Drone Delivery of an Automated External Defibrillator

TO THE EDITOR: Every year, an estimated 350,000 persons in the United States have an out-of-hospital cardiac arrest; only approximately 10% survive.[1] The probability of survival doubles when a bystander administers cardiopulmonary resuscitation (CPR) and uses an automated external defibrillator (AED) before emergency medical services (EMS) arrive, but bystander AED use occurs in less than 2% of cardiac arrests in the United States.[2] Survival is most likely when CPR and defibrillation are delivered within 5 minutes after the start of a cardiac arrest[3]; however, the median arrival time of EMS in the United States is 8 minutes and in remote areas can extend to 30 minutes.[4]

We conducted a randomized trial that consisted of 35 tests, in a community setting, in which an AED was delivered by an autonomously flying drone and a bystander searched for and retrieved a fixed-location AED from the surrounding area (details of the study methods and additional results are provided in the Supplementary Appendix, available with the full text of this letter at NEJM.org). In each test, an out-of-hospital cardiac arrest was simulated with the use of a life-size mannequin, with two participants, matched by sex and age, present at the scene; seven tests were conducted in each of five different geographic zones (Figs. S1 and S2 in the Supplementary Appendix). Zones were selected to present different environmental challenges to acquisition of the AED by bystanders and to drone navigation (Table S1). Sites varied by the number of AEDs available within 600 ft (183 m) of the simulated cardiac arrest. Drone launch sites were not visible from the cardiac arrest sites, and the distance from the launch site to the site of the arrest differed by zone, ranging from 780 to 1290 ft (238 to 393 m). In each test, we randomly assigned one participant to call a mock 911 telecommunicator who initiated the drone's autonomous flight and the other participant to simultaneously conduct a ground search to locate an AED and return to the site with it. We compared AED delivery times and conducted pretrial and post-trial interviews with participants.

The difference in the median AED delivery time between drone delivery and the ground search method differed by zone and ranged from −2 minutes 56 seconds (zone E) to 1 minute 42 seconds (zone D) (Table 1). Although zone E had the highest density of AEDs (8) in the area, access to them was limited. Of the five zones, zone D had the shortest mean distance to an AED in the area (254 ft [77 m]). These results suggest that the relative timeliness of drone delivery and ground search depends on the physical setting. Among participants randomly assigned to call for the drone, 89% reported feeling comfortable as the drone approached (Table S2). Nearly half the participants randomly assigned to conduct a ground search reported difficulty finding an AED. All the participants reported that they would be willing to access an AED drone-delivery system in a true out-of-hospital cardiac arrest.

Table 1. Delivery of an AED by Drone vs. Ground Search, According to Zone.*

Variable	Zone A	Zone B	Zone C	Zone D	Zone E
No. of tests	7	7	7	7	7
Distance from drone launch site to site of arrest — ft (m)	1290 (393)	1178 (359)	1125 (343)	780 (238)	945 (288)
Mean distance from fixed-location AED to site of arrest — ft (m)	512 (156)	488 (149)	535 (163)	254 (77)	441 (134)
AED located within 600 ft (183 m) of arrest — no.	1	5	7	7	8
Median times with drone delivery (IQR) — min:sec					
Cardiac arrest to drone launch	1:53 (1:45 to 1:57)	1:52 (1:50 to 2:12)	1:39 (1:34 to 1:40)	1:46 (1:35 to 1:55)	1:55 (1:45 to 2:06)
Drone launch to drone arrival	2:34 (2:28 to 2:35)	2:20 (2:13 to 2:51)	2:30 (2:08 to 2:35)	2:13 (2:05 to 2:20)	2:30 (2:23 to 2:34)
Drone arrival to AED delivery	0:18 (0:13 to 0:20)	0:23 (0:19 to 0:34)	0:15 (0:13 to 0:17)	0:36 (0:26 to 0:37)	0:27 (0:23 to 0:30)
Total time from cardiac arrest to AED delivery	4:47 (4:28 to 4:56)	4:45 (4:39 to 5:39)	4:18 (4:12 to 4:27)	4:38 (4:19 to 4:58)	5:00 (4:45 to 5:04)
Median times with ground search (IQR) — min:sec					
Cardiac arrest to start of bystander search for AED	1:37 (1:31 to 1:44)	1:35 (1:28 to 1:44)	1:21 (1:10 to 1:25)	1:30 (1:07 to 1:31)	1:31 (1:28 to 1:46)
Start of bystander search to retrieval of AED	3:28 (2:05 to 4:15)	2:59 (1:03 to 6:03)	2:12 (1:29 to 4:52)	0:39 (0:35 to 1:31)	3:59 (3:10 to 5:26)
Retrieval of AED to AED delivery	1:33 (1:13 to 1:56)	1:00 (0:44 to 1:30)	0:59 (0:54 to 1:23)	0:22 (0:15 to 0:25)	2:06 (1:56 to 2:23)
Total time from cardiac arrest to AED delivery	7:00 (4:49 to 7:44)	5:46 (3:12 to 9:05)	4:35 (3:47 to 7:29)	2:56 (2:18 to 3:18)	7:56 (6:44 to 8:45)
Difference in total median time — min:sec (95% CI)	−2:13 (−4.65 to 0.26)	−1:01 (−5.62 to 3.62)	−0:17 (−2.98 to 2.38)	1:42 (0.35 to 3.05)	−2:56 (−4:72 to −1:08)
Bystanders who located closest AED — no. (%)	2 (28.6)	0	1 (14.3)	7 (100)	0

* Zones were selected to present different environmental challenges to acquisition of the AED by bystanders and to drone navigation. CI denotes confidence interval, and IQR interquartile range.

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