Commentary

Continuous or interrupted chest compressions for EMS-performed cardiopulmonary resuscitation

Hideo Inaba, Testuo Maeda

Department of Emergency Medical Science, Kanazawa University Graduate school of Medicine, Ishikawa 920-8641, Japan

Correspondence to: Hideo Inaba, MD, PhD. Professor and Chair, Department of Emergency Medical Science, Kanazawa University Graduate School of Medicine, 13-1 Takara-machi, Kanazawa, Ishikawa 920-8641, Japan. Email: hidinaba@med.kanazawa-u.ac.jp.

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High-quality cardiopulmonary resuscitation (CPR), which can supply blood to critical organs such as the heart, lungs, and brain, with an optimal level of perfusion pressure, is known to be essential for the return of spontaneous circulation (ROSC) and a good outcome in case of out-of-hospital arrests (OHCAs) (1,2). The CPR guidelines 2000 (3) recommended the use of ventilation for OHCA victims with a small tidal volume and low inspiratory pressure to avoid gastric inflation. These guidelines also recommended chest compression (CC) at a rate of 100 compressions per minute with a complete release of pressure after each CC to achieve optimal forward blood flow.

Since the publishing of the CPR guidelines 2000, increasing attention has been dedicated to the proportion of time spent performing or interrupting CCs. Coronary perfusion pressure is an important indicator pertaining to the ROSC (4,5). It has been reported that a desirable level of pressure is obtained only after CCs are continued for a longer period, and the level decreases rapidly after CCs are discontinued (6). In the revised CPR guidelines of 2005 (7,8) in Europe, the US, etc., the interruption of CCs was minimized to further improve the quality of CPR. A change in the compression to ventilation ratios from 15:2 to 30:2 and the initiation of CCs immediately after defibrillation were also introduced. Furthermore, to reduce the interruption of CCs by rhythm analysis with an automated external defibrillator (AED), defibrillation was delivered only once after a 2-min interval of rhythm analysis (known as the "1-shock strategy"). Moreover, the time taken to rescue breathing (inspiration) was reduced from 2 to 1 sec. For advanced life support, CCs at a rate of 100 per minute, with ventilations at a rate of 10 per minute without pauses, were applauded for patients who had been fitted with an advanced airway.

Many observational studies have reported that higher survival rates are often associated with a higher, and not lower, CC fraction (CCF) in patients with cardiac arrest and a shockable initial rhythm (9-12). A prospective cohort study showed that increased CCF among non-VF OHCA patients was associated with a trend toward an increased likelihood of ROSC (13).

In the December 3, 2015, issue of *NEJM*, the resuscitation outcomes consortium (ROC) in the US reported a trial comparing continuous and interrupted CCs during CPR performed by emergency medical service (EMS) personnel (14). A notable difference between this ROC report and earlier trials was the application of the CPR-process monitoring. Committee members periodically reviewed data and assessed whether prescribed targets for performance were met for measures such as enrollment rate, treatment-adherence rate, and key elements of concurrent care. The committee also made recommendations regarding steps to be implemented to increase the rates.

In this cluster-randomized trial, including 114 EMS agencies, 23,711 adult patients with non-traumatic OHCAs were assigned for primary analysis either to an intervention group (continuous CCs with asynchronous ventilation, n=12,653) or a control group (30:2 interrupted CCs with synchronous ventilation, n=11,058). Continuous CCs with asynchronized ventilation comprised a series of three cycles of continuous CCs without ventilation pauses followed by rhythm analysis until the ROSC or completion of three cycles of CPR, whichever occurred first. Interrupted CCs with synchronous ventilation comprised a series of three cycles of standard CPR, each cycle further comprised sets of 30 CCs with ventilation pauses at compression: ventilation ratio of 30:2. In either patient group, the duration of manual CPR prior to the first rhythm analysis was 30–120 s. This treatment period was followed by two cycles of manual CPR and rhythm analysis (each approximately 2-min long) in either group. Each cycle was followed by rhythm analysis until ROSC or three cycles of CPR, whichever occurred first.

During the active-enrollment phase, 1,129 of 12,613 patients (9.0%) in the intervention group and 1,072 of 11,035 patients (9.7%) in the control group survived to hospital discharge (after adjustment for cluster and sequential monitoring, P=0.07). Of the patients with data concerning neurological status, 883 of 12,560 patients (7.0%) in the intervention group and 844 of 10,995 patients (7.7%) in the control group survived with a modified Rankin scale score of 3 or less (after adjustment for cluster, P=0.09). However, patients in the intervention group were significantly less likely than those in the control group to be hospitalized (P=0.03). Furthermore, hospital-free survival was significantly shorter in the intervention group than in the control group (P=0.004). According to these results and those of subgroup analyses, the study group concluded that continuous CCs during CPR performed by EMS providers did not result in significantly higher rates of survival or favorable neurological outcomes.

The results of this trial are not surprising when we consider that this prospective randomized study included CPR-process monitoring and quality assurance in both intervention and control groups and that intervention was conducted in patients with non-EMS-witnessed and non-traumatic OHCA after arrival at EMS. However, the results of this study clearly did not conform with those of many previous observational studies (10-13) or recommendations from the latest AHA guidelines stating that for witnessed OHCA with a shockable rhythm, it may be reasonable for EMS systems with a priority-based, multi-tiered response to delay positive-pressure ventilation using a strategy of up to 3 cycles of 200 continuous compressions with passive oxygen insufflation and airway adjuncts (15).

As described in detail in the supplementary appendix, this protocol included CPR training and a review of optimal CPR and post-resuscitation care performance, a practical “hands-on” session, a post-training test, and additional training with feedback during a run-in phase. Presumably because of such training, the mean difference in CC fraction (the proportion of each minute during which compressions were given) among the treatment groups during the trial was very small. This may indicate the importance of continuous training in maintaining the CPR quality, characterized by the short interval between stopping CCs and delivering a shock, and the minimal interruption of CCs for ventilation and advanced life support procedures in the current standard 30:2 CPR.

This study did not determine whether there was any benefit from ventilation in EMS-witnessed OHCA because the intervention group received asynchronized ventilation. However, the results of this study may provide a warning against the over-reliance upon continuous CCs without standard positive pulmonary ventilation based on previous studies without quality assurance. Furthermore, the results suggest the need for future studies to determine optimal ventilation in patients with OHCA and develop ways of measuring the ventilation quality (including airway management) during resuscitation. For example, what is the optimal level of ventilation that provides adequate oxygenation of blood and delivery of oxygen to the critical organs? Moreover, is advanced airway management that minimizes the interruption of CCs by continuous training, which is harmful in terms of survival from OHCA (4,16,17)?

Although this study included quality assurance analysis of EMS-performed CPR, it is difficult to conduct a similar quality assurance strategy in clinical studies for bystander CPR. The quality of bystander CPR is known to be affected by many factors (18). Furthermore, it is still questionable whether compression-only CPR without ventilation is as effective as conventional CPR with ventilation (19). Our recent component analyses of compression and ventilation for bystander-witnessed OHCAs showed that ventilation is a significant component of BCPR, particularly when the etiology is non-cardiac in origin and the victims are aged less than 20 years (20). As stated in the newest guidelines (15), continuous quality improvement by identifying the problem that is limiting survival, and then by setting goals, measuring progress toward the goals, creating accountability, and having a method for change, were vital in improving outcomes from OHCAs in the community.

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Footnote

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