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Rapid response systems

Drones can be used to provide dispatch centres with on-site photos before arrival of EMS in time critical incidents



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Abstract

Background: Drones are able to deliver automated external defibrillators in cases of out-of-hospital cardiac arrest (OHCA) but can be deployed for other purposes. Our aim was to evaluate the feasibility of sending live photos to dispatch centres before arrival of other units during time-critical incidents.

Methods: In this retrospective observational study, the regional dispatch centre implemented a new service using five existing AED-drone systems covering an estimated 200 000 inhabitants in Sweden. Drones were deployed automatically over a 4-month study period (December 2022–April 2023) in emergency calls involving suspected OHCA, traffic accidents and fires in buildings. Upon arrival at the scene, an overhead photo was taken and transmitted to the dispatch centre. Feasibility of providing photos in real time, and time delays intervals were examined.

Results: Overall, drones were deployed in 59/440 (13%) of all emergency calls: 26/59 (44%) of suspected OHCA, 20/59 (34%) of traffic accidents, and 13/59 (22%) of fires in buildings.

The main reasons for non-deployment were closed airspace and unfavourable weather conditions (68%). Drones arrived safely at the exact location in 58/59 cases (98%). Their overall median response time was 3:49 min, (IQR 3:18–4:26) vs. emergency medical services (EMS), 05:51 (IQR: 04:29–08:04) p-value for time difference between drone and EMS = 0,05. Drones arrived first on scene in 47/52 cases (90%) and the largest median time difference was found in suspected OHCA 4:10 min, (IQR: 02:57–05:28). The time difference in the 5/52 (10%) cases when EMS arrived first the time difference was 5:18 min (IQR 2:19–7:38), $p = NA$. Photos were transmitted correctly in all 59 alerts. No adverse events occurred.

Conclusion: In a newly implemented drone dispatch service, drones were dispatched to 13% of relevant EMS calls. When drones were dispatched, they arrived at scene earlier than EMS services in 90% of cases. Drones were able to relay photos to the dispatch centre in all cases.

Although severely affected by closed airspace and weather conditions, this novel method may facilitate additional decision-making information during time-critical incidents.

Keywords: Drone, UAV, OHCA, AED, Accident, Dispatch, Situational awareness

Background

Life-threatening and time-critical incidents occupy the emergency medical services (EMS) and fire departments in their daily work and include out-of-hospital cardiac arrests (OHCAs), traffic accidents, and fires in buildings. In time-critical medical and traumatic emergencies, under-triage (e.g., late arrival and/or an under-

dimensioned response such as not enough ambulances, as well as sub-optimal dispatch fire and rescue units/equipment) can occur. These EMS problems may hold up resources and cause another event's triage to be delayed. Such instances are not uncommon.^{1,2}

Technological advancements in unmanned aerial vehicles (UAVs), i.e., drones, in terms of range and camera performance have emerged over the last decade.^{3,4} Drone cameras may be used to locate individuals submerged under water in cases of drowning^{5,6}

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and provide situational awareness for fire departments and police authorities after arrival on-scene by utilizing drones flown locally within the line of sight.^{7–9} Besides using drones for situational awareness purposes in trauma or mass-casualty incidents, there is also potential for delivery of medical equipment and/or drugs such as naloxone, epinephrine, anti-epileptics or blood products.^{10,11}

Drones delivering automated external defibrillators (AEDs) in cases of real-life OHCA in beyond-visual-line-of-sight (BVLOS) flights have been integrated in the EMS in the west of Sweden since 2020. AED-drones have been shown to arrive before EMS in 67% of cases of suspected OHCA, with time differences averaging three minutes.^{12–14} Although drone-delivery of AEDs is possible during all seasons and in various conditions, dispatcher referral of bystanders to retrieve the AED is challenging, as they do not have any visual information from the scene during 112-emergency calls (See Table 1).

As delivery of AEDs in cases of suspected OHCA encompasses only a minor proportion of the operational time, there is the potential to use the same drone for other time-critical incidents during the remaining time of all operational hours. The drone camera may be used for taking an early photo from an incident scene and transmitting this back to the dispatch centre. This has the potential to enhance patient care and expedite dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) by providing situational awareness at a very early stage.

The ability of dispatch centres to understand different types of incident sites and the context surrounding the callers might therefore be optimized if drone delivery of visual information such as photos are ready and available during the first minutes of an emergency call. The aim of this study is to retrospectively examine time-savings in drones response compared to traditional dispatch unit response,

and to examine the feasibility and the characteristics of transmitting live-view photos via drones' cameras to dispatch centres during time-critical incidents prior to EMS arrival on scene.

Methods

This is a retrospective observational study evaluating the feasibility of deploying remotely operated drones for transmitting live-view photos to the dispatch centre during time-critical incidents. Feasibility in this study was defined as a) early arrival prior to EMS (time delays) and b) transmission of photos to the dispatch centre. A drone programme for delivering AEDs in cases of suspected OHCA has been operational in the west of Sweden since June 1st 2020.¹² The drone system and operational procedures was developed by the drone operator Everdrone AB, integrated with air traffic control, dispatch organizations and EMS. Drones were placed in remotely monitored hangars at five locations in the region of Västra Götaland and deployed in an automated fashion in pre-defined index-nodes within administrative areas inside the controlled airspace of two airports. Beyond visual line of sight (BVLOS) flight operations were executed within a total range of 10 km back and forth from the hangar and only after approval from air traffic control (ATC) for each single flight.

The regional emergency medical dispatch centre of Västra Götaland region implemented a new service using five already operational AED-drone systems which were placed within controlled airspace in Gothenburg and Trollhättan. The study period ranged from December 21st 2022 to April 30th 2023 – totally four months of service for transmitting live-view photos to the dispatch centre. Flight permits were granted and received by Everdrone AB from the Swedish Transportation Board. A permit for receiving photos/videos from

Table 1 – Characteristics of deploying AED- and camera-equipped drones to time-critical incidents.

Variable	Drone, n = 52	EMS, n = 52	p for difference
Time from dispatch to arrival on site, median min:sec (IQR):			
- All cases (n = 52)	03:49 (IQR: 03:18–04:26)	05:51 (IQR: 04:29–08:04)	<0.05
- OHCA (n = 26)	03:43 (IQR: 03:10–04:20)	07:29 (IQR: 5:19–09:23)	<0.05
- Traffic (n = 13)	03:49 (IQR: 03:21–04:29)	04:30 (IQR: 03:48–05:02)	NS
- Fire (n = 13)	04:22 (IQR: 03:04–04:36)	05:36 (IQR: 04:33–06:10)	<0.05
Incident site located yes, n (%):			
- All cases (n = 52)	100	100	NA
- OHCA (n = 26)	100	100	NA
- Traffic (n = 13)	100	100	NA
- Fire (n = 13)	100	100	NA
Arrival first on scene prior to other units, n, (%):			
- All cases	47/52 (90)	5/52 (10)	NA
- OHCA	23/26 (88)	3/26 (12)	NA
- Traffic	13/13 (100)	0/13 (0)	NA
- Fire	11/13 (85)	2/13 (15)	NA
Time benefit compared with other units when first on scene min:sec (IQR):			
- All cases	03:05 (IQR: 01:13–04:57)	00:36 (IQR: 00:15–00:48)	<0.05
- OHCA	04:10 (IQR: 02:57–05:28)	15, 36, 143 s*	<0.05
- Traffic	01:45 (IQR: 00:49–02:41)	No data	<0.05
- Fire	02:45 (IQR: 01:21–03:45)	6, 48 s*	<0.05
Photo received at dispatch centre, yes, n, (%):			
- All cases (n = 59)	100	NA	
- OHCA (n = 26)	100		
- Traffic (n = 20)	100		
- Fire (n = 13)	100		

* Individual times (few cases).

the drones at the dispatch centre was granted by the Swedish Authority for Privacy Protection. No individuals at the incident sites could be identified through the drones' black-and-white low-resolution cameras with the drones hovering at between 30 and 60 m altitude. The drones were dispatched to the following predefined index-nodes: 1) suspected OHCA, 2) traffic accidents, 3) fires in buildings, 4) railway accidents and 5) dispatcher-triggered events. Criteria which prevented drone launch: 1) ATC closed, 2) out of operating hours, 3) any rain or wind >8 ms, 4) no-fly zone and 5) alerts geographically out of range within administrative area.¹²

When a 112-emergency call was answered and the call indexed as any of the above events, the drone operator was alerted automatically by the dispatch centre and the exact geographical coordinate was transferred. The drone operator requested permission for take-off from Air Traffic Control (ATC), whereafter the drone left the hangar and flew to the site. On arrival a photo from the incident site was taken and transmitted to a) The regional dispatch centre Helicopter Emergency Medical Service (HEMS) coordinator, Göteborg, Västra Götaland region, and b) The fire departments' control centres in the cities of Trollhättan and Vänersborg.

In cases of suspected OHCA, the drone took a photo and an AED symbol was integrated in the photo, showing the dispatcher where the AED was delivered, so the dispatcher could refer the caller to retrieve it. In this region the closest fire, ambulance and police units can be dispatched to an OHCA alert to facilitate early CPR and early defibrillation. Data was retrieved through the national dispatch centre (SOS Alarm AB) with regards to GPS coordinates, indexing of the event, number of units and time delays from responding units, including drones and all other dispatched EMS units. Medical priority index system data was retrieved from the regional emergency medical dispatch centre with regard to indexing of the conditions and time delays. Drone flight data was retrieved from the drone operator as regards flight information, maintenance of the system, time delays, meteorological data and adverse events. After each case the dispatch centre prospectively documented characteristics of the transmission of the photo(s) and eventual changes in the dispatch of responding units with regard to the photo(s) as an evaluation of the newly implemented service. An adverse event was defined as cases when the drone caused any type of damage to objects on the ground or in the air or injury to humans.

Statistics and ethics approval

Descriptive data were used to present time delays (min:sec) with interquartile range (IQR) distribution. Event characteristics of drone alerts to time-dependent incidents are described with proportions given for each incident type. SPSS version 29 and the Mann-Whitney *U* test were used to compare distributions of continuous variables. Ethics approval for the overall AED-study dispatching drones was granted by The Swedish Ethics Review Board on 2021-03-30 with number Nr: 2020-06906 with amendment 2021-06041-02. The regional dispatch centre implementation of this new service of dispatching drones for new indexes during an ongoing AED-study was granted permission to use the camera for situational awareness by the Swedish Authority for Privacy Protection (IMY) on the 20th of December 2022. The Swedish Ethics Review Board decided to reject an amendment (Number: 2022-06624-01, 24th January 2023) from the researchers to retrospectively analyse observational data from the regional dispatch centre as it was considered to

not involve research on humans according to Swedish law. Observational data was retrieved from the dispatch centres database retrospectively after the test period had ended in April 2023.

Results

Over the study period of four months, a total of 440 emergency incidents were registered within the drone-service areas via the emergency number 112. Of these 440, the drone took off in 59 cases (13%). Reasons for not flying included closed airspace in 234 cases (53%), unfavourable weather conditions (e.g. rain and heavy wind) in 65 cases (15%), out of operating hours in 56 cases (13%), pre-take off abortion in 20 cases (4.5%) and miscellaneous reasons in four cases (0.9%). In two cases the drones were cancelled post take-off by the emergency dispatcher due to change of status of the alert (see flowchart, Fig. 1).

Out of the 59 alerts when the drone was deployed, 26 cases (44%) were suspected OHCA, 20 cases (34%) were traffic accidents, and 13 cases (22%) were fires in buildings. The exact location was defined as the place to which the dispatch centre had provided GPS coordinates to. The drone arrived at this location in 58/59 (98%) cases; in one case the dispatch centre misplaced the coordinates by approximately 150 m causing the drone to arrive correctly to the given location but not the incident scene. In 7/59 cases EMS were never dispatched, out of remaining cases, drones arrived before the EMS in 47/52 (90%). Drones had an overall median response time in these 52 cases of 03:49 min (IQR: 03:18–04:26), versus EMS with a median response time of 05:51 min (IQR: 04:29–08:04) *p*-value for time difference between EMS and drone = 0.05. When they arrived first, the median time difference for the drones was 03:05 min (IQR: 01:13–04:57) and it was 00:36 min (IQR: 00:15–00:48) for the EMS, correspondingly. Photos were transferred correctly to the dispatch centre in all alerts (59/59) (see building fires, example photos in Figs. 2–4). There were no simultaneous, conflicting alerts to different incidents and no adverse events were reported.

OHCA

Out of all alerts during the study period a total of 147 (33%) involved suspected OHCA; the drone took off in 26 of those cases (18%). In all cases of a suspect OHCA and when a drone took off a photo was also delivered. Arrival ahead of EMS occurred in 23/26 cases (88%). Drones had an overall median response time of 03:43 min (IQR: 03:10–04:20), versus EMS with a median response time of 07:29 min (IQR: 5:19–09:23, *p* < 0.05). In cases when the drone arrived first (*n* = 23) the median time difference was 04:10 (IQR: 02:57–05:28) minutes. Concerning EMS arrival, ambulance units were first on scene in 19/26 (73%) cases compared to the fire services.

Traffic accidents

The total number of emergency 112-calls concerning traffic accidents was 185 (42%), and the drone took off in 22 (12%) of those cases. In two cases, the emergency dispatcher cancelled the drone response after take-off when receiving further information, whereupon the drone aborted the mission and returned to base before arriving at the scene. Out of all alerts where both drones and EMS were dispatched (13/20 cases), the drone arrived ahead of EMS in all cases, with a median response time of 03:49 min (IQR: 03:21–04:29), whereas the EMS had a median response time of 04:30 min (IQR: 03:48–05:02, NS). Overall, the median time

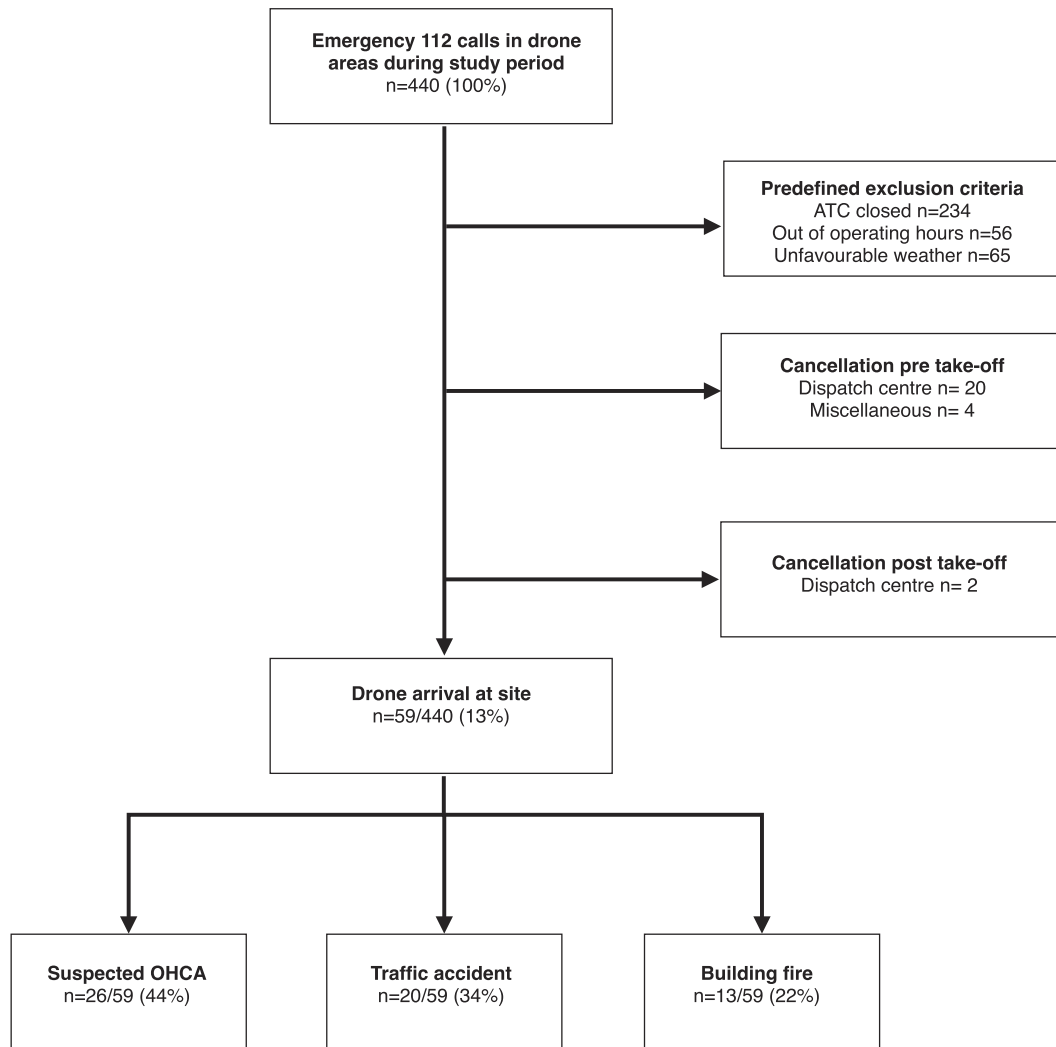


Fig. 1 – Flow chart of drone dispatch to time-critical incidents.

difference for the drone was 01:45 min (00:49–02:41) in cases when it arrived first. Concerning the EMS, the fire services arrived first in 11/13 (85%) of the calls.

During the study period there was a total of seven alerts out of 20 (35%) regarding traffic incidents where a drone took off and returned a photo to the dispatcher as part of the initial assessment of the situation and a decision was made not to call out any more resources.

Building fire

There was a total of 89 alarms during the period, and of these, drones were deployed and took off in 13 (15%) cases. Drones arrived before the EMS in 11/13 cases (85%). Drones had an overall median response time of 04:22 min (IQR: 03:04–04:36), versus 05:36 (IQR: 04:33–06:10, $p < 0.05$) for the EMS, showing a median time difference for the drones of 02:45 min (IQR: 01:21–03:45). Concerning the EMS, the fire services arrived first in all cases.

Railway accidents and dispatcher-triggered events

Over the study period, there were no emergency 112-alerts concerning railway accidents, nor did dispatchers manually trigger the drone system for any other time-critical incident.

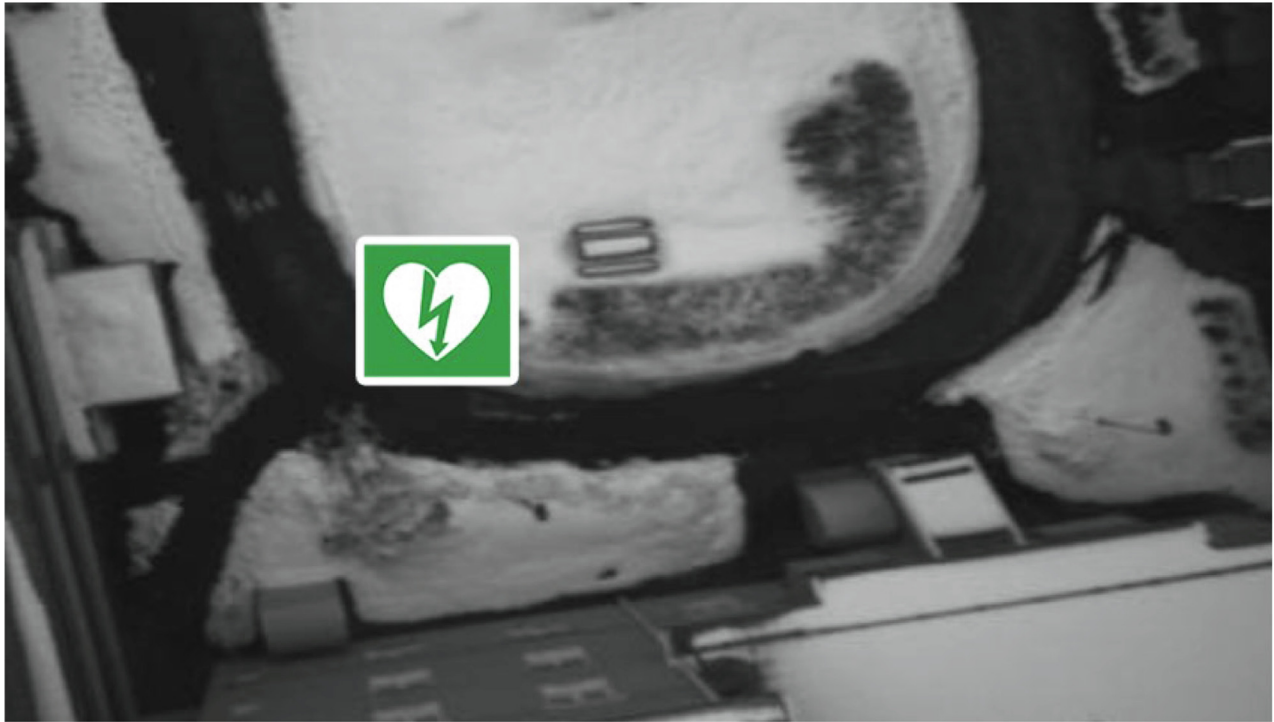
Discussion

The main finding of this retrospective observational study was that in a newly implemented drone dispatch service, drones were dispatched to 13% of relevant EMS calls. When drones were dispatched, they arrived at scene earlier than EMS services in 90% of cases. Drones were able to relay photos to the regional dispatch centre in all cases.

This novel method may present new perspectives on decision-making within EMS systems, shaping EMS responses and facilitating optimized DA-CPR in cases of OHCA. To our knowledge this methodology has never previously been used in real-life cases.

Drone surveillance of traffic-accident sites and fires has previously been shown to be feasible. However, to our knowledge, such systems are not currently employed by the Emergency Medical Dispatch Centre for BVLOS flights during the early phase of emergency 112-calls. The 59 flights in this study show that drones may be deployed, perform automated flights and safely arrive at the correct location of an incident to transmit data. However, geographical accuracy when deploying these systems needs continuous evaluation, as there may be a risk that drones transmit data/photos from the wrong location,

A.



B.



C.



D.



Fig. 2 – Drone photo of AED-delivery in suspected OHCA with AED-symbol integrated.

which in turn could be harmful if responding units were withdrawn, e.g. on the basis of no fire seen or no traffic accident noticeable.

In the region of Västra Götaland, in our current AED-drone project we have developed the type of integration required to be able to place drones at optimal locations¹⁵ and dispatch them in an automated fashion simultaneously with the EMS in cases of suspected OHCA.^{12,14} Up to now, drone systems have been deployed only in connection with suspected OHCA and they remain unused during

the majority of operational hours, thus making room for additional use. When using drones for multiple purposes, i.e., other time-critical incidents, we believe that the placement of drone systems may need to be updated from geographic information system (GIS) models concerning OHCA only, to all types of incidents, to better match them and achieve a maximal effect in terms of short response times. Considering the present results, there was a greater time difference in cases of OHCA, compared with fires and traffic incidents,



Fig. 3 – Drone photo of traffic accident in roundabout.



Fig. 4 – Drone photo of fire in building with smoke haul.

which might be a result of the fact that existing drones have been placed in optimized locations for responding to OHCA. Drones need to be placed close to where incidents occur and alerted automatically via existing dispatch structures.¹¹

There is a range of applications where drone delivery of drugs and/or medical equipment can be combined with sending early visual data from drone-cameras for decision-making within dispatch centres and EMS.^{11,16} It is unclear what would be considered as a “clin-

ical relevant time difference” in these different incident situations. This needs to be addressed in future studies.

AED-equipped drones are particularly valuable when arriving at the scene of an OHCA and delivering an AED prior to the arrival of first responders. However, by using camera-equipped drones, a photo and a simple AED symbol pinpointing the whereabouts of the delivered AED might support the dispatcher during DA-CPR and create extra value. Using an onboard camera en-route to an inci-

dent site might provide the dispatch centre with useful information at a very early stage, e.g. in traffic situations or detection of a visible distant sign of smoke. This requires live video to be transmitted and not just photos, as in this study. Information from the flight could potentially be useful almost from take-off, if accessible for the dispatcher through live-stream video from the start.

During the study period, there was a total of seven incidents where a drone took off and delivered a photo to the dispatch centre; the dispatcher included the photo in their initial assessment of the incident scene and decided not to call out any additional resources. We have no information in regards to if this decision was due to reports from the scene or if photos did play any role. We believe this indicates both a potential risk if there is uncertainty as to whether or not the drone had arrived at the correct location, as well as potential value in the dispatching of resources – not only how many resources should be dispatched but also whether to dispatch at all. The clinical value and if this effected the dispatcher's decision of the photo were not reported or analysed in this study. This needs to be examined further in future studies to be able to draw any conclusions.

These first experiences of including traffic accidents and fires in buildings in addition to AED-drone dispatch imply that there may be value in multiple purposes besides medical conditions. Similar findings from studies where photos and live video have been streamed to the dispatch centre, the incident commander and other involved parties, show that video with high resolution is preferable, recommended and that integration in the incident command structure is required.¹⁷

Sometimes there can be dual and conflicting alerts, i.e., the drones are busy when another emergency call is received, but no such situations occurred over the study period, probably as a result of the limited number of alerts. Dual conflicting alerts, and conflicts arising because of manned aircraft in the airspace are expected to be a challenge for implementation of these drone systems in the future. "U-space" solutions for today's uncontrolled airspace may provide the separation needed, but more research is needed to identify potential hazards using this kind of traffic management.¹⁸

With regard to cost-effectiveness, cameras mounted on helicopter-based EMS units or search and rescue helicopters can offer the same overview as a camera mounted on a drone, but the cost would be significantly higher.¹⁹ Also, when time is of the essence, a drone can respond in an automated fashion and probably be on the scene faster in most situations, as shown in this study. From the perspective of healthcare, and use of societal resources, using the system for multiple types of mission may reduce the financial burden, thus increasing the chance of implementation on a larger scale.

We believe that the types of events where these systems are likely to have the greatest potential are events where several different authorities such as EMS, police and fire departments are dispatched. We also see possible benefits in sending pictures or videos to response units such as ambulance, police and other emergency services.

The challenges regarding drones equipped with cameras responding to emergency situations are many. The integrity of the patient and responding personnel is crucial and this aspect needs to be addressed in a proper manor when high-resolution video is used. Healthcare confidentiality is strong and does not automatically permit the sharing of photos or videos among authorities. All of the above-mentioned problems are complex and need to be addressed continuously.

Limitations

This is an observational retrospective study conducted over a short time period in a limited geographical area, and the results may differ in other contexts. Drones were dispatched only to cases of OHCA, traffic accidents and fires in buildings for analysis of logistic variables, and the experiences of situational awareness as perceived by dispatchers is still unexplored. The use of live video streaming instead of black and white photos has the potential to further increase understanding of this novel technology. However, this was not evaluated in this study.

The drones used in this study were sensitive to weather, and there are also limitations connected to airspace regulations and compliance with ATC opening hours. The ability to fly in various weather conditions and in uncontrolled airspace would dramatically increase the number of flights. Drone location is a limiting factor, and GIS calculations for optimal placement, incorporating all included types of events would be beneficial. There are occasions when drones are not first on-site, and the use of drone cameras in such instances, i.e., drones staying on-scene, remains unexplored.

The time delay when transferring a photo from the scene to the dispatch centre was not measured, but we consider it to be brief. This is something that needs to be examined further in coming studies.

Conclusions

In a newly implemented drone dispatch service, drones were dispatched to 13% of relevant EMS calls. When drones were dispatched, they arrived at scene earlier than EMS services in 90% of cases. Drones were able to relay photos to the dispatch centre in all cases.

Although severely affected by closed airspace and weather conditions, this novel method may facilitate additional decision-making information during time-critical incidents.

CRedit authorship contribution statement

M. Kristiansson: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **M. Andersson Hagiwara:** Writing – review & editing, Supervision, Methodology, Conceptualization. **L. Svensson:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **S. Schierbeck:** Writing – review & editing, Conceptualization. **A. Nord:** Writing – review & editing, Conceptualization. **J. Hollenberg:** Writing – review & editing, Funding acquisition, Conceptualization. **M. Ringh:** Writing – review & editing, Conceptualization. **P. Nordberg:** Writing – review & editing, Conceptualization. **P. Andersson Segerfelt:** Writing – review & editing, Software, Investigation, Formal analysis. **M. Jonsson:** Writing – review & editing, Software, Investigation, Formal analysis. **J. Olsson:** Writing – review & editing, Software, Investigation, Formal analysis. **A. Claesson:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

1. SOS Alarm dispatch centre - national annual report 2022. (In Swedish). Accessed on 28th June 2023. Available via: <https://www.sosalarm.se/globalassets/dokument/112-rapporter/112-rapporten-2022.pdf>.
2. Drennan IR, Verbeek PR. The role of EMS in regionalized systems of care. *Cjem* 2015;17:468–74.
3. Mohd Daud SMS, Mohd Yusof MYP, Heo CC, et al. Applications of drone in disaster management: a scoping review. *Sci Justice* 2022;62:30–42.
4. Rosser Jr JB, Parker BC, Vignesh V. Medical applications of drones for disaster relief: a review of the literature. *Surg Technol Int* 2018;33:17–22.
5. Bäckman A, Hollenberg J, Svensson L, et al. Drones for provision of flotation support in simulated drowning. *Air Med J* 2018;37:170–3.
6. Claesson A, Svensson L, Nordberg P, et al. Drones may be used to save lives in out of hospital cardiac arrest due to drowning. *Resuscitation* 2017;114:152–6.
7. Balasingam M. Drones in medicine-The rise of the machines. *Int J Clin Pract* 2017;71.
8. Bezas K, Tsoumanis G, Angelis CT, Oikonomou K. Coverage path planning and point-of-interest detection using autonomous drone swarms. *Sensors (Basel)* 2022;22.
9. Department CVP. Chula Vista Police drone program <https://www.chulavistaca.gov/departments/police-department/programs/uas-drone-program2024>.
10. Johnson AM, Cunningham CJ, Arnold E, Rosamond WD, Zègre-Hemsey JK. Impact of using drones in emergency medicine: what does the future hold? *Open Access Emerg Med* 2021;13:487–98.
11. Roberts NB, Ager E, Leith T, et al. Current summary of the evidence in drone-based emergency medical services care. *Resusc plus* 2023;13:100347.
12. Schierbeck S, Hollenberg J, Nord A, et al. Automated external defibrillators delivered by drones to patients with suspected out-of-hospital cardiac arrest. *Eur Heart J* 2022;43:1478–87.
13. Schierbeck S, Nord A, Svensson L, et al. Drone delivery of automated external defibrillators compared with ambulance arrival in real-life suspected out-of-hospital cardiac arrests: a prospective observational study in Sweden. *Lancet Digit Health* 2023;5:e862–71.
14. Schierbeck S, Svensson L, Claesson A. Use of a drone-delivered automated external defibrillator in an out-of-hospital cardiac arrest. *N Engl J Med* 2022;386:1953–4.
15. Schierbeck S, Nord A, Svensson L, et al. National coverage of out-of-hospital cardiac arrests using automated external defibrillator-equipped drones - A geographical information system analysis. *Resuscitation* 2021;163:136–45.
16. Karaca Y, Cicek M, Tatlil O, et al. The potential use of unmanned aircraft systems (drones) in mountain search and rescue operations. *Am J Emerg Med* 2018;36:583–8.
17. Braverman A. Unmanned aerial systems (UAS) in urban search and rescue-methodology, capacity development, and integration. *J Emerg Manag* 2021;19:33–8.
18. Kotlinski M, Calkowska JK. U-Space and UTM deployment as an opportunity for more complex UAV operations including UAV medical transport. *J Intell Robot Syst* 2022;106:12.
19. Roper JWA, Fischer K, Baumgarten MC, Thies KC, Hahnenkamp K, Flessa S. Can drones save lives and money? An economic evaluation of airborne delivery of automated external defibrillators. *Eur J Health Econ* 2023;24:1141–50.