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Impact of the COVID-19 Pandemic on Out-of-Hospital Cardiac Arrest Incidence and EMS Practices: A Retrospective Analysis

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Introduction: A 2023 meta-analysis found a two-fold increase in out-of-hospital cardiac arrest (OHCA) during the COVID-19 pandemic years. Our goal in this study was to evaluate the impact of the pandemic on the incidence of OHCA, emergency medical services (EMS) termination-of-resuscitation rates, and EMS operational metrics, with particular attention to seasonal variations.

Methods: We conducted a retrospective observational analysis of 4,423 EMS encounters for OHCA between 2016–2022 across a defined catchment area comprising 11 communities in Minnesota and three in Wisconsin, representing a combined population of approximately 537,500. Seasonal periods were categorized as Winter (January–March), Spring (April–June), Summer (July–September), and Fall (October–December). We compared the OHCA incidence, termination-of-resuscitation rates, and EMS scene and transport times between pre-pandemic (2016–2019) and pandemic (2020–2022) periods using chi-square tests and analysis of variance; *P* values < .05 were considered significant. The study was reviewed by the Mayo Clinic Institutional Review Board and deemed exempt.

Results: The incidence of OHCA significantly increased during the pandemic across all seasons. The largest spike occurred in Fall 2020, aligning with the second wave of COVID-19. Termination-of-resuscitation rates significantly increased during the pandemic (56.6% pre-pandemic vs 61.2% pandemic; *P* = .01). The EMS scene times were significantly longer during the pandemic (24.4 minutes pre-pandemic vs 26.1 minutes pandemic; *P* = .04), although EMS transport (drive) times remained similar (9.6 minutes pre-pandemic vs 9.4 minutes pandemic; *P* = .68).

Conclusion: Our findings demonstrate a significant rise in out-of-hospital cardiac arrest cases and termination-of-resuscitation rates during the COVID-19 pandemic, coupled with modest increases in EMS scene durations. Future research into EMS response during emerging high-consequence, infectious disease pandemics should focus on targeted interventions and preparedness strategies to mitigate pandemic-related impacts on OHCA. In addition, studies should examine all elements of the chain of survival to understand changes in resuscitation efforts during a pandemic. [West J Emerg Med. 2026;XX(X)XXX–XXX.]

INTRODUCTION

The increase in incidence of out-of-hospital cardiac arrest (OHCA) during the COVID-19 pandemic has been previously reported.[1] A 2023 systematic review and meta-analysis found a two-fold increase in OHCA during pandemic years across 12 studies.[2] This increased incidence has been critically evaluated in the literature to determine its cause, the extent to which it altered outcomes for patients experiencing cardiac arrest, and its potentially disparate impact on less affluent populations.

This discussion overlies study of the seasonal incidence of

cardiac arrest, which has been discussed extensively in the literature outside the COVID-19 context, although not in those studies that analyzed OHCA incidence during the pandemic itself. The seasonality of OHCA has been established repeatedly, with winter months including December and January seeing the highest incidence and summer months exhibiting both lower incidence and improved outcomes.[3] In part, this trend may relate to reduced activity levels as well as physiologic changes such as systemic vasoconstriction during cold weather.[4] Years with increased mortality burden from influenza epidemics have also previously been linked to increased OHCA incidence, and influenza seasonality may play a role.[5]

Analysis of OHCA during COVID-19 has found poorer outcomes for patients experiencing cardiac arrest.[1, 2, 6] This impact may have been especially pronounced for Black patients and patients with markers of lower socioeconomic status including low education.[7] The reasons for this change are unclear, although possibilities include mortality directly attributable to COVID-19 as well as changes in pre- and in-hospital response. Notably, bystander willingness to perform cardiopulmonary resuscitation (CPR) may have been diminished during the pandemic.[8]

Study of specific emergency medical services (EMS) response parameters may assist in identifying variables in the prehospital response protocol that contributed to increased mortality from OHCA during the pandemic. The purpose of the current study was to determine whether the COVID-19 pandemic significantly influenced OHCA incidence across seasonal variations. Secondarily, we evaluated changes in EMS termination-of-resuscitation rates and operational times (on-scene and drive times) between pre-pandemic and pandemic periods.

Population Health Research Capsule

What do we already know about this issue?
COVID-19 increased the global incidence of out-of-hospital cardiac arrest (OHCA). Less is known about the effects on EMS operational metrics.

What was the research question?
Did COVID-19 affect OHCA incidence or EMS termination-of-resuscitation rates and operational times?

What was the major finding of the study?
EMS termination-of-resuscitation rates increased during the pandemic (61.2% vs 56.6%; P = .01).

How does this improve population health?
Identifying pandemic-driven rises in OHCA and field termination rates will inform EMS preparedness in future outbreaks.

METHODS

Study Design and Setting

We conducted a retrospective review of all EMS calls for service for OHCA served by a single EMS agency between January 1, 2016–December 31, 2022. The catchment area covered multiple communities in Minnesota (Albert Lea, Austin, Duluth, Rochester, St. Cloud, Owatonna, Little Falls, Fairmont, Mankato, Litchfield, Plainview) and Wisconsin (Superior, Barron, Eau Claire, Osseo), encompassing a combined population of approximately 537,500 based on the 2020 U.S. Census data.[9] The study protocol was approved by the Mayo Clinic Institutional Review Board (IRB #24-006859).

Population, Definitions and Data Sources

Mayo Clinic Ambulatory Services (MCAS) is a comprehensive prehospital care system, including ground EMS and helicopter EMS assets. The MCAS is the sole Advanced Life Support ground transport service for the catchment area, with 18 ambulance bases covering 6,894 square miles responsible for providing both 9-1-1 response and inter-facility transportation. The service also provides emergency intercept for regional Basic Life Support services.

All emergency (9-1-1) calls for service for OHCA were electronically abstracted from stored electronic patient care reports into a de novo deidentified Microsoft Excel for Mac 2023 v16.77.1 spreadsheet (Microsoft Corporation, Redmond, WA). Data points included demographic information, cardiac arrest location, rhythm, witness status, causative mechanism, bystander cardiopulmonary resuscitation (CPR) status, EMS treatment intervals (scene and transport times), sustained return of spontaneous circulation (≥ 20 minutes), and termination-of-resuscitation status. Although the study was primarily a descriptive analysis, we abstracted and reported data in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist, using best practices for retrospective chart reviews.[10]

Inclusion criteria encompassed EMS-confirmed OHCA events meeting international Utstein definitions.[11] We predefined seasonal periods, with all ranges being inclusive from the first day of the first month to the final day of the last month:

- Winter: January–March
- Spring: April–June
- Summer: July–September
- Fall: October–December

Exclusion criteria were pediatric patients (< 18 years of age) and patients with EMS encounters not OCHA. We reviewed individual EMS patient care reports to ensure that the final cohort of cases met inclusion and exclusion criteria.

Statistical Analysis

We performed Shapiro-Wilk testing and histogram analysis on quarterly incidence rate, which supported normality. Incidence rates were compared between pre-pandemic (2016–2019) and pandemic (2020–2022) periods using *t*-testing for paired subgroup mean comparisons and analysis of variance. (ANOVA) for group differences (eg, between groups of seasons). A P value < .05 was considered statistically significant. We similarly analyed operational metrics (scene and drive times).

RESULTS

Scene time in minutes are plotted in Figure 1 with data trended per year, separated by season across all years studied. Figure 1 shows minimal seasonal variation in scene time but demonstrates a moderate positive trend across the period (plotted with a dotted line). Figure 2 shows EMS drive times, plotted in the same way, and does not exhibit clear trends by season or across the study period.

We calculated average EMS scene time and drive time for pre-pandemic and pandemic years (across all seasons), and we tested means with a *t*-test. A significant difference was found between pre-pandemic (24.38 minutes) and pandemic (26.07 minutes) EMS scene times, $P = .04$), but the difference between drive times (9.56 and 9.40 minutes, respectively) in this period was not significant ($P = .68$). Data on the incidence of OHCA was disaggregated by year and defined season. Figure 3 shows incidence data plotted for pre-pandemic and pandemic years, divided by season.

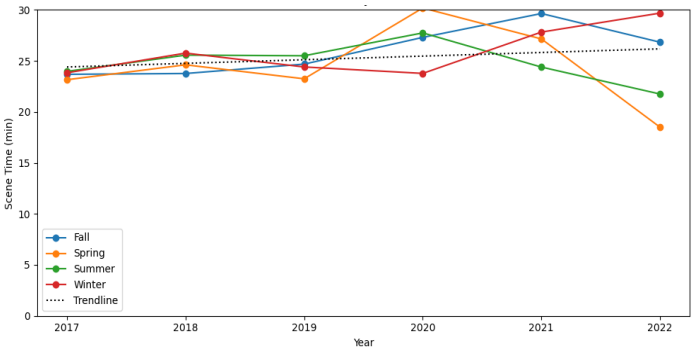


Figure 1. Length of time in minutes that emergency medicine services spent on scene by season and year in a study of out-of-hospital cardiac arrest responses from 2017–2022. A linear trendline (dotted line) illustrates the overall mean trend across all seasons, showing a slight upward trajectory.

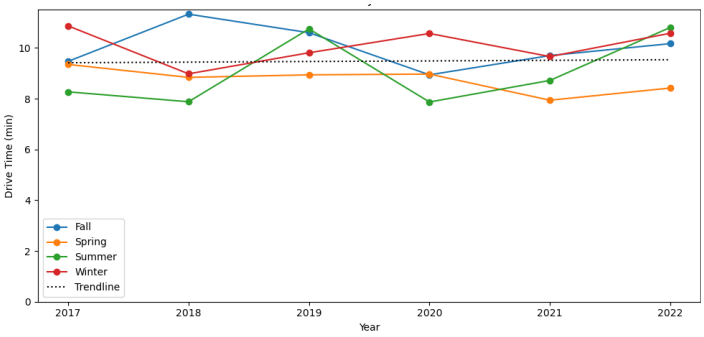


Figure 2. Emergency medical services (EMS) drive times in minutes from the scene to the hospital for out-of-hospital cardiac arrest responses between 2017–2022, A linear trendline (dotted line) indicates minimal change overall, highlighting stable EMS transport durations.

We first tested the expected seasonal trend in OHCA incidence. Table 1 shows mean incidence of OCHA per season in all years. ANOVA testing on this data failed to find a significant difference, with $P = .81$ for variance between the seasonal means. To test whether seasonality exhibited a significant difference in binary analysis, we combined data into mean quarterly incidence in Winter and Fall vs Summer and Spring. While Winter/Fall exhibited increased average incidence, this difference was not significant ($P = .16$). Figure 3 also demonstrates the sharp increase in incidence of OHCA for all pandemic years as compared with all pre-pandemic years. Table 1 demonstrates the significance of this relationship by paired *t*-test on quarterly incidence means in each period ($P < .001$).

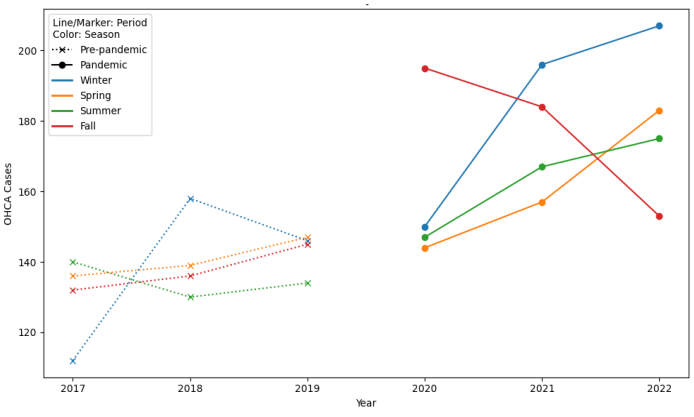


Figure 3. Incidence of out-of-hospital cardiac arrest (OCHA) by season and year in a study comparing pre-pandemic 2017–2019 period (dashed lines with 'x' markers) and pandemic period 2020–2022 (solid lines with circular markers). Notable increases in OHCA cases occurred across all seasons during the pandemic, particularly highlighted by sharp rises during winter and fall.

We then calculated the rate of OHCA field termination by EMS per year. Figure 4 demonstrates the higher rate of OHCA termination in all pandemic years as compared with all pre-pandemic years. The difference in termination rate for pandemic (61.2%) and pre-pandemic (56.6%) years was statistically significant, $P = .01$.

DISCUSSION

This retrospective analysis demonstrated a significant increase in OHCA cases during the COVID-19 pandemic across all seasons. Figure 3 demonstrates the sharp increase in OHCA incidence per quarter between the 2017-2019 and 2020-2022 year groups for pre-pandemic and pandemic conditions. Seasonal variation was less convincingly demonstrated in our data: Although binary analysis of Winter/Fall and Summer/Spring average quarterly incidence showed an increased rate in the colder months, this was not statistically significant (as shown in Table 1), and neither did the ANOVA analysis of the four-way mean variation show significance.

Our finding on pandemic OHCA incidence aligns with global observations highlighting pandemic-related spikes, potentially driven by multiple factors including viral-induced cardiovascular complications, delayed healthcare-seeking behaviors, and increased stress from pandemic-related socioeconomic impacts.[1,12,13] Despite the lack of a statistically significant seasonal trend, our observation of a marked increase in OHCA cases during Fall 2020 coincides notably with the second wave of COVID-19. Direct correlation between local COVID-19 incidence and OHCA has been previously reported, with one study finding about one-third of the increase in OHCA attributable to confirmed or suspected COVID-19 infection.[14] This could underlie the increases in OHCA reported during periods of heightened COVID-19 case load.

Notably, along with the increased OHCA incidence observed during the pandemic, we also detected both a statistically significant increase in EMS scene times during the pandemic (24.4 minutes pre-pandemic vs 26.1 min pandemic; $P = .04$) and a statistically significant increase in EMS termination-of-resuscitation rates (56.6% pre-pandemic vs 61.2% pandemic; $P = .01$). The former finding is consistent with previous studies indicating pandemic-related disruptions in EMS operational metrics, such as increased on-scene durations potentially due to enhanced safety precautions or system strain.[15, 16]

Increased rates of termination of resuscitation have also been documented elsewhere. In Korea, Kim et al (2023) found that rates of return of spontaneous circulation rates were lower in pandemic years, although not to the level of statistical significance.[17] Her, Cho and Cho (2022) investigated changes in the reasons for termination of resuscitation during the pandemic, also in the Korean context, finding significant increase in the age of patients, the number of patients in asystole at first monitoring, and the number of comorbidities.[18] This suggests that changes in the demographic and pathophysiology of patients experiencing cardiac arrest could contribute to shifts in the termination-of-resuscitation rate. Another possibility is that concern over EMS crew exposure to COVID-19 could have altered clinical behavior, both through formal policy shifts and informal behavioral changes.

In Japan, investigation of in-hospital resuscitation showed that while duration of CPR was unchanged, intubation rates were significantly lower.[19] The shift in the rate of termination of resuscitation observed in our data could reflect changes in behavior and policy during the pandemic. Finally, it is possible that the increase in absolute incidence of OHCA during the pandemic could have created a saturation effect leading to increased numbers of resuscitation being terminated in the field, perhaps through fatigue or due to resource constraints. Modelling OHCA incidence as a predictor could allow assessment of the effect size in termination of resuscitation change during the pandemic against the expected change (in the event OHCA incidence proves a significant predictor of termination of resuscitation) to assess this possibility. This may prove a fruitful approach for future research.

We did not convincingly demonstrate the increased rate of cardiac events during colder months discussed elsewhere.[6]

Table 1. Seasonal mean incidence of out-of-hospital cardiac arrest across all years in a study comparing pre-pandemic and pandemic periods.

Season	Mean quarterly incidence (all years)	Standard Deviation	95% Confidence Interval	*P* value
Winter	161.5	34.92	126.58 - 196.42	
Spring	151	17.29	133.71 - 168.29	.81
Summer	148.83	18.28	130.55 - 167.11	
Fall	157.5	26.07	131.43 - 183.57	
Winter/Fall combined	159.5	25.61	133.89 - 185.11	.16
Summer/Spring combined	149.92	17.20	132.72 - 167.12	
Pre-pandemic	137.92	13.90	124.02 - 151.82	< .001
Pandemic	171.5	10.97	160.53 - 182.47	

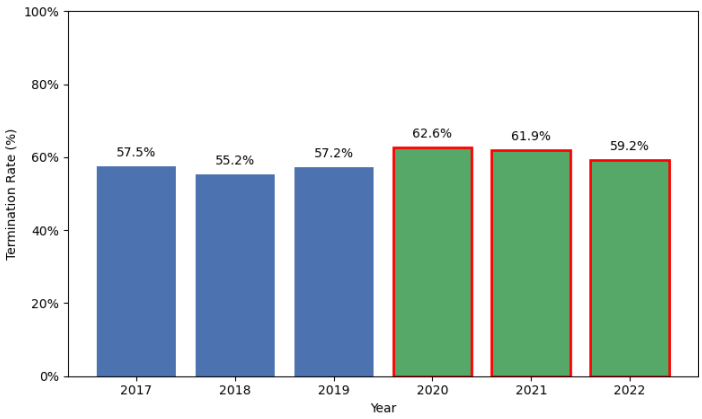


Figure 4. Annual rates of emergency medical services termination-of-resuscitation for out-of-hospital cardiac arrest, highlighting increases during pandemic years, in a study comparing pre-pandemic and pandemic periods.

However, the uniform rise across all seasons during the pandemic suggests additional mechanisms beyond typical seasonal effects, further underscoring COVID-19's direct and indirect health impacts. Future research should focus on identifying detailed causal pathways contributing to increased OHCA incidence during pandemics, examining both direct effects (eg, viral pathogenicity) and indirect factors (eg, delayed healthcare access and pandemic-induced lifestyle changes). Existing research has demonstrated that even among patients who survived to hospitalization, outcomes were poorer for those with COVID-19.[20] This underscores the importance of research examining all elements of the chain of survival and ultimate clinical outcomes, carefully considering high-impact infectious disease. Furthermore, studies exploring interventions aimed at mitigating pandemic-related increases in OHCA incidence—such as enhanced telemedicine services, public awareness campaigns to prevent delayed care, and targeted EMS resource allocation—are needed to inform proactive preparedness strategies.[3, 15]

In summary, this analysis highlights the substantial impact of the COVID-19 pandemic on OHCA incidence and a significant increase in rates of termination of resuscitation during the pandemic in our catchment area. Seasonality of OHCA, although reported in the literature elsewhere, was not replicated in our data.

LIMITATIONS

This study's retrospective nature precludes causal inference. We examined data only from the defined catchment areas in Minnesota and Wisconsin, and regional differences may prevent generalizability, in particular of our findings relevant to EMS response. Because we did not assess outcomes of OHCA in the study beyond termination of resuscitation in the field, we could not compare these data from our study to others that examined the OHCA variable. This includes analysis of the outcomes following survival of OHCA, which could be a useful marker of the quality of prehospital care for future research. In addition, we were unable to control for possible demographic changes that may have impacted pre- and post-pandemic OHCA incidence during the period examined.

Although we noted a significant increase in the rate of termination of resuscitation, our analysis did not allow insight into the reasons for this change. It is possible, for example, that behavioral elements such as EMS crew concern for infection could have impacted willingness to continue resuscitation. Other elements of the prehospital response not measured in this study may have been responsible for the increased mortality associated with OHCA during the pandemic seen in other studies; in particular, time to bystander CPR and first defibrillation may have been increased for patients who had cardiac arrests while in the home alone or when bystanders were unwilling to intervene.[13] As discussed above, changes in the presence of a shockable rhythm at first monitoring observed during the pandemic could also have had an impact on termination-of-resuscitation practices.[18]

CONCLUSION

Within the catchment area of the current study, the incidence of out-of-hospital cardiac arrest significantly increased during the COVID-19 pandemic. Further, the rate of termination of resuscitation in the field increased. Future research to understand the reasons for changes in the termination of resuscitation rate and OHCA outcomes are important to ensuring EMS preparedness for high-impact infectious disease outbreaks.

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