Increasing Trends in Out-of-Hospital Cardiac Arrests During COVID-19 Era: A Scoping Review

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ABSTRACT

Background: COVID-19 pandemic has severely impacted millions of lives and attributed to an elevated mortality rate, through both direct and indirect mechanisms; thus causing a ceaseless burden on the healthcare system. Objectives: This study aims to identify the out-of-hospital cardiac arrest related events, outcomes, management, patient characteristics, direct/indirect factors and mortality during the COVID-19 pandemic. Methods: We conducted a scoping review in accordance with the PRISMA Extension for Scoping Reviews. A systemic search was performed from March 2020 to January 2021, on PubMed, OVID Embase and Science Direct. Two authors independently screened the electronic databases for eligible articles written or translated in English, and related to OHCAs during COVID-19 pandemic compared to non-pandemic period. Later, data were extracted and charted in tables to narratively summarise the study findings. Results: We identified 1,271 online search records, whereof 28 publications were selected for the full-text assessment, and only 13 eligible studies
were included. Overall, the findings directed that OHCA related incidence and mortality was remarkably higher during the pandemic. Fear, lockdown, social distancing, and EMS response time were indirect OHCA contributors. Across the selected studies, reduced bystander-CPR, defibrillation and AED use, along with increased supraglottic airway management and unwitnessed OHCA was observed. Male, Black, hypertensive, diabetic patients with physical limitations were significantly higher, and COVID-19-positive cases had significantly lower rate of survival to hospital admission or discharge. **Conclusion:** COVID-19 pandemic is associated with poor OHCA outcomes and reduced survival rate. Direct and indirect factors are attributable to the increasing trends in COVID-19-related OHCA incidence and mortality.

**Keywords:** Out-of-hospital, Cardiac arrest, OHCA, COVID-19, Scoping review

**What is already known about the topic?**

- Out-of-hospital cardiac arrest (OHCA) in individuals have highly increased during the COVID-19 pandemic in comparison to pre-pandemic period.
- An increased rate of OHCA incidence and OHCA-related mortality has been documented amidst COVID-19 outbreak period.
- Furthermore, a reduction in the bystander-witnessed OHCAs and bystander facilitated cardiopulmonary resuscitation rate has been reported, possibly due to the fear of infection, social distancing norms and lockdown measures.

**What this paper adds?**

- This scoping review highlighted the differences in regards to the OHCA events, outcomes and management during the COVID-19 pandemic versus comparator period (pre-pandemic or non-pandemic).
It also summarised the OHCA patient characteristics and disparities between the COVID-19-positive and negative cases.

Furthermore, this paper emphasised on the direct and indirect contributors associated to the increasing trends in OHCA-related incidence and mortality during the pandemic.

Introduction

Worldwide, the novel ‘Coronavirus disease 2019’ (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) \(^1\), has been held responsible for more than 47 million infected cases and 1 million deaths, still escalating at an alarming rate \(^2\). As various regions around the world are facing subsequent waves of infection, the healthcare systems are experiencing a ceaseless burden \(^3\); including the pre-hospital emergency medical services (EMS) that provides timely action for out-of-hospital cardiac arrests (OHCAs) \(^4\).

Additionally, an increased burden of cardiac damage has also been reported among the COVID-19 patients \(^5\), as the SARS-CoV-2 infection is significantly associated with myocardial infarction or pulmonary embolism resulting from vascular inflammation, myocardial injury, arrhythmias, and thromboembolism \(^6\).
COVID-19 patients typically suffer from self-limiting lower respiratory tract illness, and often experience a swiftly deteriorating state of hypoxic respiratory failure. This may eventually lead to cardiac arrest due to delay in the effective treatment of these patients \(^6\), as majority of the OHCA cases are related to myocardial ischaemia \(^7\).

Sudden out of hospital cardiac arrest is responsible for 0.5 to 1 death per 1000 population annually \(^8\). Every year, approximately 326,000 OHCAs take place in the United States, thus sudden cardiac arrest (SCA) is considered as a leading cause of mortality. Mostly, OHCAs occur privately at homes, and almost 50% of the cases remain unwatched or unnoticed \(^9\). The major predictors in OHCA survival includes prompt initiation of bystander cardiopulmonary resuscitation (CPR) and early defibrillation. Identifying out-of-hospital cardiac arrest is a significant and modifiable factor in the survival chain that should be considered as a performance marker for the emergency medical services \(^10\).

Globally, several countries have encountered an unprecedented decline in the hospital emergency visits and also in acute coronary syndrome-related hospital admissions during COVID-19 disease outbreak \(^11\). Significant rise in the incidence of sudden extra-hospital deaths was reported in various countries, and a geographical heterogeneity was observed \(^12\). Evidently, the COVID-19 pandemic has severely impacted millions of lives and attributed to an elevated mortality rate, through both direct and indirect mechanisms. It has even caused an extensive death toll among individuals who were not directly affected by the SARS-CoV-2 infection. In fact, various regions held the increasing growth of OHCAs accountable for the indirect mortality amidst COVID-19 disease outbreak (Zangrillo et al., 2020; Scquizzato et al., 2020).

We conducted this scoping review to depict the current literature on COVID-19-related out-of-hospital cardiac arrests, and also highlight the significance of the increasing trends in
OHCA. Hence, this study aims to identify the gaps in existing literature by addressing the following research questions:

1. What are the differences in OHCA events, outcomes and management during the COVID-19 pandemic as compared to non-pandemic period?
2. Are there any differences in the patient characteristics for COVID-19 related OHCA?
3. What factors are possibly associated with the increasing trends in COVID-19 period OHCA?
4. What is the impact of COVID-19 pandemic on OHCA related mortality?

Methodology

Study Design

This scoping review was performed in accordance with the Extended Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement for Scoping Reviews (PRISMA-ScR). The PICO (Population, Intervention or exposure, Comparison, and Outcome) framework was adopted by authors to generate the research questions of this review paper in the following setting: OHCA cases (P), during COVID-19 pandemic (I), compared to non-pandemic period (C), have any differences in the incidence, aetiology, bystander-CPR, EMS response, ROSC, survival to hospital admission or discharge, AEDs or mechanical CPR device usage, airway management, patient characteristics, COVID-19 related factors, and mortality (O)?
Data Sources and Search Strategy

We conducted a systemic search on PubMed, OVID Embase and Science Direct from March 2020 to January 2021. The following search terms were mainly used: “COVID-19” OR “coronavirus 2019” OR “COVID-19 pandemic” AND “out-of-hospital cardiac arrest” OR “OHCA” OR “OOHCA”.

An initial search was independently performed by the first author on 21 October, 2020 to test the online search strategy, as well as to select the identified keywords and relevant databases. The updated literature search was carried out again on 23 January, 2021 in the aforementioned databases, after the reviewers collectively discussed and established the structured search strategy. Furthermore, the reference lists of relevant papers were also reviewed manually to further identify any additional articles.

Study Selection and Eligibility Criteria

Only English language studies or articles translated in English, and related to OHCA events reported during COVID-19 outbreak and/or compared to OHCAs before the pandemic/non-pandemic period were evaluated. Eligible studies included prospective or retrospective observational studies, cohorts, cross-sectional studies, systematic reviews and meta-analyses. While case reports, case series, commentaries, editorials, preprints, short communications and research letters on COVID-19 related OHCAs, and studies that did not fit in the scope of this review were excluded.

Review Method and Data Extraction
Duplicate literature records were removed, and eligibility assessment was carried out to exclude the irrelevant studies. Two authors reviewed abstracts/titles for inclusion in full-text review round while any disagreements were adjudicated by third and fourth authors. Subsequently, during the full-text review round, two authors re-reviewed the full-text articles for final selection of studies with any disagreements resolved through mutual agreement under the supervision of a third reviewer. The study selection process is described in PRISMA-ScR chart shown in Figure 1 below.
We used the Arksey and O’Malley framework as summarised by the Joanna Briggs Institute Reviewers’ Manual to conduct this scoping review (Arksey & O’Malley, 2005; Peters et al., 2017). The review paper had a systematic 4-step process: (1) identifying the research question, (2) identifying and selecting relevant studies, (3) charting the data, (4) collating, summarising and reporting the results. Though, the optional step of consultation was not performed by the reviewers.

All research questions were based on the same search strategy, literature search sources, and screening of references. While the study eligibility, relevant references and study findings or outcomes were specifically determined based on the review’s aims and research questions. The study framework has been illustrated to breakdown the processes as shown in Figure 2.

Figure 1: PRISMA flow diagram of scoping review to outline study selection process

<table>
<thead>
<tr>
<th>Full-text articles excluded (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No data on out-of-hospital cardiac arrests (7)</td>
</tr>
<tr>
<td>No data on COVID-19 pandemic period related OHCA (1)</td>
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<tr>
<td>Included only cases admitted to hospital (4)</td>
</tr>
<tr>
<td>Overlapping population and information (3)</td>
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</table>

Studies included in qualitative synthesis (n=13)
Figure 2: Scoping review framework to breakdown the study phases in a systematic way

Step 1: Identifying the Research Questions
- Clearly defining and designing the research questions to establish a structured search strategy (utilising the PICO framework)
- Mutually obtaining the purpose of scoping review through the research questions and the desired outcomes of interest

Step 2: Identifying and Selecting Relevant Studies
- Searching electronic databases, reference lists, authors' networking and/or other sources to identify relevant studies
- Selecting studies based on accessibility to data sources, feasibility of resources, scope of the review and authors' consensus

Step 3: Charting the Data
- Collective discussion of reviewers to determine variables for extraction & data-charting process based on study questions
- Following an iterative process to extract data and perform a continuous updating of the data-charting table

Step 4: Collating, Summarising and Reporting the Results
- Compiling and narrating the study results to report/answer the research questions as a descriptive, qualitative thematic analysis
- Identifying and summarising the study findings for health policy, interventions and future research purposes
Results

The electronic search strategy identified a total number of 1,271 records. After removing duplicate records, screening irrelevant articles, and retrieving an additional article through reference lists, only 28 studies were thereafter included in the full-text assessment review. Whereof, 13 publications were selected in the final qualitative synthesis and 15 studies were excluded during the full-text assessment.

The final list of publications summarised in this scoping review included: 2 original research articles, 1 systematic review, 4 retrospective cohorts, 2 population-based observational studies and 1 cross-sectional study, 2 multicentre longitudinal prospective studies and 1 Spanish nationwide prospective cohort.

Geographically, three studies were conducted in the United States, two in Italy, two in Australia, one in South Korea, one in Paris, one in France, one in Sweden, one in Poland, and one in Spain, though one study has collectively reviewed the findings from Australia (Victoria), Spain, United States (New York, Pennsylvania, Washington, Oregon, & California), Italy (Lombardy, Pauda & Bologna), Paris and its suburbs, and France. The included studies have been described in Table 1 below.
<table>
<thead>
<tr>
<th>Authors Name, Month &amp; Year of Publication</th>
<th>Location of Study</th>
<th>Aim/Purpose of Study</th>
<th>Study Design/Type of Publication</th>
<th>Sample Size/ Characteristics</th>
<th>Main Findings</th>
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</thead>
<tbody>
<tr>
<td>(Uy-Evanado et al., 2021) January, 2021</td>
<td>United States</td>
<td>The purpose of this study was to evaluate the potential impact of the coronavirus disease-2019 (COVID-19) pandemic on out-of-hospital cardiac arrest (OHCA) responses and outcomes in 2 U.S. communities with relatively low infection rates</td>
<td>Research paper</td>
<td>OHCA cases in Multnomah County, Oregon, and Ventura County, California, with resuscitation attempts by EMS from March 1 to May 31, 2020, and from March 1 to May 31, 2019</td>
<td>Reduced bystander CPR, delay in EMS response time, and reduced survival from OHCA. Results highlighted the COVID-19 pandemic’s indirect negative impact on OHCA, even in communities with relatively low incidence of COVID-19 infection</td>
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<tr>
<td>(Hubert, Baert, Beuscart, &amp; Chazard, 2020) December, 2020</td>
<td>France</td>
<td>The study’s objective was to introduce a methodology to assess COVID-19 home deaths by analysing the French national out-of-hospital cardiac arrest (OHCA) registry (RéAC).</td>
<td>Retrospective multicentre cohort study</td>
<td>670 patients with OHCA were included based on data recorded in the RéAC by 20 mobile medical teams (MMTs) between March 1st to April 15th, 2020</td>
<td>The ratio of COVID-19 out-of-hospital deaths to in-hospital deaths was 12.4%, and it appears that the national statistics underestimated the death rate</td>
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<tr>
<td>(Sultanian et al., 2021) December, 2020</td>
<td>Sweden</td>
<td>To study the characteristics and outcome among cardiac arrest cases with COVID-19 and differences between the pre-pandemic and the pandemic period in out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA).</td>
<td>Observational registry-based study</td>
<td>All patients reported to the Swedish Registry for Cardiopulmonary Resuscitation (SRCR) from 1 January to 20 July 2020</td>
<td>During the pandemic phase, COVID-19 was involved in at least 10% of all OHCA and 16% of the IHCA. Among the COVID-19 cases, 30-day mortality was increased, 3.4-fold in OHCA and 2.3-fold in IHCA. The adjusted 30-day survival was 4.7% for patients with COVID-19, 9.8% for patients without COVID-19, and 7.6% in the pre-pandemic period</td>
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<tr>
<td>(Chan et al., 2020) November, 2020</td>
<td>United States</td>
<td>To assess the association between the COVID-19 pandemic and OHCA outcomes, including in areas</td>
<td>Research article</td>
<td>CARES registry, a prospective multicenter registry of patients with OHCA in the US., used to compare outcomes in pandemic period</td>
<td>The rates of ROSC were 18% lower overall than before the pandemic, including 11% to 15% lower in communities with low COVID-19 mortality. Rates of survival to discharge were 17% lower, primarily</td>
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<tr>
<td>Authors</td>
<td>Region</td>
<td>Description</td>
<td>Method</td>
<td>Findings</td>
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<td>Lim et al., 2020</td>
<td>Australia</td>
<td>The study aimed to evaluate the influence of COVID-19 pandemic on the incidence, process, and outcomes of OHCA</td>
<td>Systematic review</td>
<td>120% increase in OHCA events since the pandemic. Time from OHCA to ambulance arrival was longer during the COVID-19 pandemic (p=0.036). Mortality (OR=0.67, 95%-CI 0.49-0.91) and supraglottic airway use (OR= 0.36, 95%-CI 0.27-0.46) was higher during the pandemic. While AED use (OR=1.78, 95%-CI 1.06-2.98), ROSC (OR=1.63, 95%CI 1.18-2.26) and intubation (OR=1.87, 95%-CI 1.12-3.13) was higher before pandemic. More patients survived to hospital admission (OR=1.75, 95%-CI 1.42-2.17) and discharge (OR = 1.65, 95%-CI 1.28-2.12) before the pandemic. Bystander CPR (OR=1.18, 95%-CI 0.95-1.46), unwitnessed OHCA (OR=0.84, 95%-CI 0.66-1.07),paramedic-resuscitation attempts (OR=1.19, 95%-CI 1.00-1.42) and mechanical CPR device use (OR=1.57, 95%-CI 0.55-4.55) did not defer significantly.</td>
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<td>P.H. et al., 2020</td>
<td>United States</td>
<td>To evaluate characteristics including race/ethnicity, comorbidities, emergency medical services response associated with outpatient cardiac arrests and death during the COVID-19 pandemic in New York City</td>
<td>Population-based cross-sectional study</td>
<td>OHCAs and related deaths during COVID-19 period significantly increased compared with the same period in previous year and were associated with older age, non-white race/ethnicity, hypertension, diabetes, physical limitations, and non-shockable presenting rhythms.</td>
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<tr>
<td>Authors (year)</td>
<td>Country</td>
<td>Objective</td>
<td>Study Design</td>
<td>Key Findings</td>
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<tr>
<td>Baldi, Sechi, Mare, Canevari, Brancaglione, Primi, Palo et al. (2020)</td>
<td>Italy</td>
<td>To investigate how the COVID-19 epidemic influenced the treatment of OHCA victims</td>
<td>Multicentre longitudinal prospective study</td>
<td>Lombardia Cardiac Arrest Registry Bystander CPR rate was lower in 2020 (20% vs 31%, p&lt;0.001), whilst the rate of bystander AED use was similar (2% vs 4%, p=0.11). Resuscitation attempt by EMS in 64.5% patients in 2020 &amp; 72% in 2019; of which 45% in 2020 received ALS &amp; 64% in 2019</td>
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<tr>
<td>Borkowska et al. (2020)</td>
<td>Poland</td>
<td>The study aimed to assess the characteristics and outcomes of adults who suffered an OHCA in the COVID-19 pandemic and treated by the emergency medical service (EMS) teams</td>
<td>Retrospective cohort study</td>
<td>527 adult OHCA patients for whom EMS teams intervened from March 1, 2020 to April 30, 2020</td>
<td>ROSC in EMS was observed only in 9.4% of resuscitated patients. The presence of shockable rhythms was associated with better prognosis. Prehospital mortality, even though was high, but did not differ significantly</td>
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<tr>
<td>Rosell Ortiz et al. (2020)</td>
<td>Spain</td>
<td>To analyse the influence of the COVID-19 pandemic on OHCA response and survival in Spain, whilst also comparing the differences between regions based on their infection incidence</td>
<td>Spanish nationwide prospective cohort study</td>
<td>Spanish OHCA Registry (OSHCAR) Amid COVID-19 period, the incidence of resuscitation attempts declined and survival to hospital admission (OR=1.72; 95%CI = 1.46-2.04; p&lt;0.001) and discharge (OR=1.38; 95%CI = 1.07-1.78; p=0.013) fell compared to the non-COVID period</td>
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| Ball et al. (2020) | Australia | To investigate the impact of COVID-19 pandemic period on incidence, characteristics, and survival from OHCA in Victoria, Australia | Retrospective cohort study | Using the Victorian Ambulance Cardiac Arrest Registry, 380 adult OHCA patients receiving resuscitation between 16th March 2020 and 12th May 2020, were compared with 1218 cases occurring during the same dates in 2017-2019 | OHCA incidence did not differ in pandemic. Resuscitation by EMS was significantly decreased (46.9% versus 40.6%, p=0.001). Arrests in public locations decreased in the pandemic (20.8% versus 10.0%; p<0.001), as did initial shocks by public access defibrillation or first-responders (p=0.037). Also, EMS caseload decreased in the pandemic. Delays to key interventions, (time-to-first defibrillation, time-to-first epinephrine) significantly increased. While, the survival-to-
<table>
<thead>
<tr>
<th>Study ID</th>
<th>Country</th>
<th>Study Aim</th>
<th>Study Design</th>
<th>Outcome Measures</th>
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<tbody>
<tr>
<td>Cho et al., 2020</td>
<td>South Korea</td>
<td>This study aimed to evaluate the impact of multiple, consecutive changes in resources and procedures used to treat OHCA patients in the setting of an emerging infectious disease</td>
<td>Retrospective observational study</td>
<td>171 OHCA patients based on the multicentre WinCOVID registry</td>
</tr>
<tr>
<td>Baldi, Sechi, Mare, Canevari, Brancaglione, Primi, Klersy, et al., 2020</td>
<td>Italy</td>
<td>The study aimed to verify if there is an association between the out-of-hospital cardiac arrest difference compared with 2019 and COVID-19 epidemic curve</td>
<td>Multicentre longitudinal prospective study</td>
<td>Lombardia Cardiac Arrest Registry</td>
</tr>
<tr>
<td>Marijon et al., 2020</td>
<td>Paris and its suburbs, France</td>
<td>This study aimed to assess the incidence and outcomes of out-of-hospital cardiac arrest in an urban region during the pandemic, compared with non-pandemic periods</td>
<td>Population-based, observational study</td>
<td>Using Paris Fire brigade database and comparing the 521 OHCA of the pandemic period (March 16 to April 26, 2020) to the mean of the 3052 total of the same weeks in non-pandemic period (weeks 12–17, 2012–19)</td>
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Discharge decreased by 50% during the pandemic period (11.7% versus 6.1%; p=0.002)

Lower OHCA survival rate may be due to a lower quality of resuscitation, prolonged EMS time at the scene, as well as transport time delays; although this may also be due to the direct effect of COVID-19 infection itself. Some researchers have suggested that policies on do-not-resuscitate or termination of resuscitation may have affected these results during the COVID-19 outbreak.

52% rise in the cumulative incidence of OHCA as compared to 2019 (490 OHCA in 2020 vs. 321 in 2019). Increase in OHCA in 2020 is significantly correlated to COVID-19 pandemic and it is coupled with a reduction in short-term outcome.

A transient two-times increase in OHCA incidence, coupled with a reduction in survival, was observed during the specified time period of the pandemic when compared with the equivalent time period in previous years with no pandemic. This result might be partly related to COVID-19 infections, indirect effects associated with lockdown and adjustment of health-care services to the pandemic.

**Table 1: Summary of included studies in the scoping review**
**Study Outcomes**

This review paper mapped literature on the increasing trends in COVID-19 related out-of-hospital cardiac arrests to determine the changes in OHCA events (incidence and aetiology, bystander-CPR, shockable cardiac rhythms/shocked events, EMS response, unwitnessed OHCA and location), outcomes (ROSC, survival to hospital admission or discharge) and management (AEDs and mechanical CPR, supraglottic airway and intubation, epinephrine and amiodarone).

It also helped to address the differences in patient characteristics (age, sex, ethnicity, comorbidities, with and without COVID-19), the factors associated to COVID-19 period OHCA, and lastly, the effect of COVID-19 pandemic on OHCA related mortality.

*Question 1: What are the differences in OHCA events, outcomes and management during the COVID-19 pandemic as compared to non-pandemic period?*

A temporal two-times increment in the OHCA rate, coupled with a reduction in survival, was noted during the COVID-19 pandemic period \(^{25}\). The COVID-19 pandemic have indirectly impacted a negative effect on the OHCA, even in communities with lower COVID-19 infection rate \(^{16}\).

OHCA occurring due to medical causes remained the same for both pandemic and non-pandemic period (90.0% vs. 90.5%, \(p=0.56\); OR=0.69, 95%-CI 0.45-1.06; \(p=0.09\); \(I^2=75\%\)) \(^3\). Nevertheless, OHCA occurring due to cardiac aetiology (71.9%) was more frequent during the pandemic \(^{21}\). While, trauma-related OHCA were more common before pandemic (8.9% vs. 7.4%, \(p=0.031\); OR=1.69, 95%-CI 1.07-2.69; \(p=0.03\); \(I^2=76\%\)) \(^3\).

Unwitnessed OHCA occurred less frequently before the pandemic \(^3\). In Italy, unwitnessed OHCA (53.5% vs. 45.8%; \(p=0.037\)) were more prevalent during pandemic period.
in 2020, with a 52% rise in the OHCA cumulative incidence compared to non-pandemic period in 2019. Majority of the OHCAs occurred at homes (Italy: 90% during pandemic vs. 83% in non-pandemic period; p=0.005; France: 90% vs. 77%; p<0.001)\(^24, 25\).

One study in Australia reported no significant difference in the OHCA incidence rate. However, significant reduction was noted in the rate of EMS resuscitation (46.9% versus 40.6%, p=0.001). SCA in public locations significantly decreased during the pandemic (20.8% vs. 10.0%; p<0.001), as did initial shocks by public access defibrillation or first-responders (p=0.037). Furthermore, EMS caseloads reduced during the COVID-19 pandemic. While, delays to key interventions like time-to-first defibrillation and time-to-first epinephrine significantly increased\(^4\).

Bystander CPR occurred frequently before the pandemic but was not statistically significant (OR=1.08 95% CI 0.86-1.35; p=0.51; \(I^2 = 88\%)\(^3\). Similarly, significant reductions in the bystander-CPR were also observed during COVID-19 pandemic in Italy (35% vs. 45%, p=0.02)\(^24\), France (48% vs. 64%, p<0.001)\(^25\), Spain\(^22\), and USA\(^16\), while a study in South Korea\(^23\) reported no evident differences.

During the COVID-19 outbreak, the number of BLS and ALS trained staffed vehicles increased by 40% and 29% respectively\(^24\). Although bystander CPR rate was lower in 2020 (20% vs 31%, p<0.001), whilst the rate of bystander AED use was similar in both pandemic and non-pandemic periods (2% vs 4%, p=0.11). Resuscitation attempts by EMS were carried out in 64.5% of patients in 2020 and 72% in 2019; whereof only 45% received ALS in 2020 compared to 64% in 2019\(^20\).

Another study found that the OHCA incidence rates did not change significantly (p>0.07). However, the proportion of cases receiving bystander CPR dropped from 2019 to 2020 (61% to 51%; p=0.02), and the AED use by bystanders also declined (5% to 1%; p=0.02).
While, the EMS response time increased during COVID-19 (6.6 ± 2.0 min to 7.6 ± 3.0 min; p<0.001) 16. One study in United States, revealed that the proportion of witnessed cardiac arrests remained same in 2019 and 2020. In fact, no differences existed in the median time duration from 911 call to EMS arrival for COVID-19 /non-COVID-19 period. Also, the bystander CPR and defibrillation rates remained similar in both years, regardless of the pandemic 19. However, one Swedish study found that the bystander defibrillation rate increased from 22.0% to 32.4% in pandemic 18.

One study emphasised that the time from OHCA to ambulance arrival was longer during COVID-19 period (p=0.036). It was further discovered that shockable cardiac rhythms or shocked events were more frequently occurring in the non-pandemic period (OR=1.57 95%-CI:1.17-2.09; p=0.002; I²=78%) 3, while the presence of shockable rhythms was associated with better prognosis 21.

In terms of recovery, survival to hospital admission (OR=1.75, 95%-CI 1.42-2.17) and discharge (OR=1.65, 95%-CI 1.28-2.12) was less likely during pandemic 3. Few other studies 16, 23, 19 have reported similar findings regarding reduced survival rate during the COVID-19 outbreak. In Spain, the survival to hospital admission (OR=1.72; 95%-CI=1.46-2.04; p<0.001) and discharge (OR=1.38; 95%-CI=1.07-1.78; p=0.013) dropped significantly during the pandemic as compared to non-COVID-19 period 22. Another study in Australia, the authors reported that the survival-to-discharge declined by 50% during the pandemic period (11.7% versus 6.1%; p=0.002) 4.

Paramedic-resuscitation attempts (OR=1.19 95%-CI 1.00-1.42) and mechanical CPR device use (OR=1.57, 95%-CI 0.55-4.55) did not defer significantly. However, ROSC (OR=1.63, 95%-CI 1.18-2.26) and AED use (OR=1.78, 95%-CI 1.06-2.98) was higher before pandemic 3, and the ROSC rates were 18% lower during pandemic 19. ROSC in EMS was
observed among 9.4% resuscitated patients in Poland. More patients were intubated in the non-pandemic period (51.5% vs. 47.3%, p<0.001; OR=1.87, 95%-CI 1.12-3.13; p=0.02; I²=97%). Whereas the frequency of supraglottic airway use was significantly lower before pandemic (12.5% vs. 31.9%, p<0.001); OR=0.36, 95%-CI 0.27-0.46; p<0.0001; I²=75%).

*Question 2: Are there any differences in the patient characteristics for COVID-19 related OHCAs?*

Out-of-hospital cardiac arrest patients from the non-COVID-19 period were significantly older in Spain. In the United States, OHCA patients during COVID-19 period were older (72±18 vs. 68±19 years), and presented with a high burden of comorbidities such as hypertension (53.5% vs. 45.7%), diabetes (35.7% vs. 26.0%), along with physical limitations (56.6% vs. 47.5%), and a suspected or confirmed diagnosis of COVID-19 infection. Odds of asystole (OR=3.50, 95%-CI 2.53-4.84; p<.001) and the odds of pulseless electrical activity (OR=1.99, 95%-CI 1.31-3.02; p=.001) both increased during COVID-19. Overall, various studies in literature have reported an increased number of individuals presenting with non-shockable rhythms during pandemic.

One study reported no significant differences in the age or sex of OHCA patients (pandemic versus no pandemic), but found notable ethnic differences among black race individuals who were more likely (28.0% vs. 22.6%) to suffer from OHCAs. Additionally, another study reported fewer white patients (20.4% vs. 32.9%) presenting with OHCA in pandemic and discovered that the Black, Hispanic, and Asian patients were at a higher risk to present with COVID-19 related OHCA and death.

COVID-19 disease was associated to 10% of all OHCAs in the pandemic time. Patients with COVID-19 infection were approximately 4 years younger than those without infection. Swedish population suffering with OHCAs during pandemic were younger than those before
pandemic (69.6 versus 70.8 years); whereby, 33.3% of the female patients with OHCAs were COVID-19-positive \(^{18}\). In France, significant association was found between males and COVID-19 status, as the proportion of males (71.2%) were significantly higher (OR=0.61, 95%-CI 0.41;0.92; p=0.015) \(^{17}\).

Majority of the COVID-19-positive cases (87.5%) had cardiac arrests at home. Shockable rhythms were higher among non-COVID-19 patients (22.8% vs. 7.5%) \(^{18}\). In regards to aetiology of OHCAs, COVID-19-positive cases mostly presented with respiratory causes (54.1% vs. 9.9%; p<0.001), and cardiac causes (34.9% vs. 72.9%; p<0.001) \(^{17}\).

In Italy, patients with COVID-19 symptoms were less likely to receive bystander-CPR (19%) as compared to individuals with undiagnosed or suspected COVID-19 \(^{24}\). The study in Sweden reported increased bystander-witnessed cardiac arrests during the pandemic (94.0% vs. 85.8%), although there was no significant association with COVID-19 status. Furthermore, 25.9% of the COVID-19-positive cases exhibited ROSC, and only 4.5% survived 30 days after discharge. Adrenaline was more frequently used (85.5% vs. 80.3%), while defibrillation was more common among the non-COVID-19 cases (33.6% vs. 21.3%) \(^{18}\). In regards to survival at hospital admission, one study found no statistically significant differences between the two group of patients (10.3% vs. 13.9%, p=0.271) \(^{17}\).

**Question 3:** What factors are possibly associated with the increasing trends in COVID-19 period OHCAs?

The direct and indirect factors related to the out-of-hospital cardiac arrests in COVID-19 pandemic period are described in Table 2.
OHCA-related Factors

<table>
<thead>
<tr>
<th>Direct contributor</th>
<th>Indirect contributor</th>
<th>Patient factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic infection</td>
<td>Lockdown</td>
<td>Increasing age</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>Social distancing</td>
<td>Male gender</td>
</tr>
<tr>
<td>Atherosclerotic plaque destabilization</td>
<td>Fear of infection</td>
<td>Black/Hispanic/Asian ethnic groups</td>
</tr>
<tr>
<td>Thromboembolism</td>
<td>Behavioural changes</td>
<td>Diabetes</td>
</tr>
<tr>
<td>Cerebrovascular events</td>
<td>Reorganisation of healthcare services</td>
<td>Hypertension</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>Increased EMS response time</td>
<td>Heart disease</td>
</tr>
<tr>
<td></td>
<td>Reluctance of patients to utilise EMS or present to emergency departments</td>
<td>Chronic renal disease</td>
</tr>
<tr>
<td>Myocarditis</td>
<td>Reduced OHCA witnessed status</td>
<td>Malignancy, cancer</td>
</tr>
<tr>
<td>Hypoxic respiratory failure</td>
<td>Reduced bystander-CPR and AED use</td>
<td>Physical limitations</td>
</tr>
</tbody>
</table>

Table 2: Possible factors/contributors for OHCAs during COVID-19 pandemic

**Question 4: What is the impact of COVID-19 pandemic on OHCA related mortality?**

Overall, several studies have observed a significant reduction in the OHCA survival rate after COVID-19 emergence; this justifies the escalation of OHCA-related mortality due to the direct and indirect effects of COVID-19.

Odds of OHCA mortality was greater (OR=0.67, 95%-CI: 0.49-0.91; p=0.01) during COVID-19 period and had higher level of heterogeneity ($I^2$:93%) The Swedish study also reported an increased 30-day mortality (3.4-fold increase in OHCAs) among the COVID-19 related OHCAs. French national statistics may have underestimated the death rate as ratio of COVID-19 out-of-hospital deaths to in-hospital deaths were 12.4%; whereby, the COVID-19 related at-home deaths corresponded to one eighth of the in-hospital deaths. In United States,
the OHCA survival rate to discharge was 17% lower, mainly among communities with higher COVID-19 mortality.¹⁹

Discussion

This scoping review highlighted some of the major differences in the COVID-19 pandemic versus comparator period (pre-pandemic or non-pandemic), in regards to the OHCA events, outcomes and management, as well as patient characteristics, OHCA associated factors (direct and indirect), and the cumulative effect on patient mortality.

Overall, the findings directed that OHCA related incidence and mortality was remarkably higher during the pandemic period. Across the selected studies, we noticed reduced bystander-CPR, defibrillation and AED use along with increased supraglottic airway management and unwitnessed OHCAs in the COVID-19 pandemic.³;¹⁶ Cardiac and/or medical causes were mostly related to OHCA presentations amidst COVID-19 outbreak.²¹;³

Due to lockdown and social distancing measures, majority of the OHCAs occurred frequently at homes; while public areas remained secluded so bystander-witnessed cases were often unnoticed.²⁴;¹⁷;²⁵;³ As the pandemic is still raging, the anxiety and fear of infection has altered peoples’ life, behaviour, social and mental wellbeing. This has consequently withdrawn laymen from rescuing others from cardiac arrests and/or providing necessary life-saving interventions and cardiopulmonary resuscitation. In fact, it also restrained people from seeking timely medical attention, visiting emergency departments and/or calling emergency medical services for health-related assistance. While altered healthcare services, safety measures and resuscitation guidelines during COVID-19 might have contributed an additional workload or burden over the EMS response and arrival timing, which disrupted the ambulatory care during pandemic. Thus, all these indirect factors have negatively impacted the COVID-19 related OHCAs.
OHCAs during the pandemic frequently occurred at an advanced age, predominantly affected men, Black/Hispanic and Asian origin, diabetic and hypertensive patients with renal impairment, carcinoma, and physical limitations \(^{20, 4, 25, 23, 21}\). According to the Swedish study findings, no OHCA patients with COVID-19 was discharged alive, whereas 36\% of the non-COVID-19 patients were discharged alive after hospitalisation \(^{18}\). The reduction in OHCA survival rates among COVID-19-positive patients is caused by the direct impact through cardiovascular injury and emergence of severe complications including respiratory failure, pulmonary embolisms, acute coronary syndromes, presented in the COVID-19-positive cases \(^{25}\). While, it may also be partly related to the management of OHCAs because initially there were few clearly defined guidelines on resuscitation \(^{17}\). Furthermore, the lower survival rate can also be linked to poor quality of resuscitation, prolonged EMS response and arrival at scene or delays in transport time \(^{23}\), which ultimately led to the presence of non-shockable rhythms of asystole or pulseless electrical activity \(^{5}\), and significantly lower ROSC rates in all communities, even in regions with low COVID-19 mortality \(^{19}\).

This scoping review also addressed some gaps and scope for further research. Most articles on COVID-19 related OHCAs are editorials, perspectives and short research communications which lacks clear understanding, significant markers, data and evidence. Also, majority of the studies are targeted on OHCA population in Europe, United States and United Kingdom, which eventually leads to inadequate geographical distribution, reduced diversity and overall generalizability of findings.

One major limitation is the descriptive nature of this study as no statistical interpretation was done and our results were only based on published data. Therefore, certain level of variation and underrepresentation across the regions may be present due to the extent of pandemic, absence of data, and quality of healthcare services. Moreover, a potential risk of
bias was also present in included studies, mostly due to inadequate adjustment of confounders. Thus, more clinically oriented studies in other regions like South Asia is highly recommended as the OHCA incidence and mortality rate might be higher in developing countries due to their poor healthcare system and availability of emergency medical services during the pandemic.

**Conclusion**

In summary, it can be deduced that the COVID-19 pandemic is associated with poor OHCA outcomes and reduced rate of survival, even in regions with low case-fatality. The direct and indirect factors are conspicuously attributable to these increasing trends in the COVID-19 pandemic related OHCA incidence and mortality. Hence, these factors should be carefully taken into consideration while estimating mortality data, strategizing public health interventions, and improving ambulatory care services to mitigate at-home occurring OHCA's during the pandemic.

**List of Abbreviations**

- AED: Automated external defibrillator
- ALS: Advanced life support
- BLS: Basic life support
- CPR: Cardiopulmonary resuscitation
- EMS: Emergency medical service
- OHCA: Out of hospital cardiac arrest
- ROSC: Return of spontaneous circulation
- SCA: Sudden cardiac arrest
Declaration of Competing Interest

None

Author’s Contributions

All authors critically reviewed the manuscript and approved the final version prior to submission.

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### Supplementary Table 1. Major exclusions ordered by first author initial.

<table>
<thead>
<tr>
<th>First Author</th>
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Supplemental Table 2. Search strategy

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References


doi:10.1016/j.resuscitation.2012.08.337


