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CLINICAL PAPER

Increased chest compression to ventilation ratio improves delivery of CPR☆

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Summary
Objective: Chest compressions are interrupted during cardiopulmonary resuscitation (CPR) due to human error, for ventilation, for rhythm analysis and for rescue shocks. Earlier data suggest that the recommended 15:2 compression to ventilation (*C*:*V*) ratio results in frequent interruptions of compressions during CPR. We evaluated a protocol change from the recommended *C*:*V* ratio of 15:2—30:2 during CPR in our municipal emergency medical system.
Methods: Municipal firefighters ($N = 875$) from a single city received didactic and practical training emphasizing the importance of continuous chest compressions and recommending a 30:2 *C*:*V* ratio. Both before and after the training, digital ECG and voice records from all first-responder cases of out-of-hospital cardiac arrest were examined off-line to quantify chest compressions. The number of chest compressions delivered and the number and duration of pauses in chest compressions were compared by *t*-test for the first three 1 min intervals when CPR was recommended.
Results: More compressions were delivered during minutes 1, 2, and 3 during CPR with the 30:2 *C*:*V* ratio (78 ± 29, 80 ± 30, 74 ± 26) than with the 15:2 *C*:*V* ratio (53 ± 24, 57 ± 24, 51 ± 26) ($p < 0.001$). Fewer pauses for ventilation occurred during each minute with the 30:2 *C*:*V* ratio (1.7 ± 1.2, 2.2 ± 1.2, 1.8 ± 1.0) than with the 15:2 *C*:*V* ratio (3.4 ± 2.6, 4.7 ± 7.2, 4.0 ± 2.9) ($p \leq 0.01$). Degradation of the final ECG to asystole occurred less frequently after the protocol change (asystole pre 67.1%, post 56.8%, $p < 0.05$). The incidence of return of spontaneous circulation was not altered following the protocol change.
Conclusions: Retraining first responders to use a *C*:*V* ratio of 30:2 instead of the traditional 15:2 during out-of-hospital cardiac arrest increased the number of compressions delivered per minute and decreased the number of pauses for ventilation. These data are new as they produced persistent and quantifiable changes in practitioner behavior during actual resuscitations.

☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at 10.1016/j.resuscitation.2007.01.022.

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Introduction

Recent observations of cardiopulmonary resuscitation (CPR) have noted inadequate performance by trained providers.[1,2] These studies found that chest compressions are not performed for a large fraction of the time, that the depth and rate of compressions are inadequate and that ventilation is unreliable. Excessive ventilation has been associated with increased intrathoracic pressure that can adversely affect hemodynamics during CPR.[3] Likewise, interrupting chest compressions is associated with less effective coronary perfusion pressure during CPR.[4]

The ability of changes in protocol and directed training to improve performance of CPR during actual resuscitations has not been tested. There is evidence that various methods of targeted training can improve the performance of CPR under artificial testing conditions using manikins.[5–8] Nevertheless, skills decline over time in all groups that are tested.[9,10] Because time will elapse between training and use of resuscitation skills, a time-dependent decline may account for the poor performance observed during actual resuscitation situations.[1,2]

Review of electronic data recorded by our urban first-responder system during treatment of out-of-hospital cardiac arrest (OOHCA) during 2002—2003 revealed frequent interruption of chest compressions related to ventilation and use of an automated external defibrillator (AED) that was consistent with the experience of others.[11,12] Therefore, we implemented first responder retraining and protocol change during June 2004 that included an increase in the recommended chest compression:ventilation ratio to 30:2. This quality improvement activity afforded opportunity to assess the impact of a discrete training program on actual performance of CPR in the field. We report the effects of these changes on the delivery of chest compressions during the subsequent 12 months. Specifically, we hypothesized that specific changes in treatment protocols can reduce interruptions in chest compressions during actual resuscitation.

Materials and methods

Study design

Patient care data were recorded as part of quality assurance in our city's Bureaus of Fire and EMS. Data were abstracted for research under a Waiver of Informed Consent for minimal risk research approved by our Institutional Review board. In June 2004, specific protocol changes were instituted as a quality improvement activity. These changes were (1) to increase the chest-compression to ventilation ratio from 15:2 to 30:2, (2) to restrict the of the AED to a single shock when encountering ventricular fibrillation, and (3) to reduce the frequency of AED rhythm analysis from once every 60 s to once every 120 s. Only the time allotted for CPR was changed in the AED algorithm. These protocol changes were chosen based on clinical, animal, and simulator data.[4,11,13–15] The times required for analyses, charging, and shock delivery were not altered (Figure 1). All 850 firefighters were retrained at that time using a one-hour didactic session immediately followed by three hours of CPR skill performance.

Our city has a resident population of 340,000 and a daytime population exceeding one million.

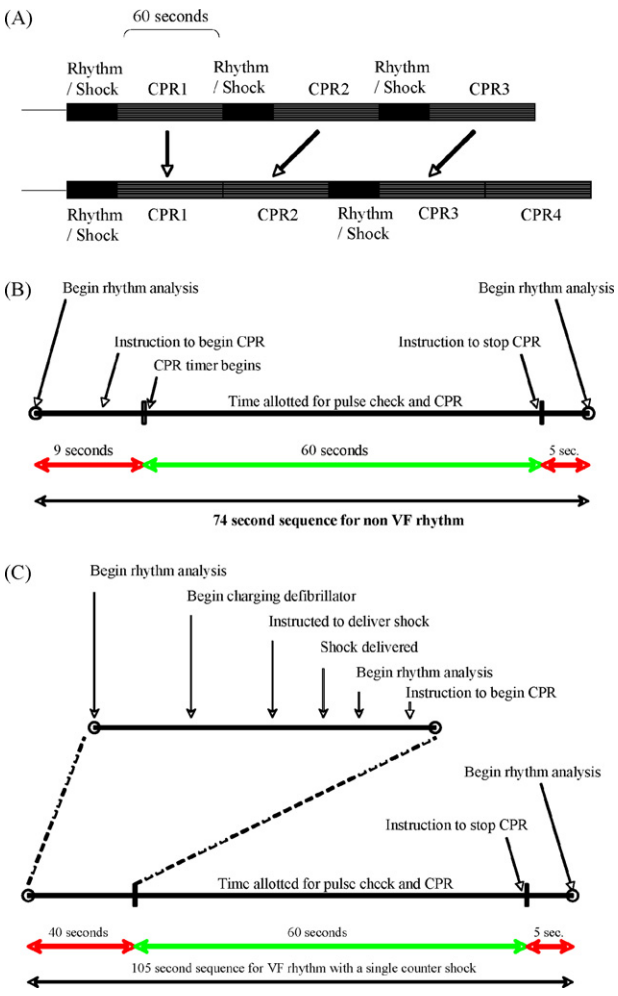

Figure 1 Schematic representation of the three 60 s epochs provided for CPR before and after the protocol change (A) and the time intervals required for AED analysis in PEA and asystole rhythms (B) and analysis/rescue shock in VF rhythms (C) not altered by the protocol change.