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Clinical paper

Long-term trends in the epidemiology of out-of-hospital cardiac arrest precipitated by suspected drug overdose



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Abstract

Background: Little is known about the long-term trends in the incidence and outcomes of drug overdose out-of-hospital cardiac arrests (OHCA).

Method: Between 2000 and 2017, we retrospectively reviewed drug overdose OHCA from the Victorian Ambulance Cardiac Arrest Registry. Incidence was assessed using linear regression, and the baseline characteristics and survival outcomes were assessed using nonparametric test for trend. Arrest factors associated with survival to hospital discharge were assessed using logistic regression. The 12-month functional recovery and health related quality of life for survivors was summarised using descriptive statistics.

Results: The incidence of emergency medical services (EMS)-attended and EMS-treated cases was 5.8 and 2.0 per 100,000 person-years, respectively, with no significant changes in trend over time. Return of spontaneous circulation increased from 23% to 34% (p for trend = 0.001), event survival increased from 23% to 30% (p for trend = 0.007), and survival to hospital discharge increased from 4% to 13% (p for trend = 0.03). Age, arrest witnessed by bystander or EMS, initial shockable rhythm or pulseless electrical activity, intubation, epinephrine and sodium bicarbonate administration were independently associated with survival. The adjusted-temporal trend for survival was not significant (per year increase; OR 1.02, 95% CI: 0.98, 1.07; p = 0.244). Of the 12-month survivors, 50% of the responders reported good functional recovery, and few reported severe problems with mobility, self-care, daily activity, pain, and anxiety/depression.

Conclusion: Although the incidence of drug overdose OHCA remained unchanged between 2000 and 2017, the rates of survival have significantly improved.

Keywords: Out-of-hospital cardiac arrest, Drug overdose, Cardiopulmonary resuscitation, Emergency medical services, Quality of life

Introduction

Out-of-hospital cardiac arrest (OHCA) is a major health issue affecting millions of people each year.¹ A number of studies demonstrated that

early initiation of cardiopulmonary resuscitation (CPR) and defibrillation by members of the community can increase survival rates.^{2–4} However, much of the improvement in survival occurred in OHCA patients precipitated by presumed cardiac aetiology or initial shockable arrest rhythms.^{2–4} In comparison, OHCA precipitated by non-cardiac

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aetiologies less frequently arrest into shockable rhythms,^{5,6} and long-term trends in outcomes are less often described.

OHCA precipitated by suspected drug overdose is a distinct subset of non-cardiac aetiologies which commonly involve middle aged males.^{7,8} They are typically unwitnessed, occur in a private locations, are less likely to receive bystander CPR, and rarely present with initial shockable arrest rhythms.⁹ As such, survival to hospital discharge outcomes have been reported as low as 3%.¹⁰ Relatively little is known about the long-term trends in the incidence, epidemiology, and survival outcomes of OHCA precipitated by drug overdose. The long-term functional recovery and health-related quality-of-life (HRQoL) outcomes of survivors is also not well understood.

In this study, we describe long-term trends in the incidence, epidemiology, and survival outcomes after drug overdose OHCA, and examine factors related to survival. Additionally, the 12-month functional recovery and HRQoL outcomes of survivors arresting between 2010 and 2016 were also examined.

Methods

Study design

This is a retrospective study of OHCA cases precipitated by presumed drug overdose from the Victorian Ambulance Cardiac Arrest Registry (VACAR). All adult (aged ≥ 16 years) emergency medical service (EMS)-attended cases between 1st January 2000 and 31st December 2017 were included. The VACAR is a quality assurance initiative approved by the Victorian Government Department of Health and Human Research Ethics Committee. This study has ethics approval from the Monash University Human Research Ethics Committee (Project number: 9600).

Setting

The population in the state of Victoria is approximately 6.3 million.¹¹ The state provides EMS using a single provider, Ambulance Victoria. The EMS system consists of advanced life support and mobile intensive care paramedics who respond simultaneously to suspected OHCA events identified in the emergency call. Additionally, firefighters and community volunteers with basic life support training respond to OHCA cases in select areas throughout the state. Paramedics' clinical practice guidelines follow the recommendations of the Australian and New Zealand Council on Resuscitation (<http://www.resus.org.au>). Cardiac arrest patients who achieve return of spontaneous circulation (ROSC) in the field are transported to the closest appropriate hospital.

Data sources and definitions

Since 1999, the VACAR maintains a record of all EMS-attended OHCA cases in the state of Victoria, Australia. The registry collects data variables according to the Utstein template,¹² and includes operational data, arrest features, patient demographics, treatment interventions, and outcomes. The VACAR also captures and stores all paper-based and electronic patient care records completed by paramedics.¹³ A central electronic database identifies and stores potential cardiac arrest cases using a sensitive search criteria. Hospital outcomes for the majority of transported patients are obtained from the hospital medical records and cross-matched against death records from the Victorian Registry of Births, Deaths

and Marriages. Cardiac arrest aetiology is presumed to be of cardiac cause unless there is an obvious precipitator (e.g. drowning, trauma). Cases precipitated by suspected drug overdose are defined as evidence that the cardiac arrest was caused by deliberate or accidental overdose of prescribed medications, recreational drugs, or ethanol.¹⁴

Since 1st January 2010, the VACAR conducts a structured telephone interview with survivors at 12-month post arrest to assess functional recovery and HRQoL. The interview process and the instruments used are described in detail previously.¹⁵ Functional recovery is assessed using the Glasgow Outcome Scale-Extended (GOSE) which is an eight-point scale ranging from 1 (death) to 8 (upper good recovery).¹⁶ HRQoL is assessed using the Twelve-Item Short Form (SF-12) health survey which summarises mental and physical health based on a weighted score ranging from zero to 100.¹⁷ Scores of ≥ 50 indicate no disability, 40–49 indicate mild disability, 30–39 indicate moderate disability, and ≤ 29 indicate severe disability.¹⁷ Proxy responses for SF-12 are not considered valid.¹⁵ In addition, the interview also administers the EuroQoL-5-3 L (EQ-5D) health survey which provides a single index score ranging from -0.594 to 1.0 for HRQoL according to five domains (mobility, self-care, usual activity, pain/discomfort, and anxiety/depression).¹⁸ Patients can also self-rate their health status using a verbal analogue scale (VAS), where 0 indicates the worst imaginable health state and 100 indicates the best imaginable health state.¹⁸

Outcomes

The primary outcome of the study was survival to hospital discharge. The secondary outcomes included ROSC, event survival, and 12-month functional recovery and HRQoL for survivors using the GOSE, SF-12, and EQ-5D.

Statistical analysis

The crude incidence rate of EMS-attended and EMS-treated cases were calculated using population estimates for people aged ≥ 16 years obtained from the Australian Bureau of Statistics.¹⁹ Age-adjusted incidence rates were also calculated using the 2001 Australian standard population.¹⁹ Trends in incidence rates over the study period were assessed using linear regression. Baseline characteristics and survival outcomes were reported using descriptive statistics and stratified by study year (2000–2003, 2004–2008, 2009–2013, and 2014–2017). Trends over time in baseline characteristics were assessed using a non-parametric test for trend.²⁰

We constructed a multivariable logistic regression model to assess factors associated with survival to hospital discharge. The variables included were: age, sex, witness status, initial arrest rhythm, arrest location, bystander CPR, intubation attempt, administration of epinephrine and sodium bicarbonate, and EMS response time. A variable denoting consecutive calendar years in the study was also included in the model to assess whether survival trends were changing independent of other arrest characteristics. Relevant interactions between arrest characteristics were also tested in the model. Effect sizes were expressed as odds ratios (ORs) with 95% confidence intervals (CI).

The 12-month outcomes were summarised using descriptive statistics. The SF-12 scores of the 12-month survivors were compared with the Australian norms by standardising the SF-12 scores of the Australian population to the distribution of the 12-month survivors.²¹

We computed the standardised mean difference (SMD) of the SF-12 scores by subtracting the mean score of the age- and sex-adjusted Australian population from the mean score of the 12-month survivors and dividing by the pooled standard deviation of both population.²² The SMD value is used to quantify the degree to which SF-12 scores of the 12-month survivors deviate from the population norm, with a value of >0.8 considered large.²² STATA statistical software version 15.0 (Statacorp, College Station, Texas, USA) was used to analyse the data. A two-tailed p value of less than 0.05 was considered statistically significant.

Results

During the 18-year study period, EMS attended 4523 cases of adult drug overdose OHCA, of which 1545 (34%) cases received an attempt at resuscitation by EMS (Fig. S1).

Trends in incidence

Fig. 1 shows the crude incidence rate of drug overdose OHCA over the study period. The crude incidence rate of EMS-attended and EMS-treated cases was 5.8 and 2.0 events per 100,000 person-years, respectively. There was no significant change in the incidence of EMS-attended and EMS-treated drug overdose OHCA over time (p for trend = 0.17 and 0.21, respectively). The age-adjusted incidence rate of EMS-attended and EMS-treated cases was 6.0 and 2.1 events per 100,000 person-years, respectively (Fig. S2), with no significant changes in trend over time (p for trend = 0.26 and 0.15, respectively).

Trends in baseline characteristics

Table 1 shows the baseline characteristics of EMS-treated cases across year groups. The overall mean age was 37.4 years, 72% were male and 76% were unwitnessed. The mean age increased from 32.9 years in 2000–2003 to 40.6 years in 2014–2017 (p trend <0.001). The majority of cardiac arrests occurred in private residences (77%), increasing from 69% in 2000–2003 to 80% in 2014–2017 (p for

trend = 0.001). Few cases presented with initial shockable rhythms (6%) and less than half received bystander CPR (44%). However, the proportion of bystander CPR increased from 27% in 2000–2003 to 59% in 2014–2017 (p trend <0.001). The median EMS response time was 7.2 min, increasing from 7.0 to 7.3 min between 2000–2003 and 2014–2017 (p trend <0.001). Rates of EMS interventions, such as endotracheal intubation, epinephrine and sodium bicarbonate administration, all declined over the study period. Table S1 in the supplementary appendix shows the baseline characteristics of drug overdose OHCA attended by EMS over time.

Trends in survival outcomes

Fig. 2 shows the survival outcomes of drug overdose OHCA treated by EMS over the study period. The overall proportion of patients who achieved ROSC was 33%, increasing from 23% in 2000 to 34% in 2017 (p for trend = 0.001). Overall event survival was 31%, increasing from 23% in 2000 to 30% in 2017 (p for trend = 0.007). Overall survival to hospital discharge was 9%, improving from 4% in 2000 to 13% in 2017 (p for trend = 0.03).

Predictors of survival to hospital discharge

The results of the multivariable logistic regression model of survival to hospital discharge are shown in Table 2. The following variables were independent predictors of survival: age (per year increase; OR 0.97, 95% CI: 0.95, 0.99; p < 0.002), witnessed by bystander (OR 2.95, 95% CI: 1.77, 4.94; p < 0.001) or EMS witnessed (OR 4.32, 95% CI: 2.20, 8.46; p < 0.001), initial shockable rhythm (OR 10.08, 95% CI: 5.01, 20.29; p < 0.001) or initial pulseless electrical activity (PEA) (OR 9.00, 95% CI: 5.51, 14.67; p < 0.001), attempted intubation (OR 1.91, 95% CI: 1.04, 3.49; p = 0.04), epinephrine administration (OR 0.39, 95% CI: 0.22, 0.70; p = 0.002), and sodium bicarbonate administration (OR 0.16, 95% CI: 0.08, 0.31; p < 0.001). Male gender, location of arrest, bystander CPR, EMS response time were not significantly associated with survival. Furthermore, the temporal trend for survival was not significant after adjustment for arrest factors (per year increase; OR 1.02, 95% CI: 0.98, 1.07; p = 0.244).

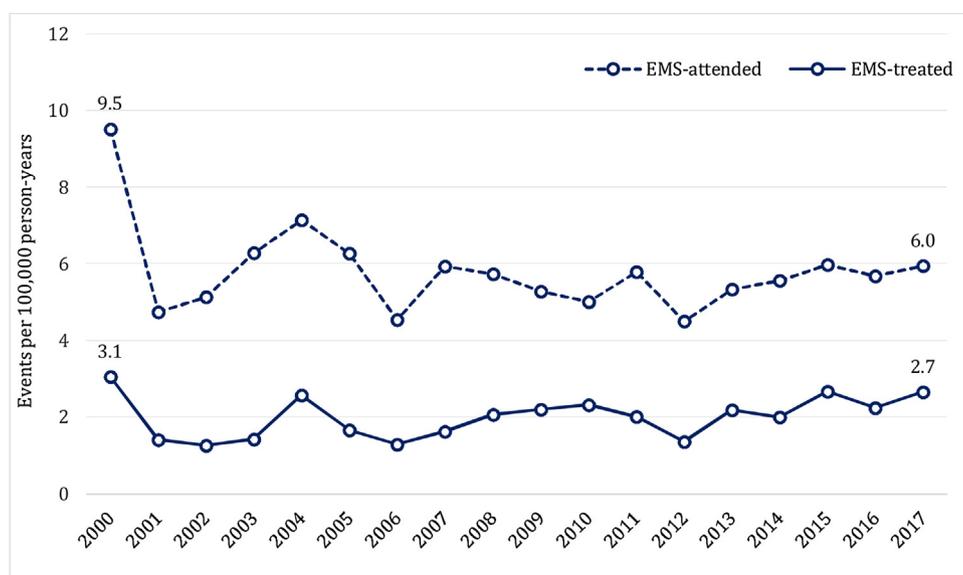


Fig. 1 – Crude incidence rate of EMS-attended and EMS-treated cases over time.

Table 1 – Characteristics of EMS-treated cases stratified by study year.

| Variable | Overall n = 1545 | 2000–2003 n = 270 | 2004–2008 n = 368 | 2009–2013 n = 445 | 2014–2017 n = 462 | p-Value for trend | Missing n (%) |
|---------------------------------|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|------------------|
| Age in years, mean (SD) | 37.4 (12.3) | 32.9 (11.8) | 35.8 (12.2) | 38.0 (12.3) | 40.6 (11.8) | <0.001 | 13 (0.8%) |
| Male, n (%) | 1106 (71.6) | 204 (75.6) | 258 (70.1) | 308 (69.2) | 336 (72.7) | 0.692 | 0 |
| Witnessed status n, (%) | | | | | | | 17 (1.1%) |
| Not witnessed | 1161 (76.0) | 199 (76.3) | 277 (75.7) | 350 (79.4) | 335 (72.8) | 0.262 | |
| Bystander witnessed | 249 (16.3) | 45 (17.2) | 67 (18.3) | 57 (12.9) | 80 (17.4) | 0.778 | |
| EMS witnessed | 118 (7.7) | 17 (6.5) | 22 (6.0) | 34 (7.7) | 45 (9.8) | 0.029 | |
| Location of arrest, n (%) | | | | | | | 0 |
| Private location | 1190 (77.0) | 185 (68.5) | 284 (77.2) | 352 (79.1) | 369 (79.9) | 0.001 | |
| Public location | 305 (19.7) | 77 (28.5) | 74 (20.1) | 79 (17.8) | 75 (16.2) | <0.001 | |
| Other | 50 (3.2) | 8 (3.0) | 10 (2.7) | 14 (3.2) | 18 (3.9) | 0.622 | |
| First documented rhythm, n (%) | | | | | | | 15 (1.0%) |
| VF/VT | 93 (6.1) | 19 (7.2) | 29 (8.0) | 26 (5.9) | 19 (4.1) | 0.068 | |
| PEA | 283 (18.5) | 36 (13.6) | 65 (17.9) | 76 (17.1) | 106 (23.1) | 0.001 | |
| Asystole | 1154 (75.4) | 209 (79.2) | 269 (74.1) | 342 (77.0) | 334 (72.8) | 0.064 | |
| Bystander CPR, n (%) | 680 (44.0) | 72 (26.7) | 101 (27.5) | 233 (52.4) | 274 (59.3) | <0.001 | 0 |
| Intubation attempted, n (%) | 1033 (66.9) | 200 (74.1) | 262 (71.2) | 318 (71.5) | 253 (54.8) | <0.001 | 0 |
| Laryngeal Mask Airway, n (%) | 321 (20.8) | 16 (5.9) | 32 (8.7) | 32 (7.2) | 241 (52.2) | <0.001 | 0 |
| Epinephrine, n (%) | 1056 (68.4) | 194 (71.9) | 259 (70.4) | 313 (70.3) | 290 (62.8) | 0.008 | 0 |
| Sodium bicarbonate, n (%) | 568 (36.8) | 143 (53.0) | 149 (40.5) | 171 (38.4) | 105 (22.7) | <0.001 | 0 |
| EMS response time, median (IQR) | 7.2 (5.9, 9.8) | 7.0 (5.0, 8.0) | 7.0 (6.0, 9.0) | 7.8 (6.0, 10.6) | 7.3 (5.7, 10.1) | <0.001 | 5 (0.3%) |
| Scene outcome, n (%) | | | | | | | 4 (0.3%) |
| Died at scene | 991 (64.3) | 175 (64.8) | 243 (66.2) | 275 (61.8) | 298 (64.9) | 0.512 | |
| Transported with ongoing CPR | 96 (6.2) | 39 (14.4) | 24 (6.5) | 18 (4.0) | 15 (3.3) | <0.001 | |
| Transported with ROSC | 454 (29.5) | 56 (20.7) | 100 (27.3) | 152 (34.2) | 146 (31.8) | <0.001 | |
| ROSC at any time, n (%) | 516 (33.4) | 69 (25.6) | 116 (31.5) | 165 (37.1) | 166 (35.9) | 0.001 | 0 |
| Event survival, n (%) | 470 (30.7) | 66 (24.8) | 102 (28.1) | 154 (34.6) | 148 (32.2) | 0.007 | 12 (0.8%) |
| Discharged alive, n (%) | 133 (8.8) | 18 (6.8) | 31 (8.6) | 33 (7.5) | 51 (11.2) | 0.029 | 26 (1.7%) |

Abbreviations: SD standard deviation; VF/VT ventricular fibrillation/ventricular tachycardia; PEA pulseless electrical activity; CPR cardiopulmonary resuscitation; EMS emergency medical services; IQR interquartile range; ROSC return of spontaneous circulation.

12-month functional recovery and quality of life outcomes

Functional recovery and HRQoL outcomes were available for patients who arrested between 1st January 2010 and 31st December 2016 (Fig. S3). The number of EMS-treated cases was 682 (44% of the overall sample), of whom 60 survived to hospital discharge. Of those, eight patients died during the 12-month follow-up period leaving 52 patients for the 12-month telephone interview. A total of 26 patients responded (21 patients and five proxies) with a response rate of 50%. The majority of non-responders were lost to follow-up (n=20), three refused to participate, and three were not appropriate for the 12-month follow-up. There was no significant differences in the baseline and arrest characteristics of responders and non-responders (Table S2).

The long-term functional recovery and HRQoL outcomes are shown in Table 3. At 12-month, 13 (50%) respondents reported good functional recovery, nine (35%) reported moderate functional recovery, and four (15%) reported severe disabilities. The median SF-12 mental and physical component scores were 52.5 (IQR 39.0, 57.0) and 41.5 (IQR 28.0, 57.0), respectively. When compared to the Australian norm, the mental component score did not differ (SMD -0.63; 95% CI: -1.35 to 0.09), however; the physical component score differed significantly (SMD -1.04; 95% CI: -1.76 to -0.32). The median EQ-5D index score was 0.85 (IQR 0.59, 1), and median VAS was 70 (IQR 50, 80). Fig. 3 shows the proportion of 12 month

survivors reporting problems across the five EQ-5D health domains. Few responders indicated that they have severe problems with mobility (n=1), activity (n=3), pain (n=5), or anxiety/depression (n=4).

Discussion

The findings from this study show that the incidence of OHCA due to suspected drug overdose in Victoria, Australia, remained unchanged over an 18-year period. Unadjusted survival rates improved substantially over time, with a three-fold increase in survival to hospital discharge between 2000 and 2017. Of the survivors to hospital discharge, 87% were alive at 12-months post-arrest. Among the patients who responded to the 12-month follow-up, 50% reported good functional recovery (GOSE \geq 7). Although the majority of patients reported good HRQoL according to the EQ-5D, the proportion of survivors who reported some or severe problems with mobility, self-care, activity, pain and anxiety/depression ranges between 15% and 48%.

National figures from Australia show that drug-related deaths have increased over the last two decades, driven largely by heroin overdose in the late 1990s and pharmaceutical overdose involving codeine, oxycodone and fentanyl since 2001.^{23,24} However, our findings show

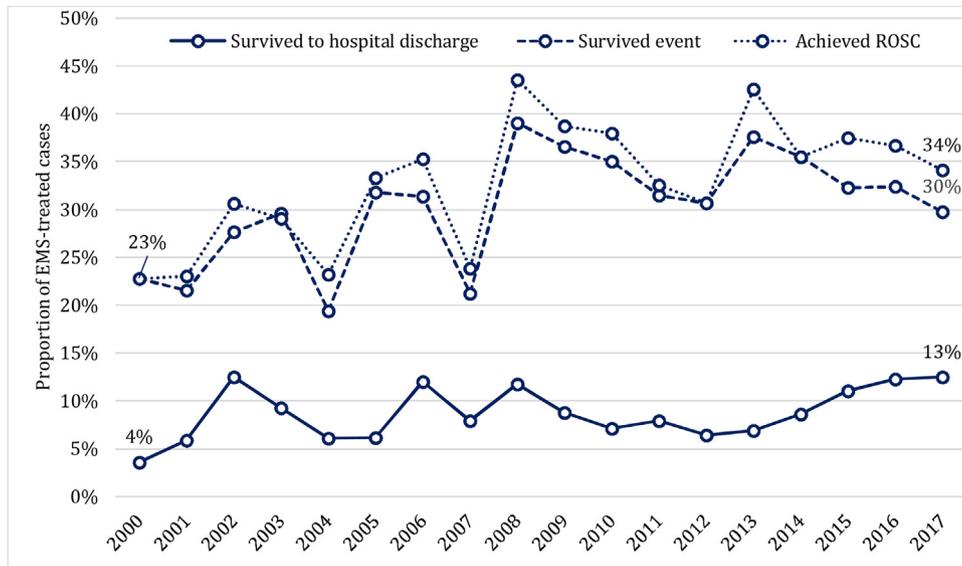


Fig. 2 – Long-term trends in the proportion of patients surviving to hospital discharge, surviving the event, and achieving prehospital ROSC.

that the incidence of drug overdose OHCA remained unchanged since 2000. The reduction in the incidence of drug overdose OHCA between 2000 and 2001 in our study could be explained by the national reduction in heroin supply between 1999 and 2001.²⁵ A number of other factors may also explain differences in the long-term incidence of drug-related deaths and drug-related OHCA. For instance, national mortality figures include data from in-hospital and out-of-hospital settings, include deaths of overseas citizens, and the cause of

death in these figures is mostly determined by a medical practitioner or a coroner.^{23,24} Our study is limited to drug overdose OHCA, and the cause of cardiac arrest is presumed for all OHCA as autopsy findings are not routinely collected by the registry. It is possible that cases without clear evidence of drug-use could be misclassified (particularly pharmaceutical overdoses, which may be more difficult to identify in the field). For example, an autopsy study from San Francisco, United States, found that 14% of OHCA of presumed cardiac aetiology were in fact precipitated by drug overdose.²⁶

Our study suggests that survival outcomes improved substantially over time. The increased rate of EMS witnessed arrests and an increase in the proportion of patients presenting with initial PEA may have contributed to this improvement. A study from British Columbia, Canada showed that EMS witnessed arrests increased significantly over a 10-year period and this was associated with improved survival to hospital discharge.²⁷ Additionally, a 26-year study from the Swedish OHCA registry showed that the proportion of initial PEA doubled between 1990 and 2016, and this led to a five-fold increase in 30-day survival.²⁸ An increase in both initial PEA and EMS witnessed arrests may indicate that bystanders are acting sooner to activate EMS following a drug-related event. Evidence from Victoria, Australia and elsewhere suggests that overdose response training programs enabled drug users and/or their peers to recognise drug-related events and activate EMS early.^{29,30}

Although bystander CPR is a strong predictor of survival from OHCA,^{2–4} it was not associated with improved survival to hospital discharge in our study population. The low rate of initial shockable rhythms in our cohort (6%) may have attenuated the impact of bystander CPR in our population. A number of studies demonstrated that the benefit of bystander CPR is diminished when the initial arrest rhythm is non-shockable.^{31,32} However, there is evidence that the benefit of bystander CPR extends beyond short-term survival.^{33,34} A national study from Denmark found that OHCA survivors who received bystander CPR were at lower risk of anoxic brain injury at one-year compared to those who did not.³³ Additionally, the effect of bystander CPR on five-year survival was 26% higher than the effect of bystander CPR on survival to hospital discharge in a

Table 2 – Adjusted odds ratio (95% CI) for survival to hospital discharge.

| Predictors | OR (95% CI) | p-Value |
|--------------------------|---------------------|---------|
| Age | 0.97 (0.95, 0.99) | 0.002 |
| Male gender | 0.86 (0.55, 1.34) | 0.516 |
| Witnessed arrest | | |
| Not witnessed | Reference | |
| Public witnessed | 2.95 (1.77, 4.94) | <0.001 |
| EMS witnessed | 4.32 (2.20, 8.46) | <0.001 |
| Initial monitored rhythm | | |
| Asystole | Reference | |
| VF/VT | 10.08 (5.01, 20.29) | <0.001 |
| PEA | 9.00 (5.51, 14.67) | <0.001 |
| Location of arrest | | |
| Private residence | Reference | |
| Public location | 0.92 (0.52, 1.58) | 0.756 |
| Other | 1.08 (0.37, 3.10) | 0.883 |
| Bystander CPR | 0.67 (0.41, 1.11) | 0.128 |
| Intubation attempted | 1.91 (1.04, 3.49) | 0.036 |
| Epinephrine | 0.39 (0.22, 0.70) | 0.002 |
| Sodium bicarbonate | 0.16 (0.08, 0.31) | <0.001 |
| EMS response time | 0.98 (0.96, 1.01) | 0.265 |
| Year | 1.02 (0.98, 1.07) | 0.244 |

Abbreviations: OR, odds ratio; VF/VT, ventricular fibrillation/ventricular tachycardia; PEA, pulseless electrical activity; CPR, cardiopulmonary resuscitation; EMS, emergency medical services.

Table 3 – 12-month outcomes according to GOSE, SF-12 and EQ-5D.

| 12-month outcomes | Overall | Patients (n=21) | Proxy (n=5) |
|-----------------------------------|-------------------|-------------------|-------------------|
| GOSE, n (%) | | | |
| Upper good recovery | 7 (26.9) | 6 (85.7) | 1 (14.3) |
| Lower good recovery | 6 (23.1) | 6 (100) | 0 |
| Upper moderate recovery | 4 (15.4) | 3 (75) | 1 (25) |
| Lower moderate recovery | 5 (19.2) | 4 (80) | 1 (20) |
| Upper severe disability | 0 | 0 | 0 |
| Lower severe disability | 4 (15.4) | 2 (50) | 2 (50) |
| Vegetative state | 0 | 0 | 0 |
| SF-12 ^a , median (IQR) | | | |
| Mental Component Score | 52.5 (39.0, 57.0) | 52.5 (39.0, 57.0) | – |
| Physical Component Score | 41.5 (28.0, 57.0) | 41.5 (28.0, 57.0) | – |
| EQ-5D, median (IQR) | | | |
| Index score ^b | 0.85 (0.59, 1.0) | 0.84 (0.64, 1.0) | 0.76 (0.41, 0.85) |
| VAS ^c | 70.0 (50.0, 80.0) | 70 (50.0, 80.0) | 67.5 (50.0, 82.5) |

Abbreviations: GOSE, Glasgow Outcome Scale Extended; SF-12, Twelve-item short form health survey; IQR, interquartile range; EQ-5D, EuroQoL-5-3L Dimension, VAS, visual analogue scale.

^a Includes patient responders only with three missing values.

^b One missing value.

^c Four missing values.

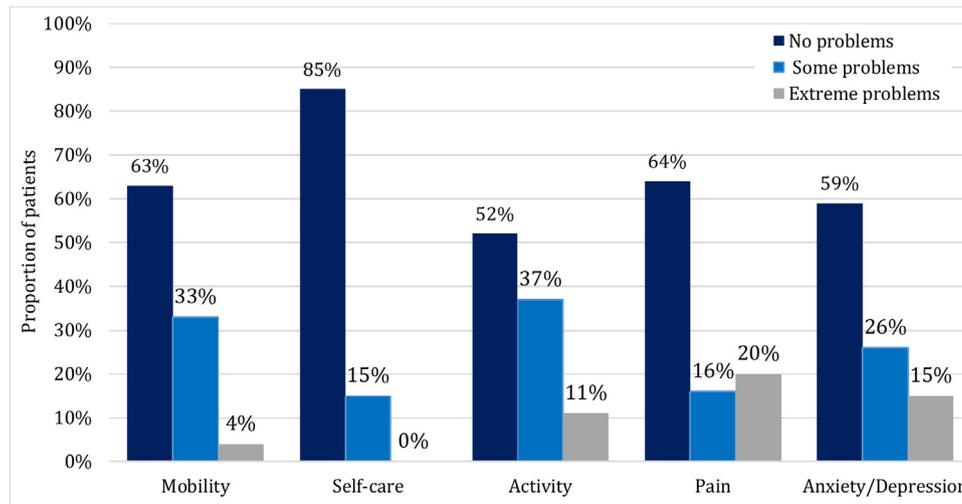


Fig. 3 – The proportion of 12 month survivors reporting problems across the five EQ-5D health domains (n = 26).

group of OHCA survivors from King County, United States.³⁴ Unfortunately, the impact of arrest factors were assessed at single point in time in our study, and we were unable to assess its impact on longer-term patient outcomes.

The majority of patients who survived to hospital discharge were alive at 12-month post-arrest (87%), and the majority of 12-month survivors reported good HRQoL outcomes. Our findings are similar to a previous study examining the functional outcome and HRQoL of 12-month survivors of OHCA, which showed that 92% survived to 12 months and 56% reported good functional recovery according to the GOSE.¹⁵ However, the majority of the population in this study involved OHCA of presumed cardiac aetiology, and to date no studies have reported the long-term outcomes of survivors of OHCA precipitated by drug overdose.⁹

A number of opportunities exist to reduce the incidence of drug-related events and improve survival. As recognition of OHCA remains the main barrier to activating EMS and initiating CPR and

defibrillation,³⁵ medically-supervised facilities could offer a safe environment for drug users without the concern of legal prosecution. In a recent systematic review, supervised injecting facilities were associated with a 35% reduction in mortality among drug users.³⁶ In addition, overdose response training programs could empower at risk populations to recognise the signs of drug overdose OHCA and respond appropriately by activating EMS and initiating CPR. Moreover, dispatcher-assisted CPR protocols could also help to increase bystander CPR in this population. Studies from Korea and the United States found that telephone-assisted CPR was associated with increased bystander CPR and improved survival in OHCA patients.^{37,38}

Limitations

Our study has a number of limitations. First, our study is retrospective in nature and carries inherent limitations in its study design. Second, the

VACAR does not record information relating to the type of drug involved in OHCA events. Due to the nature of these events, it is possible that the drug/s involved in the incident were unknown to paramedics at the time of assessment. It is also possible that cases of drug overdose OHCA were misclassified by paramedics, either due to misinformation from bystander or the presence of drugs/alcohol on scene which may be independent of the cause of arrest. Third, due to the low response rate among survivors at 12-month follow-up, it is possible that non-responders experienced poorer functional outcomes and HRQoL and this would bias our findings. Fourth, despite our adjustment for key confounding variables, unmeasured confounding from patient comorbidity and post-cardiac arrest care may also influence survival outcomes. Finally, due the small sample of survivors, we were unable to assess HRQoL outcomes over time, or in multivariable models.

Conclusion

In our region, the incidence of drug overdose OHCA remained unchanged over an 18-year period. Despite this, the unadjusted rate of survival to hospital discharge improved over time and were mainly explained by an increase in EMS witnessed arrests and patients presenting with initial PEA. The majority of survivors who responded to the 12-month follow-up, reported good functional recovery and HRQoL. Opportunities to prevent the incidence of drug overdose OHCA and improve survival include supervised injecting facilities, overdose response training programs, and telephone-assisted CPR.

Conflict of interest

No conflict of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.resuscitation.2019.08.036>.

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