Ambulance Victoria

Victorian Ambulance Cardiac Arrest Registry

2017-2018 Annual Report

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The VACAR Annual Report 2017-2018 is a publication produced by the Centre for Research & Evaluation, Ambulance Victoria.

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This publication has been produced to provide Ambulance Victoria stakeholders with an overview of out-of-hospital cardiac arrest epidemiology and outcomes in the state of Victoria. The views contained in this document are not necessarily those of Ambulance Victoria, the State Government of Victoria or any Government departments.

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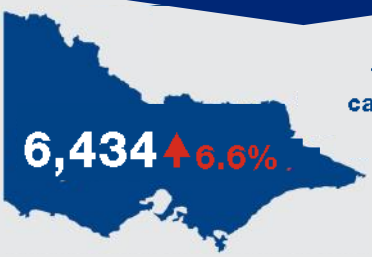
Contents

DEMOGRAPHICS

THIS YEAR WE TREATED MORE CARDIAC ARREST PATIENTS THAN EVER BEFORE



We attended 6,434 cardiac arrest patients across Victoria—the most cardiac arrest cases ever

66% MALE 65 years

34% FEMALE 72 years

75% of cases occurred in private residences

14% in a public place
9% in aged care facilities
1% in medical facilities

RESPONSE

MORE CARDIAC ARREST PATIENTS ARE RECEIVING THE CARE THEY NEED, QUICKER

95% of bystanders correctly directed their call for help to Triple Zero (000) ambulance

87% OF CARDIAC ARRESTS were correctly identified by ESTA Triple Zero (000) call takers

We recorded our **FASTEST EVER** response time

Patients were defibrillated in **under 10 minutes** consistent with recent years

BYSTANDER INVOLVEMENT

MORE OF THE COMMUNITY ARE STEPPING IN TO HELP CARDIAC ARREST EMERGENCIES

Bystander CPR has **Increased** in the past decade from 26% to 37%

Patients who received bystander CPR had a higher survival rate (12%) compared with those with no bystander CPR (4%)

Public AED usage has doubled in the past decade

82 patients were defibrillated by a publically accessible defibrillator - compared to 80 last year

POST CARDIAC ARREST OUTCOMES

CARDIAC ARREST PATIENTS ARE RETURNING HOME TO THEIR FAMILIES

371 patients were discharged alive from hospital

WE RECORDED OUR **EQUAL HIGHEST EVER** UTSTEIN SURVIVAL RATE

85% of survivors were able to return home to their families

of patients were able to return to work (if working prior)

Survivors were recorded to be as happy as the average Australian population (age matched)

VACAR data has been used to inform a large research program to improve patient care, including 14 new research papers

Work mates & ESTA save a life

When Scott Dunn returned to work after a long weekend away in Echuca with his wife Karen, he couldn't imagine that his first day back would be so eventful. Within minutes of being back, Scott's colleagues were working to save his life.

Tuesday, March 13 was like any other day for 51-year-old Scott, but after parking his car and beginning his walk into work at a tiling factory in Dandenong South, he suffered a sudden cardiac arrest and collapsed.

There had been no chest pain, no pre-existing medical condition and no warning signs.

Luckily for Scott, his colleague Peter had witnessed him collapse and immediately rushed to his aid.

While Peter commenced CPR, another colleague called Triple Zero (000) and began to relay ESTA call taker Jennifer's instructions. Meanwhile, a third colleague rushed to retrieve the worksite defibrillator.

Together, they delivered three shocks to Scott's heart in the minutes before paramedics and CFA fire fighters arrived as part of the Emergency Medical Response program.

As CFA members took over performing CPR from Peter, the Advanced Life Support and MICA paramedics were able to provide advanced care including the injection of an intraosseous needle, the administering of adrenaline, and the performing of manual ventilation. They continued to perform CPR during transport to hospital after Scott suddenly rearrested.

Seven days later, Scott awoke in the ICU of Monash Medical Centre surrounded by family, friends and doctors.

"I couldn't remember a single thing," Scott said.

"I saw no white light or anything, it's like I just went to sleep."

Meanwhile, Karen had been told that Scott was unlikely to survive after his first night in hospital. She had called their sons, Josh and Jesse, who had both flown in from interstate to say goodbye.

In telling his story, Scott becomes emotional. He explains that in almost three years of working with Peter, they had shared less than a day's worth of time together and not many conversations.

"You never know who will step in to help in these situations," Scott said.

"I don't know how to thank him. How do you tell someone 'thank you for not giving up on me'?"


PARAMEDIC

Introduction

Out-of-hospital cardiac arrest (OHCA) remains a significant public health issue in Victoria. Across the nation every year, as many as 30,000 OHCAs occur. Typically, less than 10% of arrest patients survive. However, when cardiopulmonary resuscitation (CPR) and defibrillation are provided quickly, alongside an effective system of care, the chances of an arrest patient being resuscitated and having a good neurological recovery greatly increases.

In order to improve systems of care and patient outcomes, it is essential to monitor performance, identify problems and successes and track progress. This can be achieved through a registry where all patients are enrolled to create a complete patient population. A registry can drive a quality agenda. It also fosters a culture of excellence in performance. A review commissioned by the Australian Commission on Safety and Quality in Health Care (ACSQHC) has also demonstrated the economic value of clinical quality registries to the health system (ACSQHC, 2016). In addition, the 'Strengthening Safety Statistics' report released by the Grattan Institute in 2017, emphasised the importance of health services having usable and useful safety data to drive improvements in patient safety (Duckett 2017). VACAR was one of the few clinical quality registries in the report to receive the highest possible score across all four domains used by the report to assess the robustness of clinical quality registries in Australia.

Ambulance paramedics and first responders, often with bystanders, comprise the front line in resuscitation following an OHCA event. As such, measuring the response, treatment and outcomes of OHCA patients is an essential component of an ambulance quality of care agenda. Ambulance Victoria uses VACAR data extensively to assess the quality of care of OHCA patients, identify areas for improvement and provide information and education to clinicians to drive change. The registry is also used to inform operational planning with respect to allocation and location of resources (eg prioritisation of the location of Public Access Defibrillation sites, fire first responder branches and areas to target for bystander awareness and training initiatives).

We are using our knowledge to develop a Cardiac Arrest Improvement Plan aligned with the Global Resuscitation Alliance's '10 Steps to Improve Cardiac Arrest Outcomes'. Key initiatives that we are rolling out in 2018-2019 include the introduction of a 'high performance' CPR training package to all paramedics, which focuses on a pit crew approach to resuscitation and emphasises the importance of minimal interruptions to chest compressions. To facilitate this and to support active review of resuscitation cases, we will also be introducing special defibrillation pads, which collect vital data on the quality of chest compressions performed by paramedics. This data will be linked to VACAR to further inform improvements in care.

Importantly we have also rolled out the GoodSAM app this year, which alerts trusted responders to potential cardiac arrests in their vicinity allowing them to respond and start life-saving CPR. The app also alerts of a nearby available defibrillator if one exists. Defibrillation by the public produces the best patient outcomes and this year was no different with an astounding 64% of patients defibrillated by the public leaving hospital alive. We strongly encourage all health professions to download the app and become a first responder for their community!

The Victorian Ambulance Cardiac Arrest Registry (VACAR) has been collecting data on cardiac arrest patients attended by ambulance in Victoria since 1999 and is one of the most comprehensive OHCA registries in the world. On behalf of Ambulance Victoria, we are very pleased to present the 2017-2018 VACAR Annual Report.

Professor Karen Smith
Director, Centre for Research and Evaluation
Ambulance Victoria

Professor Stephen Bernard
Medical Director
Ambulance Victoria

List of Tables

List of Figures


AMBULANCE

The Emergency Medical Service

The state of Victoria, Australia has an estimated population of 6.3 million, with over 4.8 million living in the state's capital city of Melbourne. Fifteen per cent of the population are aged over 65 years. The emergency medical service (EMS) comprises ambulance paramedics who have some advanced life support skills (e.g. laryngeal mask airway, intravenous epinephrine) and MICA paramedics who are authorised to perform endotracheal intubation, rapid sequence induction, Pneumocath® insertion and administer a wider range of medications.

Paramedics in Victoria have a base qualification of a three year bachelor degree in emergency health sciences or Paramedicine. MICA paramedics are experienced paramedics who undergo a university-level post graduate diploma in Intensive Care Paramedic Practice.

Australia operates a single national telephone number for community access to emergency services (i.e. '000'). Telephone triage of emergency calls in Victoria is performed using the Medical Priority Dispatch System. Unless circumstances suggest ventilations first (e.g. drowning), suspected cardiac arrest events identified in-call receive further call-taker instruction recommending 600 chest compressions, before two mouth-to-mouth breaths, and a subsequent ratio of 100 compressions to two breaths until professional help can take over.

Advanced Life Support and MICA paramedics are dispatched concurrently to suspected cardiac arrest events in the community. A first responder program for early defibrillation by fire-fighters operates for cardiac arrest patients in greater Melbourne and a number of large regional towns (82 fire station branches). In addition, AV co-responds with 30 volunteer community teams in smaller, predominately rural communities across the state.

The AV cardiac arrest protocols follow the recommendations of the Australian Resuscitation Council. AV paramedics are not obliged to commence resuscitation when the clinical presentation is inconsistent with life. Paramedics may discontinue resuscitation if advanced life support has been performed for 30-45 minutes without return of spontaneous circulation (ROSC), the rhythm is not Ventricular Fibrillation (VF) or pulseless Ventricular Tachycardia (VT), there are no signs of life, no gasps or evidence of pupillary reaction and no evidence of hypothermia or drug overdose.

AV also maintains a registry of public automated external defibrillators (AEDs) throughout Victoria (http://registermyaed.ambulance.vic.gov.au). As at August 2018, there were over 4,500 AEDs in the AV AED Registry. During a '000' call, the emergency call taker may identify an AED close to the event which is available for use. The public are encouraged to contact the registry and ascertain if their AED, or one that they have become aware of, is registered with up to date information.

Victorian Ambulance Cardiac Arrest Registry

The Victorian Ambulance Cardiac Arrest Registry (VACAR) was established in 1999 and represents an internationally recognised standard of OHCA monitoring and reporting. The VACAR is managed by AV, the sole EMS provider in Victoria, Australia and is overseen by a multidisciplinary Steering Committee, chaired by Professor Karen Smith (Director, Centre for Research and Evaluation, Ambulance Victoria).

The VACAR is a clinical quality assurance initiative, incorporating both prehospital clinical and operational data and hospital follow -up data from all OHCA events in Victoria where AV are in attendance. The VACAR collects data from Communication Centre dispatch records, EMS patient care records, hospital medical records and from a telephone interview of adult survivors 12 months post cardiac arrest (commenced January 2010). Hospital outcome data is supplemented by death records from the Victorian Registry of Births, Deaths and Marriages.

Data for all cardiac arrest patients attended by AV since October 1999 has been successfully captured for over 95,000 patients. The data is collated in the registry based on an internationally agreed template. The integrity and reputation of the registry relies on complete and accurate data collection, including hospital discharge data.

The VACAR provides essential information for the assessment of EMS performance in relation to the treatment and outcomes of OHCA patients. In particular, a number of key clinical indicators have been implemented, which are designed to measure the quality of care and allow for the benchmarking of EMS performance. These clinical indicators include ambulance response times, event survival and survival to hospital discharge.

The VACAR is also used to measure the impact of ambulance programs such as the fire-fighter Emergency Medical Response Program, Four Steps to Life Plus CPR training and Public Access Defibrillation (for more information, see www.ambulance.vic.gov.au). In addition, the VACAR has successfully established an internationally recognised research program, with the publication of scientific literature in key medical journals (see 2017-2018 Peer-reviewed Publications, page 51). The results of the research program are used to provide an evidence base for AV treatment of cardiac arrest patients.

In 2010, VACAR expanded its methodology to become one of few registries globally that routinely captures the quality of life of adult survivors of OHCA. A structured telephone interview with adults 12 months following the event is conducted using previously validated quality of life assessment tools. This initiative ensures that the VACAR provides a robust framework for the measurement of immediate, early and long term quality clinical outcomes following OHCA in Victoria.

The VACAR contributes to the Australian Resuscitation Outcomes Consortium (Aus-ROC) Epistry, which is an Australian and New Zealand OHCA epidemiologic registry (Beck 2016). The VACAR contributes the highest number of cases to the Epistry. The Aus-ROC Epistry was established with the aim of understanding regional, ambulance service and treatment factors associated with improved OHCA survival and outcomes. The Epistry will enable benchmarking across providers and identification of system-wide strategies associated with survival for OHCA patients in Australia and New Zealand.


PARAMEDIC
MICA
PARAMEDIC

How does VACAR operate?

Eligibility

The VACAR captures data on all OHCA patients where EMS are in attendance. For the purposes of this report, EMS is defined as AV and participating first responder organisations (see Table 1). The VACAR defines the state of cardiac arrest as the cessation of cardiac mechanical activity as confirmed by absence of signs of circulation, including the absence of a detectable carotid pulse, unresponsiveness and apnoea or agonal breathing. Patients eligible for inclusion in or exclusion from the VACAR are described below (see Tables 2 and 3).

Data capture

The registry is based on the internationally recognised Utstein template and definitions (Perkins 2015). Ambulance Victoria's in-field recording of patient data is performed electronically using VACIS©, an electronic data capture system. All electronic patient care records (PCR) are synchronised daily with organisational databases, providing an effective medium of clinical and administrative data capture. To ensure the capture of all OHCA events attended by AV, a broad electronic search is conducted of clinical databases utilising specific search criteria. This search strategy is focused at identifying potential cardiac arrest cases, which may be eligible for review. Paper PCRs may be used in cases where in-field electronic data capture is not possible. In these instances, paramedic team managers are required to forward all potential cardiac arrest cases to VACAR for review. A hand search of all paper PCRs forwarded to the AV Accounts department is performed periodically to ensure complete case capture.

Following review of potential cases, eligible cardiac arrest cases are entered into the VACAR database, with PCR data being supplemented by information from communication centre dispatch records. The VACAR participating hospitals (i.e. ethics approved participation) are contacted for survival status and patient discharge direction. A cross-match of VACAR records with the Victorian Registry of Births, Deaths and Marriages is undertaken for verification of deaths. Structured telephone interviews are conducted 12 months post cardiac arrest for adult patients identified as having survived to hospital discharge. The interview questionnaires used include: the Extended Glasgow Outcome Scale (GOS-E), 12-item Short Form (SF -12) health survey and EuroQol 5 Dimension (EQ-5D) questionnaires.

Table 1: Participating first responders dispatched to cardiac arrest events in Victoria.

1. Metropolitan Fire Brigade
2. Country Fire Authority (selected areas)
3. Community Emergency Response Teams

Table 2: VACAR inclusion criteria (all of the following).

1. Patients of all ages who suffer a documented cardiac arrest.
2. Occurs in the state of Victoria where Ambulance Victoria is the primary care giver. Cardiac arrests occurring in the neighbouring states of New South Wales and South Australia are considered for inclusion where Ambulance Victoria is clearly documented as the primary care giver.
3. Patients who are pulseless on arrival of EMS; OR Patients who become pulseless in the presence of EMS (EMS witnessed arrests); OR Patients who have a pulse on arrival of EMS, where a successful attempt at defibrillation was undertaken by a bystander prior to arrival of EMS.

Table 3: VACAR exclusion criteria (any of the following).

1. Patients who suffer a cardiac arrest in a hospital facility, where Ambulance Victoria may be in attendance but are not the primary
2. Brief episodes of pulselessness which do not receive cardiopulmonary resuscitation or defibrillation by EMS.
3. Bystander suspected a cardiac arrest, where the patient is not in cardiac arrest on arrival of EMS, or no defibrillation prior to arrival, or no other evidence verifying a cardiac arrest state is present.

Data quality

The VACAR undergoes rigorous data quality control to ensure the accuracy of data collected. During data entry, automated validation rules and error messages are embedded into the VACAR database to capture erroneous values or sequences. Quality control audits are conducted monthly on a random sample of 10% of cases to validate the accuracy of data coding by the VACAR research team. Verification of data entry undergoes routine audit to identify inconsistencies with data coding. Trend analysis is performed on a quarterly basis to ensure consistency of case numbers, patient outcomes and response times. VACAR has undergone two independent external audits over the last decade, including an audit by the Victorian Auditor-General's Office. Cardiac arrest cases also undergo clinical auditing by senior paramedics. All cases where a patient requires defibrillation or where a death occurs in AV care undergo audit.

The data in the registry is subject to ongoing audit and quality control, with any necessary changes being incorporated back into the registry as needed. Quality assurance measures are conducted routinely, leading to improvements in the integrity of the data with time. As such, data presented in this report may differ slightly from previously published data. Previous years' data is subject to updates and is most current within this report. Data on survival to hospital discharge is also being continually updated and hence should be treated and interpreted with caution.

Ethical review

The registry maintains ethical review as a quality assurance initiative from the Human Research Ethics Committee of the Victorian Department of Health and Human Services. The VACAR is supported by almost 100 ethics approvals from Victorian hospitals for the access to medical records. This successful program has resulted in the capture of almost 99% of all out-of-hospital cardiac arrests transported to a Victorian emergency department.

In accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research, all paper and electronic data are securely stored at Ambulance Victoria, with access restricted to authorised VACAR staff.

Missing data

The value of VACAR relies on completeness of data capture. Missing data remains relatively low for all variables (see Table 4). Periodic quality control checks and data verification activities ensure the long-term validity of registry data.

Table 4: Number and proportion of missing data for select registry variables, 2017-2018 (n=6,434).

Patient age	68 (1%)
Patient sex	9 (0%)
Arrest location	7 (0%)
Witnessed status	94 (1%)
Bystander CPR	0 (0%)
Rhythm on arrival	21 (0%)
EMS response time	62 (1%)
Defibrillation time	31 (0%)
Outcome at scene	11 (0%)
Event survival	7 (0%)
Hospital discharge status	46 (1%)
Hospital discharge direction	3 (0%)

About this Report

The American Heart Association states that monitoring the treatment of out-of-hospital cardiac arrest by EMS agencies should be the sentinel measure of the quality of EMS care in our communities.

Despite recent advances in resuscitation and post-arrest treatment strategies for OHCA patients, survival to hospital discharge rates remain low (<10%) (Berdowski 2010). OHCA is a significant cause of disability and death in Australia, with a reported incidence of 100 events per 100,000 peoples (Beck 2017). Much of the burden associated with OHCA, sometimes referred to as sudden cardiac death, occurs before a patient reaches hospital, therefore EMS has a crucial role in reducing the burden of illness in our communities. The American Heart Association states that monitoring treatment of OHCA by EMS agencies should be a sentinel measure of the quality of EMS care in our communities (Nichol 2008).

This report describes data from the VACAR for all OHCA events attended by AV. The main focus of this report is to summarise data pertaining to adult and paediatric OHCA in Victoria within the most recent fiscal year, 1 July 2017 to 30 June 2018. Data for this report was extracted on 7 September 2018, with pending hospital follow-up remaining in a small proportion of events.

Analyses in this report are described across two predominant populations. The 'EMS attended' population is used for all cardiac arrest patients where AV is in attendance, regardless of whether emergency treatment is provided. The 'EMS treated' population specifically refers to patients who receive an attempted resuscitation by EMS, including eligible first responders. Our outcomes are defined by two major endpoints 'event survival' and 'survival to discharge'. These endpoints define patients with sustained return of spontaneous circulation on arrival at hospital and those discharged alive from hospital, respectively. All definitions used in this report have been described in detail on page 56.

Descriptive statistics in this report are presented as frequencies and proportions for categorical data and median and interquartile ranges for continuous variables. Comparisons of proportions were undertaken using the chi-square test. A logistic regression analysis was used to describe the risk-adjusted odds of survival to hospital discharge across years for different patient subgroups. These models were adjusted for known predictors of survival and are described in more detail in the report. Unless otherwise stated, all other statistical comparisons were unadjusted.

Analyses in this report contain Metropolitan and Rural comparisons. Geospatial mapping has been used to define regional boundaries according to the Victorian Government Department of Health and Human Services regions (according to the following website https://www2.health.vic.gov.au/about/publications/formsandtemplates/Department-of-Health-regional-boundaries-and-local-government-areas-map). The Melbourne metropolitan region is comprised of three geographical regions: North and West, Eastern and Southern regions. The rural region comprises five geographical regions: Barwon South Western, Grampians, Loddon Mallee, Hume and Gippsland. The major rural urban centre of Geelong falls within the Barwon South Western region. Ballarat and Bendigo, two other rural urban centres, fall within the Grampians and Loddon Mallee regions, respectively. AV may be dispatched to a small number of OHCA events in New South Wales and South Australia which occur close to the Victorian border; these cases are attributed to the nearest Victorian Department of Health and Human Services region. Any cases which occur off the coastline of Victoria are attributed to the nearest Victorian Department of Health and Human Services region.

Regional data for this report was sourced from the Regional Population Growth report (published 24 April 2018, Australian Bureau of Statistics (ABS)). The Victorian population up to the end of June 2017 was 6,323,606 persons (excluding unincorporated areas). Annual Victorian data by age was sourced from the Australian Demographic Statistics report (published 21 June 2018, ABS). This report also specifies the 2001 Australian Standard Population for use in age-standardisation.

Patients who suffer a cardiac arrest in the presence of paramedics represent a unique sub-group of patients. These patients differ considerably in survival factors (eg. time to defibrillation, presenting rhythm etc.). This may skew analyses. As such, data relating to paramedic or EMS witnessed OHCA have been analysed and depicted separately to those which are unwitnessed by paramedics in this report. Unless specifically stated, all analyses should be assumed to exclude EMS witnessed events.

Executive Summary

Over the last decade, rates of bystander CPR in the community have steadily risen and the odds of an out-of-hospital cardiac arrest patient surviving to hospital discharge has more than doubled.

1. Ambulance Victoria attended 6,434 OHCA events in the period between 1 July 2017 and 30 June 2018, with 98% involving adults. The proportion of all adult OHCA patients receiving emergency treatment by EMS was 48%; when excluding EMS witnessed arrests, 44% of adult EMS attended arrests received attempted resuscitation by EMS. The crude incidence of OHCA was higher in the rural region than in the metropolitan region: 134 versus 91 events per 100,000 population. The Gippsland region recorded the highest crude incidence rates of OHCA. The age adjusted state-wide incidence of OHCA in 2017-2018 was 90 events per 100,000 population; age-adjusted OHCA incidence in males was 117 events per 100,000 and in females was 68 events per 100,000 (see Incidence & Demographics, pages 21-27).

2. The demographic profile of patients in 2017-2018 was similar to those observed over the last decade. OHCA due to a presumed cardiac cause accounted for 73% of adult EMS attended patients. Sudden infant death syndrome (SIDS) was the leading cause of OHCA in paediatrics. Patients who arrested in a public location had significantly better survival outcomes than those who arrested in the home (see Incidence & Demographics, pages 28-35).

3. Most bystander calls for help following OHCA were appropriately directed to ambulance (95%). Emergency call-takers were effective at identifying cardiac arrest events during the emergency call; 87% of all EMS attended arrests and 91% of EMS attended arrests due to cardiac aetiology were correctly identified (see Chain of Survival, pages 28-35).

4. The median state-wide response time to EMS treated events in 2017-2018 was 7.6 minutes (90th percentile time, 15.1 minutes), consistent with the previous year. The median EMS response time to EMS treated patients in the metropolitan region (median 7.2 minutes, 90th percentile 11.8 minutes) was faster than the previous year. The median EMS response time to EMS treated patients in the rural regions (median 9.4 minutes; 90th percentile time 23.4 minutes) was faster than the previous year (see Chain of Survival, pages 28-35).

5. The rate of bystander CPR for bystander witnessed OHCA events in 2017-2018 remained high (63%), compared to 46% in 2008-2009. Also, the rate of bystander CPR amongst bystander witnessed OHCA patients receiving EMS attempted resuscitation in 2017-2018 remained high (76%). Use of public automated external defibrillators increased two-fold over the last decade for patients presenting in a shockable rhythm (see Chain of Survival, pages 28-35).

6. In 2017-2018, when an arrest was witnessed by a bystander, the proportion of patients who survived the event was higher than that observed for all OHCA events combined (37% vs 25%, respectively). Similarly, when an arrest was witnessed by a bystander, the proportion of patients who were discharged alive from hospital was higher than for all OHCA events combined (16% vs 9%, respectively) (see Chain of Survival, pages 28-35).

7. The state-wide rate of ROSC in adult EMS treated patients during 2017-2018 was 35%. The rate of event survival for all-cause adult OHCA in the EMS treated population during this period was 25%. Meanwhile, the rate of survival to hospital discharge was 9% and remained within recent observations (see Survival Outcomes, pages 36-43).

8. The rate of event survival for adult EMS treated patients presenting in a shockable rhythm was 52%, with 32% surviving to hospital discharge. This is consistent with recent observations. For adult EMS treated patients presenting in a shockable rhythm and witnessed to arrest by EMS, event survival and survival to hospital discharge were 79% and 64%, respectively. Adults presenting in asystole or pulseless electrical activity experienced the poorest survival outcomes, with 0.2% and 7% surviving to hospital discharge, respectively (see Survival Outcomes, pages 36-43).

9. The Utstein patient subgroup survival in Victoria was 37% in 2017-2018. Victorian patients have comparable discharged alive rates to a number of international agencies (see Survival Outcomes, pages 36-43). Survival for Melbourne was 41% which is a 3% improvement on the previous year.

10. The risk-adjusted odds of survival to hospital discharge have improved significantly over time. The odds of survival to hospital discharge for OHCA patients in 2017-2018 was more than two times higher than for OHCA patients in 2002-2003 (adjusted odds ratio 2.4, 95% CI 1.8-3.2, $p<0.001$). A significant improvement was also observed for patients who presented in a shockable rhythm over the same period (adjusted odds ratio 3.3, 95% CI 2.4-4.6, $p<0.001$) (see Survival Outcomes, pages 36-43).

11. Most OHCA patients with known survival to hospital discharge were discharged home (85% in 2017-2018). Phone interviews with adult survivors showed that most survivors maintained their independence and had a good quality of life 12 months after their arrest. Of those who had worked before their arrest, 71% had returned to work 12 months after their arrest (see Long-term Functional Outcomes, pages 44-47).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Incidence & Demographics

Incidence of all adult & paediatric events†

In 2017-2018, Ambulance Victoria attended 6,434 OHCA events, of which 6,352 (98%) were defined as adults aged greater than 15 years. This number of adult cases represents the highest number of annual events recorded in Victoria. The number of paediatric events attended by paramedics was lower than the previous year (82 cases in 2017-2018), and is within normal yearly fluctuations.

Of all adult OHCA events attended in 2017-2018, 48% received an emergency resuscitation attempt by paramedics and/or first-responders (includes EMS witnessed events; in the previous year, this was 46%). The rate of EMS attempted resuscitation for adult attended OHCA has risen over the last10 year period (42% in 2008-2009; 48% vs 42%, p=0.020).

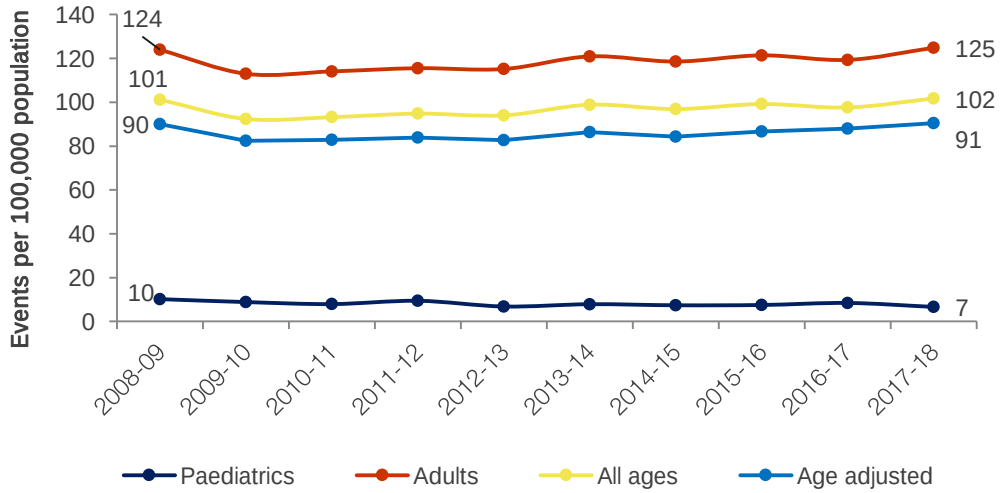


Figure 1: Crude incidence of all ages, adult and paediatric EMS attended OHCA in Victoria and age adjusted incidence rate of EMS attended events (includes EMS witnessed events).

The crude incidence of OHCA has remained consistent over the last decade. In 2017-2018, the unadjusted incidence of all OHCA in Victoria was 102 events per 100,000 population, similar to the rate of 101 events per 100,000 population observed in 2008-2009 (see Figure 1). However, age standardisation gives rise to an adjusted OHCA incidence rate of 91 events per 100,000 population during 2017-2018. Age standardisation is a technique for comparing populations where the age profiles are different. Age-adjusted rates are rates that would exist if the population in a given year had the same age distribution as the standard population. In this case we have used the age profile of the 2001 population as our standard population.

Age-adjusted incidence rates over the last 10 years have been relatively stable. The age adjusted OHCA incidence rates for males and females during 2017-2018 was 117 events and 68 events per 100,000 population, respectively.

The incidence of adult and paediatric events also remained within recent observations; 125 and 7 events per 100,000 population in 2017-2018, respectively. While variation in OHCA incidence across continents and regions are well established, these figures are within previously reported incidence rates.

Lack of bystander witnesses and prolonged downtime are the major reasons for EMS withholding resuscitation efforts in adult patients. The crude incidence of adult EMS treated events was 60 events per 100,000 population.

In paediatric patients, the proportion of EMS treated events is higher than in adults. Most paediatric patients (79%) received an attempted resuscitation by EMS during 2017-2018 (includes EMS witnessed events; in the previous year, this was 75%). The rate of EMS attempted resuscitation for paediatric events over the last 10 years has been quite variable; this rate was 70% in 2008-2009. The crude incidence of paediatric EMS treated events was seven events per 100,000 population.

† All results in this section include EMS witnessed events.

In 2017-2018, Ambulance Victoria attended 6,352 adult OHCA events, the highest number of events recorded. The rate of attempted resuscitation by EMS was 48%.

Incidence across regions of Victoria†

In 2017-2018, the highest number of OHCA events for the last 10 years was observed for the metropolitan regions of Victoria: Eastern Metropolitan, North and Western Metropolitan and Southern Metropolitan (4,366 cases, representing 68% of the total number of events attended by AV). Similarly, the highest number of events for the last decade were observed in rural Victoria in 2017-2018 (2,068 events, a 15% increase since 2008-2009).

Despite the increased proportion of events occurring in the metropolitan region, the crude incidence of OHCA was significantly higher in the rural region (134 vs. 91 events per 100,000 population, p<0.001) (see Figure 2).

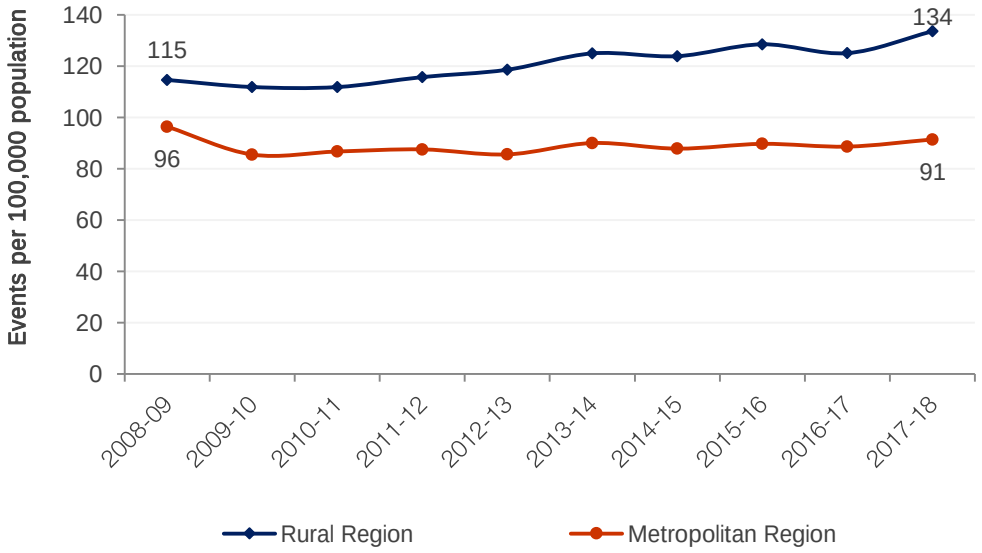


Figure 2: Yearly crude incidence of EMS attended events across metropolitan and rural regions of Victoria (includes EMS witnessed events).

The crude incidence of OHCA has increased over the last 10 years in rural Victoria, rising from 115 events in 2008-2009 to 134 events per 100,000 population in 2017-2018. As noted previously, this observation may reflect better case capture since the 2008-2009 period, which coincided with the completion of the roll-out of VACIS in the rural area. Unadjusted incidence in the metropolitan region has remained relatively unchanged during the same period. Figure 1 shows state-wide age-adjusted incidence of OHCA has remained stable.

There is regional variability in OHCA incidence across Department of Health and Human Services regions (see Figure 3). The lowest crude incidence during 2017-2018 was observed in the Eastern Metropolitan region (87 events per 100,000 population) and the highest incidence in the Gippsland region (153 events per 100,000 population). The North and West Metropolitan region, which includes the Melbourne Business District, had a total of 1,949 OHCA.

The proportion of events receiving an attempted resuscitation by EMS varies considerably across regions. The highest proportion of EMS treated events during 2017-2018 occurred in the North and West Metropolitan region (52%) and the lowest in the Grampians region (39%).

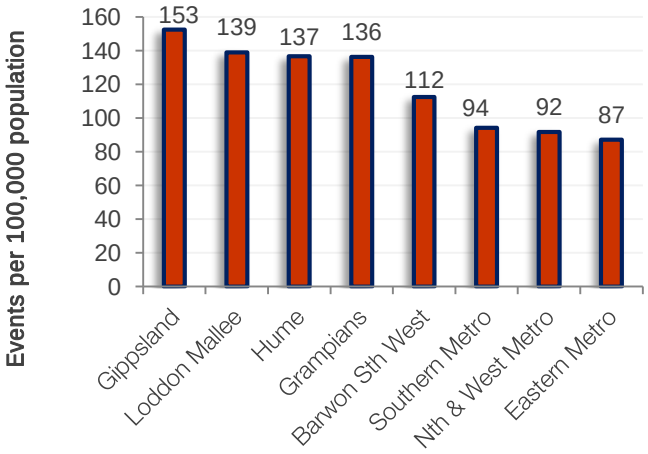


Figure 3: Crude incidence of EMS attended events across Department of Health and Human Services regions, 2017-2018.

† All results in this section include EMS witnessed events.

2017 Winter peak

OHCA usually follows a seasonal pattern with a higher incidence and lower survival rate during winter (Bagai 2013). However, during the 2017-2018 first quarter (July to September), which is primarily during winter, there was an unprecedented number of OHCAs in Victoria. Compared to 2016-2017 (n=1,668), there were 163 more OHCAs during the first quarter of 2017-2018 (n=1,831), and the highest number ever reported for a quarter in VACAR. The survival rate in the 2017-2018 first quarter (10%) was also the lowest quarterly survival rate recorded in VACAR since 2007. These findings may have been influenced by Victoria's deadliest flu season which took place during this period. Nationally, the 2017 influenza season was the largest since the 2009 pandemic year and deaths due to laboratory confirmed influenza were higher than any previous year (National Influenza Surveillance Committee 2017). The VACAR team are currently undertaking a review of the winter peak seen in OHCA incidence to better understand the trends of recent years.

Demographics of adults

The demographic profile of adult OHCA events (excluding EMS witnessed arrests) has been consistent over the last decade. In 2017-2018, EMS attended adult events were predominately male patients (66%). The median age of OHCA patients was 68 years. The age distribution varied significantly across the sexes (see Figure 4), with females having a higher median age of arrest (72 vs. 65 years, p<0.001). The proportion of cases witnessed to arrest by a bystander was 28% and the proportion occurring in a public location was 14%. Notably in 2017-2018, the proportion of adult patients receiving bystander CPR (36%), were almost a third higher than in 2008-2009 (25%) (p=0.010). In 2017-2018, 11% of adult OHCA patients presented in a shockable rhythm (VF or pulseless VT) to either EMS or a bystander who made use of an automated external defibrillator.

Paramedics attempted resuscitation in 44% of all EMS attended adult OHCA events. The demographic profile of patients receiving EMS attempted resuscitation varied significantly from the overall population, with more male patients (69%), a lower median age (66 years), more events occurring in a public location (19%), more events witnessed by a bystander (49%) and a high rate of bystander CPR (71%).

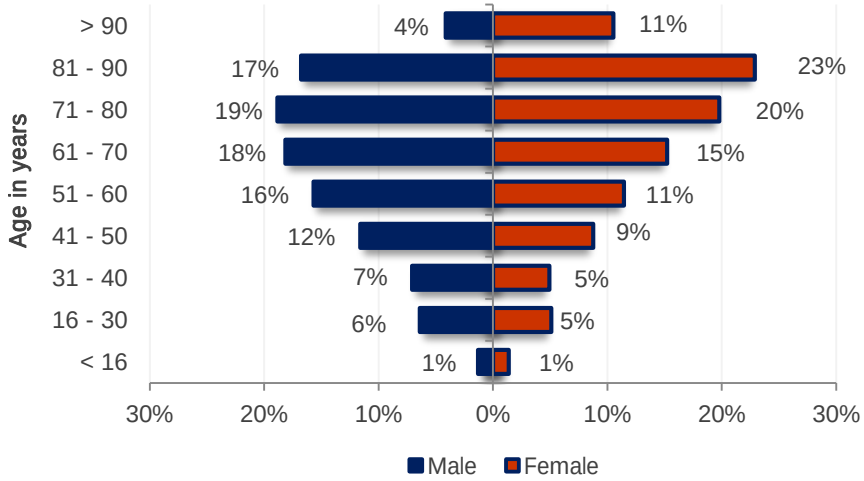


Figure 4: Age distribution of EMS attended OHCA events, 2017-2018.

Demographics of paediatrics

The frequency of EMS attended paediatric events (excluding EMS witnessed arrests) has remained relatively low over the last decade, with fewer than 100 events per year (77 in 2017-2018). The median age of arrest in 2017-2018 was twelve months, which is consistent with the past decade. The dominant precipitating factors in this population are described in a later section (see Figure 7, page 25).

The demographic profile of paediatric OHCA varies significantly across reporting years and is impacted by smaller samples sizes. In 2017-2018, EMS attended paediatric events were predominantly males (65%). Within the paediatric OHCA population, 12% of events during 2017-2018 occurred in a public location. Significantly more paediatric patients received bystander CPR than adult patients during 2017-2018 (69% vs. 36%, respectively; p<0.001).

The majority of paediatric patients during 2017-2018 presented to EMS in an asystolic rhythm (82%). In 2017-2018, no paediatric patients were defibrillated prior to the arrival of EMS with a public automated external defibrillator, compared to four patients in 2016-2017. The rate of EMS attempted resuscitation amongst paediatric patients during 2017-2018 remained high (78%). Significantly more paediatric cases received an attempted resuscitation by paramedics than adults during 2017-2018 (78% vs. 44%, respectively; p<0.001).

In 2017-2018, Ambulance Victoria attended 77 paediatric events. The median age was twelve months.

Precipitating events for adults

The precipitating causes of OHCA events are defined by paramedics and recorded directly from the patient care record. Unless the cause of arrest is clearly described (e.g. trauma, submersion, overdose/poisoning, hanging etc.), the aetiology of arrest is presumed to be of cardiac origin, as per Utstein definitions (Perkins 2015). In total, VACAR records 13 precipitating events for adults.

In 2017-2018, 73% of EMS attended adult OHCA were presumed to be of a cardiac cause. Other frequent causes of OHCA during 2017-2018 were: trauma (6%), terminal illness (6%), overdose/poisoning (5%), hanging (5%) and respiratory causes (3%), (see Figure 5).

For adult patients receiving an attempted resuscitation by EMS during 2017-2018, most cases were due to a presumed cardiac cause (76%).

The rate of EMS attempted resuscitation differed amongst patients according to the precipitating cause of the event. During 2017-2018, the rate of EMS attempted resuscitation for arrests due to presumed cardiac cases was 46%. Rates of EMS attempted resuscitation during 2017-2018 were lower for arrests due to trauma (35%), overdose/poisoning (42%), hangings (32%) and terminal illness (23%). In contrast, most OHCA events due to a respiratory cause received EMS attempted resuscitation (74%).

The precipitating event for arrests across age groups in the EMS attended population is presented in Figure 6. This graph highlights the relationship between arrest aetiology and patient age. Presumed cardiac cause was the predominant precipitating factor for most age groups: 36-50 years (58%), 51-75 years (79%) and >75 years age group (84%).

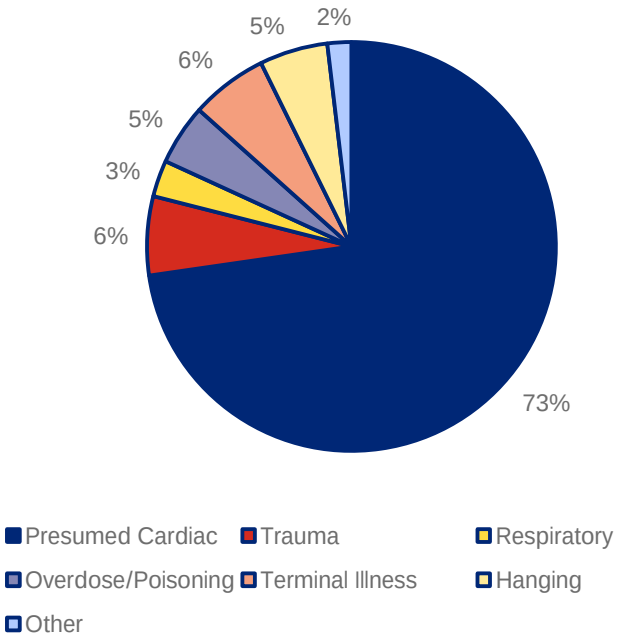


Figure 5: Adult precipitating events for EMS attended events, 2017-2018.

Meanwhile, in the 16-35 years age group during 2017-2018, the predominant precipitating factor was the combined causes of trauma and hanging (46%). In this young adult age group in 2017 -2018, presumed cardiac cause was the precipitating factor for 34% of OHCA events. There are few OHCA events due to overdose/poisoning or trauma and hanging in the older age group >75 years (<1% and 2%, respectively in 2017-2018).

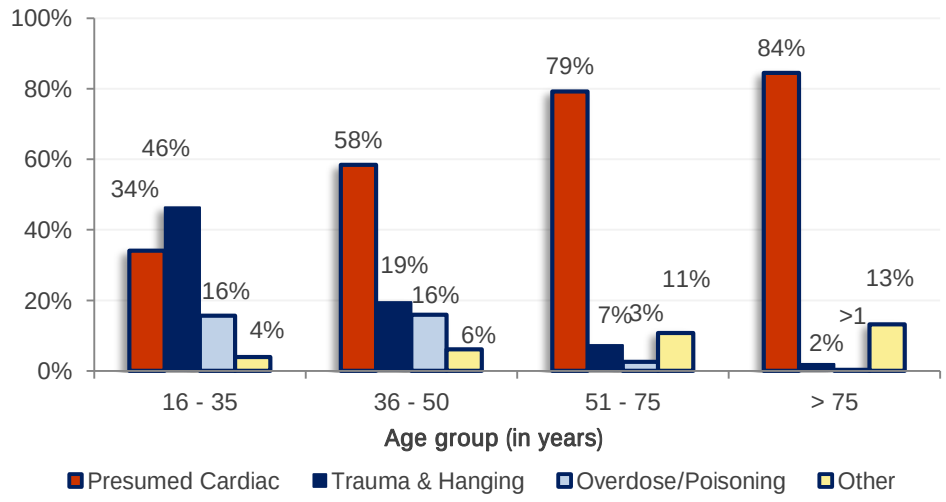


Figure 6: Adult precipitating events across age groups for EMS attended events, 2017-2018.

Presumed cardiac causes remain the most common precipitating event for adult OHCA events. In paediatric cases, sudden infant death syndrome remains the common cause.

Precipitating events for paediatrics

Precipitating events for paediatrics who suffer OHCA vary considerably in comparison to adults. In 2017-2018, 27% of EMS attended paediatric events were due to a presumed cardiac cause (see Figure 7). Sudden infant death syndrome (SIDS) is a dominant cause of paediatric OHCA (38% in 2017-2018). During 2017-2018, less common causes of paediatric OHCA include trauma (8%), respiratory causes (6%) , drowning (4%) and terminal illness (1%). Previous research by VACAR of paediatric OHCA events where trauma was the precipitating factor showed that resuscitation efforts were rarely effective and were associated with poor neurological outcome for the patient (Deasy 2012). The distribution of precipitating events in the EMS treated paediatric OHCA population mirrors the overall paediatric OHCA population data presented in Figure 7.

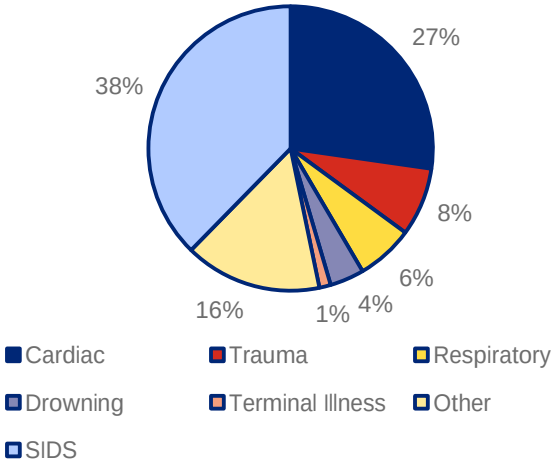


Figure 7: Paediatric precipitating events for EMS attended events, 2016-2017.

Mechanism of arrest in the traumatic sub-group*

Cardiac arrests secondary to major trauma are an important, potentially-preventable patient subgroup. During 2017-2018, arrests secondary to road trauma were responsible for 63% of events, while arrests following ballistic trauma and stabbings accounted for 14% and arrests following falls accounted for 10%, see Figure 8.

The following vehicles were the mode of transport associated with road trauma incidents during 2017-2018: a car or light vehicle (57%), train (18%), motorcycle (16%), truck (5%) and bicycle (2%). During 2017-2018, the role of the OHCA patient in these vehicles was as the vehicle driver (61%), pedestrian (30%) and passenger (9%).

*'Other trauma' refers to any of the following: chemical exposure, environmental exposure, fire/smoke exposure, sting/bite/envenomation, animal related injury, electrical contact, sporting injury, assaults (excluding shooting/stabbing), crush injury or trauma due to an unknown reason.

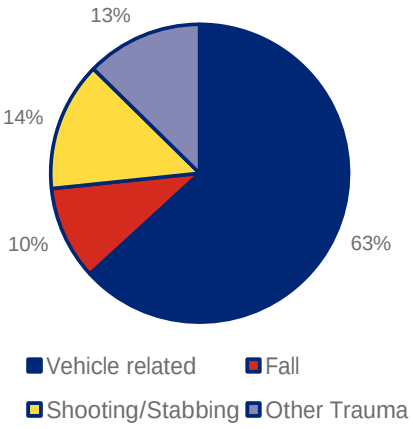


Figure 8: Sources of trauma in EMS attended traumatic OHCA sub-group, 2017-2018.


POLICE
PARAMEDIC
Linen

Arrest location for adults and paediatrics

The location of the OHCA has important implications on OHCA outcome. The VACAR records over 20 cardiac arrest locations, the most common of which are presented in Figures 9 and 10. Public places include places of work, streets or roads, shops, vehicles and sporting/recreational facilities. In 2017-2018, most (75%) EMS attended adult OHCA events occurred within a private residence. Other common arrest locations were a public place (14%) and aged care facility (9%) (see Figure 9).

Similar to EMS attended adult OHCA events, amongst adult patients who received an attempted resuscitation by EMS during 2017-2018, the most common site of an arrest was a private residence (68%), followed by arrests in a public place (20%) and aged care facility (10%). In comparison to arrests in the home, patients who arrested in public places were far more likely to be witnessed by a bystander and receive bystander CPR prior to EMS arrival (see Figure 10).

The presence of bystanders, witnessing the arrest and/or providing CPR, in public places has an important contribution on survival for adult events occurring in these locations (see Figure 10). In 2017-2018, the unadjusted rates of adult survival to hospital discharge were highest in medical facilities (31%) and public places (21%). Unadjusted adult survival to hospital discharge in a private residence (7%) and aged care facilities (2%) remained relatively low. Unadjusted adult survival to hospital discharge varied significantly between private residences and public places (7% vs. 21%, respectively; p<0.001).

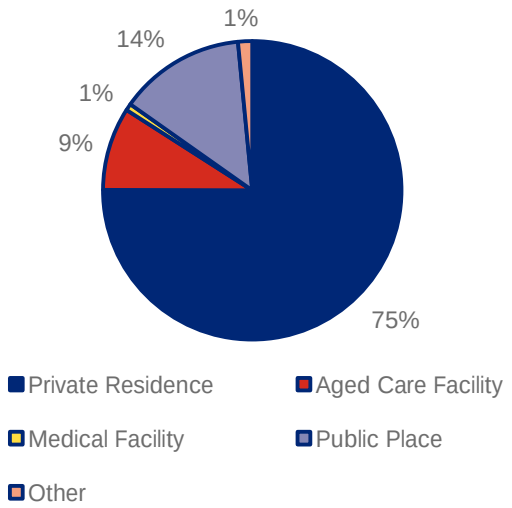


Figure 9: Location of arrest for EMS attended adult events, 2017-2018.

The locations of arrest for paediatric events were similar to those in adults. In 2017-2018, 84% of EMS attended paediatric events occurred in a private residence and 12% occurred in a public place.

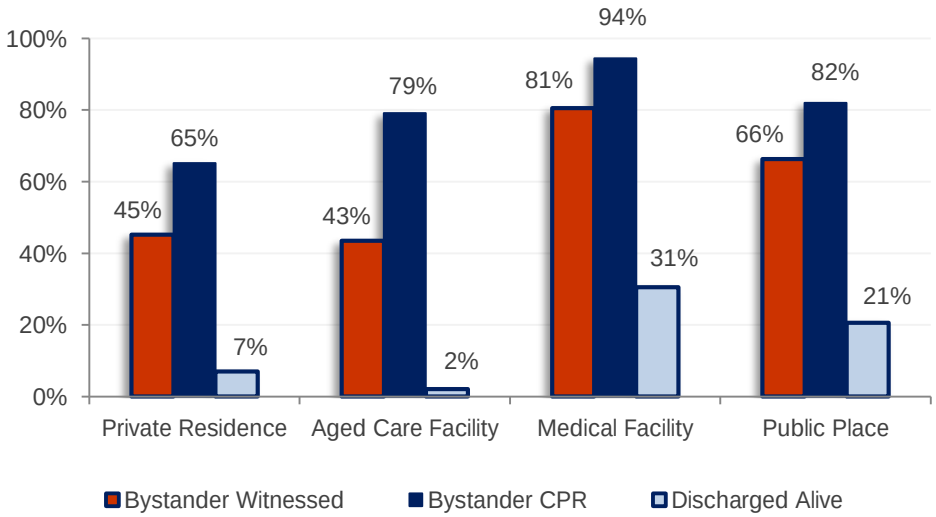


Figure 10: Proportion of EMS treated adult events that are bystander witnessed, receive bystander CPR and are discharged alive across arrest locations, 2017-2018.

Bystander action in public places, including bystander cardiopulmonary resuscitation, is a key factor influencing overall survival following OHCA.

Chain of Survival

The chain of survival is an internationally recognised initiative aimed at maximising survival following out-of-hospital cardiac arrest. The four key links in the chain involve correct identification and early access to help, early CPR, early defibrillation and early access to advanced cardiac life support.

Bystander call for help

In 2017-2018, the first bystander call for help was correctly directed to ambulance in the majority of cases (95%). However, emergency call delays continue to exist for a small subset of attended OHCA events, where the first call for help is directed to a relative/friend (2%), neighbour (1%), police (1%) or another person (<1%) rather than to emergency medical services. Previous research by the VACAR has shown that bystanders inappropriately directing their first phone call to neighbours, relatives or others is associated with significantly poorer survival outcomes following OHCA (Nehme 2014). The misdirection of the call can significantly impact the timely delivery of CPR and defibrillation.

Emergency response to the incident

The distribution of response times for the EMS treated population across regions in 2017-2018 is presented in Figure 11. EMS response time, or the time from the emergency call to arrival of EMS on scene, is an important measure of time to definitive resuscitation treatment by EMS. Some OHCA events may occur after the '000' call is made, such as those arrests which are witnessed by a paramedic. These cases may not be dispatched as a high priority as the initial event was not a cardiac arrest; including these cases in OHCA response time analyses can give rise to misleading results. As such, EMS witnessed arrests are excluded from the following response time analyses.

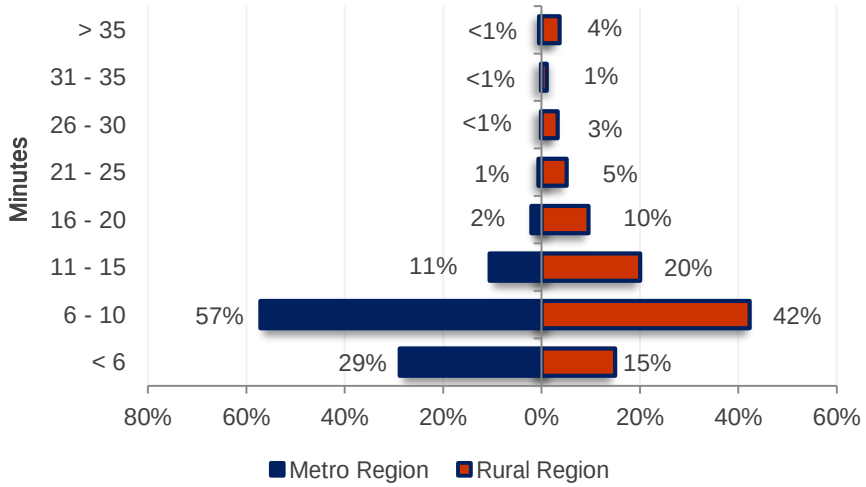


Figure 11: Distribution of time from call to arrival of EMS on scene in the EMS treated population, 2017-2018.

In 2017-2018, state-wide, median response time to EMS treated events was 7.6 minutes (90th percentile time 15.1 minutes). These were faster than the response times noted in the previous year (median time 7.7 minutes; 90th percentile time 15.4 minutes). In 2017-2018, median response time to EMS treated events in metropolitan regions was 7.2 minutes (90th percentile time 11.8 minutes) compared to 7.3 minutes (90th percentile time 12.5 minutes) in the previous year. Median response time in rural areas in 2017-2018 was 9.4 minutes (90th percentile time 23.4 minutes), faster than in the previous year (median time 9.5 minutes; 90th percentile time 21.7 minutes). Improvements in response times were observed in the face of increased demand on AV.

Bystander cardiopulmonary resuscitation

Over the last decade in Victoria, there have been significant increases in bystander CPR rates (see Figure 12). Of all OHCA events in 2017-2018, 37% of patients received CPR performed by bystanders, compared to 26% of patients receiving bystander CPR 10 years ago (p=0.011). Of OHCA events witnessed to collapse by bystanders in 2017-2018, 63% of patients received bystander CPR, in comparison to 46% of patients in 2008-2009 (p<0.001). Of bystander witnessed OHCA events receiving an attempted resuscitation by EMS, 76% received bystander CPR in 2017-2018, compared to 59% in 2008-2009 (p=0.001). The rate of bystander CPR amongst bystander witnessed OHCA cases which received EMS attempted resuscitation has been over 70% for the past six years.

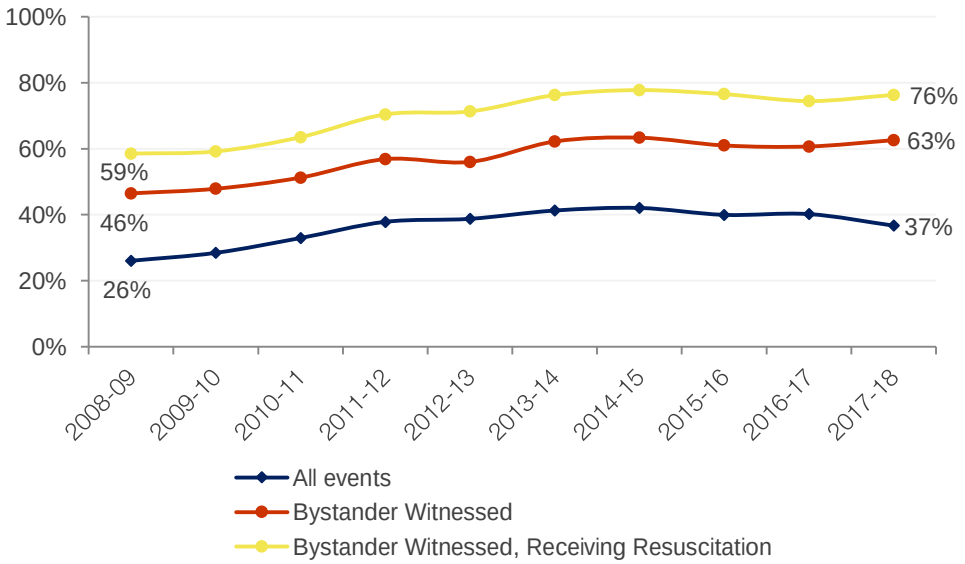


Figure 12: Bystander CPR rates.

These improvements can be partly attributed to more accurate identification of OHCA during the emergency call and delivery of dispatcher-assisted CPR instructions (Bray 2011).

Previous VACAR research shows early, effective bystander CPR increases the likelihood of an initial shockable rhythm and improves the chances of survival following OHCA (Fridman 2007).

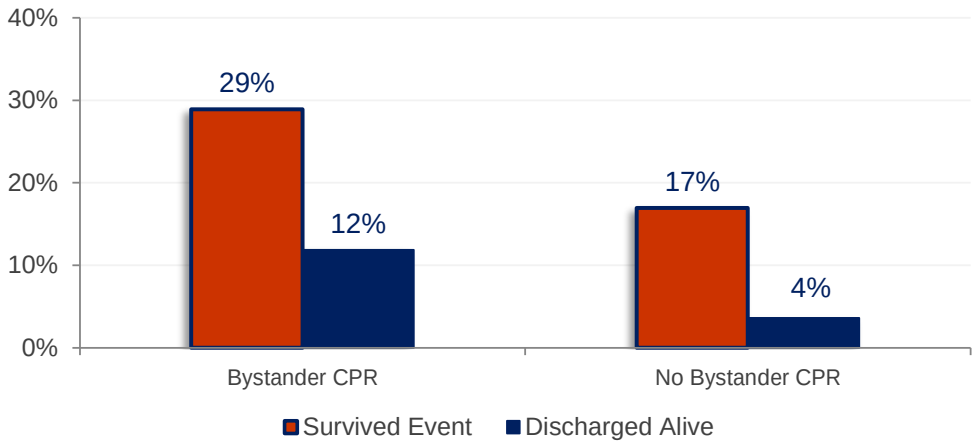


Figure 13: Unadjusted survival outcomes after bystander CPR in the EMS treated population, 2017-2018.

Unadjusted survival was strongly associated with the presence of bystander CPR (see Figure 13). In 2017-2018, for EMS treated OHCA events, the rate of event survival for patients receiving bystander CPR (29%) was significantly higher than for patients not receiving bystander CPR (17%), p<0.001.

In 2017-2018, survival to hospital discharge was significantly higher for patients receiving bystander CPR (12%) versus no bystander CPR (4%), p<0.001. These rates were similar in 2016-2017.

Time to first defibrillation

The time from emergency call to first defibrillation for patients presenting in a shockable rhythm is a key measure for EMS. Timely response by first responder teams and early intervention by bystanders remains a key factor driving favourable outcomes for patients with a shockable rhythm in Victoria (Ljovic 2014).

The proportion of cases where AV performed the first defibrillation has reduced significantly between 2008-2009 and 2017-2018, from 88% to 77% ($p<0.001$). This decline has been driven by an over two-fold increase in the use of public automated external defibrillators (AED) by bystanders over the same period (5% to13%, $p<0.001$) and the expansion of EMR over the decade. The proportion of cases first defibrillated by first responders during 2017-2018 was 10% (in the previous year this was 9%).

The time to first defibrillation by EMS is recorded for EMS treated patients whose rhythm is shockable on EMS arrival. In 2017-2018, the state-wide time to defibrillation of 9.8 minutes (90th percentile time 16.1 minutes) was slower than the previous year (median time 9.2 minutes; 90th percentile time 16.0 minutes; $p<0.001$). The median time to defibrillation in the metropolitan region in 2017-2018 was 9.5 minutes (90th percentile time 14.9 minutes), slower than the previous year (median time 9.1 minutes; 90th percentile time 14.4 minutes; $p<0.001$). In the rural region in 2017-2018, median time to defibrillation was 11.1 minutes (90th percentile time 21.0 minutes), slower than the previous year (median time 9.7 minutes; 90th percentile time 18.0 minutes; $p<0.001$).

Time to defibrillation for patients in a shockable rhythm correlates closely with EMS response time as well as the availability of public defibrillators (see Emergency response to the incident, page 28).

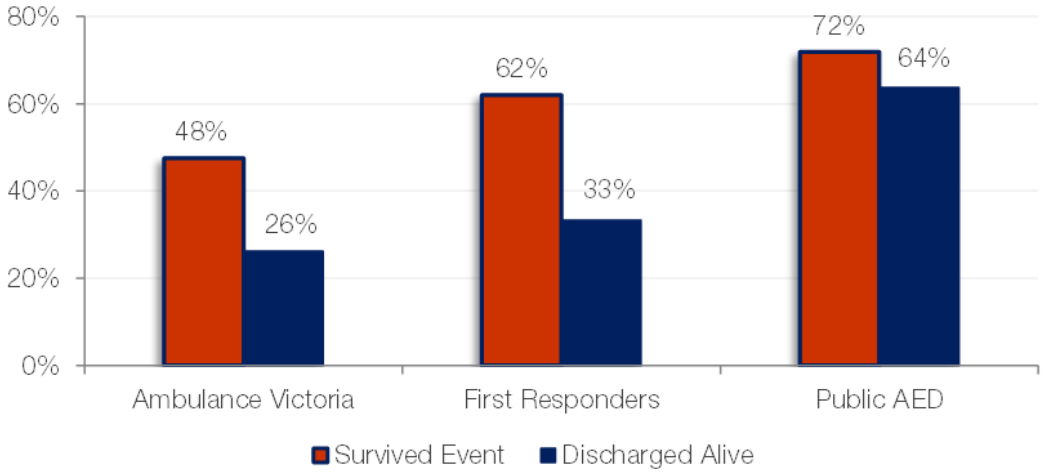


Figure 14: Unadjusted survival outcome according to who shocked first in the EMS treated population with a shockable rhythm on or before EMS arrival, 2017-2018.

It is widely accepted that reducing delays to defibrillation leads to better outcomes for patients in a shockable rhythm. Unadjusted survival outcomes for patients presenting in a shockable rhythm on or before EMS arrival vary according to who performed the first defibrillation (see Figure 14). It should be noted that some fluctuations in survival proportions may be observed over time due to small samples sizes.

The proportion of OHCA patients surviving the event when first defibrillated with a public AED was 72%, compared with 62% of patients first shocked by first responders and 48% of patients first shocked by paramedics. The 2017-2018 event survival rates were significantly higher if a public AED was used compared with patients shocked by paramedics ($p<0.001$).

Survival to hospital discharge in 2017-2018 was significantly different according to who provided the first defibrillation. The proportion of patients surviving to hospital discharge when first defibrillated with a public AED was 64%, compared with 33% of patients first shocked by first responders and 26% of patients first shocked by paramedics. The 2017-2018 survival to hospital discharge rates were significantly higher if a public AED was used compared with patients shocked by paramedics ($p<0.001$). The small sample size of these groups can result in yearly fluctuations in the survival rate.

A discharged alive rate of 64% for OHCA patients defibrillated with a public AED during 2017-2018 illustrates how early intervention, especially the application of an AED for OHCA patients in a shockable rhythm, has an obvious and positive impact on survival outcomes. In 2018, AV launched a smart phone app aimed at alerting approved public responders to cardiac arrest patients within their vicinity (https://www.ambulance.vic.gov.au/community/community-partnerships/goodsam/). The GoodSAM app can also alert lay responders to the closest available AED. VACAR will be pivotal in monitoring the impact of GoodSAM in Victoria on patient survival.


AED
AUTOMATED EXTERNAL DEFIBRILLATOR
SAFE FOR PUBLIC USE
AED LOCATED HERE
HEARTSTART FR2

early access

early cpr

early defibrillation

early advanced care

Impact of bystanders on OHCA

Bystanders play an important role in improving OHCA survival. Three of the four steps of the OHCA chain of survival can be carried out by bystanders. Typically, bystanders are the first on scene and make the emergency call (early access). With the help of the call-taker, or if skilled through prior CPR training, bystanders can start CPR prior to the arrival of EMS. If an AED is located near the location of the arrest, bystanders have the opportunity to provide vital defibrillation prior to the arrival of EMS. OHCA events witnessed to occur by a bystander have more positive survival outcomes.

Table 5: Number and proportion of patients receiving bystander CPR or defibrillation and unadjusted survival, for all and bystander witnessed events, 2017-2018.

	All OHCA	Bystander witnessed
Total events	6,434^	1,647
- Bystander CPR	2,140 (33%)	1,031 (63%)
- Bystander AED use	82 (1%)	71 (4%)
- Shockable rhythm	644 (10%)	470 (29%)
EMS treated events	2,593	1,250
- Survived event	657 (25%)	460 (37%)
- Discharged alive	244 (9%)	197 (16%)

^ Total OHCA events include EMS witnessed events; all other data in the table exclude EMS witnessed events.

Table 5 provides an overview of the impact of bystanders during 2017-2018. Bystander CPR rates were higher amongst OHCA patients witnessed to arrest by a bystander, compared with all OHCA patients (63% vs. 33%, respectively).

Also, unadjusted likelihood of an OHCA patient presenting in a shockable rhythm in 2017-2018 was twelve times higher for patients receiving bystander CPR than those not receiving bystander CPR (excludes EMS witnessed events).

The proportion of patients presenting in a shockable rhythm was higher amongst those who were witnessed to arrest by a bystander as compared to all OHCA patients combined (29% vs 10%, respectively). When an arrest was witnessed by a bystander, the proportion of patients who survived the event was higher than for all OHCA patients combined (37% vs. 25%, respectively). Similarly, when an arrest was witnessed by a bystander, the proportion of patients who were discharged alive was higher than for all OHCA events combined (16% vs. 9%, respectively).

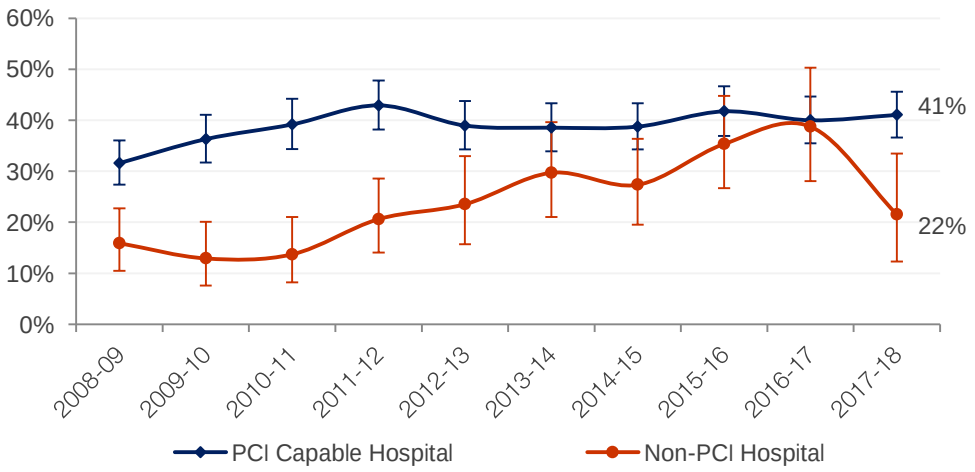
Transport to a cardiac centre

Previous VACAR research demonstrates that transport of OHCA patients to a percutaneous coronary intervention (PCI)-capable hospital is associated with improved survival to hospital discharge (Stub 2011).

State wide during 2017-2018, 87% of EMS treated arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. Within the metropolitan region during 2017-2018, 97% of arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. This is the highest rate of transportation to PCI-hospital in the last 10 years.

Within the rural region during 2017-2018, 60% of arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. This represents an the highest rate of transportation to PCI-capable hospitals in the rural region in the last 10 years (60% vs. 28%). Rates of transportation to PCI-capable hospitals in rural regions vary due to the location of arrest. Patients are predominantly transported to University Hospital Geelong and Ballarat Hospital, two PCI-capable hospitals.

In 2017-2018, 41% of OHCA patients transported to PCI-capable hospitals survived to hospital discharge (unadjusted survival, see Figure 15). Of OHCA patients transported to hospitals without PCI capability during 2017-2018, 22% were discharged alive. This is a significant decline compared to the previous year and warrants further investigation. It is plausible that other hospital-based factors contribute to the variation in outcomes observed across hospitals, including optimal post-arrest treatment strategies.



‡ Data in the graph refers to Victorian hospitals with a current process to receive AV emergency patients via a pre-notification system, have full-time PCI-interventional capabilities and was the first hospital that the OHCA patient was transported to. Error bars show the 95% confidence interval around the proportion.

Figure 15: Unadjusted survival to hospital discharge for adult presumed cardiac EMS treated events according to transport to a PCI-capable hospital.

Survival Outcomes

Scene outcomes in adults

Successful attempts at resuscitation following OHCA are often evaluated by the attainment of return of spontaneous circulation (ROSC) in the field and transportation of patients to hospital.

During 2017-2018, the achievement of ROSC was highest amongst adult OHCA patients who arrested in the presence of EMS (55%). Bystander witnessed arrests attained higher rates of ROSC than unwitnessed arrests in 2017-2018 (45% and 18%, respectively).

Across the entire state in 2017-2018, ROSC was achieved in 35% of all adult EMS treated events (includes EMS witnessed arrests); lower than the previous year. During 2017-2018, ROSC was achieved in 37% of OHCA events in the metropolitan region (unchanged from the previous year) and 32% of OHCA events in the rural region (in the previous year, this was 36%); includes EMS witnessed arrests. There was no significant difference in ROSC outcomes observed in the metropolitan region compared to the rural region (37% vs. 32%, p=0.018).

Over time, there has been an increase in the proportion of OHCA events where resuscitation efforts were ceased at scene, accompanied by a reduction in transportation with ongoing resuscitation efforts (see Figure 16). In 2017-2018, the proportion of adult EMS treated events which were transported from the scene with ROSC was 25%. Efforts were ceased at scene for 72% of adult EMS treated events and the rate of transportation with CPR was low (3%).

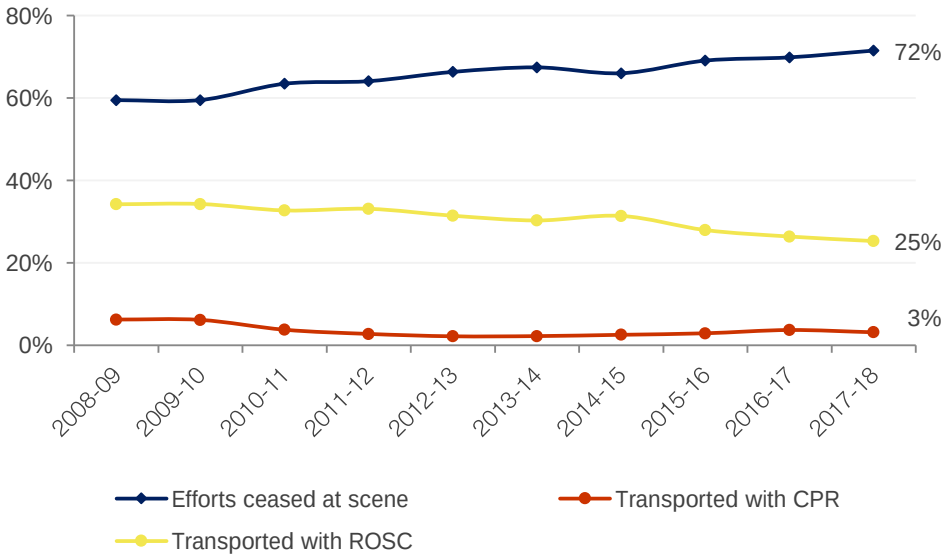


Figure 16: Scene outcomes for adult EMS treated events

Previous VACAR research has shown that the majority of OHCA patients with an initial shockable rhythm who do not achieve sustained ROSC in the field are declared deceased rather than being transported to hospital (Stub 2014). There are several reasons for the low rate of transport with ongoing CPR. Firstly, the transportation of a patient with ongoing CPR is potentially hazardous to the EMS crews. Secondly, if advanced life support measures have been provided by paramedics at the scene for >30 minutes and the patient remains in a non-shockable rhythm, there are typically no additional treatment options at hospital. However, Ambulance Victoria are planning on trialling innovative treatments for these patients to increase the treatment options for patients in a shockable rhythm who don't respond to paramedic treatment in the field.

Adult survival from all-cause cardiac arrest

Unadjusted adult survival from all-cause OHCA has remained steady over the past 10 years. In 2017-2018, the rate of event survival for adult EMS treated events was 25% and discharged alive rate was 10% (see Figure 17). The rate of event survival has declined slightly since 2008-2009, however survival to hospital discharge was consistent with recent observations.

In the metropolitan region during 2017-2018, event survival was 26% and discharged alive rate was 11%. In the rural region during 2017-2018, event survival was 24% and discharged alive rate was 7%.

In 2017-2018, 26% of the overall adult EMS treated patient population presented to EMS or bystanders in a shockable rhythm. The proportion of adults presenting in a shockable rhythm has decreased slowly over the last 10 years (33% in 2008-2009; 33% vs. 26%, p=0.001; see Figure 18). Despite this, the rate of patients surviving to hospital discharge has not significantly decreased over the past decade (11% in 2008-2009; 10% vs 11%; see Figure 17) (p=0.426).

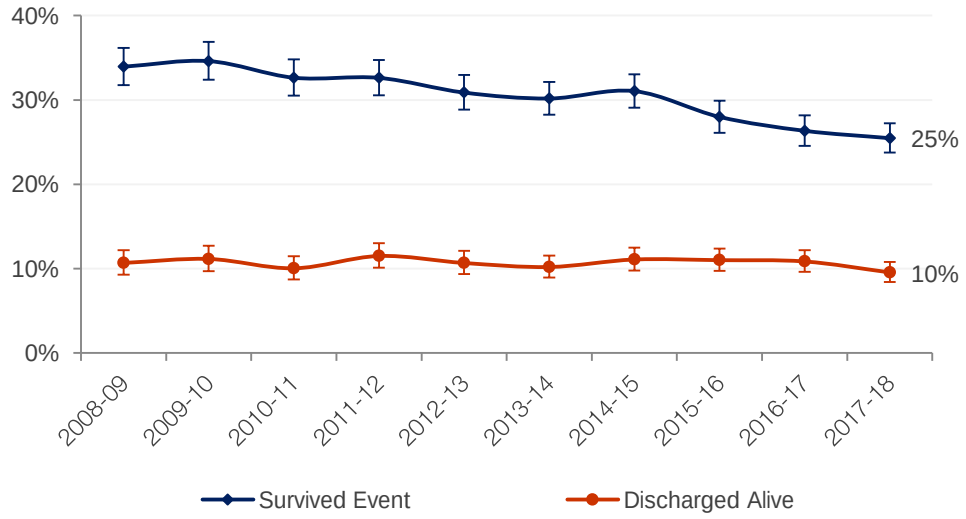


Figure 17: Unadjusted survival outcomes for all-cause adult EMS treated events.

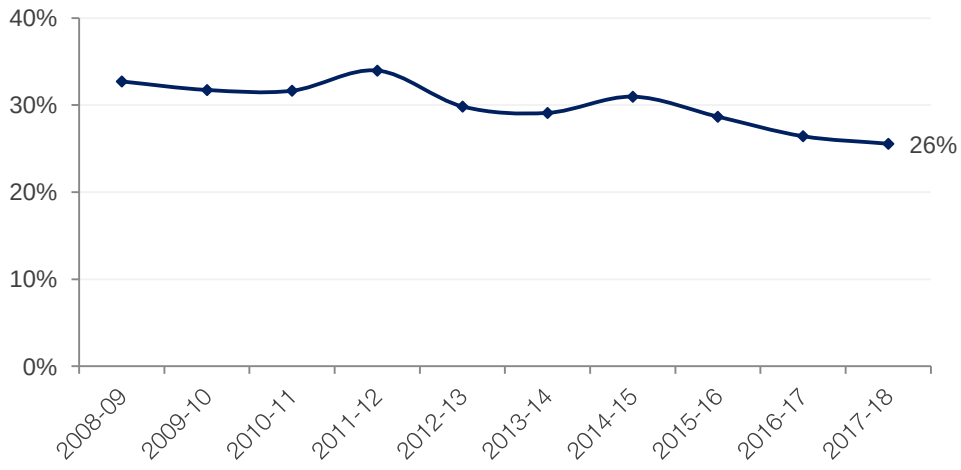


Figure 18: Proportion of adult EMS treated events presenting in a shockable rhythm on arrival.

Adult and all-ages survival from shockable rhythms

Survival outcomes for patients presenting to EMS or bystanders in a shockable rhythm are consistently better than patients presenting in pulseless electrical activity (PEA) or asystole. A shockable rhythm is a strong predictor of OHCA survival (Fridman 2007).

For patients of all ages found in a shockable rhythm during 2017-2018, the rate of event survival was 52% (in the previous year, this was 55%) and the discharged alive rate was 32% (see Figure 19).

During 2017-2018, 7% of adult patients who presented in PEA were discharged alive (in the previous year, this was 10%), while few adults presenting in asystole (0.2%) were discharged alive (in the previous year, this was 0.4%).

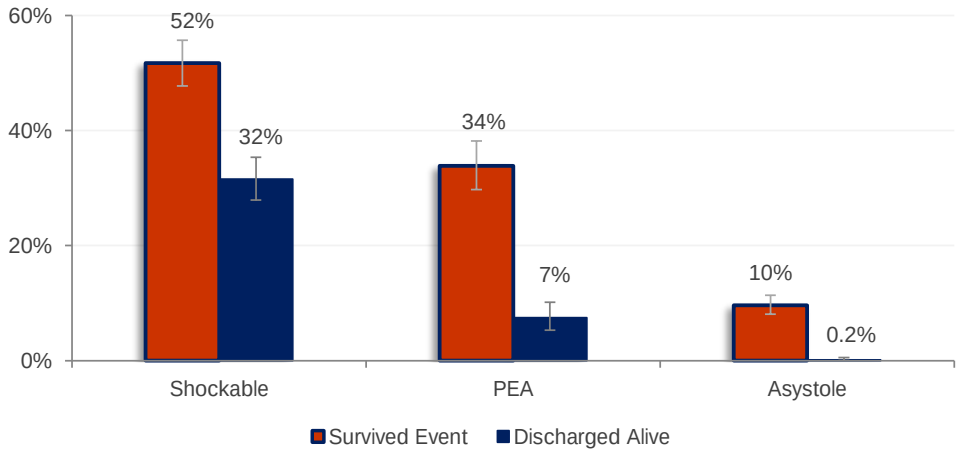


Figure 19: Unadjusted survival outcomes for adult EMS treated events according to presenting rhythm on arrival, 2017-2018.

Outcomes for patients with shockable rhythms have improved slightly over time (see Figure 20). In 2017-2018, adult event survival for patients presenting in a shockable rhythm was 52%. The rate of adult survival to hospital discharge was 32%. This is slightly lower than the adult survival to hospital discharge in shockable patients in 2016-2017 (32% vs. 34%).

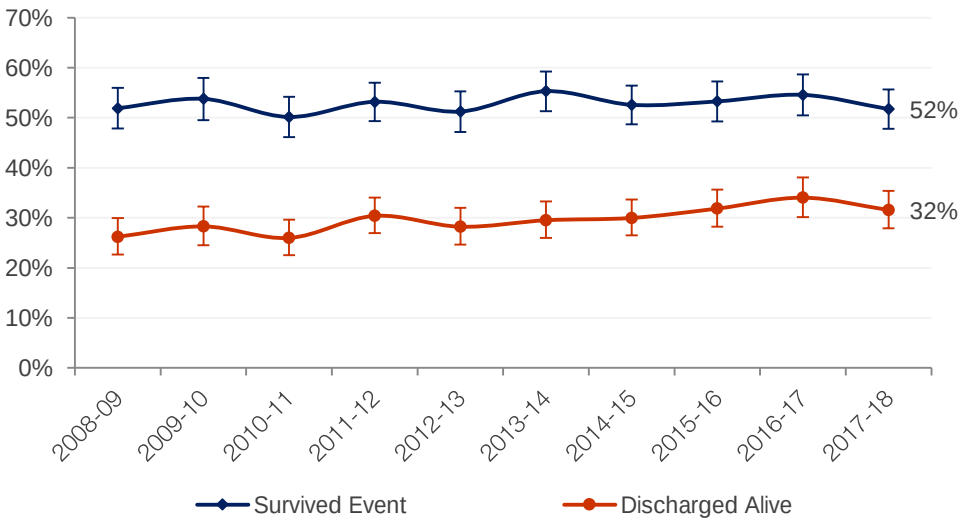


Figure 20: Unadjusted survival outcomes for adult EMS treated events with a shockable rhythm on arrival.

Adult survival from EMS witnessed arrests

In 2017-2018, for adult EMS witnessed events presenting in a shockable rhythm, the rate of event survival was 79% and the rate of survival to hospital discharge was 64% (see Figure 21). These findings are consistent with recent observations. When considering all adult EMS witnessed events during 2017-2018, the rate of event survival was 45% (in the previous year, this was 51%) and the discharged alive rate was 25% (in the previous year this was 29%).

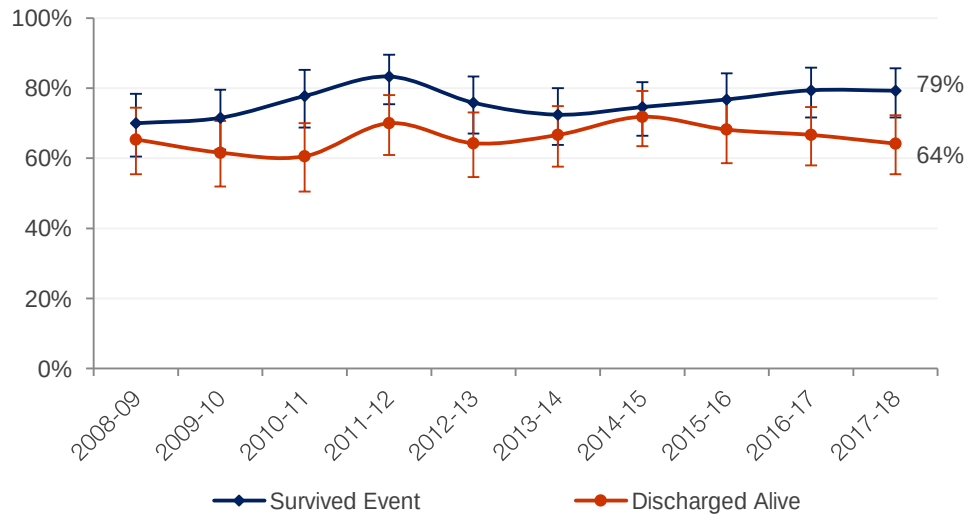


Figure 21: Unadjusted survival outcomes for adult EMS witnessed, EMS treated events with a shockable arrest rhythm.

Paediatric survival from all-cause cardiac arrest

Annual incidence of paediatric OHCA is low, with survival factors and outcomes differing from adults. Notably, paediatric cases rarely present in a shockable rhythm. In 2017-2018, 5% of EMS treated paediatric cases presented in a shockable rhythm (10% in the previous year). Asystole was the most common presenting rhythm (77%).

In 2017-2018, 23% of paediatric EMS treated patients survived the event (25% in the previous year). During 2017-2018, there were four paediatric patients (7%) who were discharged alive (9% in the previous year), consistent over the last 10 years.

There were five EMS witnessed paediatric events in 2017-2018. Four patients (80%) survived the event and two (40%) were discharged alive.

Survival per million population

In 2017-2018, there were 58 OHCA survivors per million population. This finding is consistent with recent observations. In In 2017-2018, the survivors per million population for the Utstein group (27 survivors per million), cases with an initial rhythm of VF/VT (45 survivors per million), and OHCAs that were witnessed by EMS (19 survivors per million) were also consistent with recent observations.

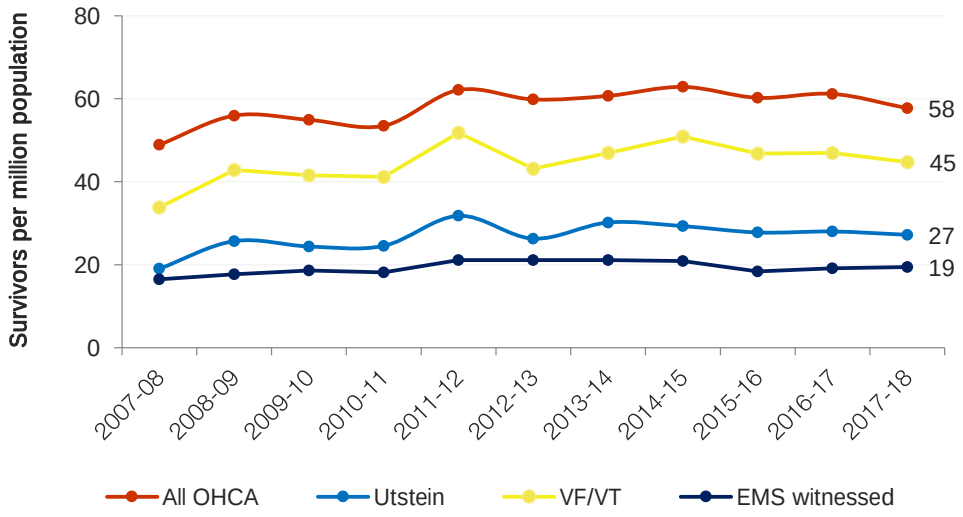


Figure 22: Survival per million population.

Utstein patient group survival

The Utstein template is part of a set of guidelines which was developed to promote uniform presentation of OHCA survival data across different regions of the world (Perkins 2015). These guidelines define key data fields to ensure consistency in terminology and makes recommendations as to core and supplementary data to be recorded for each OHCA event.

OHCA patients who are witnessed to arrest and present in a shockable rhythm are the most likely subgroup to survive an arrest. Data presented using the Utstein template focuses on survival within the following patient subgroup: OHCA events where EMS attempted resuscitation, where the arrest was witnessed by a bystander and the presenting cardiac rhythm was shockable (VF or VT).

Figure 23 shows the total number of OHCA events in 2017-2018 and progressively shows the breakdown of events according to EMS attempted resuscitation, precipitating event, witnessed status and presenting rhythm.

In 2017-2018, the state-wide rate of survival to hospital discharge for the Utstein patient subgroup presenting in a shockable rhythm was 37%. In the previous year, the state-wide rate of being discharged alive within the Utstein patient subgroup was also 37%.

Within the metropolitan and rural regions, the rates of being discharged alive within the Utstein patient subgroup was 41% and 27%, respectively. In the previous year, these rates in the metropolitan and rural regions were 38% and 36%, respectively.

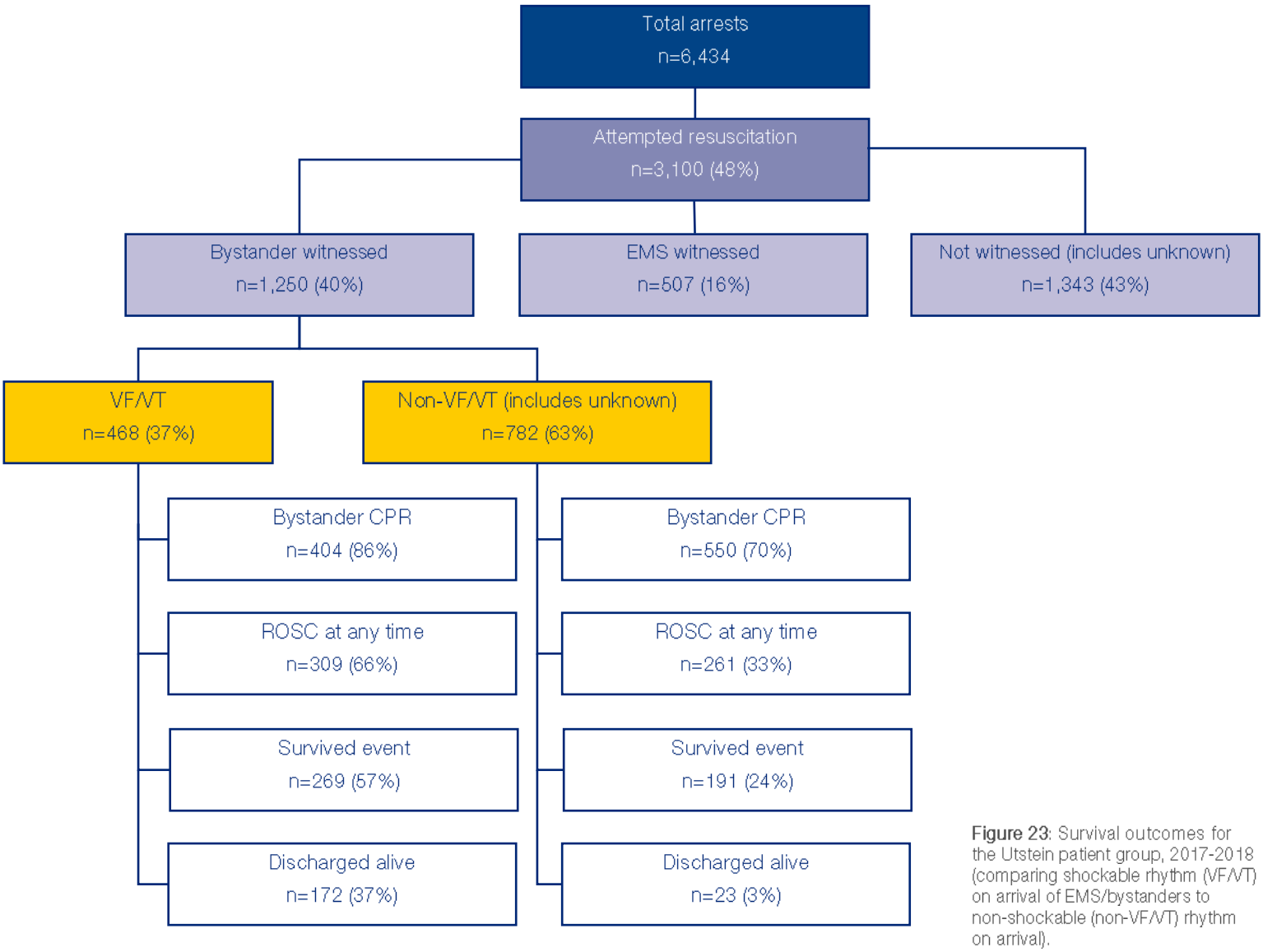


Figure 23: Survival outcomes for the Utstein patient group, 2017-2018 (comparing shockable rhythm (VF/VT) on arrival of EMS/bystanders to non-shockable (non-VF/VT) rhythm on arrival).

Utstein patient group survival in Victoria compared to international data

Table 6 compares survival to hospital discharge for the Utstein patient group in Victoria to other international data for this patient subgroup, a useful benchmarking patient group.

It should be noted that there are discrepancies in the definition of the Utstein patient subgroup by different international ambulance services; this makes comparison of survival rates difficult. Also, different ambulance services follow different guidelines for when to start and/or stop resuscitation, which further complicates comparison of resuscitation outcomes data. It is also not possible to accurately know the extent to which some international organisations omit cases from their analyses of patient outcome data (eg. omitting cases with short, yet futile resuscitation attempts), as suggested by anecdotal evidence.

The Utstein patient subgroup definition used by AV no longer specifically selects patients where the arrest was due to a presumed cardiac cause. Instead, the AV Utstein patient group definition includes arrests due to any causes, as per the most recent recommendations for reporting of the Utstein comparator group (Perkins 2015). As evident in Table 6, some groups still focus on the presumed cardiac patient subgroup.

Victorian OHCA patients experience a discharged alive rate for the Utstein patient subgroup (37%) which is comparable to a number of other ambulance services or other large collaborative studies/registries around the world. Survival for Melbourne was 41% which is a 3% improvement on the previous year.

Whilst a higher survival rate may be noted for patients in Seattle/ King County, it is important to note the following caveats: i) the Seattle/King County EMS has a markedly smaller service area than the AV service area (approx. 2,000 sq. miles versus 90,000 sq. miles, respectively) and ii) the Seattle/King County population is smaller than in Victoria (approx. 2.1 million versus 6.3 million). The Utstein survival rate for the greater Melbourne (41%) compares favourably with London (32%, population 4.8 million versus 8.8 million).

Table 6: Published Victorian and international OHCA survival to hospital discharge data for the Utstein patient group.

Organisation	Time period	% survival
Ambulance Victoria - Greater Melbourne	2017-2018	37% 41%
London Ambulance Service^ (London Ambulance Service 2018)	2017-2018	32%
Pan Asian Resuscitation Outcomes Study, PAROS^ (7 Asian EMS services; Ong 2015)	2009-2012	28%
CARES (Cardiac Arrest Registry to Enhance Survival) 2017 Annual Report ^^	2017	33%
St John New Zealand^^^ (Dicker, Oliver and Tunnage,	2017-2018	32%
Seattle/King County EMS^ (Chatalas 2017)	2017	56%
St John Western Australia (St John Ambulance WA, 2017)	2017	26%
EuReCa ONE (27 European country OHCA registries, Grasner 2016)	2014	30%

^Only includes patients arresting due to a presumed cardiac cause.
^^ Excludes patients arresting due to a traumatic cause.

Yearly risk-adjusted odds of adult survival

The risk-adjusted odds of survival outcome provide a balanced method of measuring yearly trends in resuscitation performance and outcome. In the analyses presented in Figures 24 and 25, the odds of survival to hospital discharge for the adult EMS treated population is evaluated across years using a multivariate model adjusted for known predictors of survival. These predictors include: age, sex, public location, presenting in shockable rhythm^, bystander witnessed status and bystander CPR.

The 2002-2003 year is used as the reference category; this is the first year that data capture within the VACAR can be considered complete and reliable. Table 7 outlines the start dates of a number of important AV programs and initiatives since the initiation of the VACAR, in 1999, up to the current fiscal year. Some of these initiatives are likely to have driven improvements in patient outcomes outlined in this report.

The analysis demonstrates strong growth in the survival to hospital discharge outcomes over recent years (see Figure 24). In 2017-2018, the relative odds of survival to hospital discharge for adult EMS treated patients had increased almost over two-fold compared to patient outcomes in 2002-2003 (adjusted odds ratio 2.4, 95% CI 1.8-3.2, $p<0.001$).

Similarly, over time there has been vast improvements in the odds of survival to hospital discharge for patients presenting in a shockable rhythm (see Figure 25). In 2017-2018, the relative odds of being discharged alive had increased more than three-fold for adult EMS treated patients presenting in a shockable rhythm compared to patient outcomes in 2002-2003 (adjusted odds ratio 3.3, 95% CI 2.4-4.6, p<0.001).

Of note, there was a slight decline in the odds ratios for 2017/2018 relative to the previous year (2016/2017). This is not statistically significant and is predominantly due to the high mortality seen last winter.

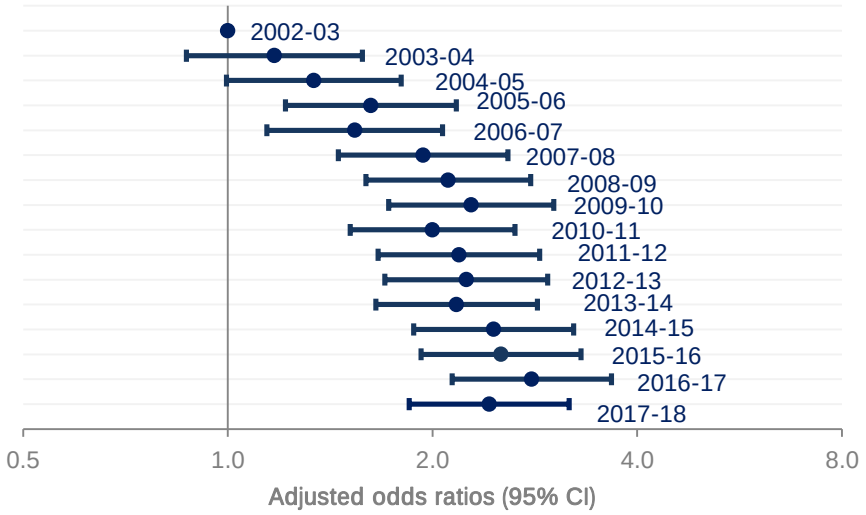


Figure 24: Risk-adjusted odds of adult survival to hospital discharge by year in the overall EMS treated population.

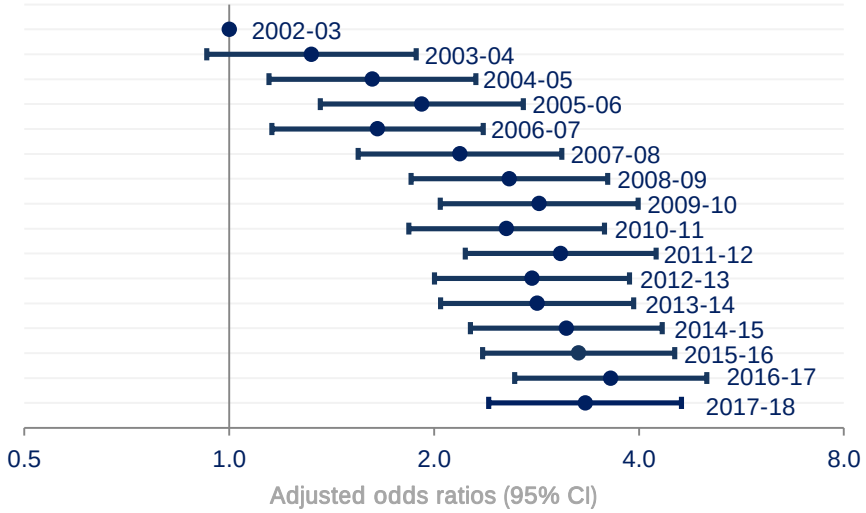


Figure 25: Risk-adjusted odds of survival to hospital discharge for adults presenting in a shockable rhythm by year in the overall EMS treated population.

^For this analysis, only patients presenting in a shockable rhythm were included. As such, the 'shockable rhythm' factor was removed from the regression model.

Long-term Functional Outcomes

Discharge direction for all survivors

When considering all adult OHCA survivors, 85% were discharged home (including EMS witnessed events and excluding unknown discharge status; see Figure 26). Discharge home for adult survivors has remained consistent over the last decade. In 2017-2018, remaining adult survivors were discharged to rehabilitation (13%) and nursing homes (2%). If a patient resided in a nursing home and was discharged to a nursing home, this was considered 'home'. For adult OHCA survivors who presented in a shockable rhythm, 87% were discharged home.

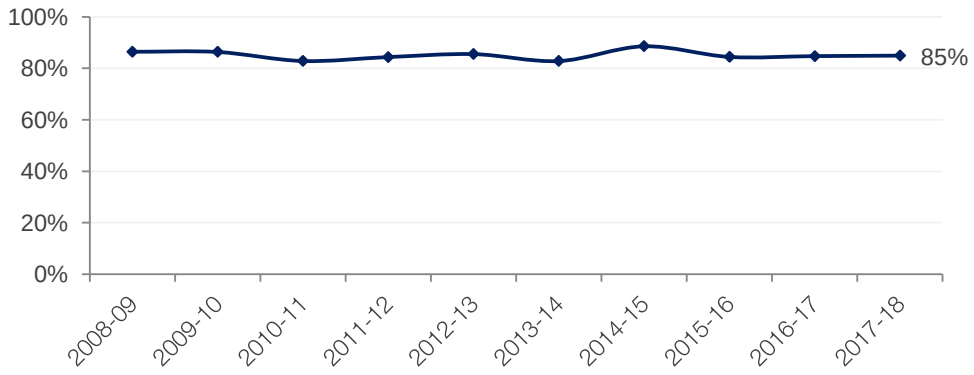


Figure 26: Proportion of adult discharged alive patients who are discharged to private residence (includes EMS witnessed events).

Assessing quality of life post arrest

Since January 2010, adult OHCA patients (aged ≥18 years) who were discharged alive have undergone health-related quality of life (HRQoL) interviews via telephone follow-up 12-months after their arrest. The Victorian Registry of Births, Deaths and Marriages is initially searched for death information. Patients identified as alive at 12-months are sent a letter indicating they will receive a telephone call regarding their health and requesting verification of current contact information. Patients are then contacted by a dedicated researcher experienced in undertaking these interviews. Where necessary, a proxy is interviewed in place of the patient (if appropriate for the tool being used). At least five attempts are made to contact patients at different time points, including after hours. Interviews are performed from a central location.

Interviews include the following measures:

The EuroQol 5 dimension (EQ-5D) questionnaire (Rabin 2001). The EQ-5D is validated to measure HRQoL. The tool assesses five domains: mobility, self-care, usual activities, pain/discomfort, anxiety/depression. EQ-5D health status can be converted to a single index score by weighting each of the dimensions against United Kingdom (UK) norms; scores range from -0.594 (worse than death) to 1 (full health) (Szende 2007).

Twelve-item short form (SF-12) health survey (Ware 1996). The SF-12 is a generic HRQoL instrument that measures physical and mental health status; only patients provide data. SF-12 scores consist of the Physical Health Component Summary (PCS) and Mental Health Component Summary (MCS). Standardised mean difference (SMD) was used to show the degree of deviation of a score from the population norm. SMD is calculated by subtracting the mean score of the corresponding Australian age and sex category from the OHCA respondent's score and dividing by the standard deviation of the appropriate age/sex category (McGough et al. 2009). The size of the SMD represents the magnitude of the difference between population groups, with values >0.8 considered large.

Glasgow Outcome Scale – Extended (GOS-E) (Wilson 1998). The GOS-E provides a global measure of function on an eight level scale from death (1) to upper good recovery (8). Scores ≥7 equate to good recovery.

Work related factors. Return to work is recorded, with additional questions regarding same employer and/or same role if the patient has returned to work.

Living status factors. Residential status of the patient at the time of interview is recorded. If the patient has returned home, they are asked about use of additional support services.

The VACAR is one of the few registries in the world to routinely collect health-related quality of life outcomes for cardiac arrest patients. It is one of the largest cohorts of OHCA quality of life outcomes.

Quality of life findings

Of 371 individuals who arrested between 1 July 2016 and 30 June 2017 and were discharged alive from hospital, 343 patients were alive 12-months post-arrest and were eligible for contact in 2017-2018. Interviews were conducted with 240 patients and 45 proxies (n=285), producing a response rate of 83%. There were 144 individuals who had worked prior to their arrest; 71% of individuals (102 of 144) returned to work after their arrest. Of those returning to work, 84% (86 of 102) returned to work in the same role.

SF-12 survey data for OHCA patients who arrested during 2016-2017 and were followed up 12 months later were expressed as SMD scores (outlined on page 45). The SMD (±95 CI) for the PCS was negative and did not cross zero meaning that the physical health of the OHCA patients was significantly worse than Australian population norms (SMD PCS -0.172, 95% CI -0.332 to 0.026). The SMD (±95 CI) for the MCS was positive and did not cross zero meaning that the mental health of the OHCA patients was significantly better than Australian population norms (SMD MCS 0.172, 95% CI -0.27 to 0.316) (see Figure 27). SF-12 data was available for all but one patient (n=239).

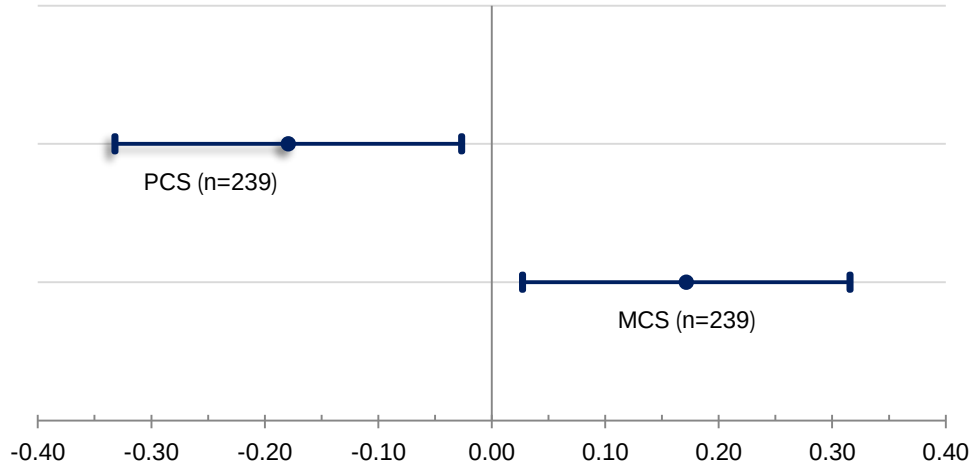


Figure 27: Standardised mean differences for SF-12 scores at 12 months post arrest for OHCA survivors versus the Australian population (patients who arrested between 2016-2017).

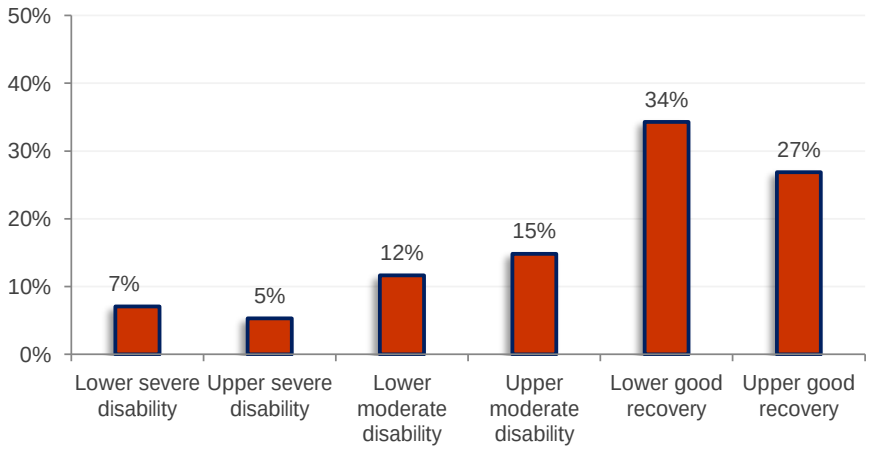


Figure 28: Disability or recovery status according to the GOS-E for OHCA survivors at 12 months post arrest (patients who arrested between 2016-2017).

The GOS-E measure indicated that 61% of survivors who arrested during 2016-2017 (173 of 285) were rated as having good functional recovery 12 months after their arrest (see Figure 28). An additional 27% reported recovery with only moderate disability.

Mean EQ-5D index score for responders followed up in 2016-2017 was 0.78 (95% CI, 0.74 to 0.81); most (58%) had an EQ-5D index score ≥0.81, approaching full health level. These high EQ-5D index scores are similar to age-and sex-adjusted population norms (Smith 2015). EQ-5D index scores were available for 277 of 285 responders.

Together, the SF-12, GOS-E and EQ-5D results indicate good HRQoL for survivors of arrests during 2016-2017 who responded.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Improving survival from out-of-hospital cardiac arrest

Ambulance Victoria is part of the Global Resuscitation Alliance (GRA) which is an international collaboration aiming to increase OHCA survival rates by at least 50%. The GRA promotes ten programs based on recent evidence and best practice in OHCA management that are designed to provide the framework for EMS systems to improve OHCA survival in their community.

In recent months, AV have been working to implement programs or improve upon existing programs in an effort to increase cardiac arrest survival rates in Victoria.

Ten Steps to Improve Cardiac Arrest Survival
1. Establish a cardiac arrest registry
2. Begin telephone-CPR with ongoing training and QI
3. Begin high-performance EMS CPR with ongoing training and QI
4. Begin rapid dispatch
5. Measure professional resuscitation using the defibrillator recording (and voice if possible)
6. Begin an AED program for first responders, including police officers, guards, and other security personnel
7. Use smart technologies to extend CPR and public access defibrillation programs to notify volunteer bystanders who can respond to nearby arrest to provide early CPR and defibrillation
8. Make CPR and AED training mandatory in schools and the community
9. Work toward accountability—submit annual reports to the community
10. Work toward a culture of excellence

Figure 29: Global Resuscitation Alliance – 10 Programs to Improve Cardiac Arrest Survival .

Programs 1 & 9: Establish a Cardiac Arrest Registry and submit Annual Reports to the community

Ambulance Victoria was the first Australian service to establish a statewide Cardiac Arrest Registry. VACAR is also the only registry in Australia and New Zealand which collects quality of life data on survivors. In addition, VACAR was the first cardiac arrest registry in Australia and New Zealand to produce an Annual report that is publically available to the community. We will continue to expand VACAR data collection and reporting to actively evaluate new initiatives as they are implemented.

Programs 2 & 4: Telephone CPR and rapid dispatch with ongoing quality improvement

AV and the Emergency Services Telephone Authority (ESTA) have been working closely to improve systems of care to decrease call-taker time to recognition of OHCA and increase the incidence of bystander CPR and AED use at the scene.

Program 3: High-Performance CPR with ongoing training and quality improvement

AV paramedics will commence high-performance CPR (HP CPR) training in late 2018 and it will become standard practice service wide from early 2019. It is anticipated that HP CPR will reduce periods of hand-off-chest time during the resuscitation attempt and afford the patient a greater chance of achieving a return of spontaneous circulation (ROSC), surviving to hospital and surviving to hospital discharge with good neurological outcomes.

AV is currently piloting the resuscitation quality improvement (RQI) CPR training program in partnership with Laerdal and the American Heart Association. The RQI program includes eLearning and CPR skills practice with feedback on performance and is designed to address the challenge of resuscitation skill deterioration. RQI allows paramedics to train in short, frequent intervals – known as low-dose high-frequency training.

Program 5: Measure resuscitation efforts

Data from feedback pads used during the resuscitation, combined with call-taking and dispatch data, VACIS data and hospital data will enable AV to accurately measure during resuscitation efforts. This data will be used to guide feedback and debriefing for responders that will aim to improve individual, team and organisation performance at OHCA.

Program 6: AED programs for first responders

AV has a well-established AED program for first responders including Community Emergency Response Teams (CERTs), Ambulance Community Officers (ACOs) and Remote Area Nurses (RANs). AV also has a successful co-responder program with the Metropolitan Fire Brigade (MFB) and the Country Fire Authority (CFA) through the Emergency Medical Response (EMR) program. The MFB and participating CFA crews are co-responded to suspected cardiac arrests and commence life-saving CPR and rapid defibrillation prior to AV arrival. EMR crews then assist with continuing efforts at the resuscitation where required. The EMR program continues to expand to CFA stations and since it commenced in 2008, has now expanded to include 30 volunteer and integrated CFA stations across Victoria with plans for further rollout over the next 12 months.

Program 7: Use technology to improve community response

AV have introduced the GoodSAM program to alert suitably qualified responders to cases of cardiac arrest and there are now numerous cases of off-duty paramedics providing early CPR and defibrillation with positive patient outcomes. The GoodSAM app connects people in cardiac arrest with nearby trained and trusted responders in the critical minutes between a Triple Zero (000) call and emergency services arriving. GoodSAM commenced at AV in January 2018, and was launched publically in May. The partnership with GoodSAM has also aided AV in maintaining a registry of publicly accessible AEDs that bystanders can be directed to when responding to an OHCA.

2017-2018 Research Highlights

'Our research agenda continues to focus on the chain of survival and answering unanswered questions relating to OHCA. This year, some research highlights have addressed recurrent OHCA, OHCA warning symptoms, long-term outcomes for elderly OHCA and trends in paediatric OHCA.' Prof Karen Smith, VACAR Principal Investigator and Chair.

Long-term functional recovery and health-related QOL of elderly OHCA survivors

Understanding the prognosis of elderly out-of-hospital cardiac arrest (OHCA) patients is vital to informing resuscitation and advanced care planning decisions. However, short-term outcomes such as survival to hospital discharge do not account for post-arrest quality of life. In this study published in Resuscitation, Andrew et al. describe the 12-month functional recovery and health-related quality of life (HR-QOL) of elderly OHCA survivors, including those arresting in aged care facilities. Most elderly OHCA survivors resided independently with good functionality 12 months post-arrest. However, increasing age was associated with less favourable outcomes. Of the patients that arrested in an aged care facility, no patient reported a good 12-month functional recovery. New strategies are needed with regard to resuscitation in aged care facilities.

Andrew E, Mercier E, Nehme Z, Bernard S, Smith K. Long-term functional recovery and health-related quality of life of elderly out-of-hospital cardiac arrest survivors. Resuscitation. 2018 May;126:118-124.

Recurrent OHCA

Little is known about the burden of recurrent out-of-hospital cardiac arrest (OHCA) episodes in initial survivors of OHCA. In this study, Nehme et al. sought to investigate the frequency of recurrent OHCA, describe time-to-event trends, and establish baseline predictors of occurrence. Recurrent OHCA episodes occur frequently in OHCA survivors, and could account for as many as one-quarter of all deaths at follow-up. Index characteristics may help to identify at-risk patients.

Nehme Z, Andrew E, Nair R, Bernard S, Smith K. Recurrent out-of-hospital cardiac arrest. Resuscitation. 2017 December;121:158-165.

Warning symptoms and patient delays

Although increasing patient delays between symptom onset and activation of emergency medical services (EMS) can lead to poorer outcomes following acute myocardial infarction, its effect in out-of-hospital cardiac arrest (OHCA) populations is unclear. In this study published in Resuscitation, Nehme et al. examined the impact of patients delays after the onset of angina symptoms on survival from EMS witnessed OHCA. Every 30 minute increase in patient delay was associated with a reduction in survival. Increasing delays in activating EMS before the onset of OHCA may be associated with reduced survival. Future research could explore whether increasing public awareness of the warning symptoms leads to earlier medical contact for OHCA.

Nehme Z, Bernard S, Andrew E, Cameron P, Bray JE, Smith K. Warning symptoms preceding out-of-hospital cardiac arrest: do patient delays matter. Resuscitation. 2018 February;123:65-70.

Trends in the incidence and outcome of paediatric OHCA

System-based improvements to the chain of survival have yielded increases in survival from out-of-hospital cardiac arrest (OHCA) in adults. Comparatively little is known about the long-term trends in incidence and survival following paediatric OHCA. In this study, Nehme et al. examined trends in paediatric OHCA incidence and outcomes. The incidence of paediatric OHCA in Victoria remained stable and survival increased over the17 year study period. This was driven, in part, by improving outcomes for initial shockable arrests.

Nehme Z, Namachivayam S, Forrest A, Butt W, Bernard S, Smith K. Trends in the incidence and outcome of paediatric out-of-hospital cardiac arrest: a 17-year observational study. Resuscitation. 2018 July;128:43-50.

2017-2018 Peer-reviewed Publications*

1. Andrew E, Nehme Z, Wolfe R, Bernard S, Smith K.
Long-term survival following out-of-hospital cardiac arrest.
Heart. 2017 July;103(14):1104-1110.

2. Andrew E, Nehme Z, Bernard S, Abramson MJ, Newbigin E, Piper B, Dunlop J, Holman P, Smith K.
Stormy weather: a retrospective analysis of demand for emergency medical services during epidemic thunderstorm asthma.
British Medical Journal. 2017 December 13;359:j5636.

3. Andrew E, Mercier E, Nehme Z, Bernard S, Smith K.
Long-term functional recovery and health-related quality of life of elderly out-of-hospital cardiac arrest survivors.
Resuscitation. 2018 May;126:118-124.

4. Beck B.
Aus-ROC Epistry a boost for out-of-hospital cardiac arrest outcomes.
Medical Journal of Australia Insight
https://www.doctorportal.com.au/mjainsight/2017/23/aus-roc-epistry-a-boost-for-out-of-hospital-cardiac-arrest-outcomes/

5. Beck B, Bray JE, Cameron P, Straney L, Andrew E, Bernard S, Smith K.
Predicting outcomes in traumatic out-of-hospital cardiac arrest - the relevance of Utstein factors.
Emergency Medicine Journal. 2017 December;34(12):786-792.

6. Beck B, Bray J, Cameron P, Smith K, Walker T, Grantham H, Hein C, Thorrowgood M, Smith A, Inoue M, Smith T, Dicker B, Swain A, Bosley E, Pemberton K, McKay M, Johnston-Leek M, Perkins GD, Nichol G, Finn J; Aus-ROC Steering Committee.
Regional variation in the characteristics, incidence and outcomes of out-of-hospital cardiac arrest in Australia and New Zealand: Results from the Aus-ROC Epistry.
Resuscitation. 2018 May;126:49-57.

7. Bray JE, Hein C, Smith K, Stephenson M, Grantham H, Finn J, Stub D, Cameron P, Bernard S; EXACT Investigators.
Oxygen titration after resuscitation from out-of-hospital cardiac arrest: A multi-centre, randomized controlled pilot study (the EXACT pilot trial).
Resuscitation. 2018 July;128:211-215.

8. Dyson K, Bray JE, Smith K, Bernard S, Straney L, Nair R, Finn J.
Paramedic Endotracheal Intubation Experience Is Associated With Successful Tube Placement but not Cardiac Arrest Survival.
Annals of Emergency Medicine. 2017 September;70(3):382-390.e1.

9. Masterson S, McNally B, Cullinan J, Vellano K, Escutnaire J, Fitzpatrick D, Perkins GD, Koster RW, Nakajima Y, Pemberton K, Quinn M, Smith K, Jónsson BS, Strömsöe A, Tandan M, Vellinga A.
Out-of-hospital cardiac arrest survival in international airports.
Resuscitation. 2018 June;127:58-62.

10. Nehme Z, Andrew E, Nair R, Bernard S, Smith K.
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*Includes publications from 2017-2018, and additional publications up to the publishing date of the VACAR 2017-2018 Annual Report.


RESCUE
RESCUE

List of Abbreviations

ACO	Ambulance Community Officer
ALS	Advanced Life Support
AED	Automated external defibrillator
AV	Ambulance Victoria
CERT	Community Emergency Response Team
CFA	Country Fire Authority
CPR	Cardiopulmonary Resuscitation
CSO	Clinical support officer
DHHS	Department of Health and Human Services
ECG	Electrocardiogram
EMS	Emergency Medical Services
EQ-5D	EuroQoL 5 Dimension questionnaire
GOS-E	Extended Glasgow Outcome Scale
HRQoL	Health-related quality of life
LGA	Local Government Areas
MCS	Mental Component Summary of the SF-12 survey
MFB	Metropolitan Fire Brigade
MICA	Mobile Intensive Care Ambulance
OHCA	Out-of-Hospital Cardiac Arrest
PCR	Patient Care Record
PCS	Physical Component Summary of the SF-12
PEA	Pulseless Electrical Activity
ROSC	Return of Spontaneous Circulation
VACAR	Victorian Ambulance Cardiac Arrest Registry
SF-12	Twelve-item Short Form health survey
VF	Ventricular Fibrillation
VT	Pulseless Ventricular Tachycardia

Ambulance Victoria key initiatives over time

Table 7 outlines the start dates of a number of important AV programs and initiatives since the initiation of the VACAR, in 1999, up to the current fiscal year. Some of these initiatives are likely to have driven improvements in patient outcomes in this report.

Table 7: Key Ambulance Victoria and other national/international initiatives impacting cardiac arrest outcomes in Victoria, since the establishment of the VACAR.

Year	AV and other national/international cardiac arrest initiatives
1999-00	Victorian Ambulance Cardiac Arrest Registry (VACAR) established Pilot of fire-fighters as first-responders in central Melbourne
2000-01	Metropolitan Ambulance Service and Rural Ambulance Victoria start training paramedics in Advanced Life Support (ALS)
2001-02	Roll out of fire-fighters as first-responders across metropolitan Melbourne Victorian State Government announces funding for a Public Access Defibrillation (PAD) program
2003-04	CPR awareness program launched in Victoria by Metropolitan and Rural Ambulance Services
2004-05	Commencement of VACIS in-field electronic data capture system and linked clinical database in Metropolitan Ambulance Service
2005-06	Completion of VACIS roll-out in ambulances servicing metropolitan regions of Victoria Australian Resuscitation Council (ARC) Guidelines update 2006
2006-07	Simplification of telephone-assisted CPR instructions to 400 compressions before mouth-to-mouth
2007-08	Pilot of volunteer fire-fighters as first-responders in peripheral Melbourne Pre-hospital therapeutic hypothermia for selected patients
2008-09	AV Dispatch Grid review/monitoring to increase accuracy of event prioritisation and Medical Priority Dispatch System coding, as well as increase appropriateness of dispatched care Completion of VACIS roll-out in ambulances servicing rural regions of Victoria Metropolitan Ambulance Service, Rural Ambulance Victoria and Alexandra District Ambulance Service merge to form Ambulance Victoria (AV) AV commences AED Registry which records the locations of AEDs across Victoria

Year	AV and other national/international cardiac arrest initiatives
2010-11	2011 ARC Guidelines update AV CPR awareness programs trains 800,000 people since 2004
2011-12	Pilot of fire-fighter first-responders in peripheral Melbourne and one rural location Expansion of operating area for MICA Single Responder Units in metropolitan areas Victorian State Government announces funding for mobile intensive care (MICA) single responder units (SRUs) in rural areas
2013-14	Electronic call taking algorithm implemented in rural areas
2014-15	Update and simplification of the Utstein template for uniform collection and reporting of OHCA data AV Dispatch Grid review and implementation of revised grid Victorian Government commits to expanding fire fighter first responder program to all integrated (staffed by both fulltime and volunteer fire-fighters) fire stations
2015-16	2016 ARC Guidelines update AV OHCA guidelines updated Commenced rollout of fire-fighter first-responders at all integrated fire stations across Victoria
2017-18	More than 95,000 OHCA cases entered into VACAR AV CPR awareness programs trains more than 1 million people since 2004 Upgrade of the AV AED Registry and publicity campaign encouraging AED owners to register their devices Pilot of real-time and post event feedback on CPR quality for paramedics Roll out of the GoodSAM first responder app to paramedics and members of partner organisations

Definitions used in this Report

Adults	Patients aged greater than 15 years of age, or where the age is missing/unknown.
Dead on arrival	Cases for which paramedics determine a patient to be deceased on arrival.
Died at scene	Patients who receive an EMS attempted resuscitation but do not survive to transport.
Emergency Medical Services (EMS)	Denotes Ambulance Victoria paramedics or first responders, including fire services, or community emergency response teams.
EMS attempted resuscitation	Cases where either paramedics or first responders attempted to revive a patient in cardiac arrest using CPR and/or defibrillation, irrespective of duration.
EMS attended	Cardiac arrest events attended by paramedics or first responders, regardless of whether treatment was provided.
EMS response time	The time from emergency call to arrival of the first EMS crew on scene.
EMS treated	Cases involving an EMS attempted resuscitation.
Event survival	Patients that have a palpable pulse on arrival at hospital as documented on the PCR.
Paediatrics	Patients aged less than 16 years.
PCI-capable hospital	Denotes a hospital with part-time or full-time Percutaneous Coronary Intervention (PCI) capabilities.
Presumed cardiac aetiology	Cases where the cause of arrest is not due to a known precipitator (e.g. trauma, overdose/poisoning etc.) as acquired from the PCR.
Return of Spontaneous Circulation (ROSC)	Cases in which the resuscitation attempt results in a return of spontaneous circulation (i.e. detectable pulse) at any time.
Survival to hospital discharge (or discharged alive)	Patients who are discharged from hospital alive.
Shockable Rhythm	Rhythms which are appropriate to receive defibrillation, including ventricular fibrillation and pulseless ventricular tachycardia, by EMS or a bystander with a public automated external defibrillator.
Transported with CPR	Patients who, at the time of scene departure, are administered ongoing CPR.
Transported with ROSC	Patients that, at the time of scene departure, have a ROSC (i.e. detectable pulse).
Utstein patient group	Patients who are witnessed to arrest by a bystander, present in a shockable rhythm and an attempt at resuscitation was made by EMS.

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