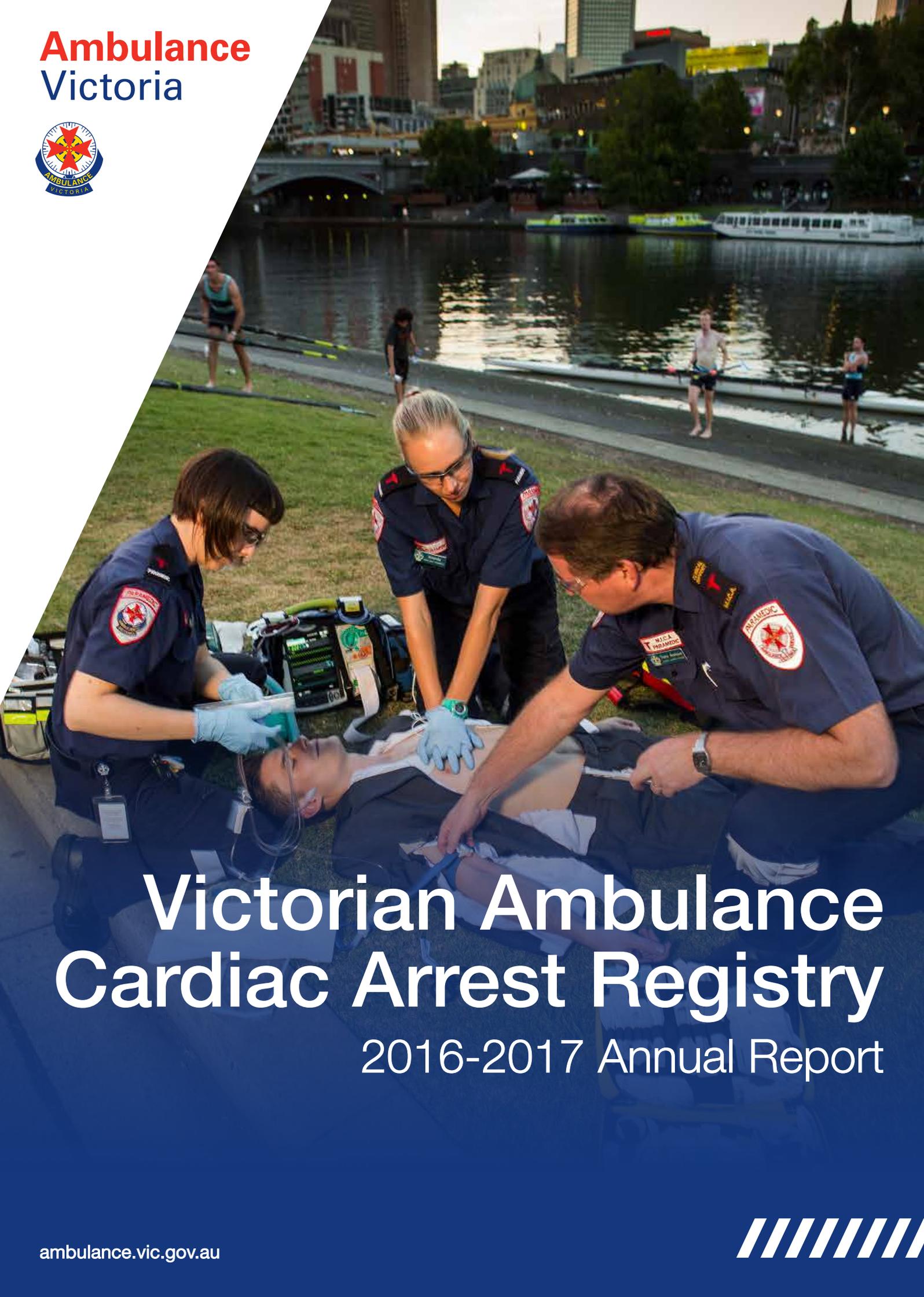


**Ambulance
Victoria**



Victorian Ambulance Cardiac Arrest Registry

2016-2017 Annual Report



Victorian Ambulance Cardiac Arrest Registry

2016-2017 Annual Report

The VACAR Annual Report 2016-2017 is a publication produced by the Centre for Research & Evaluation, Ambulance Victoria.

Director Prof Karen Smith
Author Dr Kylie Dyson

If you would like receive to this publication in an accessible format please contact the Director, Centre for Research and Evaluation, Ambulance Victoria: karen.smith@ambulance.vic.gov.au.

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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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Ambulance Victoria
375 Manningham Road
Doncaster VIC 3108

Postal Address:
PO Box 2000
Doncaster VIC 3108

Email: karen.smith@ambulance.vic.gov.au
Website: www.ambulance.vic.gov.au
Phone: 03 9896 6083
Facsimile: 03 9011 7739

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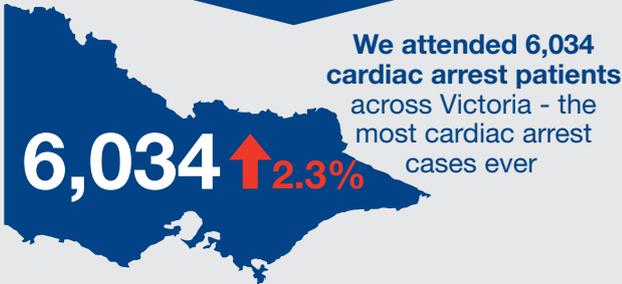
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DEMOGRAPHICS

THIS YEAR WE TREATED MORE CARDIAC ARREST PATIENTS THAN EVER BEFORE



64% MALE
65 years



36% FEMALE
72 years

76% of cases occurred in private residences

15% in a public place

8% in aged care facilities

1% in medical facilities

76%

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



86% OF CARDIAC ARRESTS were correctly identified by ETSA Triple Zero (000) call takers



7.7 minutes

We recorded our **FASTEST EVER** response time

Patients were defibrillated **ONE MINUTE FASTER** than last year in a median time of 9.2 minutes - our fastest time yet

9.2 MINUTES ↓ **1 min faster**



BYSTANDER INVOLVEMENT

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



Bystander CPR has **almost doubled** in the past decade from **23% to 40%**



Patients who received bystander CPR had a **higher survival rate** (12%) compared with those with no bystander CPR (7%)



Public AED usage has increased **600%** in the past decade

80 patients were defibrillated by a **publically accessible defibrillator** - compared to 73 last year



POST CARDIAC ARREST OUTCOMES

MORE CARDIAC ARREST PATIENTS ARE RETURNING HOME TO THEIR FAMILIES

We recored our highest number of survivors. **379** patients were discharged alive from hospital - 21 more than last year

379
↑ **21**



WE RECORDED OUR HIGHEST EVER UTSTEIN SURVIVAL RATE



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



With **77%** of patients able to return to work (if working prior)



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

VACAR data has been used to inform a large research program to improve patient care, including 13 research papers.

Including 3 world leading trials



Cycling buddies save a life

When John Tilleard went for a bike ride just after Christmas in 2016 he didn't realise how important his choice of cycling buddies was. It saved his life.

John's mates thought he was mucking around when they saw him topple from his bike at the top of a hill at Arthurs Seat on the Mornington Peninsula. But they quickly realised he wasn't breathing.

Two of his fellow cyclists started CPR while another called Triple Zero (000) and one got a defibrillator from a nearby business.

They delivered two shocks to John's heart in the minutes before paramedics arrived.

When paramedics arrived they asked the cyclists to continue CPR, which allowed the paramedics to provide advanced care.

John's heart was given a number of further shocks but it didn't revert to a normal rhythm.

Further treatment by Advanced Life Support and MICA paramedics including doses of adrenaline restored John's pulse.

John was conscious when he arrived at hospital and has made a good recovery to return to cycling.

He's thankful for his friends' efforts.

'I am the luckiest man alive. I happened to be riding with six people who just knew what to do,' John said.

'I call them my angels. What else can you call them? If it wasn't for them I wouldn't be here.'





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 OHCA 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). We were pleased to note that 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. Namely, cohort coverage, nature of the data, public reporting and feedback to clinicians.

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 Victorian Ambulance Cardiac Arrest Registry (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).

The 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 2016-2017 VACAR Annual Report.



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



Professor Stephen Bernard
Medical Director
Ambulance Victoria



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The Emergency Medical Service

The state of Victoria, Australia has an estimated population of 6.2 million, with over 4.5 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 (76 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.com.au>). As at December 2017, there were over 3,300 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 88,000 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, VACAR has successfully established an internationally recognised research program, with the publication of scientific literature in key medical journals (see 2016-2017 Peer-reviewed Publications, page 49). 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 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.



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 care givers.
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, 2016-2017 (n=6,034).

Patient age	52 (0.9%)
Patient sex	14 (0.2%)
Arrest location	13 (0.2%)
Witnessed status	80 (1.3%)
Bystander CPR	95 (1.6%)
Rhythm on arrival	19 (0.3%)
EMS response time	11 (0.2%)
Defibrillation time	41 (0.7%)
Outcome at scene	4 (0.1%)
Event survival	6 (0.6%)
Hospital discharge status	35 (0.6%)
Hospital discharge direction	5 (0.1%)





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 2016 to 30 June 2017. Data for this report was extracted on 29 November 2017, 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 52.

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 <http://health.vic.gov.au/maps/mapflash/vicpage.htm>). 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 28 July 2017, Australian Bureau of Statistics (ABS)). The Victorian population up to the end of June 2017 was 6,179,249 persons (excluding unincorporated areas). Annual Victorian data by age was sourced from the Australian Demographic Statistics report (published 27 September 2017, 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 (e.g. 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 6,034 OHCA events in the period between 1 July 2016 and 30 June 2017, with 98% involving adults. The proportion of all adult OHCA patients receiving emergency treatment by EMS was 46%; when excluding EMS witnessed arrests, 43% 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: 125 versus 89 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 2016-2017 was 88 events per 100,000 population; age-adjusted OHCA incidence in males was 114 events per 100,000 and in females was 66 events per 100,000 (see Incidence & Demographics, page 21).

2. The demographic profile of patients in 2016-2017 was similar to those observed over the last decade. OHCA due to a presumed cardiac cause accounted for 69% of adult EMS attended patients. Aside from presumed cardiac causes, sudden infant death syndrome (SIDS) was one of the leading causes 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, page 21).

3. In 95% of cases bystanders correctly called 000 first rather than an alternative such as a family member or GP. Emergency call-takers were effective at identifying cardiac arrest events during the emergency call; 86% of all EMS attended arrests and 90% of EMS attended arrests due to cardiac aetiology were correctly identified (see Chain of Survival, page 29).

4. The median state-wide response time to EMS treated events in 2016-2017 was 7.7 minutes (90th percentile time, 15.4 minutes), faster than the previous year. The median EMS response time to EMS treated patients in the metropolitan region (median 7.3 minutes, 90th percentile 12.5 minutes) was faster than the previous year. The median EMS response time to EMS treated patients in the rural regions (median 9.5 minutes; 90th percentile time 21.7 minutes) was faster than in the previous year (see Chain of Survival, page 29).

5. The rate of bystander CPR for bystander witnessed OHCA events in 2016-2017 remained high (61%), compared to 42% a decade ago. Also, the rate of bystander CPR amongst bystander witnessed OHCA patients receiving EMS attempted resuscitation in 2016-2017 remained high (74%). Use of public automated external defibrillators increased almost six-fold over the last decade for patients presenting in a shockable rhythm and the highest number of patients ever (80) received their first shock from a public defibrillator. (see Chain of Survival, page 29).

6. In 2016-2017, 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 (38% vs 26%, 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 (18% vs 11%, respectively) (see Chain of Survival, page 29).

7. The state-wide rate of ROSC in adult EMS treated patients during 2016-2017 was 37%. The rate of event survival for all-cause adult OHCA in the EMS treated population during this period was 26%. Meanwhile, the rate of survival to hospital discharge was 11% and remained within recent observations (see Survival Outcomes, page 37).

8. The rate of event survival for adult EMS treated patients presenting in a shockable rhythm was 55%, with 34% surviving to hospital discharge. This is the highest annual survival rate achieved in Victoria since VACAR commenced. For adult EMS treated patients presenting in a shockable rhythm and witnessed to arrest by EMS, event survival and survival to hospital discharge were 80% and 66%, respectively. Adults presenting in asystole or pulseless electrical activity experienced the poorest survival outcomes, with 0.4% and 10% surviving to hospital discharge, respectively (see Survival Outcomes, page 37).

9. Utstein patient subgroup survival in Victoria was 37% in 2016-2017. Victorian patients have comparable discharged alive rates to a number of international agencies (see Survival Outcomes, page 37).

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 2016-2017 was almost three times higher than for OHCA patients in 2002-2003 (adjusted odds ratio 2.8, 95% CI 2.2-3.7, $p < 0.001$). A significant improvement was also observed for patients who presented in a shockable rhythm over the same period (adjusted odds ratio 3.6, 95% CI 2.5-5.0, $p < 0.001$) (see Survival Outcomes, page 37).

11. Most OHCA patients with known survival to hospital discharge were discharged home (85% in 2016-2017). 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, 77% had returned to work 12 months after their arrest (see Long-term Functional Outcomes, page 44).





Incidence & Demographics

Incidence of all adult & paediatric events[†]

In 2016-2017, Ambulance Victoria attended 6,034 OHCA events, of which 5,931 (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 higher than the previous year, however remains low (103 cases in 2016-2017), and is within normal yearly fluctuations.

Of all adult OHCA events attended in 2016-2017, 46% received an emergency resuscitation attempt by paramedics and/or first responders (includes EMS witnessed events; in the previous year, this was 44%). The rate of EMS attempted resuscitation for adult attended OHCA has risen over the last 10 year period (43% in 2007-2008; 46% vs 43%, $p < 0.001$).

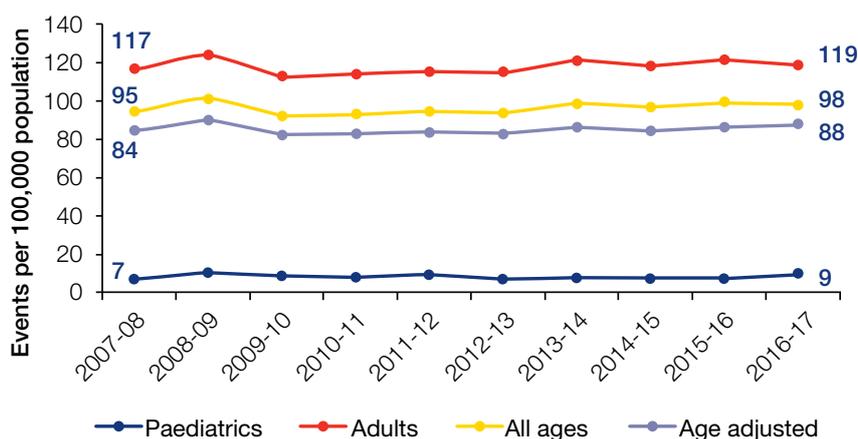


Figure 1: Crude incidence of all ages, adult and paediatric EMS attended OHCA in Victoria and age adjusted incidence rate of EMS attended events (includes EMS witnessed events).

The crude incidence of OHCA has remained relatively consistent over the last decade. In 2016-2017, the unadjusted incidence of all OHCA in Victoria was 98 events per 100,000 population, higher than the rate of 95 events per 100,000 population observed in 2007-2008 (see Figure 1). However, age standardisation gives rise to an adjusted OHCA incidence rate of 88 events per 100,000 population during 2016-2017. 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 2016-2017 was 114 events and 66 events per 100,000 population, respectively.

The incidence of adult and paediatric events also remained within recent observations; 119 and 9 events per 100,000 population in 2016-2017, 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 a major reason for EMS withholding resuscitation efforts in adult patients. The crude incidence of adult EMS treated events was 55 events per 100,000 population.

In paediatric patients, the proportion of EMS treated events is higher than in adults. Most paediatric patients (75%) received an attempted resuscitation by EMS during 2016-2017 (includes EMS witnessed events; in the previous year, this was 84%). The rate of EMS attempted resuscitation for paediatric events over the last 10 years has been quite variable; this rate was 72% in 2007-2008. The crude incidence of paediatric EMS treated events was six events per 100,000 population.

[†] All results in this section include EMS witnessed events

In 2016-2017, Ambulance Victoria attended 5,931 adult OHCA events, the highest number of events recorded. The rate of attempted resuscitation by EMS remains over 45%.



Incidence across regions of Victoria†

In 2016-2017, 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 (4,128 cases, representing 68% of the total number of events attended by AV). Similarly, the highest number of events in rural Victoria were attended in 2016-2017 for the last 10 years (1,906 events, a 40% increase since 2007-2008).

Despite the increased proportion of events occurring in the metropolitan region, the crude incidence of OHCA was significantly higher in the rural region (125 vs. 89 events per 100,000 population, $p < 0.001$) (see Figure 2).

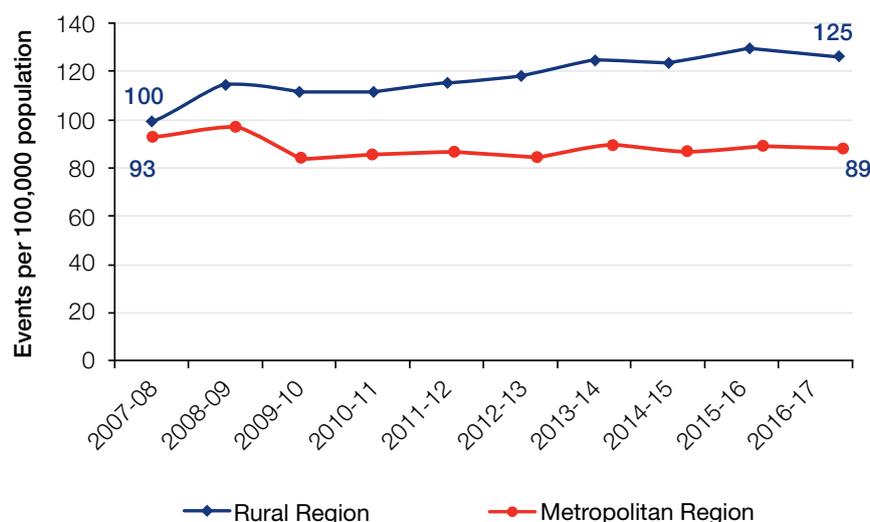


Figure 2: Yearly crude incidence of EMS attended events across metropolitan and rural regions of Victoria (includes EMS witnessed events).

The crude incidence of OHCA has increased over the last 10 years in rural Victoria, rising from 100 events in 2007-2008 to 125 events per 100,000 population in 2016-2017. As noted previously, this observation may reflect better case capture since 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 increased over the last ten years.

There is regional variability in OHCA incidence across Department of Health and Human Services regions (see Figure 3). The lowest crude incidence during 2016-2017 was observed in the Eastern Metropolitan Region (82 events per 100,000 population) and the highest incidence in the Gippsland region (132 events per 100,000 population). The North and West Metropolitan region, which includes the Melbourne Business District, had a total of 1,808 OHCA.

The proportion of events receiving an attempted resuscitation by EMS varies considerably across regions. The highest proportion of EMS treated events during 2016-2017 occurred in the North and West Metropolitan region (50%) and the lowest in the Grampians region (38%).

† All results in this section include EMS witnessed events

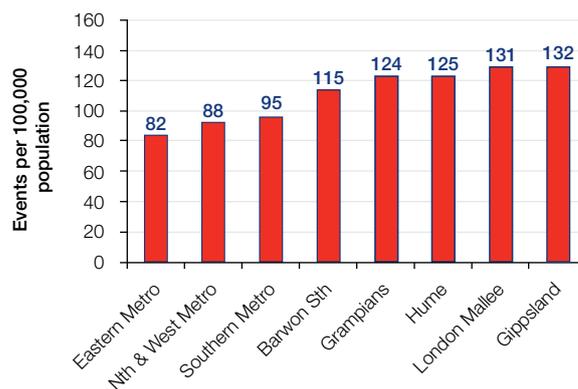


Figure 3: Crude incidence of EMS attended events across Department of Health and Human Services regions, 2016-2017.

Demographics of adults

The demographic profile of adult OHCA events (excluding EMS witnessed arrests) has been consistent over the last decade. In 2016-2017, 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 30% and the proportion occurring in a public location was 14%. Notably in 2016-2017, the proportion of adult patients receiving bystander CPR (40%), were almost double the rate in 2007-2008 (23%) ($p < 0.001$). In 2016-2017, 11% of adult OHCA patients presented in a shockable (VF or VT) rhythm to either EMS or a bystander who made use of an automated external defibrillator.

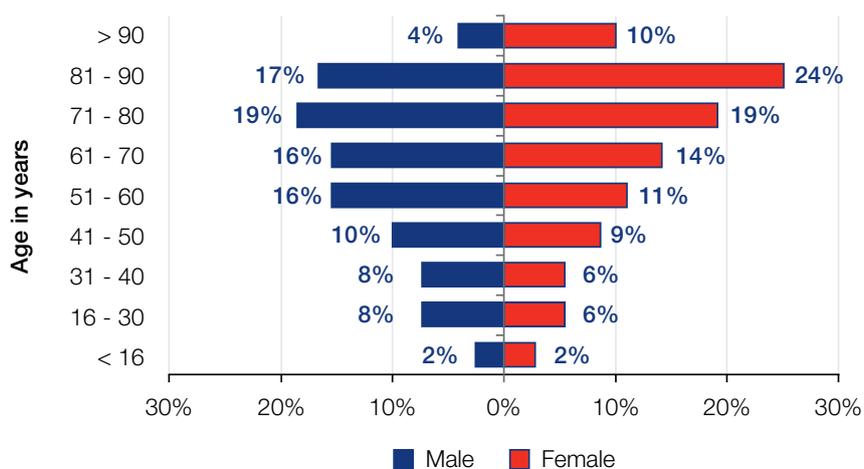


Figure 4: Age distribution of EMS attended OHCA events, 2016-2017.

Paramedics attempted resuscitation in 43% 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 (70%), a lower median age (65 years), more events occurring in a public location (20%), more events witnessed by a bystander (50%) and a high rate of bystander CPR (71%).

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 (96 in 2016-2017). The median age of arrest in 2016-2017 was thirty months, which is higher than in the past decade. During 2016-2017, 55% of paediatric OHCA events occurred in children aged less than three years. 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 2016-2017, EMS attended paediatric events were predominantly males (65%). Within the paediatric OHCA population, 18% of events during 2016-2017 occurred in a public location. Significantly more paediatric patients received bystander CPR than adult patients during 2016-2017 (66% vs. 40%, respectively; $p < 0.001$).

The majority of paediatric patients during 2016-2017 presented to EMS in an asystolic rhythm (74%). In 2016-2017, four paediatric patients were defibrillated prior to the arrival of EMS with a public automated external defibrillator. This is the highest annual number of paediatric patients defibrillated by the public ever recorded by VACAR; three (75%) of these patients survived. The rate of EMS attempted resuscitation amongst paediatric patients during 2016-2017 remained high (74%). Significantly more paediatric cases received an attempted resuscitation by paramedics than adults during 2016-2017 (74% vs 43%, respectively; $p < 0.001$).

In 2016-2017, Ambulance Victoria attended 96 paediatric events. Median age was thirty 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 2016-2017, 69% of EMS attended adult OHCA were presumed to be of a cardiac cause. Other frequent causes of OHCA during 2016-2017 were: trauma (7%), terminal illness (7%), overdose/poisoning (5%), hanging (5%) and respiratory causes (4%, see Figure 5).

For adult patients receiving an attempted resuscitation by EMS during 2016-2017, most cases were due to a presumed cardiac cause (74%).

The rate of EMS attempted resuscitation differed amongst patients according to the precipitating cause of the event. During 2016-2017, the rate of EMS attempted resuscitation for arrests due to presumed cardiac cases was 47%. Rates of EMS attempted resuscitation during 2016-2017 were lower for arrests due to trauma (28%), overdose/poisoning (42%) and hangings (33%) and terminal illness (17%). In contrast, most OHCA events due to a respiratory cause received EMS attempted resuscitation (67%).

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 (53%), 51-75 years (77%) and

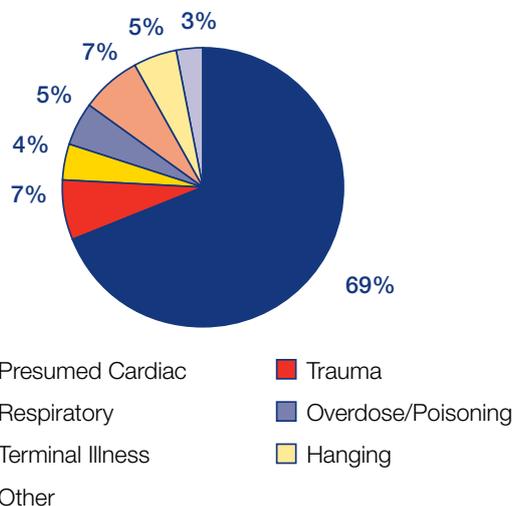


Figure 5: Adult precipitating events for EMS attended events, 2016-2017.

>75 years age group (83%). Meanwhile, in the 16-35 years age group during 2016-2017, the predominant precipitating factor was the combined causes of trauma and hanging (47%). In this young adult age group in 2016-2017, presumed cardiac cause was the precipitating factor for 28% 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 2016-2017).

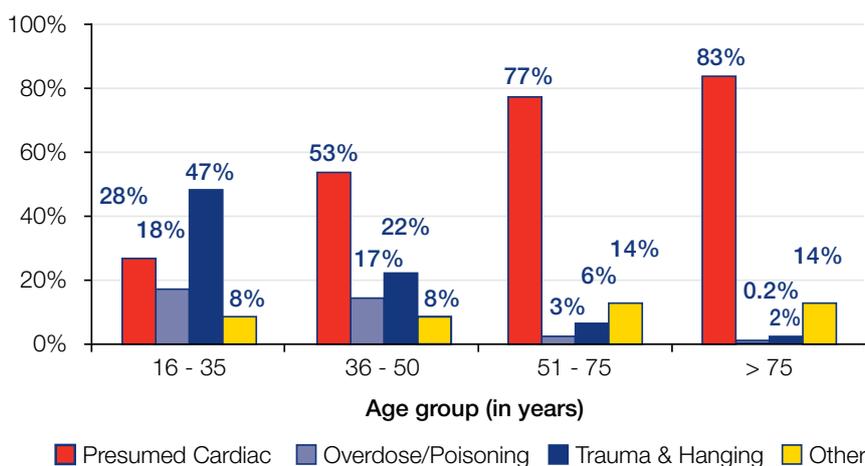


Figure 6: Adult precipitating events across age groups for EMS attended events, 2016-2017.

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

2016 Thunderstorm asthma event

The 2016 Thunderstorm Asthma event was associated with a significant increase in OHCA events (Andrew 2017). A total of 31 OHCA events were recorded on Monday 21 November 2016, 17 of which occurred between the hours of 6pm and midnight (after the storm struck at 5pm). Usually, approximately 5 OHCA events would be recorded during this 6-hour period on a Monday.

Of the 17 events occurring after the storm, 9 (53%) were respiratory in nature, and 8 (57%) were recorded as having a pre-existing history of asthma. A total of 13 (77%) patients received a resuscitation attempt by EMS, and 4 were discharged from hospital alive.

Precipitating events for paediatrics

Precipitating events for paediatrics who suffer OHCA vary considerably in comparison to adults. In 2016-2017, 30% 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 (25% in 2016-2017). During 2016-2017, less common causes of paediatric OHCA include trauma (15%), drowning (7%), respiratory causes (6%) and terminal illness (3%). Previous research by the 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.

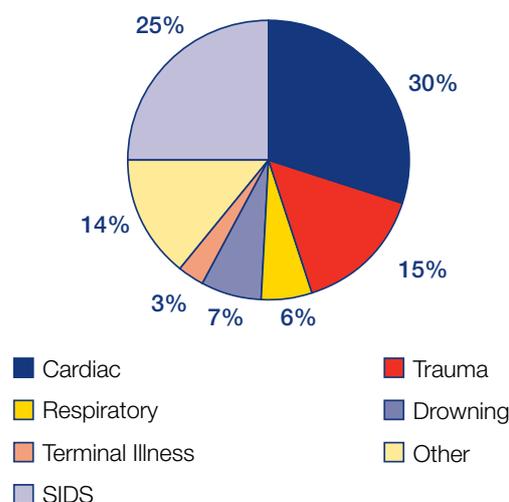


Figure 7: Paediatric precipitating events for EMS attended events, 2016-2017

Mechanism of arrest in the traumatic sub-group*

Cardiac arrests secondary to major trauma are an important, potentially-preventable patient subgroup. During 2016-2017, arrests secondary to road trauma were responsible for 64% of events, while arrests following ballistic trauma and stabbings accounted for 13% and arrests following falls accounted for 9%, see Figure 8. Blunt trauma (involving falls, crush injuries, or forces considered blunt) were responsible for 14% of traumatic OHCA during 2016-2017.

The following vehicles were the mode of transport associated with road trauma incidents during 2016-2017: a car or light vehicle (64%), motorcycle (14%), train (13%), truck (4%) and bicycle (2%). During 2016-2017, the role of the OHCA patient in these vehicles was as the vehicle driver (63%), pedestrian (29%) and passenger (7%).

* '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.

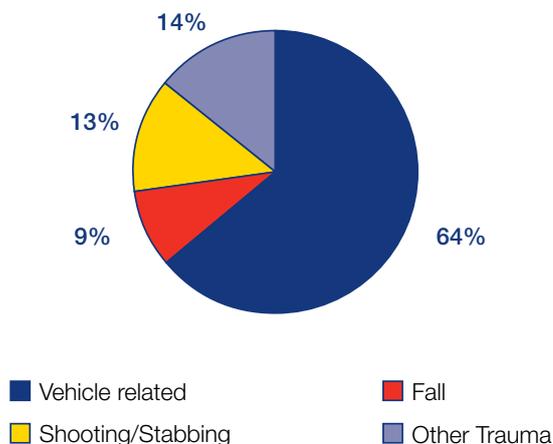


Figure 8: Sources of trauma in EMS attended traumatic OHCA sub-group, 2016-2017.





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 2016-2017, most (76%) EMS attended adult OHCA events occurred within a private residence. Other common arrest locations were a public place (15%) and aged care facility (8%) (see Figure 9).

Similar to EMS attended adult OHCA events, amongst adult patients who received an attempted resuscitation by EMS during 2016-2017, the most common site of an arrest was a private residence (71%), followed by arrests in a public place (20%) and aged care facility (7%). 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 2016-2017, the unadjusted rates of adult survival to hospital discharge were highest in public places (28%) and medical facilities (21%). Unadjusted adult survival to hospital discharge in a private residence (7%) and aged care facilities (1%) remained relatively low. Unadjusted adult survival to hospital discharge varied significantly between private residences and public places (7% vs. 28%, respectively; $p < 0.001$).

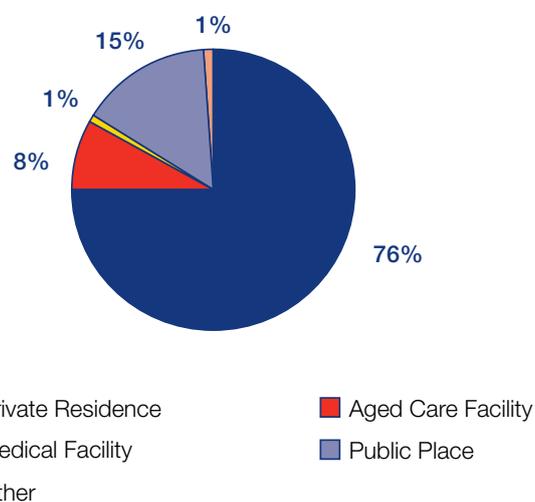


Figure 9: Location of arrest for EMS attended adult events, 2016-2017.

The locations of arrest for paediatric events were similar to those in adults. In 2016-2017, 80% of EMS attended paediatric events occurred in a private residence and 18% occurred in a public place.

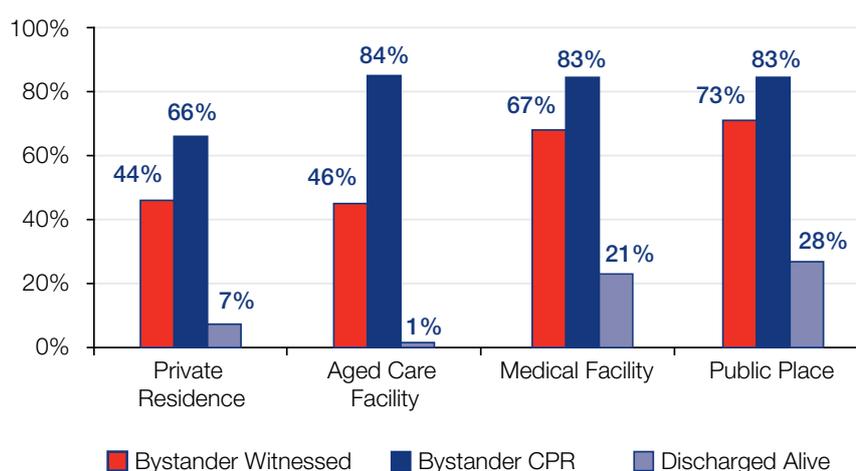


Figure 10: Proportion of EMS treated adult events that are bystander witnessed, receive bystander CPR and are discharged alive across arrest locations, 2016-2017.

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



Early Access



Early CPR



Early Defibrillation



Early Advanced Care



Chain of Survival

The chain of survival is an internationally-recognised initiative aimed at maximising survival following 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 2016-2017, 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 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.

Accurate identification of cardiac arrest during the emergency call also influences the timing of dispatcher-assisted CPR instructions and response of EMS. In 2016-2017, 86% of EMS attended arrests were correctly identified during the emergency call. For EMS attended arrests due to presumed cardiac aetiology in 2016-2017, 90% were correctly identified during the emergency call. This figure was effectively the same in the metropolitan and rural regions during 2016-2017 (89% and 90%, respectively).

Emergency response to the incident

The distribution of response times for the EMS treated population across regions in 2016-2017 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.

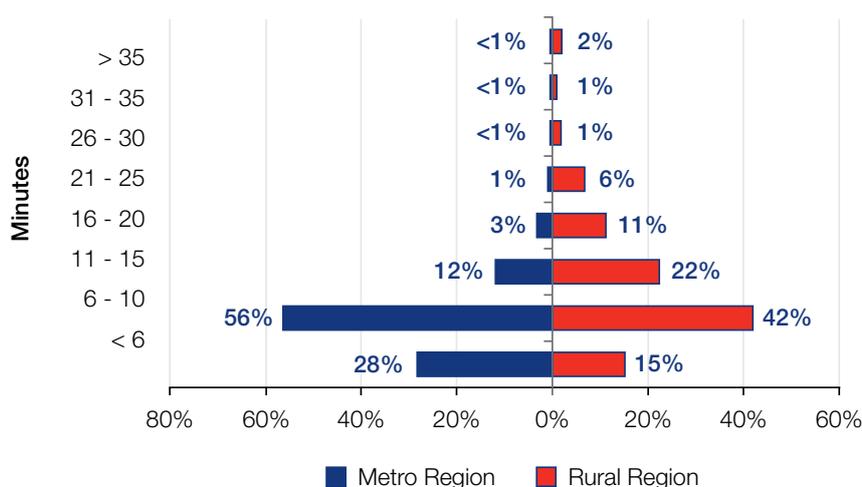


Figure 11: Distribution of time from call to arrival of EMS on scene in the EMS treated population, 2016-2017.

In 2016-2017, state-wide, median response time to EMS treated events was 7.7 minutes (90th percentile time 15.4 minutes). These were faster than the response times noted in the previous year (median time 7.8 minutes; 90th percentile time 15.4 minutes). In 2016-2017, median response times to EMS treated events in metropolitan regions was 7.3 minutes (90th percentile time 12.5 minutes) compared to 7.4 minutes (90th percentile time 12.6 minutes) in the previous year. Median response time in rural areas in 2016-2017 was 9.5 minutes (90th percentile time 21.7 minutes), faster than in the previous year (median time 10.0 minutes; 90th percentile time 21.3 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 2016-2017, 40% of patients received CPR performed by bystanders, compared to 23% of patients receiving bystander CPR 10 years ago ($p < 0.001$). Of OHCA events witnessed to collapse by bystanders in 2016-2017, 61% of patients received bystander CPR, in comparison to 42% of patients in 2007-2008 ($p < 0.001$). Of bystander witnessed OHCA events receiving an attempted resuscitation by EMS, 74% received bystander CPR in 2016-2017, compared to 53% in 2007-2008 ($p < 0.001$). The rate of bystander CPR amongst bystander witnessed OHCA cases which received EMS attempted resuscitation has been over 70% for the past five years

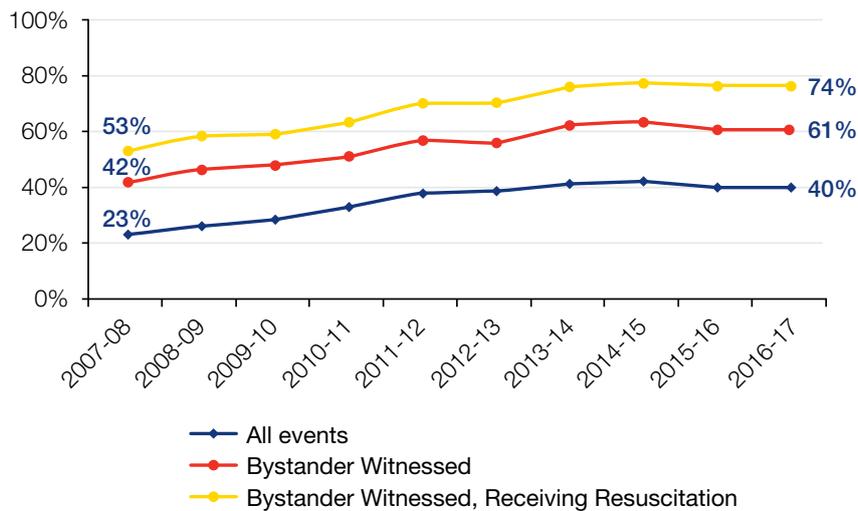


Figure 12: Bystander CPR rates.

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).

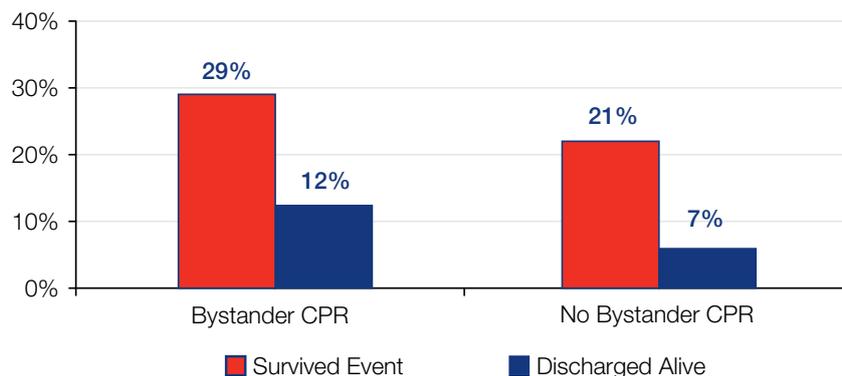


Figure 13: Unadjusted survival outcomes after bystander CPR in the EMS treated population, 2016-2017.

Unadjusted survival was strongly associated with the presence of bystander CPR (see Figure 13). In 2016-2017, 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 (21%), $p < 0.001$.

In 2016-2017, survival to hospital discharge was significantly higher for patients receiving bystander CPR (12%) versus no bystander CPR (7%), $p < 0.001$. These rates were similar in 2015-2016.

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 (Lijovic 2014).

The proportion of cases where AV performed the first defibrillation has reduced significantly between 2007-2008 and 2016-2017, from 88% to 78% ($p < 0.001$). This decline has been driven by an over six-fold increase in the use of public automated external defibrillators (AED) by bystanders over the same period (2% to 13%, $p < 0.001$). The proportion of cases first defibrillated by first responders during 2016-2017 was 9% (in the previous year, this was 8%).

The time to first defibrillation by EMS is recorded for EMS treated patients whose rhythm is shockable on EMS arrival. In 2016-2017, the state-wide time to defibrillation of 9.2 minutes (90th percentile time 16.0 minutes) was faster than the previous year (median time 10.4 minutes; 90th percentile time 17.2 minutes; $p < 0.001$). The median time to defibrillation in the metropolitan region in 2016-2017 was 9.1 minutes (90th percentile time 14.4 minutes), faster than the previous year (median time 10.0 minutes; 90th percentile time 16.1 minutes; $p < 0.001$). In the rural region in 2016-2017, median time to defibrillation was 9.7 minutes (90th percentile time 18.0 minutes), faster than the previous year (median time 11.9 minutes; 90th percentile time 20.4 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 29).

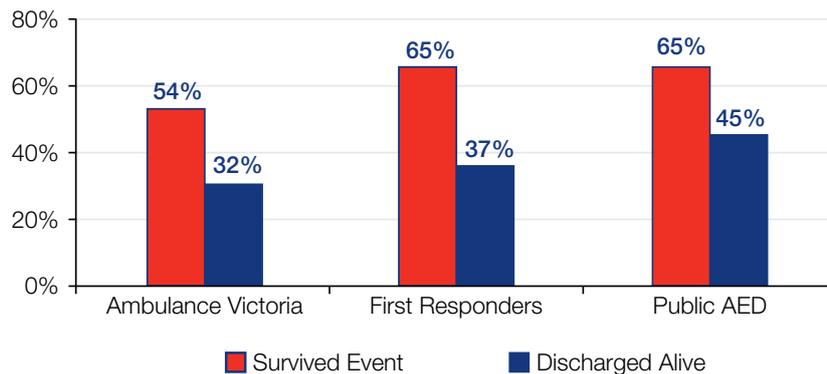


Figure 14: Unadjusted survival outcome according to who shocked first in the EMS treated population with a shockable rhythm on or before EMS arrival, 2016-2017.

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 65%, compared with 54% of patients first shocked by paramedics and 65% of patients first shocked by first responders. The 2016-2017 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 2016-2017 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 45%, compared with 32% of patients first shocked by paramedics and 37% of patients first shocked by first responders. The 2016-2017 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 45% for OHCA patients defibrillated with a public AED during 2016-2017 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 will be launching a smart phone app aimed at alerting approved public responders to cardiac arrest patients within their vicinity (www.ambulance.vic.gov.au/community-education/community/register-my-aed/goodsam-project/). 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.



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 tend to 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, 2016-2017.

	All OHCA	Bystander witnessed
Total events	6,034 [^]	1,661
- Bystander CPR	2,211 (37%)	1,007 (61%)
- Bystander AED use	80 (1%)	67 (4%)
- Shockable rhythm	610 (10%)	473 (28%)
EMS treated events	2,412	1,183
- Survived event	637 (26%)	448 (38%)
- Discharged alive	259 (11%)	208 (18%)

[^] 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 2016-2017. Bystander CPR rates were higher amongst OHCA patients witnessed to arrest by a bystander, compared with all OHCA patients (61% vs 37%, respectively).

Also, unadjusted likelihood of an OHCA patient presenting in a shockable rhythm in 2016-2017 was almost nine 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 (28% 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 (38% vs 26%, 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 (18% vs 11%, respectively).

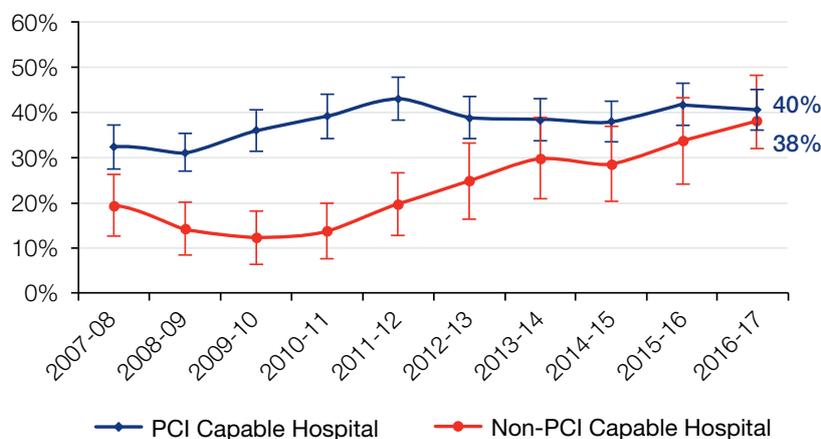


Transport to a cardiac centre

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).

Statewide during 2016-2017, 85% of EMS treated arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. Within the metropolitan region during 2016-2017, 96% of arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. In the metropolitan region in recent years, the rate of transportation to PCI-hospital has remained relatively unchanged.

Within the rural region during 2016-2017, 54% of arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. This represents the highest rate of transportation to PCI-capable hospitals in the rural region for the last 10 years. 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.



† Data in 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.

In 2016-2017, 40% 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 2016-2017, 38% were discharged alive. It is plausible that other hospital-based factors contribute to the variation in outcomes observed across hospitals, including optimal post-arrest treatment strategies.





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 2016-2017, the achievement of ROSC was highest amongst adult OHCA patients who arrested in the presence of EMS (63%). Bystander witnessed arrests attained higher rates of ROSC than unwitnessed arrests in 2016-2017 (46% and 19%, respectively).

Across the entire state in 2016-2017, ROSC was achieved in 37% of all adult EMS treated events (includes EMS witnessed arrests); unchanged from the previous year. During 2016-2017, ROSC was achieved in 37% of OHCA events in the metropolitan region (in the previous year, this was 40%) and 36% of OHCA events in the rural region (in the previous year, this was 33%); includes EMS witnessed arrests. There were no significant difference in ROSC outcomes observed in the metropolitan region compared to the rural region (37% vs. 36%, $p=0.577$).

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 2016-2017, the proportion of adult EMS treated events which were transported from the scene with ROSC was 26%. Efforts were ceased at scene for 70% of adult EMS treated events and the rate of transportation with CPR was low (4%).

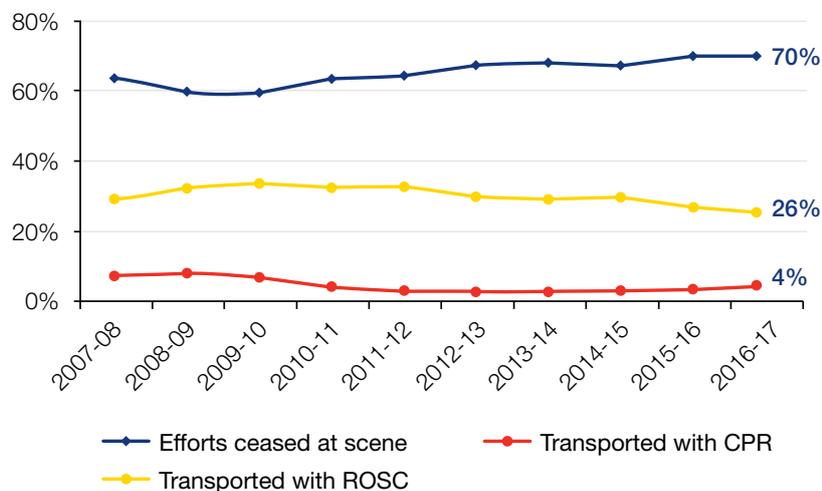


Figure 16: Scene outcomes for adult EMS treated events

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.



Adult survival from all-cause cardiac arrest

Unadjusted adult survival from all-cause OHCA has increased modestly over the past 10 years. In 2016-2017, the rate of event survival for adult EMS treated events was 26% and discharged alive rate was 11% (see Figure 17). The rate of event survival has declined slightly since 2009-2010, however survival to hospital discharge was consistent with recent observations.

In the metropolitan region during 2016-2017, event survival was 27% and discharged alive rate was 11%. In the rural region during 2016-2017, event survival was 24% and discharged alive rate was 10% (unchanged from the previous year).

In 2016-2017, 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 (31% in 2007-2008; 31% vs 26%, $p=0.014$; see Figure 18). Despite this, the rate of patients surviving to hospital discharge has not decreased over the past decade (9% in 2007-2008; 9% vs 11%; see Figure 17).

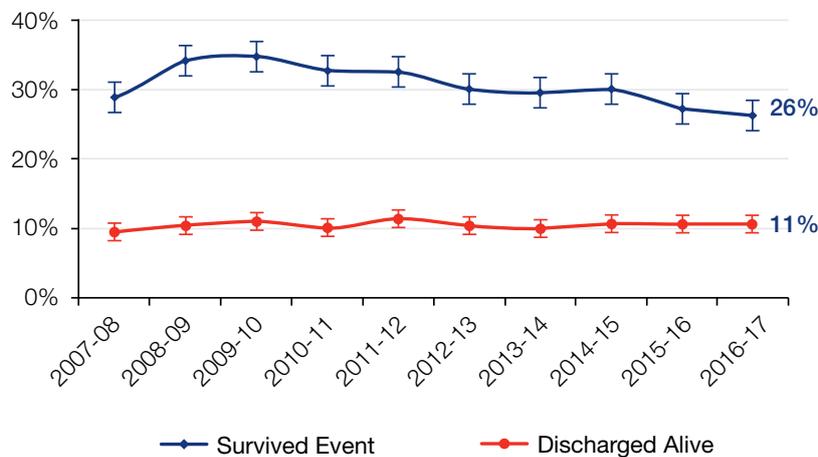


Figure 17: Unadjusted survival outcomes for all-cause adult EMS treated events.

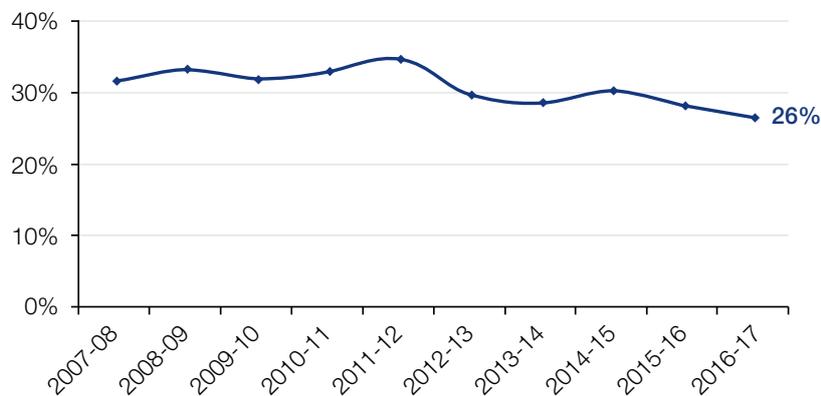


Figure 18: Proportion of adult EMS treated events presenting in a shockable rhythm on arrival.

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).

Of adult EMS treated patients, 34% presenting in a shockable rhythm during 2016-2017 were discharged alive (in the previous year, this was 32%) (see Figure 19). During 2016-2017, 10% of adult patients who presented in PEA were discharged alive (in the previous year, this was 7%), while few adults presenting in asystole (0.4%) were discharged alive (in the previous year, this was 0.3%).

For patients of all ages found in a shockable rhythm during 2016-2017, the rate of event survival was 55% (in the previous year, this was 53%) and the discharged alive rate was 34% (in the previous year, this was 32%).

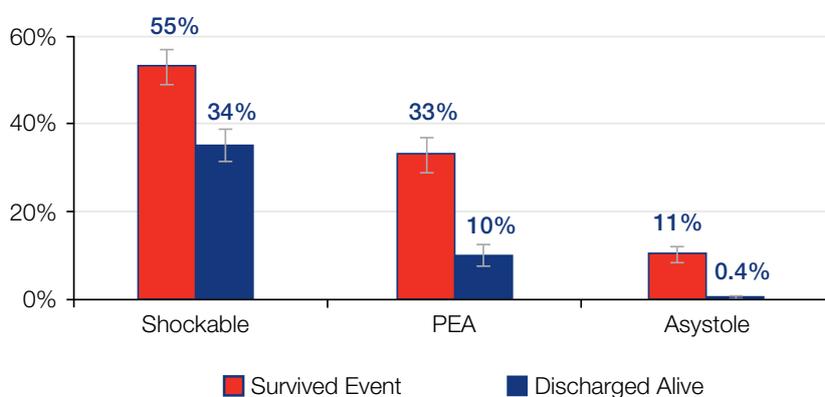


Figure 19: Unadjusted survival outcomes for adult EMS treated events according to presenting rhythm on arrival, 2016-2017.

Outcomes for patients with shockable rhythms have improved over time (see Figure 20). In 2016-2017, adult event survival for patients presenting in a shockable rhythm was 55%. The rate of adult survival to hospital discharge was 34%. This is the highest survival in shockable patients achieved by AV since VACAR commenced monitoring OHCA patients.

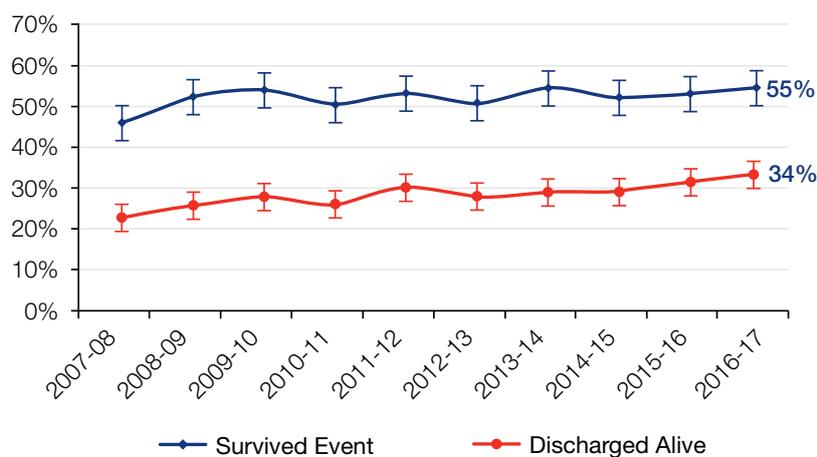


Figure 20: Unadjusted survival outcomes for adult EMS treated events with a shockable rhythm on arrival.



Adult survival from EMS witnessed arrests

In 2016-2017, for adult EMS witnessed events presenting in a shockable rhythm, the rate of event survival was 80% and the rate of survival to hospital discharge was 66% (see Figure 21). These findings are consistent with recent observations. When considering all adult EMS witnessed events during 2016-2017, the rate of event survival was 51% (in the previous year, this was 45%) and the discharged alive rate was 29% (in the previous year this was 28%).

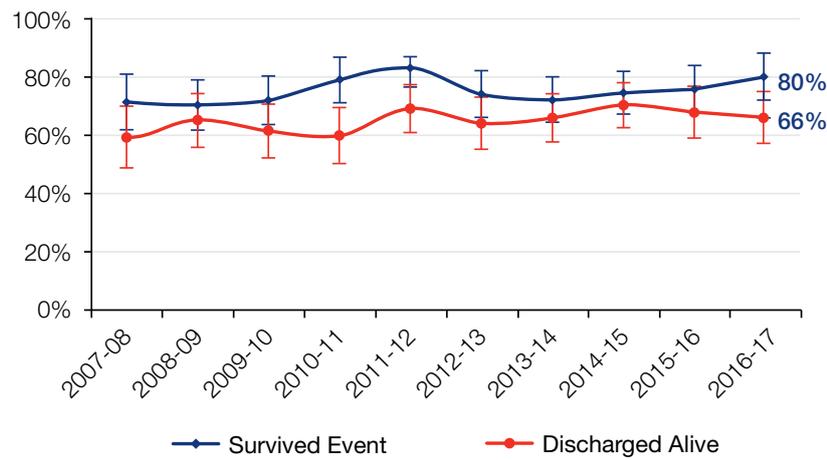


Figure 21: Unadjusted survival outcomes for adult EMS witnessed, EMS treated events with a shockable arrest rhythm.

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 2016-2017, 10% of EMS treated paediatric cases presented in a shockable rhythm (11% in the previous year). Asystole was the most common presenting rhythm (65%).

In 2016-2017, 25% of paediatric EMS treated patients survived the event (29% in the previous year). During 2016-2017, there were six paediatric patients (9%) who were discharged alive (13% in the previous year), consistent with percentages observed over the last 10 years.

There were six EMS witnessed paediatric events in 2016-2017. One patient (17%) survived the event and was discharged alive.

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 22 shows the total number of OHCA events in 2016-2017 and progressively shows the breakdown of events according to EMS attempted resuscitation, precipitating event, witnessed status and presenting rhythm.

In 2016-2017, 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 35%.

Within the metropolitan and rural regions, the rates of being discharged alive within the Utstein patient subgroup was 38% and 34%, respectively. In the previous year, these rates in the metropolitan and rural regions were 37% and 28%, respectively.

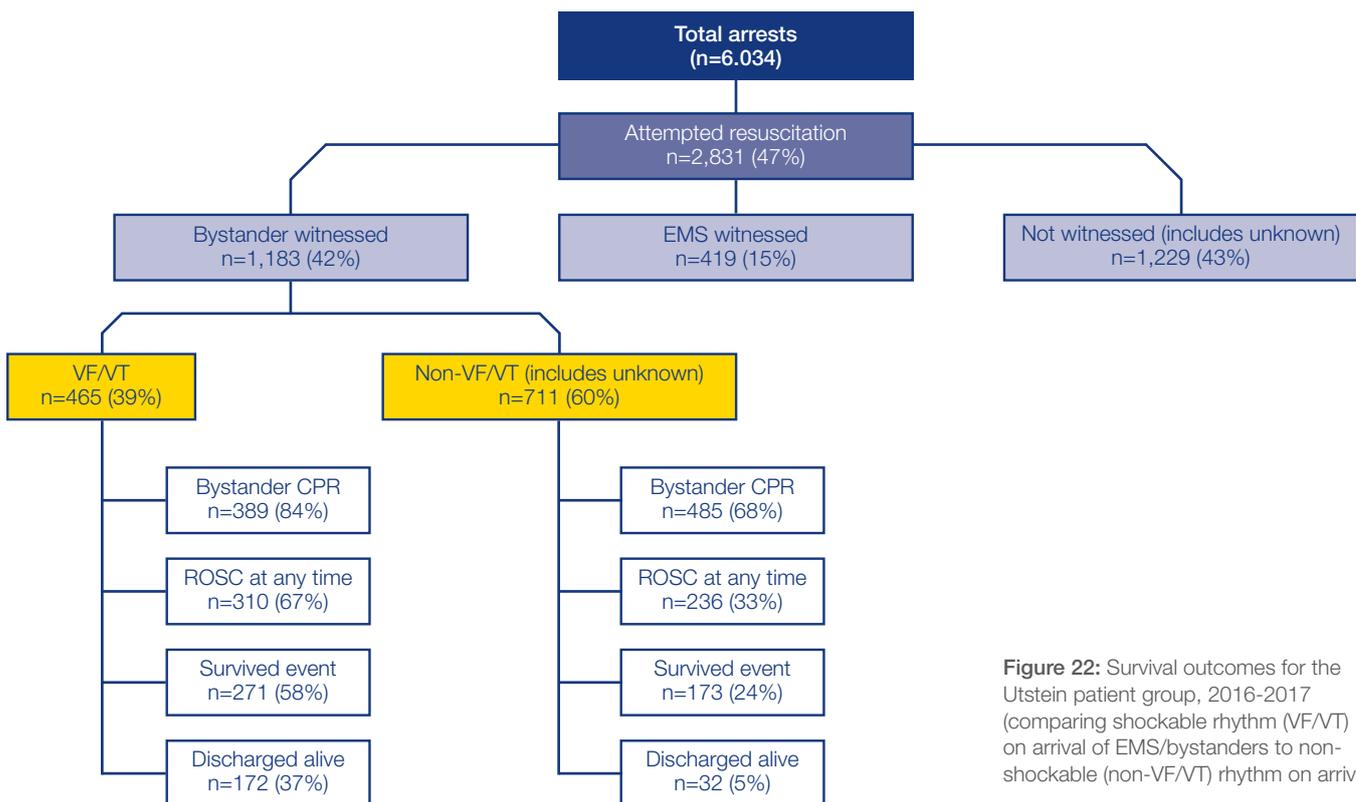


Figure 22: Survival outcomes for the Utstein patient group, 2016-2017 (comparing shockable rhythm (VF/VT) on arrival of EMS/bystanders to non-shockable (non-VF/VT) rhythm on arrival).



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 (e.g. 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.

Whilst a higher survival rate may be noted for patients in Seattle and 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 6.0 million). The Utstein survival rate for greater Melbourne (38%) compares favourably with London (30%, population 4.7 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	2016-2017	37%
- Greater Melbourne		38%
London Ambulance Service [^] (London Ambulance Service 2017)	2016-2017	30%
Pan Asian Resuscitation Outcomes Study, PAROS [^] (7 Asian EMS services; Ong 2015)	2009-2012	28%
Cardiac Arrest Registry to Enhance Survival, CARES ^{^^} (12 US OHCA registries, Vellano 2015)	2013	33%
St John New Zealand ^{^^^} (Dicker and Davey, 2016)	2016-2017	30%
Seattle/King County EMS [^] (Chatalas 2017)	2016	56%
St John Western Australia (St John Ambulance WA, 2016)	2016	35%
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.

^{^^^} Survival to 30 days

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 23 and 24, 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 23). In 2016-2017, the relative odds of survival to hospital discharge for adult EMS treated patients had increased almost three-fold compared to patient outcomes in 2002-2003 (adjusted odds ratio 2.8, 95% CI 2.2-3.7, 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 24). In 2016-2017, 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 3.6, 95% CI 2.5-5.0, $p < 0.001$). The odds of survival for patients presenting in a shockable rhythm and all adult EMS treated patients are the highest recorded by VACAR.

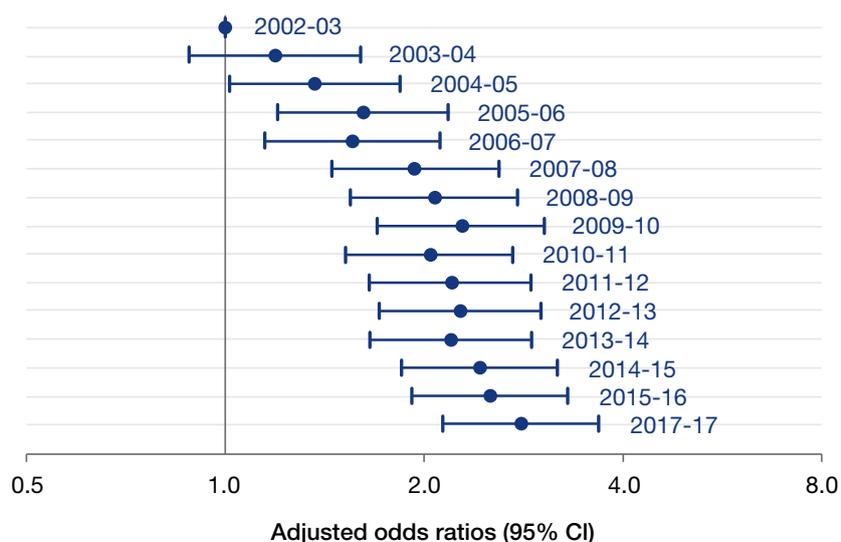
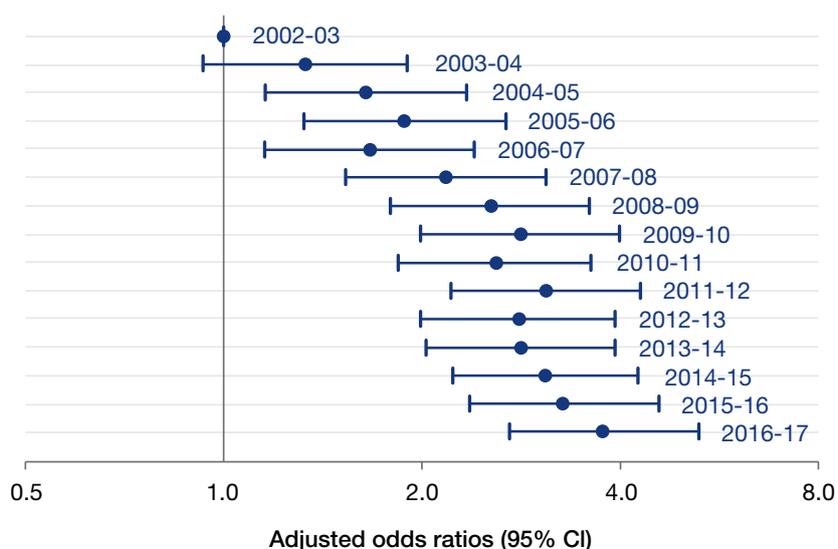


Figure 23: Risk-adjusted odds of adult survival to hospital discharge by year in the overall EMS treated population.



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

Figure 24: Risk-adjusted odds of survival to hospital discharge for adults presenting in a shockable rhythm by year in the overall EMS treated population.



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 25). Discharge home for adult survivors has remained consistent over the last decade. In 2016-2017, 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, 88% were discharged home.

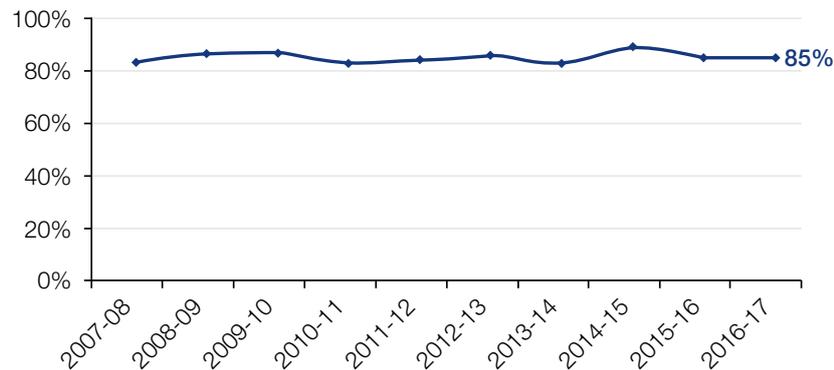


Figure 25: Proportion of adult discharged alive patients who are discharged to home (includes EMS witnessed events).

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 348 adults who arrested between 1 July 2015 and 30 June 2016 and were discharged alive from hospital, 328 patients were alive 12-months post-arrest and were eligible for contact in 2016-2017. Interviews were conducted with 234 patients and 51 proxies (n=285), producing a response rate of 87%. There were 139 individuals who had worked prior to their arrest; 77% of individuals (107 of 139) returned to work after their arrest. Of those returning to work, 86% (92 of 107) returned to work in the same role.

SF-12 survey data for OHCA patients who arrested during 2015-2016 and were followed up 12 months later were expressed as SMD scores (outlined on page 45). The SMD (± 95 CI) for both the PCS and MCS crossed zero (see Figure 26). This means there was no significant difference from Australian population norms for physical health or mental health. SF-12 data was available for all but six patients (n=228).

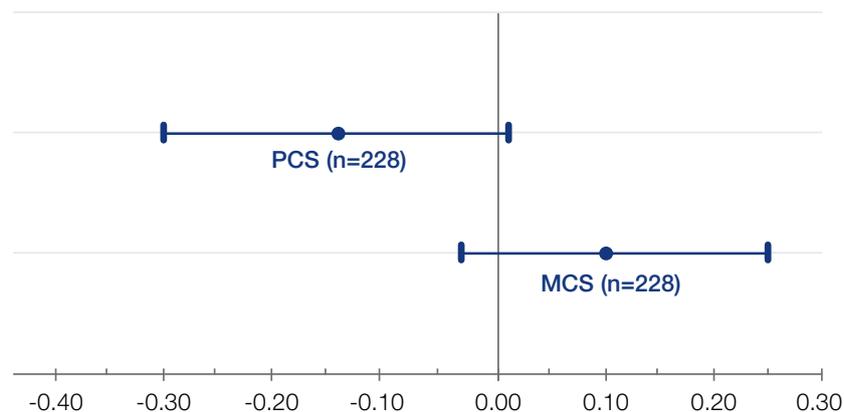


Figure 26: Standardised mean differences for SF-12 scores at 12 months post arrest for adult OHCA survivors versus the Australian population (patients who arrested between 2015-2016).

As a group, OHCA patients who arrested during 2015-2016 reported physical health scores similar to the Australian population (SMD PCS -0.140, 95% CI -0.293 to 0.014). These patients also reported mental health scores similar to the Australian population (SMD MCS 0.109, 95% CI -0.029 to 0.248)

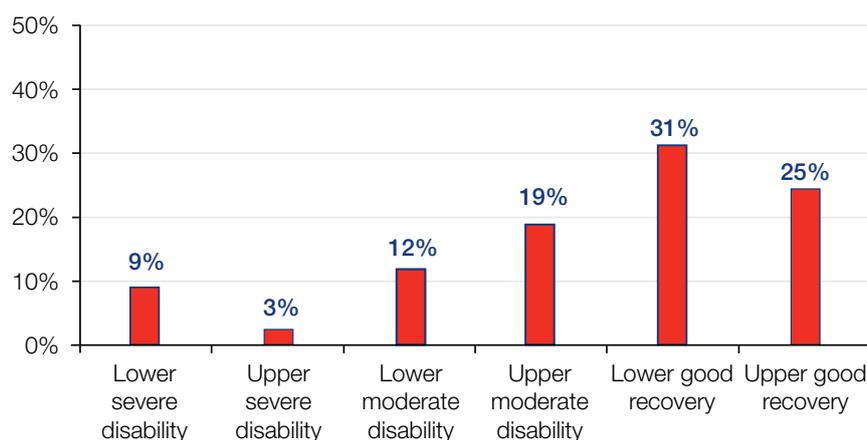


Figure 27: Disability or recovery status according to the GOS-E for adult OHCA survivors at 12 months post arrest (patients who arrested between 2015-2016).

The GOS-E measure indicated that 56% of survivors who arrested during 2015-2016 (161 of 285) were rated as having good functional recovery 12 months after their arrest (see Figure 27). In addition 31% reported good recovery with only moderate disability.

Mean EQ-5D index score for responders followed up in 2016-2017 was 0.81 (95% CI, 0.79 to 0.84); most (66%) 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 267 of 285 responders.

Together, the SF-12, GOS-E and EQ-5D results indicate good HRQoL for survivors of arrests during 2015-2016 who responded.

2016-2017 Research Highlights

“Our research agenda continues to focus on the chain of survival and answering questions relating to OHCA. This year, some research highlights have addressed long-term survival after OHCA, intubation and rhythm analysis during OHCA and the effect of the media campaigns on OHCA incidence.” Prof Karen Smith, VACAR Principal Investigator and Chair

Long-term survival after OHCA

Factors associated with short-term survival from OHCA are well established. However, among survivors to hospital discharge, relatively little is known about the duration of survival after OHCA, or the factors that influence long-term survival. In this study published in *Heart*, Andrew et al. measured the duration of patient survival after discharge from hospital over a 15-year period, and assessed the peri-arrest and 12-month outcome factors that influence long-term survival. The 1-year survival rate was 92%, while the 5-, 10- and 15-year survival rates were 81%, 70% and 62%, respectively. Few peri-arrest factors were associated with long-term survival after discharge. Rather, transport to a PCI-capable hospital, discharge directly home from hospital, returning to work and favourable functional recovery were associated with longevity.

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

EMS exposure to intubation during OHCA

Intubation is often used as the primary method of airway management during OHCA. However, literature relating paramedic experience performing the procedure with successful skill performance and OHCA patient outcomes is lacking. In this study published in *Annals of Emergency Medicine*, Dyson et al., examined the association between paramedics' previous intubation experience and successful intubation, as well as between intubation experience and OHCA survival. Paramedics typically performed three intubations per year, and most (95%) intubations were successful. Previous intubation experience was associated with intubation success, however was not associated with OHCA patient survival. Among OHCA patients where intubation was attempted, first-pass successful placement was associated with increased survival to hospital discharge.

Dyson K, Bray J, Straney L, Nair R, Smith K, Bernard S and Finn J. Paramedic Endotracheal Intubation Experience Is Associated With Successful Tube Placement but not Cardiac Arrest Survival. *Annals of Emergency Medicine*. 2017;70(3):382-90.

Rhythm analysis and defibrillation mode for OHCA

Although manual and semi-automatic external defibrillation are commonly used in the management of OHCA, the optimal strategy is not known. In this study published in *Circulation: Cardiovascular Quality and Outcomes*, Nehme et al. compared a manual rhythm analysis and defibrillation protocol during OHCA with a semi-automatic protocol. The authors hypothesized that semi-automatic mode would reduce the time to first defibrillation, and lead to higher patient survival. The proportion of patients defibrillated within 2 minutes of paramedic arrival increased under a semi-automatic defibrillation protocol. However, the semi-automatic protocol was associated with a reduction in OHCA survival when compared with a manual defibrillation strategy. Semi-automatic mode was also not associated with an improvement in the rate of successful cardioversion after the first defibrillation. The results from this analysis are informing Clinical Practice Guideline Changes which will be implemented in 2018.

Nehme Z, Andrew E, Nair R, Bernard S and Smith K. Manual Versus Semiautomatic Rhythm Analysis and Defibrillation for Out-of-Hospital Cardiac Arrest. *Circulation: Cardiovascular Quality and Outcomes*. 2017;10(7).

Effect of a mass media campaign on OHCA incidence

Increased public awareness of the warning signs of a heart attack, and the importance of early intervention, is associated with increased calls to ambulance for chest pain. However, the influence of public awareness campaigns on the incidence of OHCA is not well understood. In this study published in *European Heart Journal*, Nehme et al. investigated the impact of the Heart Foundation's public awareness campaign on the incidence of, and deaths from, OHCA. Campaign activity was associated with a 6% reduction in the monthly incidence of OHCA. Additionally, the rate of deaths from OHCA reduced by 6% during months with campaign activity. Campaign activity had a greater effect in males and patients aged ≥65 years.

Nehme Z, Andrew E, Bernard S, Patsamanis H, Cameron P, Bray J, Meredith I and Smith K. Impact of a public awareness campaign on out-of-hospital cardiac arrest incidence and mortality rates. *Eur Heart J*. 2016;38(21):1666-1673.





2016-2017 Peer-reviewed Publications*

1. Andrew E, Nehme Z, Wolfe R, Bernard S and Smith K. Long-term survival following out-of-hospital cardiac arrest. *Heart*. 2017;103(14):1104.
2. Beck B, on behalf of the Aus-ROC Management Committee: Finn J, Cameron P, Smith K, Bernard S, Grantham H, Hein C, Bray J and Williams T. Aus-ROC Epistry a boost for out-of-hospital cardiac arrest outcomes. *Medical Journal of Australia Insight*. 2017(23).
3. Beck B, Bray J, Cameron P, Straney L, Andrew E, Bernard S and Smith K. Predicting outcomes in traumatic out-of-hospital cardiac arrest: the relevance of Utstein factors. *Emergency Medicine Journal*. 2017;34(12):786-792.
4. Beck B, Bray J, Cameron P, Straney L, Andrew E, Bernard S and Smith K. Resuscitation attempts and duration in traumatic out-of-hospital cardiac arrest. *Resuscitation*. 2017;111:14-21.
5. Beck B, Smith K, Mercier E and Cameron P. Clinical review of prehospital trauma deaths; The missing piece of the puzzle. *Injury*. 2017;48(5):971-2.
6. Bray J, Smith K, Case R, Cartledge S, Straney L and Finn J. Public cardiopulmonary resuscitation training rates and awareness of hands-only cardiopulmonary resuscitation: a cross-sectional survey of Victorians. *Emergency Medicine Australasia*. 2017;29(2):158-64.
7. Bray J, Straney L, Smith K, Cartledge S, Case R, Bernard S and Finn J. Regions with low rates of bystander CPR have lower rates of CPR training in Victoria, Australia. *Journal of the American Heart Association*. 2017;6(6).
8. Bray J, Stub D, Bloom J, Segan L, Mitra B, Smith K, Finn J and Bernard S. Changing target temperature from 33 °C to 36 °C in the ICU management of out-of-hospital cardiac arrest: A before and after study. *Resuscitation*. 2017;113:39-43.
9. Dyson K, Bray J, Straney L, Nair R, Smith K, Bernard S and Finn J. Paramedic Endotracheal Intubation Experience Is Associated With Successful Tube Placement but not Cardiac Arrest Survival. *Annals of Emergency Medicine*. 2017;70(3):382-90.
10. Nehme Z, Andrew E, Nair R, Bernard S and Smith K. Manual Versus Semiautomatic Rhythm Analysis and Defibrillation for Out-of-Hospital Cardiac Arrest. *Circulation: Cardiovascular Quality and Outcomes*. 2017;10(7).
11. Nehme Z, Andrew E, Bernard S, Patsamanis H, Cameron P, Bray J, Meredith I and Smith K. Impact of a public awareness campaign on out-of-hospital cardiac arrest incidence and mortality rates. *European Heart Journal*. 2016;38(21):1666-1673.
12. Nehme Z, Andrew E, Nair R, Bernard S and Smith K. Recurrent out-of-hospital cardiac arrest. *Resuscitation*. 2017;121:158-65
13. Olausson A, Nehme Z, Shepherd M, Jennings P, Bernard S, Mitra B, Smith K. Consciousness induced during cardiopulmonary resuscitation: An observational study. *Resuscitation*. 2017;113:44-50.

* Includes publications from 2016-2017, and additional publications up to the publishing date of the VACAR 2016-2017 Annual Report



List of Abbreviations

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

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 outlined 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
2010-11	2011 ARC Guidelines update
	Pilot of fire-fighter first responders in peripheral Melbourne and one rural location
2011-12	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
	Electronic call taking algorithm implemented in rural areas
2013-14	Telephone-assisted CPR instructions changed to 600 compressions before mouth-to-mouth
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 fire stations (staffed by both fulltime and volunteer fire-fighters)
2015-16	2016 ARC Guidelines update
	AV OHCA guidelines updated
	Upgrade of the AV AED Registry
	Commenced rollout of fire-fighter first responders at all integrated fire stations across Victoria
2016-17	More than 88,000 OHCA cases entered into VACAR
	AV CPR awareness programs trains more than 979,000 people since 2004



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.

The VACAR Group

VACAR Chief Investigators

Prof Karen Smith

Director, Centre for Research & Evaluation

Ambulance Victoria

Prof Stephen Bernard

Medical Director

Ambulance Victoria

VACAR Steering Committee

Prof Karen Smith

Director, Centre for Research & Evaluation

Ambulance Victoria

Prof Stephen Bernard

Medical Director

Ambulance Victoria

Prof Peter Cameron

Pre-hospital, Emergency and Trauma Unit

Monash University

Prof John McNeil

School of Public Health and Preventive Medicine

Monash University

A/Prof Mick Stephenson

Executive Director, Emergency Operations

Ambulance Victoria

A/Prof Tim Baker

Centre for Rural Emergency Medicine

Deakin University

Mr Bill Barger

Manager, Operational Quality and Improvement

Ambulance Victoria

Prof Warwick Butt

Paediatric Intensive Care Unit

Royal Children's Hospital

VACAR Staff

Dr Kylie Dyson

Senior Research Fellow, Centre for Research & Evaluation

Ambulance Victoria

Dr Resmi Nair

Performance Analyst, Centre for Research & Evaluation

Ambulance Victoria

Ms Vanessa Barnes

Research Officer, Centre for Research & Evaluation

Ambulance Victoria

Ms Davina Vaughan

Data Processor, Centre for Research & Evaluation

Ambulance Victoria

Mrs Kerri Anastasopoulos

Data Processor, Centre for Research & Evaluation

Ambulance Victoria



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Ambulance Membership 1800 64 84 84

Ambulance Victoria
PO Box 2000
Doncaster VIC 3108

T 03 9840 3500

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