Effects of Noise Levels in Cardiopulmonary Resuscitation on Chest Compressions

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Abstract
This study is investigating the data to increase accuracy and efficiency in performing CPR by comparing chest compression accuracy depending on noise from the surrounding environment. It is an experimental research to test the ability and CPR accuracy of rescuers according to noise based on the same methods and conditions at a place with the noise level of at least 70dB and a place with the noise level below 70dB. In chest compression, the average depth and accuracy was greater in the group with the noise level below 70dB (55.97mm) than the group with the noise level of at least 70dB (54.54mm) (p<.05). Average compression speed (times/min) showed no statistically significant difference with the group with the noise level of at least 70dB at 116.50 times/min, and the group with the noise level below 70dB at 118.46 times/min. Chest compression accuracy (%) was higher in the group with the noise level below 70dB (141.98 times, 94.06%) than the group with the noise level of at least 70dB (132.26 times, 87.41%) (p<.05). The number of chest compression depth error (too weak, times) was greater in the group with the noise level of at least 70dB (13.94 times) than the group with the noise level below 70dB (7.27 times) with statistical significance (p<.05). We think it is necessary to create a calm environment in CPR education and performance, and to actively encourage CPR performance.

Keywords: Cardiopulmonary Resuscitation, Chest Compression, Noise Level

1. Introduction

1.1 Research Background
When there is an unexpected accident or a cardiac arrest patient, Cardiopulmonary Resuscitation (CPR) by the first witness is important for the prognosis of the patient. According to 2, cardiac arrest is the state of discontinued heartbeat regardless of the cause, and the time from cardiac arrest to CPR for prehospital cardiac arrest patients is an extremely critical element that determines the revivability and prognosis of the patient after the return of spontaneous circulation.

CPR is a therapeutic procedure that recovers the patient’s heartbeat and circulation. When the circulation stops, the oxygen in the brain is used up rapidly, ultimately causing irreversible damage after approximately 5 minutes. This reduces the revivability of the patient, and deteriorates the patient’s prognosis after resuscitation. Thus, it is necessary to perform prompt and accurate CPR at the initial occurrence of cardiac arrest for resuscitation and prognosis of prehospital cardiac arrest patients.

According to the guidelines of the Korean Association of Cardiopulmonary Resuscitation, the overall flow chart of the CPR carried out by the witness for cardiac arrest patients includes identification of cardiac arrest, request for help and report to 119, chest compression 30 times, artificial respiration 2 times, repetition of chest compression and artificial respiration, and recovery position (when recovered). Moreover, the standard CPR currently provided by the Korean Association of Cardiopulmonary Resuscitation offers guidelines on the exemplary position of the first witness and rescuer as well as the number of compressions and speed. However, it does not provide any conditions that affect the quality of
CPR. In particular, among the influential factors, noise or vibration is a constantly existing factor of environmental effect as a living experience inevitably encountered in daily life whether an individual perceives it or not, but there are no guidelines regarding such factor. According to the Ministry of Health and Welfare, the place where cardiac arrest most frequently occurs is at home (57.4%), but other times there is no knowing of when the accident will occur, and the cluttered situations and environments in accidents may have a negative impact on initial countermeasure of the rescuers or first witness.

Loud noises from factories, construction sites and various means of transportation disturb sleep or conversations, threatening the living environment, and thus they are regulated as sounds that are unpleasant or better off without, i.e., noise (Korea Environmental Preservation Association, 1988). The unit that measures sound is decibel marked as dB, and in general, a quiet residential environment has the noise level of 45dB, a general office environment 55dB, typing 60dB, and roadside cars 75dB. As such, there are various sounds and noises around us, and being exposed to such noises for a long time or in high levels may have unfavorable effects on humans, and deteriorate work efficiency (Korea Environmental Preservation Association, 1988).

Previous studies in Korea are on the CPR-related knowledge level and education of high school students' comparison of education effects between song Video Self-Instruction (VSI) and video self-instruction in CPR education of some university students, and basic CPR education effects and sustainability of higher-grade elementary school students (Kim, 2008). According to these studies, there has been active research on the fatigue of rescuers according to the change in chest compression ventilation ratio in the mannequin model of a single-rescuer CPR. Even if one is exposed to various noises, CPR in cardiac arrest constantly requires accurate resuscitation procedures. Since there is still no research on the accuracy of CPR according to the surrounding environment and noise, this study will provide basic data to increase accuracy and efficiency in performing CPR by comparing chest compression accuracy depending on noise from the surrounding environment.

2. Research Method

2.1 Research Design and Subject

This study compares the ability of rescuers and accuracy of chest compression according to noise. It is an experimental research to test the ability and CPR accuracy of rescuers according to noise based on the same methods and conditions at a place with the noise level of at least 70dB and a place with the noise level below 70dB. The research subjects consist of those with the BLS (Basic Life Support) Provider certification who completed the regular CPR education (15 weeks), and they are divided into a group of participants performing chest compressions at a place with the noise level of at least 70dB, and a group of participants performing chest compressions at a place with the noise level below 70dB.

2.2 Research Subject and Period

This study explained the objective of research to C University students in C Province, who obtained the BLS-Provider certification issued by the American Heart Association (AHA) and Korean Association of Cardiopulmonary Resuscitation (KACPR) and also received regular CPR education (15 weeks). 80 of them who agreed to participate were selected by convenience sampling. They were divided into two groups, and participated in the experiment twice in 5 cycles each at separate places. Group A is the group with the noise level of at least 70dB (80 participants), and Group B is the group with the noise level below 70dB (80 participants), both of which were extracted by convenience sampling with an equal number of participants. Among the 80 subjects, some of them did not participate actively in the experiment or gave up due to health problems such as injury or hospitalization, leaving final 73 subjects (in both Group A and Group B) to participate in the experiment. Table 1 shows the general characteristics of the subjects. The gender ratio of the subjects was 47.9% male students and 52.1% female students. The experiment was conducted from September 11 to 25, 2015.

2.3 Method of Experiment and Measurement

The experiment of this study divided the subjects into the group with the noise level of at least 70dB and the group...
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with the noise level below 70dB, using the same method in comparison. The experiment took place in two lecture halls for the subjects to appropriately perform CPR, assigning the two different groups in each lecture hall. A certain amount of time for rest was given between the two groups considering the fatigue and health condition of the subjects. The lecture halls have flat tile floors, and the indoor temperature is set according to the outdoor temperature that matches the season as much as possible. The equipment for chest compression in CPR consisted of Manikin Face Shields and CPR mannequins for rehearsal (Laerdal Corporation, Little Anne), and Resusci Anne w/ Skillreporter.

Before the experiment and measurement, we explained the education and process for 5 minutes to each group, and the subjects were to participate in the experiment dressed in everyday clothes instead of comfortable clothes for the prehospital situation and objectivity of the first witness. The group with the noise level of at least 70dB performed chest compressions while playing the daily white noise occurring downtown set as the baseline (70dB), and the group with the noise level below 70dB performed chest compressions without white noise and not quite reaching the baseline (70dB).

To avoid prejudice against accuracy in the experiment, one rehearsal was permitted 2 hours before the experiment. The rehearsal was carried out to increase CPR accuracy and reduce prejudice against accuracy. Moreover, to increase additional experiment accuracy, the subjects were requested not to be engaged in excessive physical activities and drinking a day before the experiment. They were to perform the experiment with a mattress set up on the flat floors so the subjects can avoid pain on knees when performing CPR. A certain amount of time for rest was given between the two groups in consideration of the fatigue and health condition of the subjects. Moreover, the participants were not to share their views among themselves about the content of the experiment in participation.

The CPR quality measurement tool in this experiment was Resusci Anne w/ Skillreporter by Laerdal, and the evaluation items of chest compression were average depth (mm), average compression speed (times/min), total number of compressions (times), accuracy (times), accuracy (%), number of inaccurate compressions (times), poor compression location (times), and insufficient relaxation (times). The performance of the experiment consisted of 5 cycles with the ratio of chest compression and artificial respiration at 30:2 with reference to the studies by 12,13, and the research procedure is as shown in Figure 1.

### 2.4 Method of Analysis

The test for difference in average per gender and measurement variable for the two groups was conducted using two-way ANOVA. The significance level was set as 5%.

### 3. Research Results

The results of comparing the CPR accuracy of the group with the noise level of at least 70dB and the group with the noise level below 70dB are as shown in Table 2. In chest

<table>
<thead>
<tr>
<th>Group with the noise level of at least 70dB</th>
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<tbody>
<tr>
<td>Assign 1 lecture hall that meets the experiment requirements</td>
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<tr>
<td>One rehearsal 2 hours before the final experiment: Little Anne</td>
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<tr>
<td>Final experiment and measurement (5 cycles): CPR(30:2)</td>
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<td>Average depth, average speed, accuracy(%)</td>
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<td>compression depth error rate</td>
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<tr>
<th>Group with the noise level below 70dB</th>
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<tr>
<td>Assign 1 lecture hall that meets the experiment requirements</td>
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<tr>
<td>One rehearsal 2 hours before the final experiment: Little Anne</td>
</tr>
<tr>
<td>Final experiment and measurement (5 cycles): CPR(30:2)</td>
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**Figure 1.** Experiment procedures.
compression, the average depth and accuracy was greater in the group with the noise level below 70dB (55.97mm) than the group with the noise level of at least 70dB (54.54mm) (p<.05). Average compression speed (times/ min) showed no statistically significant difference with the group with the noise level of at least 70dB at 116.50 times/min, and the group with the noise level below 70dB at 118.46 times/min. Chest compression accuracy (%) was higher in the group with the noise level below 70dB (141.98 times, 94.06%) than the group with the noise level of at least 70dB (132.26 times, 87.41%) (p<.05). The number of chest compression depth error (too weak, times) was greater in the group with the noise level of at least 70dB (13.94 times) than the group with the noise level below 70dB (7.27 times) with statistical significance (p<.05).

4. Discussions

The objective of performing CPR is to minimize tissue damage by supplying oxygen and blood to the patient’s brain and heart and maintain the functions as much as possible. Saving life of a cardiac arrest patient depends on CPR quality, which includes number of chest compressions, chest compression depth, compression speed, and accuracy of artificial respiration. As such, a patient’s survival is determined by appropriate chest compression and prompt CPR performance.

This study examined whether noise that exists in daily life affects the rescuer’s ability and CPR performance even though it is not provided in the general CPR guidelines. The results of the experiment showed that the place with the noise level below 70dB had greater average compression depth than the group with the noise level of at least 70dB. Average compression speed was normal in both groups, but the one with lower noise level showed a slightly higher speed as well as higher accuracy (%). Too weak chest compression (times) occurred more frequently in the group with the noise level of at least 70dB.

This study proved that accuracy of chest compression was generally higher in the group with the noise level below 70dB than the group with the noise level of at least 70dB. This indicates that noise and vibration is a living...
experience inevitably encountered in daily life regardless of whether one perceives it or not, and thus a constantly existing condition may damage an individual’s ability and work efficiency.

Moreover, there are various sounds and noises around us, and being exposed to such noises for a long time or in high levels may have unfavorable effects on humans. The Korea Environmental Preservation Association (1988) shows that noise deteriorates work efficiency.

This study proves that accuracy of chest compression was generally higher in the group with the noise level below 70dB than the group with the noise level of at least 70dB. Through this, we think it is necessary to create a calm environment in CPR education and performance, and to actively encourage CPR performance.

5. Conclusion and Suggestions

5.1 Conclusion

The results of comparing chest compression accuracy according to the existence of surrounding noise in CPR performance are as follows.

- Average chest compression depth was greater in the group with the noise level below 70dB (55.97mm) than the group with the noise level of at least 70dB (54.54mm) (p<.05).
- Average compression speed (times/min) was clinically close to the normal range (at least 100 times on average) with the group with the noise level of at least 70dB at 116.50 times/min, and the group with the noise level below 70dB at 118.4658 times/min.
- Chest compression accuracy (%) was higher in the group with the noise level below 70dB (141.98 times, 94.06%) than the group with the noise level of at least 70dB (132.26 times, 87.41%) (p<.05).
- Too weak chest compression (times) was higher in the group with the noise level of at least 70dB (13.94 times) than the group with the noise level below 70dB (7.27 times) (p<.05).

5.2 Suggestions

Future research must expand the scope of research to a comparative study on the general public or experts, and examine hemodynamic changes in a more accurate environment for experiment. Moreover, it is necessary to conduct research that enables smooth communication during rescue by using media (e.g., Bluetooth earphones) to reduce the surrounding noise in order to improve the rescuer’s ability and work efficiency in performing CPR.

6. References

8. (The) research for the application status of basic CPR and AED by the hospital nurse [Unpublished master's thesis]. Seoul, Korea: Yonsei University; 2006.