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Simulation and education

Rescuer fatigue and cardiopulmonary resuscitation positions: A randomized controlled crossover trial☆

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ABSTRACT

Background: During cardiopulmonary resuscitation (CPR), it is recommended to alternate rescuers every 2 min when two or more rescuers are available, regardless of the rescuer's position. It is unclear, however, whether rescuer fatigue depends on the rescuer's position.
Purpose: To compare rescuer fatigue by doing CPR in different positions.
Methods: This randomized controlled crossover trial studied 24 experienced health-care providers from a teaching hospital in southern Taiwan. Each participant performed CPR for 10 min on days 1, 8, and 15 of the study in three different positions: kneeling, standing on a taboret, and standing on the floor. Effective compression was recorded using the Laerdal Resusci-Anne Skillreporter manikin. The range of motion (ROM) of the elbows and lower back were detected using a flexible goniometer, and the severity of back pain was scored using the Brief Pain Inventory short-form.
Results: Rescuers maintained adequate effective compressions for 2 min while kneeling and standing on a taboret, but only for 1 min while standing on the floor. The ROM for elbows and lower back during CPR while kneeling were significantly lower than for standing on the floor. Moreover, the total pain ($p < 0.001$) and social interference ($p = 0.004$) scores 24 h after CPR were significantly lower for the kneeling position.
Conclusions: CPR is best performed in a kneeling position. In order to minimize rescuer fatigue, we recommend alternating rescuers every 2 min while kneeling or standing on a taboret, and every 1 min while standing on the floor.

1. Introduction

The performance of high-quality and effective chest compressions is one of the key elements of the "chain of survival" of cardiac arrest.[1] Adequate cardiopulmonary resuscitation (CPR) not only creates blood flow delivering oxygen to the brain and myocardium but also increases the effectiveness of shock in patients with ventricular fibrillation.[2–4] Coronary perfusion pressure is better maintained during cardiac arrest when compressions are continuous than when they are interrupted.[5] However, some studies reported significant fatigue and shallow compressions as early as 1 min after beginning CPR,[6] which can seriously affect the outcome.

According to the 2005 guidelines of the American Heart Association (AHA) for CPR and emergency cardiovascular care (ECC),[1] rescuer fatigue leads to an increase in the ineffective compression rate and a decrease in the compression depth. Therefore, when two or more rescuers are available, it is recommended to alternate rescuers every 2 min. Theoretically, this recommendation should be followed in order to avoid or minimize the adverse effects of rescuer fatigue, but in some circumstances, a rescuer needs to perform CPR alone for longer periods of time. Furthermore, the rescuer may be compelled by situational circumstances to perform CPR in various positions.

There are three common positions for performing CPR in or out of the hospital: kneeling, standing on a taboret, and standing on the floor. In the kneeling position, the rescuer kneels on a stable base just beside the patient. Standing on a taboret is frequently applied when the patient is lying on a bed, which allows the rescuer to

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keep the upper limbs perpendicular to the chest wall of the patient. Standing on the floor often occurs when a taboret is not available, and the rescuer generally stands beside the bed on tiptoes trying to keep the upper limbs perpendicular to the patient's chest wall.

We performed a thorough literature review and found two studies on the effects of CPR positions on rescuer fatigue, one in Hong Kong[7] and the other in Taiwan.[8] Neither of them found significant differences in compression effectiveness among different positions. However, in the Taiwan study the interval between different positions lasted for only 50 min, and therefore the participants might not have full recovery before undertaking the subsequent position. Therefore, we conduct a randomized controlled crossover trial with 1 week apart between each of the sessions with different CPR positions.

2. Materials and methods

2.1. Study design

We conducted this trial in a medical center in southern Taiwan. The participants performed CPR on a Laerdal Resusci-Anne Skillreporter manikin (Norway) on the 1st, 8th, and 15th days of the study in three positions: kneeling, standing on a taboret, and standing on the floor. With three positions, six different sequences can be drawn for randomization (from A to F) (Fig. 1). In order to ensure the allocation was concealed, we designed several steps for randomization process. First, we prepared 4 lots for each sequence, making up a total of 24 opaque sealed lots in one drawing box. Second, the lots were done with no detectable differences in size or weight. Third, the lots were drawn after the participants were informed and signed the consent. Fourth, since the participants were not recruited all at once, the drawing process was done separately, so that the participant was unaware of the sequences of other participants.

No participant was allowed to take any pain control medication during the study. Furthermore, they were asked to avoid strenuous exercise that could affect or induce any kind of fatigue. If participants had any intolerable discomfort, including back pain, they could drop out from the study.

2.2. Setting

We recruited 14 physicians and 14 nurses working in the emergency department (ED) of the medical center, which had about 132,000 patients visit in 2007. A qualified candidate must have a clinical work experience longer than 2 years and had performed CPR more than 20 times. Candidates with herniated intervertebral disc (HIVD), previous spinal surgery, anklyosing spondylitis or other autoimmune diseases, and pregnancy, as well as those who could not follow the sequence of randomization, were excluded. The above inclusion and exclusion criteria were designed to construct a study population consisting of healthy, experienced health-care providers. Four of the volunteers were excluded before the randomization, including two with HIVD and another two who were unable to follow the CPR sequence. A final total of 24 volunteers participated in our study.

2.3. Intervention

Each participant performed CPR on the manikin for 10 min in each of the three positions in a sequential manner on days 1, 8, and 15. They were asked to push "fast" and "hard" for 10 min continuously without pause. A skill-reporter was placed in front of the participant, and it contained a metronome set at a rate of 100 time/min to control the frequency of chest compression. The regular heights of the taboret and the bed were 22 cm and 60 cm, respectively, but in order to optimize comfort during CPR on a taboret, the bed was adjusted to level the lower edge of the par-

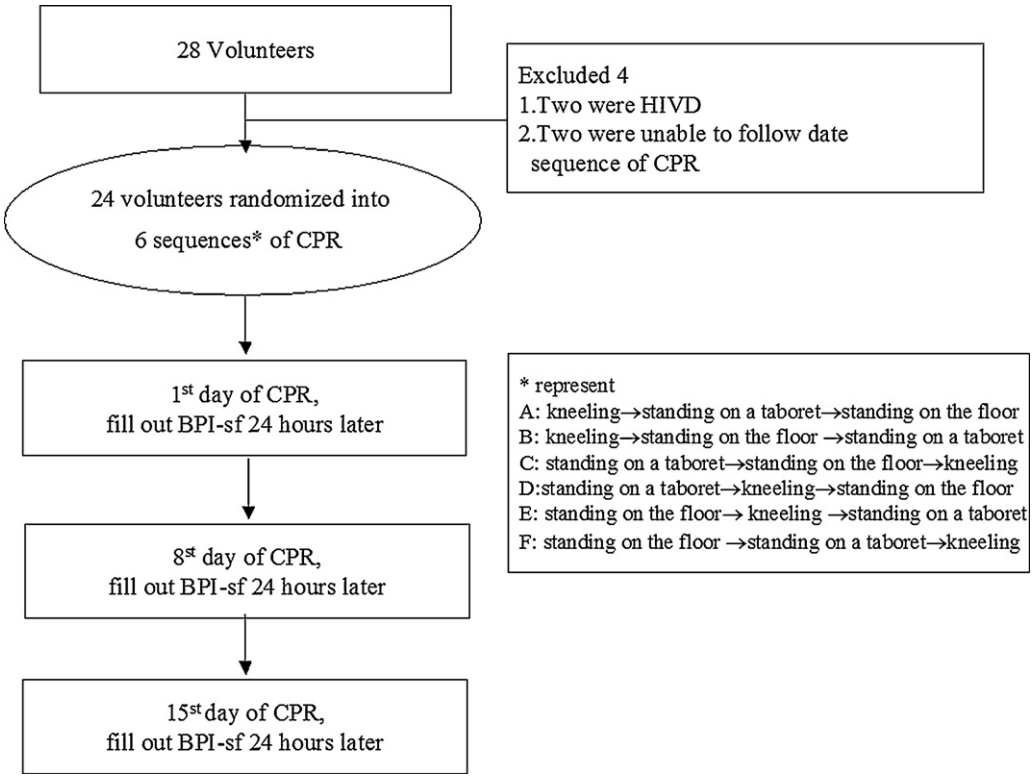

Fig. 1. Flowchart of the study. HIVD, herniation of intervertebral disc; CPR, cardiopulmonary resuscitation; BPI-sf, Brief Pain Inventory-short form.