Victorian Ambulance
Cardiac Arrest Registry

2011/12 Annual Report

Victorian Ambulance Cardiac Arrest Registry

1 July 2011 to 30 June 2012

Annual Report

This document has been prepared by the Victorian Ambulance Cardiac Arrest Registry, Department of Research & Evaluation at Ambulance Victoria.

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This document is also accessible in PDF format on the internet at www.ambulance.vic.gov.au.

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From the CEO

For an Ambulance Service that covers a population of 5.6 million people spread across 227,000 square kilometres, the task of improving survival from cardiac arrest is challenging, and requires a collaborative approach to care. In Victoria, systems of care for out-of-hospital cardiac arrest patients have been established to enhance the treatment response by emergency medical services and the community. In doing so, we acknowledge that survival from cardiac arrest is not solely dependent on the skill and response of our paramedics, but rather the willingness of the community to participate in life-sustaining resuscitation efforts.

In 2011/12, we observed the highest participation rate in cardiopulmonary resuscitation by bystanders. This effect is enhanced by the immediate intervention of first responder teams, who achieved a quicker response than Ambulance Victoria in over a quarter of cases. Patients who received their first defibrillation by first responders or a community Automated External Defibrillator observed the greatest survival benefit, with over a third surviving to hospital discharge. These findings demonstrate the importance of community partnership, and support a crucial link in our efforts to improve survival from out-of-hospital cardiac arrest.

As an organisation, we are focussed at delivering the highest outcomes in resuscitation care through advancements in operations, community education and clinical research. We have improved access to Mobile Intensive Care Ambulances (MICA) into specific regional areas and upgraded our communication centres to new state-of-the-art technology. Our '4 Steps for Life' cardiopulmonary resuscitation awareness program has successfully trained almost a million people and remains our strongest asset in promoting community action for victims of cardiac arrest. Finally, Ambulance Victoria remains a world leader in out-of-hospital cardiac arrest research, undertaking the largest randomised controlled trial into the use of therapeutic hypothermia for victims of out-of-hospital cardiac arrest.

These improvements are not without the ongoing monitoring and quality assurance initiatives introduced by the Victorian Ambulance Cardiac Arrest Registry. In fact, Ambulance Victoria is one of few emergency medical services in the country that comprehensively measures the performance of resuscitation care across the state. What we are learning from our cardiac arrest outcomes is informing our everyday clinical practice and operations, and is helping to shape the quality of care we deliver to our communities.

GREG SASSELLA
CHIEF EXECUTIVE OFFICER

Victorian Ambulance Cardiac Arrest Registry

The Victorian Ambulance Cardiac Arrest Registry (VACAR) was established in 1999, and represents an internationally recognised standard of out-of-hospital cardiac arrest monitoring and reporting. The VACAR is managed by Ambulance Victoria (AV), the sole emergency medical service (EMS) provider in Victoria, Australia, and is supported by funding from the Victorian Government Department of Health.

The VACAR is a quality control initiative, incorporating both prehospital clinical and operational data and hospital follow-up data from all out-of-hospital cardiac arrest events in Victoria where AV are in attendance. The VACAR collects data from Communication Centre dispatch records, ambulance 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.

Pre-hospital data for all cardiac arrest patients attended by AV since October 1999 has been successfully captured for over 60,000 patients. The data is collated in the registry following 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 out-of-hospital cardiac arrest 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 the ambulance response time, rate of successful defibrillation, survival to hospital arrival 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 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 Accepted for publication, page 52).

The VACAR is overseen by a Steering Committee and chaired by Associate Professor Karen Smith (Manager Research & Evaluation, Ambulance Victoria). The registry maintains ethical review as a quality assurance initiative from the Department of Health Human Research Ethics Committee and is supported by 100 ethics approvals from Victorian hospitals for the access of medical records. This successful program has resulted in the capture of almost 99% of follow-up data from all out-of-hospital cardiac arrests transported to a hospital in the state of Victoria.

Ambulance Victoria, Emergency Medical Service

The state of Victoria, Australia has a population of 5.6 million with approximately 4 million residing in metropolitan Melbourne. 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 drugs. 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 Medical Priority Dispatch System (MPDS) is operational in Victoria. MICA paramedics are dispatched to patients with critical illness, including patients with cardiac arrest. A first responder program for early defibrillation by fire-fighters operates for suspected 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.

The cardiac arrest protocols follow the recommendations of the Australian Resuscitation Council. Ambulance Victoria paramedics are not obliged to commence resuscitation when the clinical presentation is inconsistent with life. This includes decapitation, presence of rigor mortis, decomposition or post mortem lividity, where death has been declared by a Medical Officer who is or has been at the scene and where the presenting rhythm was monitored as asystole for greater than 30 seconds, and there has been more than 10 minutes downtime with no evidence of hypothermia, drug overdose or family/bystander objections. 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 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.

About this report

While cardiovascular mortality has declined over the last three decades, the case-fatality rate of sudden cardiac arrest has not declined *(Nichol et al. Circ. 2008)*. Cardiac arrest is a significant cause of disability and death in Australia, with a reported incidence of 113 events per 100,000 peoples *(Berdowski et al. Resus. 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 out-of-hospital cardiac arrest (OHCA) by EMS agencies could be the sentinel measure of the quality of EMS care in our communities *(Nichol et al. Circ. 2008)*.

This report describes data from the Victorian Ambulance Cardiac Arrest Registry (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 2011 to June 2012. Data for this report was extracted on 17 September 2012, 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. Resus. 2004)*. The data in the registry is subject to ongoing quality control, most of which has been incorporated back into the registry at the time of this report. Quality assurance measures are conducted routinely, leading to improvements in the integrity of the data with time. Data on survival to hospital discharge is also being continually updated and hence should be treated and interpreted with caution.

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 boundaries including the North and West, Eastern and Southern Regions. Rural boundaries comprise the Barwon South West, Grampians, Loddon Mallee, Hume, and Gippsland regions. Population figures used in this report are defined by the Regional Population Growth reports published by the Australian Bureau of Statistics, 2012. The population figures are provided for the end of 30 June 2011, with a Victorian population estimate of 5,533,754 (excludes unincorporated populations). Local Government Areas (LGAs) are used to define population estimates within each Department of Health region.

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. response time, time to defibrillation, presenting rhythm etc.), and may therefore skew the analyses provided. Data relating to paramedic or EMS witnessed OHCA have therefore been analysed and depicted separately to those which are unwitnessed by paramedics.

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 3). 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 into VACAR are described below (see Table 1 &2).

Table 1: 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 2: 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 cardiac arrest, where the patient is not in cardiac arrest on arrival of EMS, and where a successful attempt at defibrillation did not occur or no other evidence verifying a cardiac arrest state is present.

Table 3: Participating first responders dispatched to cardiac arrest events in Victoria.

1	Metropolitan Fire Brigade
2	Country Fire Authority
3	Community Emergency Response Teams

Data capture

Ambulance Victoria's in-field recording of patient data is conducted electronically using VACIS©, an electronic data capture system. All electronic patient care records (PCR) are automatically synchronised with organisational databases daily, providing an effective medium for the recording of clinical and administrative data. In addition, paper PCRs may be used in cases where in-field electronic data capture is not possible. These paper records are forwarded to the AV Accounts department or VACAR for storage and future review.

To ensure the capture of all out-of-hospital cardiac arrest 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. Furthermore, manual searching of paper records is conducted periodically by the VACAR research team to identify potentially eligible cases for review.

Following review of potential cases, confirmed 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 twelve months post hospital discharge for patients identified as having survived cardiac arrest. The interview questionnaires used include: the Extended Glasgow Outcome Scale (GOS-E), SF-12® Health Survey and EQ-5D™ questionnaires.

Data quality assurance and quality control

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. 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. All cases where a patient requires defibrillation or where a death occurs in the care of AV undergo audit by a clinical support officer.

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. Data verification spread sheets are performed routinely to identify inconsistencies with data coding, including the identification of error values and group outliers.

Patient confidentiality and ethical review

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

In accordance with the National Health and Medical Research Council's (NHMRC) 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 is partly due to its completeness of data capture. Missing data for all variables 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, 2011/12 (n=5,225).

Patient Age	124 (2.4%)
Patient Gender	12 (0.2%)
Arrest Location	Nil
Witnessed Status	45 (0.9%)
Bystander CPR	21 (0.4%)
Rhythm on Arrival	31 (0.6%)
EMS Response Time	36 (0.7%)
Outcome at Scene	Nil
Rhythm at Destination	7 (0.1%)
Hospital Discharge Status	24 (0.5%)

Executive summary

1. There were 5,124 adult OHCA events in the period between 1 July 2011 to 30 June 2012, with 9% of these events witnessed and monitored by paramedics. Of the events not witnessed by EMS, 46% of patients received an attempt at resuscitation by paramedics and/or first responders. Significantly fewer events are observed in peoples aged less than 16 years, with 101 recorded over the 2011/12 period. The incidence of OHCA was higher in the rural region than in the metropolitan region: 112.2 versus 87.6 events per 100,000 people (see 'Incidence & demographics', page 20).
2. In 2011/12, 70% of all OHCA events were presumed to be of cardiac aetiology, with trauma, respiratory, terminal illness, and hangings being predominately responsible for the remaining causes of arrest. The median age of adult OHCA was 69 years, with two thirds of events involving males. Of the adults receiving an attempt at resuscitation, 23% occurred in a public place. For cases involving paediatrics (aged less than 16 years), the medium age was 1 year, males represented 66% of cases, with SIDS as the perceived cause of arrest in the majority of cases (see 'Incidence & demographics', page 20).
3. Emergency call-takers are effective at identifying cardiac arrest events during the emergency call, with 91% being correctly identified in the metropolitan region. Early access, early CPR and early defibrillation play a critical role in survival from OHCA. In 2011/12, first responders including fire-services and community emergency response teams arrived on scene prior to Ambulance paramedics in over a quarter of cases. Importantly, defibrillation by first responders or public AED for patients presenting in a shockable rhythm resulted in an increase in survival to hospital discharge. Of the events witnessed by bystanders and in whom resuscitation was attempted, 70% received CPR by a member of the public (see 'Systems of care', page 32).
4. The initial rhythm on presentation of EMS provides valuable prognostic information. Of the cases receiving an attempt at resuscitation, 30% of patients presenting in a shockable rhythm survived to hospital discharge. Asystole and pulseless electrical activity were associated with poorest survival to discharge, with 0.3% and 4% respectively. Return of spontaneous circulation outcomes have increased sustainably since 2005/06, from 36% to 49% of all adult bystander witnessed cases receiving an attempted resuscitation in 2011/12 (see 'Survival outcomes', page 40).
5. Survival from OHCA continues to improve in Victoria. In 2011/12, adult OHCA from all aetiologies observed a 32% survival to hospital and 11% survival to hospital discharge rate. Adult patients presenting in a shockable rhythm fair significantly better, with 52% surviving to hospital and 30% surviving to hospital discharge. Patients who are witnessed to arrest by paramedics observe the greatest survival benefit with 67% surviving to hospital discharge. The majority of cases with known survival continue to be discharged home, or 85% in the 2011/12 reporting year (see 'Survival outcomes, page 40).
6. The risk-adjusted odds of survival to hospital discharge have improved significantly over the last 10 years. The probability of survival is 2.5 times higher in 2011/12 than cases in 2002/03. This improvement is best observed in cases presenting in a shockable rhythm where the risk-adjusted odds of survival was 3.7 when compared with survival in 2002-03. Variation in the risk-adjusted odds of adult survival to hospital discharge was also observed across regions of Victoria, although this finding did not reach statistical significance (see 'Survival outcomes', page 40).

incidence & demographics

AMBULANCE VICTORIA


PARAMEDIC

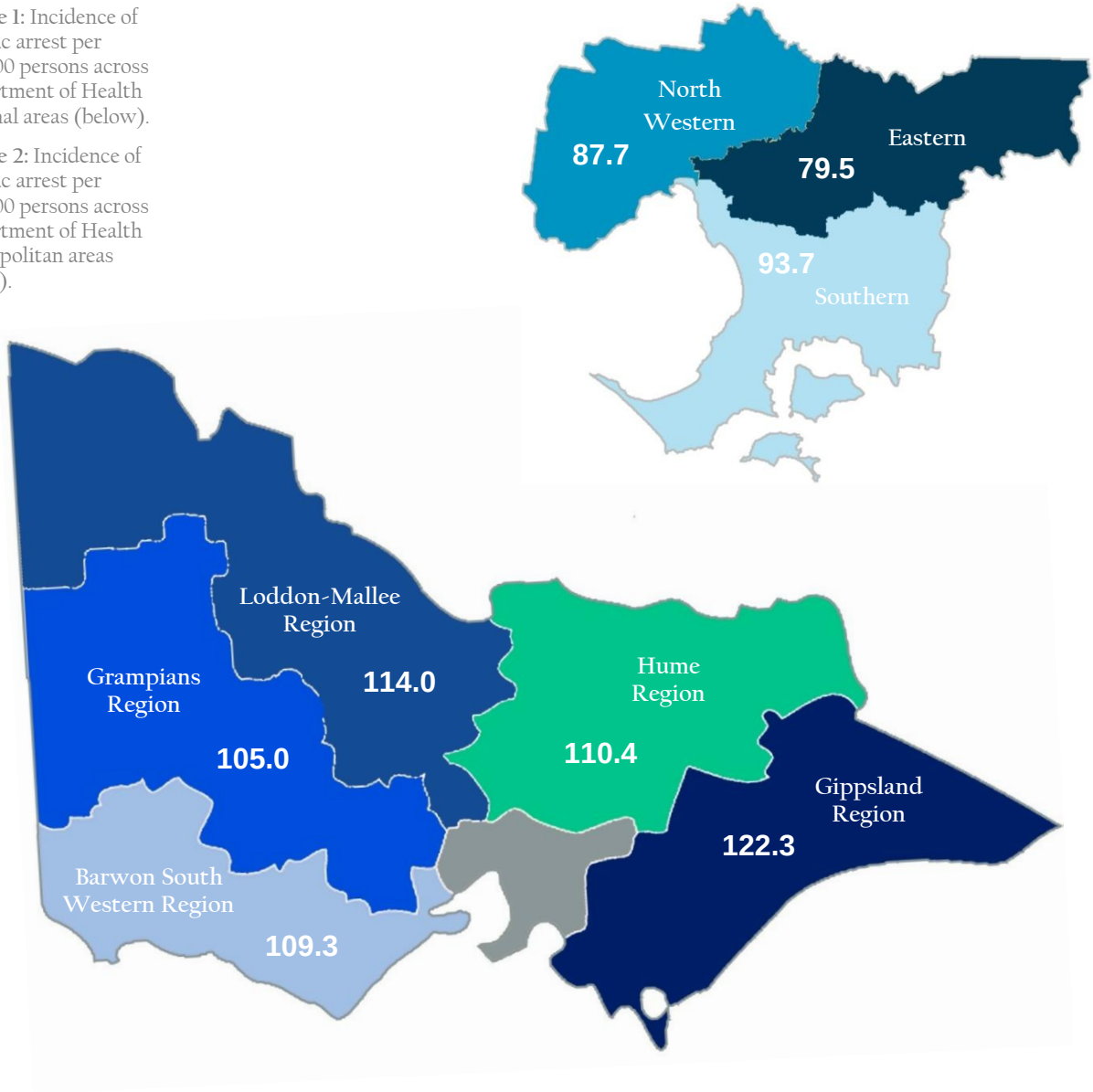
INCIDENCE

Incidence of cardiac arrest

In 2011/12, the incidence of OHCA in Victoria was 93.9 per 100,000 population.[1] This result is comparable to internationally reported incidence rates, although variation across continents is well established. In the rural region, the incidence of OHCA was higher than the metropolitan region: 112.2 versus 87.6 events per 100,000 population respectively. Incidence of events across regions did not show significant variation with the smallest incidence observed in the Eastern Metropolitan Region (79.5 events per 100,000 population) and the highest incidence observed in the Gippsland region (122.3 events per 100,000 population).

Figure 1: Incidence of cardiac arrest per 100,000 persons across Department of Health regional areas (below).

Figure 2: Incidence of cardiac arrest per 100,000 persons across Department of Health metropolitan areas (right).



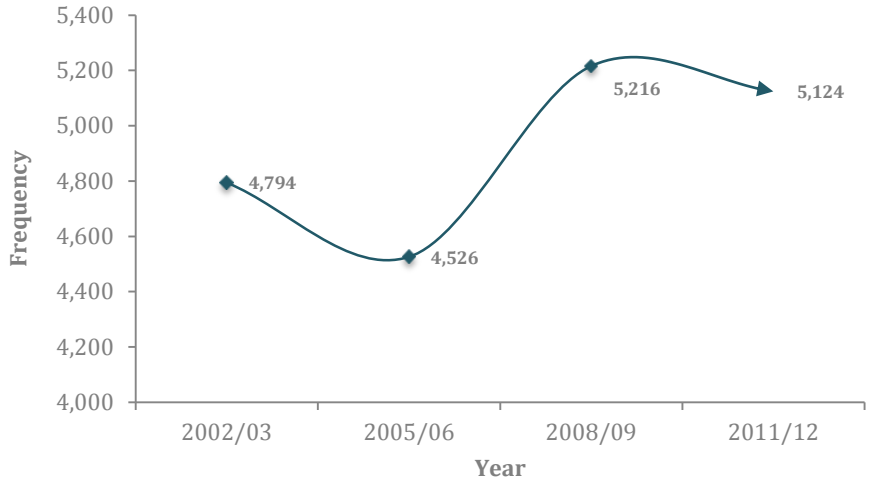
1. *This rate is based on the Australian Regional Population Growth statistics for 2011 of 5,533,754 (Australian Bureau of Statistics 2012).*

INCIDENCE

Incidence of adult cardiac arrest

In 2011/12, Ambulance Victoria attended 5,124 adult OHCA patients, representing the highest number of events since 2008/09 or the second highest in a 10 year period. The North and West Metropolitan regions[2] recorded the highest frequency of events for 2011/12 totalling 1,499. The Grampians region recorded the lowest number of events at 227.

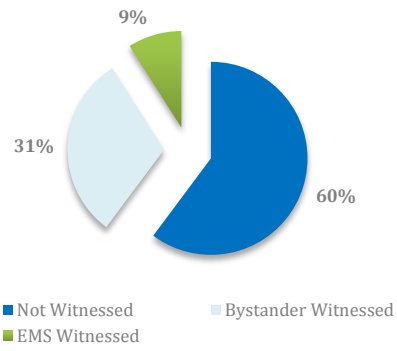
Figure 3: Yearly crude figures of adult OHCA in Victoria, Australia.[1]

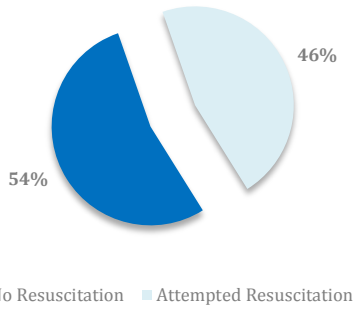


Of all adult OHCA attended, 46% received an emergency resuscitation attempt by paramedics and/or first-responders. Evidence of prolonged downtime and futility were the predominant reasons for withholding resuscitation efforts by paramedics. The vast majority of cardiac arrest events went unwitnessed (60%) in 2011/12, while 31% were witnessed by a bystander. A small proportion of adult OHCA events (9%) occur in the presence of paramedics.

Figure 4: Proportion of witnessed adult OHCA events, 2011/12 (left).[1]

Figure 5: Proportion of events which received an attempted resuscitation, 2011/12 (right).[1]





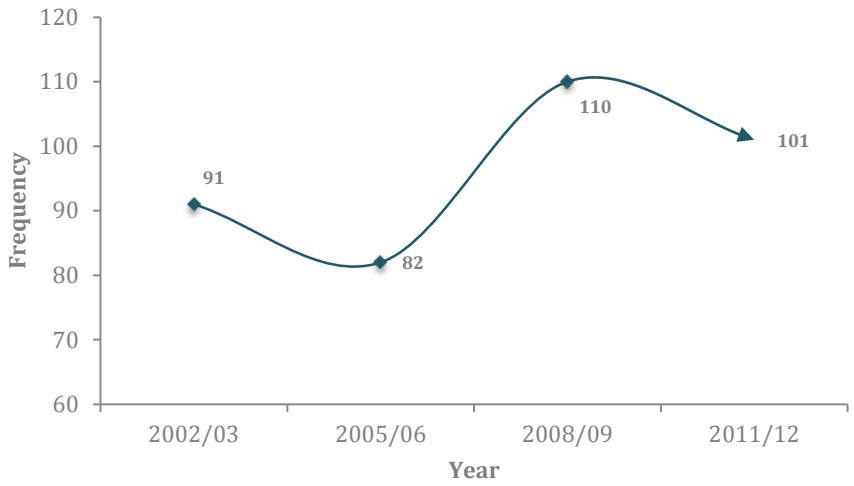
1. *Adults > 15 years or missing age, includes EMS witnessed events.*
2. *Includes the Melbourne Central Business District.*

INCIDENCE

Incidence of paediatric cardiac arrest

The incidence of paediatric out-of-hospital cardiac arrests is low, with 101 events attended by Ambulance Victoria in 2011/12. The highest number of paediatric events were also observed in the North and West Metropolitan[2] region (n=30). The Gippsland and Eastern Metropolitan regions observed the lowest number of paediatric OHCA events (n=5).

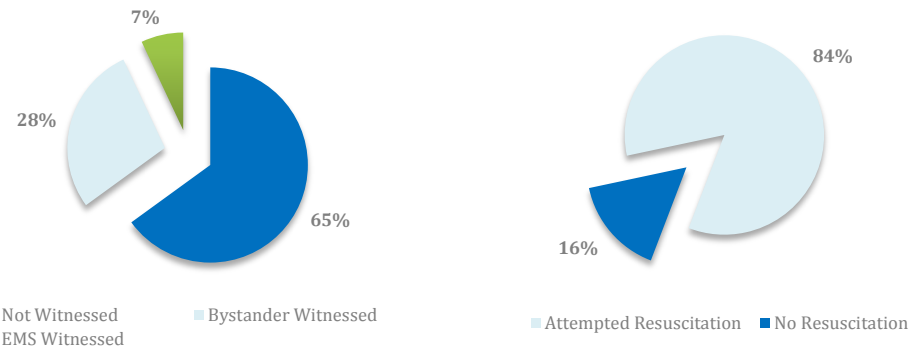
Figure 6: Yearly crude figures of paediatric OHCA in Victoria.[1]



The vast majority of paediatric OHCA events received an attempt at resuscitation by paramedics and first responders (84%). In cases which were not resuscitated, evidence of futility was clearly documented on the patient care record. Approximately 65% of paediatric events go unwitnessed, while 28% are bystander witnessed. A small proportion of events (7%) occur in the presence of paramedics, and vary considerably in aetiology to adult patients.

Figure 7: Proportion of events witnessed by paramedics, 2011/12 (left).[1]

Figure 8: Proportion of events which received resuscitation, 2011/12 (right).[1]



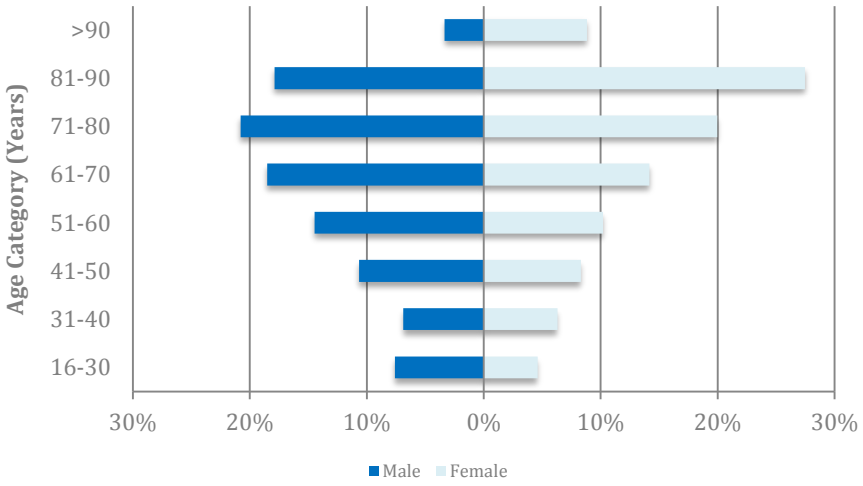
1. *Paediatrics < 16 years and includes EMS witnessed events.*
2. *Includes the Melbourne Central Business District.*

DEMOGRAPHICS

Demographics of adults

The gender distribution of OHCA cardiac arrest patients has remained consistent over the last 10 years with males accounting for the majority of all patients (66% in 2011/12). The distribution of age also varies across genders, with females observing a higher median age than males for OHCA (74.0 versus 67.0 years, $p < 0.0001$).

Figure 9: Age distribution for adult events, 2011/12.[1]



The 2011/12 adult patient demographics for all OHCA are depicted below. Trends in these variables have remained consistent over the past 10 years with the exception of bystander CPR which has increased steadily. This is attributable to trained emergency call-takers providing Dispatcher Life Support (DLS) to bystanders during emergency phone calls, as well as increased promotion of CPR through programmes such as AV's 4 Steps for Life.

Figure 10: Demographics of adult OHCA events, 2011/12.[1]

69	Median age (years)	66%	Male gender
19%	Public location	34%	Witnessed by bystander
14%	Present in VF/VT	37%	Receive bystander CPR

1. *Adults > 15 years or missing age, excluding EMS witnessed events.*

DEMOGRAPHICS

Demographics of adults, resuscitation attempted

In 2011/12, AV paramedics attempted resuscitation in 1,978 adult victims of cardiac arrest[1]. These patients represent a diverse population, and vary significantly in factors which are likely to impact on their survival. Adults who received an emergency resuscitation attempt were likely to be younger, more often witnessed by a bystander, and more likely to have received efforts at CPR by a member of the public.

Figure 11: Gender distribution, 2011/12 (left).[1]

Figure 12: Proportion of adult events witnessed by bystanders, 2011/12 (right).[1]

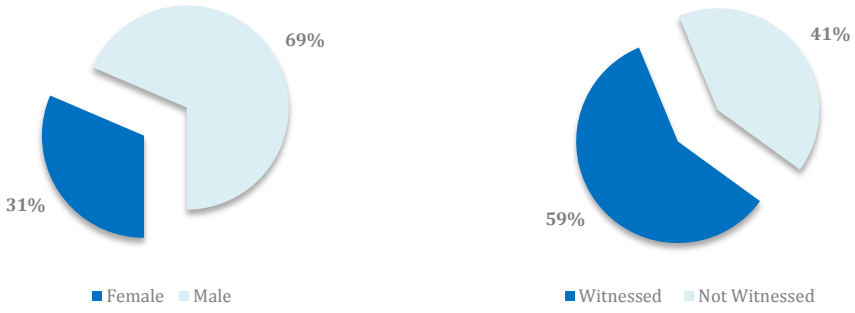


Figure 13: Proportion of adult events occuring across DH regions, 2011/12 (left).[1]

Figure 14: Proportion of adult events occuring in a public location, 2011/12 (right).[1]

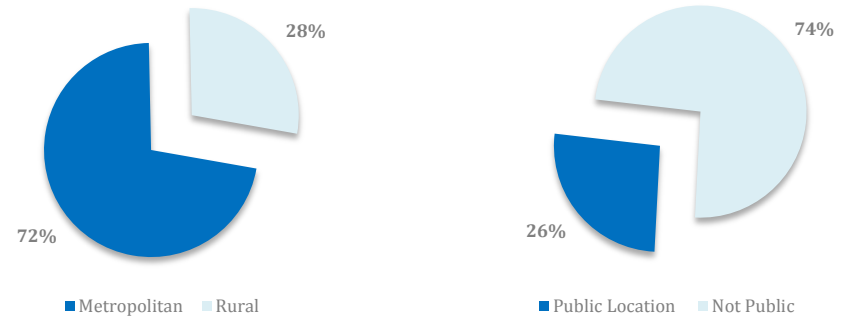
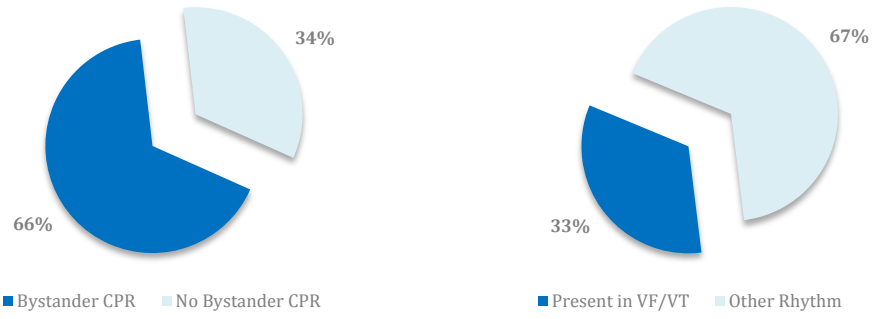


Figure 15: Proportion of adult events receiving bystander CPR, 2011/12 (left).[1]

Figure 16: Proportion of adult events presenting in VF or VT on arrival, 2011/12 (right).[1]



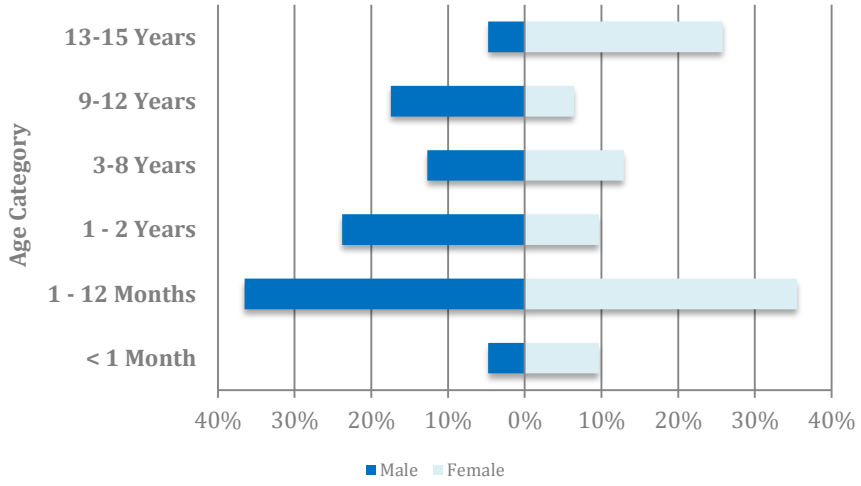
1. *Adults > 15 years or missing age, who received EMS attempted resuscitation, excluding EMS witnessed events.*

DEMOGRAPHICS

Demographics of paediatrics

The vast majority of paediatric OHCA occur in infants aged two years and younger. This trend has remained consistent over the past 10 years. Differences in the age profiles of children across gender can be observed with the median ages showing some variation (male = 1.0 years, female = 2.0 years). A significantly higher proportion of cardiac arrests in the 13-15 year age group are attributed to females.

Figure 17: Age distribution for paediatric events, 2011/12.[1]



In contrast to adult OHCA events, paediatrics were more likely to receive bystander CPR (71%). The vast majority of paediatric events present in an asystolic rhythm (79%), with only 2% presenting in VF/VT on arrival of paramedics.

Figure 18: Demographics of paediatric OHCA events, 2011/12.[1]

1 Median age (years)	67% Male gender
22% Public location	30% Witnessed by bystander
2% Present in VF/VT	72% Receive bystander CPR

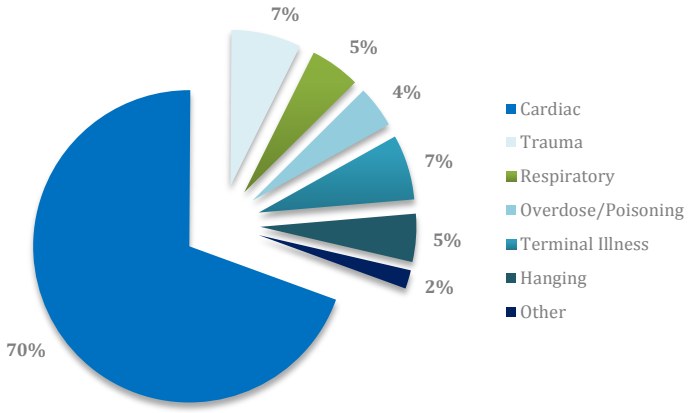
1. *Paediatrics < 16 years, excluding EMS witnessed events.*

PRECIPITATING EVENTS

Adult precipitating events

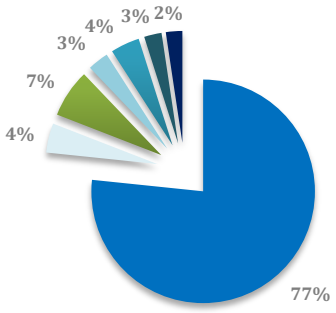
Precipitating events describe the presumed cause of a patient's cardiac arrest. The VACAR records 13 precipitating events for adults, of which the seven most common are depicted below. The VACAR follows the Utstein template reporting style for resuscitation registries which states that precipitating events should be presumed to be of cardiac aetiology unless it is known or likely to have been caused by another aetiology (e.g. trauma, submersion, drug overdose etc.) as best determined by paramedics.

Figure 19: Precipitating events for adult OHCA events, 2011/12.[1]



The overwhelming cause of OHCA cardiac arrest in Victoria is presumed to be of cardiac origin, however, sudden cardiac arrest associated with trauma and respiratory conditions continue to claim the lives of hundreds of Victorians every year.

Figure 20: Precipitating events for adult OHCA events where resuscitation was attempted, 2011/12.[2]



77%

of adult OHCA receiving an attempt at resuscitation by paramedics were believed to be of a cardiac cause.[2]

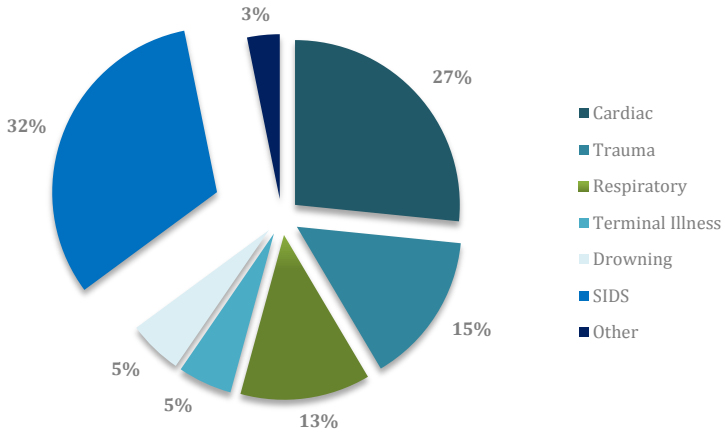
1. *Adults > 15 years or missing age, excluding EMS witnessed events.*
2. *Adults > 15 years or missing age, who received EMS attempted resuscitation, excluding EMS witnessed events.*

PRECIPITATING EVENTS

Paediatric precipitating events

Precipitating events for children who suffer OHCA vary considerably to adults. In comparison, only 27% of all paediatric OHCA are presumed to be of a cardiac cause. Trauma, respiratory and terminal illnesses play a greater role in the precipitators of cardiac arrest in children, and contributed significantly to the probability of survival in this population.

Figure 21: Precipitating events for paediatric OHCA events, 2011/12.[1]

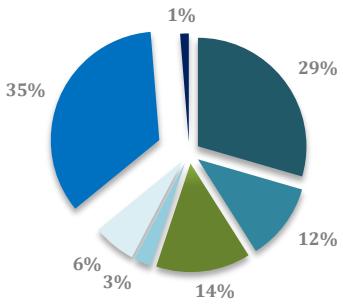


Sudden infant death syndrome or SIDS is presumed to be the leading cause of OHCA in individuals aged less than 16 years. In fact, over half of all OHCA events for children aged less than 2 years are attributable to SIDS. Despite its poor prognosis, these sudden and unexplained events often receive an attempt at resuscitation by paramedics and first responders.

Figure 22: Precipitating events for paediatirc OHCA events where resuscitation was attempted, 2011/12.[2]

35%

of paediatric OHCA receiving an attempt at resuscitation by paramedics are believed to be caused by SIDS.[2]



1. *Paediatrics < 16 years, excluding EMS witnessed events.*
2. *Paediatrics < 16 years, who received EMS attempted resuscitation, excluding EMS witnessed events.*

PRECIPITATING EVENTS

Traumatic precipitating events

Cardiac arrests secondary to major trauma represent an important surveillance group in Victoria. Road trauma or road traffic accidents are the predominant cause of cardiac arrest in the trauma sub-group of precipitating events. In fact, 65% of all trauma related OHCA were the result of road trauma. Of these, 55% were either the driver or a passenger of a road vehicle. Pedestrians being struck by a train or road vehicle also resulted in a significant proportion of traumatic related OHCA.

Falls and assault traumas were also significant causes of traumatic arrests in 2011/12, with more than a quarter of all traumatic arrests being attributed to these mechanisms. The frequency of events in these subgroups has remained consistent since 2005/6.

Figure 23: Types of road traffic accidents causing cardiac arrest, 2011/12.[1]

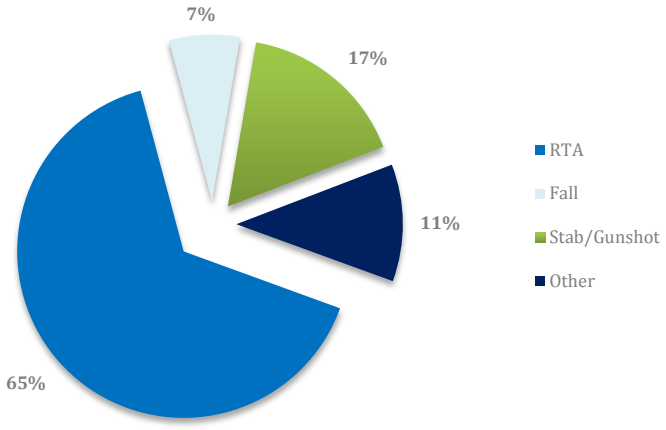
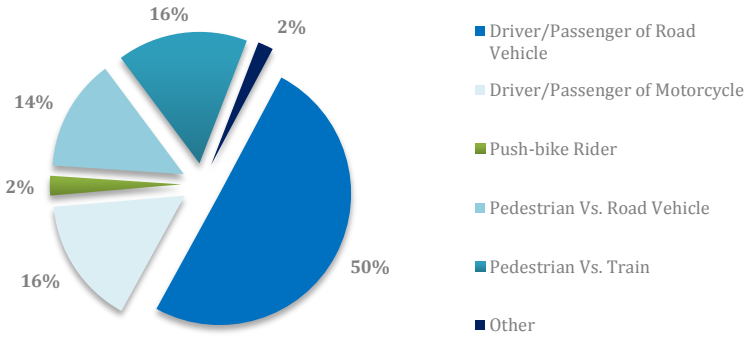


Figure 24: Traumatic mechanism presumed to have caused cardiac arrest, 2011/12.[1]



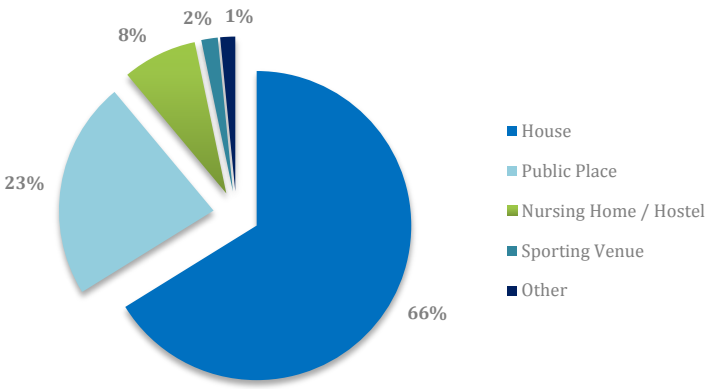
1. *All ages, all events, including EMS witnessed events.*

LOCATION OF ARREST

Arrest locations for adults, resuscitation attempted

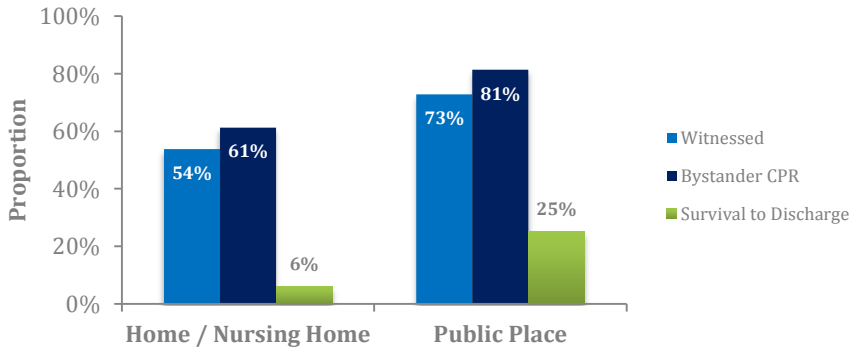
The location of the OHCA has important implications on survival. The VACAR records 12 cardiac arrest locations, the most common of which are depicted below. Public places include places of work, streets/roads, shops, vehicles, hotels, and clubs. In 2011/12, 66% of all adult OHCA with an attempted resuscitation occurred in the home, however almost half of these events went unwitnessed.

Figure 25: Location of arrest for adults with an attempted resuscitation, 2011/12.[1]



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. This effect contributed significantly to the chance of survival from OHCA. Of the patients who suffered an OHCA in a public place, 73% were witnessed, 81% received bystander CPR and survival to discharge was observed in 25%.

Figure 26: Likelihood of being bystander witnessed, receiving bystander CPR and surviving to hospital discharge relative to arrest location, 2011/12.[1]



1. *Adults > 15 years or missing age, who received EMS attempted resuscitation, excluding EMS witnessed events.*

systems of care

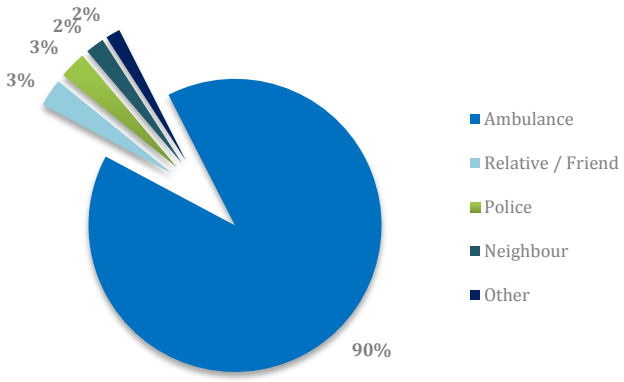
AMBULANCE VICTORIA

EARLY ACCESS

Bystander call to Triple Zero

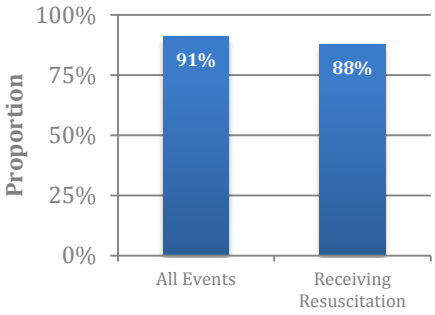
The Chain of Survival is an internationally recognised four-step initiative designed to deliver a sequence of actions to improve survival from cardiac arrest. The first step of the chain is 'early access', which involves calling for EMS immediately at the time of collapse. The direction of a bystander's first phone call can have a significant impact on the delivery of the other chains, including early CPR and defibrillation by EMS. In 2011/12, 90% of bystanders were noted to call an ambulance upon finding a patient in cardiac arrest. However, every 1 in 10 events observed a relative, neighbour or police being called first.

Figure 27: Direction of first bystander call, 2011/12.[1]



Identification of cardiac arrest during the emergency call can have a significant impact on EMS response time and the administration of bystander CPR, both of which are important predictors of survival from OHCA.

Figure 28: Proportion of presumed cardiac OHCA correctly identified in the emergency call, 2011/12.[2]



91%

of presumed cardiac aetiology OHCA are correctly identified by the Triple Zero call-taker.[2]

1. *All ages, excluding EMS witnessed events.*
2. *All ages, presumed cardiac aetiology, excluding EMS witnessed events. Ambulance Victoria metropolitan region only.*

EARLY ACCESS

Emergency response to the incident

The time lapse between the patient's collapse and administration of resuscitation is strongly associated with survival from cardiac arrest. Response time, or the time from the emergency call to arrival of EMS on scene is a crucial component of care for patients in cardiac arrest. In 2011/12, the median and 90th percentile response times for metropolitan cases were 8.1 and 13.8 minutes respectively. These results are comparable to 2010/11 figures of 7.9 and 13.7 minutes respectively. Rural cases observed figures of 11.0 and 24.0 minutes for median and 90th percentile responses. The median result was higher than the 2010/11 result of 10.0 minutes.

A first responder program for early defibrillation by fire-fighters operates in the inner and peripheral areas of Melbourne. AV also co-responds with 29 volunteer community teams in smaller, predominately rural communities across the state. The focus of these partnerships is to reduce the time from collapse to the administration of lifesaving CPR and defibrillation. In 2011/12, 26% of all cardiac arrest patients were responded to faster by first responders.

Figure 29: Time from call to arrival of EMS on scene, 2011/12.[1]

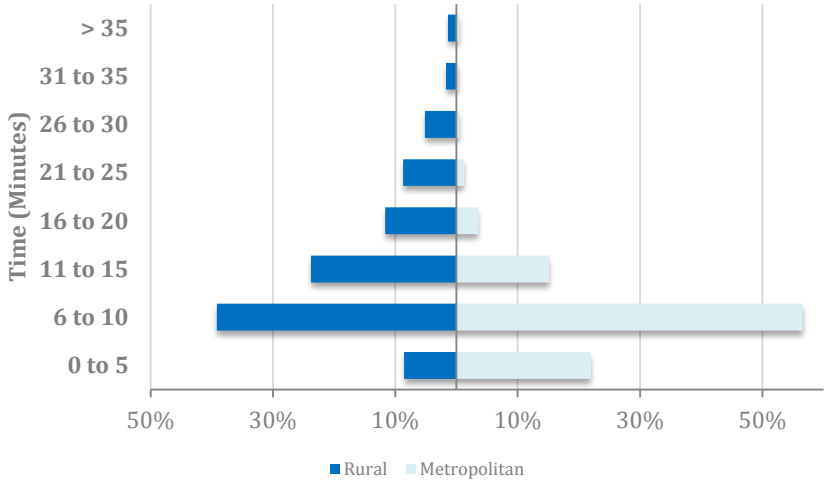
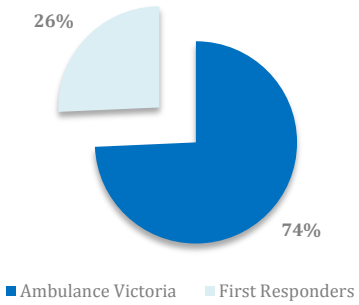


Figure 30: Who arrived first for cases with an attempted resuscitation, 2011/12.[2]



26%

resulted in a faster response by first responders for cases with an attempted resuscitation.[2]

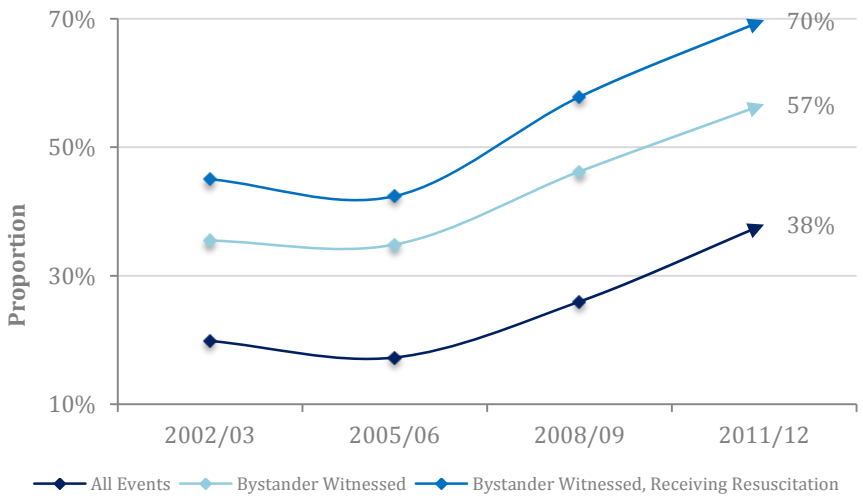
1. *All ages, who received EMS attempted resuscitation, excluding EMS witnessed events.*
2. *All ages, who received EMS attempted resuscitation, excluding EMS witnessed events (DH Metropolitan region only). First Responders include the MFB, CFA and CERT.*

EARLY CPR

Bystander-initiated cardiopulmonary resuscitation

The administration of CPR by bystanders greatly improves the chance of survival for patients in cardiac arrest. Bystander CPR observed on arrival of EMS also improves the chance of paramedics continuing resuscitation. Since 2005/06, Victoria has observed a significant increase in the participation of bystanders in CPR. In 2011/12, patients who were witnessed to collapse by bystanders had a 57% chance of receiving bystander CPR. Of those receiving an attempt at resuscitation by EMS, 70% received an attempt at bystander CPR.

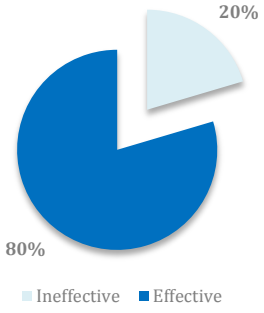
Figure 31: Paramedic reported bystander CPR rates, 2011/12.[1,3]

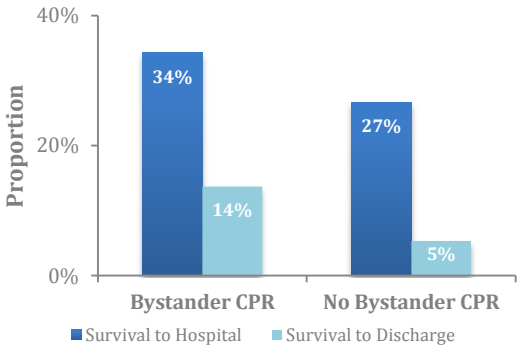


Paramedic reported effectiveness[4] of bystander CPR remains high in 2011/12. Furthermore, the presence of bystander CPR was strongly associated with survival for all cardiac arrests receiving an attempt at resuscitation in 2011/12 ($p < 0.001$, see figure 33).

Figure 32: Paramedic reported effectiveness of bystander CPR, 2011/12 (left).[1,4]

Figure 33: Survival outcomes after bystander CPR, 2011/12 (right).[2,3]





1. *All ages, excluding EMS witnessed events.*
2. *All ages, who received EMS attempted resuscitation, excluding EMS witnessed events.*
3. *If bystander CPR was not reported on the paramedic PCR, it was assumed that no CPR was administered.*
4. *If bystander CPR effectiveness was not reported on the paramedic patient care record, it was assumed that the CPR was effective.*

EARLY DEFIBRILLATION

Time from call to first defibrillation

For patients presenting in a shockable rhythm, the time to defibrillation is a key clinical indictor for the assessment of performance. This time period is defined as the time from the emergency call to the delivery of the first defibrillation in patients who present in VF or VT. First responder crews which respond concurrently with AV paramedics are also trained to perform Automatic Electronic Defibrillation. In 2011/12, the median time to defibrillation in the metropolitan region was 11.0 minutes, and 14.0 minutes in the rural region. Defibrillation times are strongly effected by response times and distances travelled.

Survival rates for patients who receive their first defibrillation from First Responders or Public Access defibrillators are worthy of mention. This is most likely the result of shorter response times, and the shorter time interval between collapse and defibrillation.

Figure 34: Time from call to first EMS defibrillation in VF/VT events, 2011/12.[1]

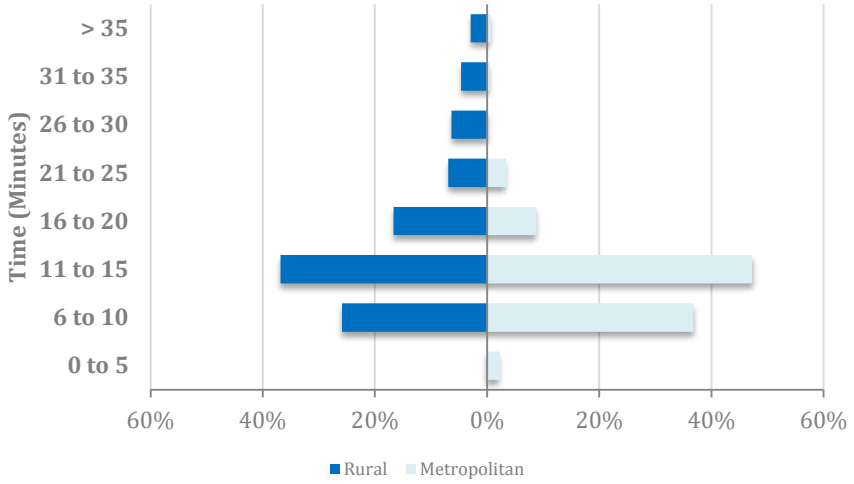
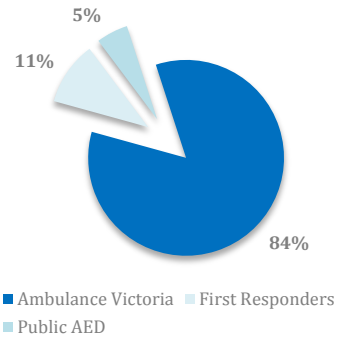
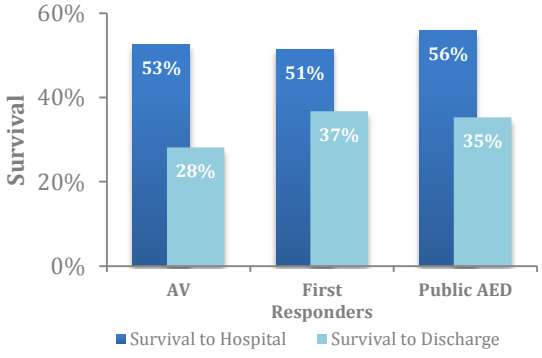


Figure 35: Who defibrillated first in VF/VT events, 2011/12 (left).[1]

Figure 36: Impact of who defibrillated first on survival from OHCA in VF/VT events, 2011/12 (right).[1,2]





1. *All ages, who received EMS attempted resuscitation, and where the presenting rhythm on arrival to EMS was VF/VT. Excludes EMS witnessed events.*
2. *Seasonal variation in survival outcomes are observed due to small sample sizes. Interpret with caution.*

EARLY ADVANCED CARE

Primary transport to speciality cardiac centre

Previous published research by VACAR has demonstrated that transport to a PCI-capable (percutaneous coronary intervention) hospital is associated with improved survival to discharge from OHCA *(Stub et al. Heart. 2011)*. In adult presumed cardiac patients transported to hospital, 90% of metropolitan cases and 39% of rural cases were initially transported to PCI-capable hospitals. This reflects a 77% PCI-capable transport rate for the state of Victoria.

Rural primary transport rates experience heavy variation and are predominantly associated with transport to two major PCI-capable hospitals outside of the metropolitan region (Geelong Hospital and Ballarat Hospital). Furthermore, it is also plausible that other hospital characteristics are associated with an improvement in survival for cardiac arrest patients, including the use of evidence-based therapies such as therapeutic hypothermia.

Figure 37: Impact of hospital PCI-capability on adult survival to hospital discharge, 2011/12.[1]

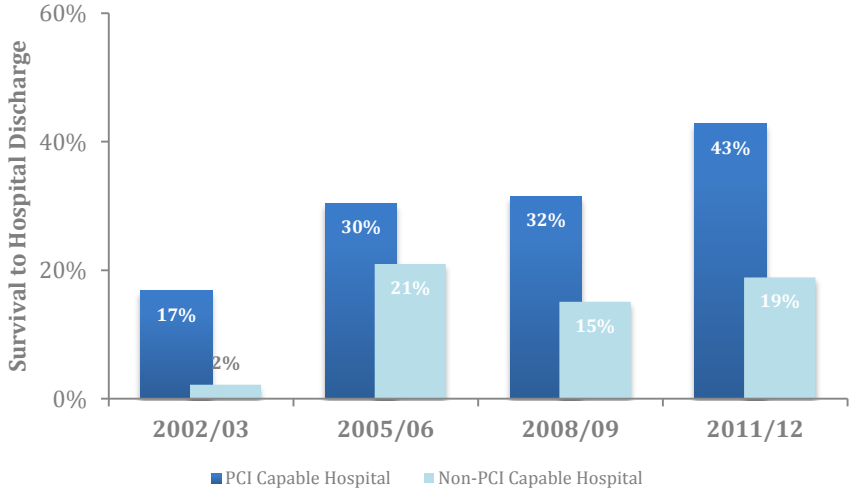
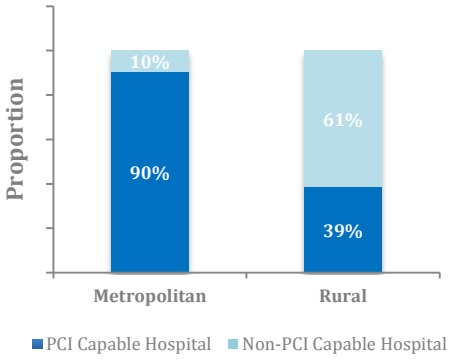


Figure 38: Proportion of adult patients transported to a PCI-capable hospital, 2011/12.[1]



77%

of adult OHCA transported to hospital are conveyed to a hospital with PCI capability.[1]

1. *Adults > 15 years or missing age, who received EMS attempted resuscitation, and presumed cardiac aetiology. Excludes EMS witnessed events.*

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survival outcomes

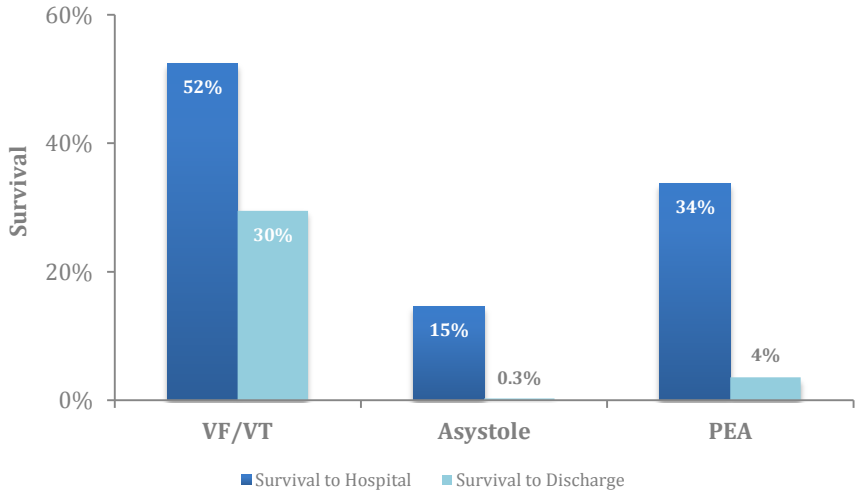

MICA

CARDIAC RHYTHMS

Presenting rhythms on arrival

The cardiac rhythm on arrival of EMS demonstrates strong prognostic information for survival from OHCA. In 2011/12, survival for patients who presented to EMS in VF or VT was significantly greater than those who presented in pulseless electrical activity (PEA) or asystole. In fact, 30% of VF/VT patients survived to hospital discharge compared with 4% for patients presenting in PEA. Three patients (0.3%) who presented in asystole survived to hospital discharge in 2011/12.

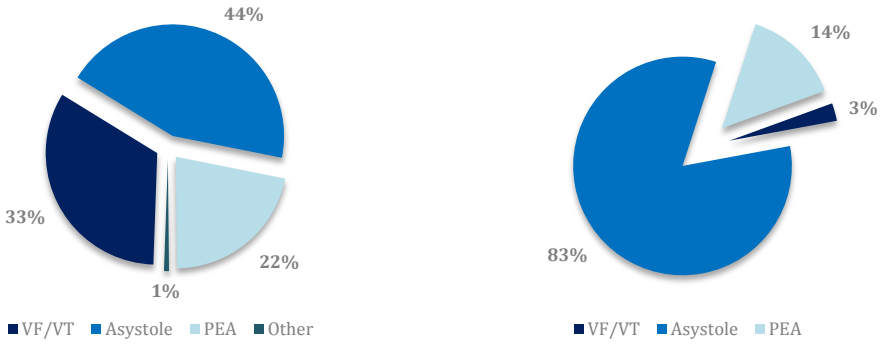
Figure 39: Adult survival by presenting rhythm on arrival, 2011/12.[1]



The vast majority of patients presented to EMS in asystole in 2011/12, with 44% of adults and 83% of paediatrics presenting in this rhythm. Patients who presented in VF/VT on arrival of EMS accounted for 33% of all adult OHCA in 2011/12, and 3% of all paediatric events.

Figure 40: Presenting rhythm on arrival for adult events, 2011/12 (left).[1]

Figure 41: Presenting rhythm on arrival for paediatric events, 2011/12 (right).[2]



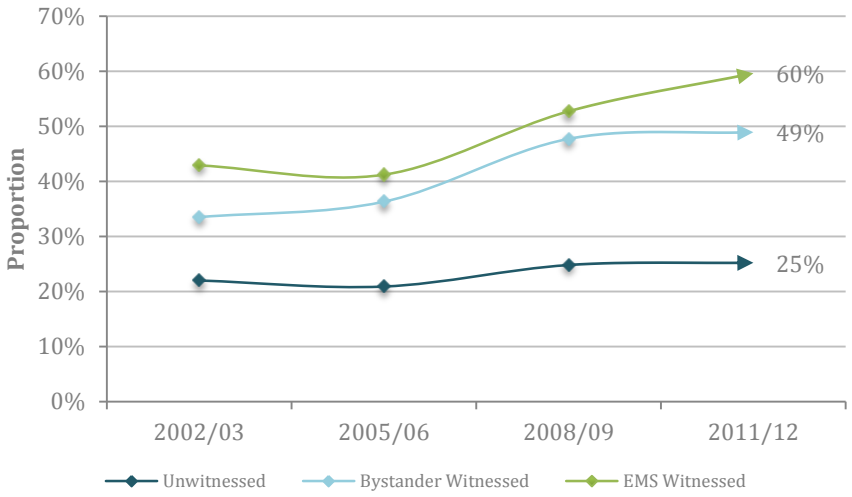
1. *Adults > 15 years or missing age, who received EMS attempted resuscitation. Excludes EMS witnessed events.*
2. *Paediatrics < 16 years, who received EMS attempted resuscitation. Excludes EMS witnessed events.*

SCENE OUTCOMES

Return of spontaneous circulation in adults

Return of spontaneous circulation (ROSC) refers to the resumption of cardiac mechanical activity leading to a detectable pulse and evidence of perfusion. Successful attempts at resuscitation are often evaluated by the attainment of ROSC. In 2011/12, ROSC was obtained in 49% of adult, bystander witnessed OHCA. This result has increased substantially since 2005/06, where the frequency of ROSC was 36%.

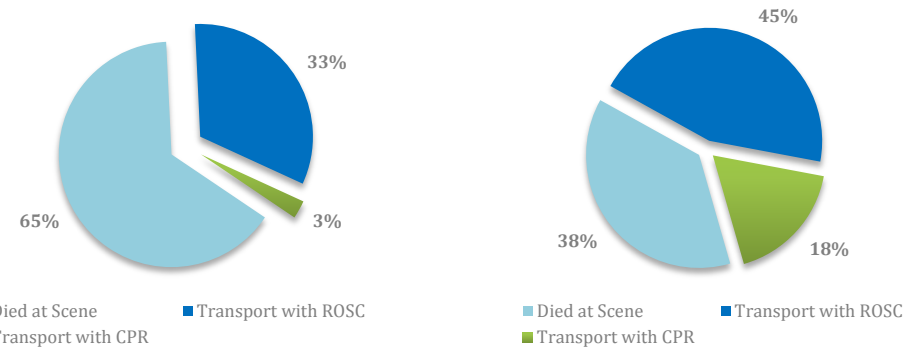
Figure 42: Proportion of adult OHCA obtaining ROSC.[1]



Scene outcomes describe the presence of ROSC at the time the patient is prepared for transport to hospital. In Victoria, 65% of OHCA were not transported after an attempt at resuscitation by paramedics. The presence of ROSC at the time of transportation was observed in 33% of patients, while a small proportion (3%) received ongoing CPR attempts while en-route to hospital.

Figure 43: Scene outcomes for adult OHCA, 2011/12.[2]

Figure 44: Scene outcomes for EMS witnessed adult OHCA, 2011/12.[3]



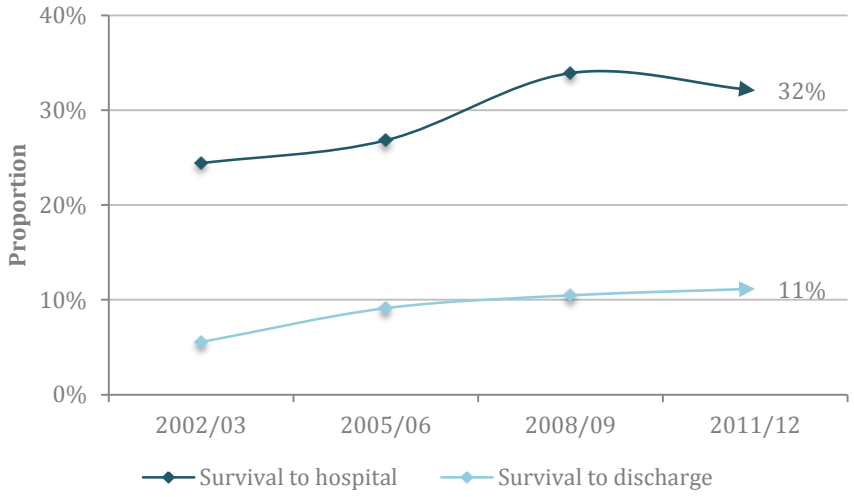
1. *Adults older than 15 years or missing age, who received EMS attempted resuscitation.*
2. *Adults older than 15 years or missing age, who received EMS attempted resuscitation. Excludes EMS witnessed events.*
3. *Adults older than 15 years or missing age, who received EMS attempted resuscitation. EMS witnessed events only.*

SURVIVAL OUTCOMES

Adult survival from cardiac arrest

Adult survival from OHCA has increased steadily over the past 10 years. In 2002/03, survival to hospital and survival to discharge were 24% and 6% respectively, for all adult OHCAs. This figure has improved to 32% and 11% respectively, in the most recent fiscal year.

Figure 45: Survival from adult OHCA from all aetiologies.[1]

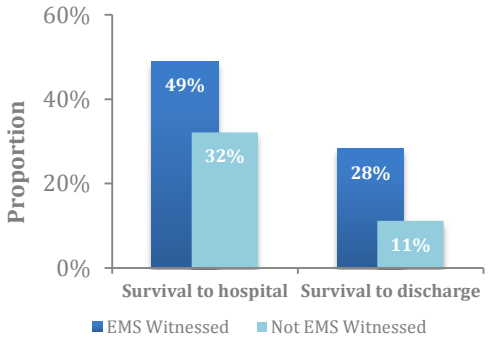


A patient who suffers a cardiac arrest in the presence of paramedics is likely to benefit from immediate resuscitation and defibrillation. In 2011/12, EMS witnessed adult events had a 21% increased chance of survival to hospital, and 21% increased chance of survival to hospital discharge when compared to non-EMS witnessed events.

Figure 46: Survival from EMS witnessed adult OHCA from all aetiologies, 2011/12.[2]

28%

of adult EMS witnessed OHCA survive to hospital discharge[2]



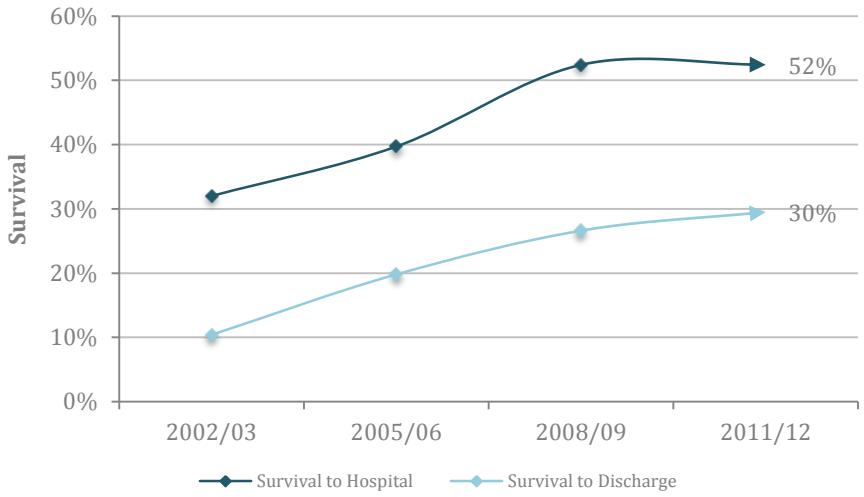
1. *Adults > 15 years or missing age, who received EMS attempted resuscitation. Excludes EMS witnessed events.*
2. *Adults > 15 years, who received EMS attempted resuscitation.*

SURVIVAL OUTCOMES

Adult survival from shockable rhythms

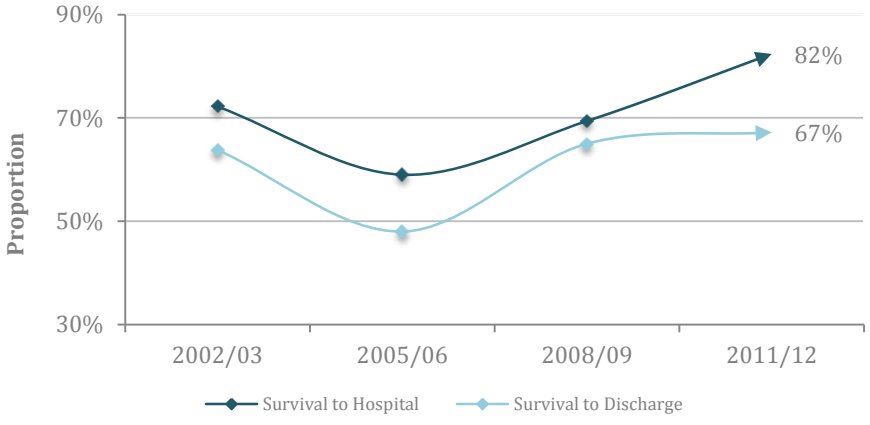
The presence of a shockable rhythm on arrival of EMS is the single strongest contributor to the chance of survival from OHCA. Ten year outcomes for patients with shockable rhythms have demonstrated favourable findings in 2011/12, with 52% of patients surviving to hospital and 30% surviving to hospital discharge. This result is significantly higher than those observed in 2002/03, where survival was 32% and 10% respectively.

Figure 47: Adult survival from VF/VT OHCA.[1]



The greatest survival benefit for patients with VF/VT is observed when immediate intervention is administered by paramedics. In 2011/12, survival to hospital and hospital discharge from adult EMS witnessed VF/VT was 82% and 67% respectively.

Figure 48: Adult survival from EMS witnessed VF/VT OHCA.[2]



1. *Adults > 15 years or missing age, who received EMS attempted resuscitation and presented in VF/VT on arrival of EMS. Excludes EMS witnessed events.*
2. *Adults > 15 years, who received EMS attempted resuscitation, and were witnessed to arrest by EMS into VF/VT.*

SURVIVAL OUTCOMES

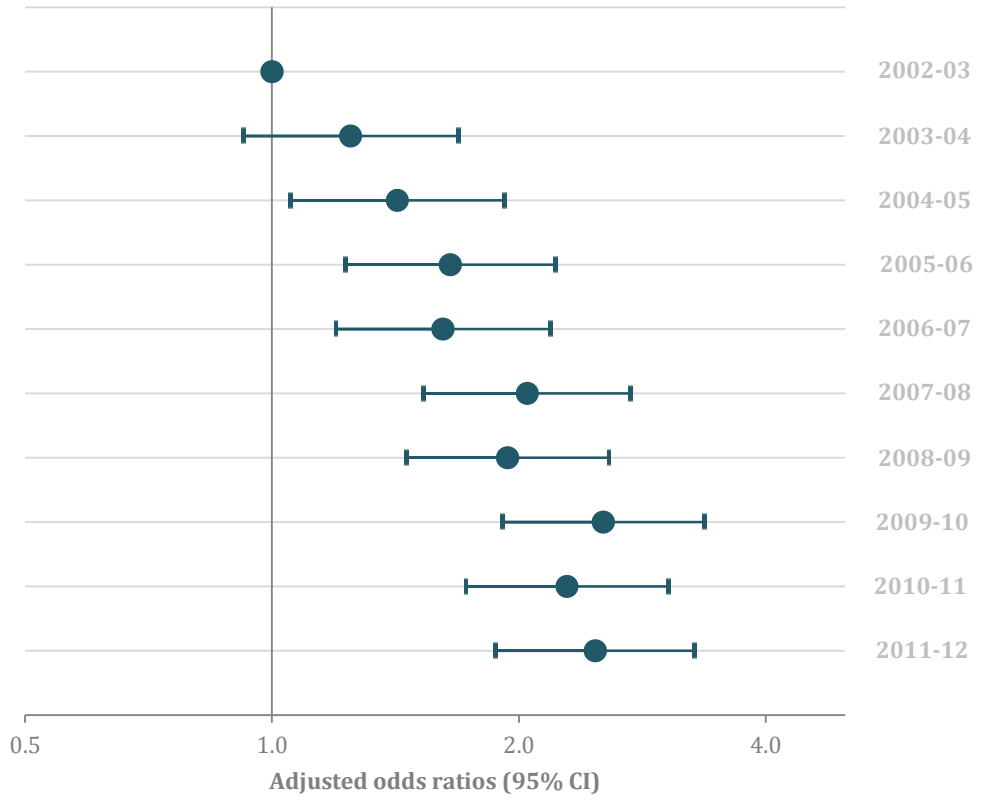
Risk-adjusted odds of adult survival by year

Risk-adjusted odds of survival provide a balanced method for measuring trends in resuscitation performance across years. Figure 49 shows the odds of survival to hospital discharge for adult patients by year, and is adjusted for known predictors of survival including age, response time, gender, public location, shockable rhythm on arrival, bystander witnessed and bystander CPR.

The risk-adjusted odds of survival to hospital discharge have improved significantly over the last 10 years. In fact, the probability of survival to hospital discharge is 2.5 times higher in 2011/12 than when compared to cases in 2002/03 (95% CI 1.9-3.3, p < 0.0001). This finding is similar to what has been observed over the last three years.

Risk-adjusted odds of survival to discharge for adult patients presenting in a shockable rhythm has also observed significant increases over 10 years. In 2011/12, the risk-adjusted odds of survival for a patient presenting in VF/VT was 3.7 (95% CI 2.7-5.3, p < 0.0001) when compared with survival in 2002-03.

Figure 49: Trends in the risk-adjusted odds of survival to hospital discharge for adult patients.[1]



1. *Adults > 15 years or missing age, who received EMS attempted resuscitation. Excludes EMS witnessed events. Adjusted odds ratios are adjusted for age, response time, gender, public location, shockable rhythm on arrival, bystander witnessed and bystander CPR.*

SURVIVAL OUTCOMES

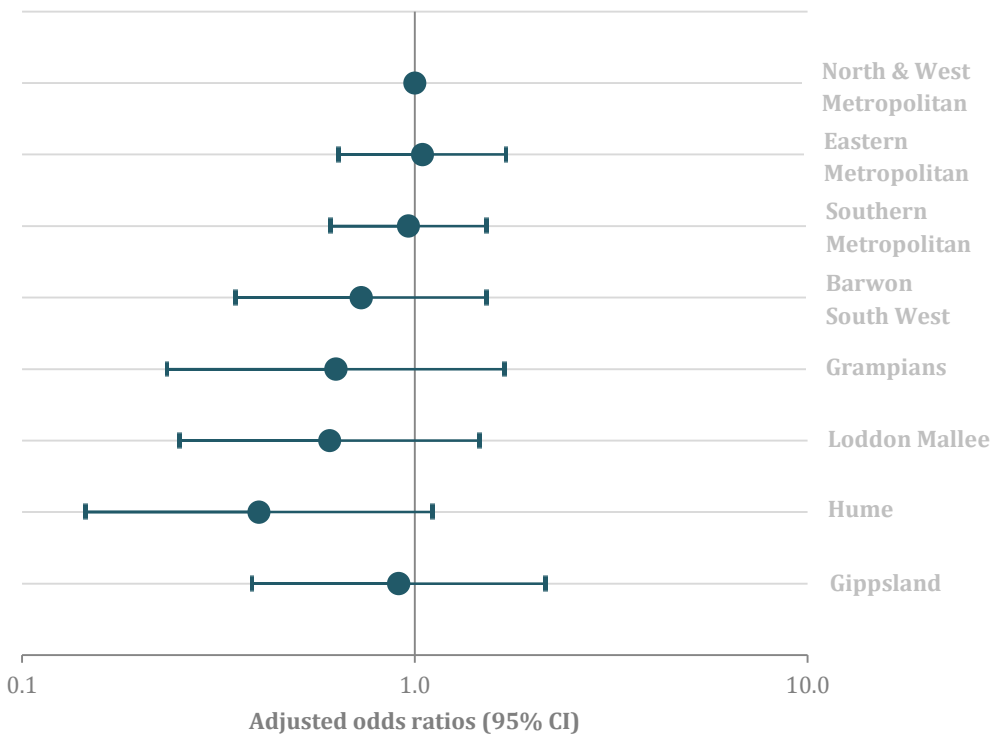
Risk-adjusted odds of adult survival by region

Regional differences in cardiac arrest outcomes have been described across continents, cities, and population densities. Earlier work by VACAR *(Jennings et al. MJA. 2006)* demonstrated a significant disparity in survival outcomes across urban and regional areas of Victoria. Despite significant improvements to this trend over the last five years, VACAR continues to monitor regional disparity in resuscitation outcomes.

Risk-adjusted odds of adult survival to hospital discharge across Department of Health regions of Victoria for the 2011/12 year are presented in Figure 50. Odds-ratios shown are adjusted for known predictors of survival including age, response time, gender, public location, shockable rhythm on arrival, bystander witnessed and bystander CPR. In the metropolitan regions, no significant difference in survival to hospital discharge can be observed for adult patients. Furthermore, although a trend of decreasing odds of survival can be observed across rural regions, these trends were not statistically significant.

It is worth noting that in some rural regions the number of cases which receive an attempt at resuscitation by paramedics may be small. This may lead to an increase in the 95% confidence interval and the degree of uncertainty in the results presented.

Figure 50: Risk-adjusted odds ratios of survival to hospital discharge for adult patients across DH regions of Victoria, 2011/12.[1]



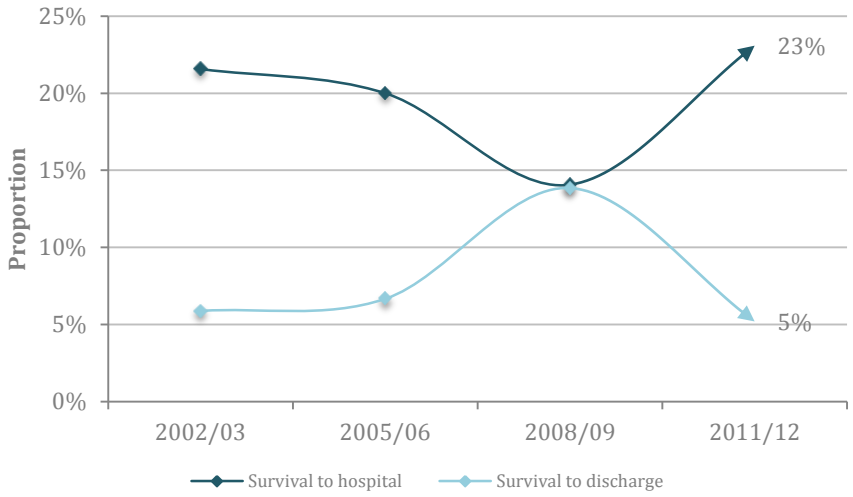
1. *Adults > 15 years or missing age, who received EMS attempted resuscitation. Excludes EMS witnessed events. Adjusted odds ratios are adjusted for age, response time, gender, public location, shockable rhythm on arrival, bystander witnessed and bystander CPR.*

SURVIVAL OUTCOMES

Paediatric survival from cardiac arrest

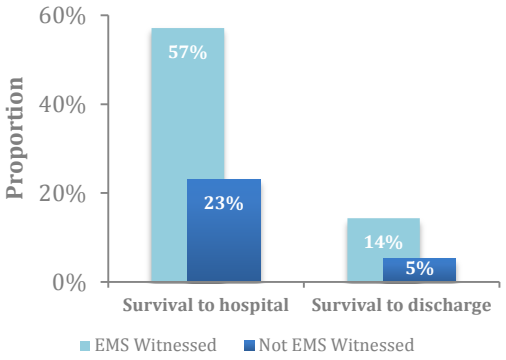
The annual incidence of paediatric OHCA is low, and survival factors vary significantly from those observed in adults, including precipitating events and the presenting cardiac rhythm on arrival of EMS. The result is a highly variable trend in survival over 10 years. In 2011/12, survival to hospital was 23% and survival to hospital discharge was 5% in paediatric OHCA of all aetiologies.

Figure 51: Survival from paediatric OHCA from all aetiologies.[1,3]



A survival benefit in EMS witnessed events is also observed for the paediatric population. The proportion of paediatric patients surviving to hospital discharge was 9% higher when witnessed by EMS personnel. In addition, 57% of paediatrics who suffer a cardiac arrest in the presence of paramedics survive to hospital admission.

Figure 52: Survival from EMS witnessed paediatric OHCA from all aetiologies, 2011/12.[2,3]



14%

of paediatric EMS witnessed OHCA survive to hospital discharge[2]

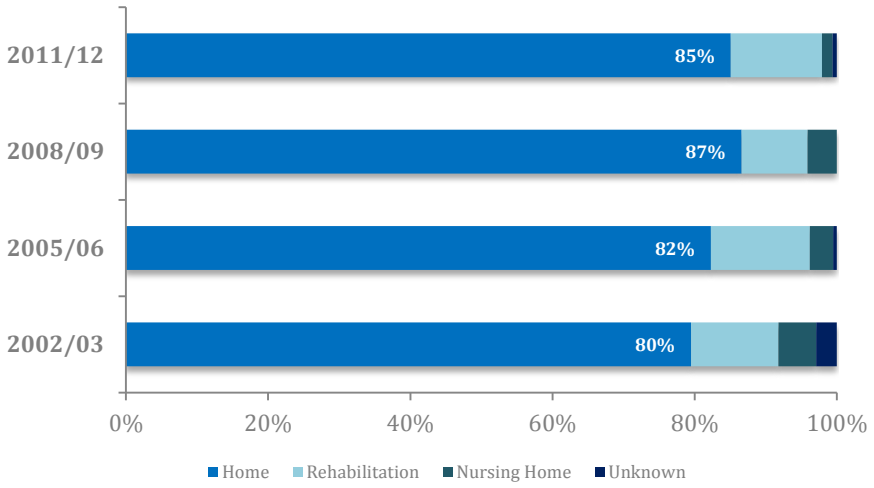
1. *Paediatrics < 16 years, who received EMS attempted resuscitation. Excludes EMS witnessed events. Data should be interpreted with caution due to the small number of events.*
2. *Paediatrics < 16 years, who received EMS attempted resuscitation. Data should be interpreted with caution due to the small number of events.*
3. *Seasonal variation in survival outcomes are observed due to small sample sizes. Interpret with caution.*

QUALITY OF LIFE

Discharge direction following survival

The VACAR records details of the patients discharge direction following survival from OHCA. Trends in discharge direction for all survivors have remained consistent over the past 10 years, observing only a slight improvement in the rate of patients being discharged home. In 2011/12, 85% of all OHCA survivors were discharged home. In 13% of patients, discharge from hospital led to rehabilitation, while 2% of patients were discharged to a nursing home.

Figure 53: Discharge direction of all survivors to hospital discharge.[1]



1. *All ages, who received EMS attempted resuscitation, and survived to hospital discharge.*

List of abbreviations

Table 5: List of abbreviations used in this report.

ACO	Ambulance Community Officers
ALS	Advanced Life Support
AV	Ambulance Victoria
CERT	Community Emergency Response Teams
CFA	Country Fire Authority
CPR	Cardiopulmonary Resuscitation
ECG	Electrocardiogram
EMS	Emergency Medical Services
LGA	Local Government Areas
MFB	Metropolitan Fire Brigade
MICA	Mobile Intensive Care Ambulance
OHCA	Out-of-hospital Cardiac Arrest
PCR	Patient Care Record
PEA	Pulseless Electrical Activity
ROSC	Return of Spontaneous Circulation
VACAR	Victorian Ambulance Cardiac Arrest Registry
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

Glossary of terms

Table 6: Glossary of terms used in this report.

Adults	Patients aged greater than 15 years of age, or where the age is missing / unknown.
Paediatrics	Patients aged less than 16 years.
Emergency Medical Services (EMS)	Denotes Ambulance Victoria paramedics or first responders, including fire services, or community emergency response teams.
Attempted EMS Resuscitation	Cases where either paramedics or first responders attempted to revive a patient in cardiac arrest, regardless of duration.
Presumed Cardiac Aetiology	Cases where the cause of arrest is not due to a known precipitator (e.g. trauma, overdose etc.) as acquired from the patient care record (PCR).
Any ROSC	Cases in which the resuscitation attempt results in a return of spontaneous circulation (i.e. detectable pulse) at any time.
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.
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).
Survival to Hospital	Patients that have a palpable pulse on arrival at hospital as documented on the PCR.
Survival to Hospital Discharge	Patients who are discharged from hospital alive.
PCI-capable hospital	Denotes a hospital with part-time or full-time Percutaneous Coronary Intervention (PCI) capabilities.

Accepted for publication

Table 7: VACAR published (or in press) articles submitted into peer-reviewed journals, 2011/12.

1. Deasy C, Bray J, Smith K, Harris L, Bernard S, Cameron P. Functional outcomes and quality of life of young adults who survive out-of-hospital cardiac arrest. *Emerg Med J. 2012.*
2. Jennings PA, Harriss L, Bernard S, Bray J, Walker T, Spelman T, Smith K, Cameron P. An automated CPR device compared with standard chest compressions for out-of-hospital resuscitation. *BMC Emerg Med. 2012;12:8.*
3. Stub D, Bernard S, Smith K, Bray JE, Cameron P, Duffy SJ, Kaye DM. Do we need cardiac centres in Australia? *Intern Med J. 2012;42(11):1173-9.*
4. Deasy C, Bray J.E, Smith K, Bernard S.A, Cameron P. Hanging associated out-of-hospital cardiac arrests in Melbourne, Australia. *Emerg Med J. 2012.*
5. Deasy, C, Bray, J.E, Smith K, Hall D, Morrison C, Bernard S.A, Cameron P. Paediatric traumatic out-of-hospital cardiac arrests in Melbourne, Australia. *Resuscitation. 2012;83(4):471-5.*
6. Deasy, C, Bray, J.E, Smith K, Harriss LR, Bernard S.A, Davidson, PM, Cameron P. Resuscitation of out-of-hospital cardiac arrests in residential aged care facilities in Melbourne, Australia. *Resuscitation. 2012;83:58-62.*
7. Bernard S, Smith K, Cameron P, Masci K, Taylor D, Cooper J, Kelly A and Silvester W. Induction of pre-hospital therapeutic hypothermia following resuscitation from non-ventricular fibrillation cardiac arrest. *Critical Care Medicine. 2011;40(3):747-53.*
8. Deasy C, Bernard S, Cameron P, Jacobs I, Smith K, Hein C, Grantham H, Finn J. Design of the RINSE trial: the rapid infusion of cold normal saline by paramedics during CPR. *BMC Emerg Med. 2011;11:17.*
9. Deasy C, Bray J.E, Smith K, Harriss LR, Bernard S.A, Cameron P. Traumatic out-of-hospital cardiac arrests in Melbourne, Australia. *Resuscitation. 2011;83(4):465-70.*
10. Lim H, Stub D, Ajani A, Andrianopoulos N, Brennan A, Reid C, Smith K, Charter K, Black A, New G, Chan W, Lim C, Farouque O, Shaw J, Duffy S, and Clark D. Survival in Patients with Myocardial Infarction Complicated by Out-of-Hospital Cardiac Arrest Undergoing Emergency Percutaneous Coronary Intervention. *International Journal of Cardiology. 2011 [in press].*
11. Bray J.E, Deasy C, Walsh J, Bacon A, Currell A, Smith K. Changing EMS dispatcher CPR instructions to 400 compressions before mouth-to-mouth improved bystander CPR rates. *Resuscitation. 2011;82:1393-8.*
12. Stub D, Smith K, Bray, J.E, Bernard S, Duffy S.J, Kaye D.M. Hospital characteristics are associated with patient outcomes following out-of-hospital cardiac arrest. *Heart. 2011;97:1489-94.*
13. Deasy, C, Bray, J.E, Smith K, Harriss LR, Bernard S.A, Cameron P. Out-of-hospital cardiac arrests in young adults in Melbourne, Australia - adding coronial data to a cardiac arrest registry. *Resuscitation.* 2011;82:1302-6.
14. Deasy, C, Bray, J.E, Smith K, Wolfe R, Harriss LR, Bernard S.A, Cameron P. Cardiac arrest outcomes before and after the 2005 resuscitation guidelines implementation: evidence of improvement? *Resuscitation.* 2011;82(8):984-8.
15. Deasy, C, Bray, J.E, Smith K, Harriss LR, Bernard S.A, Cameron P. Out-of-hospital cardiac arrests in young adults in Melbourne, Australia. *Resuscitation*. 2011; 82(7):830-4.

The VACAR group

Table 8: Members of the VACAR Steering Committee.

A/Prof Karen Smith (Chair)	Research and Evaluation **Ambulance Victoria**
Prof Stephen Bernard	Medical Advisor **Ambulance Victoria**
Prof Peter Cameron	Pre-hospital and Emergency Trauma Unit **Monash University**
Prof John McNeil	Public Health and Preventative Medicine **Monash University**
A/Prof Tony Walker	Regional Services **Ambulance Victoria**
A/Prof Tim Baker	Centre for Rural Emergency Medicine **Deakin University**
Mr Bill Barger	Operational Quality and Improvement **Ambulance Victoria**
Dr Simon Judkins	Victorian Cardiac Clinical Network **Victorian Department of Health**
Prof Warwick Butt	Paediatric Intensive Care **Royal Children's Hospital**

Table 9: Members of the VACAR Research Team, Ambulance Victoria.

A/Prof Karen Smith	Manager Research & Evaluation
Dr Marijana Lijovic	Senior Research Fellow
Dr Resmi Nair	Clinical Analyst
Ziad Nehme	Research Assistant
Vanessa Barnes	Research Officer
Marian Lodder	Research Officer
Davina Vaughan	Data Processor
Emily Andrew	Data Processor

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. *Resus. 2010;81(11)1479-87.*

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). *Resus. 2004;63(3):233-49.*

Jennings P.A, Cameron P, Walker T, Bernard S, Smith K. Out-of-hospital cardiac arrest in Victoria: rural and urban outcomes. *MJA. 2006;185:135-9.*

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.*

Stub D, Smith K, Bray, J.E, Bernard S, Duffy S.J, Kaye D.M. Hospital characteristics are associated with patient outcomes following out-of-hospital cardiac arrest. *Heart. 2011;97:1489-94.*

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