Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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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.

COVID-19, an infectious disease caused by the novel coronavirus (CoV) Severe Acute Respiratory Syndrome (SARS)-CoV-2 , has been present in the United Kingdom since January 2020.[1] It was declared a pandemic by the World Health Organization on March 11, 2020,[2] necessitating a UK-wide lockdown on March 23, 2020.[3] The ability to test people in the community was initially very limited, and it was not until September 2020 that testing was freely available to the wider public.[4,5]

Anecdotally, during the pandemic, there was an excess of out-of-hospital cardiac arrests (OOHCAs) with additional mortality.[6-8] The London Ambulance Service recorded an 81% relative increase between March 1, 2020, and April 30, 2020.[9] UK helicopter emergency medical services (HEMS) typically attend OOHCAs, accounting for at least 10% of case numbers.[10-12] Successful resuscitation and return of spontaneous circulation (ROSC) occur in 39% to 45%, with survival to discharge rates of 6% to 12%.[11,12] During the pandemic, HEMS teams continued to support National Health Service (NHS) ambulance trusts with prehospital critical care provision.

This observational study aimed to establish if there was a difference between OOHCAs attended by 1 HEMS during the first UK national lockdown (March 23, 2020-June 23, 2020) with the same time the previous calendar year (March 23, 2019-June 23, 2019).

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Methods

This retrospective observational single-center study (Essex & Herts Air Ambulance) aimed to quantify (and compare) the number of OOHCAs 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.[13] 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[4]; 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."[14] 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 OOHCAs (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 OOHCAs 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 OOHCAs (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 2.

There was no statistically significant difference between the types of OOHCAs in the nonpandemic versus the pandemic time frame ($\chi^2 = 5.0$, $P = .17$), but there was a statistically significant difference between the subclassification of medical OOHCA ($\chi^2 = 58.5$, $P < .01$). In 2020, 2 patients had symptoms consistent with COVID-19 within the previous 2 weeks, but their OOHCA was attributed to myocardial infarction.

Figure 1 shows the initial rhythm on arrival of the first emergency medical team; 1 patient was initially in sinus rhythm on arrival of the first medical responders but then experienced a cardiac arrest while the first responder was present. There was a statistically significant difference between the nonpandemic and pandemic groups, with

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 (26% of total activations)	181 (34% of total activations)	—
OOHCA stand-downs	41 (28% of OOHCA activations) (39 team clinical input not required, 1 diverted to another job, 1 due to weather)	62 (34% of OOHCA activations) (56 team clinical input not required, 1 diverted to another job, 1 technical issue, 1 ambulance left scene, 3 no data available)	—
OOHCAs attended	106	121 (108 in comparable working hours to 2019)	—
OOHCAs attended per hour available	0.07	0.05	—
Male patients, n (%)	89 (84)	85 (70)	.02[a]
Median age (years) (IQR)	59 (47-68)	53 (37-64)	.046[a]
Median time to activation of HEMS team from 999 call (min) (IQR)	9.5 (5-18.75)	18 (7-33)	<.01[a]
Patients who were intubated on scene	65	56	.02[a]

— = no calculation performed; HEMS = helicopter emergency medical service; IQR = interquartile range.
[a] Statistically significant.

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)	1 (1)
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.

52% presenting in a shockable rhythm in 2019 (ventricular fibrillation or pulseless ventricular tachycardia) versus only 32% in 2020 (χ^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 (χ^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 (χ^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 HEM 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 nonpandemic 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]

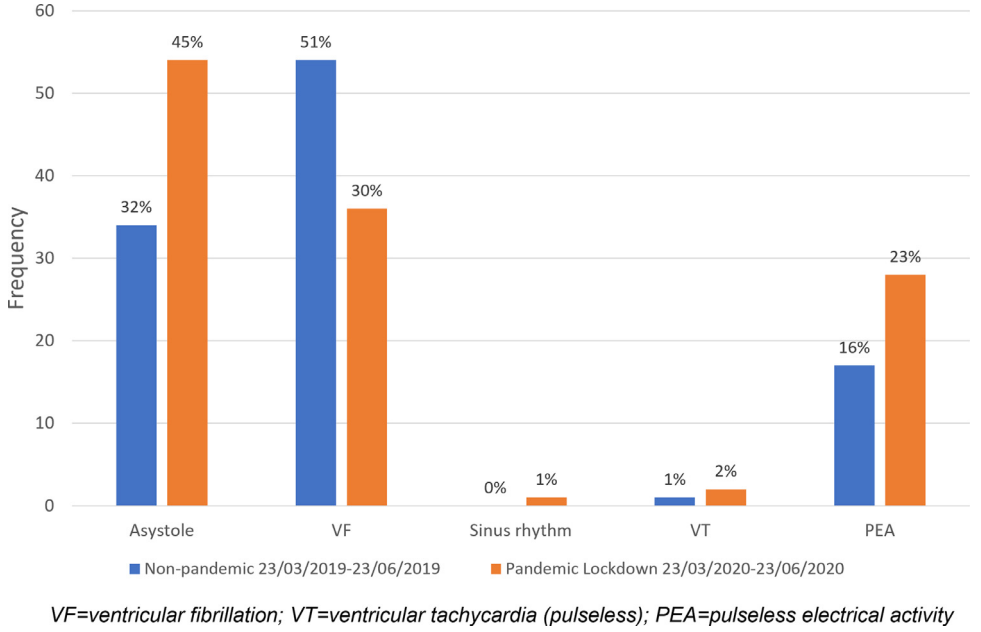

Figure 1. A comparison of the initial rhythm analysis by the HEMS team on arrival at OOHCA. PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia (pulseless).

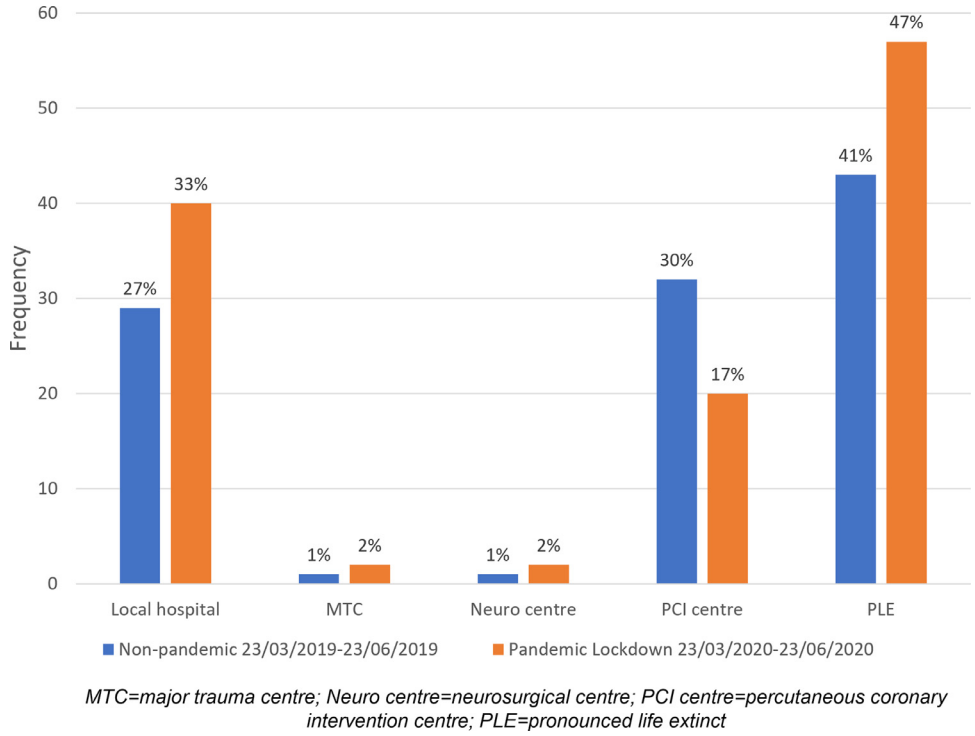

Figure 2. A Comparison of patient outcomes on scene or destination from the scene after an OOHCA. MTA, major trauma center; Neuro, neurosurgical; PCI, percutaneous coronary intervention; PLE, pronounced life extinct.

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 the 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 prepandemic (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 nonpandemic; 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%).[6,9,16] 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-hospital setting.[6,8,9,17] In nonpandemic times, the majority of OOHCAs are shockable rhythms.[11] Nonshockable rhythms in nonviable younger patients may result in increased crew requests to support complex 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 subtle 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 published for the same geographic areas and incorporates a comprehensive data set.[12,18] It is also recognized that there may have been some trends that had developed in the pre-COVID lockdown that continued 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 keeping. The capacity to test for COVID-19 in the community was initially very limited.[4] 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 OOHCAs were also recorded and used to help code the cause of arrest. There are likely to have been OOHCA causes that were misdiagnosed, including misdiagnosed COVID-19; however, it is unlikely to have caused a significant 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.[4] 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 replicated 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 characteristics were altered for one HEMS with statistically significant differences 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 additional support for ambulance crews in the less traditional roles of HEMS, such as breaking bad news in young medical OOHCAs. With additional UK lockdowns and wider testing availability since the initial 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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