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National coverage of out-of-hospital cardiac arrests using automated external defibrillator-equipped drones — A geographical information system analysis

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Abstract

Background: Early defibrillation is essential for increasing the chance of survival in out-of-hospital-cardiac-arrest (OHCA). Automated external defibrillator (AED)-equipped drones have a substantial potential to shorten times to defibrillation in OHCA patients. However, optimal locations for drone deployment are unknown. Our aims were to find areas of high incidence of OHCA on a national level for placement of AED-drones, and to quantify the number of drones needed to reach 50, 80, 90 and 100% of the target population within eight minutes.

Methods: This is a retrospective observational study of OHCAs reported to the Swedish Registry for Cardiopulmonary Resuscitation between 2010−2018. Spatial analyses of optimal drone placement were performed using geographical information system (GIS)-analyses covering high-incidence areas (>100 OHCAs in 2010−2018) and response times.

Results: 39,246 OHCAs were included. To reach all OHCAs in high-incidence areas with AEDs delivered by drone or ambulance within eight minutes, 61 drone systems would be needed, resulting in overall OHCA coverage of 58.2%, and median timesaving of 05:01 (min:sec) [IQR 03:22−06:19]. To reach 50% of the historically reported OHCAs in <8 min, 21 drone systems would be needed; for 80%, 366; for 90%, 784, and for 100%, 2408.

Conclusions: At a national level, GIS-analyses can identify high incidence areas of OHCA and serve as tools to quantify the need of AED-equipped drones. Use of only a small number of drone systems can increase national coverage of OHCA substantially. Prospective real-life studies are needed to evaluate theoretically optimized suggestions for drone placement.

Keywords: GIS, AED, OHCA, Drone, UAV

Introduction

In Europe the incidence rate of out-of-hospital-cardiac-arrest (OHCA) is approximately 38−55 per 100,000 population,[1] equivalent to around 275,000 cases every year. Overall survival is 8% (0−18%).[2] Both immediate initiation of cardio-pulmonary resuscitation (CPR), and early defibrillation, especially if performed prior to arrival of emergency medical services (EMS), increases the rate of survival.[3,4]

As in many other EMS systems, the overall aim of reaching patients within a certain time interval has not been achieved in Sweden. Every year the Swedish EMS report bystander initiation of CPR to the Swedish Registry of Cardiopulmonary Resuscitation (SRCR) in about 6000 cases of OHCA.[5] The time delay to ambulance arrival has increased over the years, reaching a median delay of 11 min in 2019.[5] Despite widespread basic-life-support (BLS) training in the community[6,7] and efforts to implement public-access defibrillators alongside a national automated external defibrillator (AED)

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register,[8] survival rates have not changed significantly over the last decade, and 90% of victims dies within 30 days.[5]

Receiving initial defibrillation within the first eight minutes after collapse dramatically increases the chance of survival.[9–11] Nearly 30% of all OHCAs occurs in public places. These cases are the ones with the highest likelihood of benefitting from public AEDs, since the distance to an AED often is short and the proportion of victims with shockable rhythm is higher.[5] However, approximately 70% of OHCAs occurs in the victims' homes,[5] and intervening with public AEDs in residential settings prior to EMS arrival has been shown to be difficult.[12] Novel means of delivering AEDs faster to the victims' homes are therefore needed.

AED-equipped unmanned aerial vehicles (UAVs), commonly called drones, used only as a complement to existing EMS systems, have in preliminary observational and simulation studies shown a potential to shorten the time to defibrillation.[13–16] However, optimal locations for drone deployment at a national level with regard to (a) the incidence of OHCA and (b) ambulance response times are less well known and have not yet been described.[16]

The first aim of this study was to find and describe areas in Sweden with a high incidence of OHCA and quantify the number of AED-equipped drones needed to shorten the time to delivery of an AED by either ambulance or drone to less than eight minutes in these areas. The second aim was to find locations for drone deployment and quantify the number of AED-equipped drones needed to reach 50, 80, 90 and 100% of the Swedish OHCA population with an AED within eight minutes.

Methods

This is a retrospective observational registry-based study of all EMS-reported OHCAs occurring between 2010 and 2018. Data was extracted from the SRCR and then analyzed using a geographical information system (GIS) model.

Swedish registry for cardiopulmonary resuscitation and Swedish AED register

Since 1990, data on resuscitation is reported to the SRCR. The data, based on the Utstein template, is reported in two parts; first, by EMS personnel directly after an event, and second, by a hospital coordinator after 30 days, adding in-hospital interventions and outcome measures. During 2019, a total of 5934 OHCAs were reported to the register.[5] Data from the SRCR was merged with data from the national emergency dispatch center to obtain geographical coordinates for all cases of OHCA. Data on all validated AEDs in Sweden was collected from the Swedish AED Register in November 2019. This registry includes registered AEDs in Sweden that are controlled and validated every six months.

Drone characteristics

DJI Matrice Pro 600 drones were used as a basis for assumptions and calculations in this study. They have a maximal flight velocity of 60 km/h and a maximal flight range to the scene of six kilometres. It was assumed that their launch sites could be placed anywhere on land.

Study setting

This observational study is based on historical OHCA data covering Sweden, a country with a population of 10.3 million inhabitants in 2019, with three major counties: Stockholm county (area 6519 km^2, approximately 2.3 million inhabitants), Västra Götaland county (area 25,247 km^2, approximately 1.7 million inhabitants) and Skåne county (area 11,303 km^2, 1.4 million inhabitants).[17]

GIS analyses, hexagon system, distance and time estimations

GIS

Spatial analyses of optimal drone placement were performed using GIS data in ArcGIS Pro software (Esri). The coordinates are provided in SWEREF99 TM, the Swedish national coordinate system.

Hexagons for categorization of drone placement

Sweden was uniformly divided into hexagons, with the middle point of every hexagon representing a potential position of an AED-equipped drone. The distance from the centre to the vertices of the hexagon was six km, this assumption being based on the fact that the drones have a maximal flight distance of six km one way owing to the limited battery life. The area of each hexagon was consequently approximately 93 km^2.

Hexagons were categorized according to their OHCA incidence rate; areas with up to 10 OHCAs during the study period were defined as low-incidence areas. Areas with between 11 and 100 OHCAs were defined as medium–high-incidence areas, whereas areas with an incidence rate of over 100 OHCAs during the study period was defined as high-incidence areas.

Distance and time estimations

The distance from each OHCA case to the centre of its respective hexagon was calculated, with flying times derived from the given drone speed of 60 km/h. We estimated an additional two minutes from distress call to 112 until the drone was dispatched and airborne. Hence, the final AED-drone delivery time was the two operational minutes plus the real flying time to reach the OHCA location. The maximal delivery time was set to eight minutes, resulting from the maximal flying distance of six km.

All OHCA cases were placed in one of four groups depending on the ambulance response time: 0–<4 min, 4–<8 min, 8–<12 min and ≥12 min. A time of eight minutes was defined as a maximal acceptable cut-off time for ambulance arrival. The drone-areas where the average ambulance response time was less than eight minutes were therefore removed from the final analysis of optimal drone placement, as it would be less optimal to place an AED-drone in those areas.

Proportion of OHCA victims potentially reached by an AED-equipped drone

Analyses were carried out to identify areas where the supplemental system of AED-drones, as a resource additional to the current EMS system, could contribute to reach totals of 50, 80, 90 and 100% of the OHCA victims within eight minutes from the OHCA. The drone-areas for each category were selected by including those with an average response time of more than eight minutes, then selecting areas in order of decreasing incidence until the percentage threshold was met.

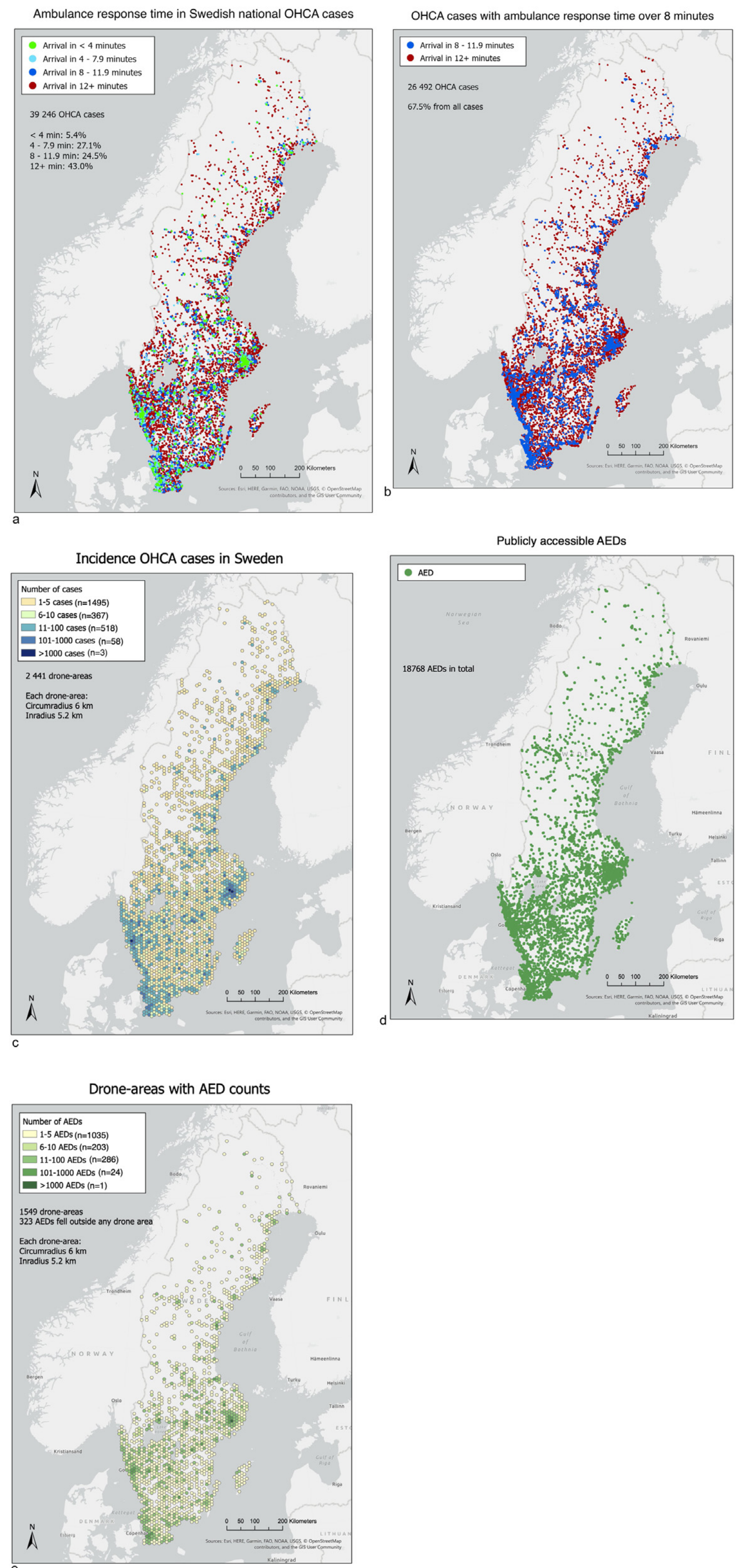

Fig. 1 – (a) Ambulance response time in all OHCA cases in Sweden 2010–2018. (b) Ambulance response time >8 min in all OHCA cases in Sweden 2010–2018. (c) Incidence OHCA 2010–2018 in hexagons, colour coded. (d) All publicly accessible AEDs in Sweden registered in the Swedish AED Register (data accessed November 2019). (e) All publicly accessible AEDs in Sweden registered in the Swedish AED Register shown as counts in possible drone areas. (data accessed November 2019).

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Table 1 – Characteristics and outcome of OHCA in relation to EMS response time and suggested AED-drone coverage, Sweden 2010–2018.

Variable	Ambulance response time					Proportion of OHCA population				Suggested areas for drone placement		
	0–3 min, n = 4136	4–7 min n = 1985	8–11 min n = 11,326	12+ min n = 8539	p	50% n = 10,569	80% n = 29,330	90% n = 34,346	100% n = 38,871	High incidence[a] n = 9061	Optimal areas A[b] n = 7850	Optimal areas B[c] n = 2268
Patient characteristics												
Age, mean years (SD)	68.98 (17.03)	68.86 (17.32)	68.81 (17.16)	68.37 (16.83)	0.203	68.55 (17.78)	68.85 (17.04)	68.82 (16.89)	68.76 (16.73)	68.59 (17.45)	68.43 (17.58)	68.85 (16.39)
Gender female, n (%)	1364 (33.9)	661 (33.6)	3783 (33.9)	2741 (32.6)	0.255	3657 (35.2)	9821 (34.0)	11 372 (33.6)	12 682 (33.1)	31 32 (35.2)	2747 (35.7)	782 (35.3)
Witnessed by anyone, n (%)	2711 (69.4)	1268 (66.1)	7123 (65.3)	5408 (65.7)	<0.001	6490 (64.5)	18 590 (66.0)	21 872 (66.2)	24 820 (66.4)	5709 (66.0)	4813 (64.6)	1379 (64.5)
Witnessed by EMS, n (%)	886 (34.2)	198 (15.9)	1208 (17.3)	1048 (19.7)	<0.001	1349 (21.4)	3865 (21.3)	4565 (21.3)	5214 (21.4)	1301 (23.3)	1043 (22.4)	324 (24.4)
Bystander CPR before EMS arrival, n (%)	1805 (48.3)	1040 (54.1)	6249 (57.1)	5054 (62.0)	<0.001	5538 (57.1)	16 465 (59.2)	19 581 (59.9)	22 564 (60.9)	4925 (58.4)	4165 (58.2)	1247 (63.2)
VT/VF first rhythm, n (%)	1019 (28.9)	543 (30.7)	2686 (26.4)	1824 (23.9)	<0.001	2171 (23.0)	6442 (24.7)	7561 (24.8)	8507 (24.6)	1814 (22.4)	1579 (22.6)	451 (22.6)
Place:												
- At home, n (%)	2480 (61.9)	1284 (65.4)	7633 (68.4)	6077 (72.3)	<0.001	7077 (68.4)	19 970 (69.2)	23 436 (69.4)	26,503 (69.3)	6266 (70.4)	5341 (69.7)	1535 (69.7)
- Public place, n (%)	840 (21.0)	414 (21.1)	2193 (19.7)	1385 (16.5)	<0.001	2150 (20.8)	5344 (18.5)	6127 (18.1)	6848 (17.9)	1652 (18.6)	1479 (19.3)	410 (18.6)
Time from OHCA to defibrillation, median (IQR)	9.00 [5.00, 17.00]	11.00 [7.00, 17.00]	13.00 [9.00, 20.00]	17.00 [11.00, 25.00]	<0.001	15.00 [8.00, 23.00]	14.00 [8.00, 23.00]	15.00 [8.00, 23.00]	15.00 [9.00, 24.00]	16.00 [10.00, 25.00]	15.00 [9.00, 24.00]	15.00 [8.00, 26.00]
30-days survival, all, n (%)	565 (14.6)	282 (14.6)	1271 (11.6)	759 (9.2)	<0.001	1089 (10.8)	3066 (10.8)	3514 (10.6)	3865 (10.3)	840 (9.7)	774 (10.3)	216 (10.1)

Abbreviations: OHCA–Out-of-hospital cardiac arrest. EMS–Emergency medical services. AED–Automated external defibrillator. CPR–Cardiopulmonary resuscitation. VT/VF–ventricular tachycardia/fibrillation.

[a] High incidence sites are defined as hexagons with >100 OHCA.

[b] Optimal locations A are defined as hexagons with >100 OHCA, ambulance arrival time >8 min and minimum time saving 3 min.

[c] Optimal locations B are defined as hexagons with >100 OHCA, ambulance arrival time >8 min and minimum time saving 4 min.

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High-incidence areas and timesaving potential

To find areas with both high incidence and high time saving potential we set up three criteria: (1) more than 100 OHCA cases occurring within one hexagon during the study period, (2) mean ambulance response time of eight min or longer, and (3) mean timesaving effect using AED-drones of at least three minutes (Optimal areas A) or four minutes (Optimal areas B) as compared with ambulance. Time to first defibrillation was also considered; in VT/VF, time to defibrillation more than seven minutes was in this context considered long. We therefore analysed high incidence areas with a high proportion of VT/VF and with long time to defibrillation by either EMS or bystanders.

Results

OHCA incidence, characteristics, high incidence distributions, AED-counts and ambulance response times

Between 2010−2018 a total of 44,977 OHCAs was reported to the SRCR. Of these, in 39, 246 (87.2%) cases coordinates were available, and these cases were thus included in the final analysis. Ambulance arrival time was less than four minutes in 5.4% of all OHCA cases and in 4−7 min in 27.1% of the cases, and thus the ambulance arrival time was less than eight minutes in 32.5% of all OHCAs in Sweden. In the remaining cases, ambulance-arrival times were between 8 and 11 min in 24.5%, and 12 min or over in 43%.

The cases with ambulance-response times of less than four minutes were mostly located in urban areas, for example in Stockholm, Malmö and Gothenburg (Fig. 1a). Cases in the group with ambulance-response times of 4−7 min were widely spread out but also concentrated in more-densely populated areas (larger cities). As seen in Fig. 1b, the groups with ambulance-response times over eight minutes were spread over all of the country, including big cities.

Fig. 1c shows the incidence of OHCA in Sweden on a national level, divided into regular hexagons. In total, 5996 hexagons were established and in 2441 of them at least one OHCA was found. The colour coding in Fig. 1c shows the incidence in each area. The incidence of OHCA was higher in big cities where the population density is higher. In 61 hexagons there was an incidence of over 100 OHCAs during the study period, and of these, three hexagons showed an incidence of >1000 OHCAs. In 630 hexagons the incidence of OHCA was one during the study period.

In total, 18,768 public AEDs were found in the Swedish AED Register. Publicly available AED numbers and distributions are illustrated in Fig. 1d and e. Of the 2441 hexagons with at least one OHCA, 1549 areas had at least one publicly available AED. Also, 323 publicly available AEDs were located within areas without any OHCA during the study period.

The characteristics of OHCA are illustrated in Table 1. Mean ages and the proportion of females were similar in all groups. In the groups with short ambulance-response times, the proportion of OHCAs that was witnessed was higher. In addition, incidence rates of shockable rhythm and 30-day survival were higher in these groups. The time to defibrillation was shorter in groups with short ambulance-response times. The characteristics of OHCAs in Optimal areas A and B were similar to those in the groups with ambulance-response times of more than eight minutes.

High-incidence areas

A total of 61 drones would be needed to reach all cases within high-incidence areas within 8 min. This would add an extra 25.7% coverage of OHCA cases (resulting in a total coverage of 58.2%). The calculated median timesaving compared with standard care would be 05:01 (min:sec) [03:22−06:19] (Table 2).

Proportion of OHCA victims reached within eight minutes

A total of 32.5% of all OHCAs in Sweden were reached by ambulance within eight minutes. In order to reach 50% delivery of an AED within eight minutes in this model of historically reported OHCAs, 21 drone systems would be needed, and the median timesaving would be 03:48 [00:58−05:52] (Table 2). For 80% coverage 366 drone systems would

Table 2 – Drone coverage, response time and time saving in analysed groups.

Variable	50%	80%	90%	100%	High incidence[a]	Optimal areas A[b]	Optimal areas B[c]
Number of hexagons/ drones	21	366	784	2408	61	22	10
Percent of hexagons (%)	0,9	15,0	32,1	98,6	2,5	0,9	0,41
Number of cases reached by drone	7 000	18 646	22 568	26 492	10 072	7 994	2 328
Percent of cases reached by drone (%)	17,8	47,5	57,5	67,5	25,7	20,4	5,9
Median time of arrival of EMS [IQR] (min)	9 [6−12]	9 [6−13]	9 [6−14]	10 [7−15]	11 [9−14]	9 [7−13]	11 [8−13]
Median time of arrival of drone [IQR] (min:sec)	05:37 [04:27−06:35]	05:47 [04:37−06:39]	05:49 [04:40−06:41]	05:50 [04:41−06:42]	05:41 [04:35−06:36]	05:33 [04:28−06:28]	05:32 [04:13−06:20]
Median time saving [IQR] (min:sec)	03:48 [00:58−05:52]	03:42 [00:31−05:50]	04:05 [00:40−05:57]	04:29 [00:53−06:04]	05:01 [03:22−06:19]	04:24 [01:40−06:05]	05:19 [02:48−06:44]

Abbreviations: EMS−Emergency medical services. OHCA−Out-of-hospital cardiac arrest.
[a] High incidence sites are defined as hexagons with >100 OHCA.
[b] Optimal areas A are defined as hexagons with >100 OHCA, ambulance arrival time >8 min and minimum time saving 3 min.
[c] Optimal areas B are defined as hexagons with >100 OHCA, ambulance arrival time >8 min and minimum time saving 4 min.

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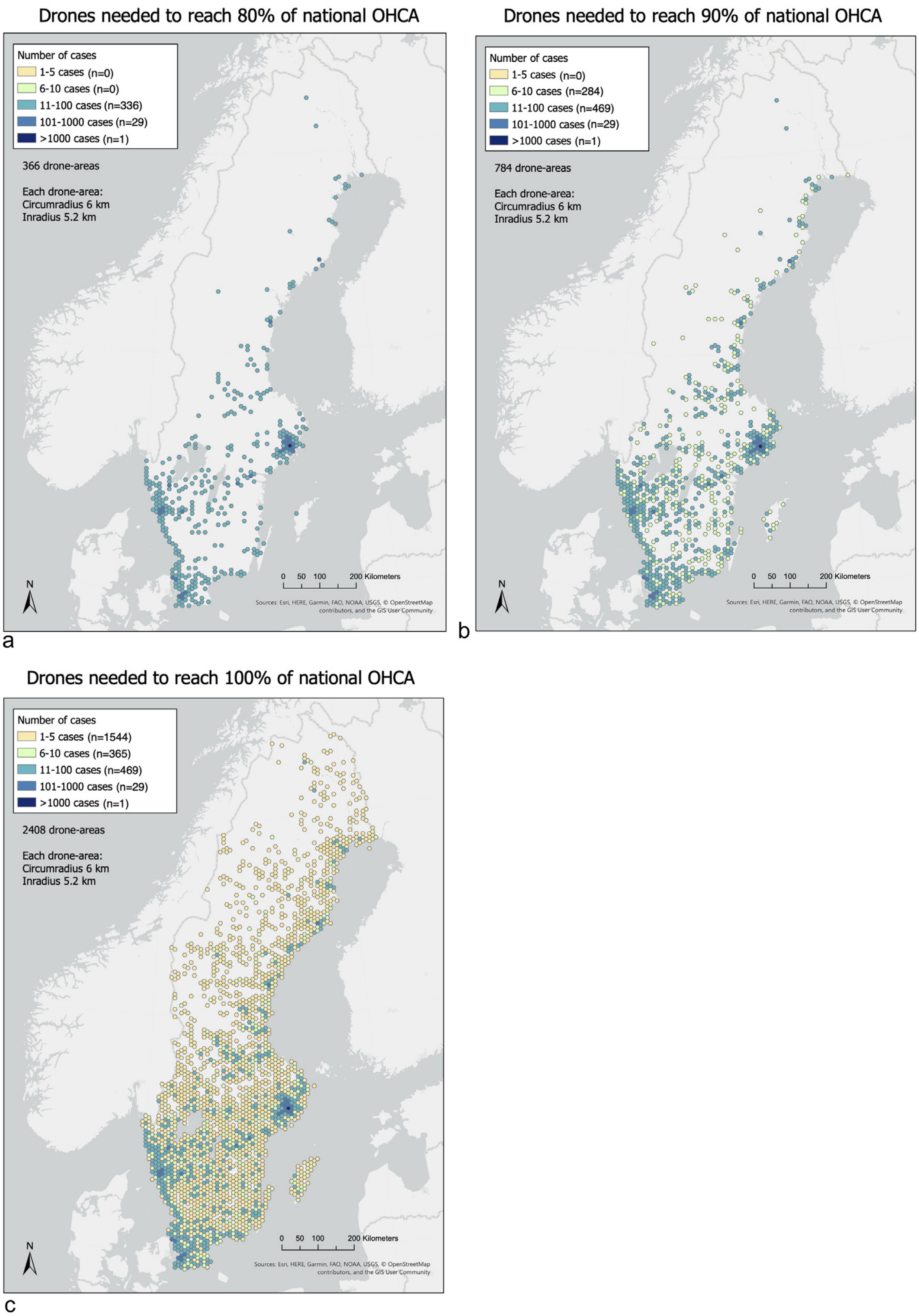

Fig. 2 – (a) Drones needed to reach 80% of OHCA cases in Sweden within 8 min. (b) Drones needed to reach 90% of OHCA cases in Sweden within 8 min. (c) Drones needed to reach 100% of OHCA cases in Sweden within 8 min.

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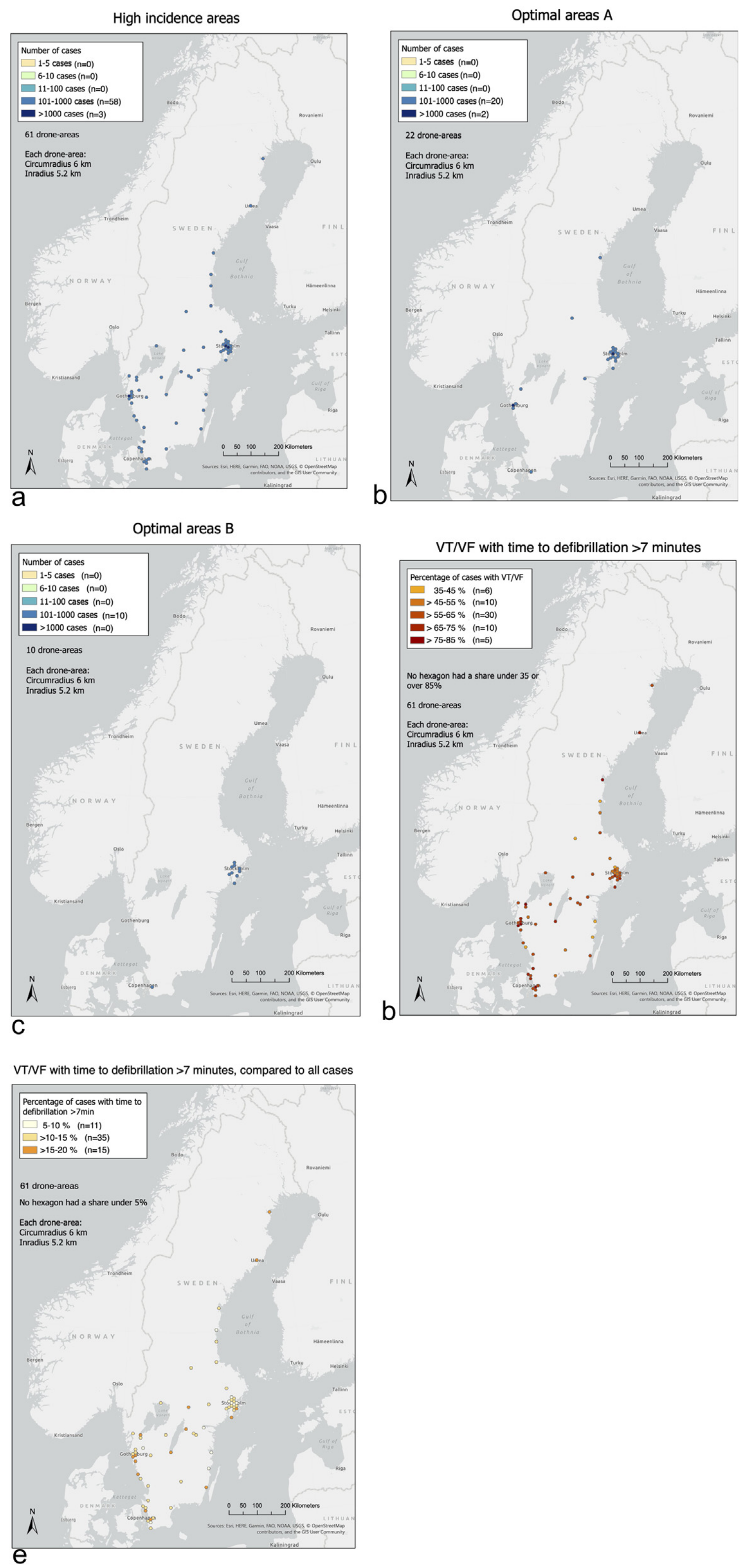

Fig. 3 – (a) High incidence areas. Defined as >100 OHCA during 2010−2018. (b) Optimal areas A. Based on three criteria: (1) >100 OHCA in a hexagon, (2) mean ambulance response time >8 min, (3) mean time saving compared to ambulance >3 min. (c) Optimal areas B. Based on three criteria: (1) >100 OHCA in a hexagon, (2) mean ambulance response time >8 min, (3) mean time saving compared to ambulance >4 min. (d) VT/VF cases with time to defibrillation >7 min compared with all VT/VF in a high incidence drone area, colours indicating proportions. (e) VT/VF cases with time to defibrillation >7 min compared with all OHCA cases in a high incidence drone area (including non-shockable rhythms), colours indicating proportions.

be needed: median timesaving 03:42 [00:31−05:50] (Fig. 2a and Table 2). For 90% coverage 784 drone systems would be needed (Fig. 2b and Table 2); calculated median timesaving 04:05 [00:40−05:57]. A total of 100% coverage was reached when using 2408 drone systems (Fig. 2c); median timesaving 04:29 [00:53−06:04] (Fig. 2c and Table 2). All examples are based on the assumption that the drones work as a complement to present EMS.

High-incidence areas with timesaving potential

In Optimal areas A, we identified a total of 22 areas for drone deployment, giving an additional 20.4% coverage (Fig. 3b and Table 2), and representing 52.9% of OHCA cases in Sweden reached with an AED from either ambulance or drone within eight minutes. The calculated median timesaving in "A" areas was 04:24 [01:40−06:05]. In Optimal areas B, 10 areas for drone deployment were found, resulting in 5.9% additional coverage (total 38.4% coverage) of OHCA cases in Sweden (Fig. 3c and Table 2). Median timesaving was 05:19 [02:48−6:44]. In Fig. 3d and e, high incidence areas with high proportion of VT/VF with long time to defibrillation are shown. Fig. 3d compares cases of VT/VF with long time to defibrillation with all VT/VF-cases in a drone area. In Fig. 3e, the VT/VF-cases with long time to defibrillation are compared to all cases in the drone area (including non-shockable rhythms).

Discussion

In this study, we found and described areas with a high incidence of OHCA, by using a model involving GIS. Furthermore, we quantified the number of drones needed to shorten the time to AED delivery to less than eight minutes for all OHCA cases in these areas. Likewise, we quantified the number of drones needed to reach 50, 80, 90 and 100% of the Swedish OHCA population within eight minutes. Moreover, we have identified suitable locations for drone placement with consideration to both incidence and timesaving potential. We have presented several maps of Sweden showing suggestions of placement of AED-equipped drones on a national level.

In addition to the above, we found that it is possible to use a GIS model to examine possible suitable locations for deployment of AED-drones. We also found that the use of AED-equipped drones can increase the proportion of OHCA patients receiving an AED within the first eight minutes after collapse, and with only a few drones that proportion can be greatly increased. However, since many areas have a low incidence of OHCA, by increasing the number of drones the benefit of extra ones decreases, to reach just an extra 10%, and to reach between 90% and 100% of cases, over a thousand more drones would be needed.

In accordance with the results of other studies, we found that implementation of a drone network as a complement to EMS has the potential to shorten times to defibrillation and theoretically increase survival.[18−20] What is new in our study is that we describe quantities and locations in connection with a potential drone network on a national level.

Since studies have shown that the chance of survival increases when CPR is provided and first defibrillation is given within the first eight minutes, many countries have targets for EMS to reach patients within a certain timeframe. For example, in the UK, the target is to have a mean response time of seven minutes and to reach 90% of cases within 15 min.[21] In Sweden, ambulances have different targets for each region. For example, in Västra Götaland there is a target to have a median arrival time to high-priority calls of 12 min and to reach 90% of the high-priority calls within 20 min. However, figures for 2020 show that only 70% of patients were reached in under 20 min, the median time being 12 min.[22] All in all, many countries fail to meet their response-time targets and therefore new ways to reach patients quickly are needed.

Recommendations from the American Heart Association (AHA) and the European Resuscitation Council (ERC) state that it is cost-effective to have AEDs at places where the predicted incidence of OHCA is one or more per five years.[23−25] The recommendations are made in regard to stationary public AEDs and are therefore based on the assumption that one AED covers an area of around 100 m radius. However, the results of a new study suggest that it is better, in terms of coverage and life-saving potential, to mathematically optimize AED placing by using historical data instead of looking at calculated incidence.[26,27]

The field of AED-equipped drones is brand new, and there are no current guidelines on how many OHCAs one drone should cover nor on where the optimal places for deployment of AED-equipped drones should be. Since the cost of an AED-drone is higher than that of a public AED, and drones also cover a larger area, it is not possible to use the same guidelines as for public AEDs. Also, because of the new results indicating that mathematically optimized AED-placement could be superior to incidence-calculated placement,[26] it is interesting to look at the possibilities concerning optimization of drone placement. Guidelines on this need to be developed. In the absence of guidelines, we made the assumption that areas with >100 OHCAs during the study period counted as high-incidence areas and we further assumed that these areas could be used as suitable drone-deployment locations. This resulted in 61 places in Sweden for deployment of AED-drones. After adding an additional criterion, i.e., areas with at least three minutes mean timesaving, we found 22 suggested places for drone deployment. Increasing this limit to at least four minutes mean timesaving we found 10 suitable locations. When analysing the proportions of VT/VF with long time to defibrillation we found that Sweden has 15 high incidence areas where 15−20% of the OHCA has VT or VF as first rhythm and that has a time to defibrillation of more than seven minutes. In these areas, we believe the potential of the use of drones as a complement to the EMS system could be substantial.

In future studies, economic aspects also have to be considered. It has been suggested that interventions that reduce times to defibrillation potentially could save more lives and also could be considered cost-effective.[28] However, the cost-effectiveness of a more expensive complete AED-drone system including pilots in real-life missions is yet to be explored.

Up to now, only a couple of small simulation studies have been carried out on the safety and feasibility of real-life flights with AED-drones.[14−16] Currently, a larger study is ongoing in Sweden, looking at the feasibility of using drones as a complement to EMS.[29] We suggest that the next step is to continue with more detailed studies of optimization of places for deployment of drones in areas that might be suitable for implementation of drones in real-life studies. A geographical information system is a good tool for calculations, optimization and planning a potential future AED-equipped drone network.

Limitations

We assumed that the AED-drone launch sites could be placed anywhere on land and that they could fly everywhere. In a real-life

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study, air- and ground conditions, regulations of manned vs unmanned flights, the use of controlled airspace and "no-fly zones" will have to be taken into account. Also, due to drone regulations from The European Union Aviation Safety Agency (EASA), approval from Swedish transport agency would have to be achieved for the drones to be able to fly beyond visual line of sight. Using other drone characteristics and other definitions of high-incidence areas would have given rise to different results. Calculations were carried out on the basis of historical data on cardiac arrests. Furthermore, coordinates were unavailable for 12.8% of the reported OHCAs. A known limitation of GIS analysis is that the results depend on the placing of the hexagons.

Conclusion

At a national level, GIS-analyses can identify high incidence areas of OHCA and serve as tools to quantify the need of AED-equipped drones. Use of only a small number of drone systems can increase national coverage of OHCA substantially. Prospective real-life studies are needed to evaluate theoretically optimized suggestions for drone placement.

Conflict of interest

None of the authors have any financial or personal relationships with other people or organizations that could inappropriately influence (bias) their work. None of the authors have any conflict of interest.

CRediT authorship contribution statement

S. Schierbeck: Methodology, Data curation, Formal analysis, Project administration, Visualization, Writing - original draft, Writing - review & editing. **A. Nord:** Methodology, Writing - review & editing. **L. Svensson:** Methodology, Conceptualization, Writing - review & editing. **A. Rawshani:** Data curation, Writing - review & editing. **J. Hollenberg:** Conceptualization, Funding acquisition, Resources, Writing - review & editing. **M. Ringh:** Conceptualization, Methodology, Writing - review & editing. **S. Forsberg:** Writing - review & editing. **P. Nordberg:** Writing - review & editing. **F. Hilding:** Data analysis, Writing - review & editing. **A. Claesson:** Conceptualization, Methodology, Supervision, Writing - review & editing.

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