SIGNA VITAE 2012; 7(1): 28 - 31

ORIGINAL

Does the change of educational strategy for chest compression based on the change of guidelines affect on the quality of prehospital chest compression?

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ABSTRACT

Background and Aims. International guidelines for cardiopulmonary resuscitation (CPR) changed their strategy with respect to the rate of chest compression (CC) and ventilation from 15:2 to 30:2. The object of this study was to clarify the effect of this change on the quality of CPR.

Subjects and Methods. We recorded the frequency of CC and ventilation performed by Emergency Life Support Technicians (ELSTs) during CPR in ambulances, and compared the period when ELSTs performed 15:2 CPR with that when they performed 30:2 CPR.

Results. During the first period, ELSTs actually performed CCs 15 times per 7.2 sec (128.1 times per minute), and performed 2 ventilations per 4.5 sec. Thirty-six percent of patients received appropriate CCs (100-120/min), while 43% received high-frequency CCs (120-150/min) and 13% received CCs that were too fast (more than 150/min). During the second period, ELSTs performed CCs 30 times per 18.1 sec (101.6 times per minute), and performed 2 ventilations per 4.3 sec.

Conclusions. The change in the CC-to-ventilation ratio for CPR in the international guidelines from 15:2 to 30:2 can improve the exactness of the frequency of CCs. However, ELSTs may not be able to perform CCs exactly as recommended. It is important to evaluate the exact frequency of CCs by ELSTs or paramedics in ambulances and to evaluate the relationship between the frequency of CCs and patient outcome.

Key words: organized and nonorganized rapid response system, rapid response team, in-of-hospital cardiac arrest, in-hospital whole paging system

Introduction

International guidelines for cardiopulmonary resuscitation (CPR) recommend 100 chest compressions (CCs) per minute and ventilation for a minimum time. The guidelines of 2000 recommend a CC-to-ventilation ratio of 15:2, but those of 2005 recommend 30:2. It is well known that even paramedics and other medical and comedical staff tend to perform CCs more slowly or quickly and to ventilate more slowly. (1-4) Excessively quick or slow CCs or excessively slow and large-volume ventilation are thought to be one of the most unfavorable factors because this decreases coronary perfusion, resulting in a worsening of the prognosis of cardiopulmonary arrest (CPA) patients. In Japan, prehospital CPR is often performed by Emergency Life Support Technicians (ELSTs) belonging to the fire department. Japanese ELSTs are licensed after 835 hours of lecture and 2,000 hours of experience on an ambulance crew, and they continue their training regularly after getting their licenses; they are subject to "medical control," that is, they are taught by medical doctors to work with a medically academic and practical viewpoint. (5) However, it remains unknown whether or not they are able to perform ideal and appropriate CPR in the ambulance. In the present study, we examined the actual conditions in which prehospital CPR is performed in the typical urban city of Yokohama.

Methods

1. The prehospital care system in Yokohama

Yokohama is the second largest city in Japan and has a surface area of 434 Km^2. The population of Yokohama is 3.68 million. The number of CPA outpatients is 4,971, and 3,409 patients were transferred to prearranged hospitals in 2008. We established a prehospital emergency medical service (EMS) system for CPA patients. We selected 12 special hospitals where the most severe patients, including those suffering CPA, are received and treated; these hospitals must receive CPA patients independent of their capacity (figure 1). One emergency director (a medical doctor) for the 12 hospitals carries out his duties in a central operation center in the emergency call center, advising the ELSTs and ordering treatment as well as ordering the transfer of CPA patients to the hospital. In Yokohama, CPA patients are typically transferred from the scene to the nearest of these 12 hospitals in 7.1 minutes.

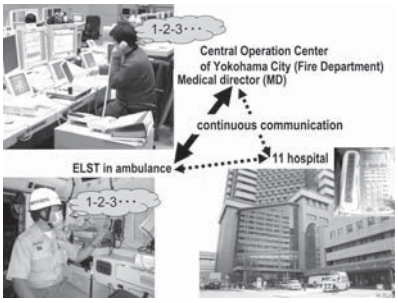
The emergency director receives all emergency calls in the central operation center. In the case of CPA patients, the director must talk with ELSTs continuously and in real time from the time of the ELSTs' first contact with the patient to the patient's arrival at the hospital, and must be readily available for consultation with ELSTs on all problems concerning patient management during transfer (figure 2). During the course of these duties, the emergency director can detect the frequency of CCs and ventilation during CPR in the ambulance. (5-7)

2. Study design

We recorded the frequency of CCs and ventilation performed by ELSTs during CPR in ambulances, and compared between the first period, when ELSTs performed CPR according to the 2000 guidelines (15:2 CPR, n=73), and the second, when they performed CPR according to the 2005 guidelines (30:2 CPR, n=74). Statistical analysis was performed using Student's t-test.

Results

During the first period, ELSTs performed CCs 15 times per 7.2 sec (128.1+/-24.9 times per minute), and performed 2 ventilations per 4.5+/-0.9 sec. Thirty-six percent of patients received appropriate CCs (100-120/min) while 43% underwent high-frequency CCs (120-150) and 13% received CCs that were too fast (more than 150/min). During the second period, ELSTs performed CCs 30 times per 18.1 sec (101.6+/-15.5 times per minute), and performed 2 ventilations per 4.3+/-0.9 sec (figures 3, 4). There is statistical difference in the frequency of chest compression between the first period and the second period ($P<0.001$) but no difference in the duration of ventilation, which indicates ELSTs performed more appropriate CCs in the second period than in the first period and they were making progress in their techniques for CC.



ELST; emergency life saving technician.

Figure 1. The prehospital emergency medical service system in Yokohama: 11 hospitals (gray circles) receiving and treating patients with the most severe conditions, including cardiopulmonary arrest (CPA) patients, and receiving CPA patients independent of their capacity; and many other hospitals with emergency departments (small black circles).

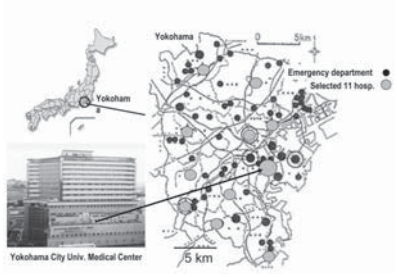


Figure 2. The prehospital emergency medical service system in Yokohama. The emergency director (a medical doctor) in the central operation and dispatch center of the emergency medical service (EMS) advises Emergency Life Support Technicians (ELSTs), who receive and treat patients with the most severe conditions. The emergency director talks with ELSTs and emergency physicians in the emergency departments of the 11 hospitals and can detect the frequency of chest compressions (CCs) and ventilation during cardiopulmonary resuscitation (CPR) in the ambulance.

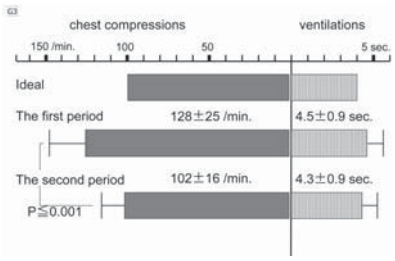


Figure 3. The mean frequency of chest compressions (CCs) and ventilation during the first period, when Emergency Life Support Technicians (ELSTs) performed cardiopulmonary resuscitation (CPR) following the 2000 guidelines (15:2 CPR), and the second, when they performed CPR according to the 2005 guidelines (30:2 CPR).

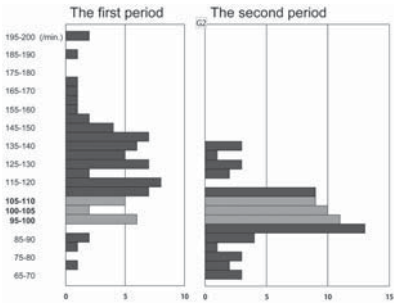


Figure 4. Histogram of the frequency of chest compressions (CCs) during the first period, when Emergency Life Support Technicians (ELSTs) performed cardiopulmonary resuscitation (CPR) according to the 2000 guidelines (15:2 CPR), and during the second period, when they performed CPR according to the 2005 guidelines (30:2 CPR).

Discussion

The 2005 guidelines for CPR (2) recommend that lay rescuers and healthcare providers perform CCs for adults at a

Figure 5. A standard Japanese ambulance, which has a small and narrow space around the patient.

rate of at least 100 compressions per minutes. Some clinical trials and laboratory studies have shown that high-frequency CCs (120-150/min) improves hemodynamics compared to standard CCs, (8-11) while other clinical and laboratory studies have found no effect of high-frequency CC and no improvement in hemodynamics over standard CPR. (12-14) Some authors have shown that even well trained paramedics tend to perform CCs faster than the appropriate frequency, (1) which may result in insufficient coronary perfusion. However, to the best of our knowledge, there has been no report concerning whether changing the ratio of chest compressions to ventilation improves or worsens the quality of CPR.

Prehospital emergency teams, such as ELSTs or paramedics, perform CCs in a moving ambulance under poor conditions, with narrow space, unstable and vibrating foot scaffolds and stretchers, sudden stops and starts, etc. (15) Japanese ambulances are usually very small in size and their inner space is very narrow (figure 5); there is no doubt that it is difficult to perform appropriate CPR in an ambulance. Moreover, in the narrow space of an ambulance, it may be difficult or impossible for one ELST to trade places with another quickly in order to perform high quality CCs. In some cases, a single ELST must continue to perform CPR for a long time, resulting in fatigue and inappropriate CPR, with CCs either faster or slower than recommended.

ELSTs are taught to perform 100 CCs per minute during CPR. Although high-frequency CPR may produce good results, it is an indication that the ELST, for whatever reason, is unable to follow the recommended procedure. In Japan, ELSTs are not permitted to deviate from the recommended procedure without specific direction from a medical doctor. It is important to evaluate the exact frequency of CCs performed by ELSTs or paramedics in ambulances and to examine the relationship between the frequency of CCs and their outcome.

We should introduce some method of controlling the frequency of CCs by ELSTs, such as a metronome, voice guide, automated external defibrillation (AED) device with voice guide or stopwatch, or we should introduce an automatic device that can perform regular CCs even in an ambulance. Additionally, ELSTs should be retrained repeatedly and frequently to perform appropriate CPR. In the selected 8 hospitals for retraining of ELSTs in Yokohama, ELSTs attend a 6-day and 6-night refresher course every 2 years in which they perform CPR on patients transferred to the hospital as on-the-job training. However, these refresher courses are insufficient to maintain the ability to perform CPR appropriately. Such training should be required more frequently and should be carried out under the supervision of a medical doctor.

Conclusion

The change in the international guidelines on the recommended CC-to-ventilation ratio in CPR from 15:2 to 30:2 can improve precision in the frequency of CCs, however, it remains difficult for ELSTs to do CCs with great precision. It is important to evaluate the exact frequency of CCs by ELSTs or paramedics in ambulances and to examine the relationship between the exact frequency of CCs and their outcome. Additionally, ELSTs should be required to attend refresher courses more frequently and under the supervision of a medical doctor.

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