bhudhisawasdi V. Factors associated with transfusion of uncross-matched type-O packed red cells for acute upper gastrointestinal hemorrhage. J Med Assoc Thai 2020;103:22-6.