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To Breathe, or Not to Breathe, That is the Question

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The publication of the National Academy of Sciences scientific statement on cardiopulmonary resuscitation (CPR) in 1966 was a pivotal moment in modern era of cardiac arrest care.[1] This scientific statement recommended that CPR consist of both exhaled air ventilations and chest compressions, and that is how standard CPR (S-CPR) was taught and performed for the next half-century.

In 1997, the American Heart Association (AHA) first revisited the role of rescue breathing during CPR based on emerging laboratory and clinical research demonstrating the efficacy of chest compressions alone during cardiac arrest.[2] However, at that time there was inadequate evidence to make specific recommendations. In 2000, AHA first recommended compression-only CPR (CO-CPR) in circumstances when rescuers were unwilling or unable to perform mouth-to-mouth rescue breathing or for dispatcher-assisted CPR instruction.[3] Over the subsequent years, a growing body of evidence emerged to support the efficacy of CO-CPR and its positive impact on bystander CPR rates, resulting in significant evolution AHA and other international CPR guidelines.

The most recent 2017 AHA and Emergency Cardiovascular Care Science Focused Update on Basic Life Support for adult out-of-hospital cardiac arrest recommends CO-CPR for untrained rescuers and those trained in CO-CPR.[4] When dispatcher instruction is needed, it is recommended that dispatchers provide CO-CPR instructions. However, when a lay rescuer is trained in CPR using chest compressions and rescue breaths, the guidelines now state it is “reasonable” to provide rescue breaths in addition to chest compressions. The weakened recommendation on rescue breaths was based on persistent uncertainty regarding the relative efficacy of S-CPR versus CO-CPR for adults in cardiac arrest when delivered by lay providers. However, for infants and children in cardiac arrest, CPR using chest compressions with rescue breaths continues to be recommended unless bystanders are unwilling or unable to deliver rescue breaths.[5] This recommendation is based on the fact that a majority of pediatric cardiac arrests have an asphyxial cause as suggested by a subset of observational clinical studies.[6–9]

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In this issue of *Circulation*, Riva, *et al.* describe the changes in the frequency and type of bystander CPR performed for all bystander-witnessed out-of-hospital cardiac arrests reported to the Swedish Register for Cardiopulmonary Resuscitation from 2000 to 2017.[10] They also analyzed the independent associations between CPR technique and 30-day survival. A number of key observations are reported that support current guidelines, generate new hypotheses for future research, and highlight persistent disparities. Of greatest significance is the increase in bystander CPR frequency from 40.8% to 68.3% during the study period, which was driven almost exclusively by the increase in bystanders performing CO-CPR. During the same period, 30-day survival nearly doubled. Both S-CPR with rescue breaths and CO-CPR were independently associated with improved 30-day survival. These results provide additional evidence supporting the effectiveness CO-CPR in increasing bystander CPR frequency.

However, it is noteworthy that S-CPR was associated with higher 30-day survival when compared with CO-CPR (adjusted OR 1.2 [95% CI 1.1–1.4]). The improvement in outcome associated with both S-CPR and CO-CPR was also intriguingly associated with emergency medical services (EMS) response time. When EMS response time was <10 minutes, both S-CPR and CO-CPR were independently associated with improved survival. When EMS response times were >14 minutes, neither S-CPR or CO-CPR were independently associated with improved survival. When EMS response time was between 10–14 minutes, only S-CPR was independently associated with improved survival. These results support the concept that the efficacy of both forms of bystander CPR decline over time and suggest that S-CPR may be preferred during prolonged CPR.

Based on their findings, the authors rightfully call for randomized controlled trials to answer the question of whether S-CPR is superior to CO-CPR when the bystanders have had previous CPR training. However, the feasibility of such a study requires a high proportion of the population to be trained in and be willing to perform CPR with rescue breaths. Alternatively, the observed differential outcomes associated with S-CPR and CO-CPR in the 10–14 minutes EMS response time subgroup may underscore the potential role for dispatcher-assisted CPR incorporating rescue breaths in cases with prolonged EMS response time.

This study also highlights important sex differences in patients receiving bystander CPR and survival. While the proportion of women receiving bystander CPR was similar to the overall population during the 2011–2017 study period, the survival rate of women was lower across all CPR groups, and the magnitude of the adjusted odds ratio for survival with S-CPR or CO-CPR compared with no CPR was smaller for women than men. The underlying cause of these sex disparities associated with bystander CPR outcome remains unclear. Recent studies have shown that public perception of why women receive less CPR included women's bodies being sexualized, perceived as physically weak and prone to injury, and misperception about women in acute medical distress.[11] In addition, women were less likely to receive bystander CPR compared with men in public locations, but not in private settings.[12] These factors could also cause delays in CPR initiation, thereby impacting its efficacy. Further studies are necessary to examine the variables associated with sex disparities in out-of-hospital cardiac arrest outcome to better inform bystander CPR education and perception.

Finally, it is important to recognize the significant knowledge gaps not addressed by this study. Survival with good neurologic function was not reported. Therefore, we do not know if the risk-adjusted difference in 30-day survival between S-CPR and CO-CPR translates into a significant difference in survival with good neurologic function. Victims of unwitnessed cardiac arrest were also excluded, which represented approximately 1/3 of the patient population in the registry. Due to this exclusion, there remains significant uncertainty regarding the relative benefit of S-CPR and CO-CPR in the unwitnessed cardiac arrest population. Although all ages were included, the associations between outcomes of CO-CPR and S-CPR in children were not reported separately. As noted above, the predominance of primary respiratory causes of cardiac arrest in children suggest a greater need for rescue breaths, and the existing data are mixed regarding the relative efficacy of S-CPR and CO-CPR in this population.[6–9] Finally, it is increasingly recognized that the interval from the onset of cardiac arrest to initiation of chest compressions is strongly associated with outcome. However, data on the correlation between the duration of this no-flow state and types of bystander CPR delivery are not reported.

Overall, the results of this study provide additional support for the current International Liaison Committee on Resuscitation Consensus on Science and Treatment Recommendations and corresponding member council guidelines regarding lay provider CPR for out-of-hospital cardiac arrest. This study also generated an important hypothesis related to how EMS response time could differentially impact the effectiveness of S-CPR and CO-CPR. Finally, many knowledge gaps remain, including the relative efficacy of CO-CPR in children and adults with primary respiratory causes of cardiac arrest and the etiologies of sex disparities in out-of-hospital cardiac arrest treatment and outcomes. How S-CPR and CO-CPR will co-exist in future guidelines and lay provider training programs is unclear. If bystander S-CPR is proven to be superior to CO-CPR overall or in specific subpopulations, the training infrastructure and public engagement required to reliably deliver bystander S-CPR should be weighed against the opportunity cost of using the same resources to increase overall bystander CPR rates, reduce delays to chest compression initiation, or optimize bystander automated external defibrillator utilization. To breathe, or not to breathe, therefore, is still a question.

Conflict of Interest Disclosures

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