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Out-of-hospital cardiac arrest volumes and characteristics during the COVID-19 pandemic

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ABSTRACT

Aim: The COVID-19 pandemic has significantly impacted Emergency Medical Services (EMS) operations throughout the country. Some studies described variation in total volume of out-of-hospital cardiac arrests (OHCA) during the pandemic. We aimed to describe the changes in volume and characteristics of OHCA patients and resuscitations in one urban EMS system.

Methods: We performed a retrospective cohort analysis of all recorded atraumatic OHCA in Marion County, Indiana, from January 1, 2019 to June 30, 2019 and from January 1, 2020 to June 30, 2020. We described patient, arrest, EMS response, and survival characteristics. We performed paired and unpaired *t*-tests to evaluate the changes in those characteristics during COVID-19 as compared to the prior year. Data were matched by month to control for seasonal variation.

Results: The total number of arrests increased from 884 in 2019 to 1034 in 2020 ($p = 0.016$). Comparing 2019 to 2020, there was little difference in age [median 62 (IQR 59–73) and 60 (IQR 47–72), $p = 0.086$], gender (38.5% and 39.8% female, $p = 0.7466$, witness to arrest (44.3% and 39.6%, $p = 0.092$), bystander AED use (10.1% and 11.4% $p = 0.379$), bystander CPR (48.7% and 51.4%, $p = 0.242$). Patients with a shockable initial rhythm (19.2% and 15.4%, $p = 0.044$) both decreased in 2020, and response time increased by 18 s [6.0 min (IQR 4.5–7.7) and 6.3 min (IQR 4.7–8.0), $p = 0.008$]. 47.7% and 54.8% ($p = 0.001$) of OHCA patients died in the field, 19.7% and 19.3% ($p = 0.809$) died in the Emergency Department, 21.8% and 18.5% ($p = 0.044$) died in the hospital, 10.8% and 7.4% ($p = 0.012$) were discharged from the hospital, and 9.3% and 5.9% ($p = 0.005$) were discharged with Cerebral Performance Category score ≤ 2.

Conclusion: Total OHCA increased during the COVID-19 pandemic when compared with the prior year. Although patient characteristics were similar, initial shockable rhythm, and proportion of patients who died in the hospital decreased during the pandemic. Further investigation will explore etiologies of those findings.

1. Introduction

In early 2020, COVID-19 reached the United States, affecting access to and delivery of healthcare throughout the nation. New protocols and strategies addressed potential surges in patient volumes, limited supplies of personal protective equipment, and the need for quarantine of infected healthcare workers and patients [1]. Mortality surged throughout the country resulting directly and indirectly from the global pandemic [2,3]. Similar to the rest of the healthcare system, emergency medical services (EMS) responded to ongoing variability in call volumes and acuity, and the challenges of safely providing care in the setting of an extremely contagious viral pandemic [4].

As COVID-19 spread, many cities noticed an increase in out-of-hospital cardiac arrest (OHCA) responses [3,5]. Similar surges occurred during other viral epidemics such as influenza, SARS, and MERS [6-8]. Those surges are unsurprising, likely resulting from both direct and indirect effects of viruses. The viruses directly increased mortality for infected patients [6-8]. Also, healthcare systems can become overwhelmed with infected patients, limiting resources available to uninfected patients. Some patients may be reluctant to access the 9–1-1 system during an infectious pandemic [9]. Such reluctance could delay care for emergent conditions leading to higher mortality. To better understand the direct

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and indirect impacts of the COVID-19 pandemic, we must examine resulting changes in patient and EMS response characteristics.

In this retrospective review, we evaluated the EMS response to OHCA in a large urban EMS system during the first six months of 2020 compared to the same time period in 2019. The primary objective was to identify trends in OHCA incidence, patient characteristics, arrest characteristics, and response characteristics during the initial months of the pandemic.

2. Methods

2.1. Study design, setting, and population

We performed a retrospective cohort analysis of all patients aged 18 years and older in Marion County, Indiana, to which Indianapolis EMS (IEMS) paramedics responded for an OHCA during the first 6 months (January–June) of 2019 compared to the corresponding period of 2020. Marion county is home to a population of 903,393 [10]. The racial composition of that population is 63% White, 27% Black, 2% Asian and 8% mixed or other races [10]. Indianapolis EMS (IEMS) is the largest ambulance service in the state of Indiana and provides EMS services throughout Marion county, responding to approximately 100,000 EMS calls per year.

2.2. Data source

Data on all OHCA is routinely collected for quality assurance by IEMS from the electronic medical record (ESO software). IEMS contacts destination hospitals for each patient to determine patient outcomes. Data of patients meeting inclusion and exclusion criteria of the study were extracted from the cardiac arrest database. All patients with incomplete data were excluded. This study was deemed exempt from review by the Indiana University Institutional Review Board, protocol number 2005639619.

2.3. Study variables and outcomes

The primary outcome was variability in the volume, characteristics, and management of OHCA during the COVID-19 pandemic in a major Metropolitan EMS system compared to the previous year.

We compared total volume of working OHCA, demographic data (age, gender), response characteristics (median response time, airway management), arrest characteristics (witness to arrest, bystander CPR, bystander AED, shockable initial cardiac rhythm), and patient outcomes (dead on arrival (DOA) of IEMS, field termination of resuscitation (TOR), survival to hospital admission or discharge, and cerebral performance category (CPC) score).

Regarding airway management, IEMS medical direction changed the protocol in April 2020 to encourage use of supraglottic airways over endotracheal intubation to reduce the risk of aerosol generating procedures.

2.4. Statistical analysis

Using SPSS 26.1 (IBM, Amarok, New York) we performed paired and unpaired *t*-tests for continuous variables, and chi-square test for categorical variables to evaluate the changes in those characteristics during COVID-19 as compared with the prior year. Data were matched by month to control for seasonal variation.

3. Results

In 2020, IEMS responded to a greater volume of OHCA than in 2019 (1034 and 884, respectively, $p = 0.016$). OHCA also represented a greater proportion of all EMS calls in 2020 than in 2019 (Fig. 1). Both are represented by month to account for seasonal variation in OHCA.

There was a trend toward more patients who were DOA upon arrival of IEMS in 2020 when compared with 2019 for some months, but this difference did not reach statistical significance ($p = 0.057$) (Supplemental Fig. 1).

In 2020, IEMS responded to a greater volume of OHCA than in 2019. We appreciated similar patient ages ($p = 0.086$) and proportion female patients ($p = 0.466$). The median response time was 18 s longer in 2020 ($p = 0.008$). More patients received a supraglottic airway rather than an endotracheal tube in 2020 than in 2019 ($p < 0.001$) secondary to a change in protocol (Table 1). Of note, there were no other significant OHCA protocol changes made.

We appreciated a similar percent of witnessed arrest ($p = 0.092$), bystander AED use ($p = 0.379$), and bystander CPR ($p = 0.242$). However, shockable initial cardiac rhythms decreased in 2020 ($p = 0.044$) (Fig. 2).

A majority of cardiac arrests happened at home and in nursing homes. In 2020, a higher percentage of patients experienced an OHCA in a nursing home and fewer occurred at home, though neither was statistically significant ($p = 0.264$ and $p = 0.100$, respectively) (Table 2).

Compared to 2019, in 2020 there were more patients who died in the field ($p = 0.001$), no significant difference in the percent of patients who died in the ED ($p = 0.809$), and fewer patients who died in the hospital ($p = 0.044$). Fewer were discharged from the hospital ($p = 0.012$), and fewer were discharged with a CPC score ≤2 ($p = 0.005$) (Fig. 3).

4. Discussion

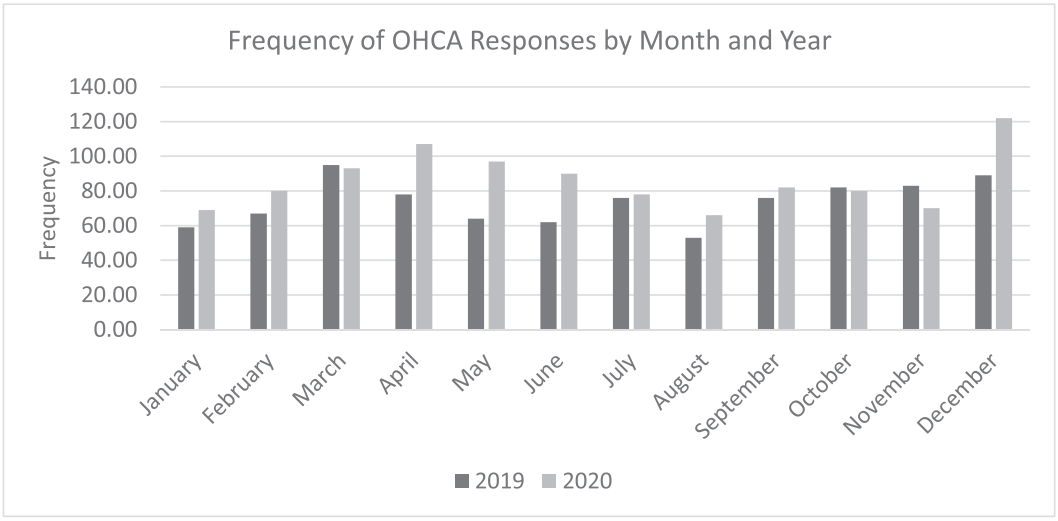
Similar to some other studies, we demonstrated an increase in OHCA observed during the initial months of the COVID-19 pandemic [3,5,8,11,12]. We speculate that the etiology is likely multifactorial - including OHCA from COVID-19 itself, patient fear of accessing care during a pandemic, and patients not recognizing illness severity at home. Interestingly no significant difference was appreciated in the proportion of patients who were DOA, suggesting that at a certain threshold of illness severity, patients accessed the emergency system at a similar rate to 2019.

Patient age and gender were similar during the COVID-19 pandemic as compared with the prior year. An evaluation of demographics in the New York City 9–1-1 system showed that OHCA during 2020 were more likely to occur in older patients, although the patient demographics between New York City and Marion county likely vary [12]. Our data does not differentiate between deaths sustained from COVID-19 and those unrelated to COVID-19. It could be that patient age did not differ significantly between 2019 and 2020 because the deaths did not result directly from COVID-19.

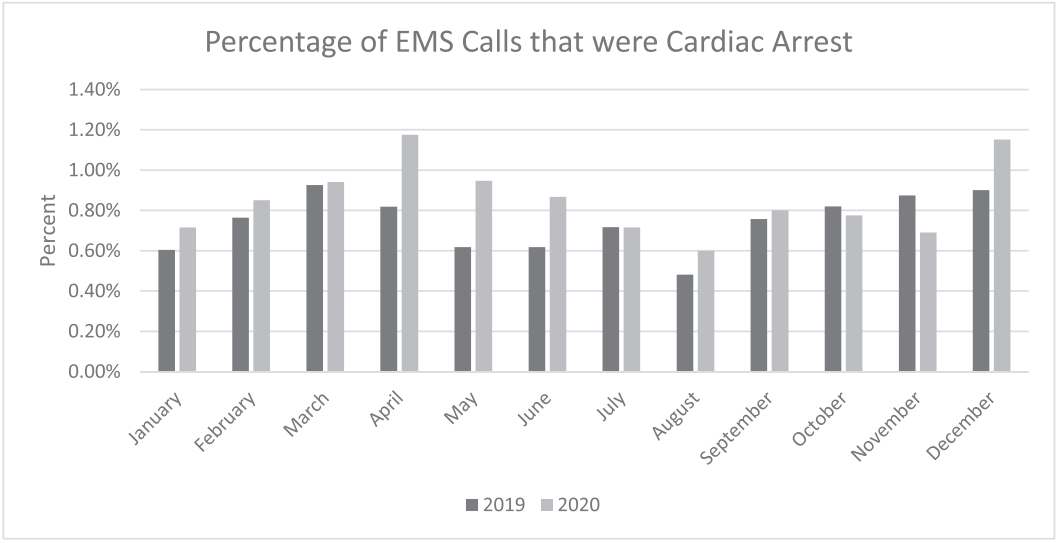
EMS response times were longer by less than 20 s in 2020 when compared to the prior year. Despite increased overall transport volumes and resource intensive critical transports (including OHCA), the EMS system was able to successfully deploy resources in a timely fashion. This differed from some other systems [13]. IEMS initiated protocols allowing EMS crews more latitude to recommend non transport of certain low acuity patients during the months of March and April. The additional protocols likely improved resource availability for the system.

We were surprised to observe a similar number of witnessed OHCA during the pandemic as compared to the prior year. We anticipated a fewer number of witnessed arrests because of a state issued “stay at home” order in late March 2020. Statewide tracking data based on cellphone location reported a decrease in mobility by 55% at the nadir in April 2020 [14]. Also surprising was the fact that there were actually more OHCA that occurred in homes or residences in 2019 as compared with 2020. We anticipated that those would have been reversed given the large population quarantined and working from home during the pandemic. However, it could be that the population that shifted from working outside the home to spending most of their time at home was mostly relatively young and relatively healthy, not the group most susceptible to COVID-19 or to OHCA. More patients sustained

a.


Frequency of OHCA Responses by Month and Year
Frequency
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
January
February
March
April
May
June
July
August
September
October
November
December
2019
2020

b.


Percentage of EMS Calls that were Cardiac Arrest
Percent
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
January
February
March
April
May
June
July
August
September
October
November
December
2019
2020

c.

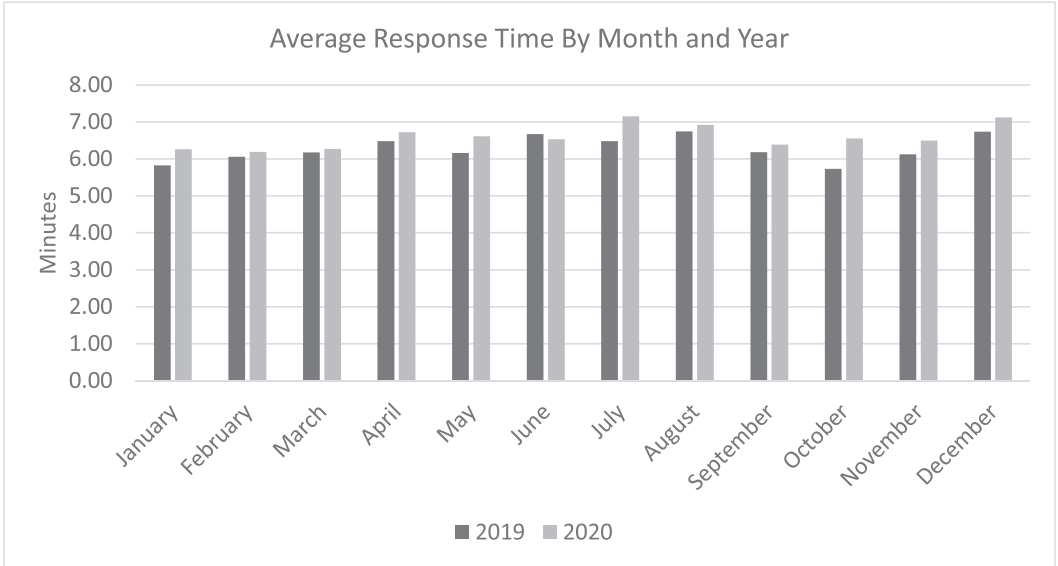

Average Response Time By Month and Year
Minutes
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
January
February
March
April
May
June
July
August
September
October
November
December
2019
2020

Table 1
Patient characteristics, arrest characteristics, and airway management in 2019 and 2020.

	2019	2020	*p*-value
Female—n(%)	340 (38.5%)	412 (39.8%)	0.466
Age in years—Median (IQR)	62.4 (48.8–73.2)	60.3 (46.9–71.8)	0.086
Response time in minutes—Median (IQR)	6.0 (4.5–7.7)	6.3 (4.7–8.0)	0.008
Airway management—n(%)			<0.001
No advanced airway	155 (17.5%)	211 (20.4%)	
Supraglottic airway	379 (42.9%)	725 (70.1%)	
Endotracheal intubation	350 (39.6%)	97 (9.4%)	

home. It could also reflect populations of nursing home patients who were in close contact and susceptible to rapid spread of COVID.

We were surprised to observe a similar incidence of bystander CPR in 2020 than in 2019, given widespread fear around close contact with the ill during the pandemic. We suspect the lower rate of initially shockable rhythms could be due to delays in seeking care or respiratory etiology of arrest.

Patients in 2020 were more likely to die in the field, with fewer patients surviving to hospital discharge and surviving with a neurologically favorable outcome. This is consistent with our finding of fewer shockable rhythms, as survival tends to be less favorable for these

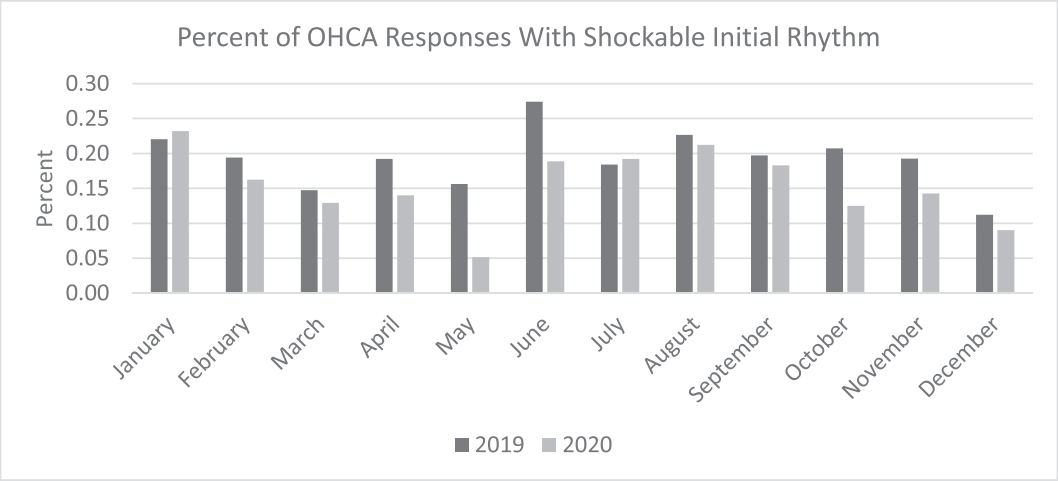


Fig. 2. Percent OHCA with shockable initial cardiac rhythm depicted by month for 2019 and 2020.

Table 2
Location and incidence of OHCA and bystander CPR in 2020 as compared with 2020.[a]

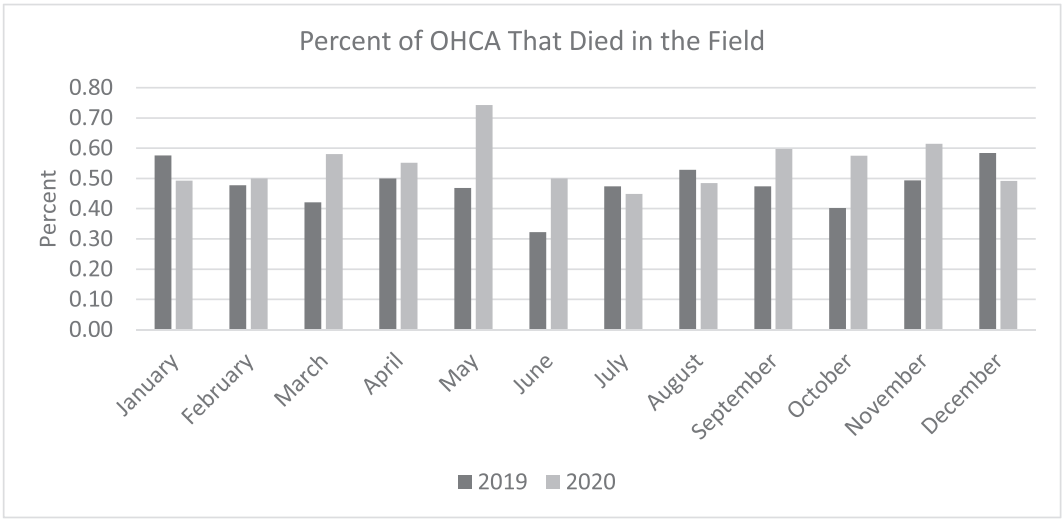
	2019 ($n = 884$) Number of Arrests	2019 Bystander CPR	2020 ($n = 1034$) Number of Arrests	2020 Bystander CPR
Assisted living	21 (2.4%)	12 (57.1%)	29 (2.8%)	23 (79.3%)
Bus Station	1 (0.1%)	1 (100.0%)	0 (0.0%)	0 (0.0%)
Dialysis	9 (1.0%	6 (66.7%)	6 (0.6%)	4 (66.7%)
Doctor's office/clinic	8 (0.9%)	5 (62.5%)	10 (1.0%)	7 (70.0%)
Home/residence	642 (72.6%)	301 (46.9%)	727 (70.3%)	337 (46.6%)
Nursing home	97 (11.0%)	73 (75.3)	139 (13.4%)	110 (79.1%)
Other specified place	3 (0.3%)	2 (66.7%)	2 (0.2%)	1 (50.0%)
Place of business	46 (5.2%)	17 (37.0%)	52 (5.0%)	22 (42.3%)
Police/jail	6 (0.7%)	4 (66.7%)	9 (0.9%)	4 (44.4%)
Public building	2 (0.2%)	1 (50%)	1 (0.1%)	1 (100.0%)
Rehabilitation center	2 (0.2%)	2 (100.0%)	10 (1.0%)	8 (80.0%)
School	4 (0.5%)	1 (25.0%)	2 (0.2%)	0 (0.0%)
Street or highway	33 (3.7%	5 (15.2%)	38 (3.7%)	10 (26.3%)
Religious institution	1 (0.1%)	0 (0.0%)	4 (0.4%)	3 (75.0%)
Residential institution	0 (0.0%)	0 (0.0%)	3 (0.3%)	2 (66.7%)

[a] Differences in 2019 to 2020 factors in this table did not reach statistical significance.

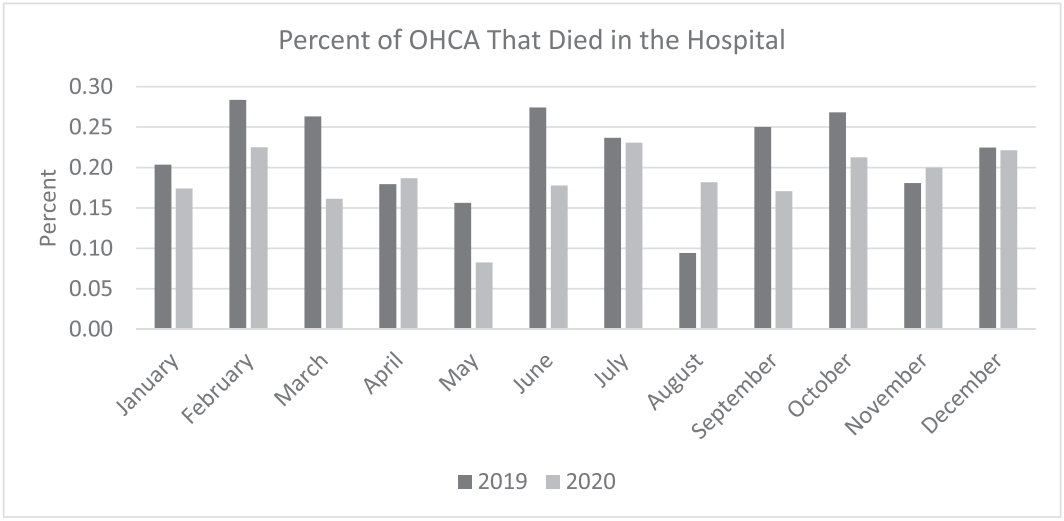
OHCA in nursing homes in 2020 than in 2019, although this did not reach statistical significance. That could represent a population of patients who were severely ill from COVID-19 and wound up in a nursing patients. This is consistent with other studies which demonstrated worse survival to hospital discharge in areas highly impacted by COVID-19 [11,15].

Fig. 1. a. Incidence of OHCA in the first six months of 2020 as compared to the prior year, b. Incidence of OHCA as a proportion of all EMS responses, and c. Average response time by month and year.

a.



b.



c.

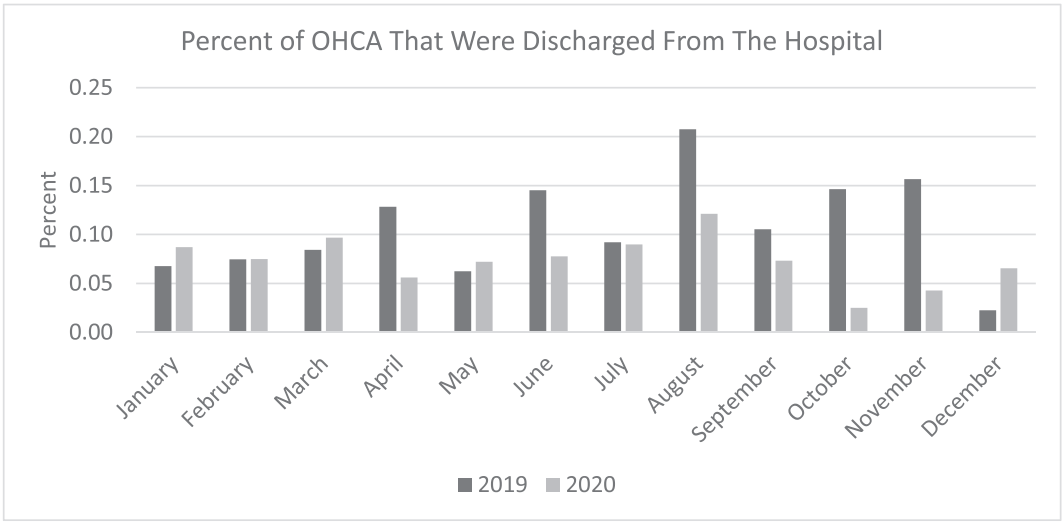


Fig. 3. a. Percent who died in the field, b. who died in the hospital, c. who were discharged from the hospital, or d. who were discharged with a CPC score ≤2, depicted by month for 2019 and 2020.

d.

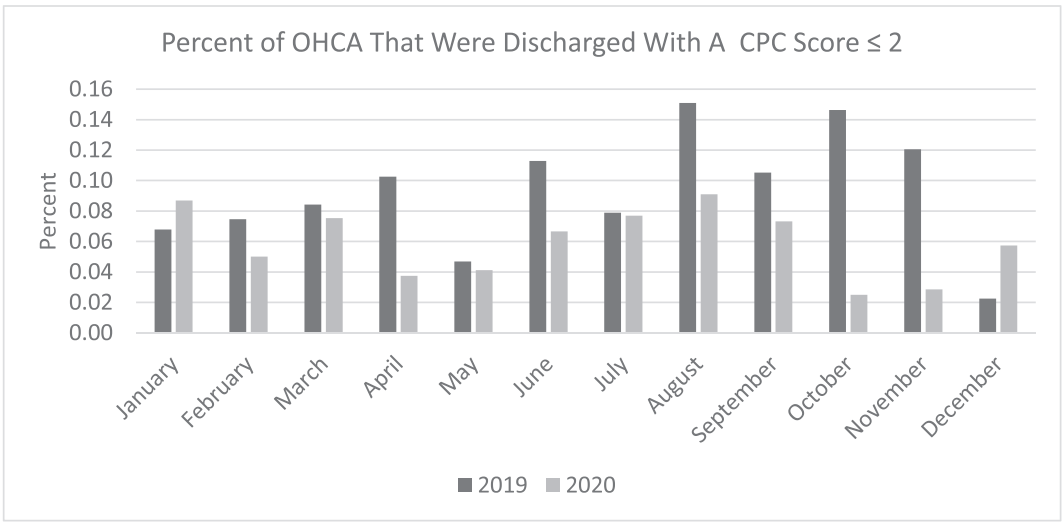


Fig. 3 (*continued*).

We hope this description will provide better understanding to EMS providers and healthcare systems that continue to respond to the ongoing COVID-19 pandemic.

5. Limitations

This is a retrospective review of patients found to have sustained OHCA within one EMS system. Within Marion county there were a limited number of coroner cases (<10%) which makes determining final cause of death difficult to determine in most cases. The etiologies of our results remain unclear and are likely multifactorial.

6. Conclusion

OHCA increased in Marion County, Indiana during the COVID-19 pandemic of 2020. Patient characteristics and EMS response and management were similar apart from the protocol change leading to exclusive use of supraglottic airways over endotracheal tubes. Despite a similar number of witnessed arrests and bystander CPR, patients were less likely to have a shockable rhythm. Patients were more likely to die in the field and less likely to survive to hospital discharge or have a favorable neurologic outcome.

Presentations

National Association of Emergency Medical Services Physicians, virtual abstract presentation January 2021.

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Credit author statement

NK, MS completed the study design, statistical analysis and manuscript writing. GF, TF, DR, EW, MK, and DO assisted in manuscript review and revision. TA and SC performed data collection. TL oversaw data collection, contributed to study design and manuscript editing.

Declaration of Competing Interest

None of the authors report any conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ajem.2021.04.072.

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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.