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# NSW Ambulance Cardiac Arrest Registry

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2017 Report

Produced by

**NSW Health and**



**NSW Ambulance**





**NSW Ambulance**

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**Produced by**

Research, Clinical Systems Integration  
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*This report from the cardiac arrest registry is an inaugural quality assurance activity designed to assist NSW Ambulance in improving clinical outcomes for an important group of acutely ill patients.*



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# Definitions used IN THIS REPORT

Term	Description
<b>Adults</b>	Persons aged 16 or over at date of cardiac arrest, or where age is missing or unknown.
<b>Automated External Defibrillator (AED)</b>	A portable electronic device that automatically diagnoses the life-threatening cardiac arrhythmias of ventricular fibrillation and pulseless ventricular tachycardia. The AED can treat these arrhythmias through defibrillation (the application of electricity which stops the arrhythmia, allowing the heart to re-establish an effective rhythm). AEDs provide simple audio and visual commands allowing them to be used by bystanders without medical training.
<b>CPR continuing during transport</b>	Patients who are administered ongoing Cardiopulmonary resuscitation (CPR) during transport and on handover at Emergency Department (ED). Final patient outcome may be unknown to paramedics.
<b>Deceased on arrival</b>	Incidents at which paramedics determine the patient to be deceased on arrival and no resuscitation attempt is undertaken.
<b>Do Not Resuscitate (DNR) order</b>	Documentation expressing the patient's wishes not to be resuscitated in the event of a cardiac arrest.
<b>Electronic Medical Record (eMR)</b>	Case sheet captured electronically using the GETAC rugged notebook computer.
<b>Emergency Medical Services (EMS)</b>	NSW Ambulance paramedics, doctors, Community First Responders (CFRs) or Volunteer Ambulance Officers (VAOs).
<b>EMS response time</b>	Time from call in queue to first vehicle arrived on scene.
<b>EMS-attended</b>	Cardiac arrest events attended by EMS, regardless of whether treatment was provided.
<b>EMS-treated/ EMS-attempted resuscitation</b>	Cases where either paramedics, CFRs or VAOs attempt to revive a patient in cardiac arrest using compressions and/or defibrillation (excluding cases where compressions were performed briefly during an information-gathering phase and ceased as a result of information provided including a DNR instruction).
<b>Event survival / survival to ED admission</b>	Patients with a return of spontaneous circulation (ROSC) on arrival at the hospital emergency department (ED).
<b>Paediatric</b>	Children aged under 16 at date of cardiac arrest.
<b>Patient Health Care Record (PHCR)</b>	Case sheet documented on paper and subsequently entered into the electronic PHCR (ePHCR) database.
<b>Presumed cardiac aetiology</b>	Cases where the cause of arrest is not due to a known precipitator (such as trauma, hanging, terminal illness) as documented on the eMR or PHCR.
<b>Return of spontaneous circulation (ROSC)</b>	Cases in which the resuscitation attempt results in a return of spontaneous circulation (measured by a detectable pulse) at any time.
<b>Shockable Rhythm</b>	Rhythms which are appropriate to receive defibrillation, including ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT), by EMS or a bystander with a public automated external defibrillator.
<b>Survival to hospital discharge</b>	Patients who are discharged from hospital alive following cardiac arrest.
<b>Utstein patient group</b>	An international comparator group representing the patients most likely to be successfully resuscitated. It contains patients who are witnessed to arrest by a bystander, present in a shockable rhythm and where an attempt at resuscitation was made by EMS.





# Introduction



**Dr Dominic Morgan ASM**

*Chief Executive, NSW Ambulance*

**OUT-OF-HOSPITAL** Cardiac Arrest (OHCA) is a recognised public health problem worldwide and survival rates from ambulance-attended OHCA are generally low. There is a great deal of variation in survival rates from OHCA between, and within, countries.<sup>1</sup> In Australia and New Zealand in 2015, the reported *survival to hospital* from OHCA for patients where resuscitation was attempted was 28 per cent (range 21 per cent - 36 per cent) and *survival to hospital discharge*, or 30 days, was 12 per cent (range nine per cent – 17 per cent).<sup>2</sup>

International collaboration to improve OHCA survival rates is ongoing. The International Liaison Committee on Resuscitation (ILCOR) produces and regularly updates guidelines summarising the most recent evidence for resuscitation science.<sup>3</sup> The 2015 Utstein Implementation Meeting discussed ways of implementing scientific recommendations at the community level. Expert consensus emerging from this meeting was distilled into 10 steps

to improve OHCA outcomes - one of which was the importance of having a cardiac arrest registry.

Measuring and reporting on OHCA survival rates is an indicator of the quality of clinical care provided by ambulance services. NSW Ambulance has developed an Out-of-hospital Cardiac Arrest Registry (OHCAR) as a clinical quality initiative. The OHCAR contains cases attended by NSW Ambulance clinicians starting from 1 January 2017.

This is the first report from the NSW Ambulance OHCAR. This report provides an introduction to the registry, outlines the data it contains and sets out descriptive statistics for 2017. It provides a baseline for measuring the success of initiatives to improve outcomes for our cardiac arrest patients. On behalf of NSW Ambulance we are pleased to join other jurisdictions in Australia and New Zealand in cardiac arrest reporting.



FIGURE 1: Characteristics and outcomes of cardiac arrests, NSW 2017



Characteristics and outcomes of cardiac arrests, NSW 2017

8,222

Cardiac arrest patients attended



3,183

Resuscitations attempted\*



Survived to ED admission



Survived to hospital discharge

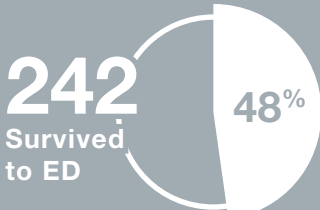
\*Excluding resuscitation by bystanders with ROSC prior to NSW Ambulance arrival

UTSTEIN SUBGROUP

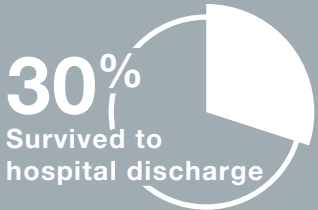
EMS-attempted resuscitation, bystander-witnessed arrest, shockable rhythm



501  
Resuscitations attempted



242  
Survived to ED



30%  
Survived to hospital discharge

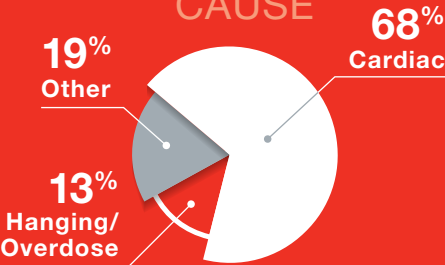
DEMOGRAPHICS

65%  
Male



35%  
Female

CAUSE



LOCATION



BYSTANDER



CPR = Cardiopulmonary resuscitation.  
EMS = Emergency Medical Services including NSW Ambulance paramedics, doctors, community first responders and volunteer ambulance officers.  
ROSC = Return of Spontaneous Circulation.  
Survival rates are as a percentage of patients on whom resuscitation was attempted by NSW Ambulance.  
The Utstein subgroup is a comparator group used to compare cardiac arrest survival rates internationally.  
This group represents the subgroup with the highest potential for successful resuscitation.

# NSW Ambulance OHCAR

## Out-of-Hospital Cardiac Arrest Registry

The NSW OHCAR includes all OHCA patients who were attended by NSW Ambulance road paramedics, aeromedical paramedics and doctors, CFRs and VAOs since 1 January 2017. Inclusion and exclusion criteria are detailed in Table 1. Appendix 1 provides further information about the establishment of the NSW OHCAR in response to the recommendations of the Global Resuscitation Alliance.

The OHCAR was built using REDCap,<sup>4</sup> a secure web application for building and managing online surveys and databases which was specifically created at Vanderbilt University to provide a data entry facility for research studies and operational activity.

REDCap is used by other areas of NSW Health.

The OHCAR is hosted by the NSW Ambulance Research group within Clinical Systems Integration, and managed by the Clinical Quality Registries Coordinator.

The OHCAR fields include Utstein variables plus additional fields relevant to NSW Ambulance. Utstein variables are a set of fields determined using an established consensus process and endorsed by the international resuscitation community to facilitate consistency and comparability in resuscitation research.<sup>3</sup>

The data collected from clinical and operational records describe the pre-hospital links in the

**TABLE 1: NSW Ambulance OHCAR inclusion and exclusion criteria.**

Inclusion criteria	Exclusion criteria
Patients of all ages who suffer a documented OHCA.	Brief episodes of pulselessness that do not receive CPR/defibrillation by EMS.
OHCA occurs in NSW (or neighbouring states) <b>and</b> NSW Ambulance is the primary care-giver.	Patients suffering an in-hospital cardiac arrest, where NSW Ambulance may attend, but is not the primary care-giver.
Patient pulseless on arrival of EMS; OR becomes pulseless in the presence of EMS; OR has a pulse on EMS arrival, where a successful bystander defibrillation attempt was undertaken prior to EMS arrival.	Patients with a pulse on EMS arrival, where a bystander suspected an OHCA but there was no defibrillation prior to EMS arrival, and no other evidence verifying the OHCA.

## OUT-OF-HOSPITAL CARDIAC ARREST EMERGENCY RESPONSE

**NSW** is Australia's most populous state, with an estimated population at 30 June 2017 of 7.9 million people, 5.1 million of which lived in the Greater Sydney area. NSW Ambulance has 250 ambulance response locations across the state, ranging from superstations in metropolitan Sydney to CFR and VAO locations in regional and rural NSW plus a number of helicopter and fixed-wing aircraft bases.

Calls to ambulance via Triple Zero (000), Australia's national emergency services telephone number, are triaged in NSW by NSW Ambulance call-takers using the Medical Priority Dispatch System (MPDS) ProQA software, the same software used in most other states and territories in Australia. The chain of survival starts with call-takers, who can play a vital role in improving patient outcomes by recognising cardiac arrest and providing cardiopulmonary resuscitation (CPR) instructions to bystanders.



## *The NSW OHCAR includes all OHCA patients who were attended by NSW Ambulance road paramedics, aeromedical paramedics and doctors, CFRs and VAOs since 1 January 2017*

chain of survival. Coders enter data in a sequence of forms in REDCap:

- Patient details
- Case location
- Operational timings
- Clinical details (witnessed status, bystander CPR, initial rhythm, patient management)
- Paramedic details (number and level)
- Dispatch details (whether CPR instructions were provided)
- Aeromedical involvement and Outcomes.

The process for recording cases in the OHCAR is to start with a monthly upload of electronic data to populate the database. The initial upload is then reviewed by coding staff who complete additional details of each arrest, interpreter case sheets and ECG paperwork, seeking additional information, cleaning and re-classifying the data where necessary.

The identification of potential cases for inclusion in the OHCAR comes from linked NSW Ambulance data - Computer-Aided Dispatch (CAD) system data linked by incident number to electronic Patient Health Care Records (ePHCR) and electronic Medical Records (eMR). The ePHCR database contains paramedics' paper case sheets transcribed into an electronic database; eMR data comes directly from the electronic case sheets entered into the eMR system using devices in each ambulance.

The inclusion criteria contain several dimensions:

- Paramedic protocols including C2 – Cardiac Arrest Resuscitation Decision Algorithm, C3 – Cardiac Arrest, A13 – Verification of Death, T20 – Traumatic Cardiac Arrest. The list is expanded when new protocols are changed or created such as the 2018 introduction of protocols OP4 - Newborn Resuscitation, OP5 – Confirmed Stillbirth and C16 - Return of Spontaneous Circulation

OR

- Patient Management such as 'Defibrillation', 'CPR', 'Witnessed Arrest', 'Resuscitation Ceased'

OR

- Initial Rhythm for example, Ventricular Fibrillation, Asystole, Pulseless Electrical Activity

OR

- Observed Outcome for example, Dead on Arrival, Died at Scene, ROSC.

Once the initial monthly upload to the Registry has occurred, the cases are reviewed to ensure they meet the OHCAR inclusion criteria. For cases deemed to be OHCAs, coders complete the OHCAR entry by viewing VisiNET and reading case sheets to capture information for fields that are not auto-populated from CAD/eMR/ePHCR. VisiNET is the recording system that interfaces with CAD and contains detailed information about the call including caller statements and interactions with other emergency services agencies.

A sample of 10 per cent of cases is re-abstracted by a second coder in as close to real-time as possible to ensure consistency and correctness. The level of agreement for key variables is monitored.

When NSW Ambulance paramedics arrive, they may be general paramedics or specialists. As a base qualification, paramedics have either a Bachelor's Degree in Paramedicine from a recognised university or a Diploma of Paramedical Science gained through the vocational entry and training route. In cardiac arrest, all registered paramedics can place supraglottic airways (i-gel), defibrillate, cannulate and give adrenaline. Specialist paramedics have higher skills that include endotracheal tube (ETT) placement and administration of anti-arrhythmic medications.

In rural and remote NSW, the initial emergency response may be by volunteers - CFRs or VAOs. The former are usually members of another agency, such as, the State Emergency Service (SES) or Rural Fire Service (RFS) who have NSW Ambulance training,

and the latter are accredited, trained and administered under the direct jurisdiction of NSW Ambulance. Volunteers can defibrillate and insert basic (nasopharyngeal and oropharyngeal) airways.

Paramedics and volunteers are governed by NSW Ambulance protocols, which are consistent with the advice of the Australian Resuscitation Council (ARC). Once on scene, paramedics may decide not to continue, or commence, resuscitation if the patient is clearly deceased or has injuries incompatible with life as no CPR was performed for at least 20 minutes prior to paramedic arrival, or there is a treatment directive in place. If resuscitation is commenced and the patient remains in asystole or pulseless electrical activity (PEA) for over 20 minutes without ROSC, paramedics may discontinue resuscitation.

# Reporting **APPROACH**

This report covers all OHCA attended by NSW Ambulance in 2017. The analysis provides indicative descriptive statistics that form a baseline for reporting OHCA trends in future. Analyses in this report relate to different populations according to the statistics being presented. The most commonly used populations are:

- All OHCA attended by NSW Ambulance (n = 8,222)
- All adult OHCA (n = 8,102)
- All paediatric OHCA (n = 120)
- All EMS-attempted resuscitations (n = 3,183)
- EMS-attempted resuscitations excluding paramedic witnessed OHCA (n = 2,712)
- Patients with ROSC prior to NSW Ambulance arrival (n=42)

Of the 8,222 OHCA records for 2017, the proportion of fields with missing data and how these were treated are shown in Table 2.

Descriptive statistics are presented as frequencies and proportions for categorical data.

Rates are reported for NSW overall.

In OHCA reported as 'CPR continuing during transport,' the patient outcome (death or survival) is either unknown to paramedics or has not been recorded in the case sheet. We have taken a conservative approach in reporting survival rates by assuming that none of the 'CPR continuing during transport' patients survived to ED.

The presumed cause of each cardiac arrest in the OHCA is based on information in the paramedic case sheet. Where the paramedic has not documented the cause directly, the coder may use other information in the case sheet to infer the cause of the arrest. In the absence of information to attribute the arrest to a particular cause (such as trauma, drowning, overdose, hanging, respiratory, terminal illness) the aetiology is assumed to be cardiac. This is consistent with the Utstein guidelines.<sup>3</sup>

For the purposes of determining defibrillator use in public, 'public locations' are taken to be all locations excluding private residences, medical facilities and nursing homes.

The Centre for Health Record Linkage (CHeReL) carried out linkage of the OHCA to the NSW Health Emergency Department Data Collection

**TABLE 2: Treatment of missing data, NSW OHCA 2017**

Field	Treatment of data	Number	Proportion
Patient sex missing	Treated as unknown sex, included in outcome measures	169	2.1%
Patient age not estimated/ DOB missing	Treat as adult, excluded from age group reporting	481	5.9%
Case classification = 'Insufficient information'	Included in age/ sex counts, excluded otherwise	20	0.2%
Resuscitation attempt, unknown outcome	Treated as not survived	16	0.2%
Witnessed status unknown	Treated as unwitnessed	731	8.9%
Bystander CPR unknown	Treated as no bystander CPR	198	2.4%
Aetiology unknown	Treated as 'Presumed cardiac'	62	0.8%
Response time missing	Not included in response time calculations	16	0.2%
Initial rhythm not documented (% resuscitations)	Initial rhythm 'Not documented' for purposes of calculating survival rates by rhythm	80	2.5% of resuscitations
"Non-shockable" initial rhythm, no further information (% resuscitations)	Initial rhythm 'Not documented' for purposes of calculating survival rates by rhythm	200	6.3% of resuscitations

*We have taken a conservative approach in reporting survival rates by assuming that none of the ‘CPR continuing during transport’ patients survived to ED.*

(EDDC), Admitted Patient Data Collection (APDC) and NSW Registry of Births, Deaths and Marriages death registrations to determine survival to hospital discharge. The linked data is stored in a secure analytics platform (SAPHaRI) in de-identified form. This de-identified linked dataset was created under the *Public Health and Disease Registers* provisions of the *NSW Public Health Act 2010*.

Not all patient records could be linked by CHeReL. This means the denominator used to calculate survival rates to ED admission differs from the denominator used in survival rates to hospital discharge. The denominator used in the calculation of survival to hospital discharge excludes OHCA where NSW Ambulance records indicated the patient was transported but no corresponding linked Emergency Department or Admitted Patient Record could be found (n=131 patients). In other words:

- Survival to ED admission is based on the NSW Ambulance patient dataset (n=3,183 resuscitations)
- Survival to hospital discharge is based on the NSW Ambulance patient dataset excluding the patients that could not be linked to the EDDC or APDC (n=3,052 records)
- Of the patients in the NSW Ambulance dataset that achieved ROSC prior to NSW Ambulance arrival (n=42), 37 had a corresponding EDDC or APDC record.





# Profile of OHCA ACROSS NSW

## Incidence of OHCA

In 2017, NSW Ambulance attended 8,222 OHCA including patients where no resuscitation attempt was made. Of these, 8,102 cases (98.5 per cent) were adults (patients aged 16 and over, or age unknown) and 120 cases (1.5 per cent) were children. The incidence of OHCA per 100,000 population is shown in Table 3.

## Resuscitation attempts

Of the 8,222 OHCA attended, 4,739 (58 per cent) were determined by paramedics to be deceased on examination. Resuscitation was withheld in a further 258 cases (1 per cent), primarily because of DNR orders or family instructions (Figure 2).

Of the 3,225 resuscitation attempts made by bystanders or NSW Ambulance, 42 (1 per cent) involved bystander resuscitation that achieved ROSC prior to NSW Ambulance arrival. All of these patients survived to ED admission. NSW Ambulance made 3,183 resuscitation attempts. This represents 39 per cent of all cases in the OHCAR for 2017.

## Cardiac arrests by age and gender

Although total deaths in NSW in 2017 were distributed 51 per cent male: 49 per cent female,<sup>5</sup> OHCA are more likely in males; cases in the registry are distributed 65 per cent male: 35 per cent female. Unsurprisingly, older people are more likely to have a cardiac arrest, reflecting increasing mortality rates by age (Figure 3). Beyond age 90, the proportion of OHCA in the OHCAR falls, reflecting lower absolute numbers of OHCA at very old age groups, and the lower likelihood of an ambulance being called for these cardiac arrests. The median attained age of adult arrests was 70. For paediatric arrests, the median age was two years old.

Age	Incidence per 100,000 population		
	Male	Female	Persons
Children (aged under 16)	9	6	8
Adults (aged 16 and over, or age unknown)	171	87	129
All ages	138	72	105

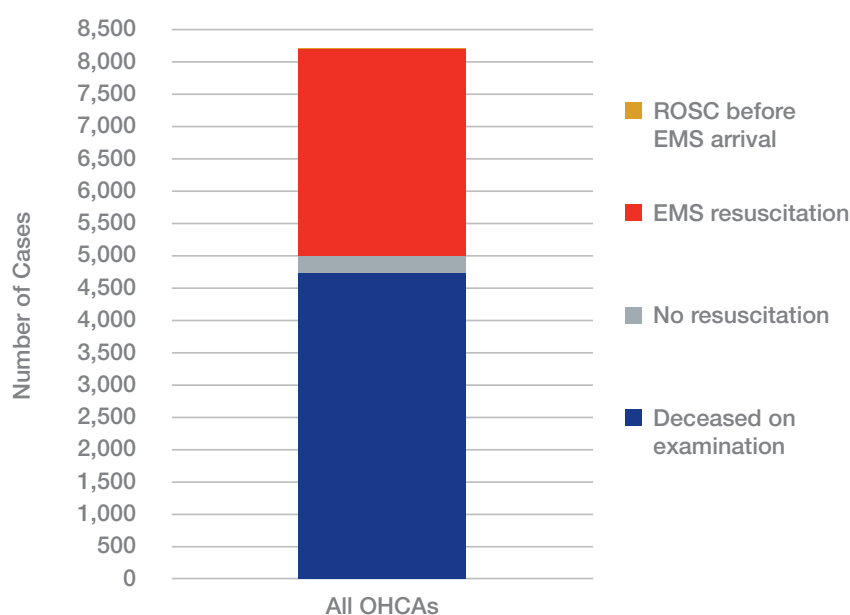
## Resuscitations by age and gender

Resuscitation was slightly more likely to be attempted on males than females when NSW Ambulance resources arrived. A resuscitation attempt was made in 41 per cent of male OHCA and 37 per cent of female OHCA.

By age, resuscitation was most likely to be attempted on paediatric patients, with the proportion of patients resuscitated generally falling as age increases. Figure 4 illustrates the likelihood of resuscitation being attempted, by age group and gender.

**TABLE 3: Crude incidence of EMS-attended OHCA by age and gender, NSW 2017**

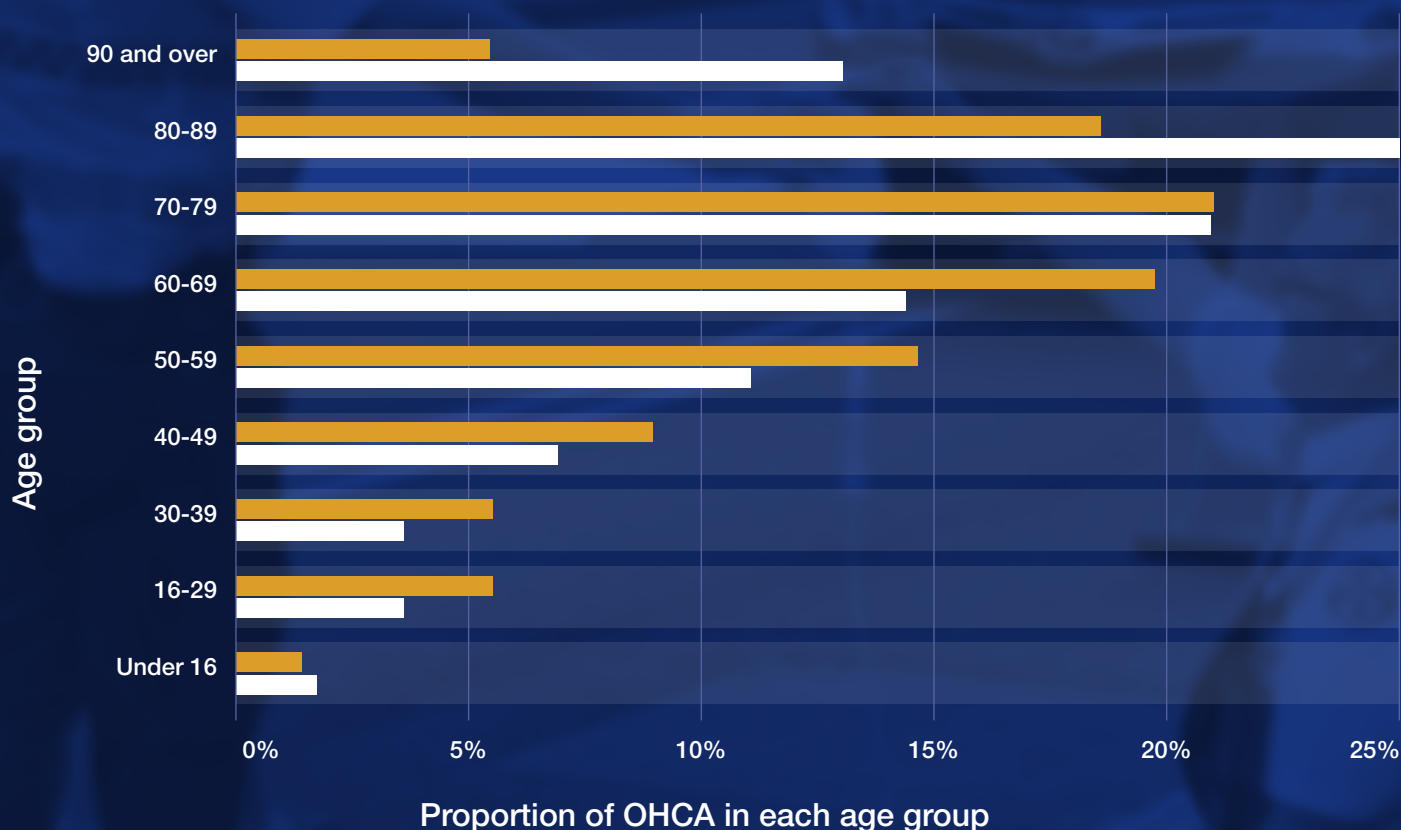
**FIGURE 2: Resuscitation attempts, NSW 2017**



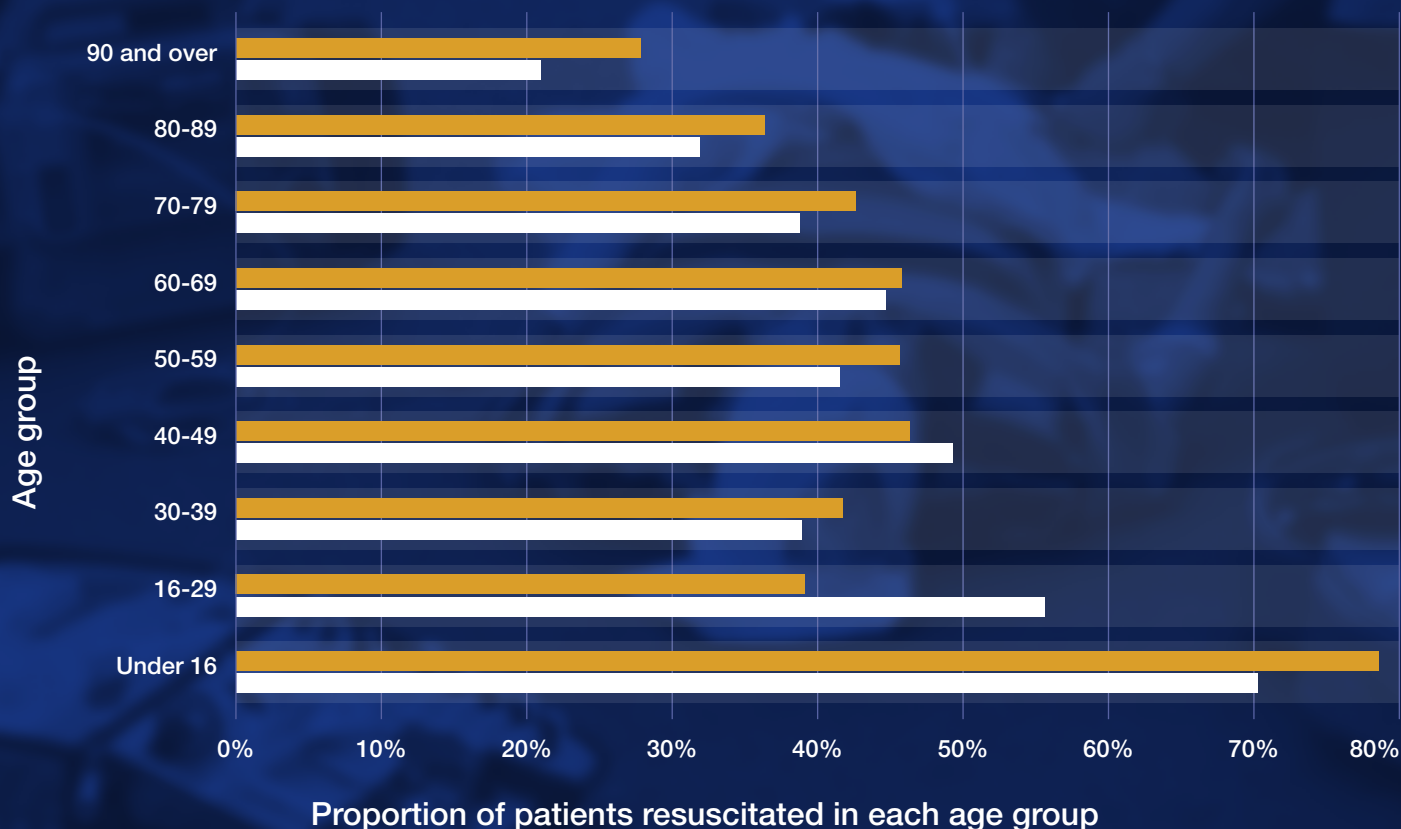




**FIGURE 3: EMS-attended OHCA's**  
by age and gender, NSW 2017



**Figure 4: EMS resuscitation attempts**  
by age group and gender, NSW 2017



### Cause of cardiac arrest in adults

The presumed cause of arrest is based on information in the paramedic case sheet, either indicated directly by paramedics or interpreted by coders. Unless there is a clear cause (including trauma, drowning, overdose, hanging, respiratory, terminal illness) the cause is assumed to be cardiac. 5,485 (68 per cent) of adult arrests attended by EMS were presumed to be of cardiac cause. Other common causes were terminal illness 761 cases, (9 per cent), trauma 551 cases, (7 per cent) and respiratory 430 cases, (5 per cent). Resuscitation was more likely to be attempted for cases of presumed cardiac aetiology arrests or overdose (41-42 per cent likelihood of resuscitation) than trauma (30 per cent likelihood).

By age group, traumatic deaths, overdoses and hangings were more likely to occur at younger ages (Figure 6).

### Cause of cardiac arrest in children

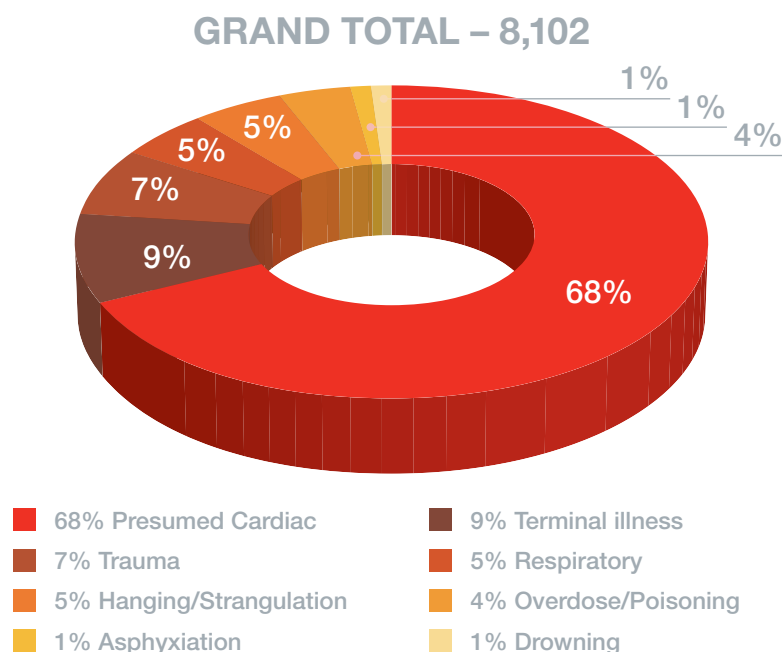
In paediatric arrests, cardiac is the most common presumed cause (31 per cent), 26 per cent of deaths were attributed to Sudden Unexpected Death in Infancy (SUDI) of which Sudden Infant Death Syndrome (SIDS) is the unexplained subset. Trauma (blunt, penetrating and burns) was another common cause of 18 per cent of arrests.

The number of paediatric arrests is very small; 120 in total (1.5 per cent) of all cases in the OHCAR. So small changes in cause from

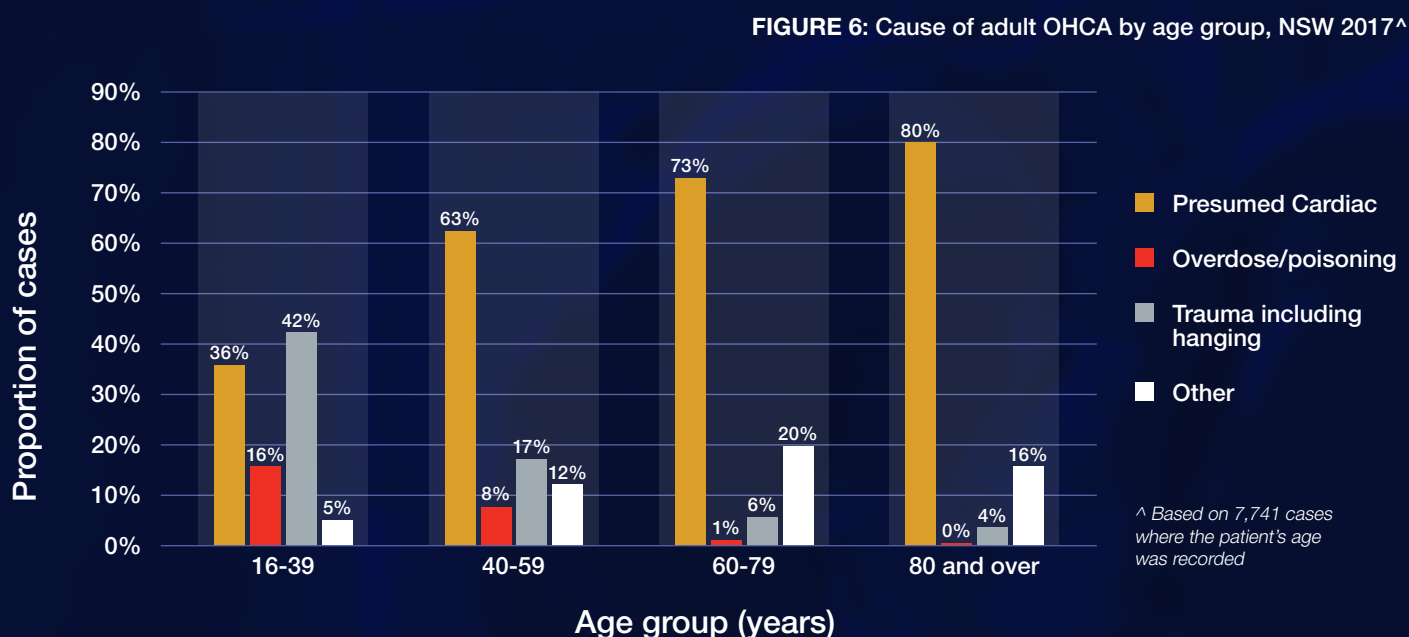
year to year can easily affect the proportions attributed to each cause.

### Location of arrest

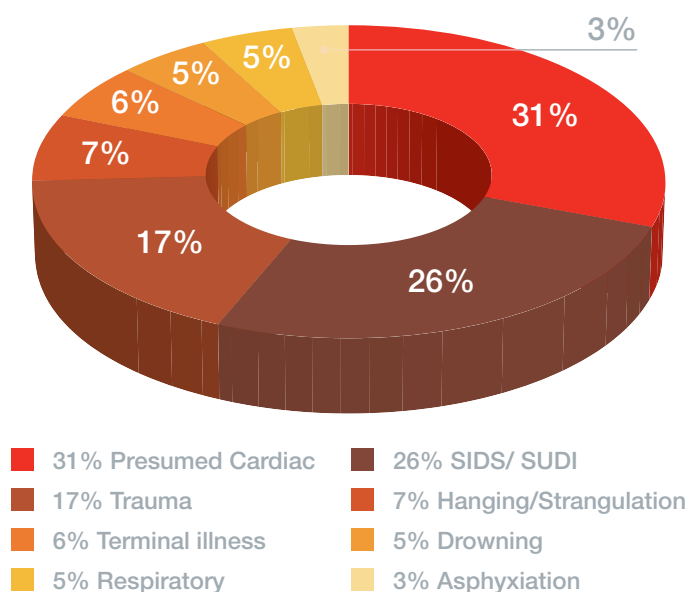
Where an arrest happened is an important factor in whether it is likely to be witnessed and whether CPR and defibrillation are likely to be performed prior to EMS arrival. Most arrests 6,377 cases, (77 per cent) occurred in a private residence, with the vast majority of these (91 per cent of private residence arrests or 70



**FIGURE 5: Cause of adult OHCA, NSW 2017**



## GRAND TOTAL – 120



**FIGURE 7: Cause of paediatric OHCA, NSW 2017**

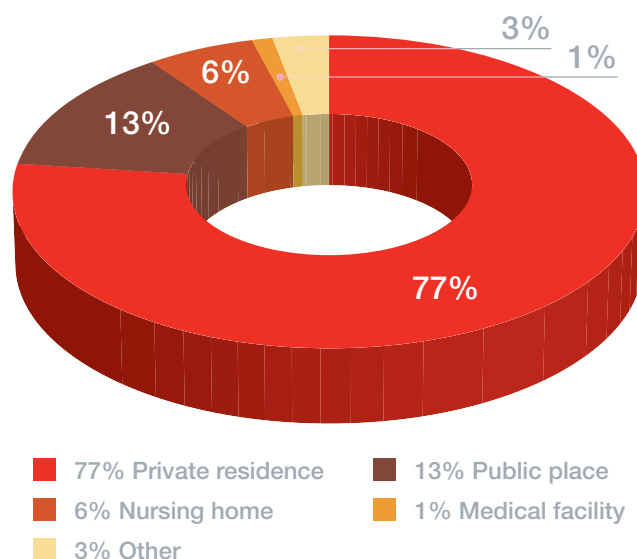
per cent of all arrests) occurring in the patient's own residence. These are taken to be cases where home address is the same as the scene address in the eMR or PHCR and the location is recorded as a Private Residence. Only 13 per cent of OHCA occurred in a public location.

### Witnessed arrests

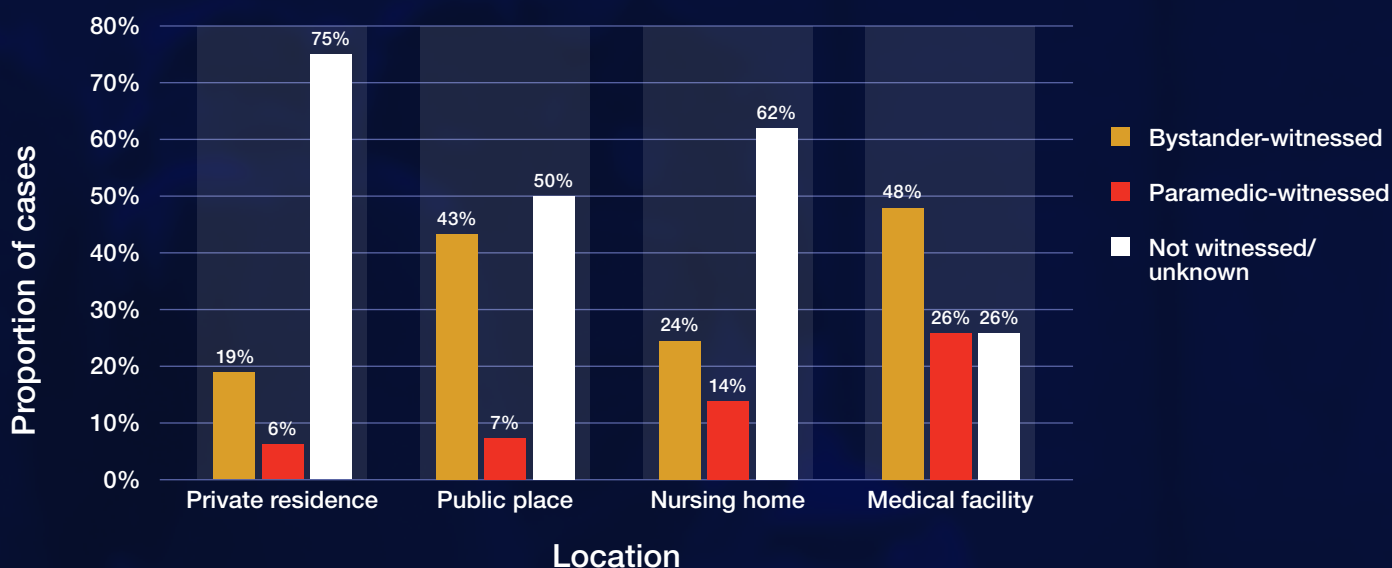
Overall, 23 per cent of arrests in the OHCA were witnessed by a bystander and 7 per cent by a paramedic. Arrests in a public

place or medical facility were more likely to be witnessed than those that occurred in a nursing home or private residence. Men were more likely than women to arrest in a public location (7 per cent of female OHCA and 15 per cent of male OHCA), and women were more likely to arrest in a private residence (82 per cent of female OHCA, 76 per cent of male OHCA in a private residence with 9 per cent of female OHCA, 5 per cent of male OHCA in a nursing home).

**FIGURE 8: Location of OHCA, NSW 2017**



**FIGURE 9: Witnessed status of OHCA by location, NSW 2017**



# Chain of SURVIVAL

**THE** links in the chain of survival are:

- Identification of cardiac arrest and activation of EMS
- Immediate high-quality CPR
- Rapid defibrillation
- EMS treatment
- Advanced life support
- Post-arrest care

This sequence aims to increase the chances of survival following cardiac arrest.<sup>6</sup>

## Identification of cardiac arrest

There is no data on how quickly callers identified arrests and called Triple Zero (000), or whether they called ambulance first as opposed to another emergency service. The assessment of whether the call-taker identified cardiac arrest during the call was based on comments in VisiNET or on the patient case sheet however, the accuracy of this approach as a method of capturing this measure is unclear. Of the EMS-attended arrests (excluding paramedic-witnessed arrests) the call-taker identified that the case was a cardiac arrest 87 per cent of the

time. In paramedic-witnessed arrests (occurring after EMS arrival at scene), call-takers would not be expected to recognise an arrest at the time of the call.

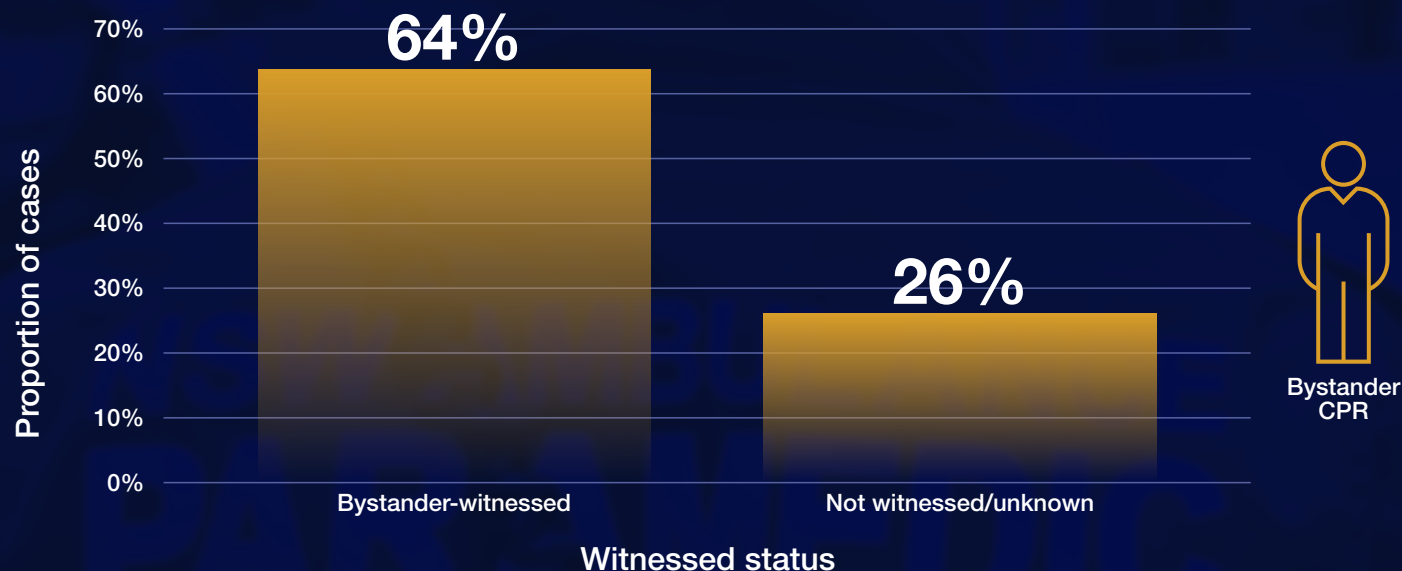
## Bystander CPR and defibrillator use prior to NSW Ambulance arrival

Overall, in EMS-attended OHCAs (excluding those that were paramedic-witnessed), bystanders performed CPR 35 per cent of the time. Figure 10 shows that bystanders were more likely to perform CPR when they witnessed an arrest. Bystanders performed CPR 64 per cent of the time in bystander-witnessed arrests and 26 per cent of the time in unwitnessed/unknown arrests.

In bystander-witnessed events, bystanders were more likely to perform CPR on patients, more likely to use an AED, and the patient was more likely to be in a shockable rhythm on EMS-arrival (Table 4). This is because either NSW Ambulance arrived sooner after the arrest occurred due to it being witnessed, or bystander CPR made a positive difference to the rhythm, or both.

In Table 4 bystanders used AEDs for 192 cardiac arrest events. This represents 2.5

**FIGURE 10: Proportion of cases with Bystander CPR, by witnessed status, NSW 2017**





	Bystander witnessed		Not witnessed/ unknown		Total (excl paramedic-witnessed events)	
	Number	%	Number	%	Number	%
Total (Column denominator)	1,896		5,766		7,662	
Bystander CPR	1,212	63.9	1,493	25.9	2,705	35.3
Bystander AED	126	6.6	66	1.1	192	2.5
Shockable rhythm on EMS arrival	526	27.7	216	3.7	742	9.7

^ Excludes paramedic-witnessed events

**TABLE 4: Bystander involvement in CPR or defibrillation for OHCA, NSW 2017^**

per cent of all OHCA in the registry for 2017. However, the vast majority of OHCA occurred in private residences, where an AED was unlikely to be accessible. When limited to cardiac arrests occurring in public locations (taken to be all locations except private residences, nursing homes or medical facilities), AEDs were used by bystanders on 134 patients out of 1,171 (11 per cent) of public-location OHCA.

#### Emergency response

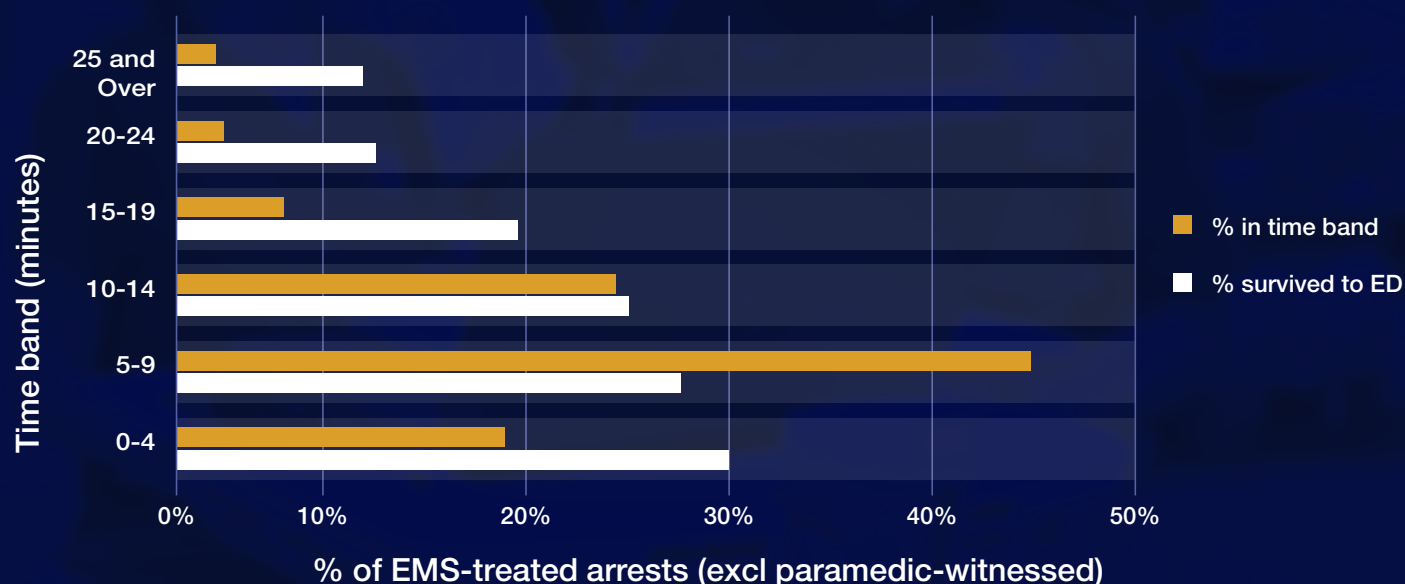
Priority 1A is the highest priority a call can be given. Of the 2,712 arrests (excluding paramedic-witnessed arrests) in which EMS-resuscitation was attempted, 2,271 (84 per cent) had a 1A response priority meriting lights

and sirens, intensive care paramedics and supervisor tasking. A further 396 (15 per cent) were 1B or 1C responses (lights and sirens) where the case was not initially flagged as a cardiac arrest.

In cases where the caller stated that the patient was already deceased, and where NSW Ambulance attended but no resuscitation attempt was made, a lower priority (2 Immediate, no lights or sirens) was assigned to the call.

For the 2,712 non-paramedic witnessed, EMS-treated arrests, faster response times were associated with higher survival rates to ED admission (Figure 11).

**FIGURE 11: Proportion of EMS-treated, non-paramedic witnessed OHCA and survival to ED by ambulance response time, NSW 2017**



# Arrest OUTCOMES

## NSW Ambulance resuscitation outcomes

Outcomes are recorded as:

- Deceased on examination
- Died at scene
- Died en route
- CPR continuing during transport
- Survived to ED admission

In the 'CPR continuing...' group, the case sheet described CPR en route but did not indicate whether the patient had ROSC on arrival at hospital.

Figure 12 relates to the 3,183 EMS-attempted resuscitation patients, excluding patients with ROSC who were successfully resuscitated by bystanders prior to EMS arrival. As expected, it shows that patients who have a paramedic-witnessed arrest are most likely to survive to ED admission compared with bystander-witnessed or not witnessed/unknown arrests.

In Table 5, the overall survival rate to ED across all patients was 28 per cent or 895 of 3,183 EMS-attempted resuscitations. Across all initial rhythms, the survival rate to ED was highest for paramedic-witnessed arrests at 41 per cent or 192 out of 471 patients), followed by bystander-witnessed arrests 33 per cent, 457 of 1,377 patients and then unwitnessed arrests 18 per cent, 246 of 1,335 patients.

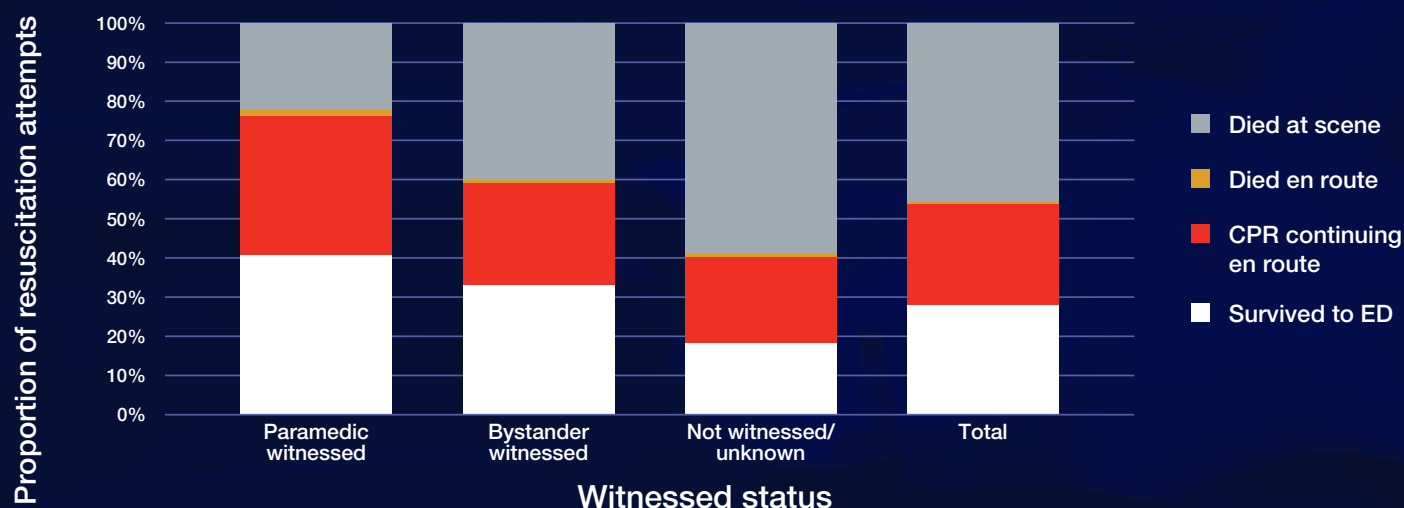
The overall survival rate to hospital discharge across all patients was 12 per cent (378 of 3,052 EMS-attempted resuscitations). Across all initial rhythms, the survival rate to hospital discharge was highest for paramedic-witnessed arrests at 28 per cent (123 of 445 patients), followed by bystander-witnessed arrests 14 per cent (189 of 1,318 patients) then unwitnessed arrests 5 per cent, (66 of 1,289 patients).

## All ages survival rates by initial rhythm

Physiologically, survival from cardiac arrest is more likely if the patient is in a shockable rhythm. Of the 3,183 patients on which an EMS resuscitation attempt was undertaken, 859 (27 per cent) initially presented in a shockable rhythm, 489 (15 per cent) were in PEA and 1,542 (48 per cent) were in asystole. For the remaining 280 (9 per cent), the initial rhythm was not documented (including unspecified 'non-shockable' rhythms).

Following resuscitation, 415 patients with a recorded initial shockable rhythm survived to ED admission (48 per cent of the 859 patients for which the first documented rhythm after cardiac arrest was shockable) compared with 28 per cent of patients in PEA and 14 per cent of patients in asystole (Figure 13 and Table 6). Survival to hospital discharge for patients with an initial shockable rhythm after cardiac arrest was 32 per cent compared with 5 per cent of patients in PEA and 3 per cent of patients in asystole (Figure 13 and Table 6).

**FIGURE 12: Ambulance outcome of EMS-resuscitated events, by witnessed status, NSW 2017**



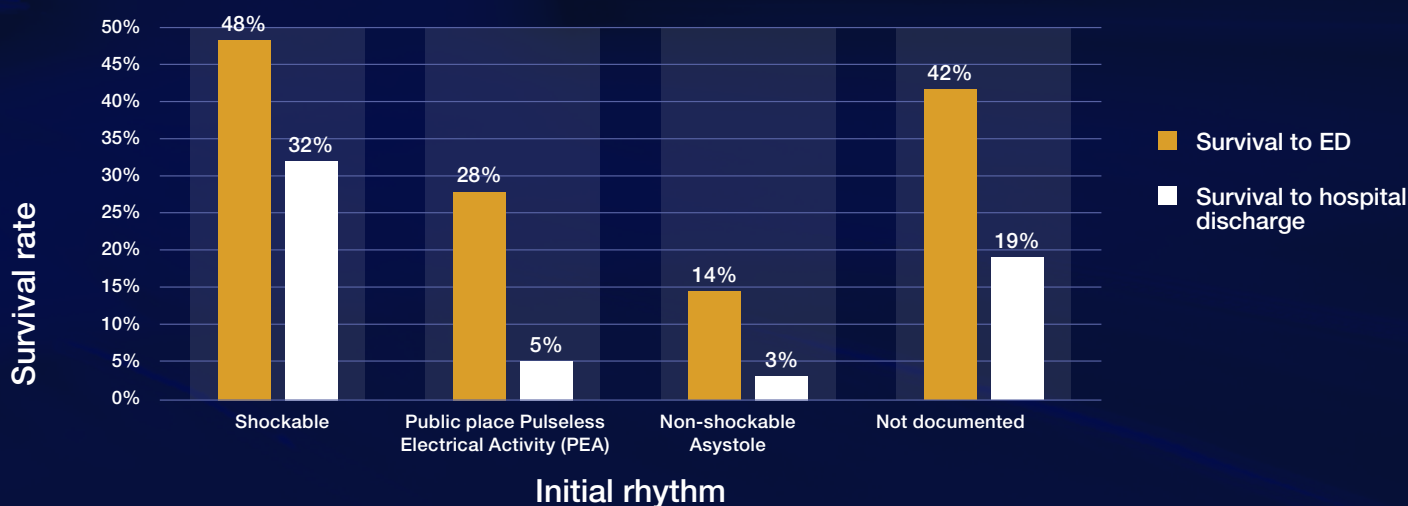
**TABLE 5: Survival by witnessed status, EMS-treated OHCA, NSW 2017<sup>^</sup>**

Indicator	Witnessed Status	Number	Denominator	%
Survived to ED	Bystander-witnessed	457	1,377	33.2
	Paramedic-witnessed	192	471	40.8
	Not witnessed/Unknown	246	1,335	18.4
	Total - all witnessed statuses	895	3,183	28.1
Survived to hospital discharge <sup>^</sup>	Bystander-witnessed	189	1,318	14.3
	Paramedic-witnessed	123	445	27.6
	Not witnessed/Unknown	66	1,289	5.1
	Total - all witnessed statuses	378	3,052	12.4

**TABLE 6: Survival outcomes by initial rhythm, EMS-treated OHCA, NSW 2017<sup>^</sup>**

Indicator	Initial rhythm	Number	Denominator	%
Survived to ED	Shockable rhythm	415	859	48.3
	Pulseless Electrical Activity (PEA)	136	489	27.8
	Asystole	222	1,542	14.4
	Not documented	122	293	41.6
	Total - all rhythms	895	3,183	28.1
Survived to hospital discharge <sup>^</sup>	Shockable rhythm	262	817	32.1
	Pulseless Electrical Activity	21	460	4.6
	Asystole	43	1,494	2.9
	Not documented	52	281	18.5
	Total - all rhythms	378	3,052	12.4

<sup>^</sup>Excludes OHCA where ambulance records indicated the patient was transported with no corresponding linked Emergency Department or Admitted Patient Record

**FIGURE 13: Survival by initial rhythm (all ages), EMS-treated OHCA, NSW 2017**


## Survival by age group and initial rhythm

Adults made up 98.5 per cent of the EMS-attended OHCA (8,102 out of 8,222) and 97 per cent of the EMS resuscitation attempts (3,095 out of 3,183). Adults are more likely to present in a shockable rhythm than children (28 per cent of adults vs 7 per cent of children) and this is a factor in the higher all-rhythm adult OHCA survival rates compared with paediatric arrests. Survival to ED was 28 per cent of adults compared with 20 per cent of children. Survival to hospital discharge was 12 per cent of adults and 9 per cent of children (Table 7).



**TABLE 7: Survival outcomes by age group and initial rhythm, EMS-treated OHCA, NSW 2017<sup>^</sup>**

Indicator	Age	Initial rhythm	Number	Denominator	%
Survived to ED	Child	Shockable	4	6	66.7
		Not shockable/ not documented	14	82	17.1
		Total - all rhythms	18	88	20.5
	Adult	Shockable	411	853	48.2
		Not shockable/ not documented	466	2,242	20.8
		Total - all rhythms	877	3,095	28.3
	All Ages	Shockable	415	859	48.3
		Not shockable/ not documented	480	2,324	20.7
		Total - all rhythms	895	3,183	28.1
Survived to Discharge <sup>^</sup>	Child	Shockable	3	6	50.0
		Not shockable/ not documented	4	72	5.6
		Total - all rhythms	7	78	9.0
	Adult	Shockable	259	811	31.9
		Not shockable/ not documented	112	2,163	5.2
		Total - all rhythms	371	2,974	12.5
	All Ages	Shockable	262	817	32.1
		Not shockable/ not documented	116	2,235	5.2
		Total - all rhythms	378	3,052	12.4

<sup>^</sup>Excludes OHCA where ambulance records indicated the patient was transported with no corresponding linked Emergency Department or Admitted Patient Record



## Adult survival by initial rhythm and witnessed status

Witnessed status and initial rhythm, survival rates to ED and hospital discharge for the 3,095 adult EMS-resuscitated patients are shown in Table 8.

**TABLE 8: Survival by witnessed status and initial rhythm, adult EMS-treated OHCA, NSW 2017<sup>^</sup>**



Indicator	Witnessed status	Initial rhythm	Number	Denominator	%
Survived to ED	Bystander witnessed	Shockable	238	497	47.9
		Not shockable/ not documented	210	853	24.6
		Total - all rhythms	448	1,350	33.2
	Paramedic witnessed	Shockable	105	145	72.4
		Not shockable/ not documented	84	322	26.1
		Total - all rhythms	189	467	40.5
	Not witnessed / unknown	Shockable	68	211	32.2
		Not shockable/ not documented	172	1,067	16.1
		Total - all rhythms	240	1,278	18.8
	All witnessed statuses	Shockable	411	853	48.2
		Not shockable/ not documented	466	2,242	20.8
		Total - all rhythms	877	3,095	28.3
Survived to hospital discharge <sup>^</sup>	Bystander witnessed	Shockable	140	468	29.9
		Not shockable/ not documented	45	825	5.5
		Total - all rhythms	185	1,293	14.3
	Paramedic witnessed	Shockable	86	140	61.4
		Not shockable/ not documented	36	302	11.9
		Total - all rhythms	122	442	27.6
	Not witnessed / unknown	Shockable	33	203	16.3
		Not shockable/ not documented	64	1,239	5.2
		Total - all rhythms	97	1,442	6.7
	All witnessed statuses	Shockable	259	811	31.9
		Not shockable/ not documented	145	2,366	6.1
		Total - all rhythms	404	3,177	12.7

<sup>^</sup>Excludes OHCA where ambulance records indicated the patient was transported with no corresponding linked Emergency Department or Admitted Patient Record

## Survival rates by cause

Cardiac arrests of medical and non-medical cause had similar survival rates to ED: 28 per cent of all-ages medical OHCA survived (766 patients out of 2,698 resuscitations) compared with 27 per cent of non-medical OHCA (129 out of 485 resuscitations) while survival to hospital discharge was slightly higher for medical OHCA at 13 per cent compared with 10 per cent of non-medical OHCA (Table 9).

Resuscitation was more likely to be commenced in the case of a medical OHCA: 40 per cent of medical OHCA (2,698 resuscitations out of 6,756 OHCA) compared with 33 per cent of non-medical cases (485 resuscitations out of 1,466 OHCA).

## Survival rate by bystander CPR

In assessing the impact of bystander CPR, we have included patients ROSC prior to EMS arrival. In bystander-witnessed, EMS-treated OHCA or cases with ROSC prior to EMS arrival, bystander

CPR was associated with a higher crude survival rate to ED admission (36 per cent with bystander CPR versus 31 per cent without bystander CPR) and hospital discharge (19 per cent with bystander CPR vs 9 per cent without). See Table 10.

Cardiac arrests that were not witnessed by a bystander or a paramedic had 19 per cent chance of survival to ED admission and 5 per cent chance of survival to hospital discharge regardless of whether CPR was attempted by bystanders (Table 10). Compared with Table 5, Table 10 includes the 42 patients that achieved ROSC prior to NSW Ambulance arrival (37 linked) and excludes the 471 paramedic-witnessed arrests (445 linked).

The fact of the cardiac arrest being witnessed and providing the opportunity to activate EMS more promptly compared with unwitnessed arrests was an important factor in whether patients survived to ED and hospital discharge. This analysis underlines the time-critical nature of cardiac arrest and the importance of early bystander CPR.



**TABLE 9: Survival outcomes by aetiology, EMS-treated OHCA, NSW 2017**

Aetiology	Indicator	Number	Denominator	%
Survived to ED	Medical ^^	766	2,698	28.4
	Non-medical	129	485	26.6
	<b>Total - all causes</b>	<b>895</b>	<b>3,183</b>	<b>28.1</b>
Survived to hospital discharge^	Medical ^^	335	2,601	12.9
	Non-medical	43	451	9.5
	<b>Total - All Causes</b>	<b>378</b>	<b>3,052</b>	<b>12.4</b>

^Excludes OHCA where ambulance records indicated the patient was transported with no corresponding linked Emergency Department or Admitted Patient Record

^^ Includes missing aetiology

**TABLE 10: Survival outcomes by witnessed status (excl paramedic witnessed) and bystander CPR, EMS-treated or ROSC prior to EMS arrival OHCA, NSW 2017 ^**

Indicator	Witnessed status	Bystander CPR	Number	Denominator	%
Survived to ED	Bystander-witnessed	No/unknown	104	338	30.8
		Yes	390	1,076	36.2
		<b>Total - All CPR</b>	<b>494</b>	<b>1,414</b>	<b>34.9</b>
	Not witnessed	No/unknown	85	452	18.8
		Yes	166	888	18.7
		<b>Total - All CPR</b>	<b>251</b>	<b>1,340</b>	<b>18.7</b>
	All witnessed statuses (excl paramedic witnessed)	No	189	790	23.9
		Yes	556	1,964	28.3
		<b>Total - All CPR</b>	<b>745</b>	<b>2,754</b>	<b>27.1</b>
Survived to Hospital Discharge	Bystander-witnessed	No/unknown	30	327	9.2
		Yes	190	1,023	18.6
		<b>Total - All CPR</b>	<b>220</b>	<b>1,350</b>	<b>16.3</b>
	Not witnessed	No/unknown	23	441	5.2
		Yes	46	853	5.4
		<b>Total - All CPR</b>	<b>69</b>	<b>1,294</b>	<b>5.3</b>
	All witnessed statuses (excl paramedic witnessed)	No/unknown	53	768	6.9
		Yes	236	1,876	12.6
		<b>Total - All CPR</b>	<b>289</b>	<b>2,644</b>	<b>10.9</b>

^Excludes OHCA where ambulance records indicated the patient was transported but no corresponding linked Emergency Department or Admitted Patient Record





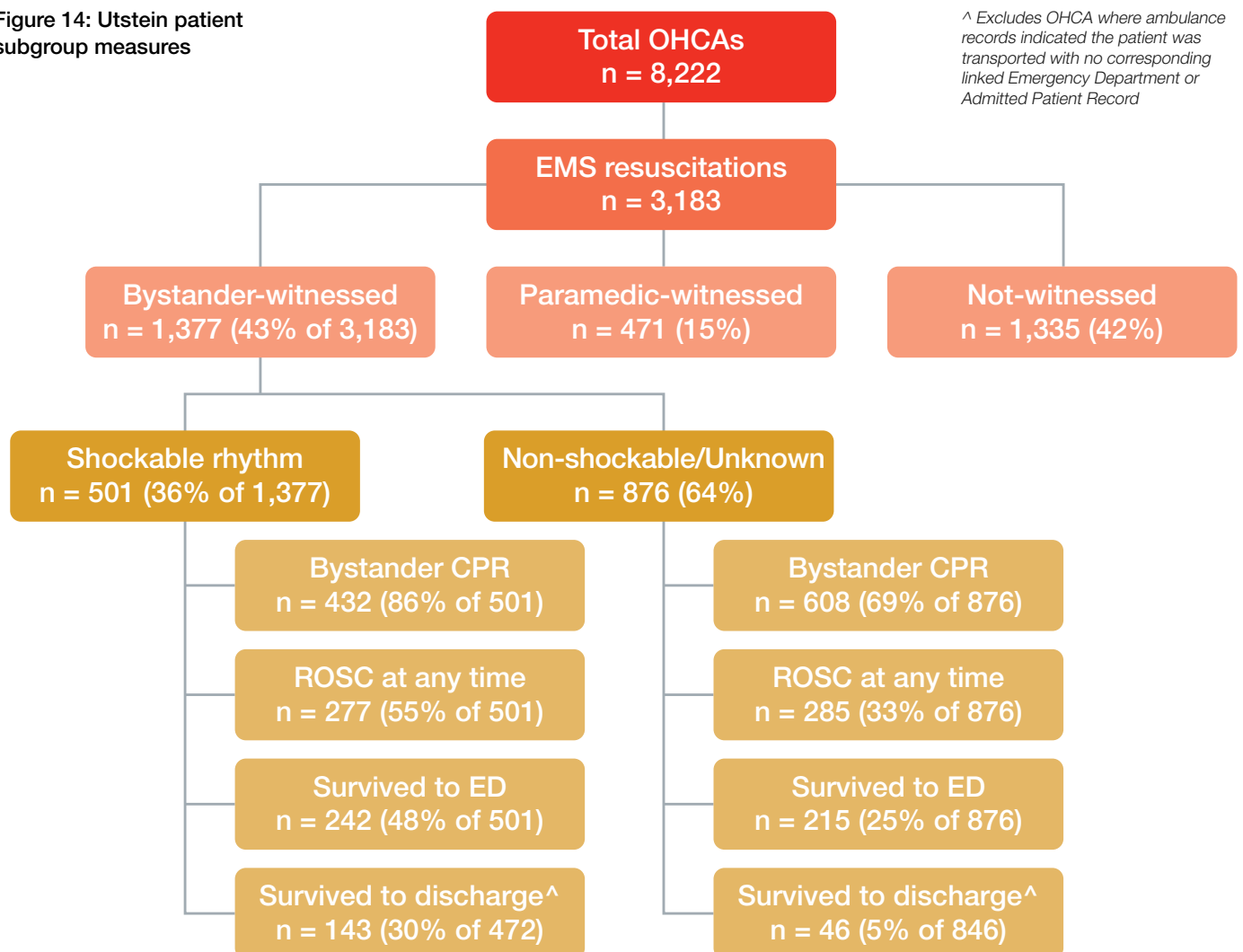
## Utstein patient group survival

The Utstein guidelines include selection criteria for cardiac arrests to allow consistent comparison of key measures between ambulance services. The Utstein patient subgroup is:<sup>3</sup>

- Arrest witnessed by a bystander (not paramedic-witnessed)
- EMS-attempted resuscitation
- Initial rhythm shockable

There were 501 (16 per cent) of 3,183 resuscitations attempted that met these criteria. The breakdown in Figure 14 indicates measures for the Utstein patient subgroup.

**Figure 14: Utstein patient subgroup measures**







### Comparison with other jurisdictions

The ability to compare performance across jurisdictions depends on consistency of presentation and definitions. The presentation of results for different patient sub-groups (age group, aetiology, initial rhythm, witnessed status) and differences in definitions (for example, what counts as a resuscitation attempt) hampers easy comparison.

The Utstein measure is intended to allow comparison of survival rates for the same patient subgroup (bystander-witnessed EMS

resuscitations with an initial shockable rhythm) but even with this measure, inconsistent definitions of resuscitation, and variations in jurisdictional population size and density make like-for-like comparisons difficult.

Seattle and King County in the United States leads the field in survival rates, but is a much smaller and denser population than NSW with 2.1 million people over 2,000 square miles compared to 7.9 million people over 309,500 square miles in NSW. Table 11 shows survival rates to ED for a range of groups, depending on the cohort that each ambulance service reports.

**TABLE 11: Benchmark OHCA survival rates across jurisdictions**

Organisation	Time Period	% survival rate to ED by patient group				% survival to discharge
		All resus	All cardiac aetiology	Excl EMS witnessed	Utstein subgroup	Utstein subgroup
NSW Ambulance	2017	28%	28%	26%	48%	30%
Ambulance Victoria <sup>7</sup>	2016/17	-	-	26%	58%	37%
Queensland Ambulance Service <sup>8</sup>	2016	-	34%	-	52%	31%
South Australia Ambulance Service <sup>9</sup>	2016/17	26%	-	-	55%	33%
St John Ambulance WA <sup>10</sup>	2016/17	21%	-	-	43%	35%
St John Ambulance NZ <sup>11</sup>	2016/17	27%	-	-	50%	30%
London Ambulance Service <sup>12</sup>	2016/17	29%	-	-	54%	30%
Seattle & King County EMS <sup>13</sup>	2016	-	-	-	*	56%

\* Not published

# Appendix 1: OHCAR ESTABLISHMENT

## Global Resuscitation Alliance

In 1990, researchers and emergency medical service (EMS) program and medical directors met at Utstein Abbey in Norway to address the issue of the lack of data on cardiac arrest survival. There were few organisations capturing data and no agreement about the variables to be captured. The 1990 meeting resulted in the development of the Utstein template, containing the key variables to be captured in a cardiac arrest registry. This template has been updated over time and remains central to the consistent recording of OHCA.

In 2015, resuscitation leaders meeting again at Utstein Abbey considered the question of how to implement successful cardiac arrest management strategies and disseminate best practice. The Global Resuscitation Alliance was formed and the importance of having a cardiac arrest registry was reiterated by its inclusion in the ten steps to improve OHCA survival rates.<sup>14</sup>

## NSW OHCAR establishment

Following the 2015 Utstein meeting, there was an increase in OHCA-related activity in Australia and New Zealand. In September 2016, NSW Ambulance made the decision to establish the OHCAR. REDCap, a secure web application for building and managing online surveys and databases for research, was selected as the platform. REDCap was developed by Vanderbilt University (Nashville, Tennessee, USA) in 2004 and is currently used by over 3,000 institutions in almost 130 countries,<sup>4</sup> including other areas of NSW Health. The REDCap consortium continues to actively develop and support the software.

The OHCAR includes all cardiac arrest patients attended by NSW Ambulance since 1 January 2017. NSW Ambulance sought advice from other Australian ambulance services (including Victoria and Queensland) to define the initial list of fields. The OHCAR fields include Utstein variables plus additional variables relevant to

NSW Ambulance. The OHCAR is hosted by the NSW Ambulance Research group within Clinical Systems Integration, and managed by the Clinical Quality Registries Coordinator. The OHCAR is managed by Nicole Packham, with support from Rosemary Carney, Sandra Ware, Steven Faddy and Sophie Dyson. A number of paramedics on alternate duties have been involved in coding cases.





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