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Clinical paper

The effect of the COVID-19 pandemic on the incidence and survival outcomes of EMS-witnessed out-of-hospital cardiac arrest

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Abstract
Aim: We sought to examine the impact of the COVID-19 pandemic on the incidence and survival outcomes of emergency medical service (EMS)-witnessed out-of-hospital cardiac arrest (OHCA) in Victoria, Australia.
Methods: We performed an interrupted time-series analysis of adult EMS-witnessed OHCA patients of medical aetiology. Patients treated during the COVID-19 period (1st March 2020 to 31st December 2021) were compared to a historical comparator period (1st January 2012 and 28th February 2020). Multivariable poisson and logistic regression models were used to examine changes in incidence and survival outcomes during the COVID-19 pandemic, respectively.
Results: We included 5,034 patients, 3,976 (79.0%) in the comparator period and 1,058 (21.0%) in the COVID-19 period. Patients in the COVID-19 period had longer EMS response times, fewer public location arrests and were significantly more likely to receive mechanical CPR and laryngeal mask airways compared to the historical period (all $p < 0.05$). There were no significant differences in the incidence of EMS-witnessed OHCA between the comparator and COVID-19 periods (incidence rate ratio 1.06, 95% CI: 0.97–1.17, $p = 0.19$). Also, there was no difference in the risk-adjusted odds of survival to hospital discharge for EMS-witnessed OHCA occurring during COVID-19 period compared to the comparator period (adjusted odd ratio 1.02, 95% CI: 0.74–1.42; $p = 0.90$).
Conclusion: Unlike the reported findings in non-EMS-witnessed OHCA populations, changes during the COVID-19 pandemic did not influence incidence or survival outcomes in EMS-witnessed OHCA. This may suggest that changes in clinical practice that sought to limit the use of aerosol generating procedures did not influence outcomes in these patients.
Keywords: Out of hospital cardiac arrest, Emergency medical services, Witness, COVID-19, Incidence, Survival

Introduction

The management of out of hospital cardiac arrest (OHCA) is a challenge for pre-hospital and in-hospital clinicians and requires timely advanced skills and a multidisciplinary approach to care.[1] Globally, the incidence of OHCA has been estimated at 83.7 cases per 100,000 person-years,[2] with an average survival to hospital discharge rate of 8.8%.[3] The optimisation of all links in the 'chain of survival' is fundamental to improving survival following OHCA.[4]

The coronavirus 2019 (COVID-19) pandemic has disrupted OHCA systems-of-care, negatively impacting all components of the chain of survival.[5] A recent systematic review reported a 120% increase in OHCA incidence and a 65% decrease in the odds of survival to hospital discharge following OHCA occurring in the pandemic period, relative to previous years.[6]

The pandemic has disrupted the effective delivery of OHCA care across the globe, with reported increases in ambulance response times, increased use of personal protective equipment by responders and clinicians, limited dispatch of community volunteers, first responders and bystanders, as well as mandated restrictions in the intra-arrest utilisation of aerosol-generating clinical procedures.[5–7] Social restrictions have led to fewer people experiencing an OHCA in public, which reduces bystander interventions such as public access defibrillation.[7] These disruptions to the chain of survival have

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largely impacted the care of patients who arrest before the arrival of emergency medical care (EMS), less is known about the effect of COVID-19 pandemic on patients who arrest in the presence of EMS clinicians.[8,9]

Globally, an estimated 11% of OHCA are witnessed by EMS.[10] In EMS-witnessed OHCA, advanced clinical care is immediately available, bypassing the time associated with bystander recognition, access to the EMS system, and EMS response times. However, a number of COVID-19 mandated and recommended changes to clinical practice, including the use of PPE and limitations in the use of aerosol-generating clinical procedures, may have impacted the quality of care delivered to EMS witnessed OHCA. There are no studies to date that have specifically analysed the effects of the COVID-19 pandemic on EMS-witnessed OHCA. In this study, we sought to examine the effect of the COVID-19 pandemic on the incidence and survival outcomes of EMS-witnessed OHCA.

Methods

Study design

We performed a 10-year interrupted time series analysis to determine the impact of the COVID-19 pandemic on OHCA witnessed by EMS personnel. This study consists of two periods, a historical comparator period (1st January 2012 to 28th February 2020) and a COVID-19 period (1st March 2020 to 31st December 2021). The study includes patients aged 16 years and over who were witnessed by EMS to have an OHCA that was of presumed medical aetiology. The study was approved by the Monash University Human Research Ethics Committee (Project Number: 32526).

Setting

The study was undertaken in Victoria, Australia where there is an estimated population of 6.6 million across 227,500 square kilometres. Ambulance Victoria is the state-wide provider of EMS. In 2020/2021, Ambulance Victoria responded to 1,022,590 emergency calls of which 6,934 were OHCA events. Australia operates a single national telephone number to emergency services (Triple Zero). Where a cardiac arrest is suspected, the emergency call-taker provides guidance to the caller in the provision cardiopulmonary resuscitation. Advanced life support (ALS) and mobile intensive care (MICA) paramedics are dispatched concurrently with basic life support first responders such as fire services and volunteer community teams. Local treatment guidelines follow the recommendations of the Australian Resuscitation Council.

Data sources and definitions

For this study, we collected data from the Victorian Ambulance Cardiac Arrest Registry (VACAR). VACAR is a state-wide clinical quality registry that records details of all OHCA events attended by EMS in the state of Victoria, Australia.[11] Patient care records (PCRs) are completed in-field by paramedics using computer tablets. Cases completed by paramedics are synchronised daily to a data warehouse. To ensure the inclusion of all OHCA events into the registry, a highly sensitive electronic search algorithm is used to identify cases in the data warehouse and registry staff then perform eligibility screening on these cases. Data from patient care records are combined with information collected from computer-aided dispatch records, emergency call logs, in-field CPR performance recordings, and first responder treatment records. To ensure complete case capture, paramedics are also required to routinely report cardiac arrest cases they attend, and these undergo audit by team managers before being referred to VACAR for data entry. The registry collects over 150 data elements, which include Utstein-style descriptors and patient discharge outcomes.[12] Hospital data is collected from over 100 participating hospitals and is validated against death records from the Victorian Registry of Births, Deaths and Marriages. Overall, missing data in the VACAR remains relatively low for all variables (<1% for most variables used in this study). Data quality control is facilitated by (1) clinical audits of all attempted resuscitations to verify the initial cardiac rhythm, time of defibrillation, and clinical practice variations, (2) a random audit of 10% of newly entered cases are conducted monthly, and (3) data range and validity checks are incorporated into the database using electronic algorithms.

Cases in the VACAR were also linked to a Victorian Department of Health register of confirmed COVID-19 patients using key patient identifiers. The register contained information on patients who had tested positive to COVID-19 on a polymerase chain reaction test.

Changes to care during the pandemic

In March 2020, modifications to Ambulance Victoria clinical practice guidelines were introduced to reduce the risk of disease transmission of COVID-19 (see Supplementary appendix). The use of nebulised therapies and non-invasive ventilation were prohibited in patients presenting with respiratory aetiologies, while bag-valve-mask ventilation (BVM) was not recommended. The preferred approach to oxygenation was via nasal cannula covered by a non-vented face mask. Changes to intubation guidelines included reduced indications for intubation, prohibition of apnoeic oxygenation for patients deemed to be 'high risk' for COVID-19, use of video laryngoscopy where available, and cessation of chest compressions during laryngoscopy until inflation of the endotracheal tube cuff. Cardiac arrest guidelines recommended the use of airborne PPE precautions (e.g., N95 mask, eye goggles, gloves and gown) when treating any cardiac arrest patient. All patients were also required to wear a face mask until the airway was secured with intubation or the placement of a laryngeal mask airway (LMA) with a viral filter. Guidelines also advised crews to consider early termination of resuscitation of a known COVID-19 patient who deteriorates into cardiac arrest with asystole or pulseless electrical activity.

Statistical analysis

Statistical analyses were undertaken using Stata Statistical Software 15 (StataCorp, 2018, College Station, TX). A p-value of < 0.05 was considered statistically significant. The primary outcome was survival to hospital discharge. The secondary outcomes included event survival (pulse at hospital arrival), prehospital return of spontaneous circulation (ROSC) and the incidence of EMS-attended and EMS-treated OHCA witnessed by EMS personnel.

Arrest characteristics, unadjusted outcomes, and resuscitation interventions were presented as frequencies and proportions for categorical variables, and median and interquartile ranges (IQR) for continuous variables. Differences between the COVID-19 and comparator period were assessed using the Chi-squared test and the Mann-Whitney U test, as appropriate.

The incidence of EMS-witnessed OHCA per 100,000 person-years were calculated for the COVID-19 and comparator periods using annual population figures from the Australian Bureau of Statistics as at 30th June. Changes in the incidence of EMS-attended and EMS-treated OHCA during the COVID-19 period were explored

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using poisson regression. In these models, we adjusted for seasonality using a categorical variable denoting month of year and the temporal trend was modelled using a continuous term denoting consecutive months in the study period. To account for population growth, the natural log of the estimated resident population of Victoria was included as an offset term in all models. Results are presented as incidence rate ratios (IRR) and 95% confidence intervals (CI). As changes to clinical practice during the COVID-19 period largely affected patients with respiratory aetiologies, we performed a stratified analysis in this population to examine changes in incidence.

To better understand the impact of the COVID-19 period on survival to hospital discharge, event survival and prehospital ROSC, we used logistic regression models adjusted for age, gender, arrest location, arrest aetiology, initial rhythm, region, consecutive month, and season. As the EMS system also implemented high-performance CPR in February 2019, we also included an indicator variable in the model denoting this time period to avoid confounding the COVID-19 period. Models were used to calculate Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CI).

Results

Population sample

We identified a total of 5,607 OHCAs witnessed by EMS personnel between January 2012 and December 2021. Of these, 524 (9.4%) were precipitated by trauma and 61 (1.1%) involved children. For this study, we included 5,034 patients (3,976 in the comparator period and 1,058 in the COVID-19 period). Of these, 4,073 (80.9%) received an EMS attempted resuscitation, 3,256 (81.9%) in the comparator period and 817 (77.2%) in the COVID-19 period ($p = 0.001$).

Incidence

The crude incidence of EMS-witnessed OHCA cases is shown in Fig. 1. There were no significant differences in the incidence of EMS-witnessed OHCA for the COVID-19 and comparator period. The incidence of EMS-witnessed cases was 8.0 per 100,000 person-years in the comparator period versus 8.8 per 100,000 person-years in the COVID-19 period (IRR 1.06, 95% CI: 0.97–1.17, $p = 0.19$). Similarly, the incidence of EMS treated cases was 6.5 per 100,000 person-years in the comparator period versus 6.8 per 100,000 person-years in the COVID-19 period (IRR 1.03, 95% CI: 0.93–1.14, $p = 0.60$). Furthermore, the incidence of EMS-witnessed OHCA precipitated by respiratory aetiology also did not differ between periods (IRR 0.93, 95% CI: 0.69–1.25, $p = 0.63$).

Baseline characteristics

The baseline characteristics of the EMS-treated population are described in Table 1. Patients treated during the COVID-19 period had longer median ambulance response times (11.4 min vs 10.4 min, $p < 0.001$), fewer public arrests (5.5% vs 7.7%, $p = 0.03$), and more arrests caused by hanging/asphyxiation (0.6% vs 0.1%, $p = 0.003$). In the overall population, unadjusted rates of prehospital ROSC were higher in the COVID-19 period (65.0% vs 60.9%, $p = 0.03$). Event survival and survival to hospital discharge rates were similar across both periods.

COVID-19 positive patients

There were 10 patients included in this study (0.9% of the COVID-19 period) that were identified as COVID-19 positive, of which 9 received an attempted resuscitation. Six patients were male, 8 occurred in a private residence, 1 was in an initially shockable rhythm, while 6 patients were in PEA, and 6 patients had their cardiac arrest precipitated by a respiratory aetiology. Prehospital ROSC was achieved in 7 (77.8%) patients, 6 (66.7%) survived the event and 2 (22.2%) were discharged alive.

Resuscitation interventions

The resuscitation interventions of the population are described in Table 2. During the COVID-19 period, patients were more likely to receive defibrillation (51.2% vs 42.3%, $p < 0.001$), laryngeal mask airway (61.1% vs 39.3%, $p < 0.001$), mechanical CPR (22.9% vs. 10.4%, $p < 0.001$) and amiodarone (15.3% vs 12.0%, $p = 0.01$); whereas the use of bag-valve-mask ventilation has significantly reduced in COVID-19 period compared to controls (39.4% vs 44.1% $p = 0.02$).

Adjusted survival outcomes

Monthly unadjusted survival to hospital discharge outcomes for the EMS-treated population is shown in Fig. 2. The results of the multivariable logistic regression models for survival to hospital discharge, event survival and prehospital ROSC are shown in Table 3. Initial

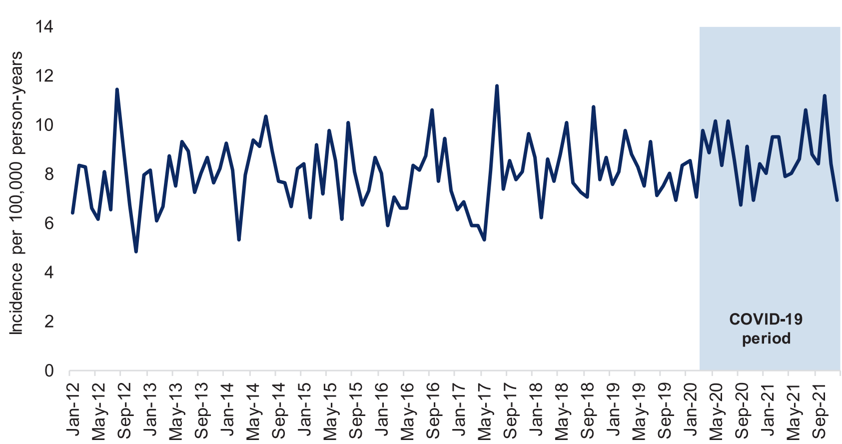

Fig. 1 – Incidence of all (EMS-attended) EMS-witnessed OHCA by month.

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Table 1 – Baseline characteristics of EMS-witnessed OHCA receiving an attempted resuscitation.

	Overall n = 4,073	Control period n = 3,976	COVID-19 period n = 1,058	p-value	Missing, n (%)
Age in years, median (IQR)	69 (56, 80)	69(56, 80)	68 (56,80)	0.74	0
Male sex, n (%)	2,623 (64.5)	2,100 (64.5)	523 (64.1)	0.81	3 (0.07)
Ambulance response time in mins, median (IQR)	10.6 (7.7, 15.5)	10.4 (7.7, 14.8)	11.4 (8.0, 20.0)	<0.001	3 (0.07)
Arrest location, n (%)					0
Private residence	2,492 (61.2)	1,958 (60.1)	534 (65.4)	0.01	
Aged Care / Supported accommodation	236 (5.8)	195 (6.0)	41 (5.0)	0.29	
Hospital / Medical facility	141 (3.5)	124 (3.8)	17 (2.1)	0.02	
Public Location	296 (7.3)	251 (7.7)	45 (5.5)	0.03	
Ambulance	872 (21.4)	701 (21.5)	171 (20.9)	0.71	
Other	36 (0.9)	27 (0.8)	9 (1.10)	0.23	
Initial arrest rhythm, n (%)					65 (1.6)
Shockable	1,329 (33.2)	1,043 (32.6)	286 (35.2)	0. 16	
Pulseless electrical activity	1,955 (48.8)	1,568 (49.1)	387 (47.7)	0.48	
Asystole	717 (17.9)	580 (18.2)	137 (16.9)	0.40	
Unknown, Non-shockable	7 (0.2)	5 (0.2)	2 (0.3)	0.58	
Arrest aetiology, n (%)					0
Presumed cardiac	3,018 (74.1)	2,421 (74.4)	597 (73.1)	0.45	
Respiratory	494 (12.1)	413 (12.7)	81 (9.9)	0.30	
Overdose/poisoning	95 (2.3)	73 (2.2)	22 (2.7)	0.45	
Terminal illness	129 (3.2)	104 (3.2)	25 (3.1)	0.85	
Hanging/asphyxiation	8 (0.2)	3 (0.1)	5 (0.6)	0.003	
Other	329 (8.1)	242 (7.4)	87 (10.7)	0.003	
Metropolitan region, n (%)	2,731 (67.1)	2,176 (66.8)	555 (67.9)	0.55	0
Arrest duration in mins, median (IQR)	16 (4,34)	16 (4,33)	17 (4,34)	0.72	6 (0.2)
Season, n (%)					0
Summer	960 (23.6)	828 (25.4)	132 (16.2)	0.00	
Autumn	1,004 (24.7)	769 (23.6)	235 (28.8)	0.002	
Winter	1,091 (26.8)	860 (26.4)	231 (28.3)	0.28	
Spring	1,018 (25.00)	799 (24.5)	219 (26.8)	0.18	
Any prehospital ROSC, n (%)	2,515 (61.8)	1,984 (60.9)	531 (65.0)	0.03	0
Event survival, n (%)	2,067 (50.8)	1,629 (50.0)	438 (53.6)	0.11	5 (0.1)
Discharged alive, n (%)	1,243 (30.8)	978 (30.3)	265 (32.8)	0.16	33 (0.8)

CPR denotes cardiopulmonary resuscitation, IQR interquartile range, ROSC return of spontaneous circulation, proportions exclude missing data.

Table 2 – Resuscitation interventions undertaken for EMS-witnessed OHCA.

	Overall n = 4,073	Control period n = 3,976	COVID-19 period n = 1,058	p-value	Missing, n (%)
CPR, n (%)	3, 800 (93.3)	3, 051 (93.7)	749 (91.7)	0.04	0
Mechanical CPR, n (%)	526 (12.9)	339 (10.4)	187 (22.9)	<0.001	0
Defibrillation, n (%)	1, 796 (44.1)	1, 378 (42.3)	418 (51.2)	<0.001	0
Airway, n (%)					
BVM	1, 759 (43.2)	1, 437 (44.1)	322 (39.4)	0.02	0
LMA	1, 779 (43.7)	1, 280 (39.3)	499 (61.1)	<0.001	0
ETT	1, 878 (46.1)	1, 480 (45.5)	398 (48.7)	0.10	0
Adrenaline administration, n (%)	2, 617 (64.3)	2, 093 (64.3)	524 (64.1)	0.94	0
Amiodarone administration, n (%)	517 (12.7)	392 (12.0)	125 (15.3)	0.01	0
Intensive care paramedic present on scene, n (%)	3, 781 (92.8)	3, 012 (92.5)	769 (94.1)	0.11	0

CPR denotes cardiopulmonary resuscitation, BVM denotes bag-valve-mask, LMA denotes laryngeal mask airway, ETT denotes endotracheal tube, MICA denotes mobile intensive care ambulance. Proportions exclude missing data.

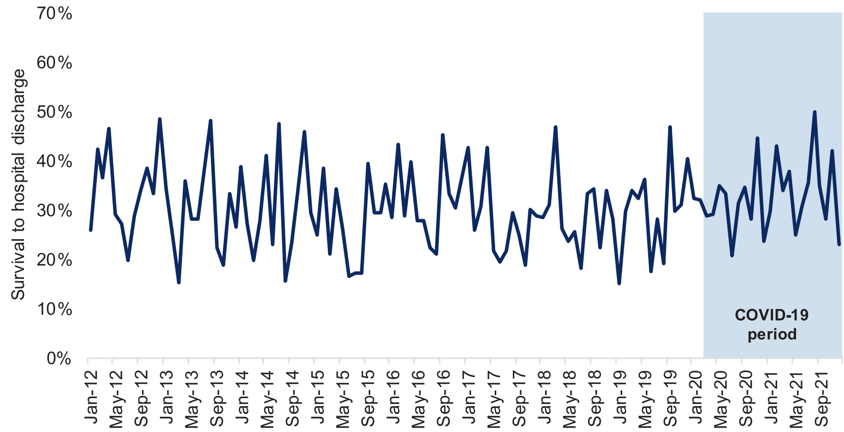

Fig. 2 – Monthly survival to hospital discharge for EMS-treated EMS-witnessed OHCA.

Table 3 – Multivariable logistic regression models for survival to hospital discharge, event survival and prehospital ROSC.

	Survival to hospital discharge		**Event survival**		**Prehospital ROSC**	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age, per year increase	0.98 (0.97, 0.98)	<0.001	0.99 (0.99, 1.00)	0.003	0.99 (0.99, 1.00)	0.001
Male gender (vs. Female)	0.97 (0.81, 1.17)	0.77	0.92 (0.79, 1.06)	0.25	0.93 (0.80, 1.08)	0.34
Arrest location						
Private residence	Reference		Reference		Reference	
Aged Care/supported accommodation	0.31 (0.17, 0.55)	<0.001	0.55 (0.40, 0.75)	<0.001	0.54 (0.40, 0.73)	<0.001
Hospital/medical facility	1.52 (0.98, 2.36)	0.06	1.15 (0.78, 1.70)	0.49	1.04 (0.69, 1.56)	0.87
Public Location	1.34 (0.97, 1.84)	0.08	1.26 (0.96, 1.65)	0.10	1.09 (0.82, 1.45)	0.55
Ambulance	1.33 (1.08, 1.64)	0.008	0.82 (0.69, 0.98)	0.03	0.76 (0.64, 0.91)	0.003
Other	0.64 (0.45, 0.93)	0.02	1.14 (0.55, 2.35)	0.73	1.11 (0.53, 2.35)	0.79
Initial arrest rhythm						
Shockable	Reference		Reference		Reference	
Pulseless electrical activity	0.06 (0.05,0.07)	<0.001	0.14 (0.12, 0.17)	<0.001	0.16 (0.13, 0.19)	<0.001
Asystole	0.10 (0.08, 0.12)	<0.001	0.18 (0.14, 0.22)	<0.001	0.18 (0.14, 0.22)	<0.001
Unknown, non-shockable	0.17 (0.31, 0.96)	0.04	0.14 (0.03, 0.71)	0.02	0.10 (0.02, 0.45)	0.003
Arrest aetiology						
Presumed cardiac	Reference		Reference		Reference	
Respiratory	0.77 (0.56, 1.05)	0.10	1.24 (1.00, 1.52)	0.05	1.15 (0.94, 1.42)	0.17
Overdose/poisoning	0.54 (0.30, 0.98)	0.04	1.23 (0.78, 1.94)	0.37	1.02 (0.64, 1.62)	0.93
Terminal illness	0.04 (0.01, 0.18)	<0.001	0.12 (0.07, 0.23)	<0.001	0.13 (0.08, 0.22)	<0.001
Hanging/asphyxiation	1.38 (0.24, 7.84)	0.71	4.70 (0.92, 24.09)	0.06	2.65 (0.51, 13.76)	0.25
Other	0.64 (0.45, 0.93)	0.02	1.34 (1.04, 1.71)	0.02	1.12 (0.87, 1.43)	0.39
Metropolitan region (vs. rural)	1.40 (1.16, 1.68)	<0.001	1.33 (1.15, 1.54)	<0.001	1.27 (1.09, 1.47)	0.002
Time trend, per month increase	0.99 (0.99, 1.00)	0.02	1.00 (1.00,1.00)	0.41	1.00 (0.99, 1.00)	0.07
Season						
Summer	Reference					
Autumn	0.93 (0.73,1.19)	0.56	0.97 (0.79, 1.19)	0.79	0.86 (0.70, 1.05)	0.14
Winter	0.80 (0.62, 1.02)	0.07	1.00 (0.82, 1.22)	1.00	0.91 (0.75, 1.11)	0.34
Spring	1.02 (0.80, 1.30)	0.89	1.21 (0.99, 1.47)	0.06	1.06 (0.87, 1.30)	0.57
HP-CPR period (vs. non HP-CPR period)	1.59 (1.13, 2.24)	0.008	1.07 (0.82, 1.41)	0.61	0.98 (0.75, 1.29)	0.91
COVID-19 period (vs. non-COVID-19 period)	1.02 (0.74, 1.42)	0.90	1.13 (0.87, 1.48)	0.35	1.43 (1.09, 1.86)	0.009

VF denotes ventricular fibrillation, VT denotes ventricular tachycardia, HP-CPR denotes high-performance cardiopulmonary resuscitation.

shockable rhythm, metropolitan region and the introduction of high-performance CPR were associated with a higher risk-adjusted odds of survival to hospital discharge. There was no difference in the risk-adjusted odds of survival to hospital discharge for OHCA occurring during the COVID-19 period compared to the comparator period (AOR 1.02, 95% CI: 0.74–1.42; $p = 0.90$). However, there was an increase in the risk-adjusted odds of prehospital ROSC during the COVID-19 period compared to the comparator period (AOR 1.43, 95% CI: 1.10–1.86; $p = 0.009$).

Discussion

Our findings show that the COVID-19 pandemic had little effect on the incidence and outcomes of EMS-witnessed OHCA. Our time series analysis showed no significant difference in the incidence of EMS-witnessed OHCA between the COVID-19 and comparator period, including those of respiratory aetiology who were believed to be the most vulnerable to the restrictions in aerosol generating procedures (e.g. mask oxygenation, nebulisation, non-invasive ventilation). Similarly, our multivariable models show no difference in the risk-adjusted odds of survival to hospital discharge for OHCA occurring during COVID-19 period.

The findings of this study are in contrast to an earlier study from our region that showed a 50% reduction in survival for non-EMS-witnessed OHCA during the COVID-19 pandemic.[5] The findings also differ to other studies describing the effect of the COVID-19 pandemic in non-EMS-witnessed OHCA. Three recent systematic reviews reported that the incidence of OHCA increased by 40%, 120% and 52% during the COVID-19 period when compared to a comparator period, respectively.[6,13,14] Two of these systematic reviews also reported that the odds of survival to hospital discharge following OHCA decreased by 48% and 35% during the COVID-19 pandemic.[6,13]

While we did not observe changes in incidence, we did notice differences in patient characteristics and cardiac arrest management during the COVID-19 period. When comparing the COVID-19 period to the comparator period, the median ambulance response time was significantly longer. These findings are consistent with those reported internationally.[6,15,16] It has been suggested that the observed changes are due to the requirement for paramedics to don additional PPE.[14] Unlike patients arresting before EMS arrival, it's not clear how an increase in EMS response time would influence the incidence or outcomes of EMS witnessed OHCA. One quarter of EMS witnessed OHCA cases arrest within 6 minutes of EMS arrival,[17] which would suggest that any delay in EMS response time may lead to fewer EMS witnessed arrests. To the contrary, our study did not identify a change in incidence during the COVID-19 period, nor did it identify a change in clinical outcomes as a result of longer response times.

The proportion of cases with an initially shockable rhythm did not differ significantly in our study. In contrast, international studies have observed fewer OHCA presenting with an initially shockable rhythm during the pandemic period.[6,15,18] According to these reports, OHCA that is caused by hypoxic respiratory failure due to COVID-19 is less likely to manifest as a shockable rhythm.[19,20] In our study, relatively few patients presented with COVID-19 infection, and this may also explain why we did not observe a concomitant increase in initial non-shockable rhythms. Six of the nine COVID-19 positive patients in our study had their cardiac arrest precipitated by respiratory aetiologies, and all but one presented with an initial non-shockable rhythm. Of the 9 patients that received an attempted resuscitation, two survived to hospital discharge (none with respiratory aetiology).

Despite changes to the management of critically unwell patients, such as limitations in the use of oxygenation, non-invasive ventilation, nebulised therapies, suction, intubation and bag valve mask ventilation, the incidence of EMS-witnessed OHCA overall did not increase, nor did respiratory precipitated events. When compared to the comparator period, the rate of LMA use was significantly higher during the COVID-19 period (61.1% vs 39.3%). The recommendation to prioritise LMA insertion with a viral filter resulted in a significant decrease in BVM use and increase in LMA use. The use of LMAs may have provided superior ventilations to patients and minimised ventilatory pauses.[21] A recommended pause for chest compressions during LMA and ETT insertion reduces hands-on-chest time. Several studies have demonstrated an inverse relationship between the duration of chest compression interruption and short-term survival.[22]

During the COVID-19 period, there was also a significant increase in the number of patients receiving mechanical CPR. This is consistent with local guidelines directing paramedics to consider early mechanical CPR to reduce potential COVID-19 exposure. There is conflicting research on whether mechanical or manual CPR provides better outcomes.[22,23]

Although our findings suggest that changes to clinical practice guidelines during the COVID-19 period were safe, only a small proportion of patients were COVID-19 positive at the time of their OHCA (0.9% of the population). As a result, many patients who posed no risk of transmitting COVID-19 to staff were subjected to restricted management. The implementation of high-performance CPR in February 2019 may have helped to attenuate the impact of the COVID-19 pandemic. The introduction of high-performance CPR involved the use of resuscitation choreography, on-screen rhythm analysis, manual mode defibrillation, pre-emptive charging and real time CPR feedback to reduce pauses in CPR, improve CPR quality and focus on timely defibrillation of shockable rhythms.[24] A recent evaluation of the introduction of high-performance CPR in our region showed improvements in survival for both non-EMS witnessed and EMS-witnessed OHCA.[24,25]

Limitations

Our findings should be interpreted in the context of some limitations. The observational design has inherent risks of bias that cannot be controlled, and causality cannot be inferred. Comorbidities between patients during the pandemic and the comparator period may have varied, and this may have affected patient outcomes. We also did not have CPR performance data for the entire study period and therefore it could not be examined. The recency of the pandemic has meant that that data pertaining to long-term follow up was not available for the pandemic period. Consequently, survival outcomes such as 12-month follow up and neurological outcome cannot be evaluated.

Conclusion

While other international studies have observed higher incidence and reduced survival in non-EMS-witnessed OHCA during the COVID-19 pandemic, this study did not identify any significant impacts on EMS-witnessed OHCA. This may suggest that changes in clinical practice that sought to limit the use of aerosol generating procedures did not influence incidence and outcomes in these patients.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resuscitation.2023.109770.

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