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Original Research

Helicopter Emergency Medical Services Out-of-Hospital Cardiac Arrests During the Initial COVID-19 Lockdown Versus Nonpandemic: A Comparison

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A B S T R A C T

Objective: COVID-19 may have contributed to an excess of out-of-hospital cardiac arrests (OOHCAs). This observational study identified changes in OOHCA epidemiology pre- and post—COVID-19 lockdown in a single UK helicopter emergency medical service (HEMS).

Methods: A retrospective, single-center (Essex & Herts Air Ambulance), observational study was undertaken with anonymized OOHCA data (demographics, etiology, and outcomes) from March 23, 2020, to June 23, 2020, and comparative data from March 23, 2019, to June 23, 2019. Supplementary data (total OOHCAs and patient outcomes) were provided by the East of England Ambulance Service National Health Service Trust. Data were analyzed using the Mann-Whitney U test and chi-square test; \( P < .05 \) was statistically significant.

Results: Of the HEMS activations during national lockdown, 33.6% were for OOHCAs compared with 25.8% during the reference time frame. The frequency of young and female OOHCAs demonstrated a statistically significant increase. Statistically significant variations in medical etiology and initial cardiac rhythm were identified.

Conclusion: During the initial UK-wide lockdown, the OOHCA characteristics attended by 1 HEMS team were altered. The changes seen may be due to the pathophysiology of COVID-19 or an alteration in dispatch due to the demand placed on the wider ambulance service; this may require further consideration for any future lockdowns or pandemics.
Methods
This retrospective observational single-center study (Essex & Herts Air Ambulance) aimed to quantify (and compare) the number of OOHCA s within the operational area (Essex & Hertfordshire, population approximately 2.9 million) between the national lockdown period and the same period during the previous year.

HEMs teams are dispatched when certain predetermined criteria are satisfied (immediate dispatch) after “999” call interrogation by a critical care paramedic or at the request of the attending medical team on scene. Immediate dispatch for criteria includes traumatic cardiac arrest. There was no formal alteration of any dispatch criteria between the 2 time periods. The HEMs team carries a Lucas 3 Stryker, Portage, MI, USA for automated chest compressions.

The computerized record system at Essex & Herts Air Ambulance (HEMSbase2.0 Medic One Systems, London, UK) was interrogated to extract anonymized OOHCA data for the 2 time periods in question (March 23, 2020–June 23, 2020, compared with March 23, 2019–June 23, 2019). Data relating to case demographics, etiology, initial presenting cardiac rhythm, and outcome were all recorded. All OOHCA patients were included irrespective of cause or outcome. Local research policies were satisfied; ethical approval was not required. Attending clinicians attributed the etiology of the OOHCA based on patient history and presenting symptoms, documenting this in the HEMSbase 2.0 system. If postmortem data were available, this information was used to determine the etiology. COVID-19 status for a patient was determined by the history on scene due to the lack of community testing; this was done by confirming on scene that the patient was currently self-isolating, had a confirmed COVID-19 contact, or had reported classic symptoms and signs in the preceding days (cough/fever/shortness of breath/anosmia). When the cause of death was attributed to COVID-19, this was due to pneumonia or acute respiratory distress syndrome rather than any other related disease; if the patient was COVID-19 positive but had an alternative cause of their OOHCA, this was documented. This correlates with advice given to medical practitioners documenting causes of death during the pandemic where COVID-19 could be written as the cause of death if “before death the patient had symptoms typical of COVID-19 infection, but the test result has not been received.” In addition, anonymized data from the East of England Ambulance Service NHS Trust provided overall OOHCA case numbers for the East of England and patient outcome (survival to discharge/death on scene) information for those attended by HEMS.

Data were analyzed using Microsoft Excel (Microsoft, Redmond, WA) and SPSS Statistics (Version 26; IBM Corp, Armonk, NY). A Shapiro-Wilk test was performed for normality on continuous values. Mean (if Gaussian) and median values (if non-Gaussian) were calculated as appropriate; the Mann-Whitney U tests and chi-square test were used to compare the data sets. \( P < .05 \) was considered statistically significant. The Strengthening the Reporting of Observational Studies in Epidemiology checklist was followed.15

Results
Between March 23, 2019, and June 23, 2019 (nonpandemic year), there were 570 activations of the Essex & Herts Air Ambulance Trust (EHAAT) HEMS, 147 of which were for OOHCA s (26%). During this time, HEMS ran until 10 PM every day, except Friday and Saturday when it ran until 2 AM. The East of England Ambulance Service recorded 912 OOHCA s for the whole East of England region, 16% of which were attended by EHAAT.

In comparison, during the lockdown period of March 23, 2020, to June 23, 2020, there were 539 activations of HEMS, 81 of which were for OOHCA s (34%). During this time frame, there were a total of 956 OOHCA calls for the whole East of England Ambulance Service region, with an activation rate of 19% for EHAAT. These data are summarized in Table 1.

Table 1
Activations for Out-of-Hospital Cardiac Arrests (OOHCAs)

|                          | Nonpandemic 3/23/19-6/23/19 | Pandemic Lockdown 3/23/20-6/23/20 | P Value |
|--------------------------|-----------------------------|-----------------------------------|---------|
| Total operating hours HEMS available | 1,569 (non–24-hour service) | 2,232 (24-hour service) | — |
| Total activations | 570 | 539 | — |
| Total stand-downs | 216 | 191 | — |
| % of activations | 37.9 | 35.4 | — |
| Activations per hour available | 0.36 | 0.24 | — |
| OOHCA activations | 147 | 181 | — |
| OOHCA stand-downs | 41 | 62 | — |
| % of OOHCA activations | 28% | 34% | — |
| (39 team clinical input not required, 1 diverted to another job, 1 due to weather) | (56 team clinical input not required, 1 diverted to another job, 1 technical issue, 1 ambulance left scene, 3 no data available) | — |
| OOHCA attended | 106 | 121 | — |
| OOHCA attended per hour available | 0.07 | 0.05 | — |
| Male patients, n (%) | 89 (85) | 85 (70) | .02 * |
| Median age (years) (IQR) | 59 (47-68) | 53 (37-64) | .046 * |
| Median time to activation of HEMS team from 999 call (min) (IQR) | 9.5 (5-18.75) | 18 (7-33) | <.01 * |
| Patients who were intubated on scene | 65 | 56 | .02 * |

* = no calculation performed; HEMS = helicopter emergency medical service; IQR = interquartile range.
* = Statistically significant.
52% presenting in a shockable rhythm in 2019 (ventricular fibrillation or pulseless ventricular tachycardia) versus only 32% in 2020 \( (\chi^2 = 8.9, P < .01) \). Figure 2 compares the destinations of the patients attended to by the HEMS team between the nonpandemic and pandemic time periods; there was no statistically significant difference \( (\chi^2 = 6.2, P = .19) \). Of the suspected COVID-19 OOHCAs during the pandemic, 59% of patients died on scene versus 43% of all other medical causes of OOHCAs during the same period. Of the patients whose death was attributed as COVID-19, the median age was 55 years, with 7 of 16 being female.

In 2019, of the 106 OOHCAs attended by EHAAT, 11 patients (10.4%) were known to have survived to hospital discharge; 65% of patients died either at the scene or in the hospital (data missing/unavailable for 23 patients; 3 transferred alive to another hospital but outcome unknown). In comparison during the 2020 lockdown, 16 survived to discharge (13.2%); 80% died on scene or in the hospital (data missing for 5 patients; 2 transferred alive to another hospital but outcome unknown). There was no statistically significant difference between the outcomes at discharge \( (\chi^2 = 0.70, P = .71) \).

### Discussion

This study demonstrates statistically significant differences in patient demographics, the etiology of medical OOHCAs, and the initial presenting rhythm for all OOHCAs attended by one UK HEMS service during the COVID-19 initial UK lockdown relative to a control period the previous year. Although it is recognized that HEMS is likely to attend a relatively “self-selected” proportion of OOHCAs, it is interesting that this has changed during the pandemic. Some of the differences, such as the increased proportion of OOHCAs in women, are reflected in similar studies in the wider ambulance service, both within the United Kingdom and internationally.6-9,16 but there are also some findings that are likely to be unique to HEMS services, such as the lower median age noted during the pandemic by HEMS.

During the initial lockdown of the United Kingdom due to COVID-19, Essex & Herts Air Ambulance was activated to an increased number of OOHCAs (33% vs. 26%) despite an overall decrease in HEMS activations during the same time period, reflecting similar trends identified by first responders both nationally and internationally.6-9,16 Both figures represent a significantly higher activation percentage for OOHCAs than other similar HEMS within the United Kingdom (11% for Kent Surrey Sussex Air Ambulance).11

In comparison with other studies, the median age of the patients showed a statistically significant decrease during the pandemic.6-9 The median age was also significantly lower than that seen in hospitals.17 Of note, in a previous study of all OOHCAs attended by the East of England Ambulance Service NHS Trust, their median age was 74 years, a contrast to the median age of 59 years in the 2019 non-pandemic time frame in this study.18 This may be because HEMS dispatch criteria result in more activations for younger patients, because they are more likely to present in shockable rhythms or have witnessed arrests, achieve ROSC, and are therefore more likely to have positive outcomes; survival to hospital in the whole East of England Ambulance Service NHS Trust has been shown to be 27.6% versus 45.0% for those attended to by the corresponding HEMS teams.12,18

### Table 2

| Causes for Out-of-Hospital Cardiac Arrest With Breakdown of Medical Etiology | Nonpandemic 3/23/19-6/23/19 | Pandemic Lockdown 3/23/20-6/23/20 |
| --- | --- | --- |
| Medical, n (%) | 88 (83) | 92 (76) |
| Arrhythmia | 12 (14) | 1 (1) |
| COVID-19 (clinical diagnosis) | NA | 27 (30) |
| COVID-19 (PCR test positive) | NA | 0 (0) |
| Hypothermia | 0 (0) | 0 (0) |
| Hypovolaemia | 2 (2) | 1 (1) |
| Hypoxia | 9 (10) | 6 (7) |
| Metabolic | 0 (0) | 1 (1) |
| Sepsis | 1 (1) | 0 (0) |
| MI | 58 (66) | 46 (50) |
| Neurologic | 2 (2) | 7 (6) |
| PE | 4 (5) | 2 (3) |
| Choking | 1 (1) | 3 (3) |
| Trauma | 10 (9) | 11 (9) |
| Self-harm | 7 (7) | 15 (12) |

COVID-19 = coronavirus disease 2019; MI = myocardial infarction; NA = not applicable; PCR = polymerase chain reaction; PE = pulmonary embolism.

![Figure 1](image-url)  
*Figure 1.* A comparison of the initial rhythm analysis by the HEMS team on arrival at OOHCA. PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia (pulseless).
Therefore, during the COVID-19 pandemic, with the overall increase in OOHCAs, it may be that dispatch focused on patient groups deemed to have reversible pathology and, therefore, the greatest chance of survival. There may have been a shift in the interrogation technique of the critical care paramedics due to the sheer volume of OOHCAs during this period, without this being an explicit or formal change.

In keeping with a similar study, this study also shows an increase in the percentage of females with OOHCA attended during the pandemic (30% vs. 16%).9 Within the hospital, one study identified a similar percentage of COVID-19–related cardiac arrests for females (34.7%).17 Of the 16 patients who died on scene from suspected COVID-19, seven of them were female. Ordinarily, there is a male predominance in OOHCAs, so the increase in females attended is interesting.11,12,18 The exact etiology causing COVID-19–related OOHCAs is still not fully understood, but an in-hospital study suggests that noncardiac causes may be a greater influence.17 It has been hypothesized that a hyperinflammatory state may result in the development of tachyarrhythmias; it is unclear if this process is influenced by sex.19 The pathophysiology attributed to this requires additional investigation. There may also have been more witnessed cardiac arrests in females resulting in HEMS dispatch because family members may have been at home as a consequence of homeschooling or childcare.

During the pandemic, other ambulance services found the time until the first emergency responder was on scene increased.9 The current study also found a notable increase in the average time to activation for the HEMS team for OOHCAs during the pandemic (almost double the median time in the reference time frame). Many of the OOHCAs attended by HEMS teams follow ambulance crew requests (eg, if it is an ongoing shockable rhythm or there is a fragile return of spontaneous circulation). If it takes longer for the initial ambulance crew to reach the scene, then this is likely to increase the time to HEMS dispatch. Increasing demand and finite resources may have influenced the dispatch threshold of the critical care paramedic.

Despite the lockdown, the HEMS team continued to attend traumatic cardiac arrests and cardiac arrests secondary to intentional self-harm, although there was no significant difference in the proportion of these cases attended relative to 2019. The number of traumatic cardiac arrests was very similar in the two time periods; this is likely to be multifactorial, but possible explanations include higher speed road traffic collisions due to generally quieter roads. More intubations were performed pre-pandemic (61.3% vs. 46.2%), perhaps because more patients achieved ROSC necessitating rapid sequence induction or because there was less desire to perform aerosol-generating procedures during the pandemic.

When medical cardiac arrests are classified by etiology, a statistically significant trend is identified. During the pandemic, it was noted internationally that there was a decrease in hospitalization due to acute myocardial ischemia.20,21 Only 16% of patients were taken to a percutaneous coronary intervention (PCI) center during the pandemic lockdown compared with 30% in the non-pandemic; this is in keeping with a study in England that showed between February and May 2020 the rates of invasive coronary angiography were significantly lower than the same time period in 2019 among OOHCA patients.22 Thirty percent of OOHCAs in the pandemic were in patients with suspected COVID-19; there may also have been additional COVID-19 patients that were not formally diagnosed in the pulmonary embolus, arrhythmia, and/or myocardial ischemia group due to the limited availability of testing in the community initially.4,23 The on-scene mortality rate in the COVID-19 group was high at 59% compared with 43% for all other medical OOHCAs for the same time period. This correlates with the higher on-scene mortality observed in other studies, although compared with London overall, it is not as high (59.0% vs. 70.3%).6,16 In regard to discharge from the hospital, 13.2% of all OOHCA patients attended by HEMS were discharged alive from the hospital during the lockdown.

An initial nonshockable rhythm (pulseless electrical activity or asystole) was more frequently identified during the pandemic,
correlating with similar studies in both a prehospital and an in-hospi-
tal setting.6,8,9,17 In nonpandemic times, the majority of OOHCA
are shockable rhythms.11 Nonshockable rhythms in nonviable you-
gger patients may result in increased crew requests to support com-
plex withdrawal decision making. It should also be recognized that
COVID-19 has taken its toll on the well-being of health care workers,
and assistance in breaking bad news to families may be a valuable
contribution from the HEMS team.24 This may have resulted in a sub-
tle change in crew requests for HEMS teams.

Strengths and Limitations

The findings of this single-service study may not be homogenous
throughout UK HEMS. However, it compliments data previously pub-
lished for the same geographic areas and incorporates a comprehen-
sive data set.12,18 It is also recognized that there may have been some
trends that had developed in the pre-COVID lockdown that con-
tinued into the COVID lockdown that were not accounted for and may
cause a small amount of bias in the results; it is hoped that by choosing
the same period of the year to analyze and with no significant change in
dispatch criteria in that time period that this impact is minimal.

The precise cause of OOCHA may be indeterminate, particularly
when the patient died on scene. This study identifies the most likely
cause of the arrest based on the expert clinicians’ detailed note keep-
ing. The capacity to test for COVID-19 in the community was initially
very limited.13 Therefore, the diagnosis of COVID-19 was made by the
health care practitioners attending “to the best of their knowledge and
belief” as per the guidance for detailing cause of death during the
pandemic.14 This included a strong clinical suspicion of COVID-19
based on classic symptoms or direct COVID-19 contacts. Any late
updates from the hospital teams after the OOHCA were also
recorded and used to help code the cause of arrest. There are likely to
have been OOHCA causes that were misdiagnosed, including mis-
diagnosed COVID-19; however, it is unlikely to have caused a signifi-
cant effect on the results.

Regarding discharge follow-up, data are missing for 22% of the
2019 data versus only 4% of the 2020 data. This lack of data may have
resulted in a loss in statistical significance. This study also covers only
the initial UK lockdown. Since June 2020, there have been a variety of
other restrictions implemented, including two further full lockdowns
during which testing was much more freely available.1 With higher
daily death rates in the United Kingdom in January 2021, research
will be required to see whether the findings of this study are repli-
cated during these additional lockdowns and throughout the country
and whether vaccination is now seen to be influencing outcomes.

Conclusion

During the initial COVID-19 UK-wide lockdown, OOHCA char-
teristics were altered for one HEMS with statistically significant dif-
fences in demographics, cause of medical cardiac arrest, and initial
presenting rhythm. In patients with suspected COVID-19, there were
high mortality rates. A lower percentage of patients were taken for
percutaneous coronary intervention compared with prelockdown.
With the increased demand on the wider ambulance services,
changes to dispatch for the HEMS are likely to have occurred despite
no explicit alteration. The HEMS is also likely to have offered addi-
tional support for ambulance crews in the less traditional roles of
HEMS, such as breaking bad news in young medical OOHCA.
With additional UK lockdowns and wider testing availability since the ini-
tial March 2020 lockdown, work is needed to explore if these trends
continue and for consideration of how HEMS can continue to support
the wider ambulance service in future lockdowns or pandemics.

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