



NSW Ambulance

NSW Ambulance Cardiac Arrest Registry

2018 REPORT



Health
NSW Ambulance



NSW Ambulance

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This report from the NSW Ambulance Cardiac Arrest Registry is a 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
Adults	Persons aged 16 or over at date of cardiac arrest, or where age is missing or unknown.
Automated External Defibrillator (AED)	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.
CPR ongoing at handover (same as 2017 term 'CPR continuing during transport')	Patients who are administered ongoing CPR during transport and on handover at ED. Final patient outcome may be unknown to paramedics.
Deceased on arrival	Incidents at which paramedics determine the patient to be deceased on arrival and no resuscitation attempt is undertaken.
Do Not Resuscitate (DNR) order	Documentation expressing the patient's wishes not to be resuscitated in the event of a cardiac arrest.
Electronic Medical Record (eMR)	Paramedic clinical record captured electronically using the GETAC rugged notebook computer.
Emergency Medical Services (EMS)	NSW Ambulance paramedics, doctors, Community First Responders (CFRs) or Volunteer Ambulance Officers (VAOs).
EMS response time	Time from call in queue to first vehicle arrived on scene.
EMS-attended	Cardiac arrest events attended by EMS, regardless of whether treatment was provided.
EMS-treated/ EMS-attempted resuscitation	Cases where NSW Ambulance clinicians attempt to revive a patient in cardiac arrest using compressions and/or defibrillation. This excludes cases where compressions were performed only briefly during an information-gathering phase and ceased as a result of information provided, such as a DNR instruction.
Event survival / survival to ED admission	Patients with a return of spontaneous circulation (ROSC) on arrival at the hospital emergency department (ED).
Paediatric	Children aged under 16 at date of cardiac arrest.
Patient Health Care Record (PHCR)	Paramedic clinical record documented on paper (and subsequently entered into the electronic PHCR (ePHCR) database).
Presumed cardiac aetiology	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.
Return of spontaneous circulation (ROSC)	Cases in which the resuscitation attempt results in a return of spontaneous circulation (measured by a detectable pulse) at any time.
Shockable Rhythm	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.
Survival to hospital discharge	Patients who are discharged from hospital alive following cardiac arrest.
Utstein patient group	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



**Adjunct Associate Professor
Dominic Morgan ASM**

Chief Executive, NSW Ambulance

OUT-OF-HOSPITAL Cardiac Arrest (OHCA) remains a public health problem worldwide, with ischaemic heart disease the number one cause of death in Australia over the last 10 years¹. Survival rates from ambulance-attended OHCA are generally low, with reported survival rates to hospital of 28% in Australia and New Zealand in cases where resuscitation was attempted (range 21% - 36%) and survival to hospital discharge or 30 days at 12% (range 9% to 17%)².

Measuring and reporting on OHCA survival rates is one indicator of the quality and effectiveness of ambulance services. Maintaining a cardiac arrest registry is one of the 10 steps to improve OHCA outcomes, with accountability through reporting being another step³. In response to the Global Resuscitation Alliance's call to action³, NSW Ambulance 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 second report from the NSW Ambulance OHCAR. In addition to public reporting, the OHCAR has been used to provide data for a range of internal quality improvement and external research projects.

In August 2019, NSW Ambulance joined with the Aus-ROC consortium, the Australia and New Zealand-wide Epistry for cardiac arrest data and received ethics approval to link the OHCAR to NSW admitted patient and death data. Our participation in Aus-ROC will allow NSW Ambulance to contribute to a wider body of Australasian cardiac arrest research. Linkage to NSW datasets will allow us to follow up cardiac arrest survivors to investigate and report on longer term survival and functional outcomes in future registry publications.



FIGURE 1: Characteristics and outcomes of cardiac arrests, NSW 2018



Resuscitations and outcomes 2018

7,993
Cardiac arrest patients attended



3,121
Resuscitations attempted*



Survived to ED admission

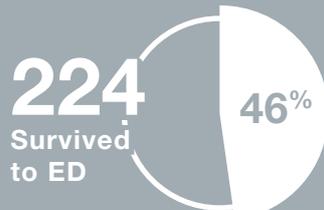


Survived to hospital discharge

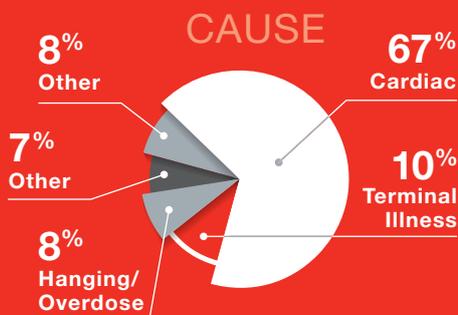
*Excluding resuscitation by bystanders with ROSC prior to NSW Ambulance arrival

UTSTEIN SUBGROUP

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



DEMOGRAPHICS



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.



Executive SUMMARY

- This report presents an analysis of patients of all ages who suffered a documented OHCA in the period 1 January 2018 to 31 December 2018. In this period, NSW Ambulance clinicians attended 7,993 OHCA and made a continued resuscitation attempt in 39% of cases (3,121 EMS-treated events). In a further 33 cases, the patient was revived by bystanders prior to EMS arrival.
- The crude incidence of cardiac arrest in NSW was lower in 2018 than in 2017, associated with a milder influenza season (100 vs 104 OHCA per 100,000 population). The incidence of OHCA was lower in Greater Sydney (84 per 100,000 population) than in the rest of NSW (130 per 100,000 population).
- 98.5% of OHCA involved adults (aged 16 or over). The demographic profile of OHCA in 2018 was similar to 2017. Two-thirds of OHCA patients were male, and the median age of adult cardiac arrests was 70 (males 67 years, females 74 years old).
- Where the cause of arrest is not attributed to a known precipitator, the aetiology is presumed to be cardiac. In 2018, 'cardiac' was the most common OHCA cause in all age groups. Apart from cardiac causes, the precipitating factors varied by age group: in older adults - terminal illness; in younger adults - hanging, overdose and trauma; in children: sudden unexplained death in infancy (SUDI).
- 27% of EMS-treated adults and 2% of children presented in a shockable initial rhythm. The majority of children (74%) initially presented in asystole.
- Overall, 27% of OHCA that received resuscitation by NSW Ambulance (EMS-treated OHCA) survived to the ED and 12% to hospital discharge.
- 79% of patients suffered a cardiac arrest in a private residence, 8% in a nursing home or medical facility and 13% in other locations (public places, schools and workplaces). Patients who arrested in a public place or medical facility were more likely to be witnessed, more likely to receive bystander CPR and more likely to survive (survival to Emergency Department (ED) was 31% in public location OHCA compared with 23% in private residences).
- The median response time for EMS-treated events was 8 minutes in Greater Sydney and 9 minutes in the rest of NSW. Faster response times were associated with higher survival rates.
- 24% of arrests were witnessed by bystanders, and in these arrests, bystanders performed CPR before EMS arrival 64% of the time.
- In the Utstein patient subgroup in 2018, 46% of patients survived to ED and 30% to hospital discharge.

The crude incidence of cardiac arrest in NSW was lower in 2018 than in 2017, associated with a milder influenza season (100 vs 104 OHCA per 100,000 population).

Out-of-hospital cardiac arrest

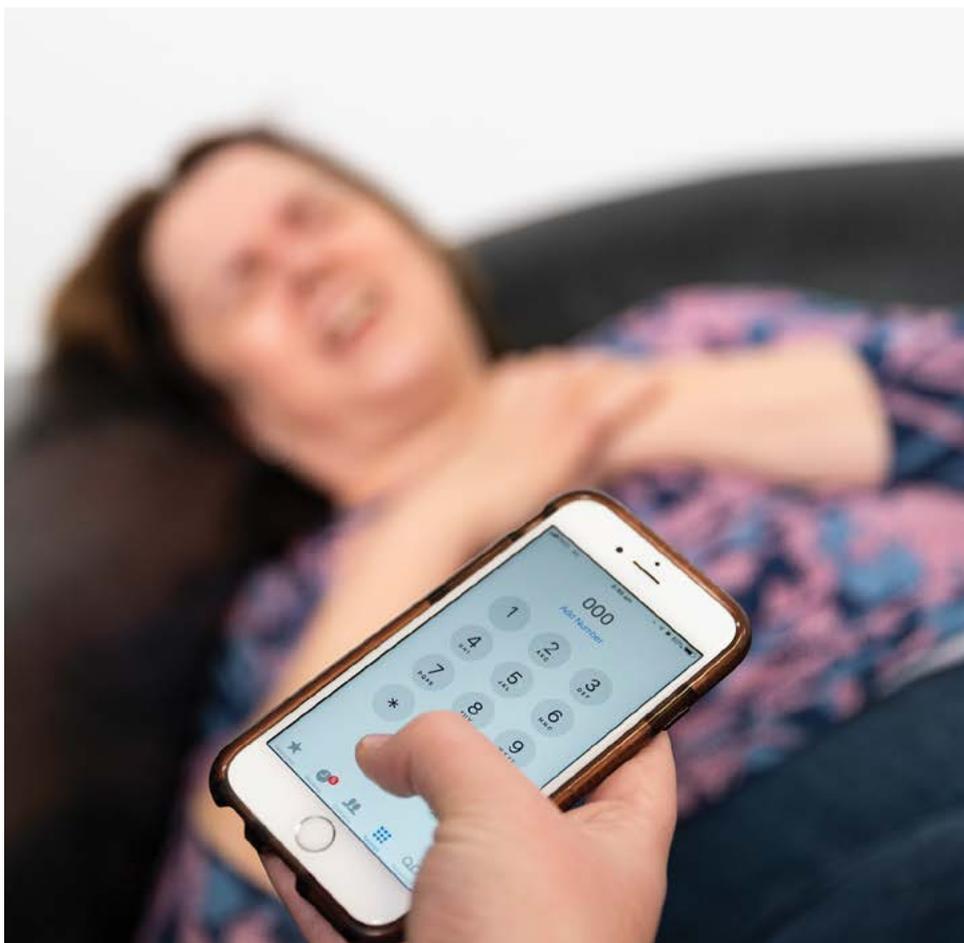
Emergency RESPONSE

NSW is Australia's most populous state, with an estimated population at 30 June 2018 of 8.0 million people, 5.2 million of whom lived in the Greater Sydney area⁴. NSW Ambulance has 236 ambulance response locations across the state, ranging from superstations in metropolitan Sydney to Community First Responder (CFR) and Volunteer Ambulance Officer (VAO) locations in regional and rural NSW plus 8 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 all other states and territories in Australia, apart from ACT. The EMS 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.

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 NSW Ambulance's vocational entry and training route. In cardiac arrest, all qualified 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) with NSW Ambulance training, and the latter are accredited, trained and administered under the direct jurisdiction of NSW Ambulance. Volunteers can defibrillate and insert basic airways (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)⁵. Once on scene, paramedics may decide not to continue or commence resuscitation if the patient is clearly deceased or has injuries incompatible with life, 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 return of spontaneous circulation (ROSC), paramedics may discontinue resuscitation.



NSW Ambulance OHCAR

Out-of-Hospital Cardiac Arrest Registry

The NSW OHCAR includes all OHCA patients who were attended by NSW Ambulance paramedics and doctors, CFRs and VAOs since 1 January 2017. Inclusion and exclusion criteria are detailed in **Table 1**.

The OHCAR was built using REDCap, ⁶ 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 variables relevant to NSW Ambulance. Utstein variables are a set of fields determined using an established consensus process, endorsed by the international resuscitation community, to facilitate consistency and comparability in resuscitation research⁷.

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

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) AND 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.

CANBERRA ★

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

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 to complete additional details of each OHCA, interpreting paramedic clinical records, seeking additional information, cleaning and re-classifying the data where necessary.

The identification of potential cases for inclusion in the OHCAR comes from an electronic sweep of 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 paramedic clinical records transcribed into an electronic database; eMR data comes directly from the electronic paramedic clinical

records entered into the eMR system using laptop computers in each ambulance. Suitable cases are identified by reviewing the contents of a number of fields, as shown in **Table 2**.

Once the initial monthly upload to the OHCAR has occurred, the cases are reviewed to ensure they meet the OHCAR inclusion criteria. For cases deemed to be OHCA, coders complete the OHCAR entry by viewing VisiNET and reading paramedic clinical records 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 service agencies.

TABLE 2: OHCA electronic search criteria

Field	Treatment of data
Paramedic protocols	Search for relevant protocols including: C2 – Cardiac Arrest Resuscitation Decision Algorithm, C3 – Cardiac Arrest, A13 – Verification of Death, T20 – Traumatic Cardiac Arrest, OP4 - Newborn Resuscitation, OP5 – Confirmed Stillbirth, C16 - Return of Spontaneous Circulation, C17 – Torsades de Pointes
Patient management	Search for relevant management fields relating to Defibrillation , CPR, or Resuscitation Ceased
Initial rhythm	Search for Ventricular Fibrillation (Coarse or Fine), Asystole, Pulseless Electrical Activity
Observed outcome	'Dead on Arrival', 'Died at Scene', 'Died en Route', 'ROSC at Hospital', 'Died in ED/ Hospital'
Assessment	'Cardiac Arrest', 'Deceased'
Other fields	'Witnessed Arrest' is not null 'Time 1st shock' is not null 'Total shocks' is not null and is not '0' 'Not transported reason' or 'Not treated reason'= 'Deceased on Examination'



Reporting APPROACH

This report presents statistics on all out-of-hospital cardiac arrests attended by NSW Ambulance between 1 January and 31 December 2018. The analyses in this report relate to different populations, depending on the statistics being presented. The most commonly used populations are:

- All OHCA's attended by NSW Ambulance (n = 7,993)
- All adult OHCA's (n = 7,874)
- All paediatric OHCA's (n = 119)
- All EMS-attempted resuscitations (n = 3,121)
- EMS-attempted resuscitations (excluding paramedic-witnessed OHCA's) (n = 2,641)
- Patients with ROSC prior to NSW Ambulance arrival (n=33)

Of the 7,993 OHCA records for 2018, the proportion of fields with missing data and how these were treated are shown in **Table 3**. With the exception of the recording of witnessed status and bystander CPR, there were fewer missing data fields in 2018 compared with 2017.

Descriptive statistics are presented as frequencies and proportions for categorical data. Unless otherwise stated, all statistical

comparisons are unadjusted (crude) rates.

Rates are reported for NSW overall, unless otherwise specified. Analyses by geographical region are based on Australian Bureau of Statistics (ABS) structures (Statistical Area Level 4 (SA4) and Greater Capital City Statistical Area (GCCSA). The latitude and longitude of the cardiac arrest scene has been used to locate each OHCA within an ABS structure. When reporting on OHCA rates by region, the 10 cases that occurred outside NSW have been excluded. However, these cases were included in all other analyses.

Population data at 30 June by age and by region was sourced from the ABS publications on Australian Demographic Statistics (Cat 3101.0) and Population by Age and Sex for Regions of Australia (Cat 3235.0) ^{4,8}.

In OHCA's reported as 'CPR ongoing on handover', the patient outcome (death or survival) is either unknown to paramedics or has not been recorded in the paramedic clinical record. We have taken a conservative approach in reporting survival rates by assuming that none of the 'CPR ongoing on handover' patients survived to ED.

The presumed cause of each OHCA is based on information in the paramedic clinical record. Where the paramedic has not

TABLE 3: Treatment of missing data, NSW OHCA 2018

Field	Treatment of data	Number	Proportion
Patient sex missing	Treated as unknown sex, included in outcome measures	60	0.8%
Patient age not estimated/DOB missing	Treat as adult, excluded from age group reporting	339	4.2%
Witnessed status unknown	Treated as unwitnessed	849	10.6%
Bystander CPR unknown	Treated as no bystander CPR	319	4.0%
Aetiology unknown	Treated as 'Presumed cardiac'	13	0.2%
Response time missing	Not included in response time calculations	-	-
Initial rhythm not documented (% resuscitations)	Initial rhythm 'Not documented' for purposes of calculating survival rates by rhythm	6	0.2% of resuscitations
"Non-shockable" initial rhythm, no further information (% resuscitations)	Initial rhythm 'Not documented' for purposes of calculating survival rates by rhythm	318	10.2% of resuscitations

documented the cause directly, the coder may use other information in the paramedic clinical record to infer the cause of the OHCA. In the absence of information to attribute the OHCA 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 ⁷.

For the purposes of determining defibrillator use in public locations, '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 OHCAR to the NSW Health Emergency Department Data Collection (EDDC), Admitted Patient Data Collection (APDC) and NSW Registry of Births, Deaths and Marriages (RBDM) 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 the CHeReL. This means the denominator used to calculate survival rates to ED admission differs from that used for survival rates to hospital discharge. The denominator for survival to hospital discharge excludes OHCA where NSW Ambulance records indicated the patient was transported but no corresponding linked EDDC or APDC record could be found (n=148 patients). In other words:

- Survival to ED admission is based on the NSW Ambulance patient dataset (n=3,121 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=2,973 records).





Incidence, demographics, causes and location Of Out-of-Hospital Cardiac Arrest

Overall incidence of out-of-hospital cardiac arrest

In 2018, NSW Ambulance attended 7,993 OHCA (including patients where no resuscitation attempt was made). Of these, 7,874 cases (98.5%) were adults (patients aged 16 and over, or age unknown) and 119 cases (1.5%) were children. The incidence of OHCA per 100,000 population is shown in **Table 4**.

The number of OHCA and the incidence per 100,000 population was lower in 2018 than in 2017 (**Figure 2**). While there will be normal fluctuations over time, it is notable that across the Australian eastern seaboard, 2017 was the worst influenza year since the pandemic in 2009⁹, with a comparatively mild 2018. In NSW, the Ministry of Health attributed 653 deaths to influenza in 2017 and 43 in 2018¹⁰.

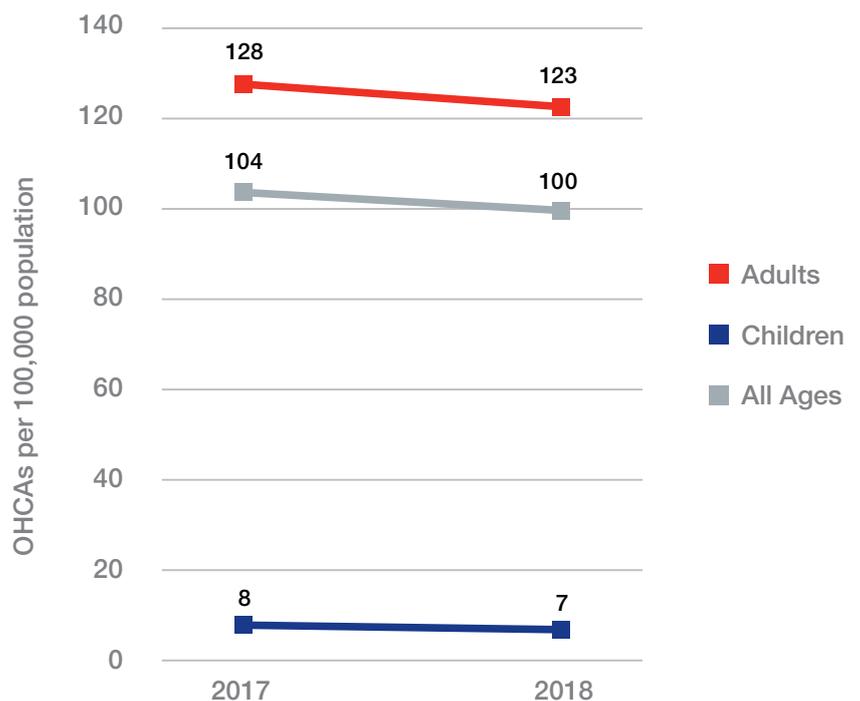
Resuscitation attempts

Of the 7,993 OHCA attended, 4,591 (57%) were determined by paramedics to be deceased on examination. Resuscitation was withheld in a further 248 cases (3%), primarily because of 'do-not-resuscitate' (DNR) orders or family instructions (**Figure 3**). Of the 3,154 resuscitation attempts made (by bystanders or NSW Ambulance), 33 (1%) involved bystander resuscitation that achieved ROSC prior to NSW Ambulance arrival. NSW Ambulance clinicians made 3,121 resuscitation attempts, representing 39% of all 2018 OHCA cases (2017: 39%).

TABLE 4: Crude incidence of EMS-attended OHCA by age group and gender, NSW 2018

Age	Incidence per 100,000 population		
	Male	Female	Persons
Children (aged under 16)	9	6	7
Adults (aged 16 and over, or age unknown)	166	81	123
All ages	134	67	100

FIGURE 2: Crude incidence of EMS-attended OHCA by age group, NSW 2018



Geographic incidence of out-of-hospital cardiac arrest

This analysis is based on the ABS structures of Greater Capital City Statistical Area (GCCSA) and Statistical Area Level 4 (SA4). The numerator is the count of OHCA in each region (based on scene location) and the denominator is the resident population.

There were 4,411 OHCA in Greater Sydney (55% of the total) and 3,572 in the Rest of NSW. The crude incidence of OHCA per 100,000 population was much lower in metropolitan Sydney than in regional and rural areas. In Greater Sydney in 2018, the crude incidence (unadjusted for differences in age and gender) was 84 per 100,000 compared with 130 per 100,000 in the rest of NSW. The 2018 incidence in both regions was lower than 2017 (Figure 4).

Patients in Greater Sydney were more likely to have a resuscitation attempt made than in the Rest of NSW (42% vs 35% respectively). At a more detailed level, by SA4, there was variation within each GCCSA. In Greater Sydney, the incidence of OHCA varied between 63 and 102 per 100,000 population (Baulkham Hills and Hawkesbury had the lowest incidence, Central Coast the highest) (Figure 5). Regionally, the incidence varied between 101 and 167 OHCA per 100,000 population (Illawarra had the lowest incidence, Far West and Orana the highest) (Figure 6).

FIGURE 3: Resuscitation attempts, NSW, 2018

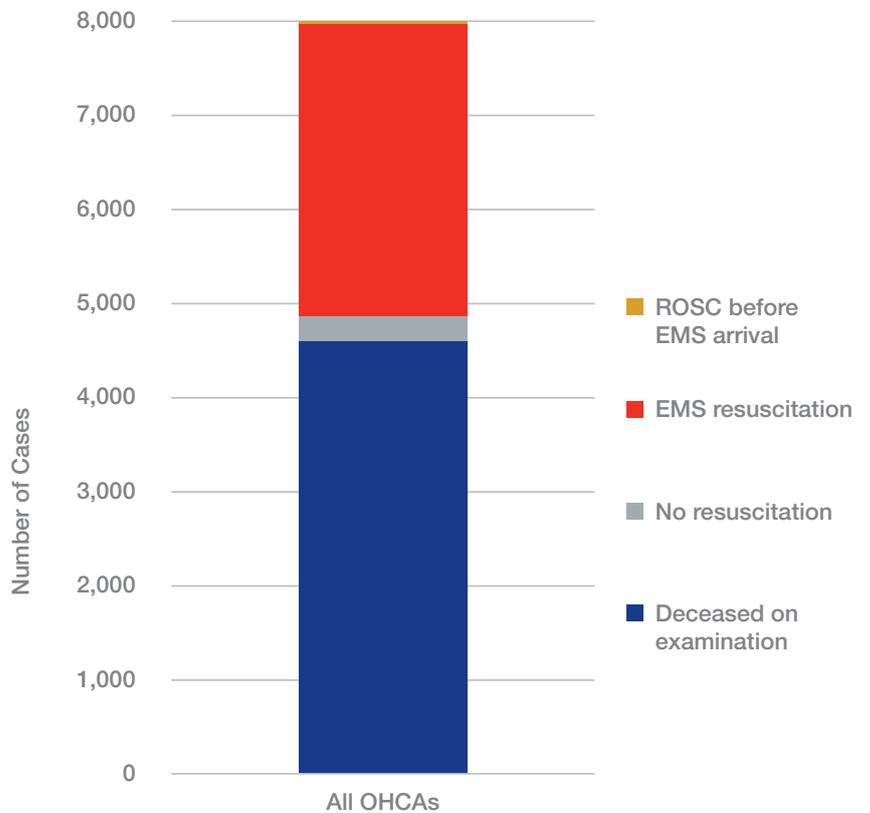


FIGURE 4: Crude incidence of EMS-attended OHCA in NSW by GCCSA

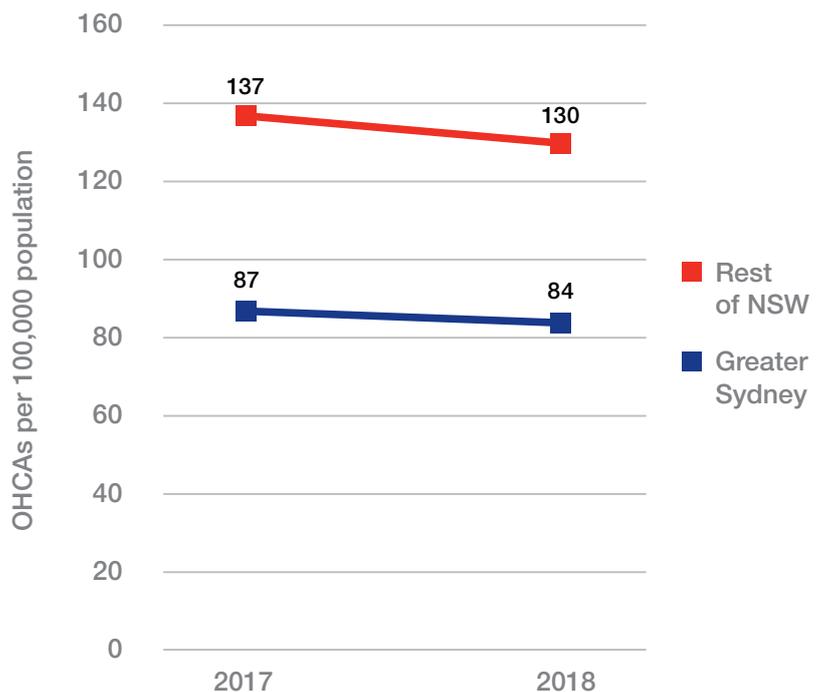


FIGURE 5: Crude incidence of EMS-attended OHCA in NSW by SA4, Greater Sydney, 2018

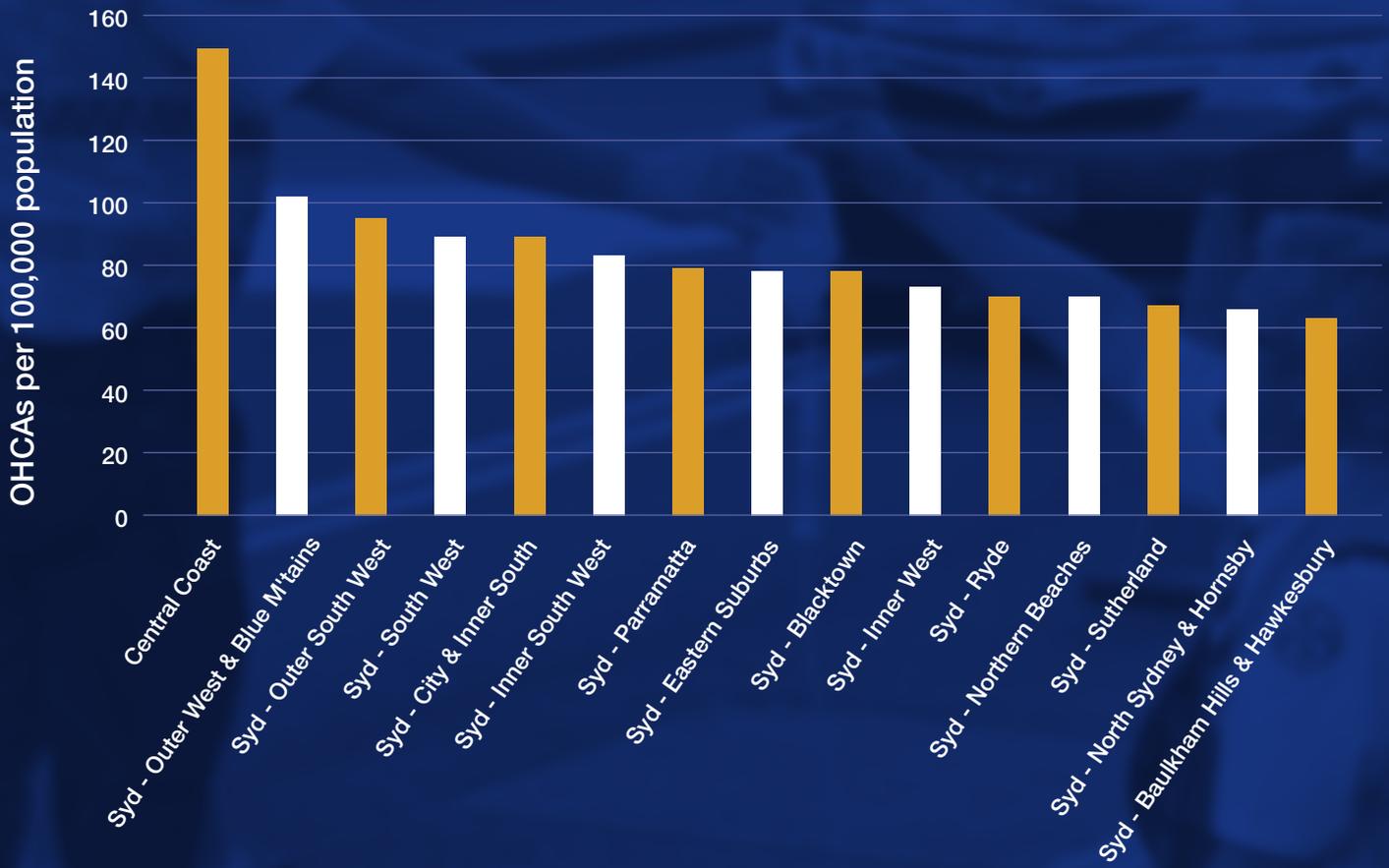
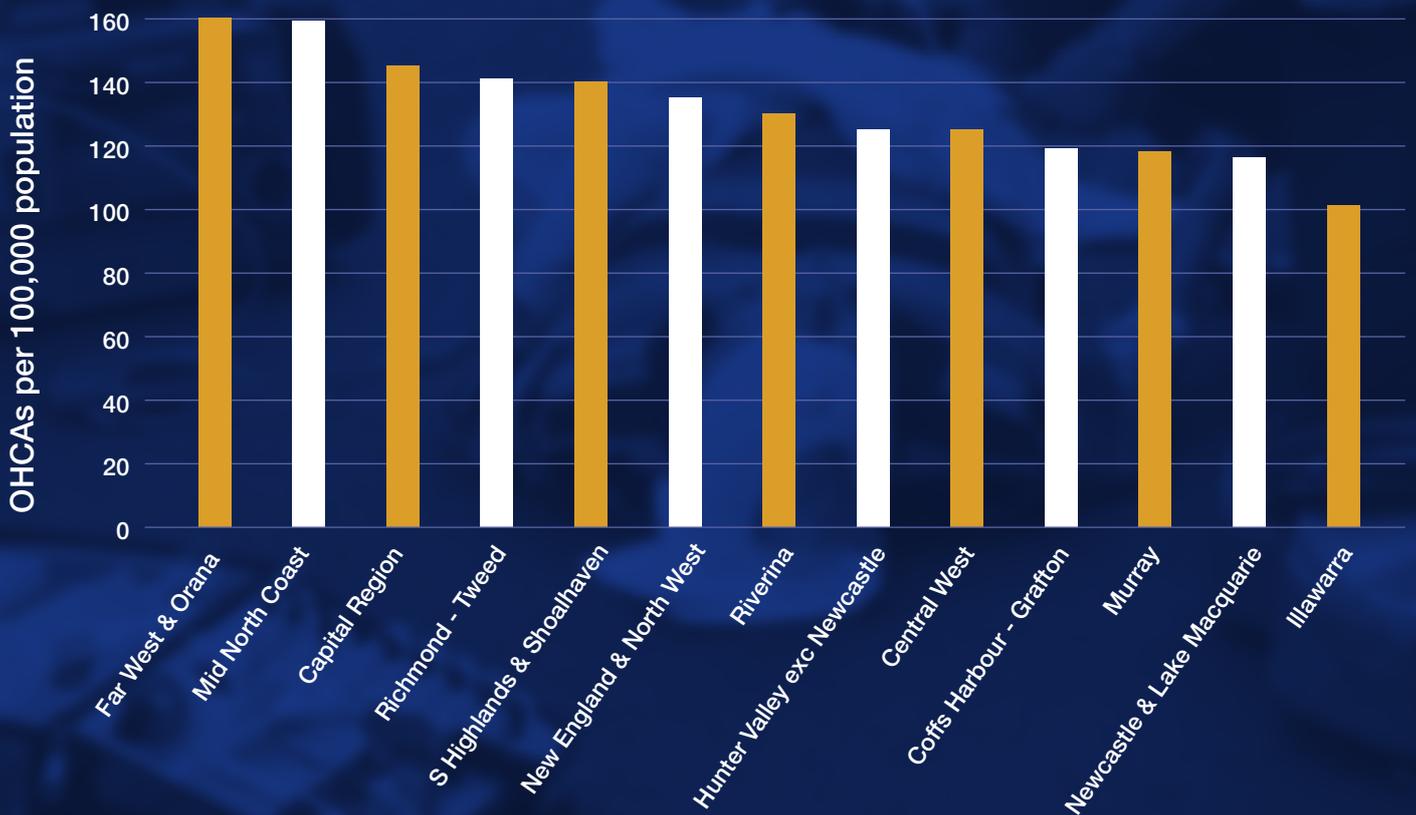


FIGURE 6: Crude incidence of EMS-attended OHCA in NSW by SA4, Rest of NSW, 2018



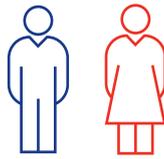
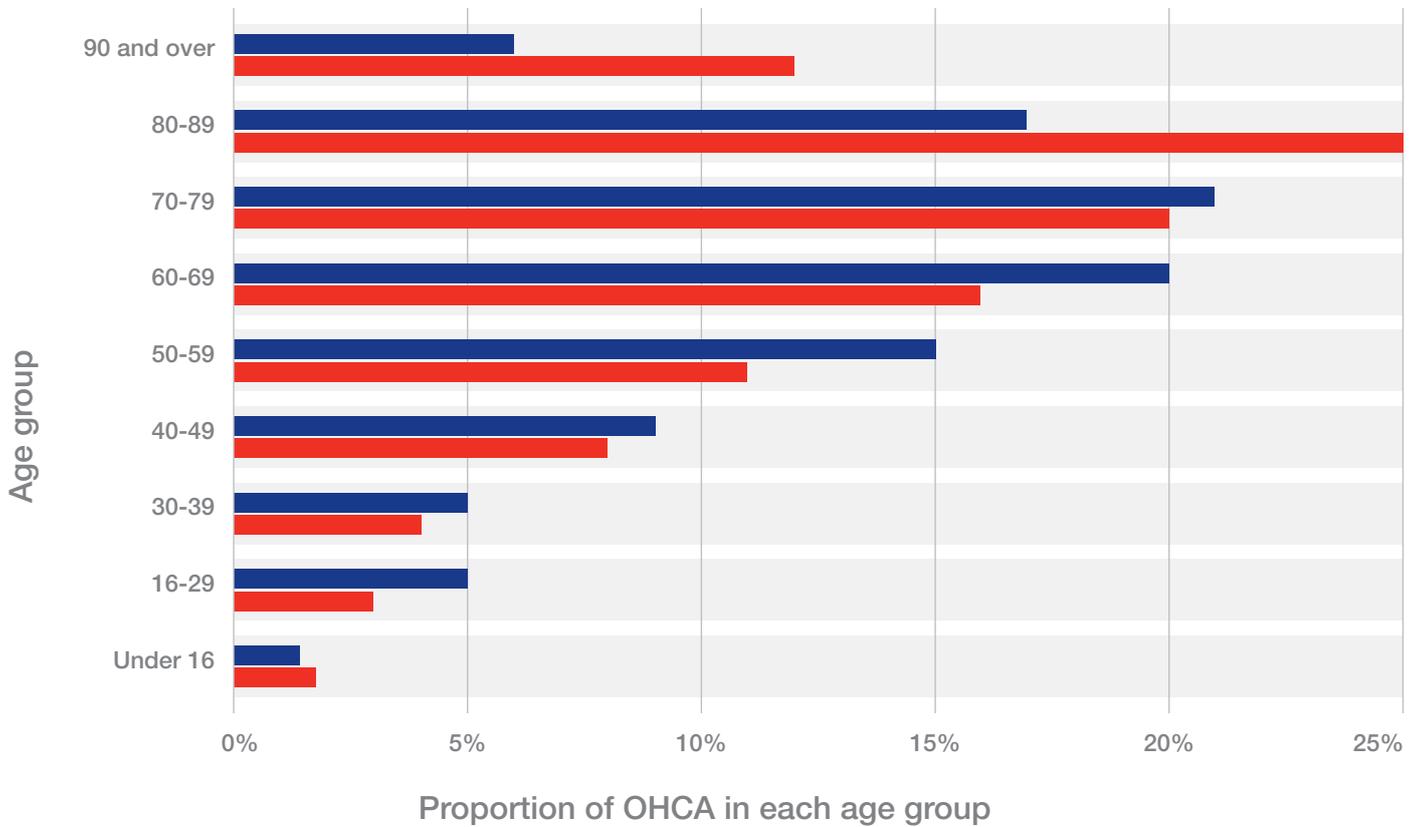


FIGURE 7: EMS-attended OHCA's by age and gender, NSW 2018



Cardiac arrests by age and gender

The distribution of OHCA's by age and gender is shown in **Figure 7**. Cases in the OHCAR in 2018 had a very similar distribution to 2017. 66% of OHCA's were male and 34% female. The median age of adult OHCA's was 70 years, with females having a higher median age at cardiac arrest (female median 74 years vs male 67 years). The median age of paediatric OHCA's was 18 months (male median 2 years vs female 1 year).

Resuscitation was slightly more likely to be attempted on males than females when NSW Ambulance resources arrived; a resuscitation attempt was made in 40% of male OHCA's and 38% of female OHCA's. Paediatric cases were much more likely to have a resuscitation attempt made than adult cardiac arrests (71% of paediatric OHCA's involved a resuscitation attempt vs 39% of adults).





Cause of cardiac arrest in adults

The presumed cause of the OHCA is based on information in the paramedic clinical record, either indicated directly by paramedics or interpreted by coders. Unless there is a clear cause the underlying precipitating factor is assumed to be cardiac. 5,349 (68%) of adult arrests attended by EMS were presumed to be of cardiac cause. Other common causes were terminal illness (808 cases, 10%), trauma (excluding drowning, asphyxiation, hanging and overdose) (512 cases, 7%), hanging/strangulation or asphyxiation (498 cases, 6%) and respiratory (404 cases, 5%). **Figure 8** shows the causes of OHCA in adults.

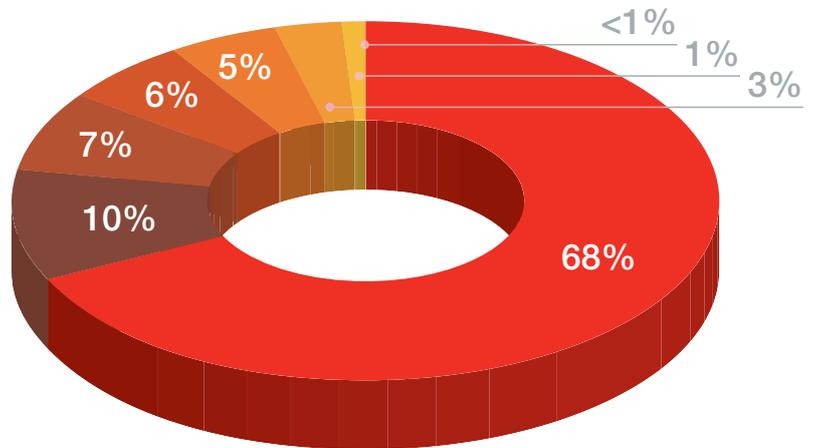
Resuscitation was more likely to be attempted for cases of medical aetiology (40%) than non-medical aetiology (32%).

By age group, traumatic deaths, overdoses and hangings were more likely to occur at younger ages (**Figure 9**). In the older age groups, cardiac and terminal illness were the most common causes.

Cause of cardiac arrest in children

As shown in **Figure 10**, cardiac was also the most common presumed cause (34%) of paediatric arrests. 25% of OHCA were attributed to Sudden Unexpected Death in Infancy (SUDI) (of which Sudden Infant Death Syndrome (SIDS) is the unexplained subset).

GRAND TOTAL – 7,874



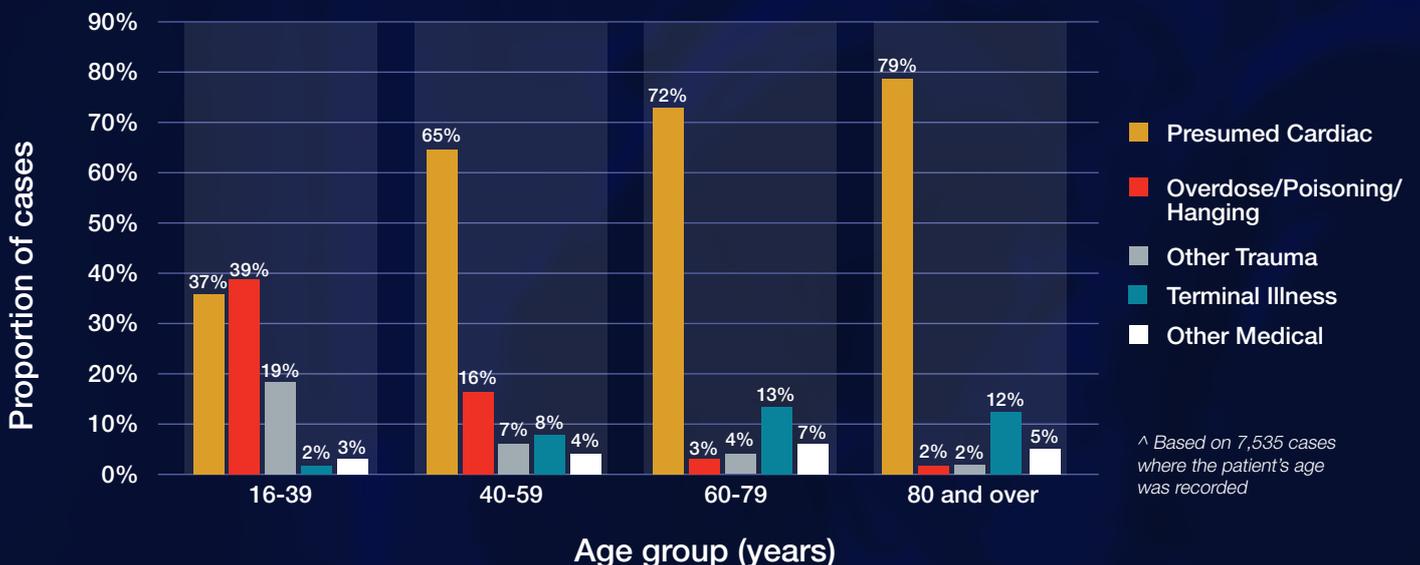
- 68% Presumed Cardiac
- 10% Terminal illness
- 7% Other Trauma
- 6% Hanging/Strangulation
- 5% Respiratory
- 3% Overdose/Poisoning
- 1% Drowning
- <1% Other medical

Trauma (blunt, penetrating and burns) was another common cause (17% of OHCA).

FIGURE 8: Cause of adult OHCA, NSW 2018

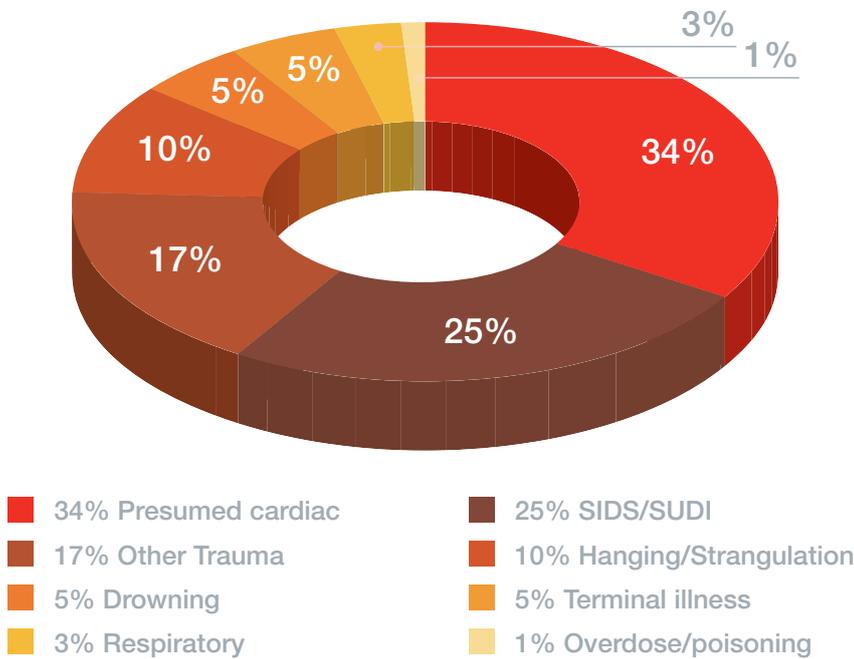
The number of paediatric arrests is very small (119 in total or 1.5% of all cases in the OHCA), and small changes in cause from year to year can affect the proportions attributed to each cause.

FIGURE 9: Cause of adult OHCA by age group, NSW 2018[^]



[^] Based on 7,535 cases where the patient's age was recorded

GRAND TOTAL – 119



Adult patients were more likely to be in a shockable rhythm than children (27% vs 2%).

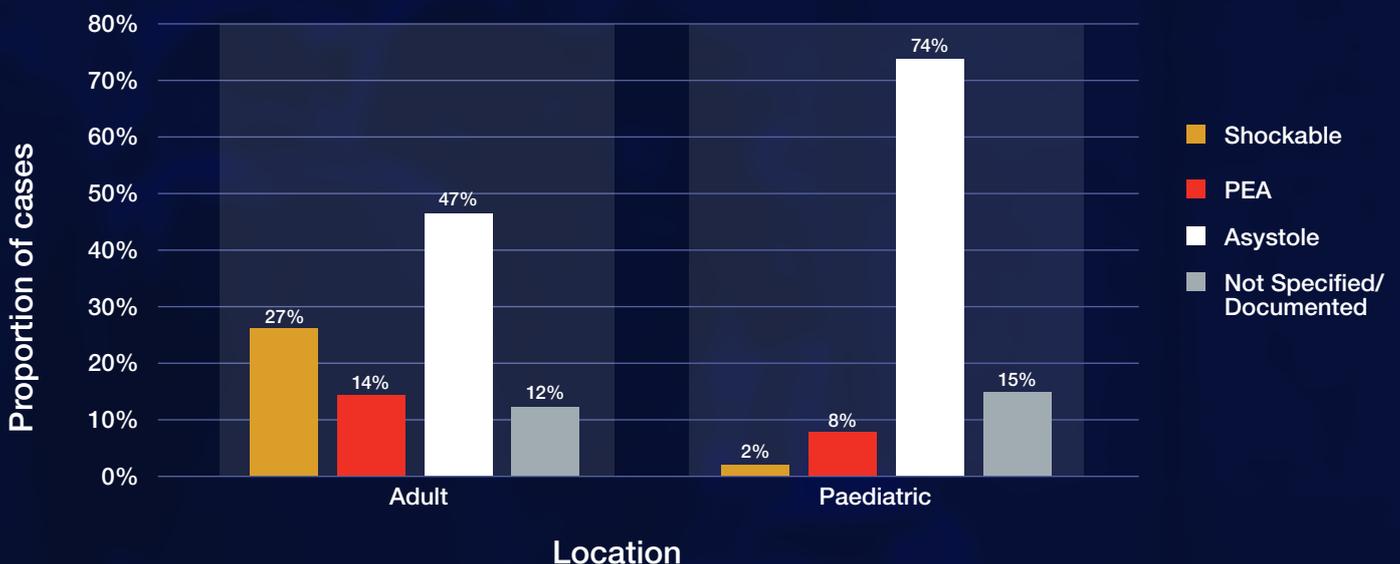
FIGURE 10: Cause of paediatric OHCA, NSW 2018

Initial rhythm

Of the 3,121 patients on which an EMS resuscitation attempt was undertaken, 819 (26%) initially presented in a shockable rhythm, 438 (14%) were in a non-shockable Pulseless Electrical Activity (PEA) and 1,475 (47%) were in a non-shockable asystole. For the remaining 389 (12%), the initial rhythm was not fully

documented (including unspecified 'non-shockable' rhythms). Adult patients were more likely to be in a shockable rhythm than children (27% vs 2%). The majority of paediatric patients (74%) were in asystole. **Figure 11** indicates the distribution of initial rhythms for adult and paediatric patients.

FIGURE 11: Distribution of Initial presenting rhythm following OHCA, by age group, NSW 2018





Location of arrest

Where an OHCA 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 OHCA's (6,302 cases, 79%) occurred in a private residence. 13% of OHCA's occurred in a public location (Figure 12). Women were more likely to arrest in a private residence or nursing home than men (91% of female vs 83% of male OHCA's) whereas men were more likely to arrest in a public location (16% of male vs 8% of female OHCA's).

In 2018, 24% of all cardiac arrests in the OHCA's were witnessed by a bystander and 7% by a paramedic, similar to 2017. 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 (Figure 13).

Bystander involvement by location

When considering events, the 2,641 attempted resuscitations that were not witnessed by a paramedic, the involvement of bystanders, whether witnessing the cardiac arrest or providing CPR, contributes to OHCA survival. Figure 14 presents, for arrests not witnessed by a paramedic, the proportion of OHCA's witnessed by a bystander, receiving bystander CPR and surviving to ED.

In 2018, the proportion of OHCA's witnessed by a bystander and receiving bystander CPR

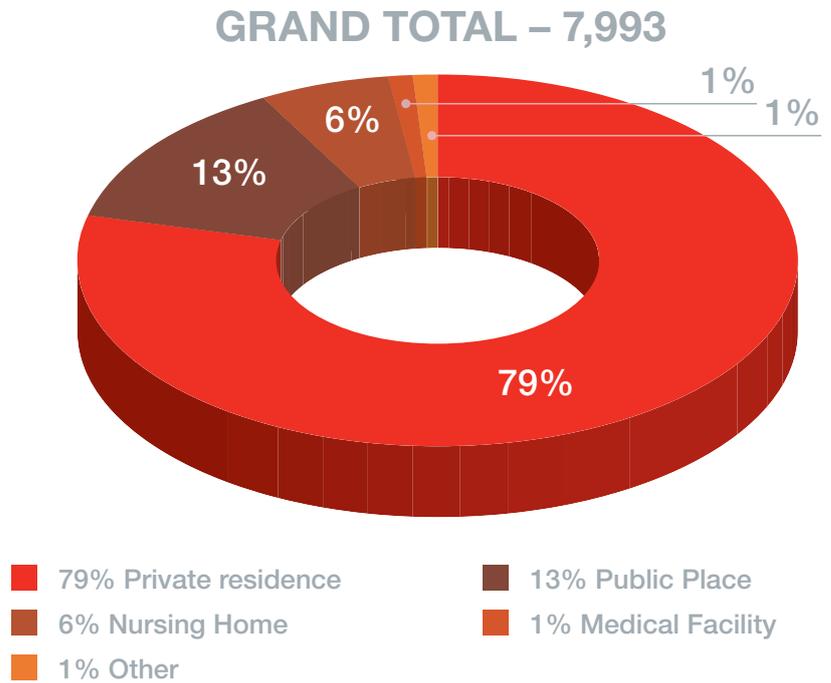


FIGURE 12: Location of OHCA, NSW 2018

was highest in medical facilities and public locations. These were the locations with the highest survival rate to ED. By contrast, in nursing homes and private residences, a lower proportion of events were witnessed, bystander CPR was performed less commonly and survival rates were lower. These rates are unadjusted, and do not take account of any differences in survival attributable to patient characteristics, such as age, in different locations.



FIGURE 13: Witnessed status of OHCA by location, all OHCAs, NSW 2018

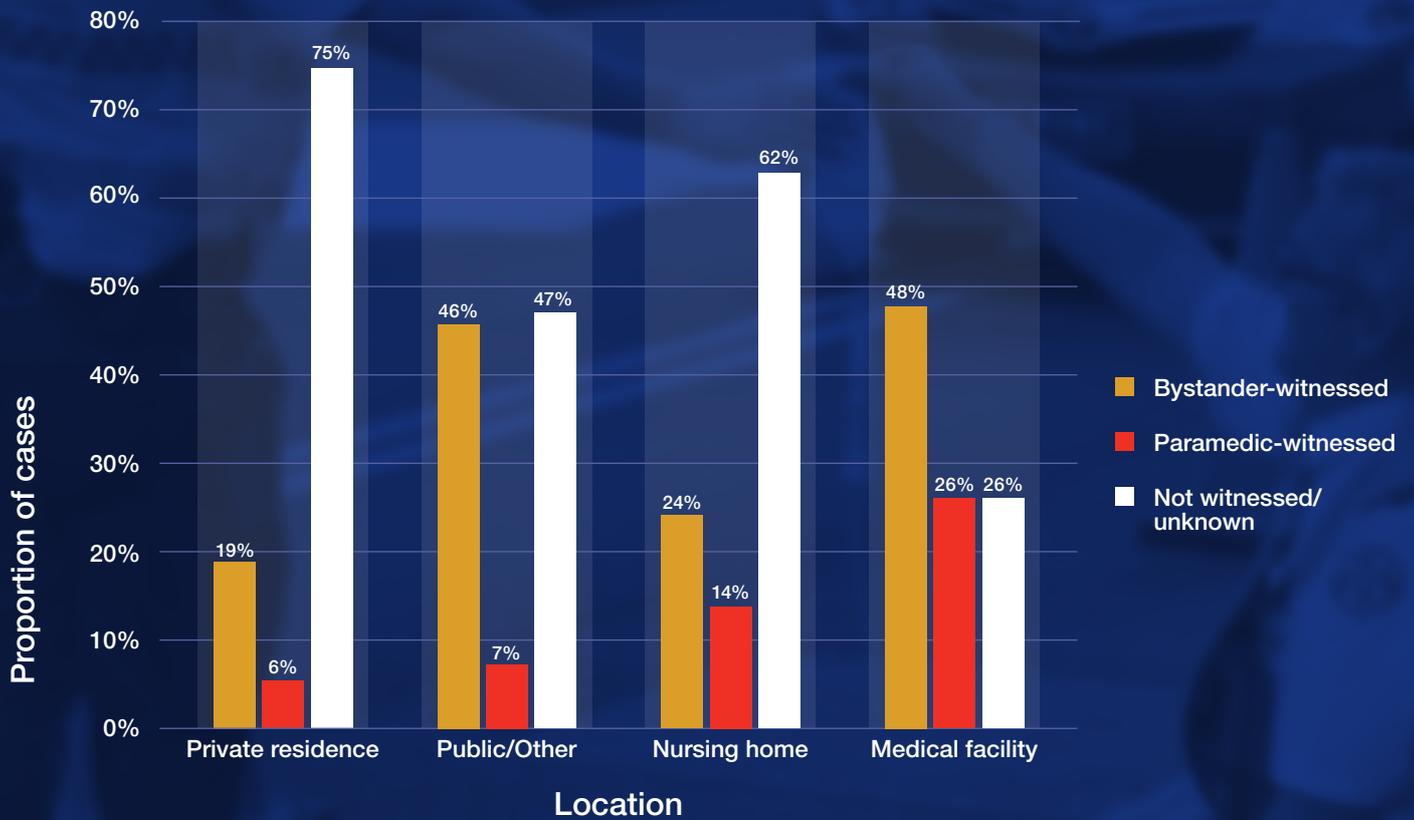
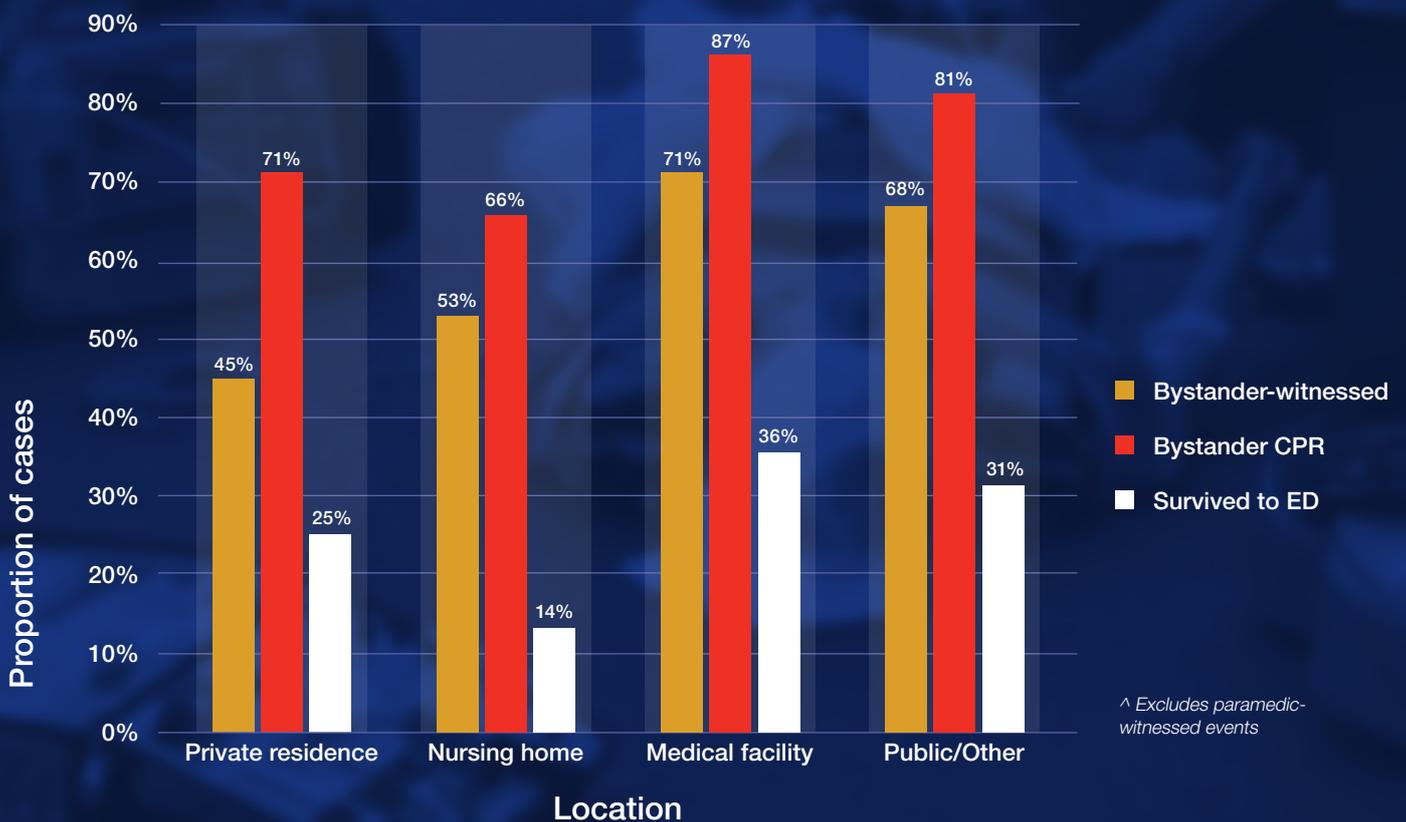


FIGURE 14: Bystander witness, CPR and event survival by location, EMS-treated OHCA, NSW 2018[^]





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 and post-arrest care. This sequence aims to increase the chances of survival following cardiac arrest¹¹.

Identification of cardiac arrest

There are no data on how quickly callers identified cardiac 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 paramedic clinical record. On this basis, it appears that call-takers identified the call as a cardiac arrest in 88% of OHCA's (excluding those witnessed by paramedics).

Bystander CPR and defibrillator use prior to NSW Ambulance arrival

Overall, in EMS-attended OHCA's (excluding paramedic-witnessed), bystanders performed CPR 38% of the time. **Figure 15** shows that bystanders were more likely to perform CPR when they witnessed an OHCA: bystanders performed CPR 64% of the time in bystander-witnessed arrests and 29% of the time in unwitnessed/unknown arrests.

In 2018 as in 2017, 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 5**). 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 5** bystanders used AEDs for 189 cardiac arrest events. This represents almost 3% of all OHCA's (excluding paramedic-witnessed events). In cases where resuscitation was continued by paramedics, an AED had been used by bystanders before EMS arrival in 5.6% of cases (147 out of 2,641 non-paramedic-witnessed resuscitations). An AED was used in 7% of bystander-witnessed OHCA's. An AED was used in 26 out of the 33 cases in which ROSC was achieved prior to NSW Ambulance arrival.

Most OHCA's occurred in private residences, where an AED was unlikely to be accessible. When limited to OHCA's occurring in public and other locations (all locations except private residences, nursing homes or medical facilities), AEDs were used by bystanders on 133 patients out of 1,113 OHCA's (12% of public-location, school or workplace OHCA's).

FIGURE 15: Proportion of OHCA with Bystander CPR, by witnessed status, NSW 2018[^]

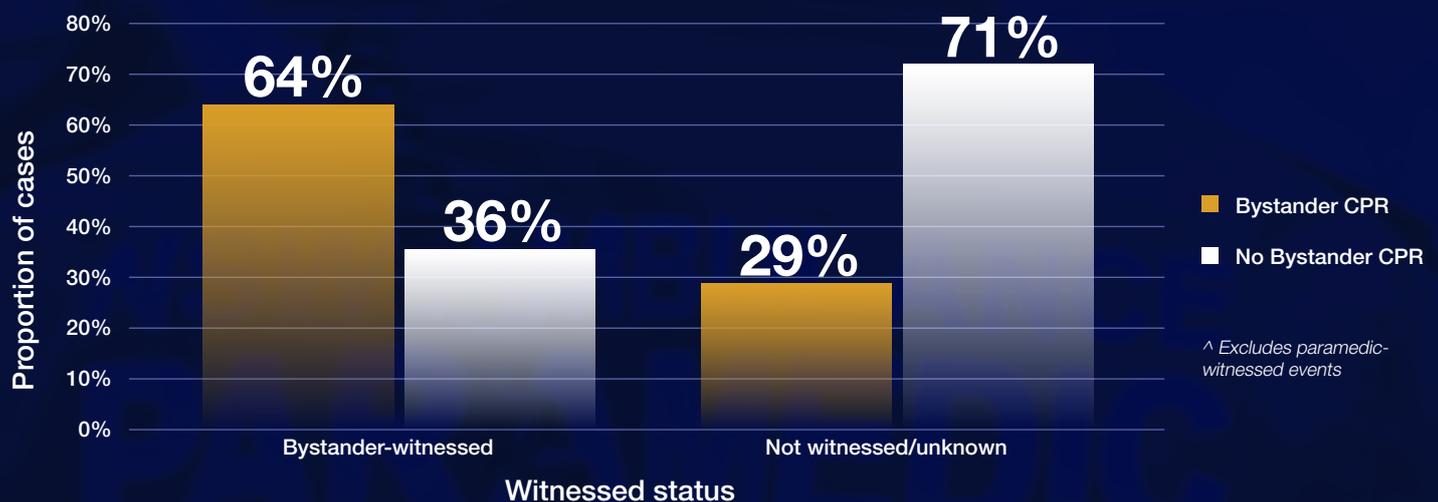


TABLE 5: Bystander involvement in OHCA CPR or defibrillation, NSW 2018[^]

	Bystander witnessed		Not witnessed/ unknown		Total (excl paramedic-witnessed events)	
	Number	%	Number	%	Number	%
Total (Column denominator)	1,883		5,528		7,411	
Bystander CPR	1,211	64.3	1,627	29.4	2,838	38.3
Bystander AED	134	7.1	55	1.0	189	2.6
Shockable rhythm on EMS arrival	516	27.4	219	4.0	735	9.9

[^] Excludes paramedic-witnessed events

Emergency response

Priority 1A is the highest priority a call can be given. Priority 1A calls receive a lights and siren response with possible multiple resources committed. Of the 2,641 arrests (excluding paramedic-witnessed arrests) in which EMS-resuscitation was attempted, 2,200 (83%) had a 1A response priority. A further 407 (16%) were 1B or 1C responses (also lights and siren). Overall, 99% of OHCA where a resuscitation attempt was made by paramedics received a lights and siren response.

Paramedic-witnessed arrests are excluded from the above analysis because the OHCA did not occur until after the paramedics arrived on scene, so these cases would not normally be assigned a priority 1A at the time of the call. Overall, 89% of paramedic-witnessed arrests originally received a lights and siren response (1A, 1B or 1C).

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 was assigned to the call (2 Immediate, no lights or siren). This made up 21% of cases in the OHCAR (excluding paramedic-witnessed arrests).

The median response time to OHCA where a resuscitation attempt was made was 8 minutes in Greater Sydney, and 9 minutes in the Rest of NSW. **Figure 16** illustrates the distribution of response times in Sydney and the Rest of NSW.

For the 2,712 non-paramedic witnessed, EMS-treated arrests, faster response times were associated with higher survival rates to ED admission (**Figure 17**). Overall, survival to ED in Greater Sydney was 28% compared with 26% in the Rest of NSW.

FIGURE 16: Distribution of response times, EMS-treated OHCA, by region, NSW 2018

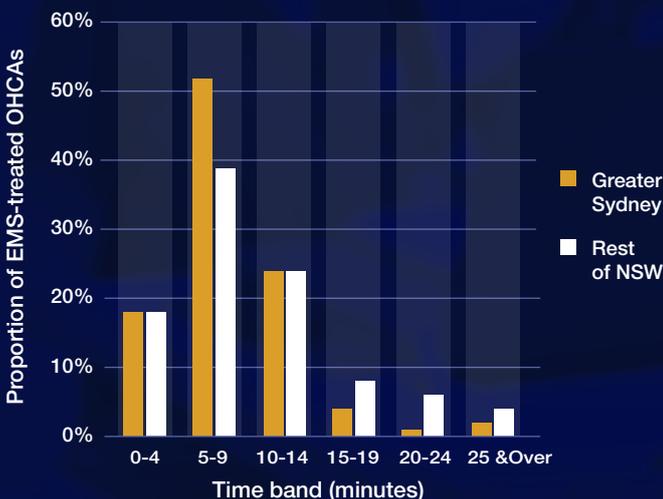
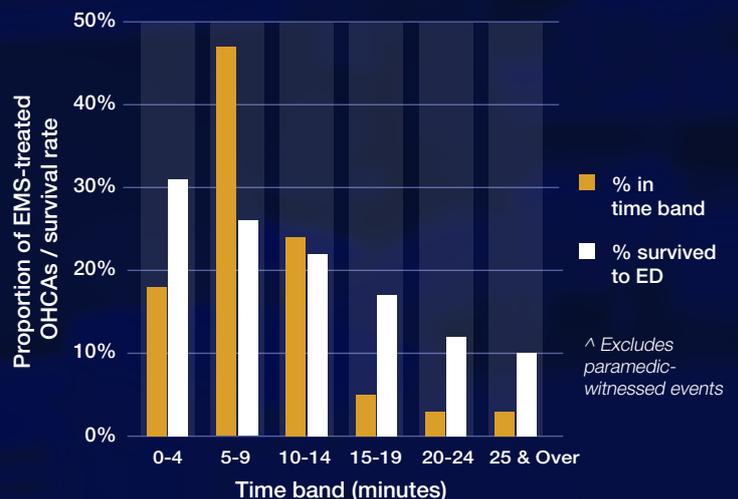


FIGURE 17: Distribution of response times and survival to ED, EMS-treated OHCA, NSW 2018[^]



Cardiac Arrest OUTCOMES

NSW Ambulance resuscitation outcomes

Ambulance outcomes are recorded as: deceased on examination; died at scene; died en route; CPR continuing on handover; or survived to ED admission. In the 'CPR continuing...' group, the paramedic clinical record described CPR en route to hospital but did not indicate whether the patient had ROSC on arrival at hospital.

Figure 18 relates to the 3,121 EMS-attempted resuscitation patients (that is, resuscitations by NSW Ambulance clinicians and 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 OHCA are most likely to survive to ED admission compared with bystander-witnessed or not witnessed/ unknown cardiac arrests.

The overall survival rate to ED across all patients was 27% (852 of 3,121 EMS-attempted resuscitations). Across all initial rhythms, the survival rate to ED was highest for paramedic-witnessed OHCA at 42% (202 out of 480 patients), followed

by bystander-witnessed OHCA (31%, 416 of 1,347 patients) and then unwitnessed OHCA (18%, 234 of 1,294 patients).

The overall survival rate to hospital discharge across all patients was 12% (348 of 2,973 EMS-attempted resuscitations where records could be matched to EDDC or APDC). The survival rate to hospital discharge was highest for paramedic-witnessed OHCA at 27% (123 of 449 patients), followed by bystander-witnessed OHCA (13%, 171 of 1,277 patients) then unwitnessed OHCA (4%, 54 of 1,247 patients). See **Table 6**.

All ages survival rates by initial rhythm

Physiologically, survival from cardiac arrest is more likely if the patient is in a shockable rhythm. Over all attempted resuscitations, 27% of patients survived to ED and 12% to hospital discharge). For patients in a shockable initial rhythm, the survival rate to ED was 46% and to hospital discharge was 31%, compared with 12% survival to ED and 2% to discharge for patients in asystole on initial presentation (**Figure 19** and **Table 7**).

FIGURE 18: Ambulance outcome, EMS-treated OHCA, by witnessed status, NSW 2018

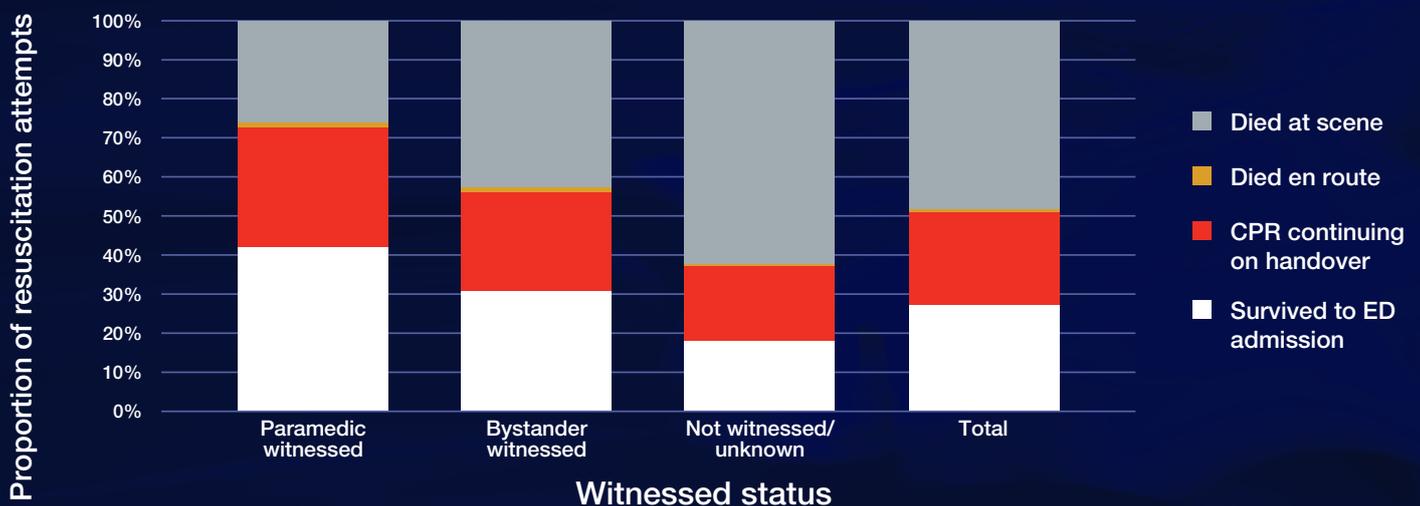


TABLE 6: Survival by witnessed status, EMS-treated OHCA, NSW 2018[^]

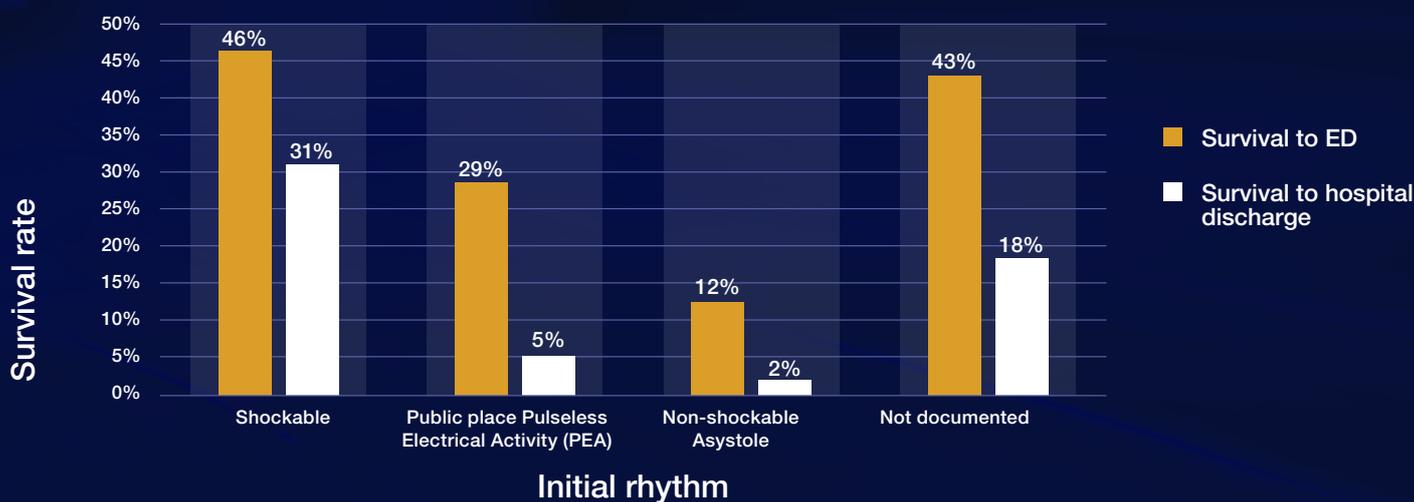
Indicator	Witnessed Status	Number	Denominator	%
Survived to ED	Bystander-witnessed	416	1,347	30.9
	Paramedic-witnessed	202	480	42.1
	Not witnessed/Unknown	234	1,294	18.1
	Total - all witnessed statuses	852	3,121	27.3
Survived to hospital discharge [^]	Bystander-witnessed	171	1,277	13.4
	Paramedic-witnessed	123	449	27.4
	Not witnessed/Unknown	54	1,247	4.3
	Total - all witnessed statuses	348	2,973	11.7

TABLE 7: Survival outcomes by initial rhythm, EMS-treated OHCA, NSW 2018

Indicator	Initial rhythm	Number	Denominator	%
Survived to ED	Shockable rhythm	374	819	45.7
	Pulseless Electrical Activity (PEA)	129	438	29.5
	Asystole	182	1,475	12.3
	Not documented	167	389	42.9
	Total - all rhythms	852	3,121	27.3
Survived to hospital discharge [^]	Shockable rhythm	237	766	30.9
	Pulseless Electrical Activity (PEA)	19	412	4.6
	Asystole	26	1,430	1.8
	Not documented	66	365	18.1
	Total - all rhythms	348	2,973	11.7

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

FIGURE 19: Survival by initial rhythm (all ages), EMS-treated OHCA, NSW 2018





Survival by age group and initial rhythm

Adults make up 98.5% of the EMS-attended OHCA (7,894 out of 7,993) and 97% of the EMS resuscitation attempts (3,037 out of 3,121). Adults are more likely to present in a shockable rhythm than children (27% of adults vs 2% of children) and this is a factor in the higher all-rhythm adult OHCA survival rates compared with paediatric arrests (survival to ED 28% of adults compared with 20% of children; survival to hospital discharge 12% of adults, 11% of children (**Table 8**).



TABLE 8: Survival outcomes by age group and initial rhythm, EMS-treated OHCA, NSW 2018[^]

Indicator	Age	Initial rhythm	Number	Denominator	%
Survived to ED	Child	Shockable	2	2	100.0
		Not shockable/ not documented	15	82	18.3
		Total - all rhythms	17	84	20.2
	Adult	Shockable	372	817	45.5
		Not shockable/ not documented	463	2,220	20.9
		Total - all rhythms	835	3,037	27.5
	All Ages	Shockable	374	819	45.7
		Not shockable/ not documented	478	2,302	20.8
		Total - all rhythms	852	3,121	27.3
Survived to Discharge [^]	Child	Shockable	2	2	100.0
		Not shockable/ not documented	6	74	8.1
		Total - all rhythms	8	76	10.5
	Adult	Shockable	235	764	30.8
		Not shockable/ not documented	105	2,133	4.9
		Total - all rhythms	340	2,897	11.7
	All Ages	Shockable	237	766	30.9
		Not shockable/ not documented	111	2,207	5.0
		Total - all rhythms	348	2,973	11.7

[^]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

Combining witnessed status and initial rhythm, survival rates to ED and hospital discharge for the 3,037 adult EMS-resuscitated patients are shown in **Table 9**.



TABLE 9: Survival by witnessed status and initial rhythm, adult EMS-treated OHCA, NSW 2018[^]

Indicator	Witnessed status	Initial rhythm	Number	Denominator	%
Survived to ED	Bystander witnessed	Shockable	224	492	45.5
		Not shockable/ not documented	185	832	22.2
		Total - all rhythms	409	1,324	30.9
	Paramedic witnessed	Shockable	83	114	72.8
		Not shockable/ not documented	118	363	32.5
		Total - all rhythms	201	477	42.1
	Not witnessed / unknown	Shockable	65	211	30.8
		Not shockable/ not documented	160	1,025	15.6
		Total - all rhythms	225	1,236	18.2
	All witnessed statuses	Shockable	372	817	45.5
		Not shockable/ not documented	463	2,220	20.9
		Total - all rhythms	835	3,037	27.5
Survived to hospital discharge [^]	Bystander witnessed	Shockable	137	455	30.1
		Not shockable/ not documented	30	802	3.7
		Total - all rhythms	167	1,257	13.3
	Paramedic witnessed	Shockable	68	107	63.6
		Not shockable/ not documented	55	341	16.1
		Total - all rhythms	123	448	27.5
	Not witnessed / unknown	Shockable	30	202	14.9
		Not shockable/ not documented	20	990	2.0
		Total - all rhythms	50	1,192	4.2
	All witnessed statuses	Shockable	235	764	30.8
		Not shockable/ not documented	105	2,133	4.9
		Total - all rhythms	340	2,897	11.7

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



Survival rates by cause

Survival rates to ED were higher for cardiac arrests of medical cause than non-medical causes. 28% of all-ages medical OHCA survivors (743 patients out of 2,673 resuscitations) compared with 24% of non-medical OHCA survivors (109 out of 448 resuscitations). Survival to hospital discharge was also higher for medical OHCA survivors (13%) compared with 10% of non-medical OHCA survivors (**Table 10**).

Resuscitation was more likely to be commenced in the case of a medical OHCA: 40% of medical OHCA survivors (2,673 resuscitations out of 6,652 OHCA cases) compared with 33% of non-medical cases (448 resuscitations out of 1,341 OHCA cases). The proportions of patients resuscitated by aetiology in 2018 were the same as for 2017.

Survival rate by bystander CPR

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

CPR was associated with a higher crude survival rate to ED admission (35% with bystander CPR vs 25% without bystander CPR) and hospital discharge (17% with bystander CPR vs 8% without, **Table 11**).

Cardiac arrests that were not witnessed by a bystander or a paramedic had an 18% chance of survival to ED admission regardless of whether CPR was attempted by bystanders, but survival to hospital discharge was higher in the unwitnessed group where CPR was attempted by bystanders. (**Table 11**). Compared with **Table 6**, **Table 11** includes the 42 patients that achieved ROSC prior to NSW Ambulance arrival (33 linked) and excludes the 480 paramedic-witnessed OHCA survivors (448 linked).

The fact of the OHCA being witnessed (that is, 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 10: Survival outcomes by aetiology, EMS-treated OHCA, NSW 2018

Aetiology	Indicator	Number	Denominator	%
Survived to ED	Medical ^^	743	2,673	27.8
	Non-medical	109	448	24.3
	Total - all causes	852	3,121	27.3
Survived to hospital discharge^	Medical ^^	323	2,563	12.6
	Non-medical	25	410	6.1
	Total - All Causes	348	2,973	11.7

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

^^ Includes missing aetiology

TABLE 11: Survival outcomes by witnessed and bystander CPR, EMS-treated or ROSC prior to EMS arrival OHCA, all ages, NSW 2018

Indicator	Witnessed status	Bystander CPR	Number	Denominator	%
Survived to ED	Bystander-witnessed	No/unknown	80	322	24.8
		Yes	366	1,055	34.7
		Total - All CPR	446	1,377	32.4
	Not witnessed	No/unknown	71	384	18.5
		Yes	166	913	18.2
		Total - All CPR	237	1,297	18.3
	All witnessed statuses (excl paramedic witnessed)	No	151	706	21.4
		Yes	532	1,968	27.0
		Total - All CPR	683	2,674	25.5
Survived to hospital discharge^	Bystander-witnessed	No/unknown	26	308	8.4
		Yes	169	995	17.0
		Total - All CPR	195	1,303	15.0
	Not witnessed	No/unknown	11	370	3.0
		Yes	46	880	5.2
		Total - All CPR	57	1,250	4.6
	All witnessed statuses (excl paramedic witnessed)	No/unknown	37	678	5.5
		Yes	215	1,875	11.5
		Total - All CPR	252	2,553	9.9

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



Utstein patient group survival

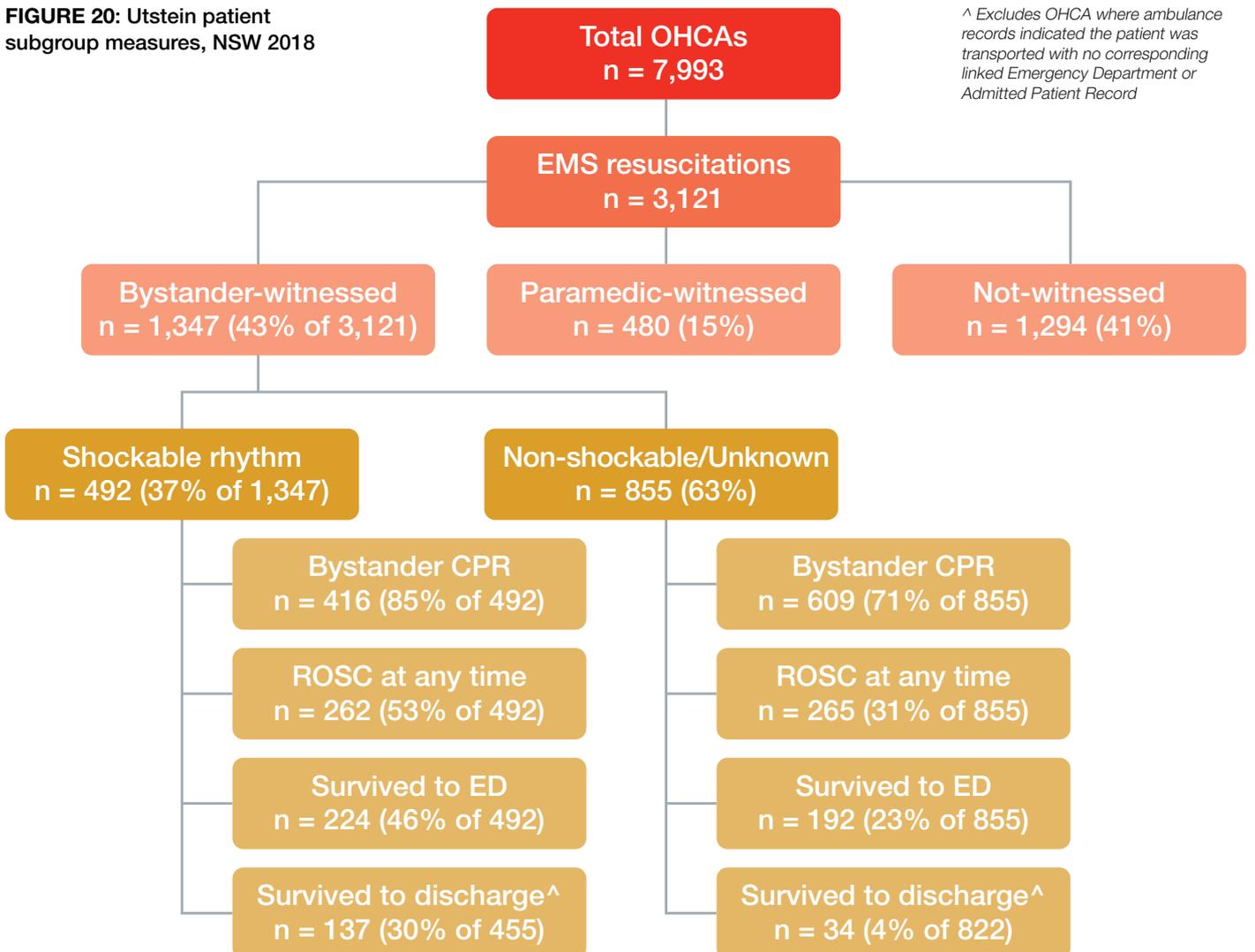
The Utstein guidelines include selection criteria for cardiac arrests to allow consistent comparison of key measures between ambulance services. The Utstein patient subgroup is:³

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

There were 492 (16%) of 3,121 resuscitations attempted that met these criteria.

Figure 20 indicates measures for the Utstein patient subgroup.

FIGURE 20: Utstein patient subgroup measures, NSW 2018





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. King County in the United States leads the field in survival rates, but is a much smaller and denser population than NSW (2.1 million people over 2,000 square miles compared with 8.0 million people over 309,500 square miles). **Table 12** shows the latest available figures from a number of ambulance services on survival rates to ED and hospital discharge for all patients and the Utstein subgroup.

TABLE 12: Benchmark OHCA survival rates across jurisdictions

Organisation	Time Period	% survival rate to ED by patient group		% survival to hospital discharge or 30 days	
		All resus	Utstein subgroup	All resus	Utstein subgroup
NSW Ambulance	1 Jan 18 – 31 Dec 18	27%	46%	12%	30%
Ambulance Victoria ¹²	1 Jul 17 – 30 Jun 18	25%	57%	10%	37%
Queensland Ambulance Service ¹³	1 Jan 17 – 31 Dec 17	-	49%	-	32%
South Australia Ambulance Service ¹⁴	1 Jul 16 – 30 Jun 17	26%	55%	11%	33%
St John Ambulance WA ¹⁵	1 Jan 18 – 31 Dec 18	24%	46%	15%	38%
St John Ambulance NZ ¹⁶	1 Jul 17 – 30 Jun 18	28%	52%	13%	32%
London Ambulance Service ¹⁷	1 Apr 17 – 31 Mar 18	33%	57%	9%	32%
King County EMS ¹⁸	1 Jan 18 – 31 Dec 18	-	-	22%	56%



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