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EDITORIAL COMMENT

Facing the Obstacles of OHCA Response

Integrating First Responders With Drone Delivery for AED Deployment

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Primary return of spontaneous circulation after out-of-hospital cardiac arrest (OHCA) is achieved in approximately one-third of patients experiencing OHCA with poor survival rates ranging from 8% to 10% in the United States[1,2] with similar rates in Europe.[3] Essential factors improving survival rates include prompt basic life support performed by fast-reacting bystanders, arrival of first responders (FRs), and early defibrillation with an automated external defibrillator (AED).[4,5] Several concepts have attempted to improve these rates by training the overall population,[6-8] implementing apps to facilitate the AED search,[9,10] activate trained FR in urban areas,[11,12] or training specific groups like kids at school.[13,14] However, survival rates after OHCA did not really improve in the past years.[2] In other words, the barrier breaking innovation is still missing. A current scientific statement of the International Liaison Committee of Resuscitation to improve OHCA survival rates recommends all the abovementioned concepts with the goal to enhance the rate and quality of bystander cardiopulmonary resuscitation (CPR) and the availability and usage of AEDs with their geographic distribution being one obstacle in the chain-of-survival.[15] Here, the concept of drones delivering AEDs to an emergency location might come into play. This idea has been introduced and studied in several regions of world for years.[16-20] Technical innovations have developed drones further, being able to improve flight range and carry sufficient payloads. The feasibility of drone-based AED delivery was confirmed by several study groups.[21-24]

The recent study conducted by Starks et al[25] in this issue of *JACC: Advances* investigated the potential improvement of AED arrival times by either providing AEDs to FRs or by the implementation of a tightly meshed network of drones capable of delivering AEDs. The targeted arrival time was set to an ambitious limit of <5 minutes. The analysis was based on retrospective data of the CARES (Cardiac Arrest Registry to Enhance Survival) registry that captured 28,292 OHCA in North Carolina, USA. The historical median response time in the covered region was 8.0 minutes (IQR: 7.0-9.0 minutes) and only 17% of AEDs arrived in <5 minutes. A simulation showed that FRs did not have a profound impact on response times while AED-equipped drones could potentially improve response times of <5 minutes from 17% to 62%. The calculated improvement of hospital discharge was predicted to rise from 14.5% to 19.4% which would account for a relative improvement of 34%. The authors have addressed a very important topic and suggested an innovative solution to reduce the time to defibrillation. This study highlights that survival rates are low and bystander CPR is not self-evident.

Time matters but what is the real number of minutes that count? Firstly, the OHCA must be recognized; secondly, an emergency call must be made; and thirdly, CPR must be started. One must remember that AED delivery and defibrillation is just one part of the chain of survival and in some cases the cause of the OHCA does not lead to a shockable heart rhythm where an AED will probably provide no further help. Current registries suggest that 50% to 60% of laypersons provide CPR measures. Probably these would be able to use a drone-delivered AED. It is unclear if the remaining 40% to 50% would use an AED

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delivered by drone. One might speculate that a drone-based AED delivery could enhance the CPR rates of laypersons due to public campaigns and information on how the system works. Simulation studies showed good acceptance in health care professionals. Laypersons and FRs would need additional trainings or potentially guidance by the dispatcher during the emergency call. The real-world impact of these measures needs to be studied in a large-scale trial in a real-world setting before drawing a final conclusion.

This study presents several important factors that need to be considered before implementing drones in OHCA care: not only a neat calculation of each drone base location to provide the optimal network of AED-equipped drones are necessary but also specific drone dispatch decision rules. This shows that a clear and thought-through workflow is needed to implement drones to further reduce response times wherever possible. We must increase research of actual implementation of multimodal innovations in the field of OHCA to improve survival rates additional to conventional measures such as widespread CPR trainings. Furthermore, several challenges must be addressed concerning an aerial AED delivery: Weather conditions (rain, wind), distances, transmission of signals in rural areas, and communication with other air vehicles. Finally, the human factor plays a role as a real-life difficulty such as bystanders ignoring how to recognize an OHCA or unable to perform CPR measures or even refusing to deliver CPR.

This work highlights that survival rates after OHCA are still problematically low. Given this issue, this work should call to action for industry, health care providers, and further research groups to investigate this field to accelerate a real-world implementation. When considering Starks et al[25] and the prior studies, some truths and future directions become clear. Several steps in the chain-of-survival needs improvements to implement a drone-based AED delivery: Optimizing dispatch systems (early recognition of OHCA) to purposeful sent an AED-equipped drone, selecting the areas in which drones can assist FRs (rural/urban; outdoor/indoor) and optimizing the drone/AED networks to guarantee a meaningful coverage to achieve as low as possible response times. Nevertheless, innovation and technology still depend on human factors: less shocks will be applied and less lives will be saved without trained bystanders or FRs.

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