Accuracy of Pulse Checks in Terms of Basic Life Support by Lifesavers, as Lay Persons

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Background: The lifesavers responsible for lifesaving at the waterside routinely undergo cardiopulmonary resuscitation (CPR) training, but in Japan, they are considered as lay persons. Lifesavers are likely to have better basic life support skills than lay persons. The objective of this study is to demonstrate that the accuracy of carotid pulse checks by lifesavers is not inferior to that of paramedics and is superior to that of lay persons by using CPR training mannequins.

Methods and Results: This was an observational study in which the subjects included 48 lifesavers certified by the Japan Lifesaving Association, as well as 16 paramedics and 15 lay persons. The accuracy of the examinees’ answers and the time taken to answer in the 3 groups were compared. The accuracy rate was 93% in lifesavers, 94% in paramedics, and the difference was not significant (P=1). The accuracy rate of the lay persons’ answers was 63%, with significant differences between this group and the lifesavers (P<0.001) and the paramedics (P<0.001). The average time taken to answer the questions was 6.6 s for the lifesavers and 7.0 s for the paramedics, and the difference was not significant (P=0.44). The average time taken to answer the questions from the lay persons group was 20.5 s, with significant differences between this group and the lifesavers (P<0.001) and the paramedics (P<0.001).

Conclusions: The results of this evaluation, using CPR-training mannequins, to test the accuracy of carotid pulse checks by lifesavers were equivalent to those of paramedics and superior to those of lay persons. (Circ J 2010; 74: 1895–1899)

Key Words: Basic life support; Cardiopulmonary resuscitation; Circulatory state; Lifesavers pulse check

The early return of spontaneous circulation (ROSC) after cardiac arrest can provide better long-term neurological outcomes. To achieve early ROSC, high-quality bystander cardiopulmonary resuscitation (CPR) and an effective pre-hospital lifeline system are keys to early ROSC.

Many medical reports state that it is difficult for lay rescuers to accurately judge whether there is a pulse by palpating the carotid artery in the first step of basic life support (BLS). Flesche et al investigated the extent to which medical students and emergency medical service (EMS) personnel were able to perform pulse checks on mannequins and found that only 9.7% of them were able to do so. Moreover, when medical students were asked to check the pulse of unconscious patients, it took 18.3 s for them to answer. Flesche et al also used mannequins to investigate the ability of lay persons to check for a pulse after just completing a 12-h first-aid training course that included CPR, and the results showed that 22% of them were able to perform a pulse check accurately.

Bahr et al had lay persons check the pulse of healthy adults and found that 47.4% were able to perform an accurate pulse check within 5 s.

Eberle et al had lay persons and paramedics check the carotid pulse of patients who had undergone an aortocoronary bypass operation, and found that 53% of the lay persons and 89% of the paramedics were able to accurately judge whether there was a carotid pulse. Moreover, the time required to judge this averaged 24 s (22 s for patients who had a pulse, and 32 s for patients who did not have a pulse), and thus it took longer to judge in the patients who did not have a pulse.
Cummins and Hazinski calculated the following percentages based on the data obtained by Eberle et al in regard to lay persons: proportion who replied, “There’s a pulse”, when there was a pulse, 93%; proportion who replied, “There’s no pulse”, when there was no pulse, 45%; proportion who were able to judge accurately, 65%. In addition, Cummins and Hazinski warned that CPR would not have been performed for 10% of the cardiac arrest patients because of incorrect judgments about whether there was a pulse.9

Based on the above data, the statement that lay persons should check for a pulse in order to determine whether circulatory arrest had occurred before starting CPR, which had been performed up until then, was deleted from the 2000 version of the Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Guidelines (CPR & ECC Guidelines 2000).10 The new Guidelines recommended observing whether the victim was breathing and coughing and has body movements instead of checking for a pulse as the method for lay persons to determine whether cardiac arrest has occurred.10 “Occasional gasps” was added in the CPR & ECC Guidelines 2005.11 In contrast, it is said that the method of circulatory evaluation performed by health-care providers, such as physicians, nurses, and paramedics, is a pulse check, and that it should be performed within 10s.

In order to avoid incorrect judgments or taking a long time to make pulse checks by lay persons that results in failure or delay in instituting chest compression, it is better to judge that an unconscious injured or ill person who is not breathing normally, coughing, or making body movements is in cardiac arrest, and to immediately institute chest compression. At the same time, however, neither is there any evidence that observation of breathing, coughing, or body movements is superior to a pulse check as a means of evaluating the circulation.12

Moreover, the reason for evaluating circulatory dynamics is not just to judge whether to institute CPR. It is also important for evaluating the restoration of a pulse during CPR. For example, when an automated external defibrillator (AED) is used and the pulse has resumed, the voice prompt message simply says that shock is unnecessary. Occasions when shock with an AED is unnecessary consist of times when cardiac arrest has occurred but electrical shock is not indicated, such as asystole and pulseless electrical activity, and times when the pulse has resumed and there is a normal ECG. These 2 occasions must be differentiated, and at such times a pulse check is important, the reason being that often breathing, coughing, body movements, etc. are not observed immediately after the pulse resumes. Moreover, it is also necessary to check for a pulse to diagnose cardiac arrest in the form of pulseless electrical activity and pulseless ventricular tachycardia, in which no pulse is palpated.

Furthermore, checking for a carotid pulse is nothing more or less than confirming blood flow to the brain, which is important as a target organ during CPR. Therefore, a carotid pulse check is considered to be significant, the same as observing breathing, coughing, and body movements.

If someone is capable of checking for a pulse accurately, it is not acceptable for that person to not hesitate to check for a pulse, the same is recognized for health-care providers.

Lifesavers themselves perform regular physical training as well as engage in drills to rescue drowning persons and first-aid practice, including CPR (BLS).

There are approximately 2,000–2,500 active lifesavers in Japan, but they are not regarded as so-called health-care providers under Japanese law. Their CPR skills, for which they routinely continue to constantly train, appear to be rather superior to those of lay persons.

In this study we used mannequins for CPR training in 2 groups, a group of lifesavers and a group of paramedics, and compared the accuracy of their pulse checks according to whether there actually was a carotid pulse. In Japan, paramedics are classified as health-care providers and check for a carotid pulse as a method of evaluating the circulation during CPR. The hypothesis that this study was conducted to test was that the accuracy of carotid pulse checks by lifesavers is not inferior to that of paramedics.

**Methods**

This study was an observational study and compared the accuracy of pulse checks on mannequins used for CPR training by 3 groups, a group of lifesavers, a group of paramedics and a group of lay persons, according to whether a carotid pulse was actually present.

A balloon was embedded in the carotid artery part of the CPR practice mannequin (Resusci Anne, Laerdal Medical Japan K.K.) and was connected to a cuff. The examiner simulated the presence of a carotid artery pulse by squeezing the cuff at a rate of 60 times a minute.

The lifesavers who served as the subjects were lifesavers who had participated in the Instructor training course hosted by the Japan Lifesaving Association in March, 2008 (N.B.).

When the examiner gave the “start” signal, the examinee started to check for a carotid pulse. As soon as the examinee decided whether it was present, the examinee answered orally, “There’s a pulse” or “There’s no pulse”. The time required to reply was recorded with a stopwatch (SEIKO water-resistant plastics S031-4000, Seiko Sports Life Co, Ltd, Tokyo, Japan). Each examinee was tested 10 times. Whether a pulse would be present in each trial was determined at random in advance by a heads-or-tails coin toss. The lifesavers’ trials were performed at the training course venue.

The Japan Lifesaving Association conducts CPR training courses in a curriculum in accordance with the AHA in regard to CPR, and all of the lifesavers who belong to the association are obligated to attend the CPR training course. New participants in the lifesaver association must first attend the CPR training course and then qualify as a Basic lifesaver. When 1 year or more of patrol experience has been completed after obtaining the Basic qualification, the lifesaver can acquire the Advanced lifesaver qualification. When 1 year or more of patrol experience has been completed after obtaining the Advanced qualification, the lifesaver can acquire the Instructor qualification.

The paramedics in the control group were current practitioners who had come to the Emergency and Critical Care Center of Tokai University Hospital during the period between April and June 2008 for the hospital training mandated by the Emergency Life-Saving Technicians Act. The trials were conducted at the center, and they each took a 10-trial test, the same as the lifesavers.

Clerks and cleaning staff members of the hospital were enrolled in this study as laypersons.

The following parameters were calculated from the answers
obtained from the lifesaver group and the paramedic group:
Sensitivity (trials when the answer was "There’s a pulse" as a percentage of the trials when there was a carotid pulse);
Specificity (trials when the answer was "There’s no pulse" as a percentage of the trials when there was no carotid pulse);
Accuracy rate (trials when the answer was correct as a percentage of the number of trials, irrespective of whether there was a pulse).

The results on the sensitivity, specificity and accuracy were compared among the 3 groups. The \( \chi^2 \) test and multiple comparisons (Bonferroni type) were conducted, and differences at \( P<0.05 \) were regarded as being significant. The results on the time taken to answer were also compared among the 3 groups. Analysis of variance and multiple comparisons were conducted, and differences at \( P<0.05 \) were regarded as being significant.

Results

This study was conducted using 48 lifesavers (mean age, 32.9±7.5 years; 37 men and 11 women; mean length of experience [in years] as lifesavers, 11.8±7.1 years), 16 paramedics (mean age, 32.6±9.2 years; 16 men and no women; mean length of experience [in years] as paramedics, 5.2±4.2 years), and 15 lay persons (mean age, 40.9±15.1 years; 5 men and 10 women). There were no significant differences in the age distribution among the 3 groups.

All the lifesavers who participated in this study had participated in the Instructor training course sessions; 16 paramedics and 15 lay persons also participated.

The results for the lifesavers’ answers are shown in Table 1. Sensitivity was 92%, specificity was 95%, and accuracy was 93%.

The paramedics’ answers are shown in Table 2, and their sensitivity, specificity, and accuracy were 97%, 92%, and 94%, respectively.

The lay persons’ answers are shown in Table 3, and their sensitivity, specificity, and accuracy were 51%, 77%, and 63%, respectively.

There were no significant differences between the lifesavers’ and the paramedics’ answers in terms of sensitivity (\( P=0.66, 95\%CI=0.011 \text{ to } 0.128 \)), specificity (\( P=0.97, 95\%CI=0.123 \text{ to } 0.052 \)) and accuracy (\( P=1, 95\%CI=0.045 \text{ to } 0.066 \)).

In contrast, there were significant differences between the lifesavers’ and the lay persons’ answers in terms of sensitivity (\( P<0.001, 95\%CI=0.101 \text{ to } 0.128 \)), specificity (\( P=0.97, 95\%CI=0.123 \text{ to } 0.052 \)) and accuracy (\( P=1, 95\%CI=0.045 \text{ to } 0.066 \)).

In the presence of a pulse, the time taken for giving an answer was 4.64±4.91 s in the lifesaver group, 3.50±3.13 s in the paramedic group, and 19.19±15.23 s in the lay person group. There was no significant difference between the lifesaver group and the paramedic group (\( P=0.52, 95\%CI=1.303 \text{ to } 3.580 \)), whereas the differences between the lifesaver and lay person groups (\( P<0.001, 95\%CI=16.930 \text{ to } 12.163 \)) and the

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**Table 1. Performance of Pulse Check by Lifesavers**

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<th>Pulse is present</th>
<th>Pulse is absent</th>
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<tr>
<td>Rescuer thinks pulse is present</td>
<td>228</td>
<td>11</td>
<td>239</td>
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<tr>
<td>Rescuer thinks pulse is absent</td>
<td>21</td>
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<tr>
<td>Totals</td>
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**Table 2. Performance of Pulse Check by Paramedics**

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<td>7</td>
<td>81</td>
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<tr>
<td>Rescuer thinks pulse is absent</td>
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<td>Totals</td>
<td>76</td>
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**Table 3. Performance of Pulse Check by Lay Persons**

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<td>Rescuer thinks pulse is present</td>
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<tr>
<td>Rescuer thinks pulse is absent</td>
<td>40</td>
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<td>93</td>
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<tr>
<td>Totals</td>
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<td>69</td>
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paramedic and lay person groups (P<0.001, 95%CI –18.661 to –12.710) were significant.

In the absence of a pulse, the time taken for giving an answer was 7.49±5.18 s in the lifesaver group, 10.24±14.53 s in the paramedic group, and 22.07±14.77 s in the lay person group. The time required to deliver a judgment tended to be longer in the paramedic group than in the lifesaver group, but the difference was not significant (P=0.08, 95%CI –5.763 to 0.265). The differences between the lifesaver and lay person groups (P=0.001, 95%CI –17.829 to –11.338) and the paramedic and layperson groups (P<0.001, 95%CI –15.678 to –7.991) were significant.

Discussion

The validity of the sample size in this study was investigated by analysis of power. The analysis included 480 lifesaver cases (48 lifesavers×10 trials), 160 paramedic cases (16 paramedics×10 trials), and 150 lay person cases (15 lay persons×10 trials). Under the conditions including a significance level of 0.05, a medically significant difference of 0.1, and the accuracy of the paramedics’ answers of 0.94, the analysis of power was 0.95 (95%) and the β error was 0.05 (5%). The results indicated that the power was adequately high.

The CPR training mannequins used in this study are widely used throughout the world, and they are useful as simulation training for practicing basic CPR skills or for evaluating the achievement level acquired in the OSCE (Objective Standardized Clinical Examination).

However, there are several problems. The feel of the simulator carotid artery and actual patients’ carotid artery is different. It is better if training can be performed on actual patients in the way that Eberle et al used patients during open heart surgery, but it seems unrealistic for many beginners to participate and perform it in that way.

For the sake of convenience in the present study, the examiners manipulated the cuff to create pulses at a rate of 60 beats/min, whereas in reality, there are times when there are rapid pulses and slow pulses. As the manipulations by the examiner were manual manipulations, the blood pressure also was not always uniform, and the “blood pressure” level was unclear. Moreover, if the patient is obese, it is even more difficult to feel the carotid pulse, and pulse checks on actual patients appear to be more difficult than on a simulator.

Thus, the results of the present study were obtained with a mannequin simulator that modeled the carotid artery, and accuracy with the mannequin was 93% in the lifesaver group and was not significantly different from the 94% in the paramedic group; however, accuracy in actual patients might be different.

The definition of a “health-care provider” stated in the guidelines is vague. For CPR performed by health-care providers, they state to perform a pulse check as a means of evaluating the circulation, but the situation in regard to the occupations that are included under the category of health-care provider varies from country to country. In Japan, there are different levels of lifesavers, that is, Basic, Advanced (1 year after Basic), Instructor (1 year after Advanced), etc, depending on the number of years of experience and skill, but they are all regarded as lay persons. In Canada, in contrast, there are 2 levels: lifesaver and lifeguard (having acquired a Bronze Cross lifesaver qualification and a first-aid qualification are conditions), and lifesavers are the same as lay persons in regard to evaluating circulation, whereas lifeguards are permitted to perform pulse checks.13

Moreover, the treatment provided by practical nurses, midwives, medical engineers, etc, as tasks defined under the category of health-care providers is unclear. Moule investigated carotid pulse checking in mannequins by students from a variety of occupations, that is, physiotherapists (physiotherapy), radiologists (radiography), maternity nurses, and nursing students studying for a diploma in nursing, and found that accuracy rates varied considerably according to occupation, and Moule reported an accuracy rate within 10s of 38%.14

It appears necessary to verify the ability to accurately judge the state of the circulation on an individual basis and not lump all health-care providers together in terms of this skill.

Lifesavers are more likely than lay persons to encounter persons who are in cardiac arrest, and for that reason, unlike lay persons, their CPR training is often performed routinely, and their level of achievement of CPR skills appears to be superior to that of lay persons. According to the 2005 guidelines, lifesavers are regarded as lay persons in Japan, and pulse checks are not recommended for BLS. However, if it were possible for lifesavers to perform pulse checks accurately and rapidly and they are able to judge cardiac arrest in combination with observations of breathing, coughing and body movements, in a comprehensive manner, they would be better able to appropriately judge cardiac arrest or restore the heartbeat.

As the first step in becoming able to perform pulse checks, allowing lifesavers to acquire pulse check skills by using a simulator and testing their skills will be necessary as a medical education process. The results of the present study with a simulator showed the non-inferiority of lifesavers in comparison with paramedics in regard to the accuracy rate and time required to judge whether a carotid pulse was present. The next step will be an educational strategy that will enable pulse checks to be performed in actual patients. On-site training in clinical settings, such as emergency and critical-care centers, the same as that for medical students, would be necessary as part of this.

It would be preferable if lifesavers became able to conduct evaluations for CPR by performing the pulse checks that health-care providers perform instead of, as the guidelines state, just observing breathing, coughing and body movements as lay persons do.

Study Limitations

This study performed carotid pulse checks on mannequins that are used for CPR training. The ease of feeling and checking the carotid pulse on mannequins and actual patients is very different. The results (accuracy) of pulse checks on the mannequins and the results of pulse checks in actual patients are not always the same. However, because repeated sufficient practice on a simulator before performance on patients is a necessary condition in terms of education to acquire medical skills, the results obtained with the simulator in this study appear to be the first step. In the future, it will be necessary to further investigate the results in actual ill and injured persons.

Moreover, each individual performed 10 trials, and there appeared to be a learning effect during the 10 trials they performed. A single trial by each individual appears to be more realistic.
Conclusion
The accuracy and speed of carotid pulse checks on mannequin simulators by lifesavers are equivalent to those of paramedics and superior to those of lay persons. It would be desirable to establish an educational curriculum for persons like lifesavers, who are not regarded as health-care providers, but appear to possess better CPR skills than lay persons, so that after education on a simulator they could become accustomed to checking the carotid pulse of actual patients.

Disclosure
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References