Ambulance Victoria

Victorian Ambulance Cardiac Arrest Registry

2015-2016 Annual Report

ambulance.vic.gov.au

Victorian Ambulance Cardiac Arrest Registry

2015-2016 Annual Report

The VACAR Annual Report 2015-2016 is a publication produced by the Research & Evaluation Department, Ambulance Victoria.

Manager: Prof Karen Smith
Editor: Dr Marijana Lijovic
Author: Dr Marijana Lijovic

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

Disclaimer and Copyright

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.

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

January 2017

Contents


HERALD SUN
AMBULANCE
EMERGENCY AMBULANCE
1800 64 84 84
000
6260
MICA PARAMEDIC
ZNY 607

Introduction

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

In order to improve systems of care and patient outcomes, it is essential to monitor performance, identify problems and successes and track progress. This can be achieved through a registry where all patients are enrolled to create a complete patient population. A registry can drive a quality agenda. It also fosters a culture of excellence in performance. A recent review commissioned by the Australian Commission on Safety and Quality in Health Care has also demonstrated the economic value of clinical quality registries to the health system (Australian Commission on Safety and Quality in Health Care, 2016).

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.

The Victorian Ambulance Cardiac Arrest Registry (VACAR) has been collecting data on cardiac arrest patients attended by ambulance in Victoria since 1999 and is one of the most comprehensive OHCA registries in the world. On behalf of Ambulance Victoria, we are very pleased to present the 2015-2016 VACAR Annual Report.

Professor Karen Smith
Manager, Research and Evaluation
Ambulance Victoria

Professor Stephen Bernard
Medical Director
Ambulance Victoria

List of Tables

List of Figures


PARAMEDIC
PARAMEDIC
AMBULANCE
VICTORIA

The Emergency Medical Service

The state of Victoria, Australia has an estimated population of 6.0 million, with 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. Triple Zero (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 until 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 the inner and some peripheral areas of Melbourne (57 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 2016, there were almost 2,300 AEDs in the AV AED Registry. During a Triple Zero (000) call, the emergency call taker may identify an AED close to the event which is available for use.

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 (Manager, Research & 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 85,000 patients (as at December 2016). 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, the rate of successful defibrillation, event survival and survival to hospital discharge.

The VACAR is also used to measure the impact of ambulance programs such as the Firefighter Emergency Medical Response Program, Four Steps to Life Plus CPR training and Public Access Defibrillation (for more information, see www.ambulance.vic.gov.au). In addition, the VACAR has successfully established an internationally recognised research program, with the publication of scientific literature in key medical journals (see 2015-2016 Peer-reviewed Publications, page 50).

In 2010, the VACAR expanded its methodology to become one of the 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.


PARAMEDIC
PARAMEDIC
PARAMEDIC

How does VACAR operate?

Eligibility

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

Data capture

The registry is based on the internationally recognised Utstein template and definitions (Perkins et al. 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 upon 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. Confirmation of cardiac rhythms is possible from electrocardiograms (ECGs) received from paramedic teams or public AEDs. 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 (Limited pilot)
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 AV's clinical support officers (CSOs). All cases where a patient requires defibrillation or where a death occurs in AV care undergo audit by a CSO.

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 of 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.

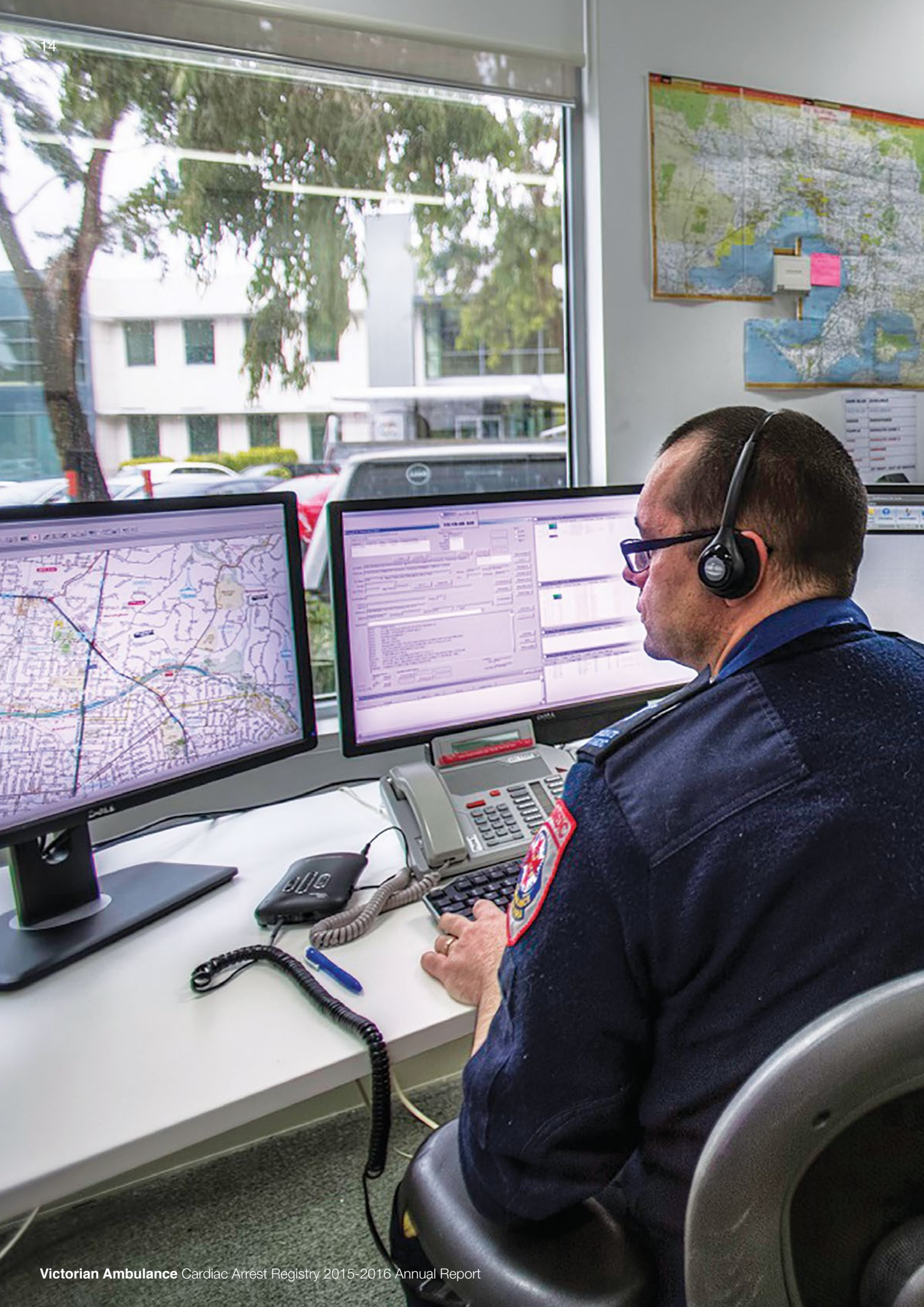
In accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research, all paper and electronic data are securely stored at Ambulance Victoria, with access restricted to authorised VACAR staff.

Missing data

The value of the 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, 2015-2016 (n=5,899).

Patient age	74 (1.3%)
Patient sex	20 (0.3%)
Arrest location	Nil
Witnessed status	64 (1.1%)
Bystander CPR	63 (1.1%)
Rhythm on arrival	15 (0.3%)
EMS response time	18 (0.3%)
Defibrillation time	27 (0.5%)
Outcome at scene	1 (<0.1%)
Event survival	2 (<0.1%)
Hospital discharge status	19 (0.3%)
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%) (Deo and Albert, 2012). OHCA is a significant cause of disability and death in Australia, with a reported incidence of 113 events per 100,000 persons (Berdowski et al. 2010). 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 et al. 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 2015 to 30 June 2016. Data for this report was extracted on 7 November 2016, 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 websites ‘https://www2.health.vic.gov.au/about/publications/formsandtemplates/Department of Health regional boundaries and local government areas map’ and ‘https://www2.health.vic.gov.au/about/publications/policiesandguidelines/Health Regions and Local Government Areas - Metropolitan Melbourne’). The Melbourne metropolitan region is comprised of three geographical regions: North and Western, Eastern and Southern Regions. Rural regions are comprised of five geographical regions: Barwon South Western, Grampians, Loddon Mallee, Hume and Gippsland Regions. 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 30 March 2016, Australian Bureau of Statistics (ABS)). The Victorian population up to the end of June 2015 was 5,936,729 persons (excluding unincorporated areas). Annual Victorian data by age was sourced from the Australian Demographic Statistics report (published 22 September 2016, 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 5,899 OHCA events in the period between 1 July 2015 and 30 June 2016, with 99% 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: 128.6 versus 89.7 events per 100,000 population. The Gippsland region recorded the highest crude incidence rates of OHCA. Age-adjusted state-wide incidence of OHCA in 2015-2016 was 86.7 events per 100,000 population; age-adjusted OHCA incidence in males was 125.5 events per 100,000 and in females was 52.1 events per 100,000 (see Incidence & Demographics, pages 21-23).

2. The demographic profile of events in 2015-2016 was similar to those observed over the last decade. OHCA due to a presumed cardiac cause accounted for 72% of adult EMS attended events. 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, pages 24-27).

3. Most bystander calls for help following OHCA were appropriately directed to ambulance (96%). 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 2015-2016 was 7.8 minutes (90th percentile time, 15.4 minutes), significantly lower than observed in the previous year. The median EMS response time to EMS treated events in the metropolitan region (median 7.4 minutes, 90th percentile 12.5 minutes) was significantly lower than in the previous year. The median EMS response time to EMS treated events in the rural regions (median 9.9 minutes; 90th percentile time 21.4 minutes) was also significantly lower than in the previous year (see Chain of Survival, page 29).

5. The rate of bystander CPR for bystander witnessed OHCA events in 2015-2016 remained high (61%), compared to 36% in 2006-2007. Also, the rate of bystander CPR amongst bystander witnessed OHCA cases receiving EMS attempted resuscitation in 2015-2016 remained high (76%). Use of public automated external defibrillators increased almost four-fold over the last decade for patients presenting in a shockable rhythm (see Chain of Survival, pages 30-31).

6. In 2015-2016, 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 27%, 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 (17% vs 11%, respectively) (see Chain of Survival, page 32).

7. The state-wide rate of ROSC in adult EMS treated events during 2015-2016 was 37%. The rate of event survival for all-cause adult OHCA in the EMS treated population during this period was 27%. Meanwhile, the rate of survival to hospital discharge was 11% and remained within recent observations (see Survival Outcomes, pages 37-38).

8. The rate of event survival for adult EMS treated patients presenting in a shockable rhythm was 53%, with 31% surviving to hospital discharge. For adult EMS treated patients presenting in a shockable rhythm and witnessed to arrest by EMS, event survival and survival to hospital discharge were 76% and 68%, respectively. Adults presenting in asystole or pulseless electrical activity experienced the poorest survival outcomes, with 0.3% and 7% surviving to hospital discharge, respectively (see Survival Outcomes, pages 38-40).

9. Utstein patient subgroup survival in Victoria was 35% in 2015-2016. Victorian patients have comparable discharged alive rates to a number of international agencies (see Survival Outcomes, page 41-42).

10. The risk-adjusted odds of survival to hospital discharge have improved significantly over time. The odds of survival to hospital discharge for adult OHCA patients in 2015-2016 was more than two times higher than for OHCA patients in 2002-2003 (adjusted odds ratio 2.5, 95% CI 1.9-3.3, $p<0.001$). This significant improvement was also observed for patients who presented in a shockable rhythm over the same period (adjusted odds ratio 3.3, 95% CI 2.4-4.5, $p<0.001$) (see Survival Outcomes, page 43).

11. Most adult OHCA patients with known survival to hospital discharge status were discharged home (85% in 2015-2016). 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, 74% had returned to work 12 months after their arrest (see Long-term Functional Outcomes, pages 44-46).

The following two pages provide an illustrated overview of 2015-2016 data, for all patients (Figure 1) and for patients presenting in a shockable rhythm (Figure 2).

Figure 1: All cardiac arrest patients, 2015-2016 (* means excludes EMS witnessed arrests).

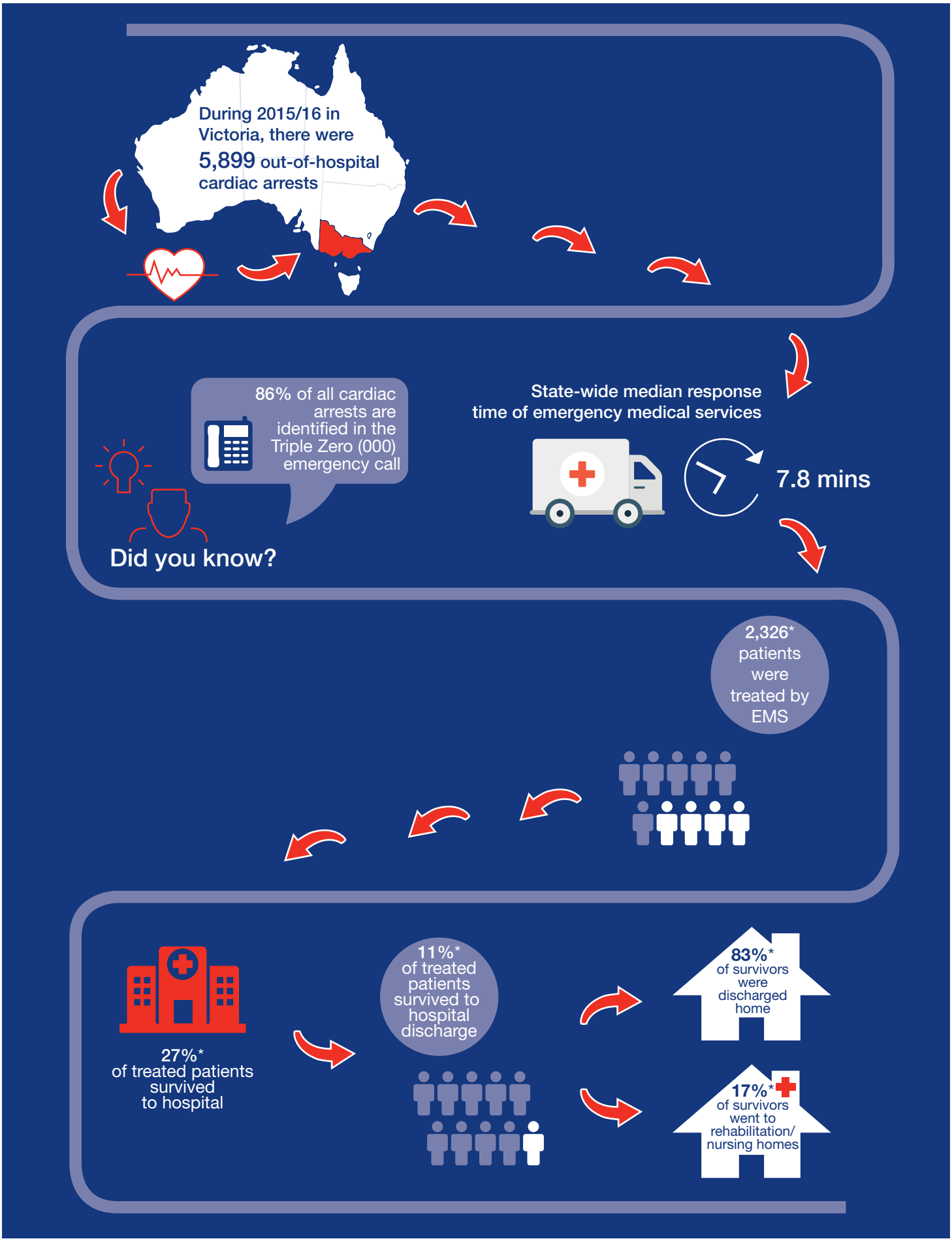
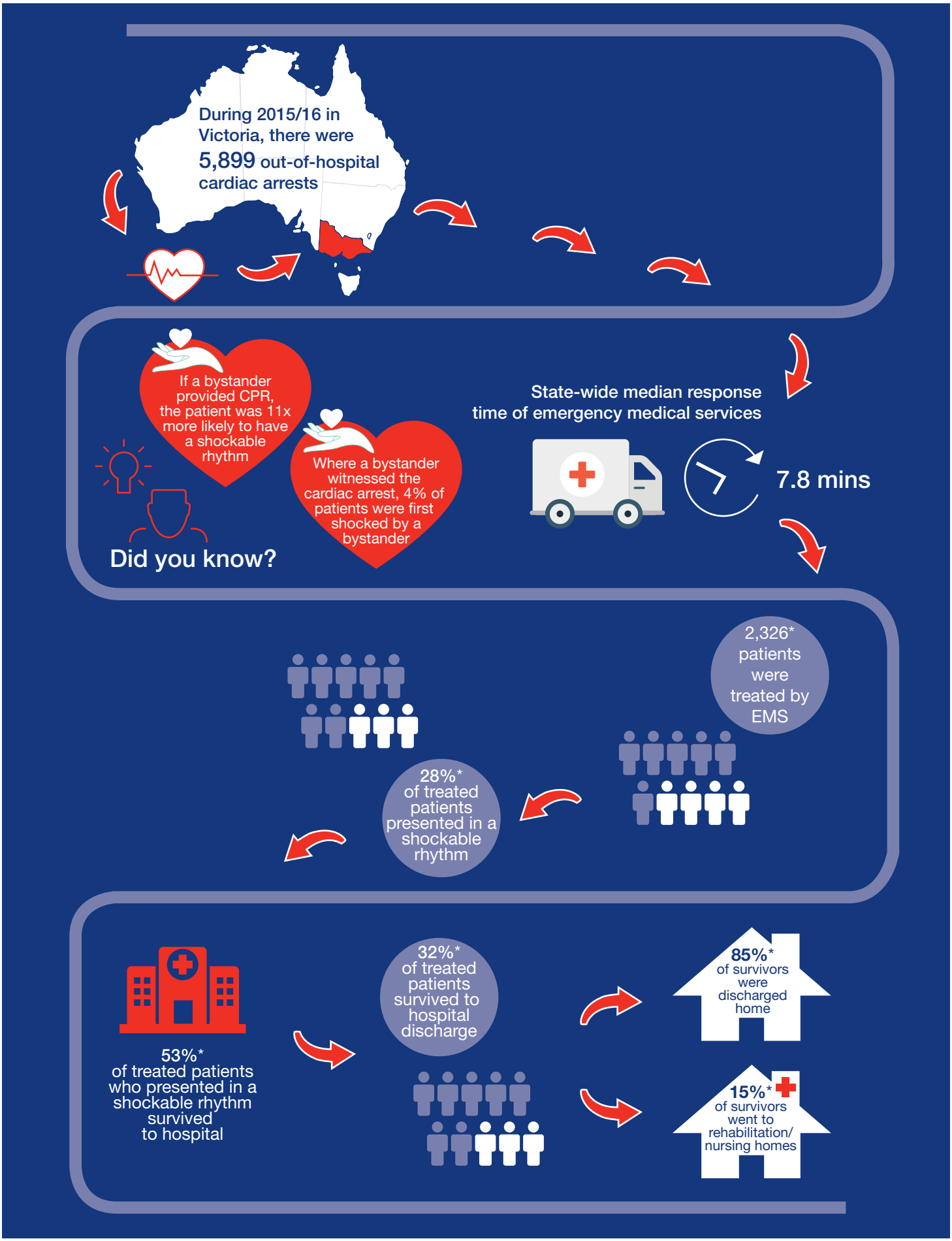


Figure 2. Cardiac arrest patients presenting in a shockable rhythm, 2015-2016 (* means excludes EMS witnessed arrests).




M.I.C.A.
PARAMEDIC
AMBULANCE VICTORIA

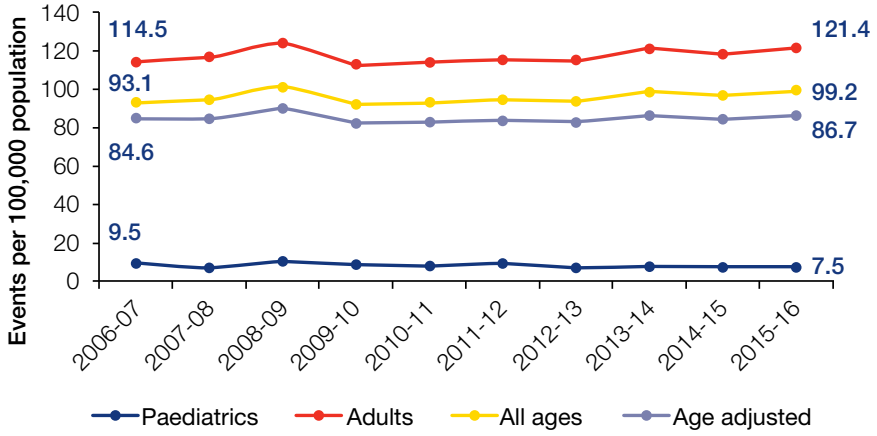

PARAMED

Incidence & Demographics

Incidence of all adult & paediatric events†

In 2015-2016, Ambulance Victoria attended 5,899 OHCA events, of which 5,812 (99%) were defined as adults aged greater than 15 years or patients with unknown age. This number of adult cases represents the highest number of events in a 10 year period. The number of paediatric events attended by paramedics remains low (87 cases in 2015-2016), though this number is within normal yearly fluctuations.

The crude incidence of OHCA has remained relatively consistent over the last decade. In 2015-2016, the unadjusted incidence of all OHCA in Victoria was 99.2 events per 100,000 population, higher than the rate of 93.1 events per 100,000 population observed in 2006-2007 (see Figure 3). However, age-standardisation gives rise to an adjusted OHCA incidence rate of 86.7 events per 100,000 population during 2015-2016. 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.



Note: Age-standardised rates were calculated using the 2001 Australian Standard Population (source: Australian Bureau of Statistics).

Figure 3: 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).

Age-adjusted incidences rates over the last 10 years have been relatively stable. The age-adjusted OHCA incidence rates for males and females during 2015-2016 was 125.5 events and 52.1 events per 100,000 population, respectively.

The incidence of adult and paediatric events also remained within recent observations; 121.4 and 7.5 events per 100,000 population in 2015-2016, respectively. While variation in OHCA incidence across continents and regions are well established, these figures are within previously reported incidence rates within Victoria.

Of all adult OHCA events attended in 2015-2016, 46% received an emergency resuscitation attempt by paramedics and/or first-responders (includes EMS witnessed events; in the previous year, this was 48%). The rate of EMS attempted resuscitation for adult attended OHCA has risen over the last 10 year period (42% in 2006-2007; 46% vs 42%, p<0.001).

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 55.8 events per 100,000 population in 2015-2016.

In paediatric events, the proportion of EMS treated events is higher than in adults. Most paediatric patients (85%) received an attempted resuscitation by EMS during 2015-2016 (includes EMS witnessed events; in the previous year, this was 83%). The rate of EMS attempted resuscitation for paediatric events over the last 10 years has been quite variable; this rate was 76% in 2006-2007. The crude incidence of paediatric EMS treated events was 6.4 events per 100,000 population in 2015-2016.

† All results in this section include EMS witnessed events.

In 2015-2016, Ambulance Victoria attended 5,812 adult OHCA events, the highest number of events in adults in recent years. The rate of attempted resuscitation by EMS remains under 50%.

Incidence across regions of Victoria†

In 2015-2016, 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 (4,002 cases, representing 68% of the total number of events attended by AV). Similarly, the highest number of events in rural Victoria were attended in 2015-2016 for the last 10 years (1,897 events, a 38% increase since 2006-2007.

Despite the increased proportion of events occurring in the metropolitan region, the crude incidence of OHCA was significantly higher in the rural region (128.6 vs. 89.7 events per 100,000 population, p<0.001) (see Figure 4).

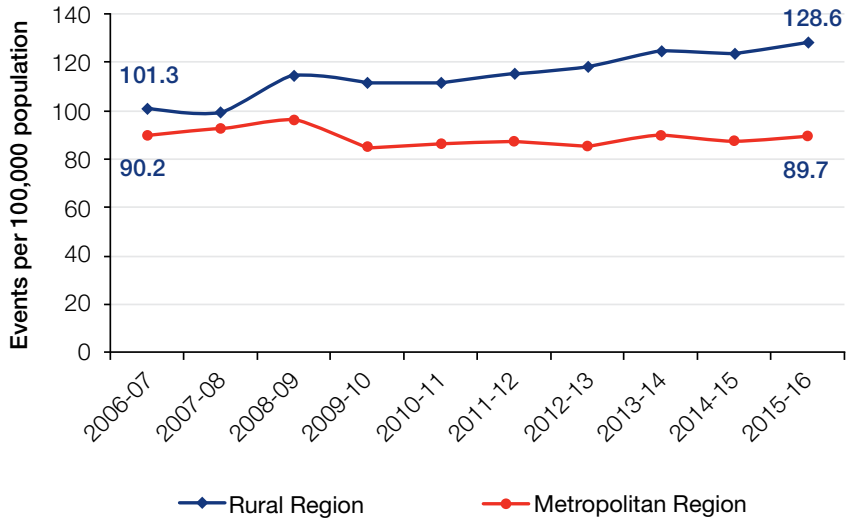


Figure 4: Yearly crude incidence of EMS attended events across metropolitan and rural regions of Victoria (includes EMS witnessed events).

The crude incidence of OHCA has increased over the last 10 years in rural Victoria, rising from 101.3 events in 2006-2007 to 128.6 events per 100,000 population in 2015-2016 (p<0.001). As noted previously, this observation may reflect better case capture since the 2008-2009 period, which coincided with the completion of the roll-out of VACIS in the rural area. Unadjusted incidence in the metropolitan region has remained relatively unchanged during the same period. Figure 3 shows state-wide age-adjusted incidence of OHCA has also remained relatively unchanged over the last ten years.

There is regional variability in OHCA incidence across Department of Health and Human Services regions (see Figure 5). The lowest crude incidence during 2015-2016 was observed in the Eastern Metropolitan Region (81.3 events per 100,000 population) and the highest incidence in the Gippsland region (140.3 events per 100,000 population). The North and Western Metropolitan region, which includes the Melbourne Business District, had a total of 1,698 OHCA. Almost all rural regions experienced their highest number of OHCA events in 2015-2016 for the last 10 years, except Gippsland.

The proportion of events receiving an attempted resuscitation by EMS varies considerably across regions. The highest proportion of EMS treated events during 2015-2016 occurred in the North and Western Metropolitan region (52%) and the lowest in the Grampians region (36%).

† All results in this section include EMS witnessed events.

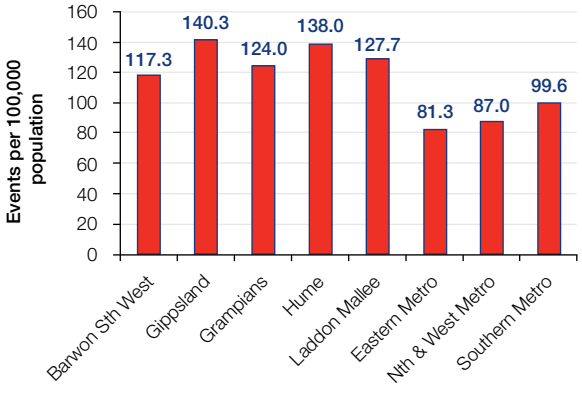


Figure 5: Crude incidence of EMS attended events across Department of Health and Human Services regions, 2015-2016.

Demographics of adults

The demographic profile of adult OHCA events (excluding EMS witnessed arrests) has been consistent over the last decade. In 2015-2016, EMS attended adult events were predominately male patients (67%). The median age of adult OHCA patients was 68 years. The age distribution varied significantly across the sexes (see Figure 6), with females having a higher median age of arrest (74 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 2015-2016, the proportion of adult patients receiving bystander CPR was 39%, more than double the rate in 2006-2007 (19%) (p<0.001). In 2015-2016, 12% 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.

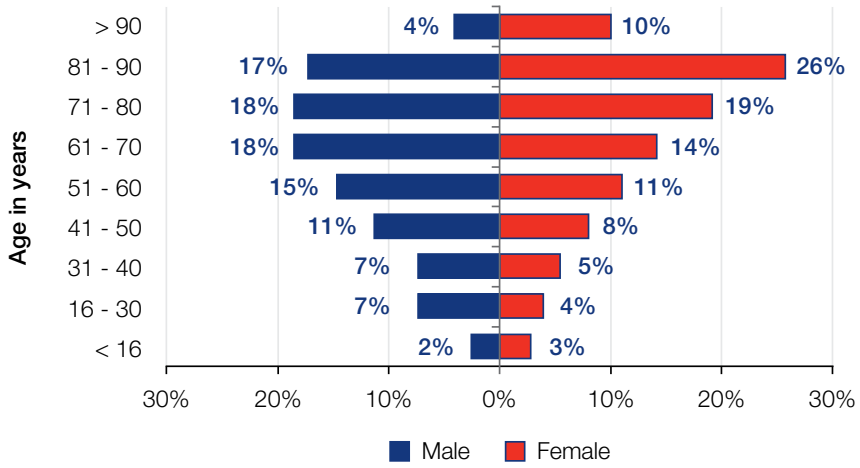


Figure 6: Age distribution of EMS attended OHCA events, 2015-2016.

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 (67 years), more events occurring in a public location (20%), more events witnessed by a bystander (51%) and a high rate of bystander CPR (72%).

Demographics of paediatrics

The frequency of EMS attended paediatric events (excluding EMS witnessed arrests) has remained relatively low over the last decade, with fewer than 100 events per year (77 in 2015-2016). The median paediatric (<16 years) age of arrest in 2015-2016 was eight months. During 2015-2016, 64% 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 9, page 25).

The demographic profile of paediatric OHCA varies significantly across reporting years and is impacted by smaller samples sizes. In 2015-2016, EMS attended paediatric events were predominantly males (54%). Within the paediatric OHCA population, 13% of events during 2015-2016 occurred in a public location. Significantly more paediatric patients received bystander CPR than adult patients during 2015-2016 (75% vs. 39%, respectively; p<0.001).

The majority of paediatric patients during 2015-2016 presented to EMS in an asystolic rhythm (79%). In 2015-2016, one paediatric case was defibrillated prior to the arrival of EMS with a public automated external defibrillator. The rate of EMS attempted resuscitation amongst paediatric patients during 2015-2016 remained high (83%). Significantly more paediatric cases received an attempted resuscitation by paramedics than adults during 2015-2016 (83% vs 43%, respectively; p<0.001).

In 2015-2016, Ambulance Victoria attended 77 paediatric events. Median paediatric age was eight 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 et al. 2015). In total, the VACAR records 13 precipitating events for adults.

In 2015-2016, 72% of EMS attended adult OHCA were presumed to be of a cardiac cause. Other frequent causes of OHCA during 2015-2016 were: trauma (7%), respiratory causes (3%), overdose/poisoning (5%), terminal illness (6%) and hanging (5%) (see Figure 7).

For adult patients receiving an attempted resuscitation by EMS during 2015-2016, most cases were due to a presumed cardiac cause (76%).

The rate of EMS attempted resuscitation differed amongst patients according to the precipitating cause of the event. During 2015-2016, the rate of EMS attempted resuscitation for arrests due to presumed cardiac cases was 46%. Rates of EMS attempted resuscitation during 2015-2016 were lower for arrests due to trauma (22%), overdose/poisoning (39%), terminal illness (27%) and hangings (25%). Meanwhile, most OHCA events due to a respiratory cause received EMS attempted resuscitation (70%).

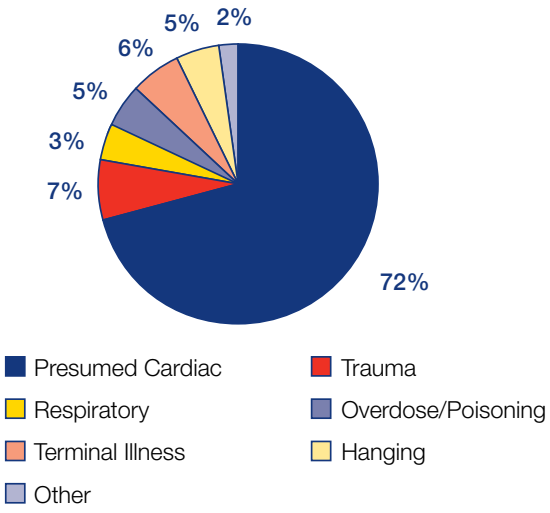


Figure 7: Adult precipitating events for EMS attended events, 2015-2016.

The precipitating event for arrests across age groups in the EMS attended population is presented in Figure 8. This graph highlights the relationship between arrest aetiology and patient age. Presumed cardiac cause was the predominant precipitating factor for most age groups: 36-50 years (58%), 51-75 years (77%) and >75 years age group (84%). Meanwhile, in the 16-35 years age group during 2015-2016, the predominant precipitating factor was the combined causes of trauma and hanging (48%). In this young adult age group in 2015-2016, presumed cardiac cause was the precipitating factor for 27% 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 2015-2016).

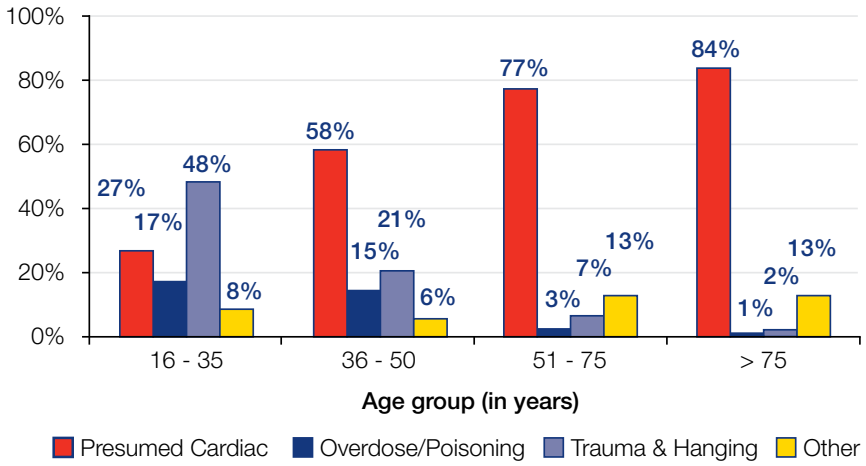


Figure 8: Adult precipitating events across age groups for EMS attended events, 2015-2016.

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.

Precipitating events for paediatrics

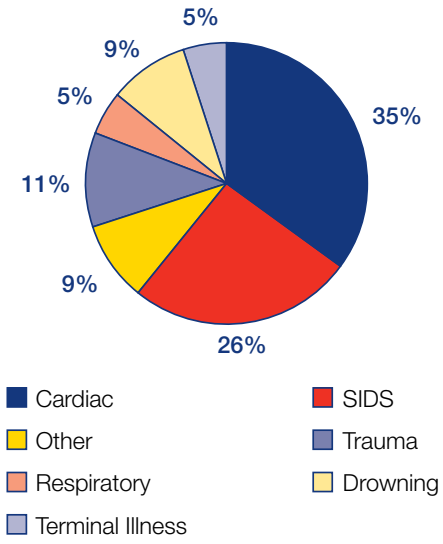


Figure 9: Paediatric precipitating events for EMS attended events, 2015-2016.

Precipitating events for paediatrics who suffer OHCA vary considerably in comparison to adults. In 2015-2016, 35% of EMS attended paediatric events were due to a presumed cardiac cause (see Figure 9). Sudden infant death syndrome (SIDS) is a dominant cause of paediatric OHCA (26% in 2015-2016). During 2015-2016, less common causes of paediatric OHCA include trauma (11%), drowning (9%), terminal illness (5%) and respiratory causes (5%). 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 et al. 2012). The distribution of precipitating events in the EMS treated paediatric OHCA population mirrors the overall paediatric OHCA population data presented above.

Mechanism of arrest in the traumatic sub-group*

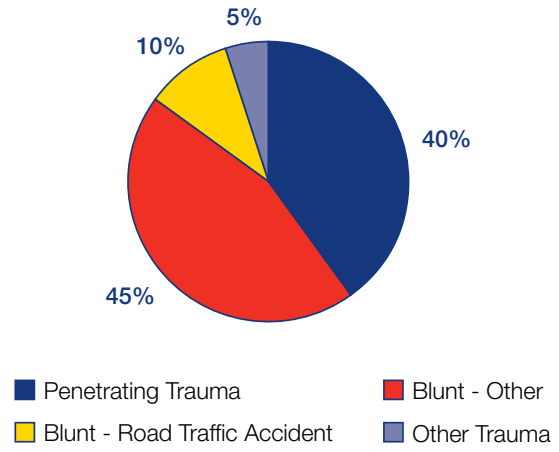


Figure 10: Sources of trauma in the EMS attended traumatic OHCA sub-group, 2015-2016.

Cardiac arrests secondary to major trauma are an important, potentially-preventable patient subgroup. During 2015-2016, blunt trauma (involving falls, crush injuries, or forces considered blunt) were responsible for 45% of events, while arrests following ballistic trauma and stabbings (penetrating trauma) accounted for 40%, see Figure 10. Arrests secondary to road trauma were responsible for 10% of traumatic OHCA during 2015-2016.

The following vehicles were the mode of transport associated with road trauma incidents during 2015-2016: a car or light vehicle (46%), train (31%), motorcycle (15%) and bicycle (8%). During 2015-2016, the role of the OHCA patient in these vehicles was as the vehicle driver (69%) or pedestrian (31%).

* 'Other trauma' refers to any of the following: hanging, drowning/immersion, chemical exposure, environmental exposure, fire/smoke exposure, sting/bite/envenomation, animal related injury, electrical contact or trauma due to an unknown reason.


KERRIS
RESCUE
RESCUE
ABN
HEALTHCARE SYSTEMS

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 11 and 12. Public places include places of work, streets or roads, shops, vehicles and sporting/recreational facilities. In 2015-2016, most (76%) EMS attended adult OHCA events occurred within a private residence. Other common arrest locations were a public place (14%) and aged care facility (8%) (see Figure 11).

Similar to EMS attended adult OHCA events, amongst adult patients who received an attempted resuscitation by EMS during 2015-2016, the most common site of an arrest was a private residence (68%), followed by arrests in a public place (20%) and aged care facility (9%). The locations of arrest for paediatric events were similar to those in adults. In 2015-2016, 86% of EMS attended paediatric events occurred in a private residence and 13% occurred in a public place.

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 12).

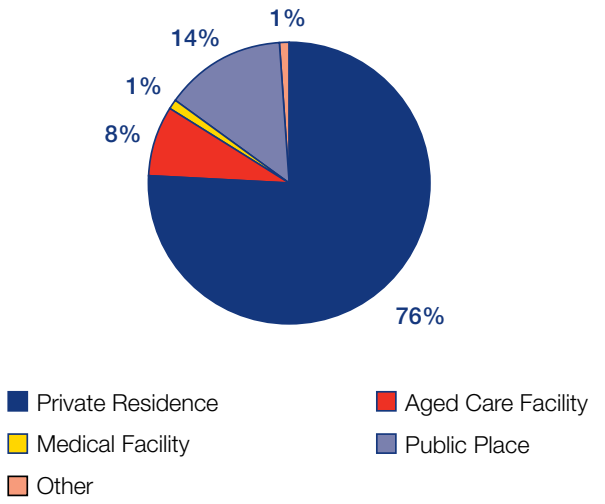


Figure 11: Location of arrest for EMS attended adult events, 2015-2016.

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 12). In 2015-2016, the unadjusted rates of adult survival to hospital discharge were similar in public places (26%) and medical facilities (29%). Unadjusted adult survival to hospital discharge in a private residence remained relatively low (7%). Unadjusted adult survival to hospital discharge varied significantly between private residences and public places (7% vs. 26%, respectively; p<0.001).

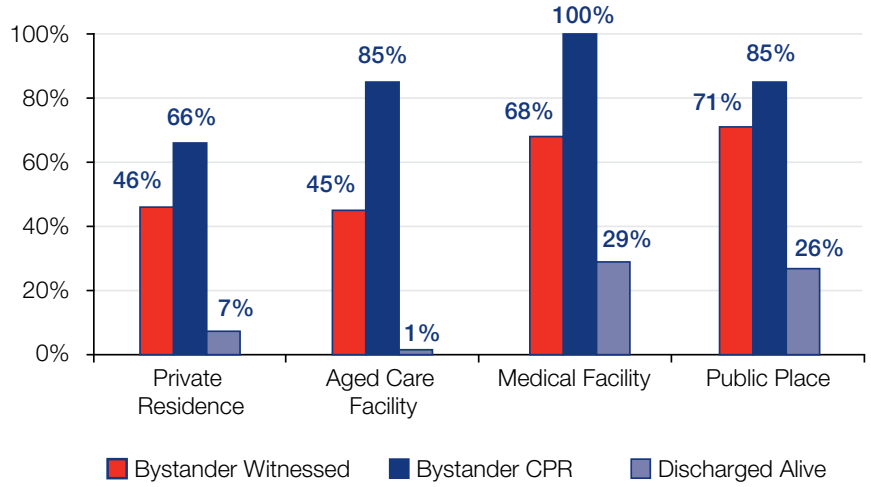


Figure 12: Proportion of EMS treated adult events that are bystander witnessed, receive bystander CPR and are discharged alive across arrest locations, 2015-2016.

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 early access, early CPR, early defibrillation and early access to advanced cardiac life support.

Bystander call for help

In 2015-2016, the first bystander call for help was correctly directed to ambulance in the majority of cases (96%). 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 et al. 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 2015-2016, 86% of EMS attended arrests were correctly identified during the emergency call. For EMS attended arrests due to presumed cardiac aetiology in 2015-2016, 90% were correctly identified during the emergency call. This figure was effectively the same in the metropolitan and rural regions during 2015-2016 (90% and 89%, respectively).

Emergency response to the incident

The distribution of response times for the EMS treated population across regions in 2015-2016 is presented in Figure 13. 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 Triple Zero (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.

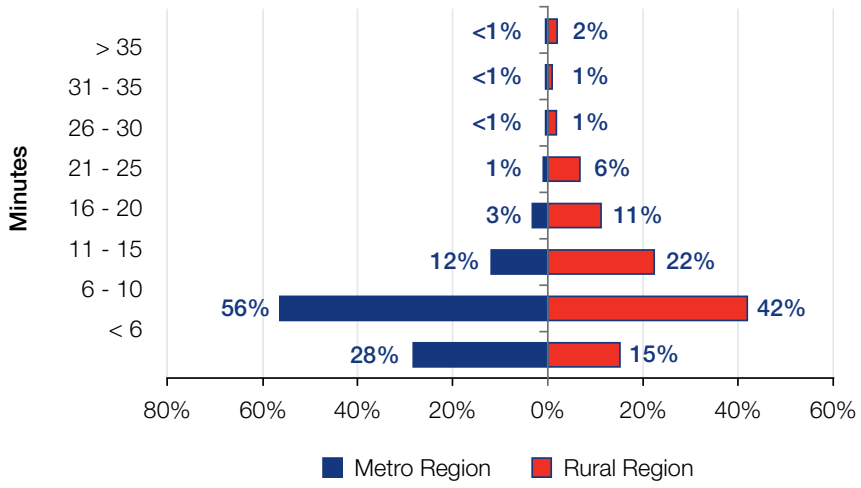


Figure 13: Distribution of time from call to arrival of EMS on scene in the EMS treated population, 2015-2016.

In 2015-2016, state-wide, median response time to EMS treated events was 7.8 minutes (90th percentile time, 15.4 minutes). This was lower than response times noted in the previous year (median time 8.0 minutes; 90th percentile time 16.4 minutes; p=0.008). In 2015-2016, median response times to EMS treated events in metropolitan regions was 7.4 minutes (90th percentile time 12.5 minutes) compared to 7.5 minutes (90th percentile time 12.9 minutes) in the previous year (p=0.041). Median response time in rural areas in 2015-2016 was 9.9 minutes (90th percentile time 21.4 minutes), lower than in the previous year (median time 10.2 minutes; 90th percentile time 24.5 minutes; p=0.046).

Bystander cardiopulmonary resuscitation

Over the last decade in Victoria, there have been significant increases in bystander CPR rates (see Figure 14). Of all OHCA events in 2015-2016, 40% of patients received CPR performed by bystanders, compared to 20% of patients receiving bystander CPR 10 years ago ($p<0.001$). Of OHCA events witnessed to collapse by bystanders in 2015-2016, 61% of patients received bystander CPR, in comparison to 36% of patients in 2006-2007 ($p<0.001$). Of bystander witnessed OHCA events receiving an attempted resuscitation by EMS, 76% received bystander CPR in 2015-2016, compared to 45% in 2006-2007 ($p<0.001$). The rate of bystander CPR amongst bystander witnessed OHCA cases which received EMS attempted resuscitation is one of the highest for the last decade.

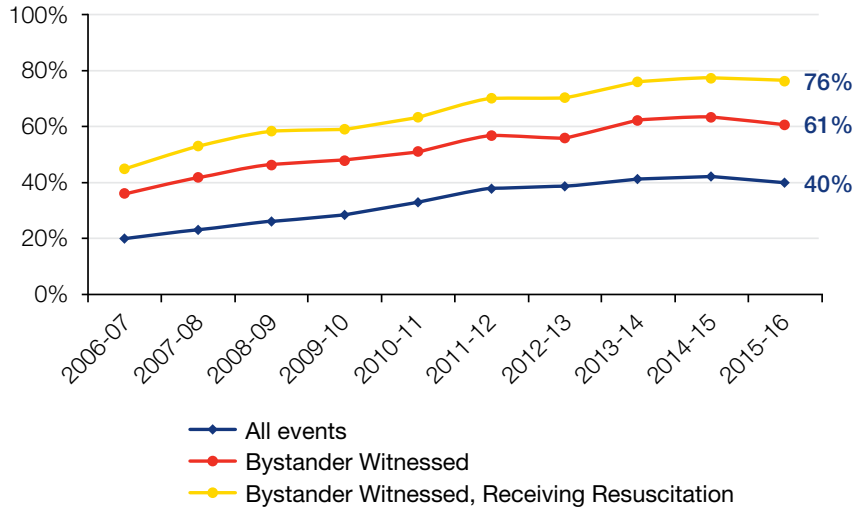


Figure 14: Bystander CPR rates.

These improvements can be partly attributed to more accurate identification of OHCA during the emergency call and delivery of dispatcher-assisted CPR instructions for (Bray et al. 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 et al. 2007).

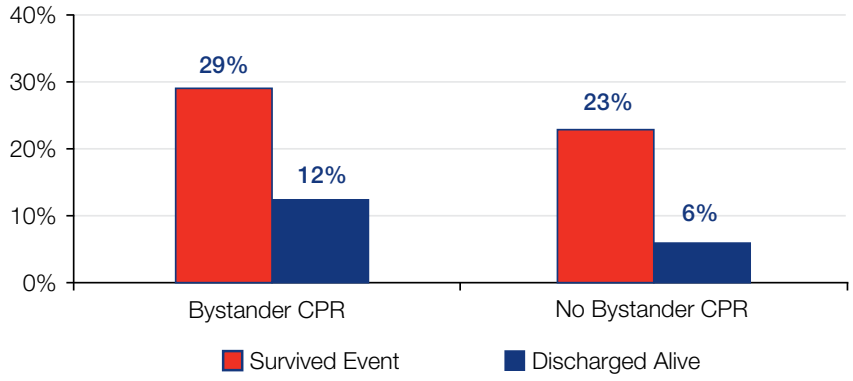


Figure 15: Unadjusted survival outcomes after bystander CPR in the EMS treated population, 2015-2016.

Unadjusted survival was strongly associated with the presence of bystander CPR (see Figure 15). In 2015-2016, 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 (23%), $p=0.003$.

In 2015-2016, survival to hospital discharge was significantly higher for patients receiving bystander CPR (12%) versus no bystander CPR (6%), $p<0.001$. These rates were the same in 2014-2015.

Time to first defibrillation

The time from emergency call to first defibrillation for patients presenting in a shockable rhythm is a key performance indicator 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 et al. 2014).

The proportion of cases where Ambulance Victoria performed the first defibrillation has reduced significantly between 2006-2007 and 2015-2016, from 91% to 82% ($p<0.001$). This decline has been driven by an almost four-fold increase in the use of public automated external defibrillators (AED) by bystanders over the same period (2.8% to 11.0%, $p<0.001$). The proportion of cases first defibrillated by first responders during 2015-2016 was 8% (in the previous year, this was 7%).

The time to first defibrillation by EMS is recorded for EMS treated patients whose rhythm is shockable on EMS arrival. In 2015-2016, the state-wide time to defibrillation of 10.4 minutes (90th percentile time 17.2 minutes) was similar to the previous year (median time 10.7 minutes; 90th percentile time 18.0 minutes; $p=0.314$). The median time to defibrillation in the metropolitan region in 2015-2016 was 10.0 minutes (90th percentile time 16.1 minutes), similar to the previous year (median time 10.2 minutes; 90th percentile time 14.7 minutes; $p=0.852$). In the rural region in 2015-2016, median time to defibrillation was 11.8 minutes (90th percentile time 20.6 minutes), similar to the previous year (median time 12.3 minutes; 90th percentile time 23.7 minutes; $p=0.262$).

Time to defibrillation for patients in a shockable rhythm correlates closely with EMS response time (see Emergency response to the incident, page 29).

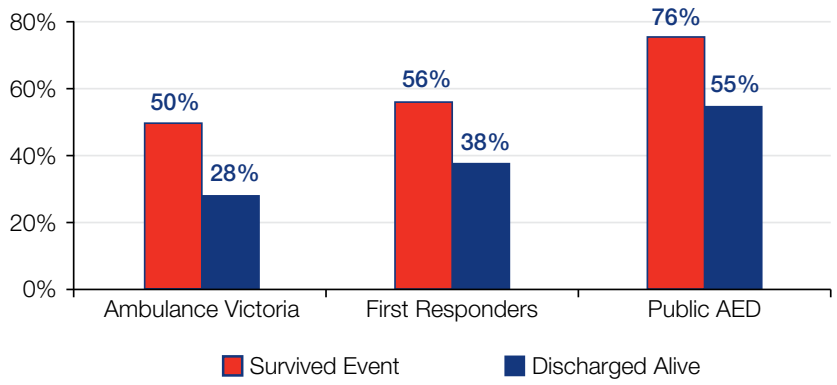


Figure 16: Unadjusted survival outcome according to who shocked first in the EMS treated population with a shockable rhythm on or before EMS arrival, 2015-2016.

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 16). 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 76%, compared with 50% of patients first shocked by paramedics and 56% of patients first shocked by first responders. The 2015-2016 event survival rates according to who provided the first shock were significantly different ($p<0.001$).

Similar to event survival, survival to hospital discharge in 2015-2016 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 55%, compared with 28% of patients first shocked by paramedics and 38% of patients first shocked by first responders ($p<0.001$).

A discharged alive rate of 55% for OHCA patients defibrillated with a public AED during 2015-2016 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.

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, 2015-2016.

	All OHCA	Bystander witnessed
Total events	5,899^	1,607
- Bystander CPR	2141 (36%)	977 (61%)
- Bystander AED use	72 (1.2%)	65 (4.0%)
- Shockable rhythm	766 (13%)	485 (30%)
EMS treated events	2,326	1,167
- Survived event	634 (27%)	444 (38%)
- Discharged alive	244 (11%)	192 (17%)

^ 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 2015-2016. Bystander CPR rates were higher amongst OHCA patients witnessed to arrest by a bystander, compared with all OHCA patients (61% vs 36%, respectively).

Also, unadjusted likelihood of an OHCA patient presenting in a shockable rhythm in 2015-2016 was almost eleven 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 (30% vs 13%, 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 27%, 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 (17% vs 11%, respectively).

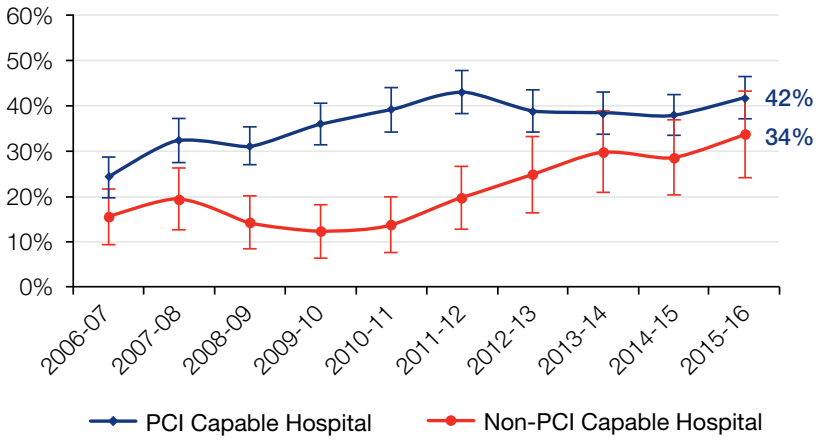

HABITAT REHABILIT
AMBULANCE
WKO 206

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 et al. 2011).

Statewide during 2015-2016, 81% of adult EMS treated arrests due to a presumed cardiac cause were transported to a PCI-capable hospital. Within the metropolitan region during 2015-2016, 94% of adult 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-capable hospitals has remained relatively unchanged.

Within the rural region during 2015-2016, 45% of adult 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.

Figure 17: ‡Unadjusted survival to hospital discharge for adult presumed cardiac EMS treated events according to transport to a PCI-capable hospital. Error bars show the 95% confidence interval around the proportion.

In 2015-2016, 42% of adult OHCA patients transported to PCI-capable hospitals survived to hospital discharge (unadjusted survival, see Figure 17). Of OHCA patients transported to hospitals without PCI capability during 2015-2016, 34% 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.

Ambulance Victoria key initiatives over time

Table 6 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 6: 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
2000-01	Metropolitan Ambulance Service and Rural Ambulance Victoria start training paramedics in Advanced Life Support (ALS)
2001-02	Fire-fighters commence as first-responders in Melbourne (Metropolitan Fire Brigade)
	Victorian State Government announces funding for a Public Access Defibrillation (PAD) program
2003-04	CPR awareness program launched in Victoria by Victorian ambulance services and the Victorian State Government
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 released in 2006
2006-07	Simplification of telephone-assisted CPR instructions to 400 compressions before mouth-to-mouth used by Triple Zero (000) call takers (Emergency Services Telecommunications Authority, ESTA)
2007-08	Fire-fighters as first-responders in peripheral Melbourne (Country Fire Authority, CFA)
	Pre-hospital therapeutic hypothermia for selected patients
2008-09	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)**
	Pilot of fire-fighter first-responders with CFA
	AV commences AED Registry which records the locations of AEDs across Victoria
2010-11	2011 ARC Guidelines update
	AV CPR awareness programs trains 800,000 people since 2004
2011-12	Expansion of operating area for mobile intensive care ambulance (MICA) Single Responder Units (SRUs) in metropolitan areas
	Victorian State Government announces funding for MICA SRUs in rural areas
	Electronic call taking algorithm implemented in rural areas
2014-15	Update and simplification of the Utstein template for uniform collection and reporting of OHCA data is published
	AV Dispatch Grid review and implementation of revised grid
	Victorian Government commits to expanding fire fighter first responder program to all professional rural brigades in the CFA
2015-16	2016 ARC Guidelines update released
	More than 82,000 OHCA cases entered into VACAR
	AV CPR awareness programs trains more than 975,000 people since 2004
	AV OHCA guidelines under review
	Upgrade of the AV AED Registry


PARAMED

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 2015-2016, the achievement of ROSC was highest amongst adult OHCA patients who arrested in the presence of EMS (59%). Bystander witnessed arrests attained higher rates of ROSC than unwitnessed arrests in 2015-2016 (46% and 19%, respectively).

Across the entire state in 2015-2016, ROSC was achieved in 37% of all adult EMS treated events (includes EMS witnessed arrests); in the previous year, this was 40%. During 2015-2016, ROSC was achieved in 38% of OHCA events in the metropolitan region (in the previous year, this was 43%) and 32% of OHCA events in the rural region (in the previous year, this was 34%); includes EMS witnessed arrests. Significantly better ROSC outcomes were observed in the metropolitan region than rural region (38% vs. 32%, p=0.003).

Over time, there have 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 18). In 2015-2016, the proportion of adult EMS treated events which were transported from the scene with ROSC was 27%. Efforts were ceased at scene for 70% of adult EMS treated events and the rate of transportation with CPR was low (3%).

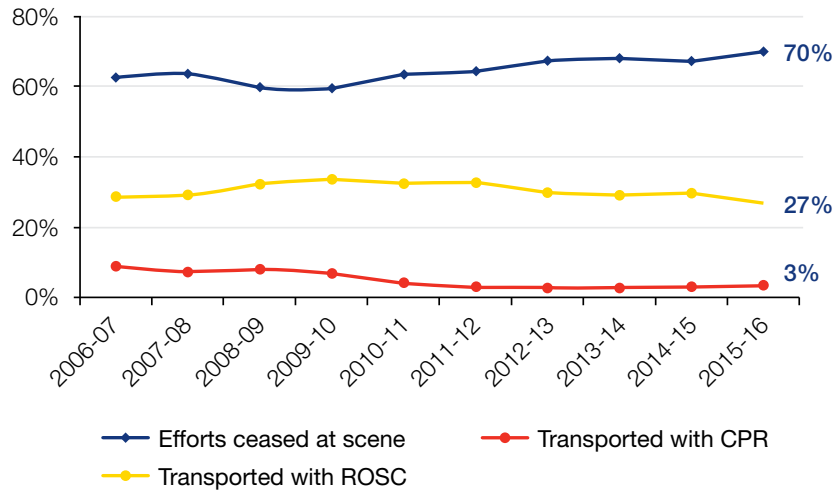


Figure 18: Scene outcomes for adult EMS treated events

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 et al. 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.

Ambulance Victoria has invested significantly in improving the system response to out-of-hospital cardiac arrest patients.

Adult survival from all-cause cardiac arrest

Unadjusted adult survival from all-cause OHCA has increased modestly over the past 10 years. In 2015-2016, the rate of event survival for adult EMS treated events was 27% and discharged alive rate was 11% (see Figure 19). 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 2015-2016, event survival was 23% and discharged alive rate was 11%. In the rural region during 2015-2016, event survival was 22% and discharged alive rate was 9% (unchanged from the previous year).

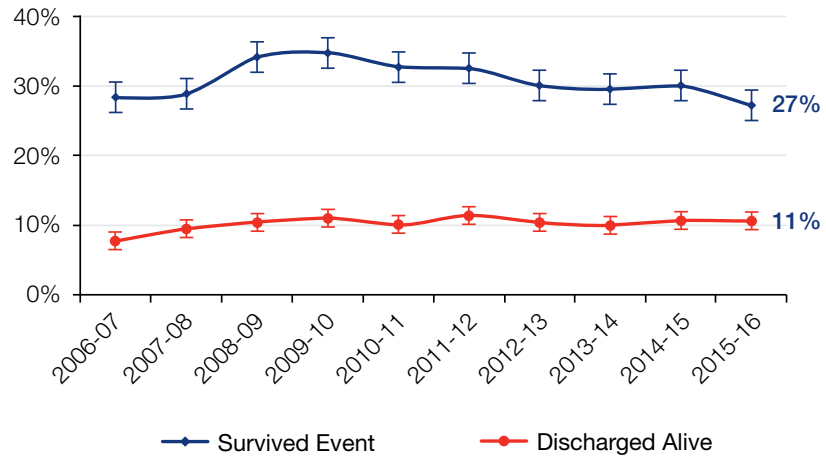


Figure 19: Unadjusted survival outcomes for all-cause adult EMS treated events.

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 et al. 2007).

Of adult EMS treated patients, 31% presenting in a shockable rhythm during 2015-2016 were discharged alive (in the previous year, this was 29%) (see Figure 20). During 2015-2016, 7% of adult patients who presented in PEA were discharged alive (in the previous year, this was 8%), while few adults presenting in asystole (0.3%) were discharged alive (in the previous year, this was 0.5%).

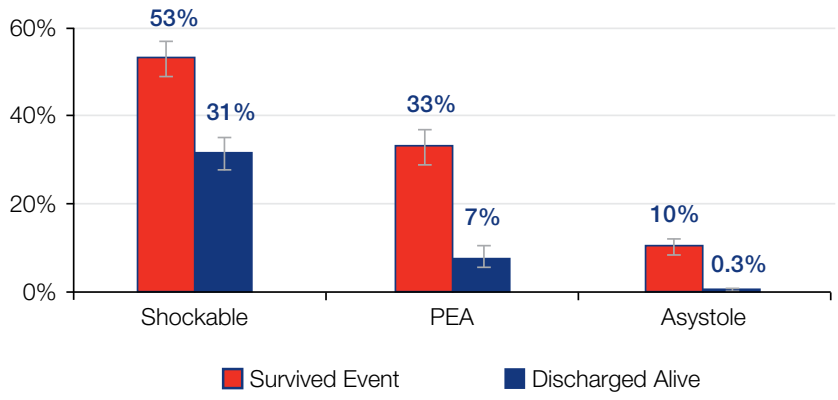


Figure 20: Unadjusted survival outcomes for adult EMS treated events according to presenting rhythm on arrival, 2015-2016.

For patients of all ages found in a shockable rhythm during 2015-2016, the rate of event survival was 53% (in the previous year, this was 52%) and the discharged alive rate was 32% (in the previous year, this was 29%).

In 2015-2016, 28% 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 (32% in 2006-2007; 32% vs 28%, p=0.013; see Figure 21).

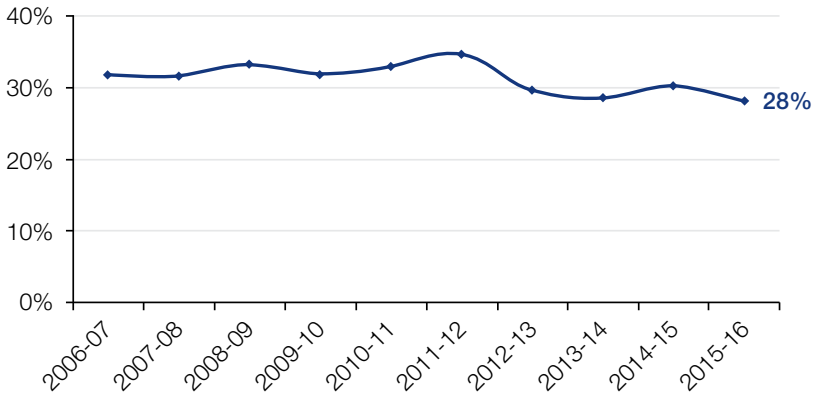


Figure 21: Proportion of adult EMS treated events presenting in a shockable rhythm on arrival.

Outcomes for patients with shockable rhythms have improved over time (see Figure 22). In 2015-2016, adult event survival for patients presenting in a shockable rhythm was 53%. The rate of adult survival to hospital discharge was 31%.

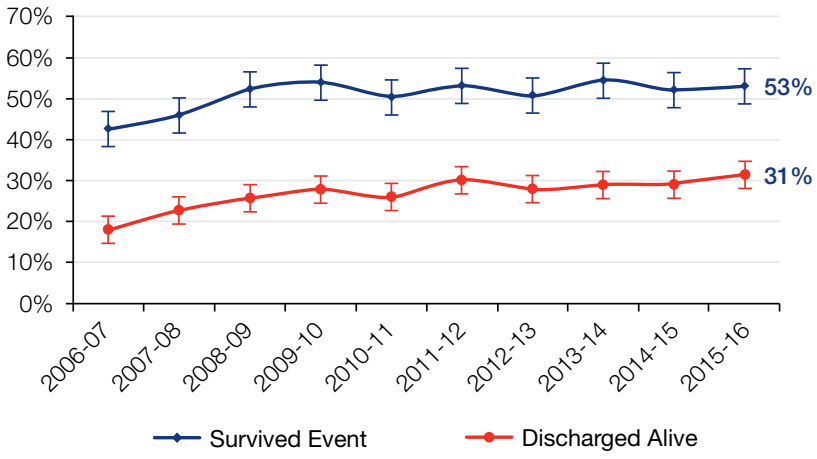


Figure 22: Unadjusted survival outcomes for adult EMS treated events with a shockable rhythm on arrival.

Adult survival from EMS witnessed arrests

In 2015-2016, for adult EMS witnessed events presenting in a shockable rhythm, the rate of event survival was 76% and the rate of survival to hospital discharge was 68% (see Figure 23). These findings are consistent with recent observations. When considering all adult EMS witnessed events during 2015-2016, the rate of event survival was 43% (in the previous year, this was 45%) and the discharged alive rate was 27% (unchanged from the previous year).

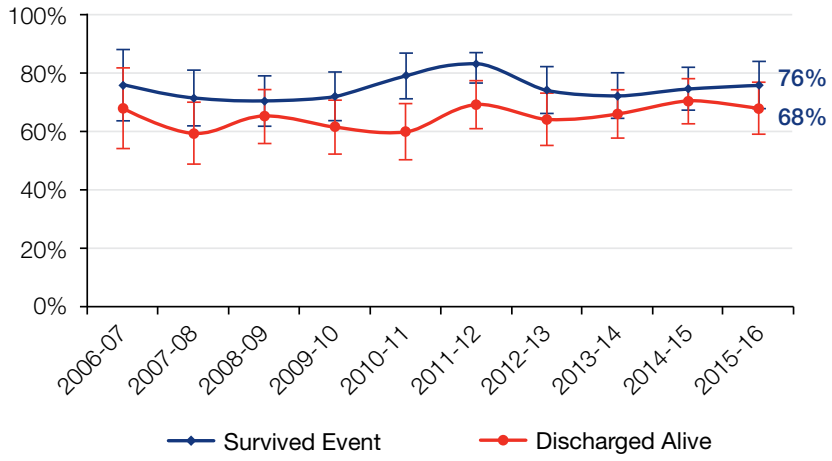


Figure 23: Unadjusted survival outcomes for adult EMS witnessed, EMS treated events with a shockable arrest rhythm.

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 2015-2016, 12% of EMS treated paediatric cases presented in a shockable rhythm (excludes EMS witnessed arrests). Asystole was the most common presenting rhythm (75%).

In 2015-2016, 28% of paediatric EMS treated patients survived the events (excludes EMS witnessed arrests). This was the highest paediatric rate of event survival for the last 10 years. During 2015-2016, there were six paediatric patients (10%) who were discharged alive, consistent over the last 10 years.

There were ten EMS witnessed paediatric events in 2015-2016. Four (40%) survived the event and two (20%) were 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 et al. 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 24 shows the total number of OHCA events in 2015-2016 and progressively shows the breakdown of events according to EMS attempted resuscitation, witnessed status and presenting rhythm.

In 2015-2016, the state-wide rate of survival to hospital discharge for the Utstein patient subgroup presenting in a shockable rhythm was 35%. This percentage remains unchanged if only arrests due to a presumed cardiac cause within the Utstein patient subgroup were included. In the previous year, the state-wide rate of being discharged alive within the Utstein patient subgroup was 32%.

Within the metropolitan and rural regions, the rates of being discharged alive within the Utstein patient subgroup was 38% and 28%, respectively. In the previous year, these rates in the metropolitan and rural regions were 35% and 26%, respectively.

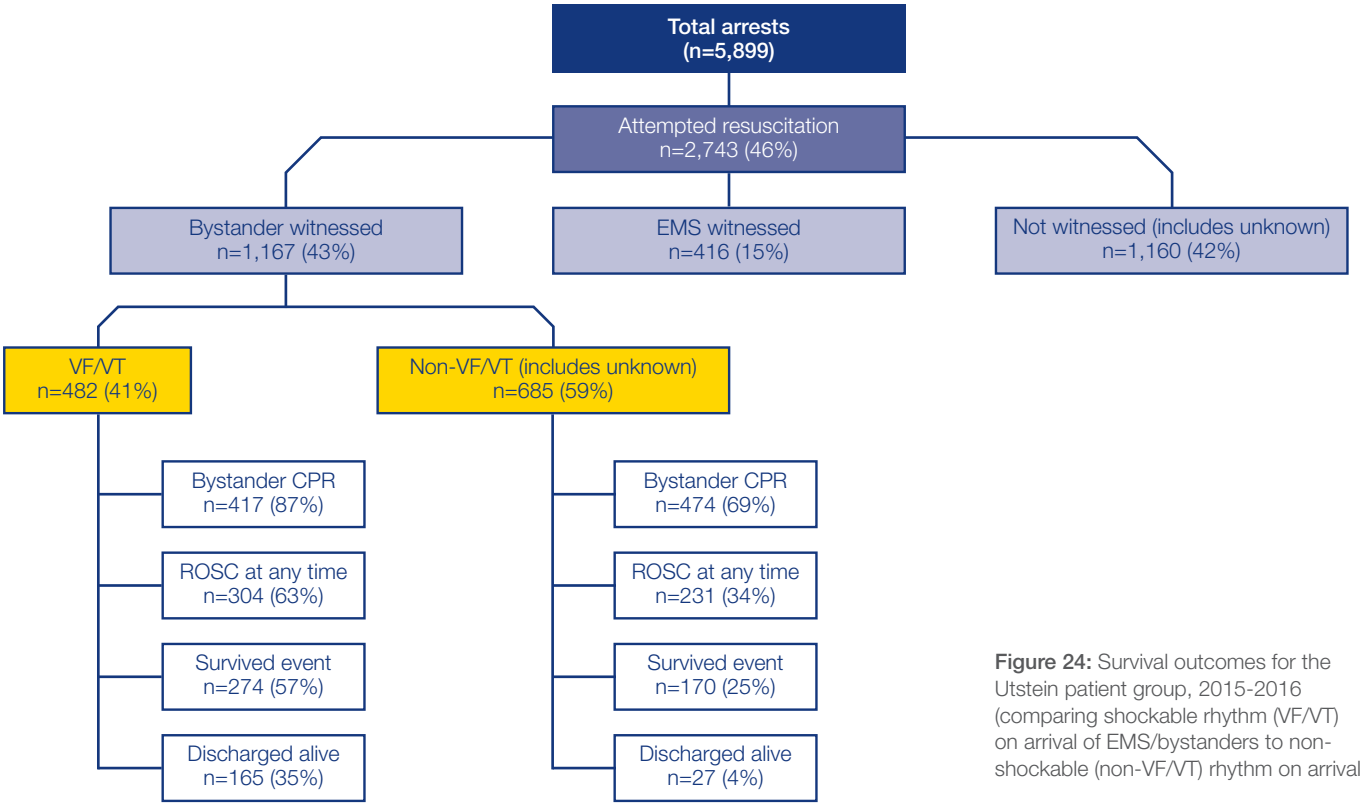


Figure 24: Survival outcomes for the Utstein patient group, 2015-2016 (comparing shockable rhythm (VF/VT) on arrival of EMS/bystanders to non-shockable (non-VF/VT) rhythm on arrival).

Utstein patient group survival in Victoria compared to international data

Table 7 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 cause, as per the most recent recommendations for reporting of the Utstein comparator group (Perkins et al. 2015). As evident in Table 7, some groups still focus on the presumed cardiac cause patient subgroup.

During the period 2015-2016, Victorian OHCA patients experienced a discharged alive rate for the Utstein patient subgroup (35%) which was comparable to the survival outcomes reported by a number of other ambulance services or other large collaborative resuscitation studies/registries around the world. As mentioned earlier, this percentage survival remained unchanged if only arrests due to a presumed cardiac cause within the Utstein patient subgroup in Victoria were included in the analysis.

Whilst a higher survival rate is noted for patients in Seattle and King County, it is important to note the following caveats: i) the Seattle/King Country 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 Country population is smaller than in Victoria (approx. 2.1 million versus 6.0 million, respectively).

Table 7: Published Victorian and international OHCA survival to hospital discharge data for the Utstein patient group.

Organisation	Time period	% survival
Ambulance Victoria	2015-2016	35%
London Ambulance Service^ (Virdi et al. 2015)	2014-2015	31%
Pan Asian Resuscitation Outcomes Study, PAROS^ (7 Asian EMS services; Ong et al. 2015)	2009-2012	28%
Cardiac Arrest Registry to Enhance Survival, CARES^^ (12 US state OHCA registries, Vellano et al. 2015)	2013	33%
St John New Zealand^ (Dicker and Davey, 2016)	2015-2016	35%
Seattle/King County EMS^ (Chatalas et al. 2016)	2015	46%

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

Yearly risk-adjusted odds of adult survival

The risk-adjusted odds of survival provides a balanced method of measuring yearly trends in resuscitation performance and outcome. In the analyses presented in Figures 25 and 26, 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 a 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.

The analysis demonstrates strong growth in the survival to hospital discharge outcomes over recent years (see Figure 25). In 2015-2016, the relative odds of survival to hospital discharge for adult EMS treated patients had increased more than two-fold compared to patient outcomes in 2002-2003 (adjusted odds ratio 2.5, 95% CI 1.9-3.3, p<0.001). The 2015-2016 data is consistent with observations over recent years.

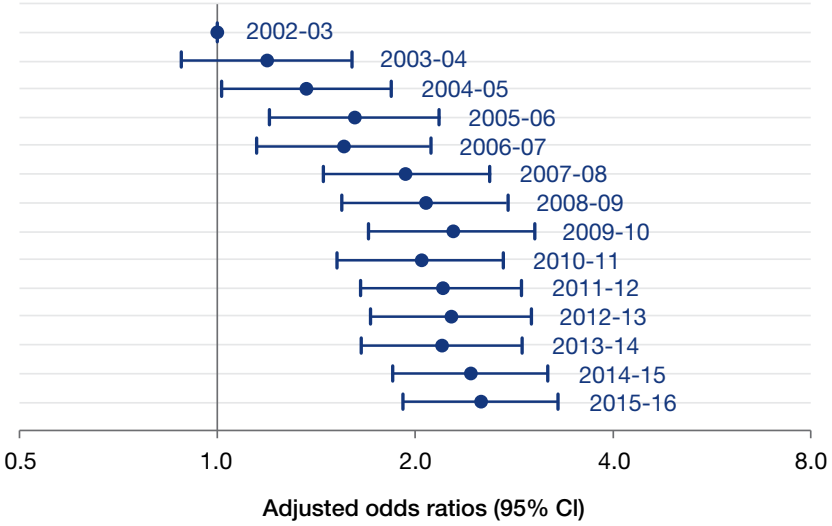
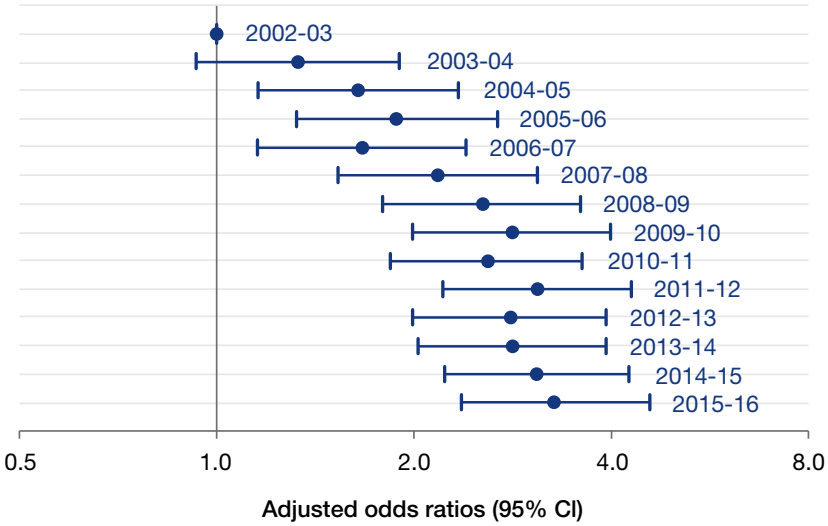


Figure 25: Risk-adjusted odds of adult survival to hospital discharge by year in the overall EMS treated population.

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 26). In 2015-2016, the relative odds of being discharged alive had increased three-fold for adult EMS treated patients presenting in a shockable rhythm compared to patient outcomes in 2002-2003 (adjusted odds ratio 3.3, 95% CI 2.4-4.5, p<0.001).



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

Figure 26: 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 27). Discharge home for adult survivors has increased modestly over the last decade. In 2015-2016, remaining adult survivors were discharged to rehabilitation (13%) and nursing homes (2%). For adult OHCA survivors who presented in a shockable rhythm, 84% were discharged home (including EMS witnessed events and excluding unknown discharge status).

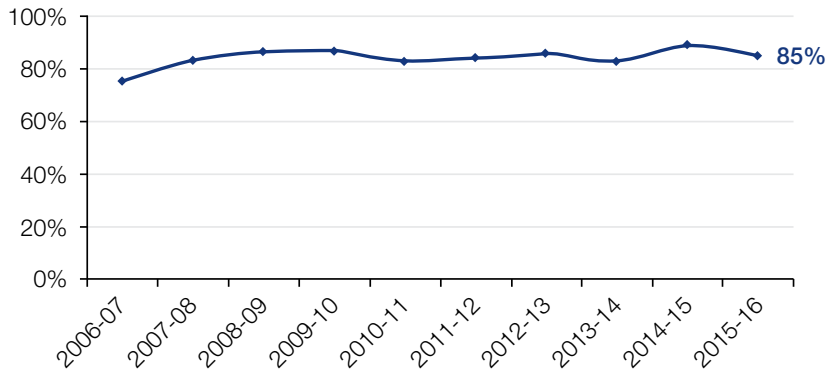


Figure 27: Proportion of adult discharged alive patients who are discharged to a private residence (includes EMS witnessed events).

Assessing quality of life post arrest

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

Interviews include the following measures:

The EuroQol 5 dimension (EQ-5D) questionnaire *(Rabin et al. 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 et al. 2007)*.

Twelve-item short form (SF-12) health survey *(Ware et al. 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 et al. 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 the 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 352 adults (≥18 years) who arrested between 1 July 2014 and 30 June 2015 and were discharged alive from hospital, 323 patients were alive 12 months post-arrest and were eligible for contact in 2015-2016. Interviews were conducted with 207 patients and 74 proxies (n=281), producing a response rate of 87%. There were 134 individuals who had worked prior to their arrest; 74% of individuals (98 of 133) returned to work after their arrest. Of those returning to work, 94% (91 of 97) returned to work in the same role (excludes unknown status for one individual).

SF-12 survey data for OHCA patients who arrested during 2014-2015 and were followed up 12 months later were expressed as SMD scores (outlined on page 45). SMD (±95 CI) for the PCS crossed zero, whilst SMD for MCS was greater than zero (see Figure 28). This means there was no significant difference from Australian population norms for physical health, whilst mental health was in fact more favourable than Australian population norms.

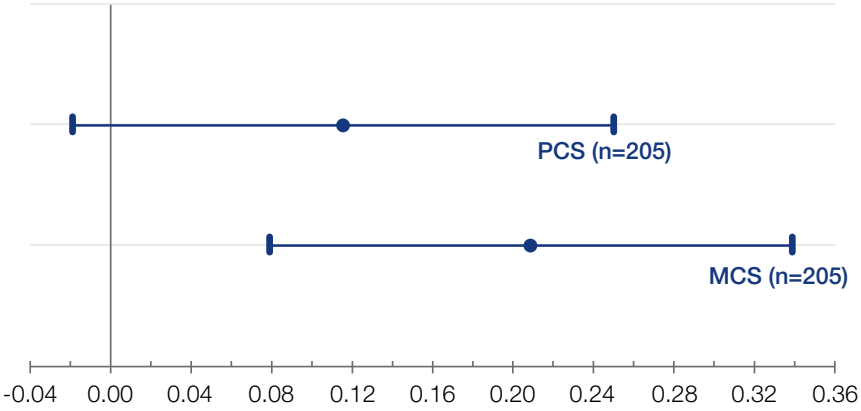


Figure 28: Standardised mean differences for SF-12 scores at 12 months post arrest for adult OHCA survivors versus the Australian population (patients who arrested between 2014-2015).

As a group, OHCA patients who arrested during 2014-2015 reported physical health scores similar to the Australian population (SMD PCS 0.116, 95% CI -0.019 to 0.250). Meanwhile, these patients reported mental health scores slightly higher than the Australian population (SMD MCS 0.209, 95% CI 0.079 to 0.339). SF-12 data was available for all but two patients (n=205).

The GOS-E measure indicated that 66% of survivors who arrested during 2014- 2015 (185 of 279) were rated as having good functional recovery 12 months after their arrest (see Figure 29).

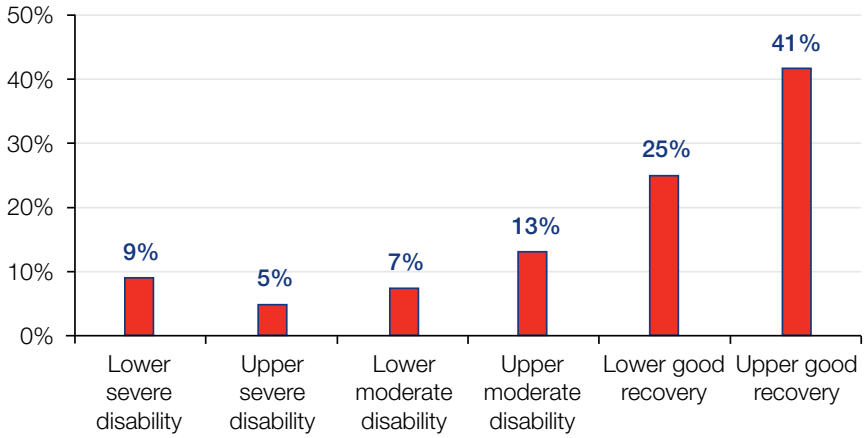


Figure 29: Disability or recovery status according to the GOS-E for adult OHCA survivors at 12 months post arrest (patients who arrested between 2014-2015).

Mean EQ-5D index score for responders followed up in 2015-2016 was 0.85 (95% CI, 0.82 to 0.87); most (72%) 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 et al. 2015). EQ-5D index scores were available for 251 of 281 responders.

Together, the SF-12, GOS-E and EQ-5D results indicate good HRQoL for survivors of arrests during 2014-2015 who responded at 12 months.


PARAMEDIC
PARAMEDIC
PARAMEDIC
AIRWAY

2015-2016 Research Highlights

"Our research agenda continues to focus on the chain of survival and answering unanswered questions relating to OHCA. This year, some research highlights have addressed disparities in bystander CPR rates across Victoria, how co-morbidities and EMS exposure to OHCA influence survival and the outcomes from a clinical trial involving induction of hypothermia during CPR."

Prof Karen Smith, VACAR Principal Investigator and Chair

Rapid Infusion of Cold Normal Saline

OHCA patients successfully resuscitated by paramedics may have severe neurologic injury. Laboratory and observational clinical reports suggest that induction of therapeutic hypothermia during CPR may improve neurologic outcomes. In this study published in Circulation, Bernard et al. undertook a multicentre, randomised controlled trial where adult OHCA patients receiving CPR were assigned to rapid infusion of large-volume cold saline or standard care. For patients with an initial shockable cardiac rhythm, there was a decrease in the rate of ROSC in patients who received cold saline compared with standard care (41.2% compared with 50.6%, P=0.03). Overall 10.2% of patients allocated to therapeutic hypothermia during CPR were alive at hospital discharge compared with 11.4% who received standard care (P=0.71). As such, it was found that intravenous cold saline during CPR may decrease the ROSC rate in patients with an initial shockable rhythm. There was no trend toward improved outcomes at hospital discharge.

Bernard et al. Induction of Therapeutic Hypothermia During Out-of-Hospital Cardiac Arrest Using a Rapid Infusion of Cold Saline: The RINSE Trial (Rapid Infusion of Cold Normal Saline). Circulation. 2016;134(11):797-805.

OHCA incidence and bystander CPR

Rates of OHCA and bystander CPR vary considerably in Victoria. Understanding the factors driving these variations is important in explaining the variation seen in OHCA survival, and may provide information for targeting interventions to reduce OHCA incidence and improve rates of bystander CPR. In this study published in BMJ Open, Straney et al. examined the extent to which rates of bystander CPR variation were explained by sociodemographic and population health characteristics of a region. Regional characteristics independently associated with a higher incidence of OHCA were older age, lower socioeconomic status, smoking and high levels of education. Higher population density was significantly associated with low bystander CPR for bystander witnessed OHCAs. Education targeting regions with low bystander CPR may need to be designed and tailored for each region's characteristics, as well as first understanding the local barriers to providing CPR.

Straney et al. Are sociodemographic characteristics associated with spatial variation in the incidence of OHCA and bystander CPR rates? A population-based observational study in Victoria, Australia. BMJ Open. 2016;6(11):e012434.

Effect of diabetes on OHCA survival

Preliminary reports have shown in-hospital OHCA patients with diabetes experience poorer survival and neurological recovery at hospital discharge. Also, patients with and without diabetes experience changes in blood glucose level (BGL) after cardiac arrest, believed to influence survival and neurological outcomes after resuscitation. In this study published in Critical Care and Resuscitation, Nehme et al. reported on the impact of diabetes and pre-hospital capillary BGL on survival to hospital discharge and 12-month functional recovery. Crude survival to hospital discharge differed among patients with and without diabetes (6.8% v 13.4%; P<0.001). Diabetes, which affects one in five patients, significantly reduced the odds of surviving to discharge for patients presenting in a shockable rhythm (adjusted odds ratio [OR], 0.57; 95% CI, 0.38–0.86; P=0.007) and reduced the odds of good 12-month functional recovery for patients discharged alive (OR, 0.57; 95% CI, 0.35–0.95; P=0.03). Mild-to-moderate elevation of pre-hospital BGL (8.0–15.9 mmol/L) was associated with improved survival and functional recovery outcomes, independent of diabetes status.

Nehme et al. The impact of diabetes and prehospital blood glucose on survival and 12-month functional recovery following out-of-hospital cardiac arrest. Crit Care Resusc. 2016;18(2):69-77.

EMS exposure to OHCA and survival

In this study published in Circ Cardiovasc Qual Outcomes, Dyson et al. examined whether previous paramedic exposure to OHCA resuscitation is associated with patient survival. During the study period, there were 4,151 paramedics employed and 48,291 OHCAs (44% with resuscitation attempted). The median exposure of all paramedics was two (interquartile range 1–3) OHCAs/year. Patient survival after OHCA significantly increases with the number of OHCAs that paramedics have previously treated. Compared with patients treated by paramedics with a median of ≤6 exposures during the previous 3 years (7% survival), the odds of survival were higher for patients treated by paramedics with >6 to 11 (12% survival, adjusted odds ratio 1.26, 95% confidence interval 1.04–1.54), >11 to 17 (14% survival, adjusted odds ratio 1.29, 95% confidence interval 1.04–1.59), and >17 exposures (17% survival, adjusted odds ratio 1.50, 95% confidence interval 1.22–1.86). Paramedic years of experience were not associated with survival.

Dyson et al. Paramedic Exposure to Out-of-Hospital Cardiac Arrest Resuscitation Is Associated With Patient Survival. Circ Cardiovasc Qual Outcomes. 2016;9(2):154-60.

2015-2016 Peer-reviewed Publications*

1. Beck B, Bray JE, Smith K, Walker T, Grantham H, Hein C, Thorrowgood M, Smith A, Inoue M, Smith T, Dicker B, Swain A, Bosley E, Pemberton K, McKay M, Johnston-Leek M, Cameron P, Perkins GD, Finn J and Aus-ROC Steering Committee. Description of the ambulance services participating in the Aus-ROC Australian and New Zealand out-of-hospital cardiac arrest Epistry. Emerg Med Australas. 2016;28(6):673-683.

2. Straney LD, Bray JE, Beck B, Bernard S, Lijovic M and Smith K. Are sociodemographic characteristics associated with spatial variation in the incidence of OHCA and bystander CPR rates? A population-based observational study in Victoria, Australia. BMJ Open. 2016;6(11):e012434.

3. Nehme Z, Andrew E, Bernard S, Patsamanis H, Cameron P, Bray JE, Meredith IT and Smith K. Impact of a public awareness campaign on out-of-hospital cardiac arrest incidence and mortality rates. Eur Heart J. 2016. http://dx.doi.org/10.1093/eurheartj/ehw500 .

4. Andrew E, Nehme Z, Bernard S and Smith K. The influence of comorbidity on survival and long-term outcomes after out-of-hospital cardiac arrest. Resuscitation. 2016;110:42-47.

5. Andrew E, Nehme Z, Bernard S and Smith K. Comparison of health-related quality of life and functional recovery measurement tools in out-of-hospital cardiac arrest survivors. Resuscitation. 2016;107:57-64.

6. Bernard SA, Smith K, Finn J, Hein C, Grantham H, Bray JE, Deasy C, Stephenson M, Williams TA, Straney LD, Brink D, Larsen R, Cotton C and Cameron P. Induction of Therapeutic Hypothermia During Out-of-Hospital Cardiac Arrest Using a Rapid Infusion of Cold Saline: The RINSE Trial (Rapid Infusion of Cold Normal Saline). Circulation. 2016;134(11):797-805.

7. Nehme Z, Nair R, Andrew E, Bernard S, Lijovic M, Villani M, Zoungas S and Smith K. The impact of diabetes and prehospital blood glucose on survival and 12-month functional recovery following out-of-hospital cardiac arrest. Crit Care Resusc. 2016;18(2):69-77.

8. Beck B, Bray J, Smith K, Walker T, Grantham H, Hein C, Thorrowgood M, Smith A, Smith T, Dicker B, Swain A, Bailey M, Bosley E, Pemberton K, Cameron P, Nichol G, and Finn J, on behalf of the Aus-ROC Steering Committee. Establishing the Aus-ROC Australian and New Zealand out-of-hospital cardiac arrest Epistry. BMJ Open. 2016;6(4):e011027.

9. Nehme Z, Andrew E, Bernard S and Smith K. Impact of cardiopulmonary resuscitation duration on survival from paramedic witnessed out-of-hospital cardiac arrests: An observational study. Resuscitation. 2016;100:25-31.

10. Dyson K, Bray JE, Smith K, Bernard S, Straney L and Finn J. Paramedic Exposure to Out-of-Hospital Cardiac Arrest Resuscitation Is Associated With Patient Survival. Circ Cardiovasc Qual Outcomes. 2016;9(2):154-60.

11. Nehme Z, Bernard S and Smith K, for the Victorian Ambulance Cardiac Arrest Registry. Early CPR in Out-of-Hospital Cardiac Arrest. N Engl J Med. 2015;373(16):1572.

12. Straney LD, Bray JE, Beck B, Finn J, Bernard S, Dyson K, Lijovic M and Smith K. Regions of High Out-Of-Hospital Cardiac Arrest Incidence and Low Bystander CPR Rates in Victoria, Australia. PLoS One. 2015;10(10):e0139776.

13. Dennekamp M, Straney LD, Erbas B, Abramson MJ, Keywood M, Smith K, Sim MR, Glass DC, Del Monaco A, Haikerwal A and Tonkin AM. Forest Fire Smoke Exposures and Out-of-Hospital Cardiac Arrests in Melbourne, Australia: A Case-Crossover Study. Environ Health Perspect. 2015;123(10):959-64.

14. Haikerwal A, Akram M, Del Monaco A, Smith K, Sim M, Meyer M, Tonkin A, Abramson M and Dennekamp M. The impact of fine particulate matter (PM2.5) exposure during wildfires on cardiovascular health outcomes. Journal of the American Heart Association. 2015;4(7). pii: e001653.

* Includes publications from 2015-2016, and additional publications up to the publishing date of the VACAR 2015-2016 Annual Report

List of Abbreviations

ALS	Advanced Life Support
AED	Automated external defibrillator
AV	Ambulance Victoria
CERT	Community Emergency Response Teams
CFA	Country Fire Authority
CPR	Cardiopulmonary Resuscitation
CSO	Clinical support officer
DHHS	Department of Health and Human Services
ECG	Electrocardiogram
EMS	Emergency Medical Services
EQ-5D	EuroQoL 5 Dimension questionnaire
ESTA	Emergency Services Telecommunications Authority, which services the Triple Zero (000) phone line for emergency service dispatch and call taking in Victoria
GOS-E	Extended Glasgow Outcome Scale
HRQoL	Health-related quality of life
LGA	Local Government Areas
MCS	Mental Component Summary of the SF-12 survey
MFB	Metropolitan Fire Brigade
MICA	Mobile Intensive Care Ambulance
OHCA	Out-of-Hospital Cardiac Arrest
PCR	Patient Care Record
PCS	Physical Component Summary of the SF-12
PEA	Pulseless Electrical Activity
ROSC	Return of Spontaneous Circulation
SRU	Single Responder Unit
VACAR	Victorian Ambulance Cardiac Arrest Registry
SF-12	Twelve-item Short Form health survey
VF	Ventricular Fibrillation
VT	Pulseless Ventricular Tachycardia

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 who, 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.


2
PARAMEDIC

The VACAR Group

VACAR Chief Investigators

Prof Karen Smith (Chair)
Manager, Research & Evaluation
Ambulance Victoria

Prof Stephen Bernard
Medical Director
Ambulance Victoria

VACAR Steering Committee

Prof Karen Smith (Chair)
Manager, 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

Mr Mick Stephenson
Acting 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 Marijana Lijovic
Senior Research Fellow, Research & Evaluation
Ambulance Victoria

Dr Resmi Nair
Performance Analyst, Research & Evaluation
Ambulance Victoria

Ms Vanessa Barnes
Research Officer, Research & Evaluation
Ambulance Victoria

Mrs Marian Lodder
Data Processor, Research & Evaluation
Ambulance Victoria

Ms Davina Vaughan
Data Processor, Research & Evaluation
Ambulance Victoria

Mrs Kerri Anastasopoulos
Data Processor, Research & Evaluation
Ambulance Victoria

References

- Australian Commission on Safety and Quality in Health Care. Economic evaluation of clinical quality registries: Final report. Sydney: ACSQHC; 2016.
- Berdowski J, Berg RA, Tijssen JGP and Koster RW. Global incidence of out-of-hospital cardiac arrest and survival rates: systematic review of 67 prospective studies. Resuscitation. 2010; 81(11)1479-87.
- Bray JE, Deasy C, Walsh J, Bacon A, Currell A and Smith K. Changing EMS dispatcher CPR instructions to 400 compressions before mouth-to-mouth improved bystander CPR rates. Resuscitation. 2011; 82:1393-8.
- Chatalas H, editor. Division of Emergency Medical Services 2016 Annual Report to the King County Council. Seattle, WA; 2016.
- Deasy C, Bray JE, Smith K, Hall D, Morrison C, Bernard SA and Cameron P. Paediatric traumatic out-of-hospital cardiac arrests in Melbourne, Australia. Resuscitation. 2012; 83(4):471-5.
- Deo R and Albert CM. Epidemiology and genetics of sudden cardiac death. Circulation. 2012;125(4):620-37.
- Dicker B and Davey P. St John New Zealand Out-of-Hospital Cardiac Arrest Registry Annual Report 2015/16. St John NZ; 2016.
- Fridman M, Barnes V, Whyman A, Currell A, Bernard S, Walker T and Smith K. A model of survival following pre-hospital cardiac arrest based on the Victorian Ambulance Cardiac Arrest Register. Resuscitation 2007; 75(2): 311-22.
- Lijovic M, Bernard S, Nehme Z, Walker T and Smith K, for the Victorian Ambulance Cardiac Arrest Registry Steering Committee. Public access defibrillation—results from the Victorian Ambulance Cardiac Arrest Registry. Resuscitation. 2014; 85(12):1739-44.
- McGough JJ and Faraone SV. Estimating the size of treatment effects: Moving beyond P values. Psychiatry. 2009; 6(10):21-9.
- Nichol G, Rumsfeld J, Eigel B, Abella BS, Labarthe D, Hong Y, O'Connor RE et al. Essential features of designating out-of-hospital cardiac arrest as a reportable event: a scientific statement from the American Heart Association Emergency Cardiovascular Care Committee; Council on Cardiopulmonary, Perioperative, and Critical Care; Council on Cardiovascular Nursing; Council on Clinical Cardiology; and Quality of Care and Outcomes Research Interdisciplinary Working Group. Circulation. 2008; 117(17):2299-308.
- Nehme Z, Andrew E, Cameron P, Bray JE, Meredith IT, Bernard S and Smith K. Direction of first bystander call for help is associated with outcome from out-of-hospital cardiac arrest. Resuscitation. 2014; 85(1):42-8.
- Ong ME, Shin SD, De Souza NN, Tanaka H, Nishiuchi T, Song KJ, Ko PC, Leong BS, Khunkhlai N, Naroo GY, Sarah AK, Ng YY, Li WY, Ma MH and PAROS Clinical Research Network. Outcomes for out-of-hospital cardiac arrests across 7 countries in Asia: The Pan Asian Resuscitation Outcomes Study (PAROS). Resuscitation 96 (2015) 100–110.
- Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, Bossaert LL et al. Cardiac Arrest and Cardiopulmonary Resuscitation Outcome Reports: Update of the Utstein Resuscitation Registry Templates for Out-of-Hospital Cardiac Arrest: A Statement for Healthcare Professionals From a Task Force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian and New Zealand Council on Resuscitation, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa, Resuscitation Council of Asia); and the American Heart Association Emergency Cardiovascular Care Committee and the Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Resuscitation. 2015; 96:328-40.
- Rabin R and de Charro F. EQ-5D: a measure of health status from the EuroQol Group. Ann Med. 2001; 33(5):337-43.
- Smith K, Andrew E, Lijovic M, Nehme Z and Bernard SA. Quality of life and functional outcomes 12-months after out-of-hospital cardiac arrest. Circulation. 2015 13;131(2):174-81.
- Stub D, Nehme Z, Bernard S, Lijovic M, Kaye D and Smith K. Exploring which patients without return of spontaneous circulation following ventricular fibrillation out-of-hospital cardiac arrest should be transported to hospital? Resuscitation. 2014; 5(3):326-33.
- Stub D, Smith K, Bray, JE, Bernard S, Duffy SJ and Kaye DM. Hospital characteristics are associated with patient outcomes following out-of-hospital cardiac arrest. Heart. 2011; 97(18):1489-94.
- Szende A and Williams A, editors. Measuring Self-Reported Population Health: An International Perspective based on EQ-5D. Rotterdam (The Netherlands): SpringMed Publishing; 2004.
- Vellano K, Crouch A, Rajdev M and McNally B. CARES Report on the Public Health Burden of Out-of-Hospital Cardiac Arrest, Institute of Medicine; 2015.
- Virdi G, Picton S and Fothergill R. Cardiac Arrest Annual Report: 2014/15. London Ambulance Service NHS Trust, London; 2015.
- Ware J Jr, Kosinski M and Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care. 1996; 34(3):220-33.
- Wilson JT, Pettigrew LE and Teasdale GM. Structured interviews for the Glasgow Outcome Scale and the extended Glasgow Outcome Scale: guidelines for their use. J Neurotrauma. 1998; 15(8): 573-85.

In an emergency call Triple Zero (000)

Ambulance Membership 1800 64 84 84

Ambulance Victoria
PO Box 2000
Doncaster VIC 3108

T 03 9840 3500

ambulance.vic.gov.au