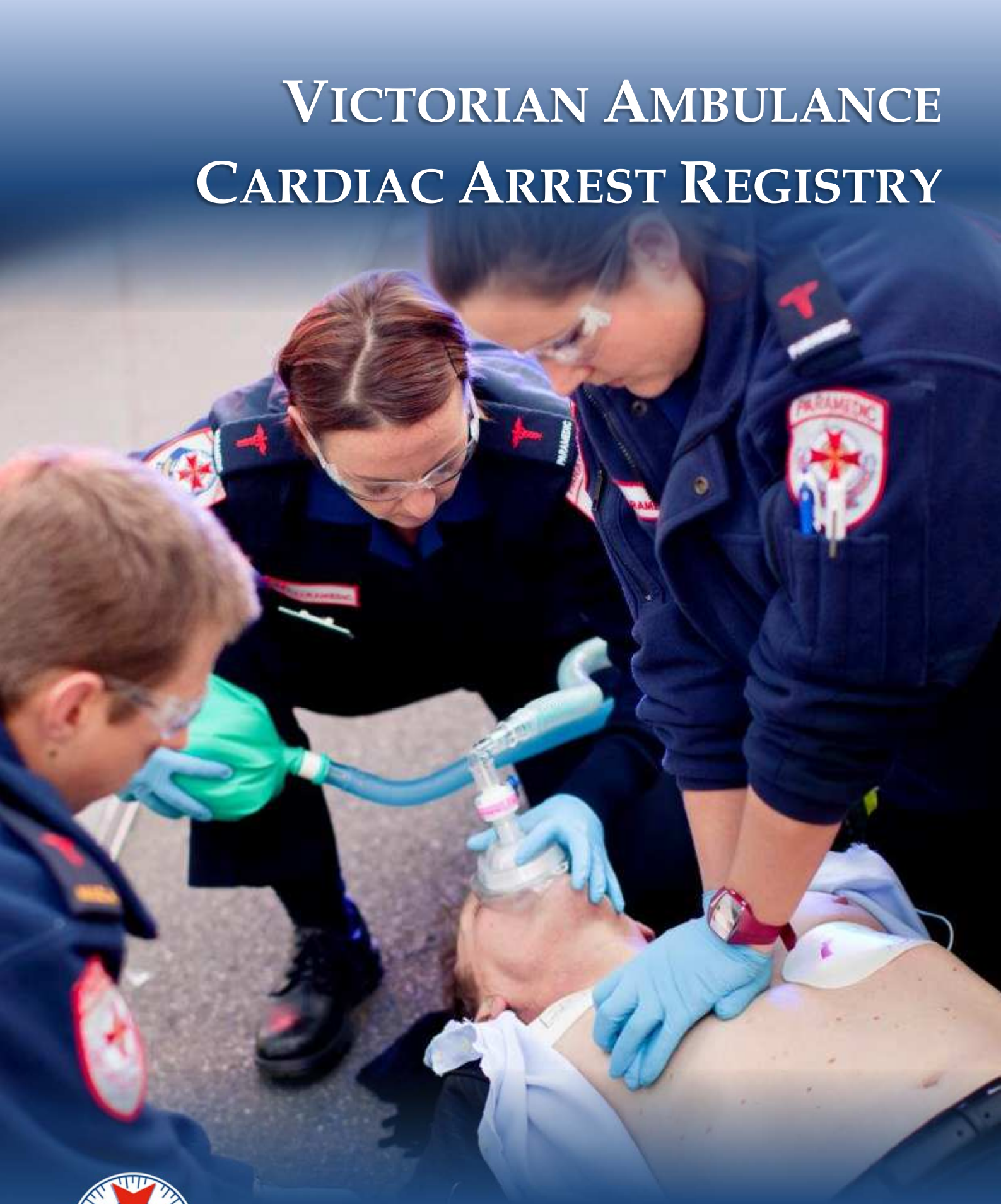
Victorian Ambulance Cardiac Arrest Registry



Annual Report 2013-2014

Victorian Ambulance Cardiac Arrest Registry
Annual Report 2013-2014

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

December 2014

The *VACAR Annual Report 2013-2014* is a publication produced by the Department of Research & Evaluation, Ambulance Victoria.

Manager A/Prof Karen Smith
Editor Dr Marijana Lijovic
Authors 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.

Contents

List of Tables

List of Figures


Police
H-PVG
AMBULANCE VICTORIA

The Emergency Medical Service

The state of Victoria, Australia has an estimated population of 5.7 million, with 76% living in the state's capital city of Melbourne. Thirteen 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 (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.

Australia operates a single national telephone number for community access to emergency services (i.e. "000"). Telephone triage of emergency calls is performed using the Medical Priority Dispatch System. Suspected cardiac arrest events identified in-call receive further call-taker instruction recommending 400 chest compressions before mouth-to-mouth resuscitation.

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. In addition, AV co-responds with 29 volunteer community teams in smaller, predominately rural communities across the state. A pilot fire-fighter first responder program involving the Country Fire Authority (CFA) commenced in 2008, and operates at a number of sites in outer metropolitan Melbourne and at Shepparton.

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.

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 minutes without return of spontaneous circulation (ROSC), the rhythm is not Ventricular Fibrillation (VF) or pulseless Ventricular Tachycardia (VT), and there are no signs of life, no gasps or evidence of pupillary reaction and no evidence of hypothermia or drug overdose.

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 Associate 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 survivors 12 months post cardiac arrest (commenced January 2010, excludes children). 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 72,000 patients. The data is collated in the registry using 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 Emergency Medical Response Program, Four Steps to Life Plus CPR training and Public Access Defibrillation (for more information, see www.ambulance.vic.gov.au). In addition, VACAR has successfully established an internationally recognised research program, with the publication of scientific literature in medical journals (see 2013-2014 Peer-reviewed Publications, page 40).

In 2010, VACAR expanded its methodology to become one of few registries globally that routinely captures the quality of life of adult survivors of OHCA. A structured telephone interview at 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

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 opposite (see Tables 2 & 3).

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 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 attempt prior to arrival, or no other evidence verifying a cardiac arrest state is present.

Data capture

The registry is based on the internationally recognised Utstein template and definitions (*Jacobs et al. 2004*). 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 cases attended by AV, a broad electronic search is conducted of clinical databases utilising specific search criteria. This search strategy is focused at identifying potential cardiac arrest cases, which may be eligible for review. Paper PCRs may be used in cases where in-field electronic data capture is not possible. In these instances, paramedic team managers are required to forward all potential cardiac arrest cases to VACAR for review. A hand search of all paper PCRs forwarded to the AV Accounts department is performed periodically to ensure complete case capture.

Following review of potential cases, eligible cardiac arrest cases are entered into the VACAR database, with PCR data being supplemented by information from communication centre dispatch records. The VACAR participating hospitals (i.e. ethics approved participation) are contacted for survival status and patient discharge direction. A cross-match of VACAR records with the Victorian Registry of Births, Deaths and Marriages is undertaken for verification of deaths. Structured telephone interviews are conducted 12 months post cardiac arrest for 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.

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. Comparisons of these results are made with national and international data. 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 Department of Health Human Research Ethics Committee. 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 strict access to authorised VACAR staff.

Missing data

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

Table 4: Number and proportion of missing data for select registry variables, 2013-2014 (n=5,667).

Patient age	106 (1.9%)
Patient sex	16 (0.3%)
Arrest location	Nil
Witnessed status	114 (2.0%)
Bystander CPR	925 (16.3%)
Rhythm on arrival	10 (0.2%)
EMS Response time	6 (0.1%)
Defibrillation time	30 (0.5%)
Outcome at scene	1 (<0.1%)
Event survival	3 (0.1%)
Hospital discharge status	28 (0.5%)
Hospital discharge direction	3 (0.1%)

About this Report

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

While cardiovascular mortality has declined over the last three decades, the case-fatality rate of sudden cardiac arrest has not declined *(Nichol et al. 2008)*. OHCA is a significant cause of disability and death in Australia, with a reported incidence of 113 events per 100,000 peoples *(Berdowski et al. 2010)*. Much of the burden associated to sudden cardiac death occurs before a patient reaches the hospital, and therefore EMS has a crucial role in reducing the burden of illness in our communities. The American Heart Association states that monitoring the treatment of OHCA by EMS agencies could be the 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, July 2013 to June 2014. Data for this report was extracted on 9 September 2014, with pending hospital follow-up remaining in a small proportion of events.

The registry is based on the internationally recognised Utstein template and definitions *(Jacobs et al. 2004)*. 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.

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 44.

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 and population regions of Victoria. 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 regions (www.health.vic.gov.au/regions). The Melbourne metropolitan region is comprised of three geographical regions: North and West, Eastern and Southern Regions. Rural regions comprises 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, other rural urban centres, fall within the Grampians and Loddon Mallee regions, respectively. AV may be dispatched to a small number of OHCA cases 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 region. Any cases which occur off the coastline of Victoria are attributed to the nearest Victorian Department of Health region.

Population figures used in this report are defined by the Regional Population Growth reports published 3 April 2014 by the Australian Bureau of Statistics. The population figures are provided for the end of June 2013, with a Victorian population estimate of 5,739,341.

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.) and may therefore skew the analyses presented in this report. Data relating to paramedic or EMS witnessed OHCA have therefore been analysed and depicted separately to those which are unwitnessed by paramedics. Unless specifically stated, all analyses should be assumed to exclude EMS witnessed events.

Executive Summary

Survival outcomes are supported by a decade of growth in community-initiated cardiopulmonary resuscitation and a ten-fold increase in the use of automated external defibrillators by members of the public.

1. Ambulance Victoria attended 5,667 OHCA events in the period between July 2013 and June 2014, with almost 99% involving adults. The proportion of patients receiving emergency treatment by EMS was 48% overall, or 44% in the non-EMS witnessed population. The crude incidence of OHCA was higher in the rural region than in the metropolitan region: 124.7 versus 90.0 events per 100,000 population. The Gippsland and Hume regions recorded the highest crude incidence rates of OHCA (see Incidence & Demographics, page 16).

2. The demographic profile of events in 2013-2014 was similar to those observed over the last decade. OHCA precipitated by a presumed cardiac aetiology accounted for 69% 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. Arrests in public locations produced significantly better survival outcomes than arrest in the home (see Incidence & Demographics, page 16).

3. Less than 10% of bystander calls for help following OHCA are inappropriately directed to a relative, friend or neighbour rather than directly calling for an ambulance. Emergency call-takers are effective at identifying cardiac arrest events during the emergency call, with 89% being correctly identified in the metropolitan region. Median EMS response times in 2013-2014 to EMS treated events in the metropolitan (median 7.6 minutes, 90th percentile 13.2 minutes) and rural regions (median 11.1 minutes; 90th percentile time 25.4 minutes) were similar to the previous year (see Chain of Survival, page 24).

4. Bystander CPR increased to 75% for bystander witnessed events undergoing an attempted resuscitation by EMS (43% in 2004-2005). The use of automated external defibrillators by members of the public increased 10-fold over the last decade for patients presenting in shockable rhythms (see Chain of Survival, page 24).

5. The statewide rate of ROSC in adult EMS treated events was 39% in 2013-2014. Survival for all-cause OHCA in the EMS treated population was 10% in 2013-2014 and remains within recent years' figures (see Survival Outcomes, page 30).

6. Survival outcomes for EMS treated patients presenting in shockable rhythms was 54% and 29% for event survival and survival to hospital discharge, respectively. For patients presenting in shockable rhythms and witnessed to arrest by EMS, event survival was 73% and 66% were discharged alive. Patients presenting in asystole and pulseless electrical activity experienced the poorest survival outcomes, with 0.8% and 7% surviving to hospital discharge, respectively (see Survival Outcomes, page 30).

7. The risk-adjusted odds of survival to hospital discharge have improved significantly over time. The odds of survival to hospital discharge are more than two times higher for OHCA patients in 2013-2014 than for patients in 2002-2003 (adjusted odds ratio 2.2, 95% CI 1.7-2.9, $p<0.001$). This improvement was also observed for cases presenting in shockable rhythms over the same period (adjusted odds ratio 2.8, 95% CI 2.0-3.9, $p<0.001$) (see Survival Outcomes, page 30).

8. The majority of OHCA cases with known survival to hospital discharge continue to be discharged home (84% in 2013-2014). Phone interviews showed that the majority of survivors maintained their independence and have a good quality of life 12 months after their arrest (see Long-term Functional Outcomes, page 36).

Incidence & Demographics

Incidence & Demographics

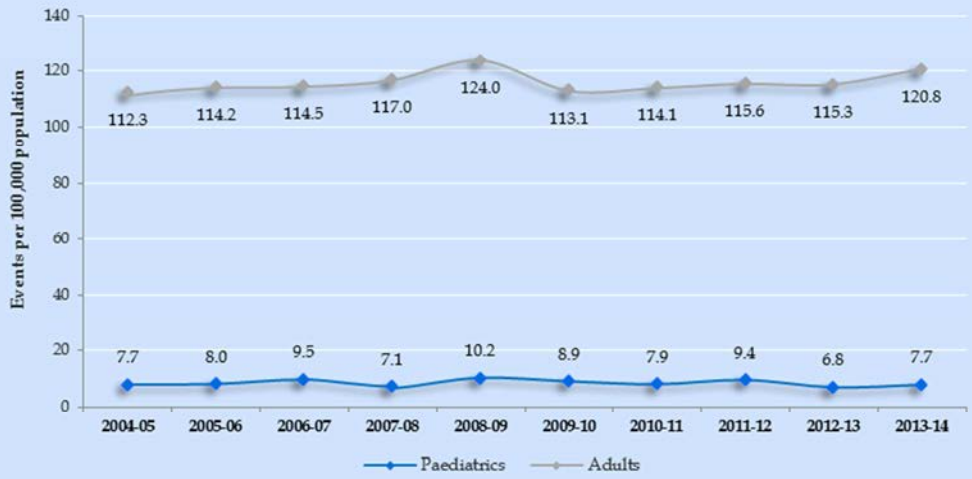


Figure 1: Crude incidence of adult and paediatric EMS attended OHCA in Victoria (includes EMS witnessed events).

Incidence of all adult & paediatric events †

In 2013-2014, Ambulance Victoria attended 5,667 OHCA events, of which 5,581 (98.5%) were defined as adults aged greater than 15 years or patients with unknown age. The 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 (86 cases in 2013-2014), though his number is within normal yearly fluctuations.

The crude incidence of OHCA has remained relatively consistent over the last decade. In 2013-2014, the incidence of all OHCA in Victoria was 98.7 events per 100,000 population. The incidence of adult and paediatric events also remained within recent observations, and was 120.8 and 7.7 events per 100,000 population, respectively (see Figure 1). While variation in OHCA incidence across continents and regions are well established, these figures are within previously reported incidence rates.

Of all adult OHCA events attended, 48% received an emergency resuscitation attempt by paramedics and/or first-responders (includes EMS witnessed events). This figure remains under 50%, as also noted in the previous fiscal year, but is significantly higher than the lowest 10 year finding in 2005-2006 (48% vs. 41%, $p<0.001$).

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 58.0 events per 100,000 population.

In paediatric events, the proportion of EMS treated events is higher than in adults, with the majority receiving an attempted resuscitation by EMS (77% in 2013-2014, includes EMS witnessed events). The trend in the rate of attempted resuscitation for paediatric events has increased over the last 10 years; this rate was 68% in 2004-2005. The crude incidence of paediatric EMS treated events was 5.9 events per 100,000 population.

† All results in this section include EMS witnessed events.

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

In 2013-2014, Ambulance Victoria attended 5,581 adult OHCA events, representing the highest number of events in a 10 year period. The rate of attempted resuscitation by EMS remains just under 50%.

Incidence across regions of Victoria†

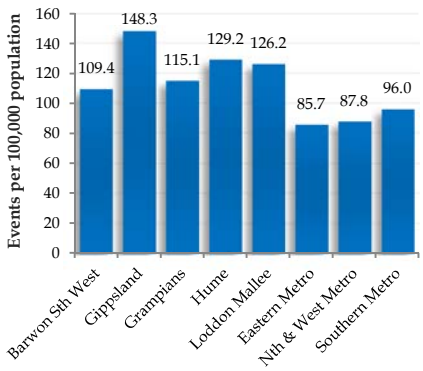


Figure 3: Crude incidence of EMS attended events across Department of Health regions, 2013-2014.

A significantly higher number of OHCA events were observed in the metropolitan region representing 3,853 cases (68% of the total number of events attended in 2013-2014). The number of events attended in rural Victoria yielded its highest 10 year figure with 1,814 events, a 44% increase since 2003-2004.

Despite the increased proportion of events occurring in the metropolitan region, the crude incidence of OHCA was significantly higher in the rural region (124.7 vs. 90.0 events per 100,000 population, p<0.001).

† All results in this section include EMS witnessed events.

In fact, the crude incidence of OHCA has observed a steady increase over the last 10 years in rural Victoria, rising from 94.5 events in 2003-2004 to 124.7 events per 100,000 population in 2013-2014 (p<0.001). However, this observation may reflect better case capture, especially after the 2008-2009 period which coincides with the completion of the roll-out of VACIS in the rural area. Incidence in the metropolitan region has remained relatively unchanged during the same period (see Figure 2).

Regional variability in OHCA incidence was observed across Department of Health regions in 2013-2014 (see Figure 3). The lowest crude incidence was observed in the Eastern Metropolitan Region (85.7 events per 100,000 population) and the highest incidence in the Gippsland region (148.3 events per 100,000 population). All three metropolitan regions recorded the highest frequency of events in their region in the last 10 year period. The North and West Metropolitan region, which includes the Melbourne Business District, had a total of 1,622 OHCA cases. Within the rural region, the Gippsland, Grampians and Loddon Mallee regions recorded the highest frequency of OHCA events over the last 10 years.

The proportion of events receiving an attempted resuscitation varies considerably across regions. The highest EMS treated proportion was found in the North and West Metropolitan region (53%) and the lowest in the Grampians region (42%).

Demographics of adults

The demographic profile of adult events (excluding EMS witnessed arrests) has remained consistent over the last decade. In 2013-2014, EMS attended adult events consisted predominately of males (66%) with a median age of 67.0 years. The age distribution varied significantly across the sexes (see Figure 4), with females having a higher median age of arrest (73.0 vs. 65.0 years, p<0.001). The proportion of cases witnessed to arrest by a bystander (32%), occurring in a public location (16%), and receiving bystander CPR (41%) were not significantly different to those observed in the previous year.

Paramedics attempted resuscitation in 44% of all EMS attended adult OHCA events. The demographic profile of patients receiving an attempted resuscitation varies significantly from the overall population, with a lower median age (66.0 years), more events occurring in a public place (21%), more events witnessed by a bystander (54%), and an increased rate of bystander CPR (70%).

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 (82 in 2013-2014). The median age of arrest was 24 months, and is driven predominantly by aetiology in this population (see Figure 7, page 21). The vast majority of paediatric OHCA occur in paediatrics aged less than three years, accounting for 58% of all arrests in this population.

The demographic profile of paediatric OHCA varies significantly across reporting years, and is impacted by smaller samples sizes. In 2013-2014, the proportion of cases involving males was 56%, with 21% occurring in a public location. More paediatric arrests were witnessed by a bystander compared to adult arrests (43% vs 32%, p=0.05) and significantly more paediatric patients received bystander CPR (59% vs. 41%, p=0.001). The vast majority of paediatric patients present in an asystolic rhythm (82%), with only 2% presenting to EMS in a shockable rhythm. The proportion of paediatric cases receiving an attempted resuscitation by paramedics was significantly higher than for adults (76% vs 44% in 2013-2014).

Figure 4: Age distribution of EMS attended OHCA events, 2013-2014.

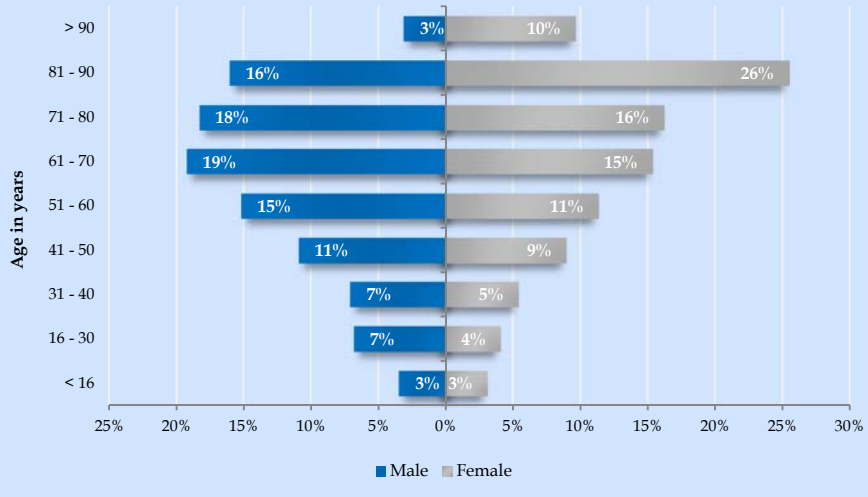
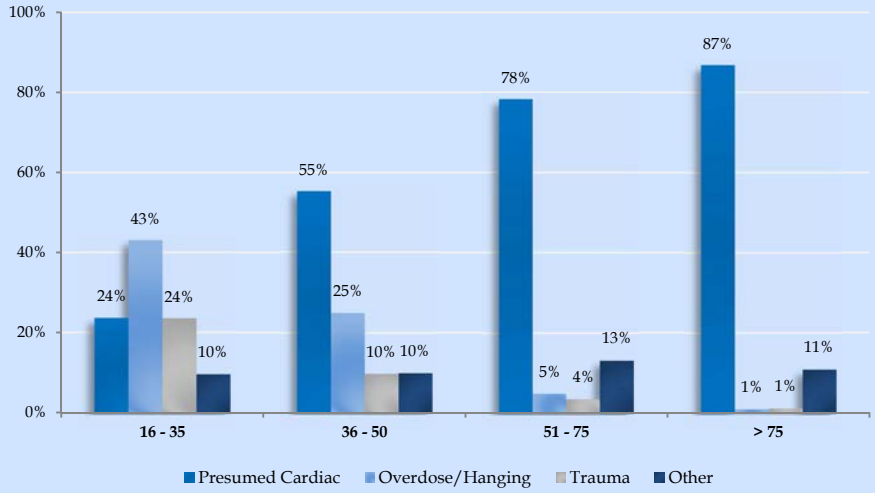


Figure 5: Adult precipitating events across age groups for EMS attended events, 2013-2014.



Precipitating events for adults

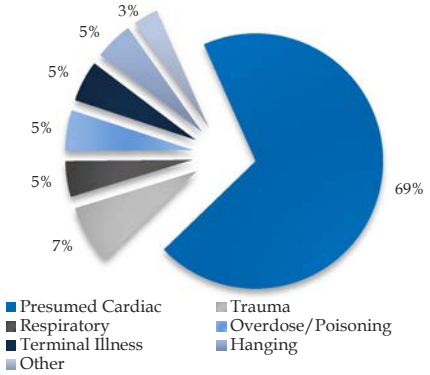


Figure 6: Adult precipitating events for EMS attended events, 2013-2014.

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 (*Jacobs et al. 2004*). In total, VACAR records 13 precipitating events for adults, of which six are the predominant causes of arrest.

In 2013-2014, 69% of EMS attended adult OHCA were presumed to be of a cardiac cause. Arrests precipitated by trauma (7%), respiratory (5%), overdose/poisoning (5%), terminal illness (5%) and hanging (5%) were also frequent causes of OHCA (see Figure 6).

In patients receiving an attempted resuscitation by EMS, most cases were of presumed cardiac origin (74%).

The rate of EMS attempted resuscitation differed amongst patients according to the precipitating cause of the event. Compared to presumed cardiac cases, the rate of EMS attempted resuscitation is lower for arrests precipitated by trauma, overdose/poisoning, terminal illness and hangings. Meanwhile, most OHCA cases due to a respiratory cause received EMS attempted resuscitation (71%).

The precipitating event for arrests across age groups in the EMS attended population is depicted in Figure 5. This graph highlights the important relationship between arrest aetiology and patient age group. While arrests from a presumed cardiac cause dominated overall proportions, arrests secondary to overdose/poisoning, hanging, and trauma accounted for the majority of arrests in the 16-35 year age group. In fact, arrests secondary to overdose/poisoning and hangings are a leading cause of arrest in patients aged 16-50 years.

Road traffic accidents remain a significant cause of death and disability in Australia, with 59% of all OHCA from a traumatic cause being attributed to road trauma.

Precipitating events for paediatrics

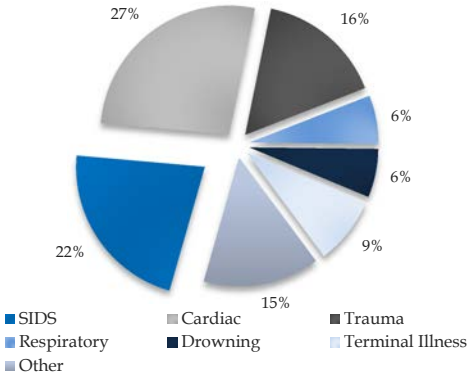


Figure 7: Paediatric precipitating events for EMS attended events, 2013-2014.

Precipitating events for paediatrics who suffer OHCA vary considerably in comparison to adults, with only 27% of EMS attended paediatric events being of a presumed cardiac cause (see Figure 7). Another overwhelming cause of OHCA in paediatrics is presumed to be secondary to SIDS (22% of events), where there are very few survivors (<1%). Trauma, respiratory and terminal illnesses also play a significant role in the aetiology of arrest in paediatrics, and contributes strong prognostic information in this population (*Deasy et al. 2012*). The distribution of precipitating events in the EMS treated paediatric population mirrors that of the overall paediatric population.

Mechanism of arrest in the traumatic sub-group

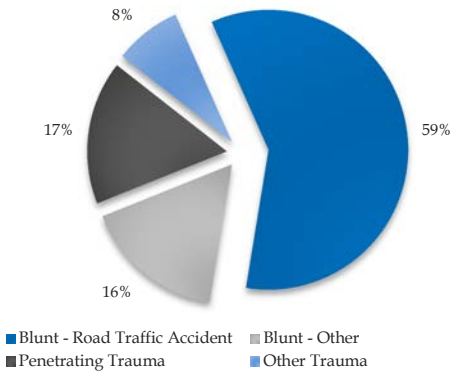
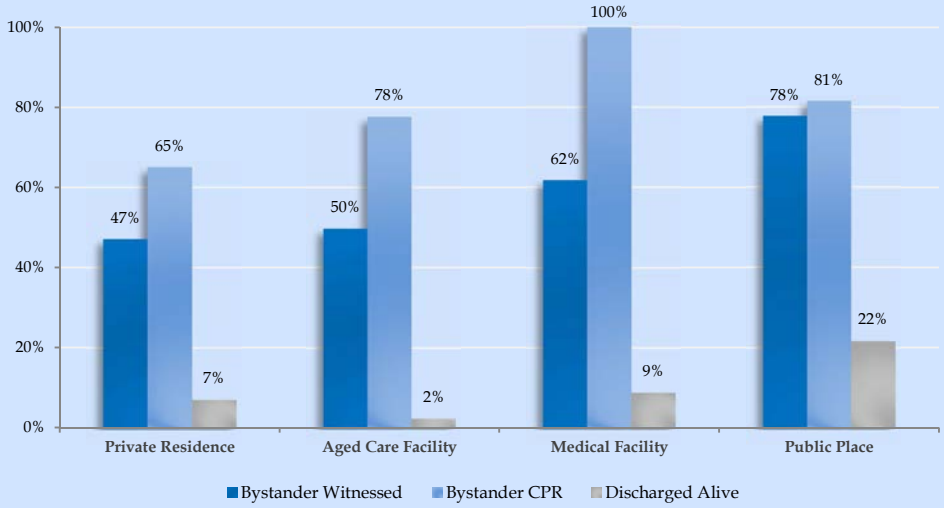


Figure 8: Sources of trauma in EMS attended traumatic OHCA sub-group, 2013-2014.

Cardiac arrests secondary to major trauma represent an important surveillance group in Victoria. In this population, arrests secondary to road trauma were responsible for 59% of traumatic OHCA in 2013-2014. Blunt trauma involving falls, crush injuries, or other blunt forces, were responsible for 16% of events, while arrests following ballistic trauma and stabbings accounted for 17% (see Figure 8).

The leading mechanism precipitating cardiac arrests associated with road trauma incidents were: a car or light vehicle (57%), train (18%) or motorcycle (14%). Of these, the majority of events implicated the driver (55%), with the remaining involving pedestrians (30%) or passengers (13%).

Figure 9: Proportion of EMS treated adult events that are bystander witnessed, receive bystander CPR and are discharged alive across arrest locations, 2013-2014.



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

Arrest location for adults and paediatrics

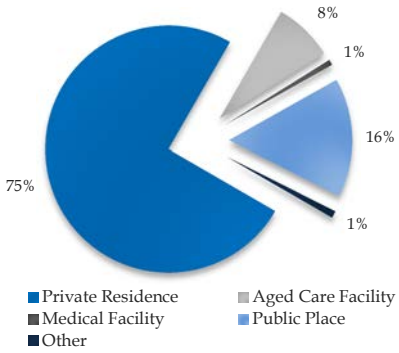


Figure 10: Location of arrest for EMS attended adult events, 2013-2014.

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 depicted in Figure 10. Public places include places of work, streets or roads, shops, vehicles, and sporting/recreational facilities. In 2013-2014, 75% of EMS attended adult OHCA events occurred within a private residence, while 16% occurred in a public place. Of the patients receiving an attempted resuscitation, 69% were in a private residence and 21% 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 9).

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. Survival to hospital discharge varied significantly between private residence and public place (7% vs. 22%, $p<0.001$).

The locations of arrest for paediatric events were similar to those in adults. In 2013-2014, 80% of EMS attended paediatric events occurred in the home, while 20% occurred in a public place. The distribution of arrest locations for paediatrics was similar in both EMS attended and EMS treated populations.

Chain of Survival

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 access to advanced cardiac life support.

Bystander call for help

The direction of a bystander's first phone call can have a significant impact on the effective and timely delivery of CPR and defibrillation. Previous work by VACAR has demonstrated that inappropriate emergency call delays to neighbours, relatives, and the local doctor were associated with significantly poorer outcomes following OHCA (*Nehme et al. 2014*).

In 2013-2014, the first bystander call for help was correctly directed to ambulance in the majority of cases (93.5%). However, emergency call delays continue to exist for a small portion of cases attended, where the first call for help is instead directed to a relative/friend (3%), neighbour (1.5%), police (1%) or other person (1%).

Accurate identification of cardiac arrest during the emergency call is also an important factor influencing the receipt of early dispatcher-assisted CPR instructions and the timely response of emergency medical teams. In 2013-2014, 89% of all EMS attended OHCA events of presumed cardiac aetiology were correctly identified in the emergency call (metropolitan region only).

Emergency response to the incident

EMS response time, or the time from the emergency call to arrival of EMS on scene, is an important measure of time to definitive resuscitation treatment by EMS. Some OHCA events may occur after the "000" call is made, such as those arrests which are witnessed by a paramedic. These cases may not be dispatched as a high priority as the initial event was not a cardiac arrest; including these cases in OHCA response time analyses can give rise to misleading results. As such, EMS witnessed arrests are excluded from the following response time analyses. The distribution of response times for the EMS treated population across regions in 2013-2014 is depicted in Figure 11.

Statewide, median response time to EMS treated events was 8.3 minutes (90th percentile time, 17.1 minutes). This was very similar to the previous year (median time 8.5 minutes; 90th percentile time 17.2 minutes; p=0.46). In 2013-2014, median response times to EMS treated events in metropolitan regions, was 7.6 minutes (90th percentile time 13.2 minutes) compared to 7.8 minutes (90th percentile time 13.7 minutes) in the previous year (p=0.10). Median response time in rural areas in 2013-2014 was 11.4 minutes (90th percentile time 23.6 minutes), similar to response time observations in the previous year (median time 11.1 minutes; 90th percentile time 25.4 minutes; p=0.84).

Figure 11: Distribution of time from call to arrival of EMS on scene in the EMS treated population, 2013-2014.

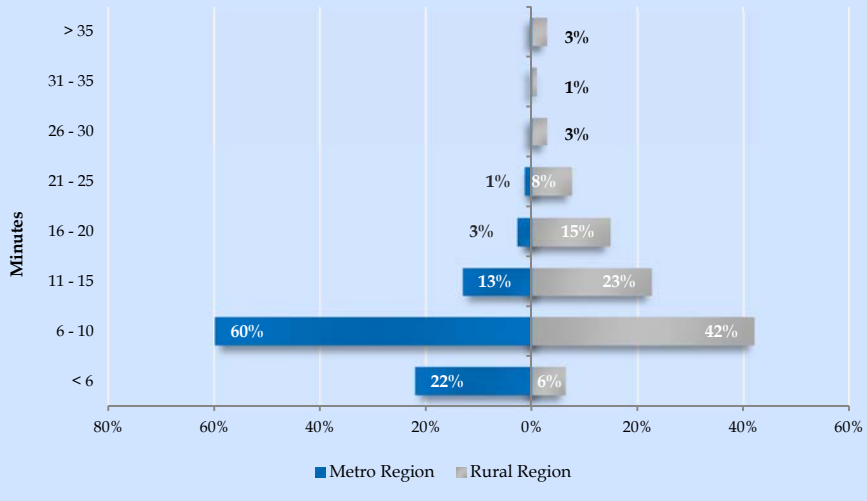
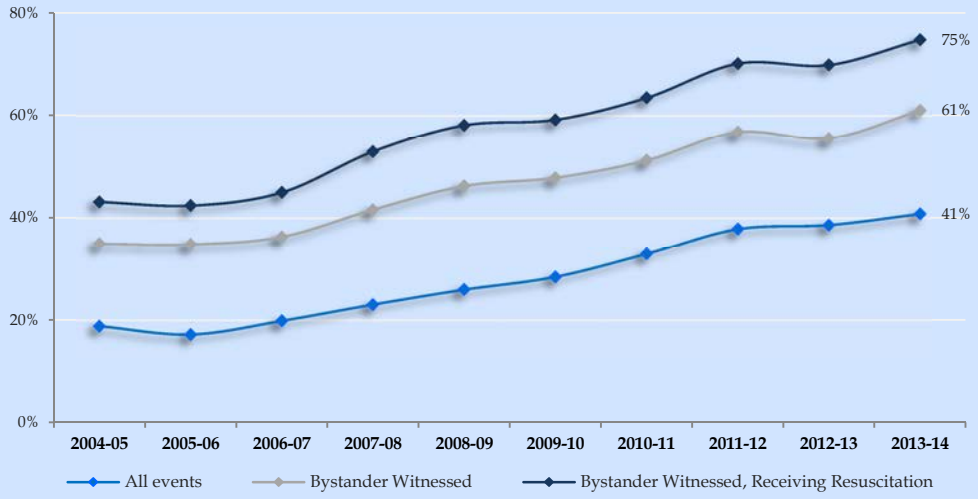


Figure 12: Bystander CPR rates.

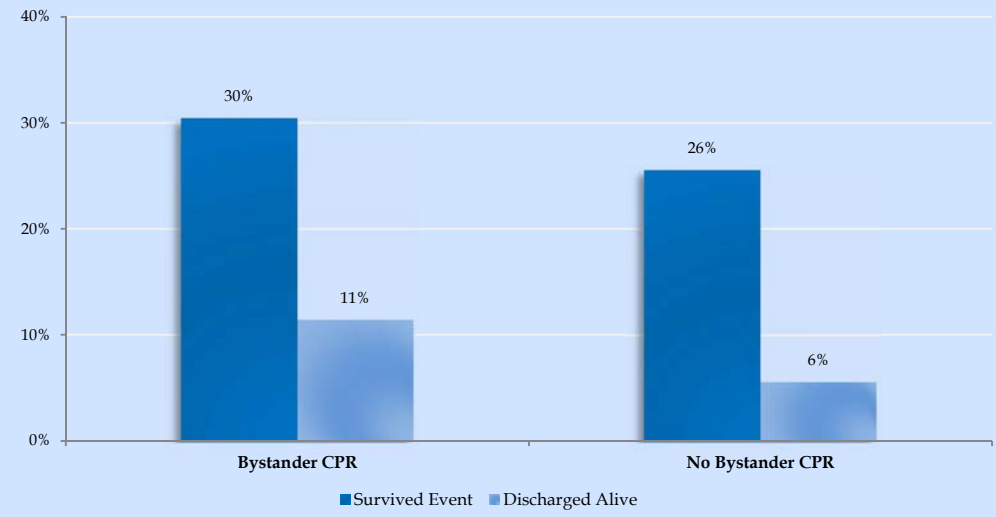


Bystander cardiopulmonary resuscitation

Previous research by VACAR has shown that early effective bystander CPR increases the likelihood of an initial shockable rhythm, and greatly improves the chance of survival following OHCA (*Fridman et al. 2007*). Over the decade, Victoria has observed significant increases in bystanders CPR rates, which can be partly attributed to accurate identification of OHCA during the emergency call and delivery of dispatcher-assisted telephone instructions for CPR (*Bray et al. 2011*). In 2013-2014, patients witnessed to collapse by bystanders had a 61% chance of receiving bystander CPR, in comparison to 35% in 2004-2005 ($p<0.001$). Of the bystander witnessed events receiving an attempted resuscitation by EMS, 75% received CPR by a bystander in 2013-2014 (see Figure 12).

The unadjusted likelihood of survival is strongly associated with the presence of bystander CPR in 2013-2014 (see Figure 13). In the EMS treated population, both event survival (30% vs. 26%, $p=0.018$) and survival to hospital discharge (11% vs.6%, $p<0.001$) were significantly higher in patients receiving bystander CPR compared to those with no bystander intervention.

Figure 13: Survival outcomes after bystander CPR in the EMS treated population, 2013-2014.



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 shockable rhythms in Victoria. In fact, the proportion of cases where Ambulance Victoria performs the first defibrillation has reduced significantly since 2004-2005, from 91% to 82% in 2013-2014 ($p<0.001$) (*Lijovic et al. 2014*). This decline has been driven by a 10-fold increase in the use of public automated external defibrillators (AED) by bystanders over the same period (from 1% to 10%). First defibrillation by first responders has been relatively stable over this period (8% of events in 2013-2014).

It is widely accepted that reducing delays to defibrillation lead to better outcomes for patients in shockable rhythms. Unadjusted survival outcomes for patients presenting in shockable rhythms on or before EMS arrival vary according to who performed the first defibrillation (see Figure 14). While fluctuations in survival proportions are commonly observed in this analysis (small samples sizes), 2013-2014 demonstrated particularly rewarding outcomes for patients receiving first defibrillation by bystanders. The proportion of patients surviving the event when first defibrillated by public AED was 64%, compared with 53% when shocked by paramedics and 57% by first responders.

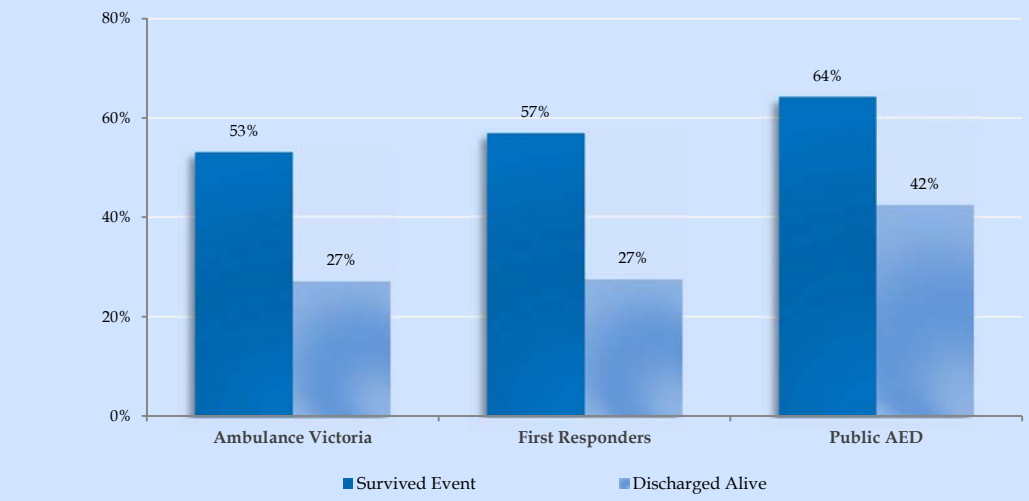
Survival to hospital discharge was significantly different according to who provided the first defibrillation. The proportion of patients surviving to hospital discharge when first defibrillated by public AED was 42%, compared with 27% when shocked by paramedics or first responders ($p=0.033$).

The time to first defibrillation by EMS is recorded in EMS treated patients whose rhythm is shockable on EMS arrival. In 2013-2014, the median time to defibrillation in the metropolitan region was 10.3 minutes (90th percentile time 15.3 minutes), which was significantly lower than the previous year (median time 11.0 minutes; 90th percentile time 16.1 minutes; $p=0.033$). In the rural region, median time to defibrillation was 12.9 minutes (90th percentile time 24.5 minutes), similar to the previous year (median time 13.8 minutes (90th percentile time 25.5 minutes; $p=0.25$).

The statewide time to defibrillation of 11.0 minutes (90th percentile time 17.4 minutes) was a significant improvement over the 2012-2013 result of 11.5 minutes (90th percentile time 19.2 minutes), $p=0.048$.

Time to defibrillation for patients in shockable rhythms correlates closely with EMS response time. (see Emergency response to the incident, page 25).

Figure 14: Survival outcome according to who shocked first in the EMS treated population with a shockable rhythm on or before EMS arrival, 2013-2014.



A discharged alive rate of 42% in 2013-2014 for patients defibrillated by public AED represents the most rewarding outcomes for patients in shockable rhythms, and encourages improvements in outcomes for OHCA patients.

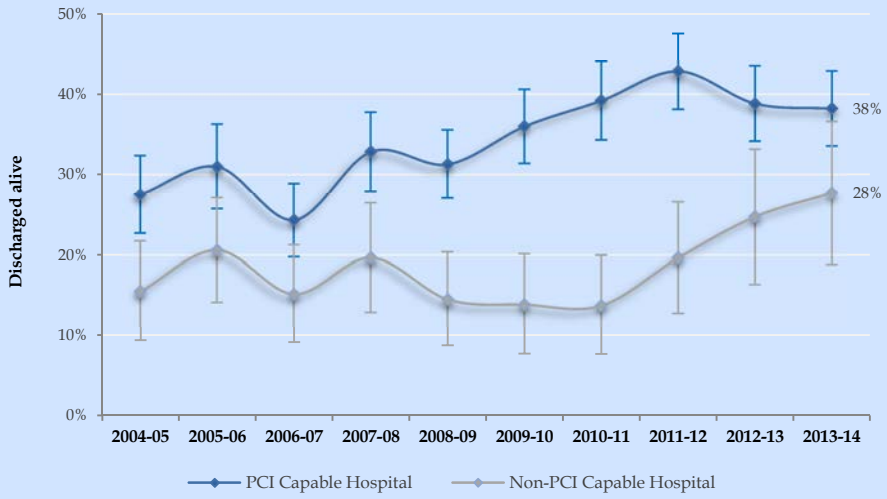
Transport to a speciality cardiac centre ‡

Previous research by VACAR has demonstrated that transport to a percutaneous coronary intervention (PCI)-capable hospital is associated with improved survival to hospital discharge following OHCA *(Stub et al. 2011)*.

In EMS treated adult presumed cardiac patients transported to hospital, 94% of metropolitan and 40% of rural cases were transported to a PCI-capable hospital (or 80% statewide). While this rate has remained relatively unchanged in metropolitan regions, rural trends experience yearly fluctuations and are predominantly associated with transport to two PCI-capable hospitals (University Hospital Geelong and Ballarat Hospital).

In 2013-2014, 38% of patients transported to PCI-capable hospitals survived to hospital discharge, whilst 28% of patients transported to hospitals without PCI capability were discharged alive (see Figure 15). It is also plausible that other hospital-based factors are contributing to the variation in outcomes observed across hospitals, which may include the uptake of optimal post-arrest treatment strategies such as therapeutic hypothermia.

Figure 15: Proportion of adult presumed cardiac EMS treated events discharged alive according to transport to a PCI-capable hospital. Error bars show the 95% confidence interval around the proportion.



‡ Data in this section refers to Victorian hospitals with full or part-time PCI-interventional capabilities which have a current process in place to receive AV emergency patients via a pre-notification system and was the first hospital that the OHCA patient was transported to.

Survival Outcomes

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. In 2013-2014, ROSC was achieved in 39% of adult EMS treated events statewide. Metropolitan events observed significantly better ROSC outcomes when compared to rural events (41% vs. 34%, p=0.001). A reduction in the proportion of ongoing resuscitation efforts during transport was reflected by an increase in those whose resuscitation efforts were ceased at scene (see Figure 16). The proportion of adult EMS treated events which were transported from the scene with ROSC was 29% in 2013-2014.

In fact, VACAR data has shown that the majority of OHCA patients with OHCA and an initial shockable rhythm who do not achieve sustained ROSC in the field are declared deceased rather than transported to hospital (*Stub et al. 2014*). The study also noted a decrease in the proportion of patients transported with ongoing CPR over time, over the study period 2003 to 2012.

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.

Figure 16: Scene outcomes for adult EMS treated events

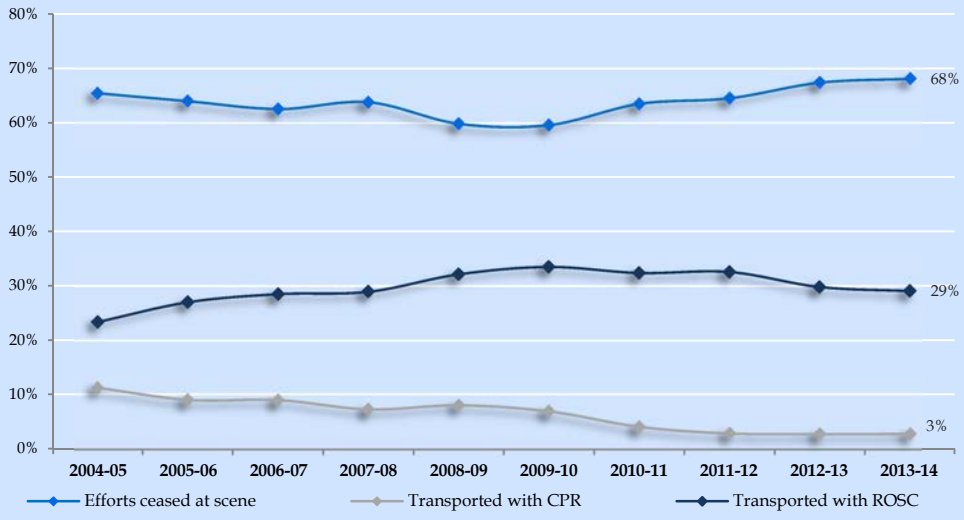
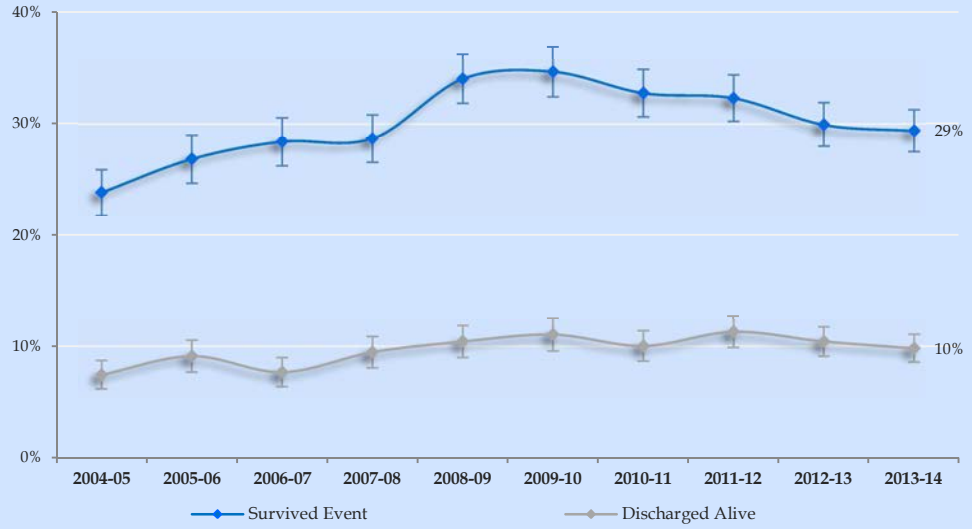


Figure 17: Survival outcomes for all-cause adult EMS treated events.



Adult survival from all-cause cardiac arrest

Adult survival from all-cause OHCA has increased steadily over the past 10 years. In 2004-2005, event survival and survival to hospital discharge for adult EMS treated events was 24% and 7% respectively. In 2013-2014, the rates of event survival and survival to hospital discharge for adult EMS treated events were 29% and 10% respectively. These rates of survival are consistent with recent observations (see Figure 17).

Adult survival from shockable rhythms

The presence of a shockable rhythm on arrival of EMS or bystanders is a strong predictor of survival from OHCA (*Fridman et al. 2007*). Survival proportions for patients who presented to EMS or bystanders in shockable rhythms are consistently better than those who presented in pulseless electrical activity (PEA) or asystole (see Figure 18).

In fact, 29% of patients in shockable rhythms survived to hospital discharge compared with 7% for patients in PEA. Nine patients (0.8%) who presented in asystole survived to hospital discharge in 2013-2014.

In 2013-2014, the proportion of adult EMS treated events that presented to EMS or bystanders in a shockable rhythm was 29% of the overall population. Ten year outcomes for patients with shockable rhythms have demonstrated strong growth (see Figure 19). In 2013-2014, outcomes for shockable rhythms experienced a modest improvement in both overall event survival and survival to hospital discharge when compared with the previous year. In 2013-2014, overall rate of event survival was 54%, compared with 51% in the previous year. A survival to hospital discharge rate of 29% in 2013-2014 was similar that observed in the previous year (28%).

Figure 18: Survival outcomes for adult EMS treated events according to presenting rhythm on arrival, 2013-2014.

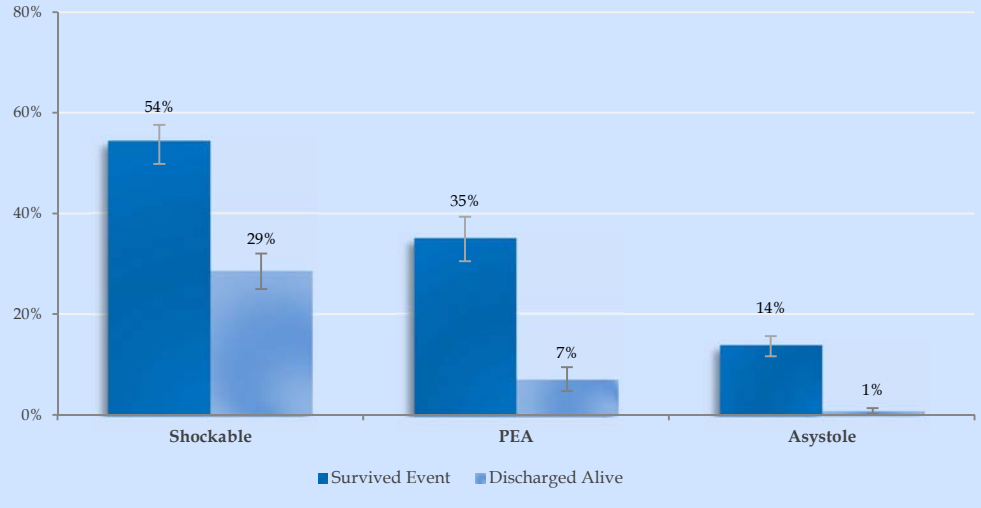
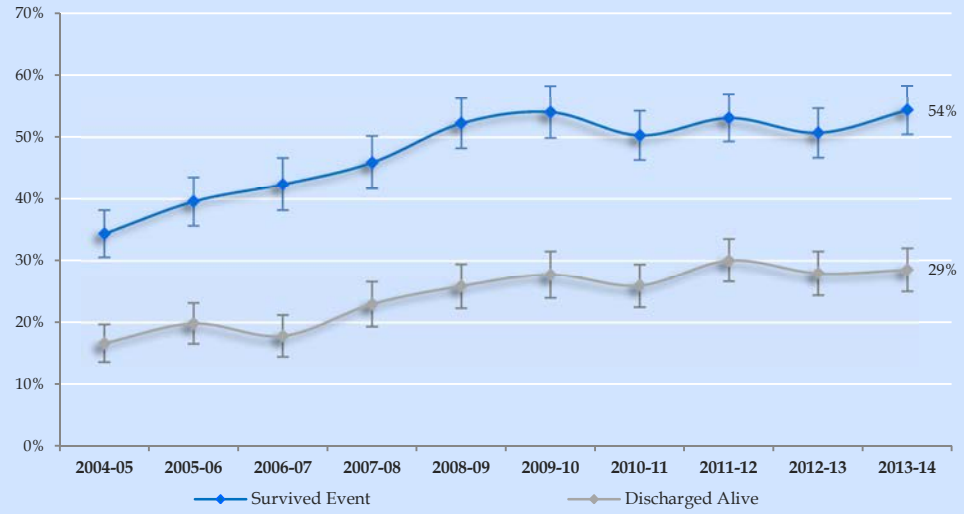


Figure 19: Survival outcomes for adult EMS treated events with a shockable rhythm on arrival.



Adult survival from EMS witnessed arrests

The greatest survival benefit for patients in shockable rhythms is observed when immediate intervention is administered by paramedics. In 2013-2014, event survival and survival to hospital discharge for adult EMS witnessed events with a shockable rhythm were 73% and 66% respectively (see Figure 20). These findings are consistent with those observed over recent years. In adult EMS witnessed events from all rhythms, survival outcomes in 2013-2014 were 46% and 28% for event survival and survival to hospital discharge respectively.

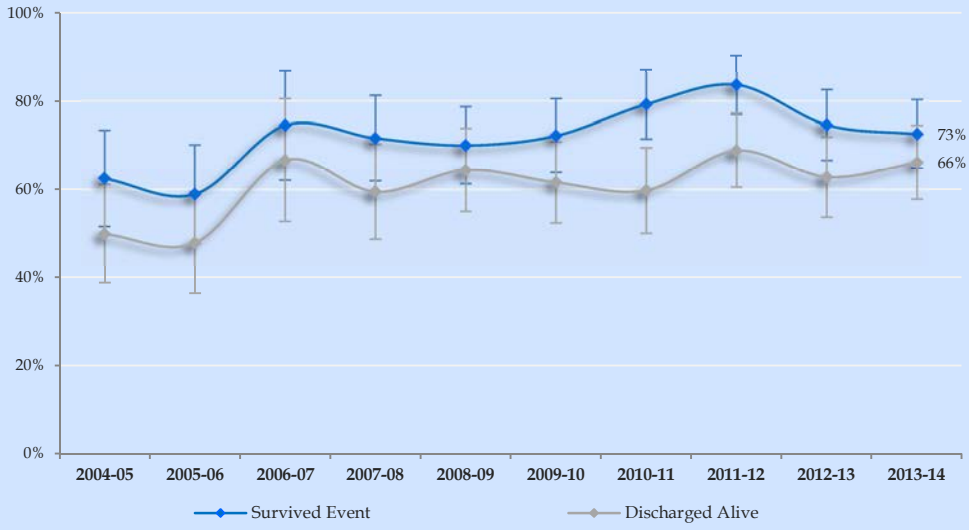
Paediatric survival from all-cause cardiac arrest

The annual incidence of paediatric OHCA is low, and survival factors vary significantly from those observed in adults. In particular, presenting cardiac rhythms in children are rarely shockable. In 2013-2014, only two paediatric cases treated by EMS presented in a shockable rhythm (2%). Asystole is the most common finding in paediatric OHCA, with 76% of the EMS treated population being found in this rhythm.

In 2013-2014, 16% (n=10) of paediatric EMS treated patients survived the event, although less than a third were discharged alive (n=3). These findings were similar over the last decade.

A total of four EMS witnessed paediatric events were identified in 2013-2014, of which two survived the event, and only one patient survived to hospital discharge.

Figure 20: Survival outcomes for EMS witnessed, adult EMS treated events with a shockable rhythm on arrival.



Ambulance Victoria key initiatives over time

Figure 21 is a diagrammatic representation of 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.

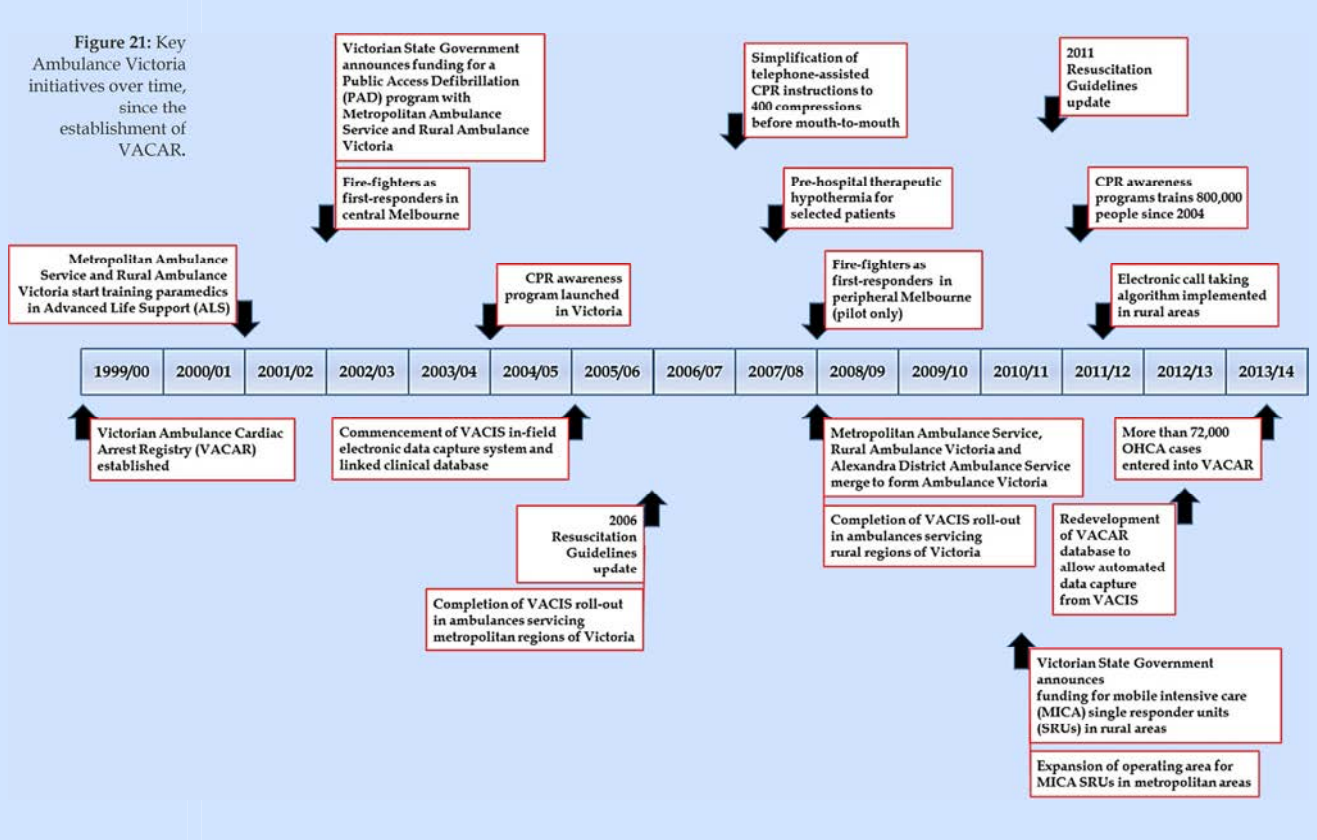
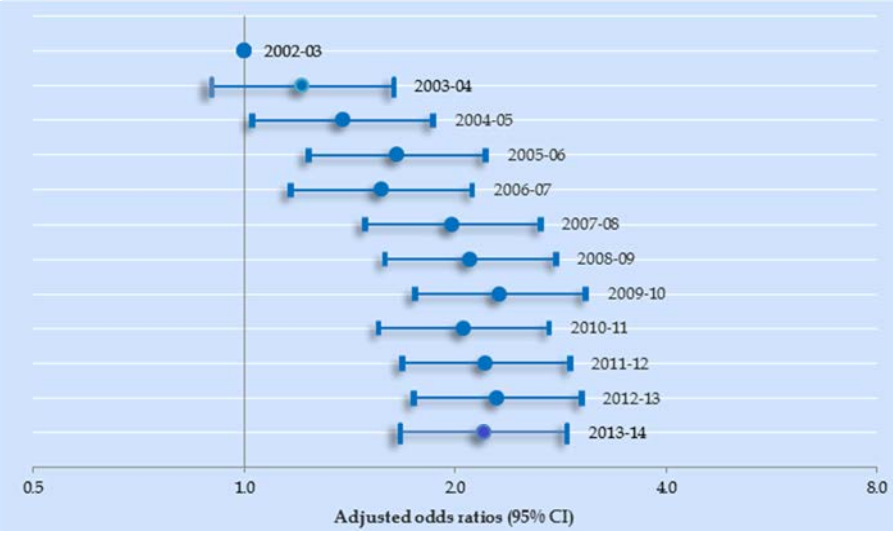


Figure 21: Key Ambulance Victoria initiatives over time, since the establishment of VACAR.

Ambulance Victoria has invested significantly in improving the system response to cardiac arrest patients.

Figure 22: Risk-adjusted odds of adult survival to hospital discharge by year in the overall EMS treated population.



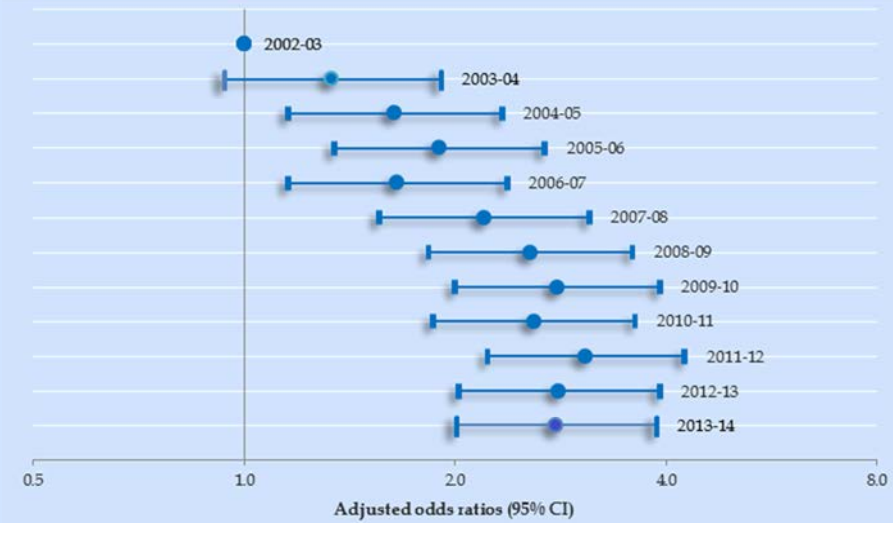
Yearly risk-adjusted odds of adult survival

The risk-adjusted odds of survival outcome provide a balanced method of measuring yearly trends in resuscitation performance and outcome. In the analysis presented in Figure 22, 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, shockable rhythm on arrival, 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. In 2013-2014, the relative odds of survival to hospital discharge had increased two-fold when compared to outcomes observed in 2002-2003 (adjusted odds ratio 2.2, 95% CI 1.7-2.9, $p<0.001$). The odds of survival to hospital discharge for adult OHCA patients in 2013-2014 are consistent with recent observations.

Similarly, the risk-adjusted odds of survival to hospital discharge for adult patients presenting in a shockable rhythm has observed significant improvements over time. In 2013-2014, the risk-adjusted odds of survival to hospital discharge for a patient presenting in VF/VT was 2.8 (95% CI 2.0-3.9, $p<0.001$) when compared with 2002-2003 (see Figure 23).

Figure 23: 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 adult survivors

Discharge direction trends in adult survivors have observed modest improvement over the last decade (see Figure 24). In 2013-2014, 84% of all adult OHCA survivors were discharged to home. This proportion equates to 83% for non-EMS witnessed events and 86% in events witnessed by EMS. The proportion of all surviving patients discharged to rehabilitation and nursing was 13% and 3%, respectively.

Assessment of quality of life post arrest

Since January 2010, adult OHCA patients (aged ≥18 years) who survived to hospital discharge have undergone health-related quality of life (HRQoL) interviews via telephone follow-up 12-months after 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 the administration of the study instruments. Where necessary and applicable, a proxy is interviewed in place of the patient. 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. SF-12 scores consist of the Physical Component Summary (PCS) and Mental Component Summary (MCS).
Standardised mean difference (SMD can be used to show the degree of deviation of a score from the population norm. SMD was 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 SF-12 SMD represents the magnitude of the difference between population groups, with values greater than 0.8 are 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).

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

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

Figure 24: Proportion of adult discharged alive patients who are discharged to private residence (includes EMS witnessed events).

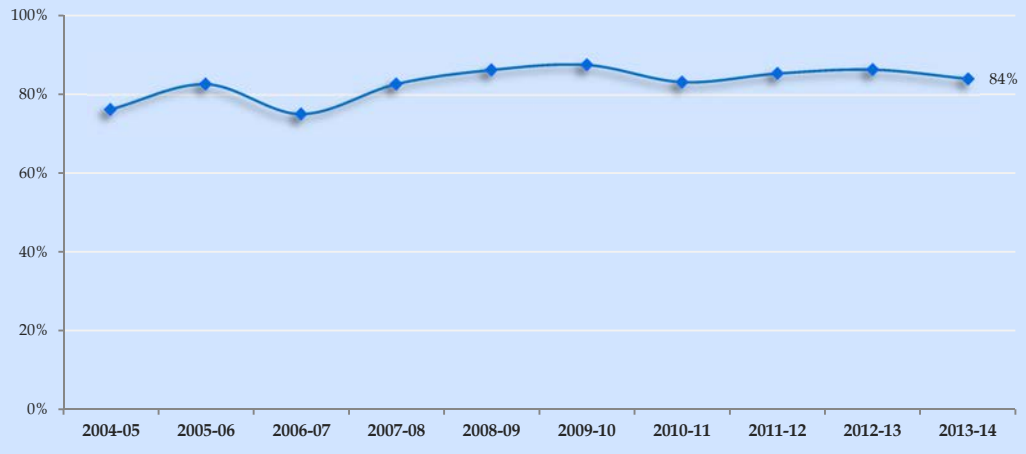
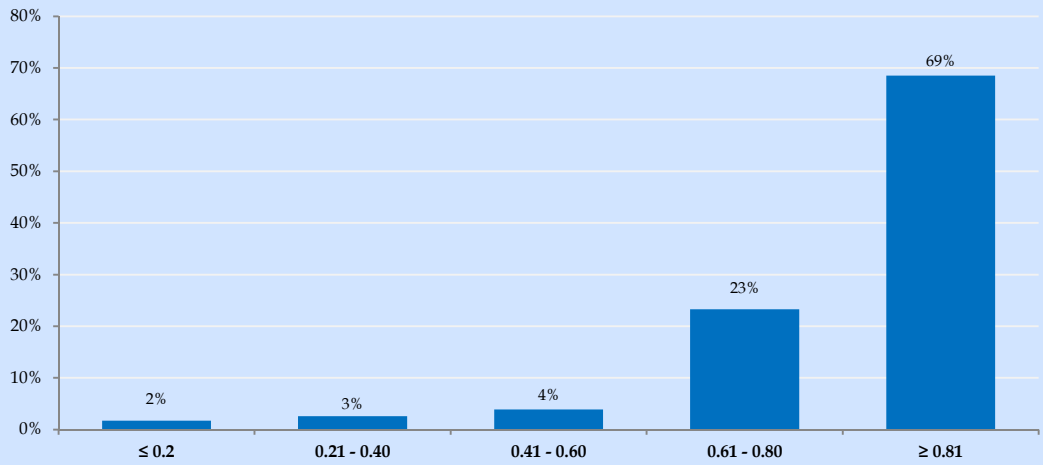


Figure 25: Distribution of EQ-5D Index scores for OHCA survivors at 12 months post arrest.



The Victorian Ambulance Cardiac Arrest Registry is one of the few out-of-hospital cardiac arrest registries in the world to routinely collect health-related quality of life outcomes. The registry has constructed one of the largest cohorts of quality of life outcomes for cardiac arrest patients.

Quality of life findings

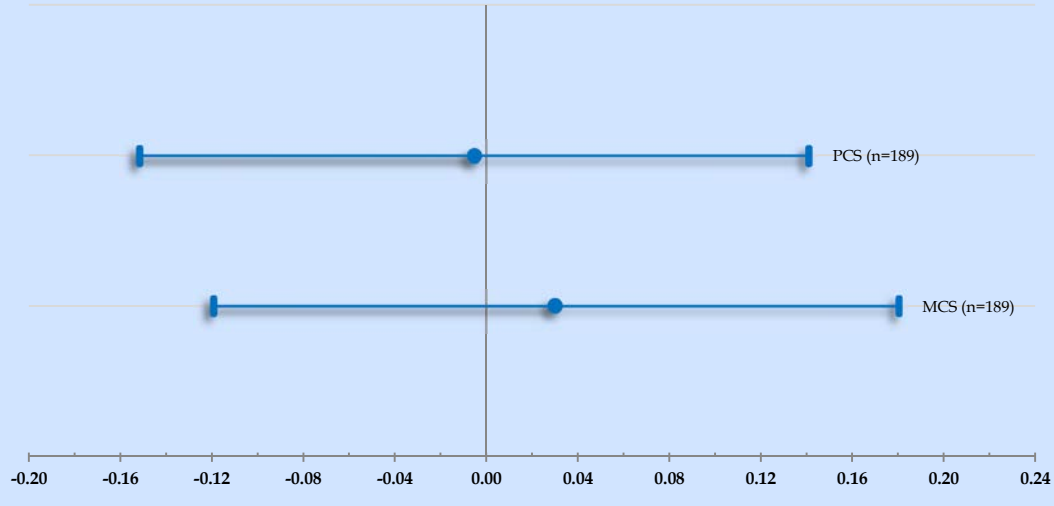
Of 342 individuals who arrested between 1 July 2012 and 30 June 2013 and were discharged alive from hospital, 296 patients were considered likely to be alive 12-months post-arrest in 2013-2014. Interviews were conducted with 191 patients and 42 proxies (n=233), producing a response rate of 79%. Of the interviewed survivors who had previously worked prior to their arrest, 74% (90 of 121) had returned to work after their arrest. More specifically, 69% (84 of 121) had returned to work in the same role.

The mean EQ-5D index score for responders was 0.85 (95% CI 0.82 to 0.87). Most (69%) respondents generated an EQ-5D index score ≥0.81 (see Figure 25). EQ-5D index scores, which include proxy responses, were available for 232 of 233 respondents.

Overall, OHCA patients reported PCS scores similar the Australian population (SMD -0.005, 95% CI -0.152 to 0.141). Patients also reported similar MCS Score as the Australian population (SMD 0.030, 95% CI -0.119 to 0.180) (see Figure 26). Standardised mean differences for PCS and MCS scores both crossed zero, meaning there was no significant difference from normal individuals.

The HRQoL summary scores obtained via the EQ-5D and the SF-12 both support good quality of life in survivors who responded.

Figure 26: Standardised mean differences for SF-12 scores at 12 months post arrest for OHCA survivors versus the Australian population.




EMERGENCY AMBULANCE
PARAMEDIC

Research Highlights

"Our research agenda focuses on every aspect of the chain of survival, from the early actions of bystanders and EMS following patient collapse to outcome at hospital discharge. We continue to strive towards addressing the important and unanswered questions relating to cardiac arrest."

A/Prof Karen Smith, VACAR Principal Investigator and Chair

Outcomes following asystole or pulseless electrical activity

Historically, efforts to improve survival from OHCA have focussed on patients presenting in shockable rhythms. However, incidence of shockable OHCA has declined in recent years, and an increasing proportion of patients are presenting in asystole or PEA. In this study published in *Resuscitation*, Andrew et al. evaluate survival to hospital discharge and 12-month functional recovery in patients presenting in asystole or PEA. The study found survival outcomes in OHCA patients with initial rhythms of asystole or PEA did not improve over the 10-year study period. Some patients received attempted resuscitation despite meeting EMS guidelines for withholding resuscitation. Adherence to the guidelines may reduce futile resuscitations.

Andrew E, Nehme Z, Lijovic M, Bernard S and Smith K. Outcomes following out-of-hospital cardiac arrest with an initial cardiac rhythm of asystole or pulseless electrical activity in Victoria, Australia. Resuscitation. 2014 Aug 7. pii: S0300-9572(14)00678-9. doi: 10.1016/j.resuscitation.2014.07.015.

Survival benefits of public access defibrillation

The probability of survival for OHCA patients who present in a shockable rhythm is estimated to decrease by 9% for each minute increase in time to defibrillation. One strategy to decrease time to defibrillation is if bystanders perform defibrillation using an automated external defibrillator (AED). In this study published in *Resuscitation*, Lijovic et al. show that use of public AEDs in Victoria increased almost 11-fold between 2002-2003 and 2012-2013. First defibrillation occurred sooner in cases of bystander defibrillation (5.2 vs 10.0 minutes). Multivariable regression analysis showed that first defibrillation by a bystander using an AED was associated with a 62% increase in the odds of survival to hospital discharge compared to first defibrillation by EMS. More widespread availability of AEDs in public places may further improve OHCA survival.

Lijovic M, Bernard S, Nehme Z, T Walker and Smith K. Public access defibrillation- results from the Victorian Ambulance Cardiac Arrest Registry. Resuscitation [in press 2014]. doi:10.1016/j.resuscitation.2014.10.005.

Population density and outcome

Timely access to EMS treatment remains an integral aspect of the chain of survival, and has an important role in determining the provision and performance of EMSs across both urban and regional communities. Regional variation in the characteristics and outcomes of OHCA has been described internationally, though few authors examine the contribution of population density on outcome. In this study published in the *Medical Journal of Australia*, Nehme et al. find that population density is independently associated with survival after OHCA, and significant variation in the incidence and characteristics of these events are observed across Victoria. However, the causative factors remain speculative and require further investigation.

Nehme Z, Andrew E, Cameron P, Bray J, Bernard S, Meredith I and Smith K. Population density predicts outcome from out-of-hospital cardiac arrest in Victoria, Australia. Medical Journal of Australia. 2014 May 5;200(8):471-5.

Return of spontaneous circulation in the field

Currently many emergency medical services that provide advanced cardiac life support at scene do not routinely transport OHCA patients without sustained ROSC. Patients without ROSC in the field who receive CPR to hospital have poor outcomes. In this study published in *Resuscitation*, Stub et al. found that few patients with OHCA and an initial shockable rhythm who do not achieve ROSC in the field are transported to hospital with ongoing CPR in Victoria and survival was low in those patients who are transported. Further research into which patients may benefit from prolonged resuscitative efforts is warranted.

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 Mar; 85(3):326-33.

2013-2014 Peer-reviewed Publications

1. Stub D, Bernard S, Pellegrino V, Smith K, Walker T, Sheldrake J, Hockings L, Shaw J, Duffy SJ, Burrell A, Cameron P, Smit DV and Kaye DM. Refractory Cardiac Arrest Treated with Mechanical CPR, Hypothermia, ECMO and Early Reperfusion (the CHEER Trial). Resuscitation. 2014 Sep 30. pii: S0300-9572(14)00751-5. doi: 10.1016/j.resuscitation.2014.09.010.
2. Smith K and Lijovic M. Increasing bystander participation in resuscitation. Resuscitation. 2014 Sep 15. pii: S0300-9572(14)00736-9. doi: 10.1016/j.resuscitation.2014.09.001.
3. Smith K and Bernard S. Quality of life after cardiac arrest: How and when to assess outcomes after hospital discharge? Resuscitation. 2014 Sep;85(9):1127-8.
4. Nehme Z, Andrew E, Bernard S and Smith K. The impact of partial resuscitation attempts on the reported outcomes of out-of-hospital cardiac arrest in Victoria, Australia: Implications for Utstein-style outcome reports. Resuscitation. 2014 Sep;85(9):1185-91.
5. Dyson K, Bray J, Smith K, Bernard S and Finn J. A systematic review of the effect of emergency medical service practitioners' experience and exposure to out-of-hospital cardiac arrest on patient survival and procedural performance. Resuscitation. 2014 Sep;85(9):1134-1141.
6. Andrew E, Nehme Z, Lijovic M, Bernard S and Smith K. Outcomes following out-of-hospital cardiac arrest with an initial cardiac rhythm of asystole or pulseless electrical activity in Victoria, Australia. Resuscitation. 2014 Aug 7. pii: S0300-9572(14)00678-9. doi: 10.1016/j.resuscitation.2014.07.015.
7. Nehme Z, Andrew E, Cameron P, Bray J, Bernard S, Meredith I and Smith K. Population density predicts outcome from out-of-hospital cardiac arrest in Victoria, Australia. Medical Journal of Australia. 2014 May 5;200(8):471-5.
8. Nishiyama C, Brown SP, May SJ, Iwami T, Koster RW, Beesems SG, Kuisma M, Salo A, Jacobs I, Finn J, Sterz F, Nürnberger A, Smith K, Morrison L, Olasveengen TM, Callaway CW, Shin SD, Gräsner JT, Daya M, Ma MH, Herlitz J, Strömsöe A, Aufderheide TP, Masterson S, Wang H, Christenson J, Stiell I, Davis D, Huszti E and Nichol G. Apples to apples or apples to oranges? International variation in reporting of process and outcome of care for out-of-hospital cardiac arrest. Resuscitation. 2014 Jul 8. pii: S0300-9572(14)00641-8. doi: 10.1016/j.resuscitation.2014.06.031.
9. Bray J, Bernard S, Cantwell K, Stephenson M and Smith K. The association between systolic blood pressure on arrival at hospital and outcome in adults surviving from out-of-hospital cardiac arrests of presumed cardiac aetiology. Resuscitation. 2014 Apr;85(4):509-15.
10. 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 Mar; 85(3):326-33.
11. 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 Jan;85(1):42-8.
12. Lijovic M, Bernard S, Nehme Z, T Walker and Smith K. Public access defibrillation- results from the Victorian Ambulance Cardiac Arrest Registry. Resuscitation [in press 2014]. doi:10.1016/j.resuscitation.2014.10.005.
13. 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 [in press 2014]. doi:10.1161/CIRCULATIONAHA.114.011200.

List of Abbreviations

ACO	Ambulance Community Officers
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
DH	Department of Health
ECG	Electrocardiogram
EMS	Emergency Medical Services
EQ-5D	EuroQoL 5 Dimension questionnaire
GOS-E	Extended Glasgow Outcome Scale
HRQoL	Health-related quality of life
LGA	Local Government Areas
MCS	Mental Component Summary of the SF-12 survey
MFB	Metropolitan Fire Brigade
MICA	Mobile Intensive Care Ambulance
OHCA	Out-of-Hospital Cardiac Arrest
PCR	Patient Care Record
PCS	Physical Component Summary of the SF-12
PEA	Pulseless Electrical Activity
ROSC	Return of Spontaneous Circulation
VACAR	Victorian Ambulance Cardiac Arrest Registry
SF-12	Twelve-item Short Form health survey
VF	Ventricular Fibrillation
VT	Pulseless Ventricular Tachycardia

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 discharge	Patients who are discharged from hospital alive.
Shockable Rhythm	Rhythms which are appropriate to receive defibrillation, including ventricular fibrillation and pulseless ventricular tachycardia, by EMS or a bystander with a public automated external defibrillator.
Transported with CPR	Patients who, at the time of scene departure, are administered ongoing CPR.
Transported with ROSC	Patients that, at the time of scene departure, have a ROSC (i.e. detectable pulse).

The VACAR Group

VACAR Chief Investigators

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

Prof Stephen Bernard
Medical Advisor
Ambulance Victoria

VACAR Steering Committee

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

Prof Stephen Bernard
Medical Advisor
Ambulance Victoria

Prof Peter Cameron
Pre-hospital, Emergency and Trauma Unit
Monash University

Prof John McNeil
School of Public Health and Preventive Medicine
Monash University

A/Prof Tony Walker
General Manager, Regional Services Division
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
Clinical Analyst, Research & Evaluation
Ambulance Victoria

Ms Vanessa Barnes
Research Officer, Research & Evaluation
Ambulance Victoria

Ms 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

Berdowski J, Berg R.A, Tijssen J.G.P, Koster R.W. 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.

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.

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: 19: 311-322.

Jacobs I, Nadkarni V, Bahr J, Berg R.A, Billi J.E, Bossaert L, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries. A statement for healthcare professionals from a task force of the international liaison committee on resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Southern Africa). *Resuscitation.* 2004;63(3):233-49.

McGough JJ, 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 B.S, Labarthe D, Hong Y, 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. *Circ.* 2008;117(17):229-308.

Nehme Z, Andrew E, Cameron P, Bray JE, Meredith IT, Bernard S, et al. Direction of first bystander call for help is associated with outcome from out-of-hospital cardiac arrest. *Resuscitation*. 2014 Jan;85(1):42-8.

Rabin R, de Charro F. EQ-5D: a measure of health status from the EuroQol Group. Ann Med. 2001; 33(5):337-43.

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 Mar; 85(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;97:1489-94.

Szende A, Williams A, editors. Measuring Self-Reported Population Health: An International Perspective based on EQ-5D. Rotterdam (The Netherlands): SpringMed Publishing; 2004.

Ware J Jr, Kosinski M, 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, 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.

Ambulance Victoria
375 Manningham Road
Doncaster VIC 3108

Postal Address-
PO Box 2000
Doncaster VIC 3108