QUEENSLAND AMBULANCE SERVICE

SURVIVAL TRENDS

Out of Hospital Cardiac Arrest in Queensland

2000-2016

Queensland Government

812aQAS

December 2018
Survival Trends Out of Hospital Cardiac Arrest in Queensland 2000-2016
For further information please contact: QAS.Research@ambulance.qld.gov.au

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Executive summary

A vast state

Queensland is a large decentralised state with over one-third of the population residing in regional or remote locations. This geographic distribution presents significant challenges for the QAS in the delivery of high quality ambulance services in an environment of competing priorities and increasing demand. Despite this, the QAS responds quickly to OHCA events, with two-thirds of all cases statewide attended within ten minutes.

Over the 17 year reporting period, 2000-2016, QAS attended 69,338 OHCA cases. Analysis from 2000-2016 has identified an increase in OHCA rates in Queensland from 79 events per 100,000 head of population to 102 events per 100,000 population. The areas that demonstrate the largest growth in OHCA rates are those in regional and remote locations; surpassing the OHCA rate in metropolitan areas by approximately 40% in 2016. Given the substantial proportion of Queensland's population that live in regional and remote parts of the state, the growth in OHCA rates in these outlying areas is illustrative of the challenges associated with delivering time critical ambulance services across a vast geographic area.

A patient profile emerges

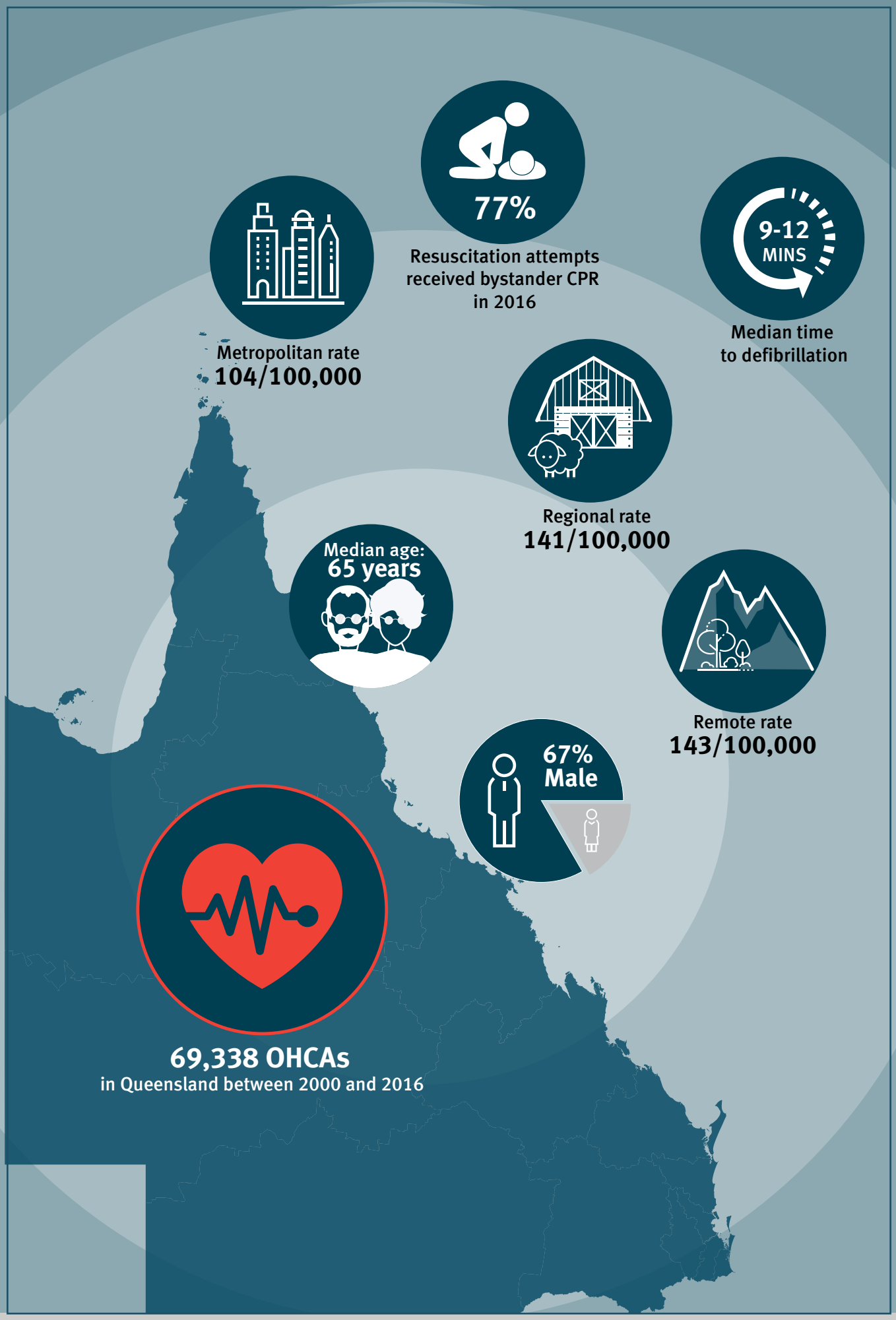
The majority of cases involved adult patients (n=65,129) with a median age of 65 years, two out of three were male, and two-thirds were identified as presumed cardiac aetiology. There is a clear relationship between OHCA of presumed cardiac origin and increasing age, with less than ten per cent of cases amongst patients under the age of 40 years identified as cardiac in nature. Inversely, OHCAs of traumatic aetiology are much younger (median age 41 years), and strongly dominated by males (75%). More than half (55%) of all traumatic OHCAs are the result of road related events, including motor vehicle and motorcycle crashes, and events involving pedestrians and cyclists. The service attended 1947 cases of paediatric OHCA between 2000-2016, with the leading causes identified as probable SIDS (31%), trauma (17%), and drowning (11%). The remaining 28% were attributed to a range of other conditions.

A household emergency

Location of the OHCA can be an important factor in determining outcomes for cardiac arrest patients. In Queensland, as in most reported jurisdictions, the predominant location of OHCA is a private residence (77%); far fewer occur in public places (11%), or in aged care / supported accommodation (5%). Almost three-quarters (71.5%) of cardiac arrests in private residences are unwitnessed. By comparison, less than half of cardiac arrests in public places are not witnessed (47.2%); the greater availability of bystanders to initiate CPR and activate emergency medical care in a timely manner positively impacts the survival rate of arrests in public places. Patient age also varies significantly across the cardiac arrest locations, with a median age of 67 years for cardiac arrests in a home location, and 81 years in an aged care facility / supported accommodation; compared to a younger median of 52 years for OHCA in public places (p=0.001).

A reduction of patients with a shockable rhythm

A notable trend observed across the study period is the reduction in the proportion of OHCA cases presenting with a shockable rhythm. Amongst resuscitation attempts, the percentage of cases presenting in Ventricular Fibrillation (VF) or Ventricular Tachycardia (VT) has reduced from 39% to 27%. This is likely to reflect the impact of increasing age and complex chronic illness in the community.[5] Only very small numbers of patients received defibrillation by an Automated External Defibrillator (AED) across the report time period. However, these cases suggest slightly higher rates of Return Of Spontaneous Circulation (ROSC) at hospital than resuscitated cases where AED defibrillation was not administered (small numbers prevent reliable percentage calculations to be reported, however more than half of the AED group achieved ROSC at hospital in 2014, 2015 and 2016). There is opportunity for substantial improvement in survival amongst this patient cohort if public education and community AED provision are prioritised as public health strategies.


77%
Resuscitation attempts received bystander CPR in 2016
9-12 MINS
Median time to defibrillation
Metropolitan rate
104/100,000
Regional rate
141/100,000
Median age:
65 years
Remote rate
143/100,000
67% Male
69,338 OHCAs
in Queensland between 2000 and 2016

A need for community education

Bystander CPR rates have increased from 2000 to 2016, with witnessed cardiac arrests more often receiving bystander CPR (64%) than unwitnessed cases (25%). In 2016, bystander CPR was provided in 77% of cases that subsequently had a resuscitation attempt made by paramedics. This was over double the percentage across all OHCA cases (32%). Amongst witnessed OHCA that received bystander CPR, and where resuscitation was attempted, 36% of cases achieved ROSC on arrival at hospital. This figure increases to 46% for paramedic witnessed events.

Several key factors affect the likelihood of a patient's survival from OHCA: whether the event was witnessed, whether bystander CPR was administered, and whether the patient's presenting cardiac rhythm was shockable.

In cases where this trio of survival factors exists, ROSC at hospital rates for patients have almost doubled over the 17 year reporting period:

Where the cardiac arrest is witnessed, bystander CPR attempted, and resuscitation by QAS paramedics performed, ROSC at hospital has increased from 18% in 2000, to 36% in 2016.

Patients with an initial shockable rhythm have seen great improvement in prehospital outcomes, with ROSC at hospital doubling from 24% in 2000, to 48% in 2016.

In Queensland, survival to hospital discharge has increased from 9% in 2000 to 16% in 2016.

The QAS has delivered CPR Awareness and skills to 57,572 Queenslanders as at the end of 2016.

Recognition of outcomes for non-shockable cases

Whilst survival rates for witnessed OHCA with initial shockable rhythms have increased, with greater than 50% now considered a 'Survived Event' under the Utstein Guidelines definition, it is important to recognise that almost two-thirds of all OHCAs present in non-shockable rhythms. The outcomes for these patients are substantially poorer. On average this group achieves only half the ROSC rates, and one-tenth of the discharged alive rates of those cases presenting in VF/VT. To accurately represent survival from OHCA, reporting of non-shockable cases should be standard, as these patients are an increasing proportion of the OHCA cohort and present opportunities for improvement through community engagement, and CPR and AED education.

The future of acute cardiovascular care

QAS OHCA survival outcomes compare favourably with other ambulance jurisdictions against which they are benchmarked, despite the unique challenges of delivering services to a much larger, decentralised population in regional and remote areas. Clinical developments and system enhancements are ongoing to support continuing improvements to OHCA survival rates into the future. The QAS Cardiac Outcomes Project (COP) facilitates the systematic evaluation and measurement of performance and continues to inform clinical practice. This report is the first in a series of planned publications that will evolve to include additional aspects of cardiac arrest and coronary care intervention each year.

Queensland Ambulance Service

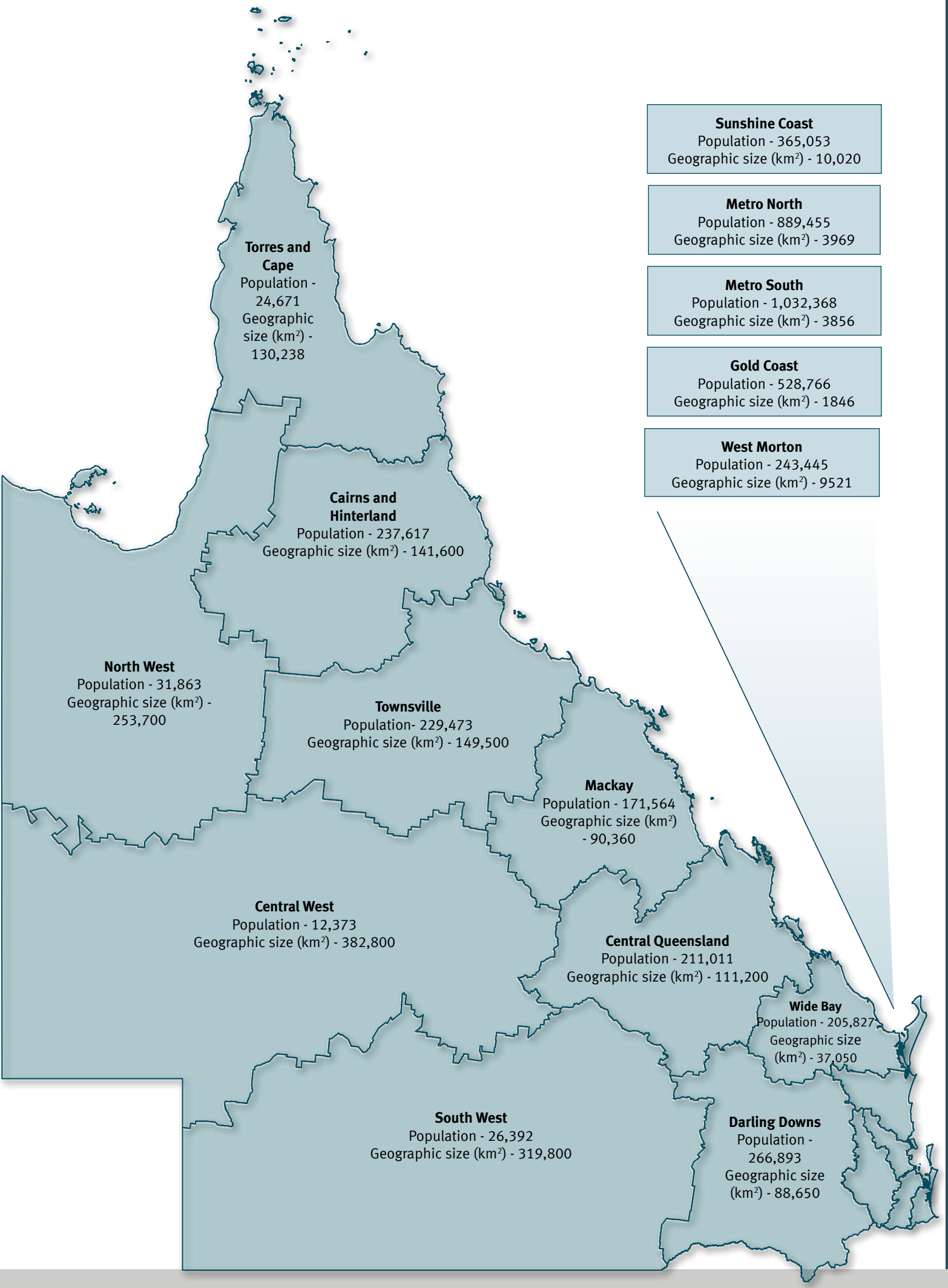
The QAS provides care to an estimated five million Queensland residents that are geographically dispersed over 1.7 million square kilometres. Relative to other Australian states, Queensland has a high proportion of its population residing outside major cities, with more than one-third of Queenslanders living in regional or remote areas (37%, compared with 21-26% in other states).[1] Given the size and terrain of the state, this wide population dispersion presents some unique challenges for QAS in the delivery of high quality ambulance services to all Queenslanders.

The service uses a two-tiered response model that consists of Advanced Care Paramedics (ACPs) who provide advanced life support skills (e.g. Laryngeal Mask Airway, intravenous adrenaline and cannula chest decompression) and Critical Care Paramedics (CCPs) who are authorised to perform further procedures and administer additional drugs (e.g. Endotracheal Intubation (ETT), atropine and amiodarone). The service also incorporates a High Acuity Response Unit (HARU) in metropolitan areas, which is staffed by specially trained paramedics and Medical Officers who are deployed as an adjunct response to deliver extended scope interventions such as Rapid Sequence Induction (RSI), thoracotomy, Focused Assessment with Sonography for Trauma (FAST)© and packed red blood cells. A typical response to an OHCA involves the concurrent deployment of advanced and critical care paramedics, where available.

The state is divided into 15 geographical Local Ambulance Service Network (LASN) areas. There are 296 ambulance response locations across the state, including: 229 permanent ambulance locations, 22 hospital based ambulance locations, ten airport locations, five field offices, 24 first responder and six honorary locations (volunteer). In addition to road ambulances, aeromedical and helicopter retrieval services are available, coordinated by Retrieval Services Queensland (RSQ) under the governance of the Queensland Government Department of Health.

The request for an emergency ambulance in Australia is made through a single national Triple Zero (000) telephone number. In Queensland, these calls are answered by Emergency Medical Dispatchers (EMDs) who work from seven Operations Centres located throughout the state. Their role is to obtain the location of the incident, ensure clinical prioritisation and dispatch of an emergency ambulance response, and provide instructions to implement first aid or CPR where appropriate. Telephone triage in Queensland is performed using the Medical Priority Dispatch System (MPDS), which is complemented by Computer Aided Dispatch (CAD) to facilitate the rapid deployment of resources.

The QAS cardiac arrest treatment protocols are consistent with the recommendations prescribed by the Australian Resuscitation Council (ARC) for the management of OHCA. In circumstances where there are obvious signs of death, paramedics may appropriately withhold resuscitation. The discontinuation of resuscitation may occur if 20 minutes of continuous CPR is performed without ROSC, in the presence of a cardiac rhythm of asystole or pulseless electrical activity (PEA) at a rate less than 10 per minute, and determination of life extinct criteria being met.


Sunshine Coast
Population - 365,053
Geographic size (km²) - 10,020
Metro North
Population - 889,455
Geographic size (km²) - 3969
Metro South
Population - 1,032,368
Geographic size (km²) - 3856
Gold Coast
Population - 528,766
Geographic size (km²) - 1846
West Morton
Population - 243,445
Geographic size (km²) - 9521
Torres and Cape
Population - 24,671
Geographic size (km²) - 130,238
Cairns and Hinterland
Population - 237,617
Geographic size (km²) - 141,600
North West
Population - 31,863
Geographic size (km²) - 253,700
Townsville
Population- 229,473
Geographic size (km²) - 149,500
Mackay
Population - 171,564
Geographic size (km²) - 90,360
Central West
Population - 12,373
Geographic size (km²) - 382,800
Central Queensland
Population - 211,011
Geographic size (km²) - 111,200
Wide Bay
Population - 205,827
Geographic size (km²) - 37,050
South West
Population - 26,392
Geographic size (km²) - 319,800
Darling Downs
Population - 266,893
Geographic size (km²) - 88,650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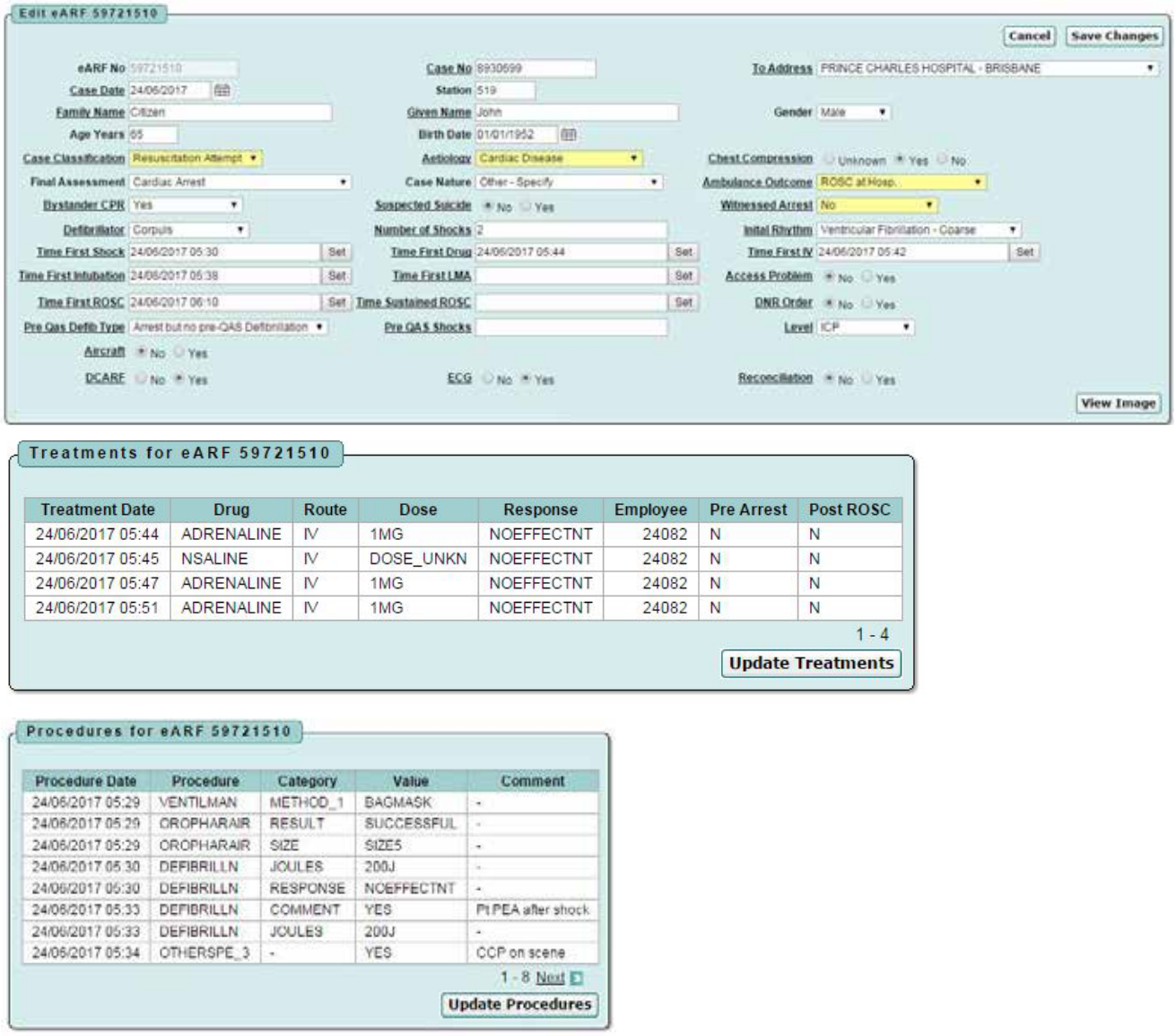
Queensland Ambulance Service Cardiac Outcomes Project

The QAS Cardiac Outcomes Project including the Cardiac Arrest Database (CADB) was established in 1999 and is used to provide important performance measures in terms of process and outcomes, as well as enable long term trend analyses. Over the 17 year time period, 2000-2016, the QAS CADB has captured more than 69,000 cases.

The database includes information obtained during the initial Triple Zero (000) call, from patient care records, and more recently hospital discharge information, to accurately describe the incidence, demographics, management, and survival outcomes of all cardiac arrests attended by the QAS. Primary data sources for the CADB include the electronic Ambulance Report Form (eARF), CAD, the Death and Cardiac Arrest Report Form (DCARF), and Electrocardiogram (ECG) tracing strips from cardiac monitors. Key case elements such as ambulance response times, prevalence of bystander CPR, presumed aetiology and survival to discharge can be derived from the CADB, and are used to undertake trend analysis and to measure service delivery and performance.



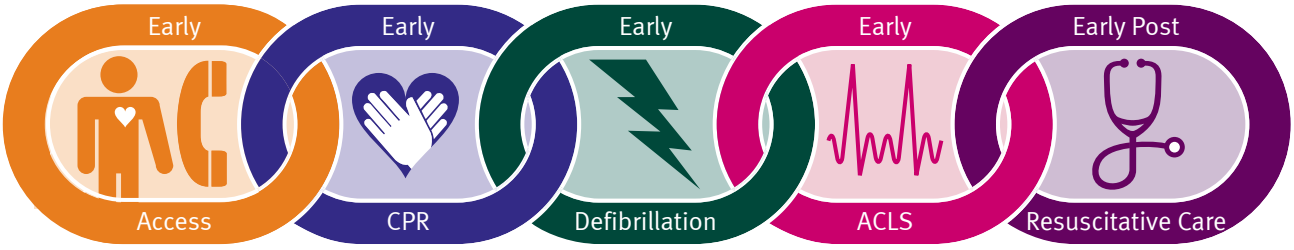
Screenshot of the Queensland Ambulance Service **Cardiac Arrest Database** *(CADB)*

Cases of cardiac arrest are eligible for inclusion in the CADB if patients are confirmed as unconscious and having no pulse on ambulance arrival (or at any time during ambulance treatment or transport); or, if there is good evidence of the patient having no pulse and being unconscious prior to ambulance arrival, even if circulation has been restored (for example, where sinus rhythm is restored in the patient due to defibrillation by AED). The database also includes all cases of obvious death, where paramedics may not monitor vital signs.

All cases of OHCA attended by QAS are reviewed and processed for calendar year reporting. The veracity of the database is maintained through a rigorous ongoing process which ensures uniformity and consistency. The data is subject to a comprehensive cleaning process, where missing data is identified (and recovered where possible), duplicate cases are removed, and inconsistent or conflicting data elements are corrected. The dataset is periodically reconciled with the main QAS electronic data warehouse using a search script consisting of key words and phrases to identify possible cardiac arrest cases not captured through the usual paper documentation submission method. These cases then undergo the same manual data auditing process to incorporate them into the CADB collection. Prior to finalisation, the dataset undergoes a multilevel review process, which involves a large number of randomly selected cases for reprocessing and validation.

Chain of Survival

The Chain of Survival, first described in 1989, is now a globally recognised concept that refers to four key actions or links that underpin OHCA resuscitation efforts.[2] These involve ***early access, early CPR, early defibrillation***, and ***early advanced life support***. More recently, the fifth link – ***integrated post cardiac arrest care*** – has been added. The fifth link has been shown to significantly improve survival and neurological outcomes in post ROSC OHCA patients.[3] When these links are optimised, together they maximise the likelihood of survival from OHCA. The service plays a role in supporting every component of the Chain of Survival, underpinning the importance of continually enhancing our operational and clinical practice.



Early access

The first link in the Chain of Survival involves early access and begins with a bystander's Triple Zero (000) call to the ambulance Operations Centre. The time taken to answer incoming Triple Zero (000) calls represents the first critical component of the ambulance response to cases of OHCA. In 2016, across the state's seven Operations Centres, in excess of 91% of incoming Triple Zero (000) calls were answered within ten seconds.

The EMDs' ability to quickly and correctly identify time critical cases sets in motion the appropriate ambulance response as a vital first step. QAS EMDs are expertly trained to recognise emergency Triple Zero (000) calls, including OHCA. In high volume centres, high priority Code One calls, such as OHCA cases, can be scrutinised by the Deployment Supervisor (DS) to help ensure the appropriate level of clinical response is dispatched in the shortest possible timeframe.

The ambulance response time is measured from when Operations Centre staff receives the Triple Zero (000) call to when the ambulance arrives at the scene of the incident. In 2016, response times for OHCA cases where resuscitation was attempted are shown in the table below.

	Metropolitan	Regional	Remote	Statewide
Median (minutes)	8	8.5	8.5	8
Standard Deviation	10.9	18.8	24.9	15.1
90th Percentile	15	24	41.90	18
%‹10 mins	64.4%	57.8%	60.0%	61.3%

Table 1: All OHCAs - Response times by location, 2016.

Statewide, QAS has a median response time between 8-8.5 minutes for OHCA where resuscitation is attempted; and in metropolitan areas nearly two-thirds are responded to within 10 minutes. The variance in response times in remote areas (standard deviation 24.9 minutes) is representative of the challenges inherent in delivering ambulance services across a diverse and decentralised state.

Early Cardiopulmonary Resuscitation

Bystander CPR can significantly increase the likelihood of survival following OHCA.[3] It is most effective when initiated as soon as possible after cardiac arrest onset, but should be encouraged in all cases unless the patient presents with obvious signs of death. Bystander witnessed cardiac arrests are most likely to receive bystander CPR, and in turn most likely to result in a resuscitation attempt being made by paramedics. This is because early CPR results in coronary artery blood flow and prolongs shockable cardiac rhythm VF/VT, making the heart more receptive to successful defibrillation. In addition, CPR maintains a blood supply to the brain and other vital organs, prolonging survivability.[4]

EMDs are highly skilled at providing CPR instructions over the phone to bystanders on scene, to ensure minimisation of delays in the application of CPR while an ambulance is enroute. The QAS continues to play an important role in improving bystander CPR participation through campaigns, such as the QAS CPR Awareness Program, aimed at increasing public awareness, education and training in CPR.

Early defibrillation

The likelihood of successful reversion to a life sustaining cardiac rhythm rapidly declines following the first few minutes after the cardiac arrest event. Therefore, early defibrillation of OHCA patients, whilst in a shockable rhythm, is the key to maximising favourable survival outcomes. An interesting trend noted amongst the QAS patient cohort is a reducing proportion of OHCA cases with a presenting shockable rhythm, most likely due to ageing of the population and common chronic illnesses which decrease the likelihood of presenting shockable rhythms.[5] Across the time period, QAS OHCA patients with an initial shockable rhythm on arrival of paramedics were defibrillated within 9-12 minutes (median) of the Triple Zero (000) call for QAS assistance being received. This measure has fluctuated slightly over the last 17 years, with no identifiable trend.

Public access to AEDs has been widely promoted by health authorities globally in recent years as a practical and effective way of reducing the delay to defibrillation of OHCA patients. The OHCA patients likely to benefit from AED access are those who have a witnessed cardiac arrest, where assistance can be offered immediately; the majority of these occur in public locations. In 2016, QAS attended 464 OHCA cases in public places (airport, workplace, sporting venue, public toilets and public areas) where resuscitation was subsequently attempted. Of these, only 17 were defibrillated by an AED prior to QAS arrival.

There is great opportunity for ambulance services and other health authorities to invest additional effort in this link in the Chain of Survival, as more widespread use of AEDs will undoubtedly improve OHCA outcomes.[6] Strategies to raise awareness in the Queensland community of the importance of early defibrillation in OHCA, and to improve access to and education in the use of public AEDs, are of key importance to QAS.

Early advanced life support

Early advanced life support is important for identifying and addressing reversible causes of OHCA and has been shown to improve both short and long term outcomes for patients in OHCA.[7] In 2016, all OHCA cases attended by QAS, where resuscitation was attempted, had an ACP2 clinical response as a minimum (the QAS response model also includes volunteer first responders and ACP1, with a narrower scope of practice). In addition, 78% had a CCP or higher in attendance. QAS paramedic practice is continually being reviewed at all levels to ensure it remains at the forefront of prehospital emergency care. Practices, procedures and drug therapy protocols have since been transformed and extended based on the latest clinical evidence. This process continues to evolve, driven by recognition of the importance of early advanced intervention in this group of patients.

Integrated post cardiac arrest care

In cases of OHCA where ROSC is achieved, transportation to the nearest appropriately equipped facility occurs without delay. This includes Percutaneous Coronary Intervention (PCI) capable hospitals where direct admission to the catheterisation laboratory can be negotiated between QAS paramedics and the on call specialist Cardiac Interventionist prior to hospital arrival, or specialist trauma centres in the case of trauma-related cases.

Flight CCPs and/or Medical Officer responses often occur for patients in remote or isolated areas, when long or delayed transports are anticipated, or when multistage transports are required. Retrieval Services Queensland is responsible for coordinating inter hospital retrievals of post-OHCA patients that are recognised as requiring transfer for specialised care in highly equipped tertiary hospitals. Together, these strategies ensure all OHCA patients receive the highest level of care possible, with minimal delay.

Incidence and demographics

Incidence rates of Out of Hospital Cardiac Arrest in Queensland

The incidence of OHCA in Queensland is increasing. Over a 17 year period (2000-2016), the QAS responded to 69,338 OHCA events (n=65,129 adults aged 16 years and over, n=1947 paediatrics, n= 2262 where the age was not recorded or unable to be determined). In the most recent reported year (2016), a total of 5101 events occurred (n=4860 adult, n=105 paediatric).

Across the time period from 2000 to 2016, overall incidence of OHCA in Queensland increased from 79 events per 100,000 head of population to 102 events per 100,000 population (Figure 1). Amongst adults, the rate increased by almost one-third (29%) from 96 to 124 events per 100,000 population. Rates of paediatric cardiac arrest declined slightly from 13 events per 100,000 population in 2000, to 11 events per 100,000 in 2016. It should be noted, continual improvement in record collection and the enhancements made to the QAS CADB (including electronic reporting) since its inception may have contributed to some increases in case identification of OHCA during the period.

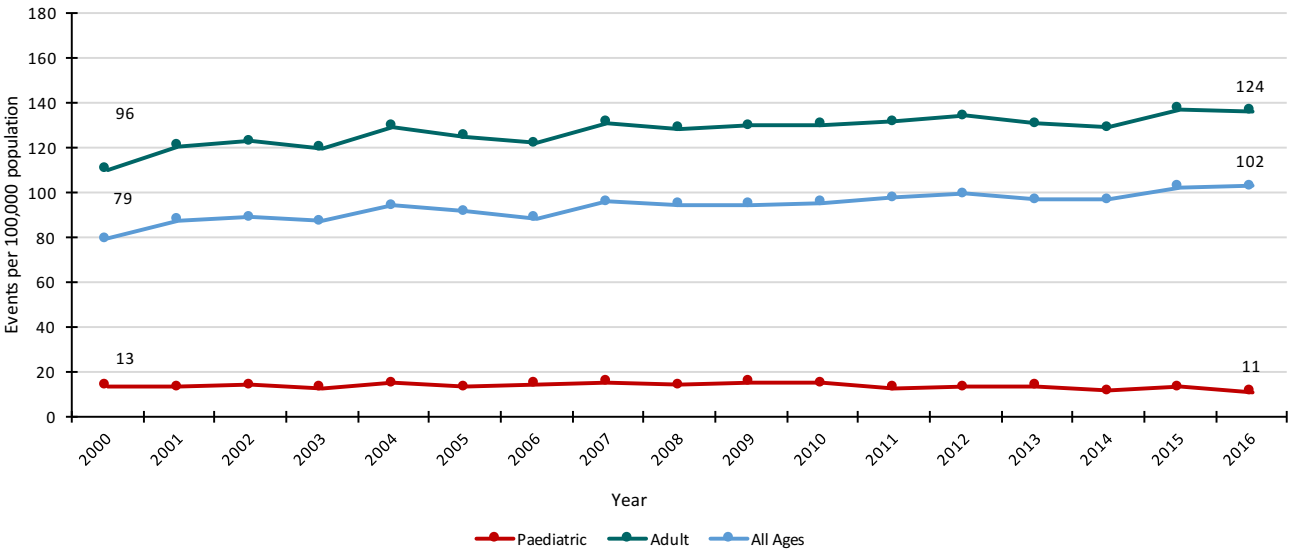


Figure 1: Crude incidence rate of all OHCA in Queensland – Adult, paediatric, all ages, 2000-2016
**Excludes cases where age unknown. (N=67,076)*

The most densely populated LASNs (Metro North, Metro South, Gold Coast, West Moreton and Sunshine Coast) demonstrate similar trends of increasing incidence rates from 2000 to 2016; ranging between 59 and 65 events per 100,000 population in 2000 and increasing to between 90 and 129 events per 100,000 population in 2016 (Figure 2). The greatest increases in OHCA rates were observed in Central West LASN (303% increase from 32 to 129 events per 100,000), and Wide Bay LASN (107% increase from 77 to 160 events per 100,000) recording the highest rate of cardiac arrest in the state in 2016. (Refer to the LASN map p.9 in the Queensland Ambulance Service section of the report for a graphic display of the characteristics of these areas).

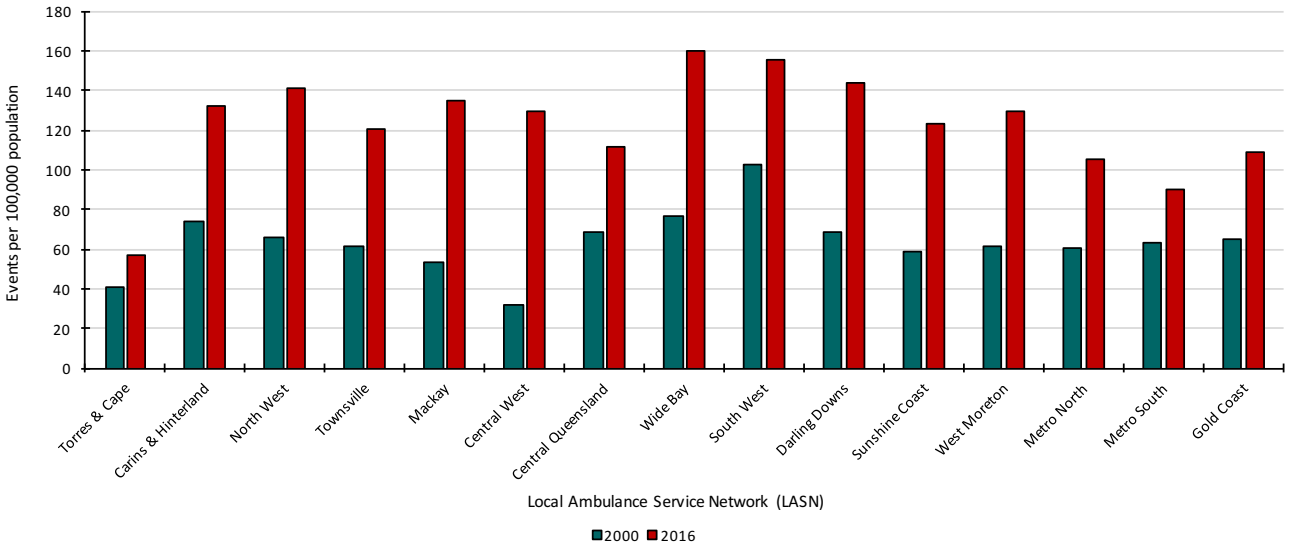


Figure 2: Crude incidence rate of all OHCA in Queensland, Local Ambulance Service Network, 2000-2016. (N = 7951)

Given the wide geographic dispersion of the Queensland population, the changes in OHCA incidence rates vary considerably between highly populated metropolitan areas, regional centres, and more sparsely populated remote parts of the state. In 2016, OHCA rates in regional and remote parts of Queensland (141 per 100,000 and 143 per 100,000, respectively) outnumbered those in metropolitan areas (104 per 100,000) by approximately 40% (Figure 3). The high rates of OHCA in regional and remote Queensland demonstrates the complexities and challenges associated with the delivery of care to these parts of the state, particularly in relation to time critical OHCA (Figure 4).

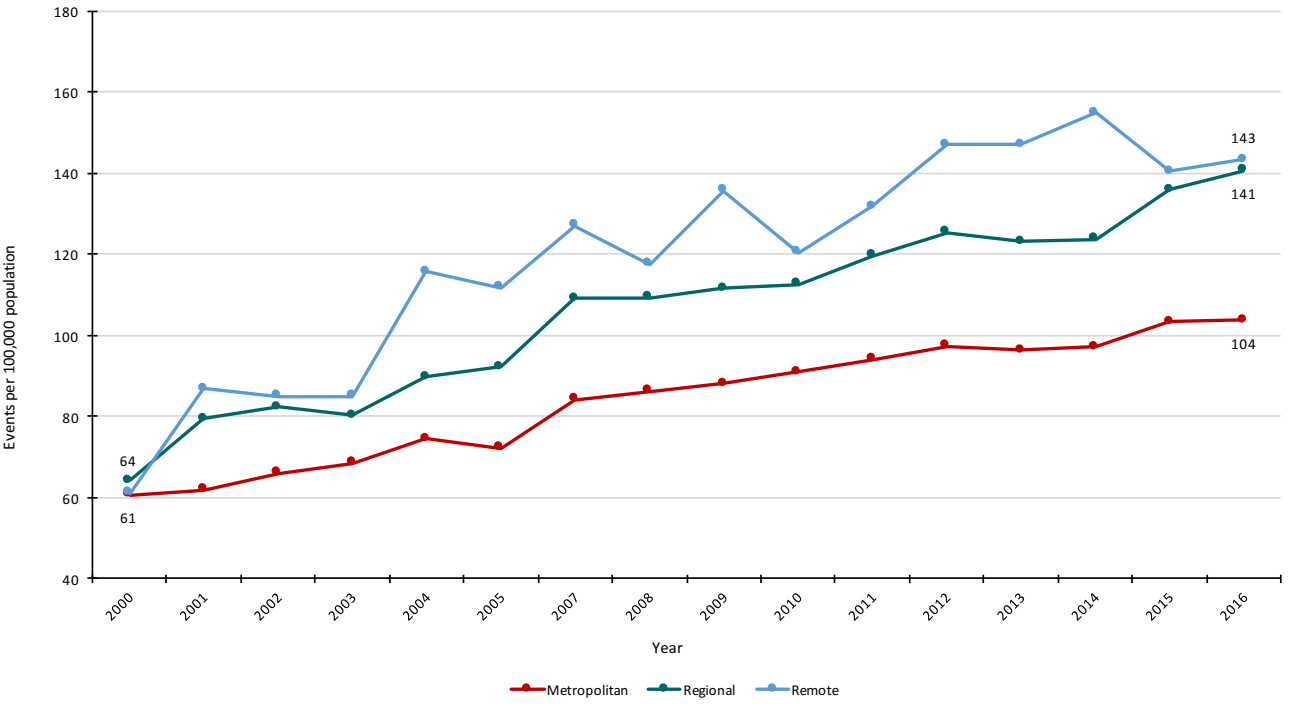
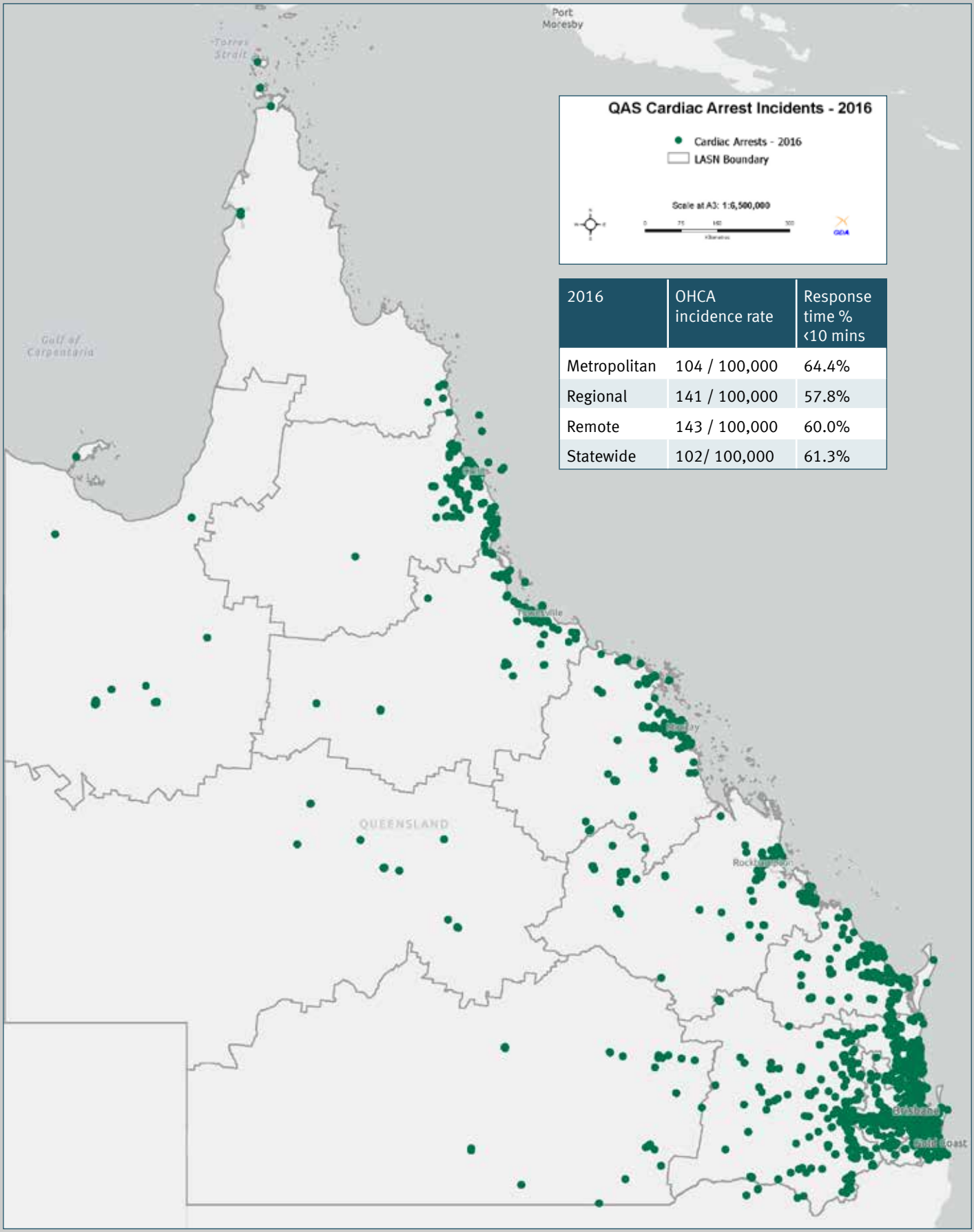


*Figure 3: Crude incidence rate of all OHCA in Queensland – Metropolitan, regional, remote, 2000-2016. * Data from 2006 excluded due to change in data collection method. (N=66,340)*

*Incidence rates were calculated using Australian Bureau of Statistics 2011 Census data as a central time point in the data collection (2000 – 2016) to base estimates upon.

QAS cardiac arrest incidents – 2016



2016	OHCA incidence rate	Response time % <10 mins
Metropolitan	104 / 100,000	64.4%
Regional	141 / 100,000	57.8%
Remote	143 / 100,000	60.0%
Statewide	102/ 100,000	61.3%

Figure 4: QAS cardiac arrest incidents – 2016

Profile of cardiac arrest patients

Across the entire 17 year time period (2000-2016), the majority of OHCA cases attended by QAS were male (67%), with a median age of 65 years (Figure 5). Males showed significantly younger median age of arrest than females (63 years vs 70 years; p<0.001). Only a very small proportion (3%) of cardiac arrests occurred amongst paediatric patients.

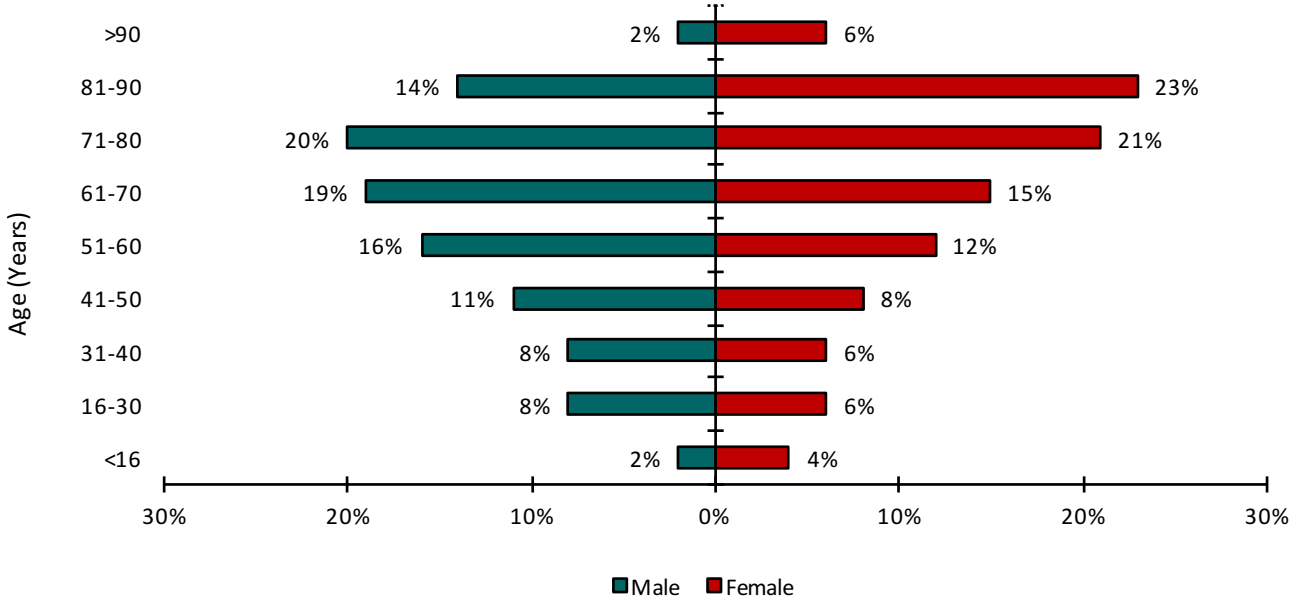


*Figure 5: Age distribution of all OHCA in Queensland, 2000-2016. (N=66,989) *Excludes cases where age unknown*

Aetiology of Out of Hospital Cardiac Arrest in Queensland

Paramedics record the circumstances of the OHCA on the Death and Cardiac Arrest Report Form (DCARF), which is manually audited in conjunction with the electronic patient record and entered into the QAS CADB. In accordance with the Utstein Guidelines, any cardiac arrest that does not have an alternative cause clearly identifiable (e.g. trauma, overdose, hanging etc.) is presumed to be of cardiac aetiology. The leading cause of cardiac arrest amongst adult patients attended by QAS paramedics is presumed cardiac aetiology, with approximately two-thirds (65%) of all cases attributed to a cardiac cause (Figure 6). A relatively smaller proportion are identified as trauma (8%), hanging (6%), overdose / poisoning (4%), terminal illness (3%), respiratory disease (3%) or other (11%).

The differences in aetiology between adult and paediatric patients are marked, with presumed SIDS being the cause for approximately one-third (31%) of all paediatric arrests, and 17% attributed to trauma. Only 4% of children were identified as having a primary cardiac origin, requiring evidence of a congenital heart problem in this young group. Interestingly, a much larger proportion of cases are coded as 'Other' (28%), highlighting the difficulties with identifying causative factors amongst this cohort of young patients. In addition, SIDS aetiology may be underestimated due to the Utstein definition exclusion of children ‹2 months and ›14 months,[8] and a proportion of these cases may be included in the 'Other' category.

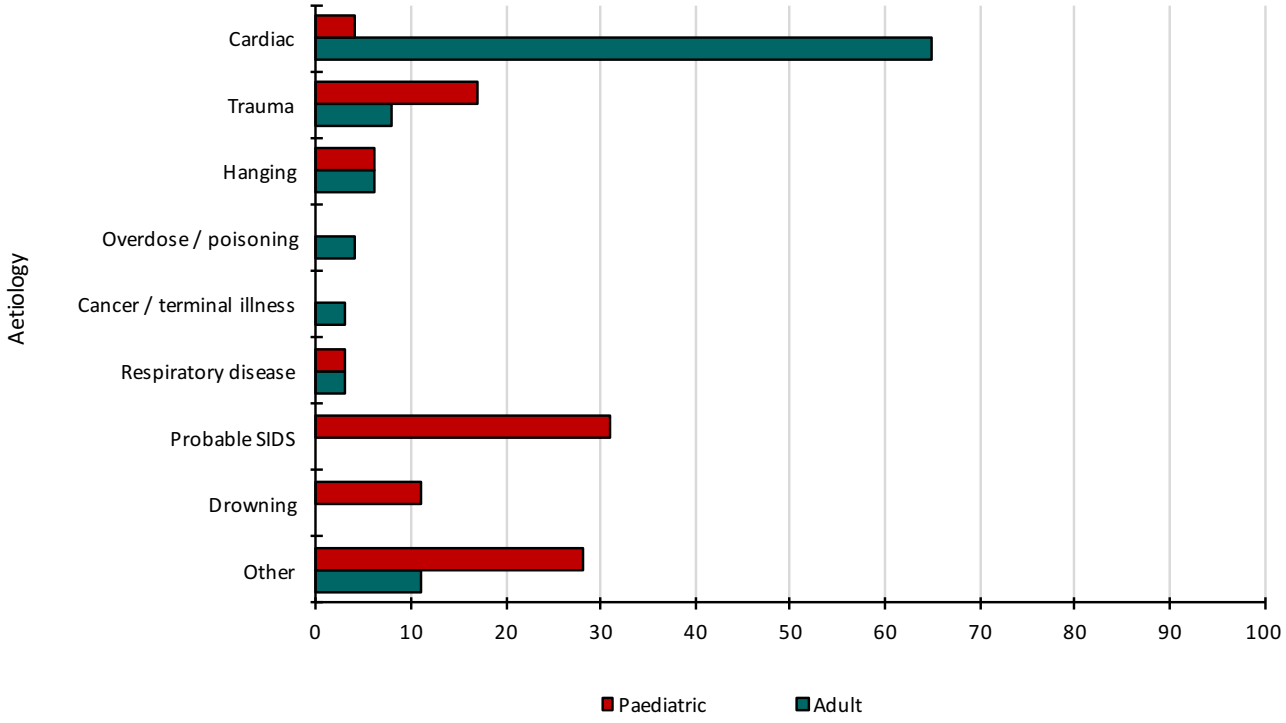


Figure 6: All cases of OHCA by aetiology – Adult, paediatric, 2000-2016. (N=67,075)
**Excludes cases where age or aetiology is unknown.*

When examining the cause of OHCA by age, there is a clear relationship between cardiac origin and increasing age. Less than ten per cent of OHCA are identified as cardiac in nature amongst patients under the age of 40 years (Figure 7). From the age of 40, an increasing proportion of cases are deemed to be cardiac related in each age category. The age band of 41-50 years shows approximately 45% cardiac aetiology, increasing to 90% for those in the 90+ years age group.

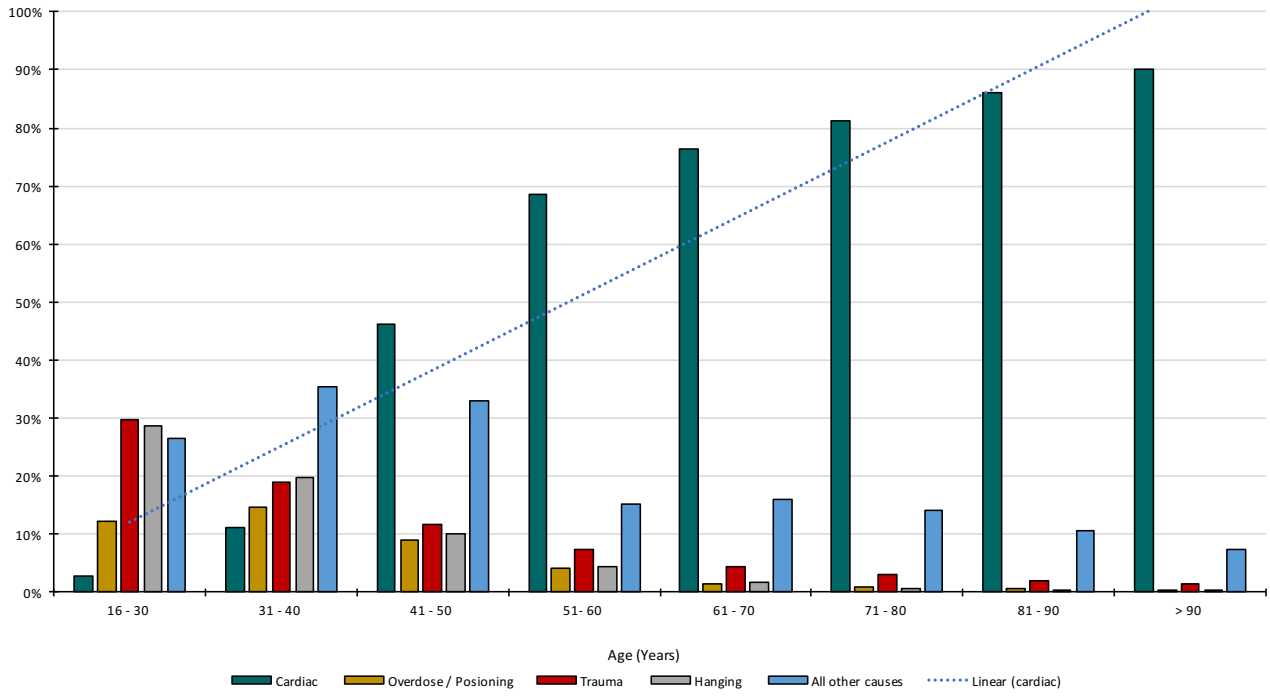


Figure 7: Adult OHCA – Age, aetiology, 2000-2016. (N=65,128)

A clear relationship between OHCA, cardiac origin, age and gender is apparent, particularly after the age of 50 years. Male incidence of cardiac origin arrest markedly increases at age 40 (which is a function of the Utstein Guidelines,[8] asserting that non-traumatic arrests with no obvious precipitating cause is assumed to be of cardiac origin for males ≥40 and females ≥ 50 years). By the 51-60 years age group, more than two-thirds of all cases are presumed cardiac aetiology in both men and women (Figure 8).

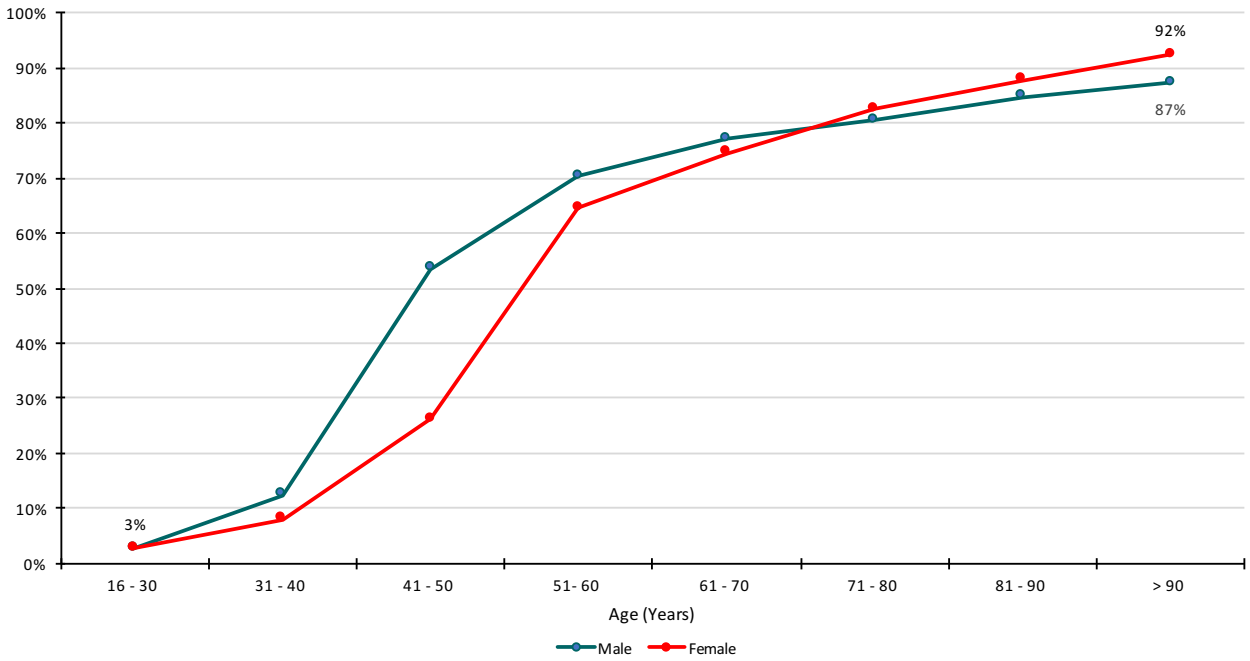


Figure 8: Adult OHCA of cardiac aetiology – Age, gender, 2000-2016. (N= 42,192)

Traumatic Out of Hospital Cardiac Arrest sub-groups

Across the period 2000-2016, the most common source of adult traumatic OHCA in Queensland is road traffic related events. Half of all traumatic mechanism OHCAs occur on the roads (including motor vehicle and motorcycle collisions, pedestrian and bicycle incidents) (Figure 9). Blunt trauma (including crush, fall, and struck by object) comprises almost a fifth of OHCA; penetrating trauma (including shooting and stabbing) and all other traumatic causes (sporting injury, assault, electrical contact, explosion and others) make up the remaining third of traumatic cardiac arrest cases.

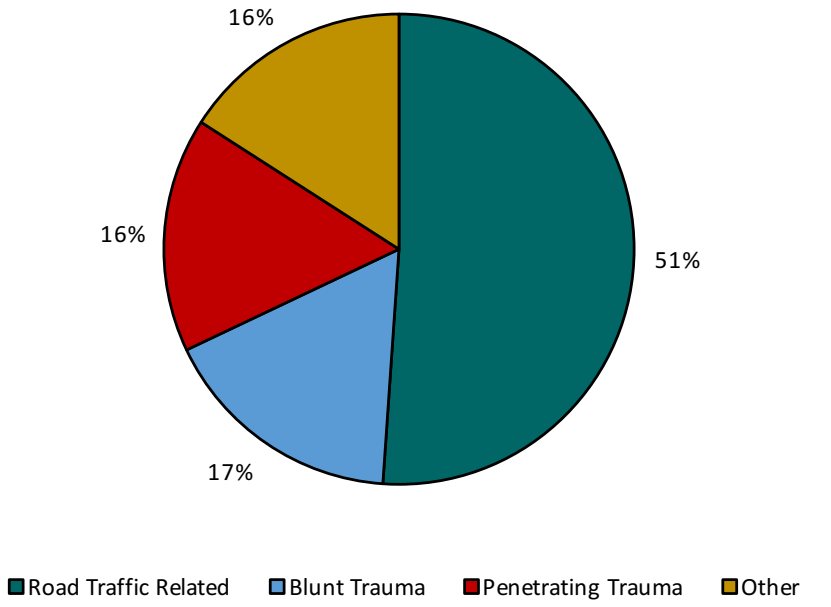


Figure 9: Adult OHCA of traumatic aetiology - Traumatic sub-groups, 2000-2016. (N=3412)

The overall outcomes for cardiac arrests secondary to traumatic injury are poorer than those of cardiac origin (See OHCA Outcomes Non-cardiac aetiology). The majority of adult traumatic OHCA cases occur amongst younger cohorts, with a median age of 41 years, and over three-quarters are male (77.1%) (Figure 10). Males dominate every age category up to greater than 90 years of age for traumatic cardiac arrest.

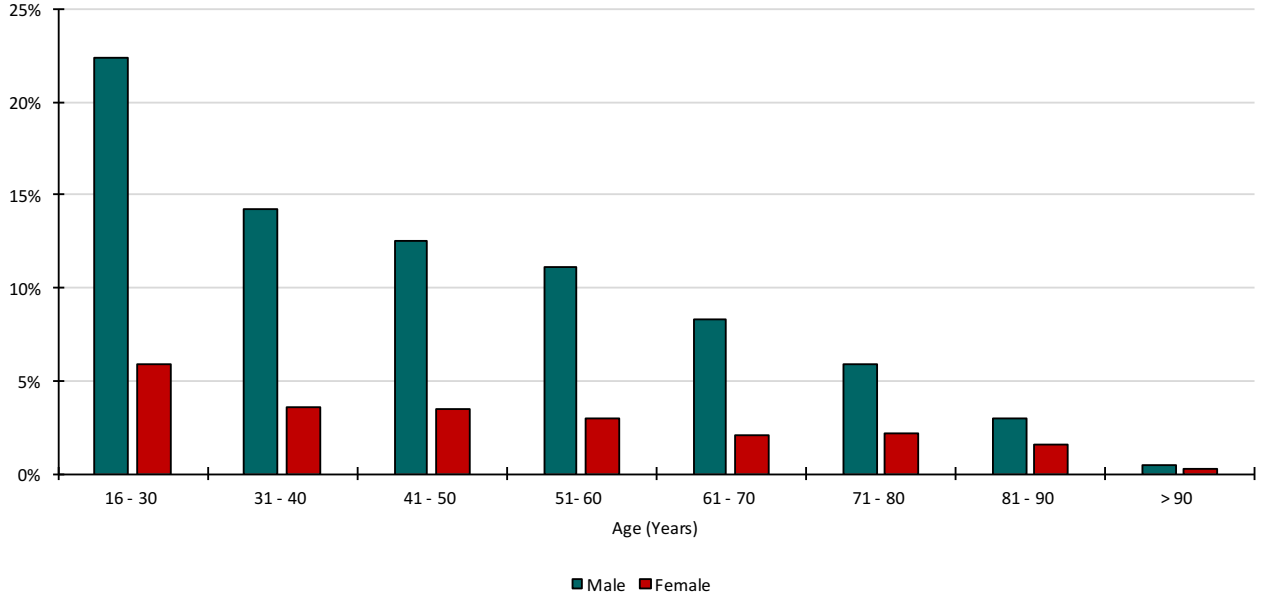


Figure 10: Adult OHCA of traumatic aetiology – Age, gender, 2000-2016. (N = 5083)

Location of Out of Hospital Cardiac Arrest

The outcome of an OHCA is heavily influenced by the location of the event as this impacts factors such as the proximity to bystanders, and capacity to effect early access to an emergency response and rapidly initiate appropriate resuscitative care. The most common location of OHCA is a private residence, with three-quarters occurring in private homes (Figure 11). Cardiac arrest in public places (including workplace, schools, shopping centre, sporting venue) occurs less frequently, comprising only one in ten cases of OHCA in Queensland, and only one in 20 occur at an aged care facility.

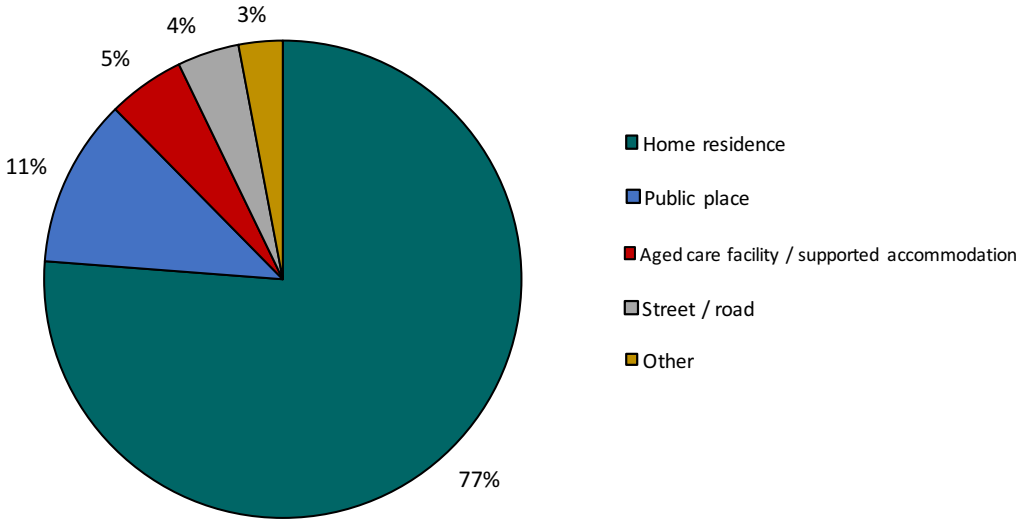


Figure 11: All cases of OHCA - Location (where recorded), 2000-2016. (N=66,187)

Outcomes for patients whose cardiac arrest occurs in a public place are better than those in a private residence or aged care facility / supported accommodation (See Outcomes section). It can be assumed age has an influential role to play in this result (Figure 12), with a significantly older age group suffering cardiac arrests at home (median age 67 years) or in aged care facilities / supported accommodation (median age 81 years), compared to a younger cohort of OHCAs in public places (median age 52 years) (p=0.001).

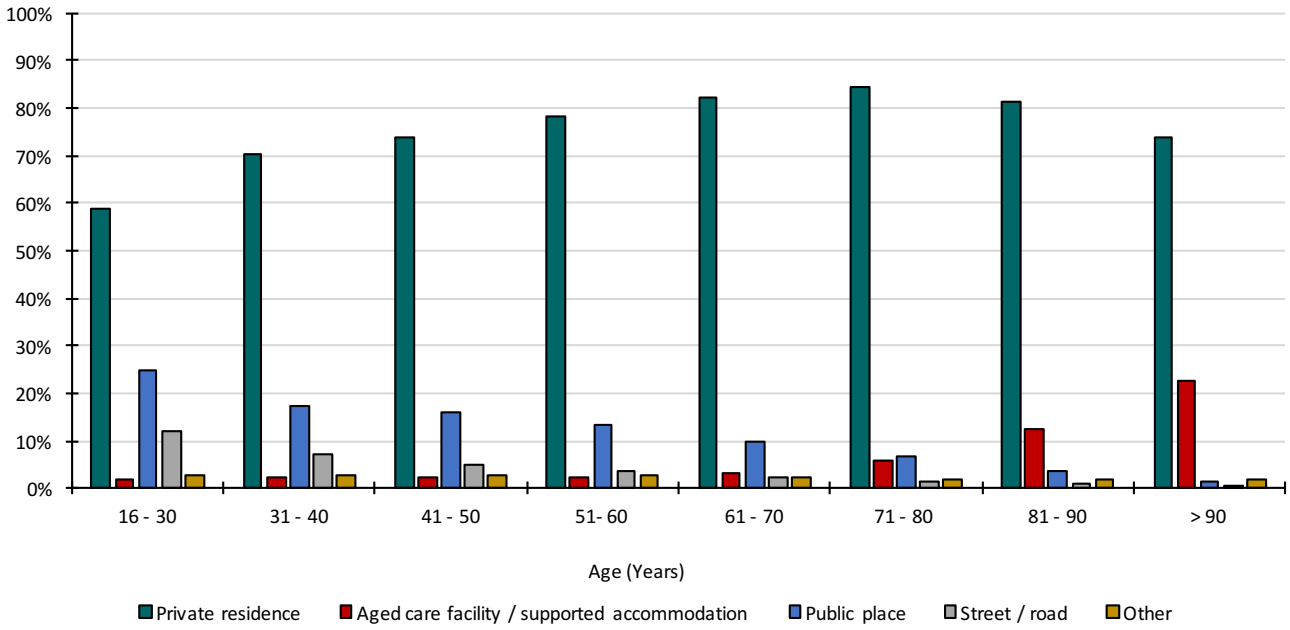


Figure 12: All cases of OHCA – Location, age categories (16+), 2000-2016. (N=62,188)

Cardiac arrest is more likely to be witnessed in a public place (44%), compared to a private residence (20%) (Figure 13). The higher proportion of witnessed arrests in public places impacts the greater availability of bystanders to initiate CPR and activate emergency medical care in a timely manner, which positively impacts survival rates.

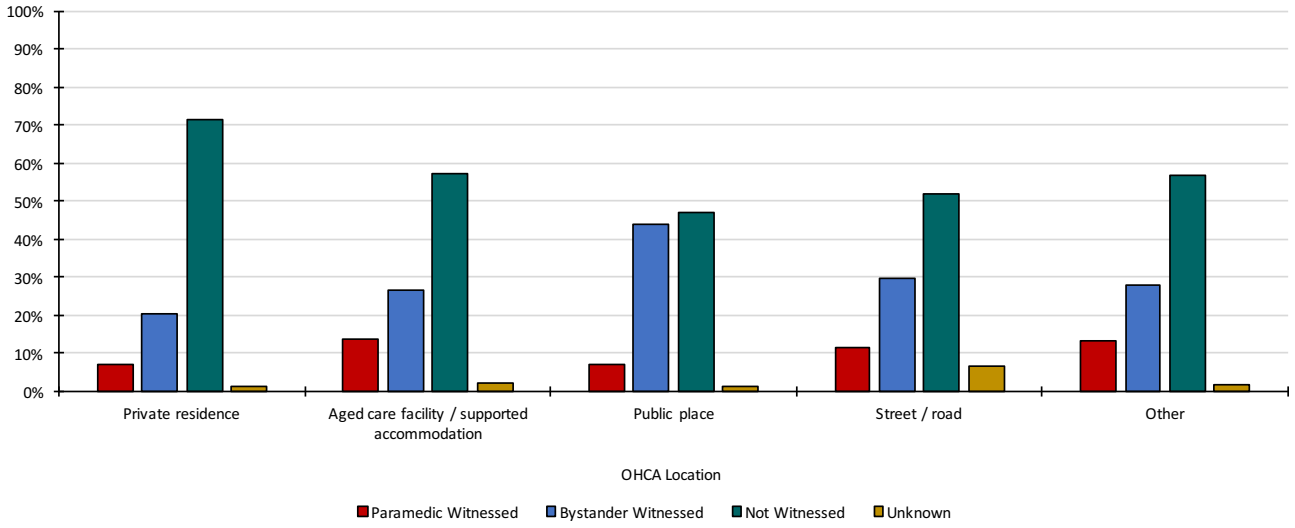


Figure 13: All cases of OHCA – Location, witnessed status, 2000-2016. (N=65,859)

Key features of Out of Hospital Cardiac Arrest events

There are several important features of all cardiac arrest cases that heavily influence the survival outcome for the patient. Witnessed cardiac arrests are more likely to receive bystander CPR than unwitnessed cases, and witnessed cardiac arrests that receive bystander CPR are far more likely to have successful outcomes than other cases. Therefore, it is vital ambulance services promote CPR awareness and encourage the community to be ready and willing to provide resuscitation to family members and friends, particularly given most OHCAs occur in the home.

Bystander CPR rates in Queensland have steadily increased over the past 17 years. Of all cases of OHCA that were witnessed by a bystander, 54% received bystander CPR in 2000, increasing to 64% in 2016. In witnessed cases where a resuscitation attempt was made by paramedics, bystander CPR increased from 58% in 2000 to 77% in 2016 (Figure 14).

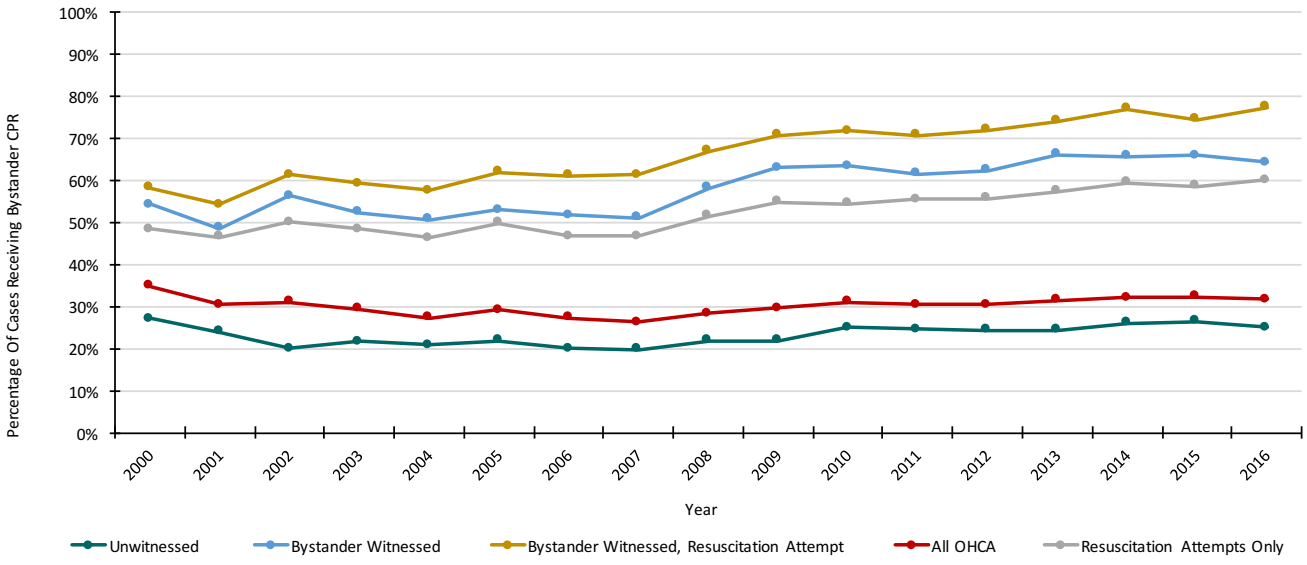


Figure 14: Per cent of cases that receive bystander CPR, 2000-2016 (N=68,970)

Initial rhythm

Over time, the proportion of OHCA presenting with cardiac rhythms amenable to electrical defibrillation (VF/VT) has reduced (Figure 15). Originally comprising 39% of cardiac arrests where resuscitation was attempted, shockable rhythms now only represent 27% of these cases, despite no variation in response timeframes and decreasing overall resuscitation attempt rates.

Declining resuscitation rates are observed from 54% in 2000 to 41% in 2016, except for OHCA cases where bystander CPR is a feature (48% in 2000 versus 60% in 2016). This further demonstrates the importance of bystander CPR, and the increasing ability of QAS paramedics to identify cases and commence resuscitation where it is appropriate, and to withhold advanced measures when they are likely to be futile.

Taking into consideration the overall trends in increasing age and chronic complex conditions amongst the population, it is likely that the observed increase in non-shockable rhythms is a result of this phenomena.[5]

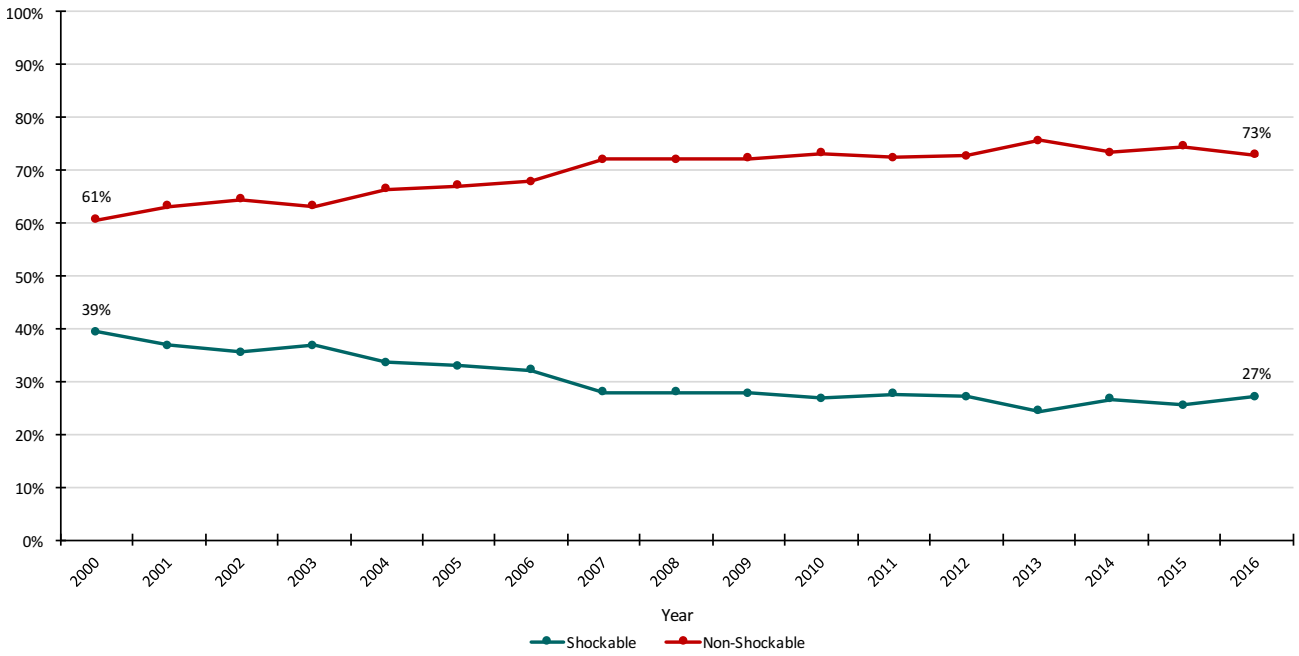


Figure 15: All cases of OHCA - Resuscitation attempts, initial rhythm, 2000-2016. (N=31,540)

As outlined in the Chain of Survival, early defibrillation is the next crucial link in survival from OHCA. Amongst QAS OHCA cases, the time taken to deliver the first shock has varied between nine and 12 minutes over the time period (Figure 16). No clear trend is apparent, although it does appear as though some outlier cases may be moving the 75th percentile higher. In an environment of increasing demand for ambulance service, high levels of urban traffic congestion and a population residing significant distances from metropolitan areas; the consistent delivery of an initial shock within 12 minutes of the Triple Zero (000) call to QAS being received is a commendable result.

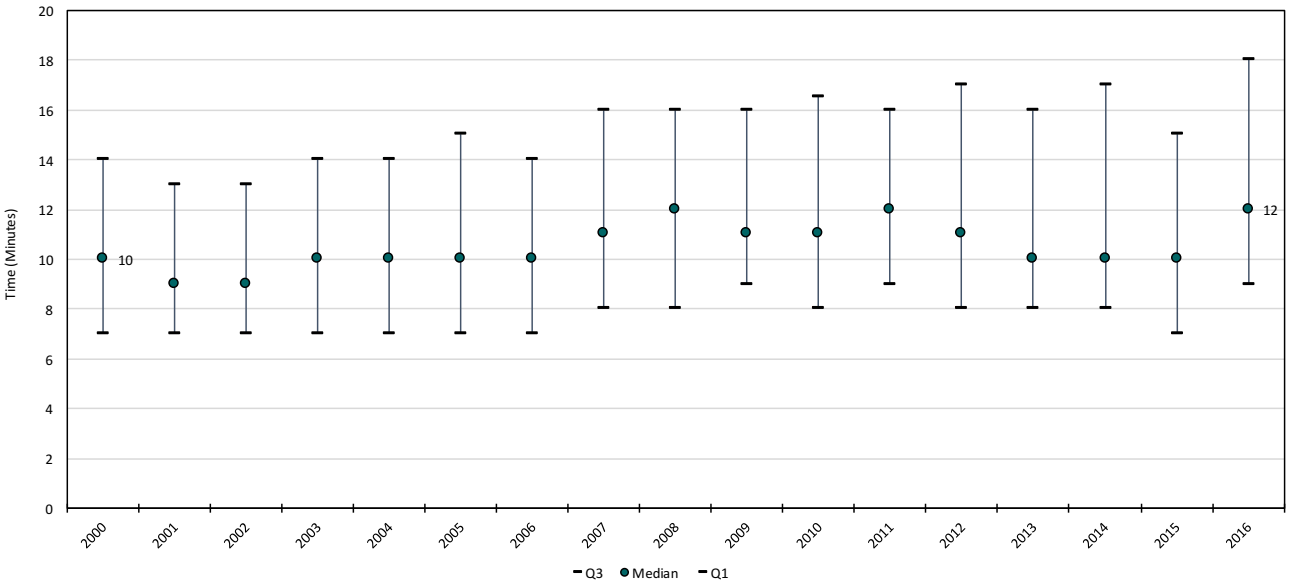


Figure 16: All cases of OHCA – Shockable rhythm, time 000 call received to first defibrillation, 2000-2016 (N=8471)


Coca-Cola
30

Out of Hospital Cardiac Arrest survival outcomes

Survival from OHCA is a key performance indicator for emergency medical systems internationally. In accordance with Utstein Guidelines, QAS measures OHCA outcomes in terms of:

- Successful resuscitation leading to ROSC that is maintained to hospital arrival;
- Survival to hospital discharge.

As identified throughout this report, several important factors influence the likelihood of a patient's survival from OHCA. These include whether another person was present and witnessed the patient going into cardiac arrest (witnessed cardiac arrest); whether bystanders attempted CPR on the patient (bystander CPR); and whether the patient's presenting cardiac rhythm was amenable to shock via a cardiac defibrillator when paramedics first arrived (initial rhythm).

All survival to discharge calculations have been limited to cases of presumed cardiac aetiology only until the end of 2016 due to the availability of linked outcome information for this group. Survival calculations that include all cases of OHCA, not only those of presumed cardiac aetiology, will be reported in future publications in accordance with the updated International Liaison Committee on Resuscitation (ILCOR) Consensus Statement.[9]

Increasingly, public places where large groups of people congregate (shopping centres, sporting venues, airports etc) have AEDs installed to resuscitate individuals who suffer an OHCA on the property. AEDs are small, lightweight and straightforward for the lay person to use, requiring no knowledge or training. Only a small proportion of QAS OHCA patients receive pre QAS defibrillation via an AED, but those who do appear to be more likely to achieve ROSC at hospital than other OHCA patients. The very small numbers make accurate comparisons difficult, however at least one-half of all patients who received AED in 2014, 2015 and 2016 achieved ROSC at hospital (Table 2).

Year	AED cases	ROSC at hospital
2000	11	4
2001	9	4
2002	7	1
2003	13	6
2004	9	4
2005	16	9
2006	11	3
2007	17	4
2008	12	8
2009	12	2
2010	14	6
2011	14	7
2012	15	8
2013	17	5
2014	18	9
2015	20	12
2016	17	10

Table 2: All OHCAs in public places - Resuscitation attempts, AED prior to QAS arrival, 2000-2016. (N=232)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The overall outcomes for witnessed OHCA events have improved substantially over the 17 year study period, with ROSC at hospital rates nearly doubling from 16% in 2000 to 30% in 2016 amongst patients who received a resuscitation attempt where bystander CPR was performed (Figure 17). There is a notable improvement in outcomes after implementation of the updated ILCOR guidelines[10] (~2008) (International Liaison Committee on Resuscitation) that revised the CPR compression and breath rate (30:2) and recommended a focus on hands on resuscitation education for paramedics.

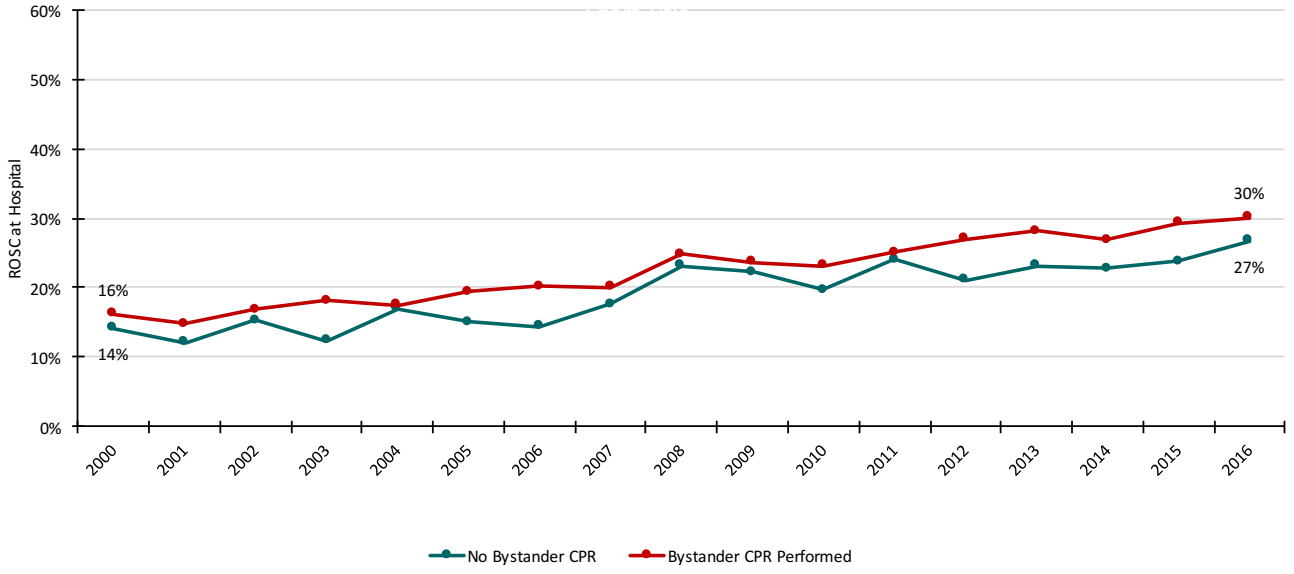

*Figure 17: Survival outcome of OHCA that receive a resuscitation attempt, No bystander CPR vs Bystander CPR, 2000-2016 (N=26,273) *Excludes paramedic witnessed cases*

Unwitnessed OHCA have universally poor prognoses, with low rates of subsequent resuscitation attempts and ROSC at hospital. Unwitnessed cardiac arrests that receive resuscitation are considerably less likely to obtain ROSC at hospital (23% versus 36% for witnessed OHCA in 2016), despite the ROSC rate doubling from 10% in 2000 to 23% after 2016 (Figure 18).

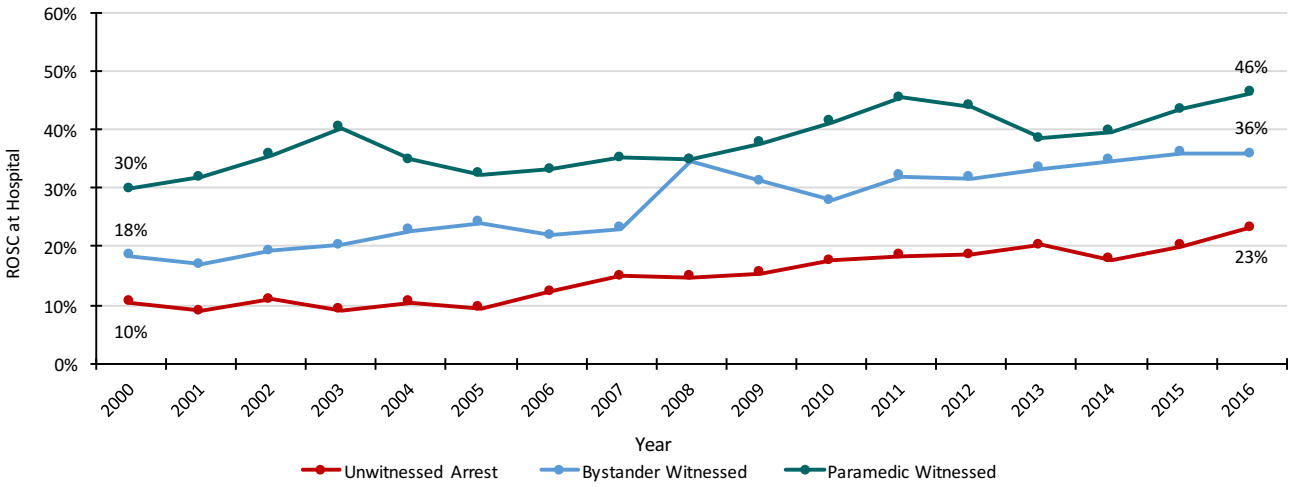

Figure 18: Survival outcome of OHCA that receive a resuscitation attempt, Witnessed vs Unwitnessed, 2000-2016 (N=31,356)

The rate of survivors as a result of QAS resuscitation efforts has almost doubled from 2000 to 2016 as a result of substantial clinical and system improvements. This is particularly apparent amongst OHCA cases presenting in a shockable rhythm, with this group of patients now twice as likely to achieve ROSC (48%) than patients presenting in non-shockable rhythm (23%) (Figure 19).

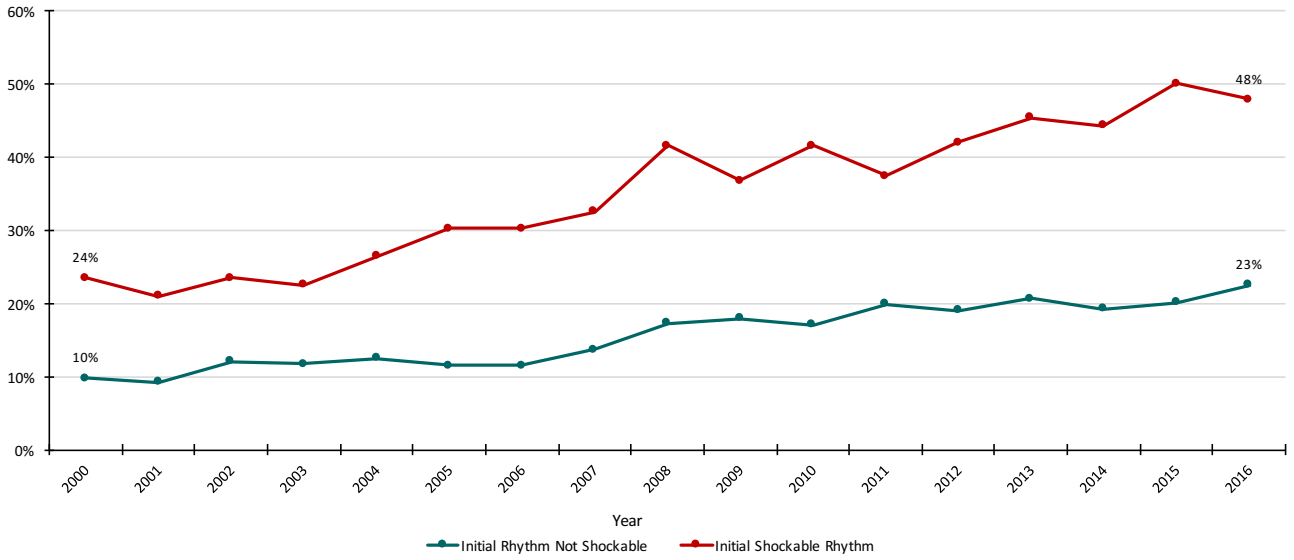

*Figure 19: Survival outcome of OHCA that receive a resuscitation attempt, Initial rhythm Shockable vs Non-shockable, 2000-2016 (N=26,273) *Excludes paramedic witnessed cases*

QAS paramedics have demonstrated improved clinical judgement in terms of selecting appropriate patients to commence resuscitation, with resuscitation for OHCA cases of cardiac origin reducing from 40% to 27% across the study period. Evidence of this decreasing resuscitation rate being a result of enhanced clinical judgement lies in the corresponding increases in ROSC and survival to discharge rates amongst the same patient group, indicating paramedics are increasingly making effective clinical decisions on where resuscitation efforts can be maximised, and avoiding futile resuscitation effort. In 2016, 34% of these patients achieved ROSC at hospital, an increase of 16 percentage points from 2000, and survival to hospital discharge increasing from 9% to 16% during the period (Figure 20).

Whilst overall survival to hospital discharge remains universally low amongst the OHCA cohort, it has approximately doubled since the year 2000 in Queensland. This equates to 226 individuals who survived an OHCA in 2016 (16%), compared with 100 survivors (9%) in 2000. Thanks to a timely and sophisticated ambulance response, an additional 126 people return to their community, family and friends.

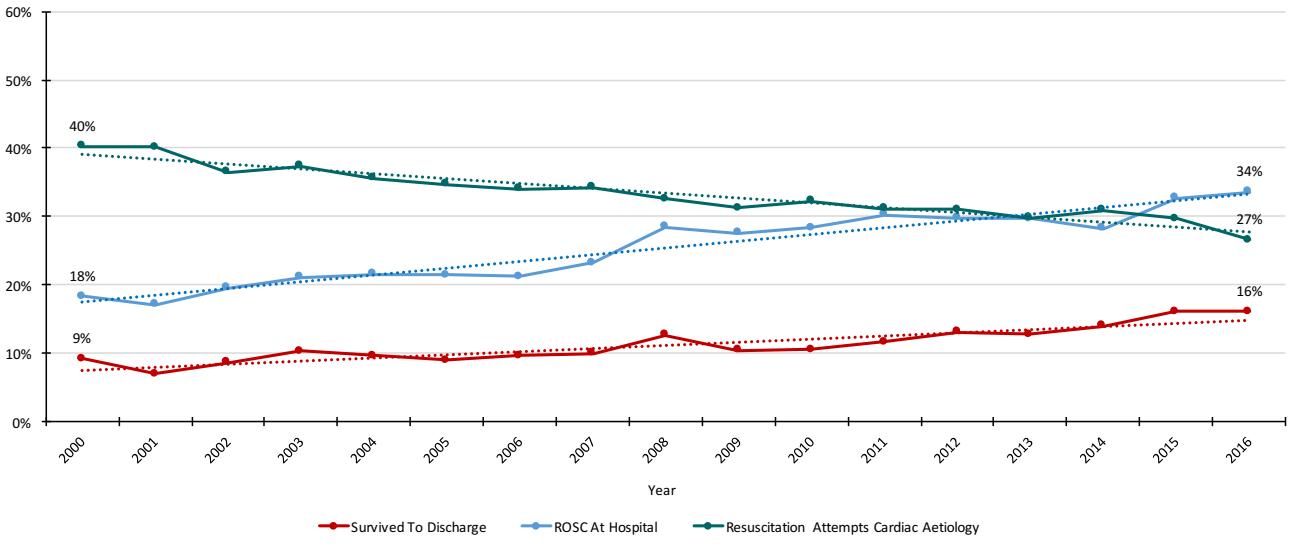

Figure 20: Survival outcome of OHCA that receive a resuscitation attempt, Presumed cardiac aetiology, 2000-2016 (N=21,278)

The Utstein Guidelines 'Survived Event Rate' Measure

All cases where resuscitation is attempted by paramedics are used in the calculation of OHCA survival statistics, termed the Survived Event Rate (SER). This is in accordance with the Utstein Guidelines for reporting OHCA.[8] SERs are reported as number of events and as a percentage of total cases. Survival rates vary depending on the inclusion criteria used. Some cases of OHCA have a much better prognosis for attaining ROSC than others. Numerous factors affect survivability after OHCA, therefore it is important that reported survival statistics clearly define the inclusion criteria used so accurate comparisons can be made.

The OHCA SER is used by most ambulance jurisdictions as a measure of operational performance. It is most useful for measuring internal performance trends and is usually measured on an annual basis. More frequent reporting and reporting based on much smaller subsets is difficult because there may be insufficient case numbers to provide a stable measure that is sufficiently robust to random variation over time.

The SER is less useful for making interjurisdictional performance comparisons. Although the Utstein definitions used by most ambulance services provide some degree of homogeneity, the inherent variations in interpretation, data definitions and case classification across jurisdictions introduce variance in denominator groups, making comparisons difficult.[11]

The results in Figure 21 provide a clear demonstration of the different treatment groups within the 2016 OHCA cohort, and the differing outcomes achieved for witnessed and unwitnessed events, shockable and non-shockable rhythms, and the impact of bystander CPR. It is clear from this figure OHCA presenting in non-shockable rhythms (63% of all bystander witnessed events) have far poorer outcomes, with:

- Half the 'Survived Event Rate' (26% versus 52% for VF/VT presentations)
- Less than four per cent discharged alive compared to 31% for VF/VT presentations.

Much of the performance reporting around OHCA has concentrated on the favourable statistics generated by the VF/VT cohort, however more than half of OHCA cases present with rhythms not conducive to defibrillation, and the rate of OHCA presenting in non-shockable rhythms is increasing. Focusing on the survival statistics of patients presenting in shockable rhythms is at the expense of the majority of OHCA cases where good quality CPR commenced immediately has the potential to improve survival.


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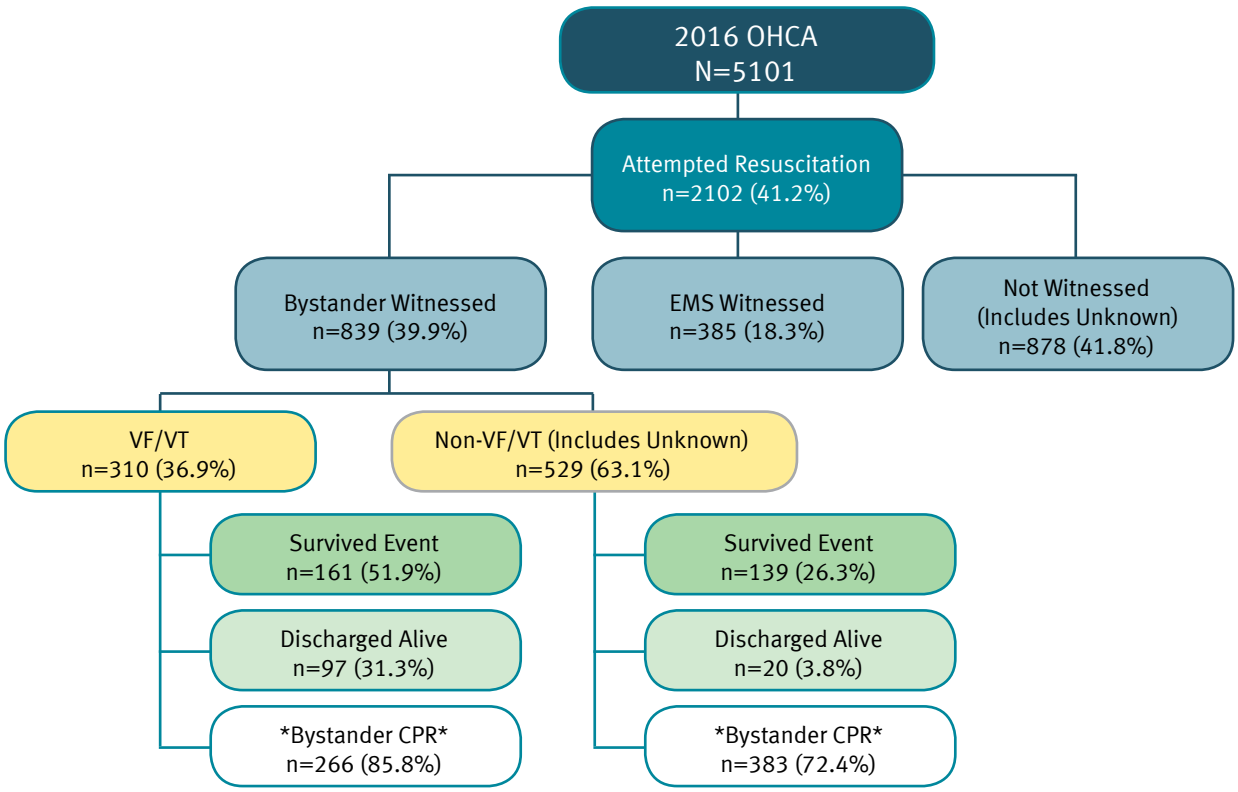


Figure 21: All cases of OHCA, 2016. (N=5101)

Population standardised rates provide the most comparable measure of cardiac arrest survival outcomes. Table 3 demonstrates survival to hospital discharge in metropolitan, regional and remote areas of Queensland for OHCA cases that received resuscitative efforts by QAS paramedics. Despite a large proportion of the Queensland population residing in regional and remote areas, and increasing rates of OHCA occurring outside metropolitan Queensland, survival to hospital discharge rates per head of population are comparable across the state. The QAS delivers high quality emergency ambulance services to all Queenslanders, regardless of their location.

Year	2013	2014	2015	2016
Metropolitan OHCA	778	805	816	758
Metropolitan survived to hospital discharge	103	123	137	128
Metropolitan survival rate per 100,000	13,239	15,279	16,789	16,886
Regional OHCA	480	520	558	496
Regional survived to hospital discharge	54	64	83	79
Regional survival rate per 100,000	11,250	12,308	14,874	15,927
Remote OHCA	34	35	32	33
Remote survived to hospital discharge	9	4	6	5
Remote survival rate per 100,000	26,471	11,429	18,750	15,151

Table 3: Survival to hospital discharge of OHCA of presumed cardiac aetiology that receive a resuscitation attempt, 2013-2016, (N=5345)


CARDIAC 1

Improving Out of Hospital Cardiac Arrest outcomes

Earlier in this report, the discussion around the Chain of Survival highlighted many factors influencing survival from OHCA. It is recognised no single intervention for improving outcomes is likely to provide a wholly effective solution. Achieving substantial improvements in OHCA outcomes requires a strategic, systems-based approach that addresses each link in the chain. Current limitations in the continuum of care need to be identified to target appropriate improvement strategies.

To this end, QAS has implemented a number of key initiatives including the following:

- Review of OHCA best practice and an epidemiological analysis of OHCA patients
- The 'Survival Trends 2000-2016' QAS OHCA Report (this report)
- QAS Prehospital Cardiac Reperfusion Strategy
- Collaboration on the Australian Resuscitation Outcomes Consortium (Aus-ROC)

QAS Prehospital Cardiac Reperfusion Strategy

QAS has invested in a paramedic workforce with the capacity to improve the availability and accessibility of cardiac reperfusion therapies for ST-elevation Myocardial infarction (STEMI) patients. All paramedics in Queensland have the ability to acquire and interpret 12-lead ECGs, and CCPs autonomously deliver fibrinolysis or refer to cardiac catheter laboratories. ACPs access a 24/7 internal clinical support system, designed to ensure safe and prompt administration of prehospital fibrinolysis, or facilitate early referral for primary Percutaneous Coronary Intervention (pPCI) following the identification of an acute STEMI. The early identification and subsequent restoration of coronary circulation through paramedic-initiated treatment is an important associated prehospital determinant of OHCA outcome that is often overlooked in survival reporting.

In 2016, QAS paramedics made 460 referrals to pPCI capable facilities, with an additional 93 administrations of prehospital fibrinolysis following the early recognition of acute STEMI. These numbers are expected to increase over the next few years due to consolidation of the program and more sophisticated audit and reporting processes.

An important element of this strategy is the service's partnership with the Queensland Cardiac Outcomes Registry (QCOR), a collaboration that collects and reports on the delivery, trends and outcomes of cardiac interventions in Queensland. The QAS provides prehospital data points to the registry and is a key collaborator in projects relevant to the prehospital delivery of cardiac interventions.

Photo courtesy of Studio Deco Photography, Brisbane.

Australian Resuscitation Outcomes Consortium

QAS is a collaborator in the Aus-ROC Epistry (epidemiologic registry). This is a National Health and Medical Research Council (NHMRC) funded initiative, modelled on the successful North American Resuscitation Outcomes Consortium. This initiative involves a collaborative research agreement across seven ambulance services (Queensland Ambulance Service, Ambulance Victoria, St John Western Australia, St John Northern Territory, South Australia Ambulance Service, St John New Zealand, and Wellington Free Ambulance), and three universities (Monash University, University of Western Australia, and Flinders University). The purpose is to establish an Australia and New Zealand wide epidemiological collection of OHCA, to measure and report on the population based effects of changes in prehospital resuscitation policy and resuscitation management practices. This collaboration promises to provide valuable data on OHCA survival, and further identify factors associated with favourable outcomes.

Community Cardiopulmonary Resuscitation awareness

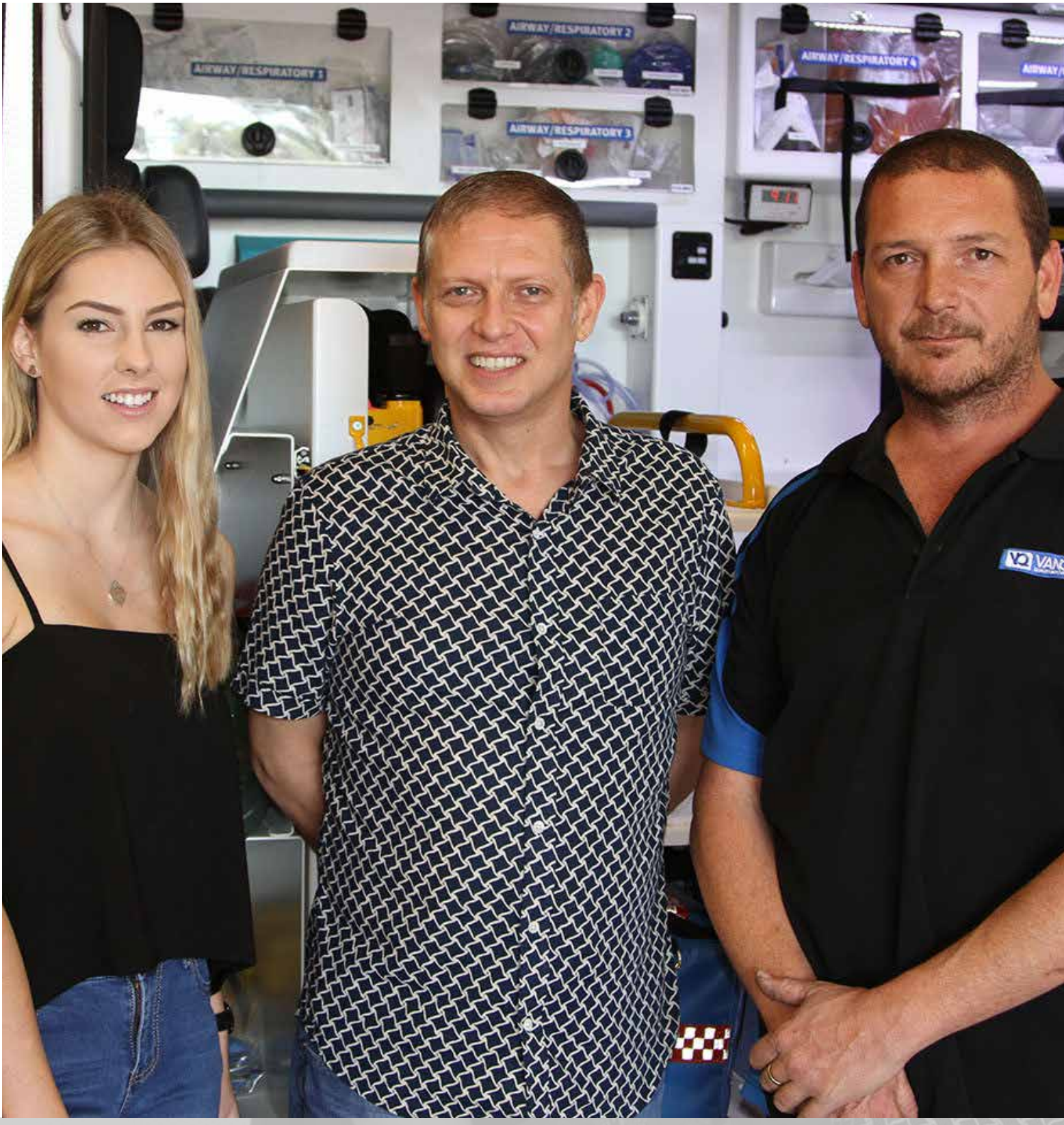
A key priority of the QAS is enhancing the community's capacity to respond to OHCA as most OHCAs occur in a private residence, proximal to family members or friends.

The CPR Awareness (CPRA) Program was launched in 2008 and is a Local Ambulance Committee (LAC) led initiative that aims to provide the community with the knowledge, skills and confidence necessary to respond to a sudden OHCA. At a CPRA session, community members will become familiar with the life-saving skill of single operator CPR.

With 149 active LACs across the state, the QAS is proud of the collective efforts of its 1,280 LAC volunteers delivering this program to members of the community at local shows, fetes, school visits and public gatherings, in conjunction with our paramedics.

Since its inception, the CPRA Program has been delivered to 57,572 members of the community across the state (to the end of 2016). By equipping individuals with the knowledge, skills and confidence to perform quality CPR, patient outcomes are likely to improve for those presenting in a shockable rhythm for OHCA.

Queensland's OHCA survival outcomes compare favourably with other jurisdictions against which they are benchmarked. Clinical developments and system enhancements are ongoing to assure continued improvement in survival rates into the future. The QAS Cardiac Outcomes Project facilitates the systematic evaluation and measurement of performance and continues to inform developments in clinical practice. This report is the first in a series of planned publications that will evolve to include additional cardiac arrest and coronary care intervention aspects each year.


AIRWAY/RESPIRATORY 2
AIRWAY/RESPIRATORY 3
AIRWAY/RESPIRATORY 4

A survivor's story

Metro South Hospital and Health Service (HHS) Registered Nurse, Dale Marshall, has seen CPR save the lives of countless patients throughout his 25 year career. Like many clinicians, he never anticipated he would one day be included amongst the patient cohort known as 'cardiac arrest survivors', least of all being cared for within his own work unit as one. But he is, thanks to the quick thinking of two bystanders following his collapse at a Brisbane service station in July, 2017.

In an emotional reunion organised by QAS Media and Brisbane's Channel 9 News, Dale thanked the two strangers who sprang into immediate action, seamlessly working together by immediately calling Triple Zero (000) and beginning effective chest compressions.

Speaking about his experience, the Princess Alexandra Hospital (PAH) Intensive Care Unit nurse said he knew he was extremely lucky to have been in the right place at the right time.

'I had felt unwell on and off the past few months and my only cardiac symptom was what I thought to be an ectopic beat, I was actually on my way to the doctors that day— just as a precaution— and I must have pulled into the service station knowing something was wrong,' Dale said.

'Later I learned I had collapsed and arrested just moments after, and thankfully the actions of two complete strangers, Peter Virgulti and Samantha Golledge, saved my life,' Dale said.

'Without them starting that early, effective CPR and ringing Triple Zero (000) straight away, I know all too well the life altering complications I could have faced, including severe neurological dysfunction, irreversible damage to my heart or other vital organs, and of course—death.'

'Peter and Samantha were extremely humble, and I will be forever thankful they were there in my time of need.'

'It was wonderful to reunite with them to thank them for saving my life. I've since found out that Samantha is a nurse in training and Peter, an Auto Electrician, recalled CPR training from school swimming classes at a very young age. He said to me that he knew the situation was extremely serious and any attempt was better than nothing— and I totally agree, because without that quick thinking and determination from him and Samantha, I would not be here today.

'Of course, taking over from Peter and Samantha were an extremely competent team of clinicians from QAS, and their expertise ensured I had the best chance of survival.'

Dale was transported code One to the PAH ICU, where we underwent angioplasty, with one stent being placed in the circumflex artery.

'Certainly, it was a role reversal being a patient in my own ward, but from the prehospital to health care setting— I cannot fault a thing with my treatment,' he said.

'I can imagine like nursing, the scope of paramedicine has evolved to a degree where patients who would have previously had a small chance of survival now have significantly better outcomes, and that's something I've appreciated as a clinician, but of course, am now eternally grateful for on a personal level.'

Our team – about the QAS

Information Support, Research and Evaluation Unit

Located in Brisbane, our small team is made up of corporate and operational staff including research and public health professionals, statisticians, data analysts and clinical coders.

In addition to running the Cardiac Outcomes Program, the unit is committed to the pursuit of strategic research collaborations with the aim of developing the prehospital evidence base and informing clinical and operational decision making. Key roles of the Information Support, Research and Evaluation (ISRE) Unit include: clinical and service related research, program evaluation, support for internal QAS committees, governance over access to QAS data and supervision/mentorship to paramedic researchers.

At a glance – the data collection of Out of Hospital Cardiac Arrests - from 1999-2016

In 1999, the QAS OHCA Program was established to meet the reporting requirements for Key Performance Indicators for the QAS. The now current Director of the ISRE Unit (Assoc. Professor Emma Bosley, at the time a new graduate and Research Assistant) set about establishing processes to collect and collate OHCA information recorded by paramedics across Queensland.

The task involved large scale mail-outs to all stations and manual identification and extraction of data from patient records. To assist paramedics with compliance, and to ensure consistency with the Utstein Guidelines, the Death and Cardiac Arrest Report Form (DCARF) was developed to ensure necessary elements were captured. Despite the many barriers to success, in just under a year, the process was completed and the initial data storage system became operational.

Soon after, a Memorandum of Understanding was signed between QAS and hospitals across Queensland to enable data matching for aggregate statistics for survival outcomes. Due to Machinery of Government changes in recent years, the QAS has been provided with linked, unit level outcome data, allowing for far more advanced analysis on the factors driving survival rates.

Considerable automation has been built into the program in the last decade, with electronic patient records and a substantially more streamlined audit and reconciliation process. In addition, the program has benefited from long serving staff, who have entered in excess of 40,000 cardiac records, embedding a level of consistency and reliability into the collection. Since 2007, the program has also benefited from the clinical input of the Cardiac Outcomes Manager role.

Over the years, a number of individuals have made important contributions to the QAS Cardiac Outcomes Program, including: Brendan Schultz, Louise Sims, Kirsten Wilson, Katherine Pemberton, Steven Raven, John Woodall, Molly McCarthy, Dr Trisha Johnston and Professor Vivienne Tippett.

This report was authored by Assoc. Professor Emma Bosley, Jamie Quinn, Brendan Schultz and Elizabeth Cardwell, with contributions from Steven Raven and Katherine Pemberton.

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Acronyms and abbreviations

ACP	Advanced Care Paramedic
AED	Automated External Defibrillator
Aus-ROC	Australian Resuscitation Outcomes Consortium
CAD	Computer Aided Dispatch
CCP	Critical Care Paramedic
CPG	Clinical Practice Guidelines
CPM	Clinical Practice Manual
CPR	Cardiopulmonary Resuscitation
DCARF	Death and Cardiac Arrest Report Form
eARF	electronic Ambulance Report Form
ECG	Electrocardiogram
ETT	Endotracheal Tube
LASN	Local Ambulance Service Network
LMA	Laryngeal Mask Airway
MPDS	Medical Priority Dispatch System
NHMRC	National Health and Medical Research Council
NPA	Nasopharyngeal Airway
OHCA	Out of Hospital Cardiac Arrest
PEA	Pulseless Electrical Activity
QAS	Queensland Ambulance Service
ROSC	Return of Spontaneous Circulation
RSQ	Retrieval Services Queensland
SER	Survived Event Rate
SIDS	Sudden Infant Death Syndrome
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

Definitions

Adult	Patients aged 16 years or older
Clinical Practice Manual	A document outlining the QAS Clinical Practice Guidelines, procedures and Drug Therapy Protocols, systematically developed using the best available evidence
Code One	A time critical, life threatening emergency requiring an immediate lights and siren ambulance response
Defibrillation	Providing an electric shock to the heart to stop an extremely rapid, irregular heart beat and restore normal heart rhythm in patients in a shockable rhythm
Deployment Supervisor	Manager in high volume Operation Centres with the expertise to review cases and deploy additional resources where necessary
Obvious death	Cases that display signs of hypostasis or rigor mortis, an ECG reading of asystole with suspected prolonged 'down time', other factors that quickly lead paramedics to determine that resuscitation would be futile (e.g. injuries incompatible with life)
Paediatric	Patients aged 0 to 15 years
Presumed cardiac aetiology	Cardiac arrest of presumed cardiac cause for males ≥40 years and females ≥50 years in the absence of evidence indicating other known causes (trauma, overdose, hanging)
Response time	The time (minutes) from when the Triple Zero (000) call is received to when the ambulance arrives at the scene
Resuscitation attempt	Cases that receive ≥5 minutes CPR, or defibrillation, or an advanced airway device (NPA, LMA, ETT)
Return of Spontaneous Circulation	The return of spontaneous perfusing cardiac activity (a detectable pulse) at any time during the case
Shockable rhythm	A cardiac rhythm treatable by defibrillation, includes ventricular fibrillation and ventricular tachycardia
Sinus rhythm	Normal, regular heart beat with respect to rate and rhythm
Survival to discharge	Patients discharged from hospital alive
Non-shockable rhythm	A cardiac rhythm that is not amenable to cardiac defibrillation, includes asystole and pulseless electrical activity (PEA)

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