Improvement and limitation of chest compression skills by a BLS training program

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ABSTRACT
We held an “American Heart Association (AHA) Family & Friends® CPR Course using one simple-type manikin and assessed chest compression skill by the CPR Skills Measurement System.

As a result of training, there was a significant increase mean chest compression depth (Pre-training : 43.2±10.8mm, post-training : 50.5±7.2mm, P<0.05). The implementation rate for appropriate hand location and full chest wall recoil were significantly higher for females both before and after the training (P < 0.05). The implementation rate for appropriate depth and both the mean depth and mean compression rate were significantly higher for males, both before and after the training, with deeper depth and a higher compression rate than females (P < 0.05).

We divided the students into the following each three groups based on the mean chest compression rate and the mean chest compression depth. The results of our investigation of the percentage of subjects in each group indicated a significant difference in females only prior to the training (P < 0.05).

In addition, 57.1% of females had a depth of <50 mm after the training, We believe that it is necessary to investigate training methods that take into account the differences between males and females in terms of physical strength. In order to increase the quality even further, it is necessary to investigate training methods that emphasize the revisions made in the 2015 JRC Guidelines. We also believe that it is necessary to assess the number of years before re-training designed to maintain an appropriate skill level.

Introduction
The 2015 Japan Resuscitation Council (JRC) Guidelines were revised to now indicate that high-quality chest compression provided as early as possible is an essential element of high-quality cardiopulmonary resuscitation (CPR), which makes it more likely that return of spontaneous circulation and the patient will survive cardiac arrest. The recommended compression depth listed in the Guidelines was revised from “at least 5 cm” to “a depth of approximately 5 cm, avoiding over-

compression that exceeds 6 cm,” and the recommended compression rate was revised from “at least 100 /min” to “100-200 /min”.

Here we report the effectiveness of BLS courses and training attended by fourth-year students on improving knowledge of life-saving techniques and desire to engage in life-saving tasks using CPR and automated external defibrillator (AED)2). We also held an “American Heart Association (AHA) Family & Friends® CPR Course”3) and assessed both the quality of chest compression by students before and after the course using the 2015 JRC Guidelines and investigated the
changes and challenges of these education methods.

Methods

1. Subjects

Study subjects were 798 fourth-year students who were matriculated in the Faculty of Pharmacy, Kindai University between 2011 and 2015.

2. Training contents

After a 90-min introductory lecture, the AHA Family & Friends® CPR Course (for adults and children) based on the 2010 Guidelines was held. The CPR training manikin used was a CPR & AED Personal Training Kit (Laerdal Medical Japan, Tokyo, Japan). Each student used one simple-type manikin. Before and after the training session, the skills of each student in the “Adult CPR & AED skill test” were assessed in private booths set up for this purpose. Objective assessments of the quality of chest compression were conducted by the CPR Skills Measurement System. The CPR Skills Measurement System utilized the PC Skill Reporting System (Laerdal Medical Japan).

3. Outcome measures

The following items were measured using the CPR Skills Measurement System: mean depth, mean speed/total number of compressions, number of times compression was performed at an appropriate depth (at least 50 mm), number of times compression was performed with hands in the appropriate location, and number of times full chest wall recoil. The proportion of attempts in which “depth,” “hand location,” and “chest wall recoil” were performed appropriately was then calculated. The system was set so that cases in which the mean depth was ≥ 60 mm were measured as “60 mm.”

4. Statistical methods

Students who did not attend the training were excluded from analysis.

The paired t-test was used to analyze the rate of appropriate chest compressions as measured using the CPR Skills Measurement System, mean compression rate, mean compression depth, and mean tidal volume before and after the training. Gender differences were made using the non-paired t-test. The chi-square test was used to compare the chest compression depth and compression rate groups. The level of statistical significance was set at $P < 0.05$.

5. Ethical considerations

The present study was conducted in accordance with the Ethical Guidelines for Epidemiological Research and the Act on the Protection of Personal Information. This study was approved by the Institutional Review Board of the Faculty of Pharmacy, Kindai University.

Results

1. Subjects

A total of 781 (315 males, 466 females) of the 798 fourth-year students in the Faculty of Pharmacy, Kindai University attended the training. In total, 738 students (297 males, 441 females) had attended some type of BLS course prior to the training and 32 (11 males, 21

<table>
<thead>
<tr>
<th>Table 1. Assessment results by the CPR Skills Measurement System</th>
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<tr>
<td>Outcome measures</td>
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<tr>
<td>Implementation rate for appropriate hand location (%)</td>
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<tr>
<td>Mean chest compression depth (mm)</td>
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<td>Implementation rate for depth ≥ 50mm (%)</td>
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<tr>
<td>Implementation rate for full chest wall recoil (%)</td>
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<tr>
<td>Mean chest compression rate (compression/min)</td>
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females) had not attended any BLS course. For 11 (7 males, 4 females) students, it was unknown whether they had attended any BLS course.

2. Assessment results

1) Pre- vs. post-training assessments

Investigation of the implementation rate for appropriate depth revealed a rate of 36.1% prior to the training and a significant increase to 61.9% after the training. Although the mean depth was 43.1 ± 10.8 mm prior to the training, this significantly increased to 50.5 ± 7.2 mm after the training (P < 0.05).

The implementation rate for appropriate hand location was 49.2% prior to the training and increased significantly to 80.3% after the training (P < 0.05).

The implementation rate for full chest wall recoil was high both before (96.1%) and after (96.9%) the training with no significant increase seen.

The mean chest compression rate was 128.1 ± 21.3/min prior to the training and 128.4 ± 11.6/min after the training, indicating no significant change (Table 1).

2) Gender differences

The implementation rate for appropriate depth and both the mean depth and mean compression rate were significantly higher for males, both before and after the training, with deeper depth and a higher compression rate than females (P < 0.05; Table 1).

Distributions for chest compression depth and rate indicated that both males and females showed wide variation in their skill levels for appropriate depth and rate prior to the training (Fig. 1).

We divided the students into the following three groups based on the mean chest compression rate: ≤ 120/min, 121-130/min, and ≥ 131/min. Similarly, chest compression depth was divided into the following: ≤ 40 mm, 41-49 mm, and ≥ 50 mm. The results of our investigation of the percentage of subjects in each group indicated a significant difference (P < 0.05) in females only prior to the training, with a trend for the group with a higher chest compression rate to also perform deeper chest compressions. No significant differences between pre- and post-training results were observed in males, with no correlation between the rate and depth of chest compressions (Fig.2).

Discussion

In order to increase the return of spontaneous circulation and the patient will survive cardiac
arrest, an essential part of high-quality CPR is the implementation of high-quality chest compressions. Multiple components have an effect on the quality of chest compressions, including the location at which the hands are placed, the position of the rescuer, the location of the victim, the depth, the rate, and the chest wall recoil.

As a result of training, there was a significant increase in the implementation rate for chest compression with the hands at the appropriate location. This suggests that the clicking sound produced by the manikin each time a chest compression was implemented with the hands at the appropriate location and at the appropriate depth was effective in helping students remain aware of the proper hand location.

Investigation of the mean depth, which is an outcome measure for chest compression, indicated that males improved from 48.2 ± 9.6 mm to 55.0 ± 4.7 mm and females improved from 39.8 ± 10.3 mm to 47.5 ± 7.0 mm after the training, indicating that they remained aware of the need to press firmly and had learned the necessary skills. However, compression depth by females was significantly shallower than that by males, which may be related to the relatively weaker physical strength of females in general. In spite of this, however, males had significantly lower implementation rates than females for other outcome measures, such as correct hand location and full chest wall recoil. Males had a significantly lower mean compression rate than females, indicating that learning the proper compression rate can be expected to improve hand location and chest wall recoil.

In addition, 57.1% of females had a depth of < 50 mm after the training, and 13.2% of those subjects had a mean depth of < 40 mm. A study that investigated the optimum chest compression depth based on the survival rate until discharge as an outcome of out-of-hospital cardiac arrest reported that the appropriate chest compression depth was 40.3-55.3 mm and that the optimum depth was 45.6 mm. A study of trauma due to chest compression suggested that when performing chest compression on an adult, a compression depth of 60 mm had a higher trauma rate than a compression depth of 50-60 mm. Based on the evidence, the 2015 JRC Guidelines recommended that when performing CPR on adults, chest compression to a depth of > 60 mm should be avoided and that a depth of approximately 50 mm is optimum. However, Stiell et al. reported data obtained from Canadian and American patients suggesting that the optimum chest compression depth for patients whose physical stature differs from those of Asians, and especially Japanese, is

Fig. 2. The correlation between chest compression rate and chest compression depth

<table>
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<tr>
<th>Depth (mm)</th>
<th>Males Pre-training</th>
<th>Males Post-training</th>
<th>Females Pre-training</th>
<th>Females Post-training</th>
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<tr>
<td>&lt; 40</td>
<td>40-49</td>
<td>≥ 50</td>
<td>&lt; 40</td>
<td>40-49</td>
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<tr>
<td>40-49</td>
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45.6 mm, suggesting that the chest compression depth to be used in Japanese and other Asian patients need not be > 50 mm. We look forward to furthering studies on the optimum compression depth for Japanese patients. We believe that it is necessary to investigate training methods that take into account the differences between males and females in terms of physical strength so that females can also learn appropriate techniques to achieve a chest compression depth of 50 mm that is recommended by the 2015 JRC Guidelines. We also believe that it is necessary to conduct further studies on the relationship of the rescuer’s weight and physical strength to the chest compression depth.

Research has suggested that as the chest compression rate increases, the chest compression depth also decreases. Thus, the 2015 JRC Guidelines were revised from “at least 100/min” to “100–120 /min”. In the training utilized in the present study, the mean compression rate was 128/min, which is relatively fast. Although only the females in the fast group had significantly deep compression depth, there was no significant difference between females after the training and males pre- or post-training. All subjects of the present study were fourth-year students, indicating that their young ages (approximately 22 years) may have been a factor. However, a study of high school students compared those in a >120/min group with 100-120/min group and <100 /min group. Although they found that the chest compression depth was deep, the implementation rate for chest wall recoil was low. In the present study, the implementation rate for full chest wall recoil was at least 95% both before and after the training, which suggests that the relation of youth to the rate and depth may vary.

The analytical results of the present study indicated that the short-term training course for the lay rescuer that follows the 2010 Guidelines led to the improvement of skills such as chest compression. In order to increase the quality even further, it is necessary to investigate training methods that emphasize the revisions made in the 2015 JRC Guidelines. We also believe that it is necessary to examine the inclusion of course contents designed for the healthcare provider and assessment tests for various skills and to assess the number of years before re-training designed to maintain an appropriate skill level.

Acknowledgments

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Reference

一次救命処置（BLS）実習実施による胸骨圧迫手技の変化と課題

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1人1体のマネキンを使用した「アメリカ心臓協会（AHA）ファミリー＆フレンズコース」を実施し、心肺蘇生（CPR）手技測定システムにより胸骨圧迫手技を評価した。胸骨圧迫について実習後有意に手技が向上した（平均深さ 前: 43.2 ± 10.8 mm, 後: 50.5 ± 7.2 mm, p<0.05）。実習前後ともに、「適切な手の位置」および「完全な圧迫解除」の実施率は、女性において有意に実施率が高かった（p<0.05）。 「適切な深さ」での実施率、胸骨圧迫の平均深さおよび平均テンポについては実習前後ともに男性の実施率が高く、深さ、テンポについても女性より有意に深く、早いことが認められた（p<0.05）。胸骨圧迫の平均深さを3群に分類した割合を検討した結果、実習前の女性についてのみ有意差が認められ（p<0.05）、胸骨圧迫のテンポが早い群が、深さが深い傾向となった。実習実施により手技の向上が示されたが、胸骨圧迫において平均深さが50 mm未満である女性が57.1%認められたことから、体力的な要因も考慮した圧迫手技の習得可能な実習内容の検討が必要と考えられた。今後、ガイドラインの変更点を強調した実習内容での手技の習得の検討をするとともに、手技の評価検証方法や、手技の維持について再トレーニングの時期の検証をする必要があると考える。

キーワード：薬学教育, 心肺蘇生法, 胸部圧迫, BLS, トレーニング

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