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Editorial

High-quality CPR training: Let's get smart!



High-quality cardiopulmonary resuscitation (CPR) delivered by the lay public is a key link in the chain of survival for out-of-hospital cardiac arrest (OHCA). Bystander CPR has been associated with higher survival rates in comparison with no CPR both for cardiac^{1,2} and non-cardiac origin.³

Despite this life-saving intervention, there has been wide variability in survival after cardiac arrest noted between and within systems of care.⁴ The quality of multiple parameters of CPR have been shown to be inconsistent and often not meeting published guideline recommendations, even when performed by well-trained hospital staff.⁵ To overcome this preventable harm, i.e. poor-quality CPR, the American Heart Association (AHA) now recommends the use of instrumented directive feedback devices or manikins, at a minimum, that provides audio and/or visual feedback on the rate and depth of compressions in all AHA courses that teach the skills of adult CPR.⁶ The software incorporated into these devices can determine if a rescuer is not making a complete release from the compression and some can measure other parameters such as ventilation rate and volume. These real-time quantitative CPR feedback techniques could potentially guide resuscitation care in a goal-directed fashion and prevent low-quality CPR resulting from lack of CPR familiarity or from rescuer fatigue during chest compressions.⁷ However, these professional CPR feedback devices are not designed for lay public use in emergency OHCA situations. Further, other factors including the lack of confidence, anxiety and the perception that CPR might do more harm than good, are known to influence high-quality CPR performance in real-life scenarios,^{5,8} and are not remediable with the current versions of smart-feedback devices.

In the current issue of *Resuscitation*, An et al.⁹ performed a systematic review of CPR smart device randomized trials to determine if the use of these tools during CPR training could improve some of the objective metrics associated with high-quality CPR. The review then further stratified the findings based on the type of the device used (smartphone or smartwatch) for the primary CPR measures of chest compression rate, mean chest compression depth and proportion of compressions of adequate depth. Of 11 studies (5 randomized controlled trials, 1 randomized trial, and 5 randomized crossover trials) selected, 8 used smartphones and 3 utilized smartwatches for their CPR training programs. There was significant heterogeneity between studies; a meta-analysis could not be performed. Some of the studies suffered from significant biases particularly due to lack of detailed information on the randomization, blinding processes, or had insufficient documentation on the time gap between experimental sessions. Outcomes were estimated using quantitative information obtained from the manikins and was a significant methodological strength of most of these studies.

This review did not find any apparent benefit from smart device use during CPR in terms of maintaining the AHA recommended compression rate and depth of chest compressions, when compared to non-smart device groups.¹⁰ However, all three smartwatch studies reported that the proportion of chest compressions of adequate depth was significantly improved with the use of smartwatch. From a qualitative data perspective, albeit based on very few studies, the participants favored smartwatches (N = 1) over smartphones (N = 4) based on ease of use and convenience. Participants gave negative feedback related to the holding of the smartphone when administering CPR and complained of pain in the back of the hand and overall discomfort.

This review is the first to evaluate investigations utilizing mobile technology with the commonly available CPR-feedback based applications such as iCPR, PocketCPR as well as self-developed applications compatible with smartwatches. The systematic review highlights the technical challenges associated with most of these studies deterring the utility of smart devices as CPR aids in the setting of OHCA. As suggested by the authors, the biggest limitation was the small number of participants enrolled in majority of the studies included (6 of 11, 55% studies had <50 participants). Further, all three studies on smartwatches had less than 50 participants.

Second, all of the studies focused on the effectiveness of an individual type of smart device. No studies have done any direct comparisons between the two types of smart devices. A randomized controlled study with adequate power, preferably with a cross-over trial design comparing the two types of devices, followed by an assessment of the attitudes and the preferences of the participants, would be very helpful to build on these prior investigations and would have a greater impact on public health education.

Third, the geographical location where these studies were performed impeded the generalizability of the findings. Majority of the studies were executed in Asian countries; indeed, all three studies with smartwatches involved participants from Korea and Japan. Cultural factors are likely important with regard to CPR prompting and public device use. There are inherent socio-economic disparities as people in advanced economies are more likely to have mobile phones — smartphones in particular.¹¹ In addition, far more people own smartphones than smartwatches, which may limit the usage and potential benefit if deemed advantageous.

Lastly, demographic factors like age, sex, and prior CPR training have been shown to affect CPR performance as well as rescuer fatigue, and thus provide significant confounding in high-quality CPR accuracy measures when it comes to real-life scenarios.^{5,12} The studies included participants from diverse age groups, sex, medical

backgrounds, and prior CPR training status, but the influence of these factors on high-quality CPR during training were not investigated.

Challenges associated with translation of skills from training environments to actual cardiac arrest settings likely limit CPR quality in actual practice. It is perhaps not surprising that large trials and a recent meta-analysis could find no survival advantages provided by the use of audio-visual feedback devices during resuscitation from OHCA.^{13,14} Nevertheless, this review underscores the need for continued development of optimal and widely available CPR monitoring as a key component to improved performance. Some of the nuances offered by smartphone-based feedback-devices and the ability to assume normal CPR position for both hands while wearing a smartwatch, potentially makes smartwatches more promising candidates for future CPR guidance. Such tools may not necessarily help completely untrained individuals, but in future could be tailored to help trained individuals perform the highest quality CPR before the arrival of professional help.

Conflict of interests

Dr. Agarwal has nothing to disclose.

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REFERENCES

- Riva G, Ringh M, Jonsson M, et al. Survival in out-of-hospital cardiac arrest after standard cardiopulmonary resuscitation or chest compressions only before arrival of emergency medical services: nationwide study during three guideline periods. *Circulation* 2019; 139:2600–9.
- Yannopoulos D, Aufderheide TP, Abella BS, et al. Quality of CPR: an important effect modifier in cardiac arrest clinical outcomes and intervention effectiveness trials. *Resuscitation* 2015;94:106–13.
- Christensen DM, Rajan S, Kragholm K, et al. Bystander cardiopulmonary resuscitation and survival in patients with out-of-hospital cardiac arrest of non-cardiac origin. *Resuscitation* 2019;140:98–105.
- Nichol G, Aufderheide TP, Eigel B, et al. Regional systems of care for out-of-hospital cardiac arrest: a policy statement from the American Heart Association. *Circulation* 2010;121:709–29.
- Abella BS, Alvarado JP, Myklebust H, et al. Quality of cardiopulmonary resuscitation during in-hospital cardiac arrest. *JAMA* 2005;293:305–10.
- Bhanji F, Donoghue AJ, Wolff MS, et al. Part 14: education: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2015;132:S561–73.
- Abella BS. High-quality cardiopulmonary resuscitation: current and future directions. *Curr Opin Crit Care* 2016;22:218–24.
- Mäkinen M, Niemi-Murola L, Ponzer S, et al. Healthcare professionals hesitate to perform CPR for fear of harming the patient. *Resuscitation* 2014;85:e181–2.
- An M, Kim Y, Cho WK. Effect of smart devices on the quality of CPR training: a Systematic review. *Resuscitation* 2019;144:145–56.
- Meaney PA, Bobrow BJ, Mancini ME, et al. Cardiopulmonary resuscitation quality: improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American Heart Association. *Circulation* 2013;128:417–35.
- Pew Research Center. Smartphone ownership is growing rapidly around the world, but not always equally. 2019.
- Truszczyński Z, Szarpak L, Kurowski A, et al. Randomized trial of the chest compressions effectiveness comparing 3 feedback CPR devices and standard basic life support by nurses. *Am J Emerg Med* 2016;34:381–5.
- Hostler D, Everson-Stewart S, Rea TD, et al. Effect of real-time feedback during cardiopulmonary resuscitation outside hospital: prospective, cluster-randomised trial. *Br Med J* 2011;342:d512.
- Kirkbright S, Finn J, Tohira H, et al. Audiovisual feed-back device use by health care professionals during CPR: a systematic review and meta-analysis of randomized and non-randomized trials. *Resuscitation* 2014;85:460–71.

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