2018

Annual Report

Queensland Ambulance Service

Out of Hospital Cardiac Arrest in Queensland

Queensland Government

This report is authored by the Information Support, Research and Evaluation Unit (ISRE), Queensland Ambulance Service.

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Abbreviations

ACP	Advanced Care Paramedic
AED	Automated External Defibrillator
CCP	Critical Care Paramedic
CI	Confidence Interval
CPR	Cardiopulmonary Resuscitation
CPRIC	Cardiopulmonary Resuscitation Induced Consciousness
IQR	Interquartile Range
LASN	Local Ambulance Service Network
OHCA	Out of Hospital Cardiac Arrest
OR	Odds Ratio
QAS	Queensland Ambulance Service
ROSC	Return of Spontaneous Circulation
SIDS	Sudden Infant Death Syndrome
VF	Ventricular Fibrillation
VT	Ventricular Tachycardia

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Executive Summary

5364 cardiac arrests attended

2153 resuscitations attempted
40% bystander witnessed

8 minutes (average)
response time in both
metropolitan and **rural** areas

67% cardiac aetiology

76% received **bystander CPR**

Utstein patient group

51% survived event
36% discharged alive
36% survived to 30 days

CPR induced consciousness

52% survived event
46% discharged alive
46% survived to 30 days

Established in 1999, the Queensland Ambulance Service (QAS) Out of Hospital Cardiac Arrest (OHCA) Program celebrated its 20th anniversary in 2018.

Developed as part of the Program was an OHCA database, which to date has collected detailed data on more than 82,000 patients. The database provides important insights into patient characteristics and outcomes, and the quality of prehospital cardiac services delivered by the QAS. The database provides critical information for optimising QAS activities, resource planning and designing effective prehospital care strategies for cardiac arrest patients.

This annual report presents findings from the 2018 calendar year for OHCA patients who received resuscitation from QAS paramedics. Also presented is an analysis of a unique subset of patients who regained consciousness during cardiopulmonary resuscitation (CPR) – a phenomenon known as CPR induced consciousness (CPRIC).

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About this report

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Incidence and demographics

In 2018, QAS paramedics attended 5364 OHCA cases, equating an incidence rate of 107 per 100,000 population in that year. Incidence rates varied across Local Ambulance Service Network (LASN) geographic areas, ranging from 67 (Torres and Cape) to 167 (North West) per 100,000 population (Figure 1). Of the 5364 patients, 2153 (40.1%) received resuscitation from paramedics, and are the subject of this report.

The majority of patients (67.1%) were male. The median (interquartile range, IQR) age was 63 (47-75) years. The age distribution varied significantly across the genders, with female patients having a higher median age of arrest than males (65 versus 62 years, p = 0.006). Case distribution by age group and gender is shown in Figure 2; adults (16 years or older) accounted for 96.5% of cases. Arrests occurred most frequently in residential homes (71.8%), followed by public places (8.5%) and aged care facilities (3.1%).

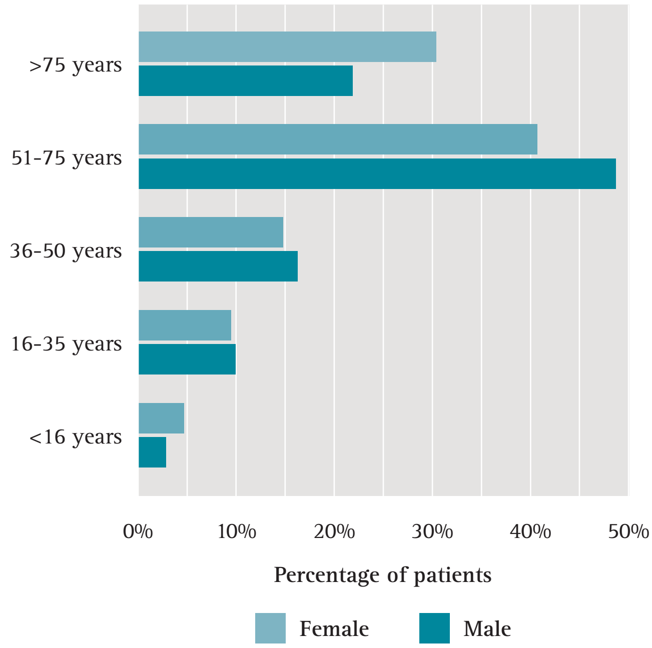
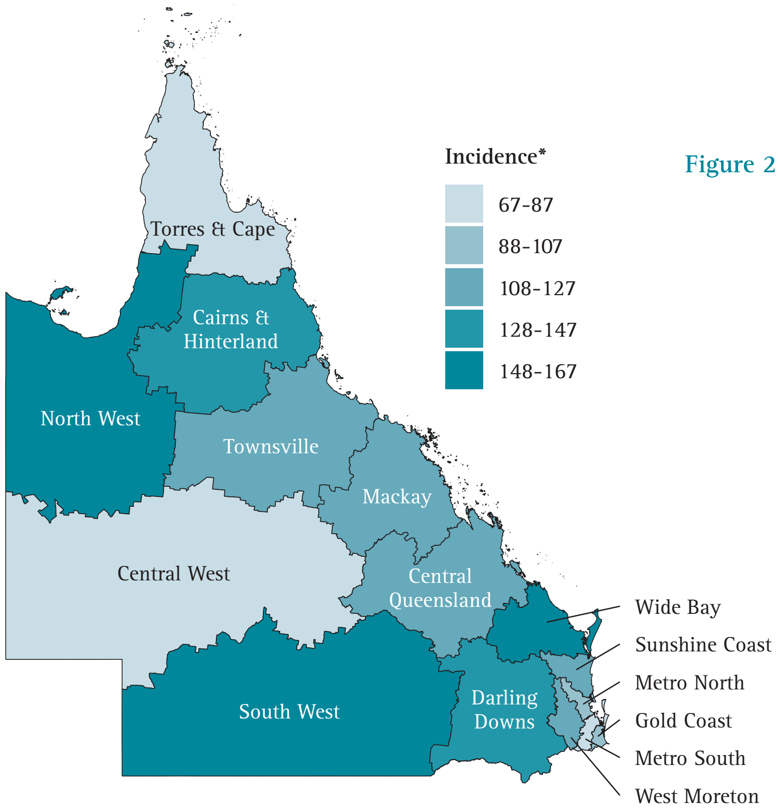


Figure 2. **Case distribution by age group and gender.**



LASN	Population	OHCA cases‡	Incidence*
Torres & Cape	26,889	18	67
North West	30,494	51	167
Central West	10,474	9	86
South West	24,365	40	164
Cairns & Hinterland	245,940	352	143
Townsville	246,718	298	121
Mackay	172,587	218	126
Central Queensland	210,665	256	122
Wide Bay	215,596	351	163
Sunshine Coast	416,828	453	109
Metro North	999,148	954	95
Metro South	1,142,808	978	86
Gold Coast	606,291	618	102
West Moreton	291,031	356	122
Darling Downs	299,910	406	135

Figure 1. **OHCA incidence rate by LASN geographic area.** ‡LASN area was unknown for six patients. *per 100,000 population per year.

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Survival and factors associated with survival

For all patients who received resuscitation from paramedics, the rates of event survival (return of spontaneous circulation [ROSC] on hospital arrival), survival to discharge and 30-day survival were 32.0%, 15.3% and 15.1%, respectively (Figure 3). The probability of survival from OHCA diminished with increasing age (Figure 4). Specifically, for every five-year increase, the likelihood of event survival, survival to discharge and 30-day survival reduced by 3.0% (p = 0.017), 5.0% (p = 0.001) and 5.0% (p = 0.001), respectively.

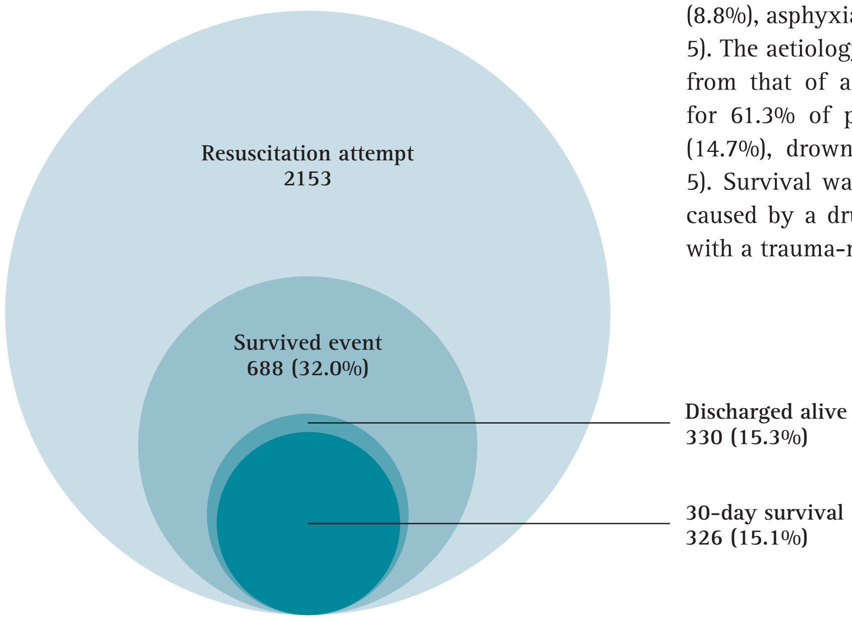


Figure 3. **Survival outcomes of all patients who received resuscitation from paramedics.**

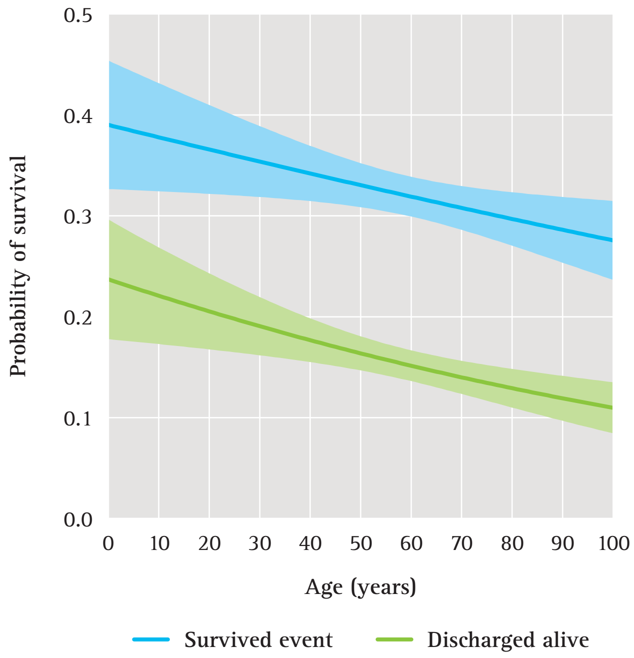


Figure 4. **Fitted curves and the associated 95% confidence intervals (shaded areas) showing the probability of survival as a function of age.** Predictions were based on a univariate logistic regression model. The curve for 30-day survival overlaps with the curve for discharged alive, and therefore is not shown.

The majority (81.7%) of adult arrests were of a medical cause (primarily presumed cardiac), followed by trauma (8.8%), asphyxia (5.2%) and drug overdose (3.0%) (Figure 5). The aetiology of arrest for paediatric patients differed from that of adults. A medical cause was responsible for 61.3% of paediatric arrests, followed by asphyxia (14.7%), drowning (12.0%) and trauma (9.3%) (Figure 5). Survival was highest among patients with an arrest caused by a drug overdose, and lowest among patients with a trauma-related arrest (Figure 6).

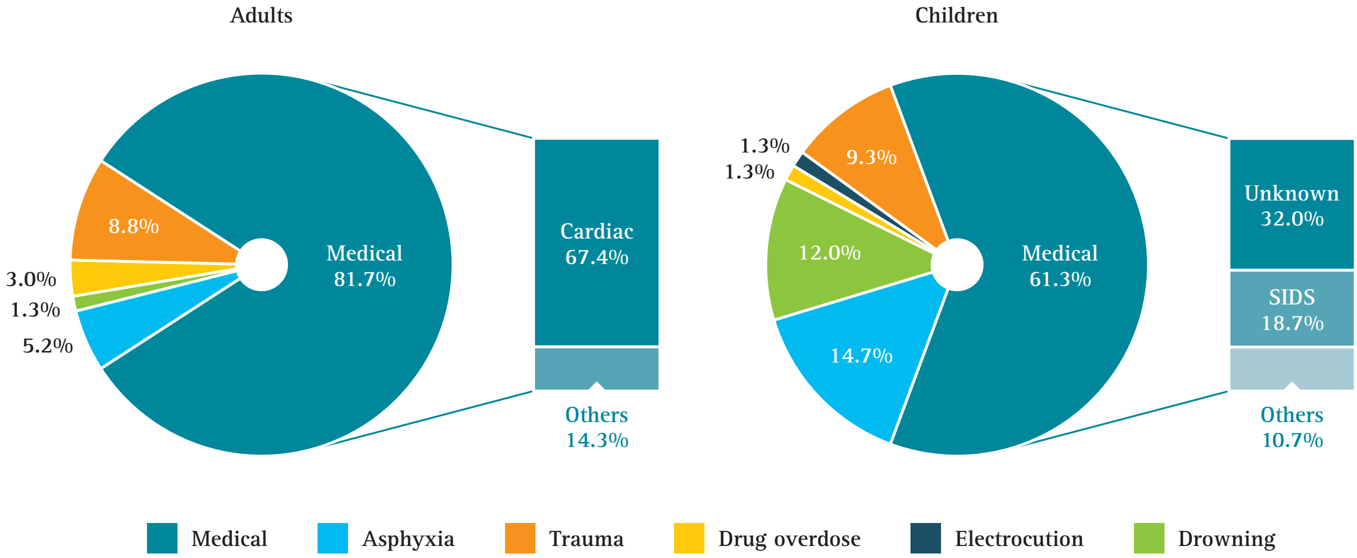
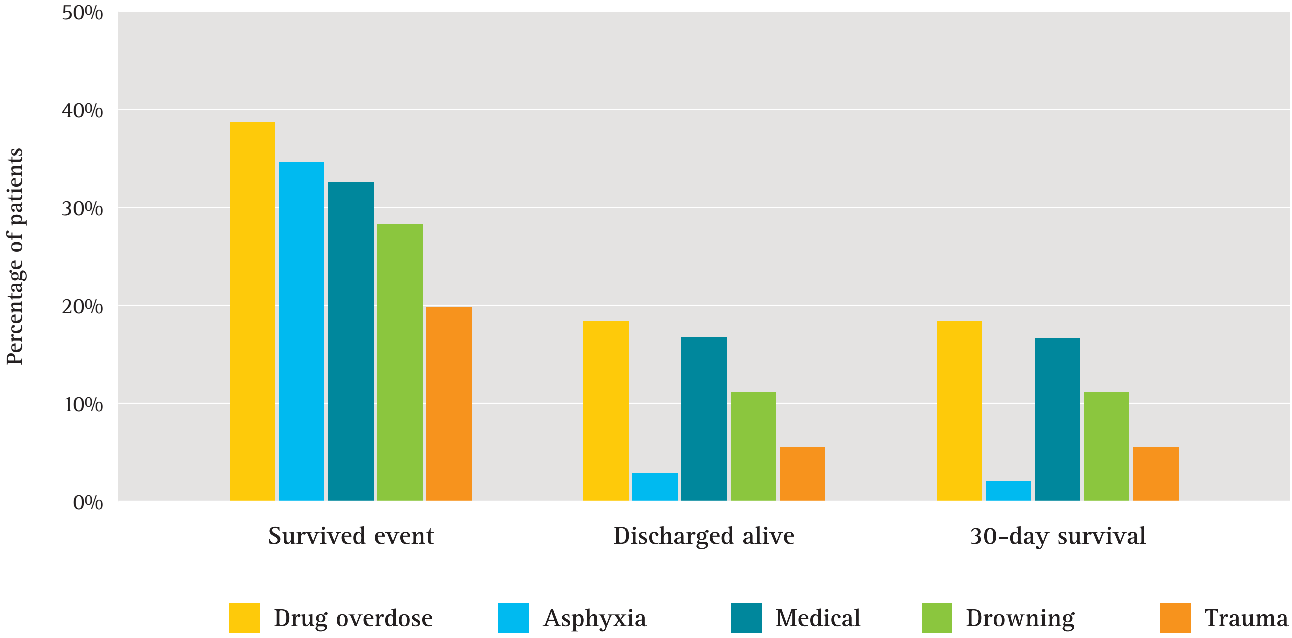


Figure 5. Aetiology of arrest.



	Drug overdose	Asphyxia	Medical	Drowning	Trauma
Survived event	39.1%	35.0%	32.9%	28.6%	20.1%
Discharged alive	18.8%	3.3%	17.1%	11.4%	5.8%
30-day survival	18.8%	2.5%	17.0%	11.4%	5.8%

Figure 6. Survival outcomes by aetiology.

An initial shockable rhythm (ventricular fibrillation or ventricular tachycardia, VF/VT) was observed in 27.5% of patients. Initial rhythm differed markedly by witness status, with witnessed arrests (by bystanders or paramedics) being more likely to present in a shockable rhythm than unwitnessed arrests (Figure 7). Patients who presented in a shockable rhythm had a higher survival rate than those with non-shockable rhythm (Figure 8). In particular, the former had an event survival rate of 53.3%, compared to 23.8% ($p < 0.001$) for the latter. These patients also had significantly longer survival durations (Figure 9). Patients presenting in a shockable rhythm had a greater likelihood of being discharged alive (37.7% versus 6.8%, $p < 0.001$) and 30-day survival (37.6% versus 6.6%, $p < 0.001$) than those with non-shockable rhythm.

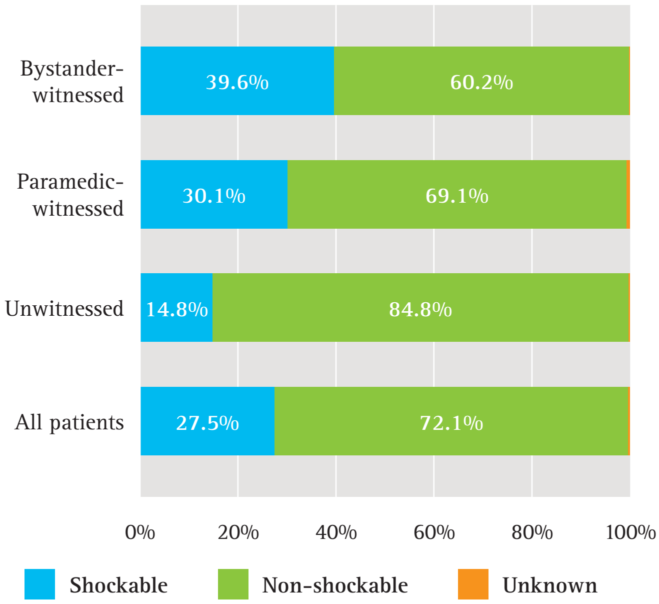


Figure 7. Initial rhythm by witness status.

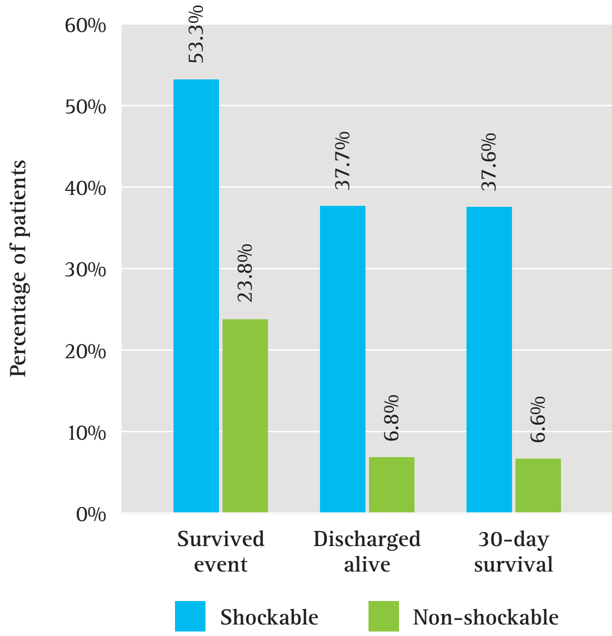


Figure 8. **Survival outcomes by initial rhythm.** *p*-value for between-group difference for each survival outcome was < 0.001.

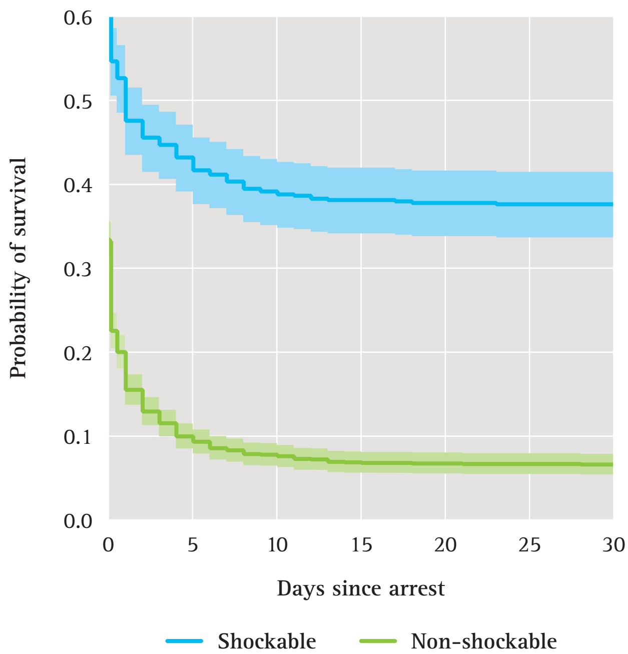


Figure 9. **Probability of survival as a function of time (days) since arrest, by initial rhythm.** *p*-value for between-group difference was < 0.001.

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Arrest witness status

39.6% of arrests were witnessed by bystanders, and 16.2% by paramedics. Witnessed arrests had substantial survival benefit compared to unwitnessed arrests (Figure 10). Bystander-witnessed and paramedic-witnessed arrests were 2.4 and 3.0 times more likely to survive the event, respectively (Figure 11).

The survival benefit of witnessed arrests was more substantial for discharged alive and 30-day survival outcomes. Specifically, bystander-witnessed arrests were 3.5 times more likely to have survived to hospital discharge and 30 days after the arrest, compared to unwitnessed arrests; and paramedic-witnessed arrests were 6.9 times for both survival outcomes (Figure 11). Patients with witnessed arrests also had significantly longer survival durations than those with unwitnessed arrests (Figure 12).

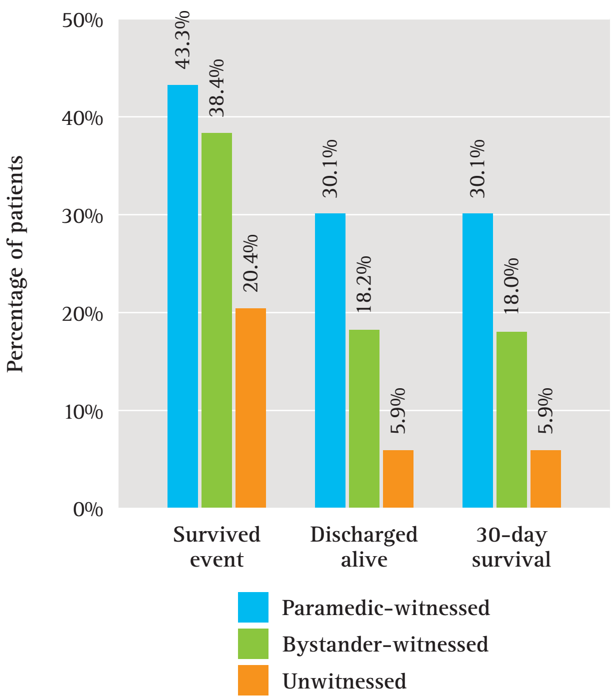
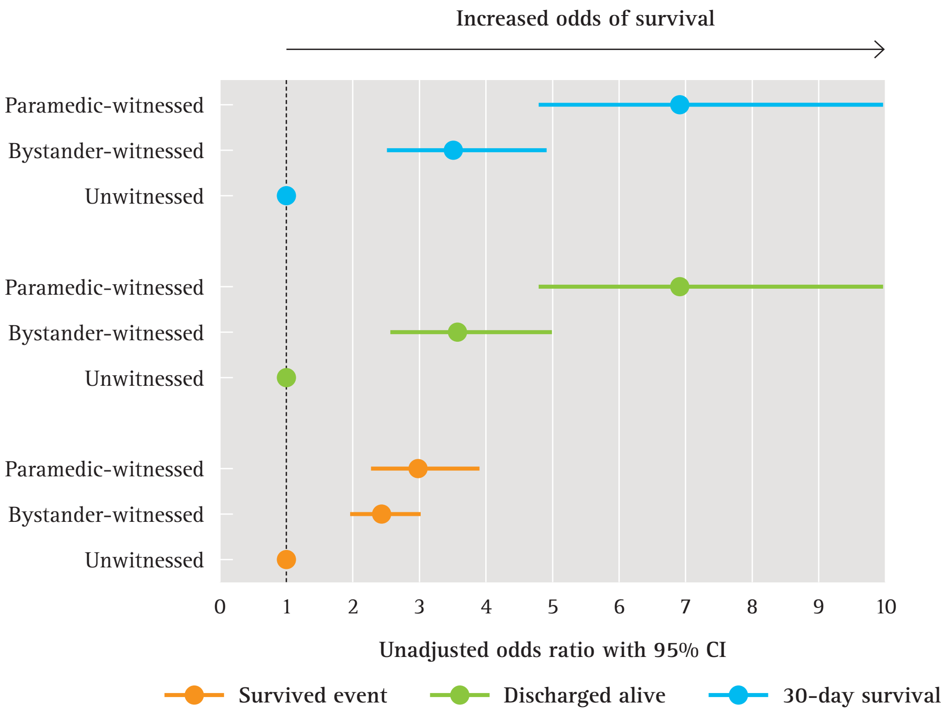


Figure 10. Survival outcomes by witness status.



Odds ratio (95% CI)	*p*-value
6.91 (4.79-9.97)	<0.001
3.52 (2.51-4.91)	<0.001
Reference	
6.91 (4.79-9.97)	<0.001
3.57 (2.56-4.99)	<0.001
Reference	
2.98 (2.27-3.90)	<0.001
2.43 (1.96-3.02)	<0.001
Reference	

Figure 11. Odds of survival by witness status from a univariate logistic regression analysis.

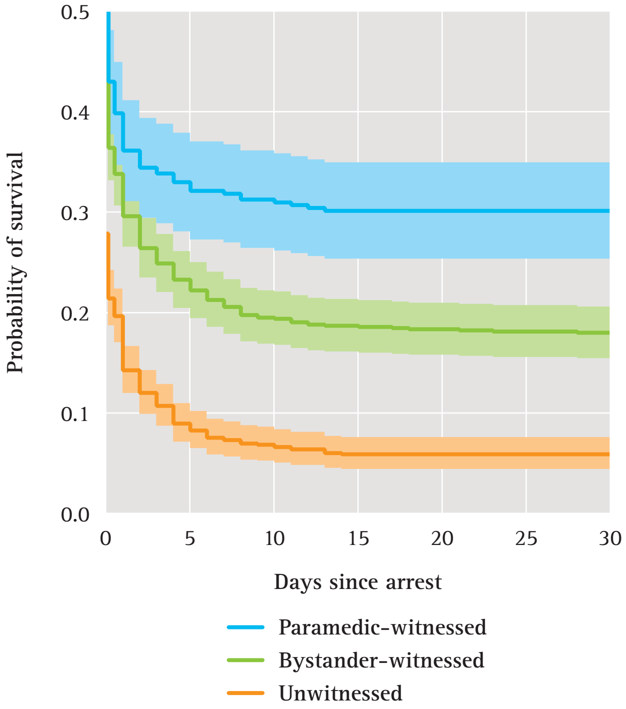


Figure 12. Probability of survival as a function of time (days) since arrest, by witness status. *p*-value for between-group difference was < 0.001.

The survival benefit of witnessed arrest may in part be attributed to the differences in patient-related and system-related factors. Compared to unwitnessed arrests, both paramedic-witnessed and bystander-witnessed arrests less often occurred in residential homes, were more frequently of cardiac aetiology, more often had initial shockable rhythm, and more often received bystander CPR (only applicable to bystander-witnessed arrest) (Table 1).

Table 1. Patient characteristics and survival outcomes by witness status

Variable	Paramedic-witnessed	Bystander-witnessed	Unwitnessed	*p*-value*
Number of patients[‡]	349	852	853	n/a
Age (median, IQR)	66 (55-77)	66 (52-76)	59 (41-74)	**<0.001, <0.001**
Male	62.8%	70.9%	65.2%	0.426, **0.013**
Location of arrest				
Public place	5.8%	12.5%	5.1%	0.669, **<0.001**
Residential home	72.5%	64.1%	81.0%	**0.002, <0.001**
Aged care facility	4.3%	3.2%	2.4%	0.087, 0.305
Initial shockable rhythm	30.1%	39.6%	14.8%	**<0.001, <0.001**
Cardiac aetiology	67.6%	73.7%	57.8%	**0.002, <0.001**
Bystander CPR	n/a	80.2%	71.8%	n/a, **<0.001**

*For the difference of paramedic-witnessed and bystander-witnessed versus unwitnessed, respectively. Bold values indicate statistically significant ($p < 0.05$).

‡Unknown witness status for 99 patients.

n/a, not applicable.

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Bystander interventions

Early interventions initiated by bystanders during the first moments after the patient collapses are critical for survival. In 2018, of all non-paramedic witnessed OHCA patients who subsequently received resuscitation by paramedics, 75.7% had received bystander CPR. As expected, bystander CPR rate was highest among those whose arrest was witnessed by a bystander, at 80.2%.

Figure 13 shows greater survival in patients who received bystander CPR compared to those who did not. The survival benefit of bystander CPR was more substantial in the subset of patients whose arrest was witnessed by a bystander and had an initial shockable rhythm on QAS arrival (Figure 14). More than half (52.0%) of these patients survived the event when they received bystander CPR, compared to 41.2% without bystander CPR. Survival to discharge (36.8% versus 26.5%), and 30-day survival (36.8% versus 26.5%) was also higher for patients receiving bystander CPR.

Bystander defibrillation, when the patient is in VF/VT, is another bystander intervention that has proven survival benefit.[1] International literature reports bystander defibrillation rates of less than 2%.[2] In 2018, 15 patients (0.8%) were defibrillated by a bystander prior to paramedic arrival. In addition to automated external defibrillators (AEDs) being placed in suitable locations, it has been shown that the availability of a system that captures these locations improves the uptake of bystander defibrillation.[3] The potential to improve survival through increased bystander delivered defibrillation prior to ambulance arrival presents a valuable opportunity for civic agencies and communities to engage and invest in furthering this important link in the chain-of-survival.

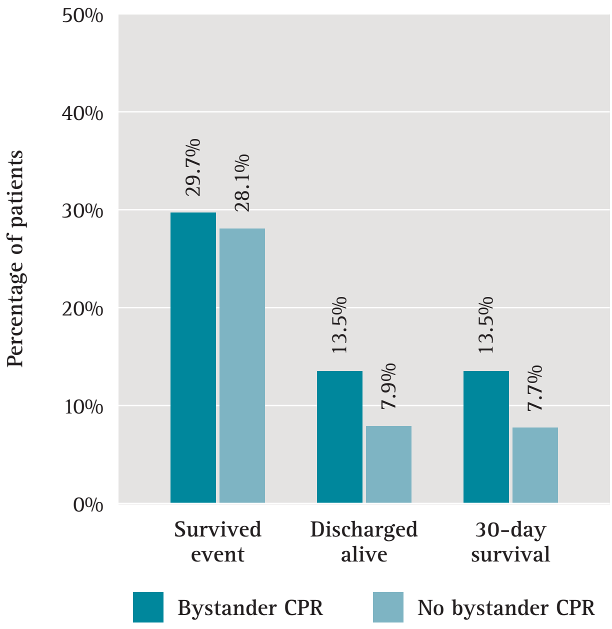

Figure 13. Survival outcomes, bystander CPR versus no bystander CPR. *p*-value for between-group difference for each survival outcome was < 0.05.

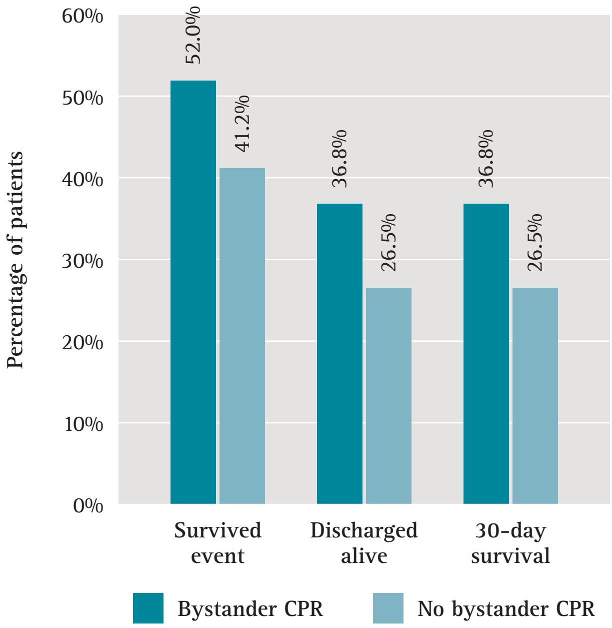

Figure 14. Survival outcomes, bystander CPR versus no bystander CPR. Included were bystander-witnessed patients with initial shockable rhythm.

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Ambulance response time

In 2018, the median (IQR) response time, from when the Triple Zero (000) call requesting ambulance attendance is received to when the ambulance arrives at the scene of the incident, was 8 (6–11) minutes. The response time has remained consistently short, at 8 minutes, for the past decade and across geographic regions (Figure 15). This is significant given the increase in workload and the demand for ambulance services over the years as the result of the aging and growing population. Indeed, the demand for Code 1 and Code 2 ambulance response has increased substantially over time, from approximately 511,000 emergency responses in 2010 to 803,000 in 2018 (a 57.1% relative increase). The QAS ambulance response time to OHCA compared favourably with other Australian and international ambulance services (Figure 16).

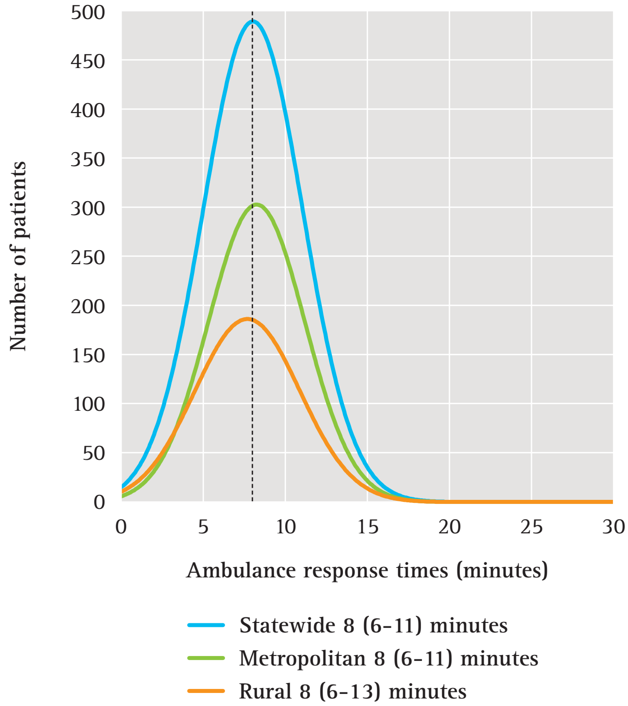
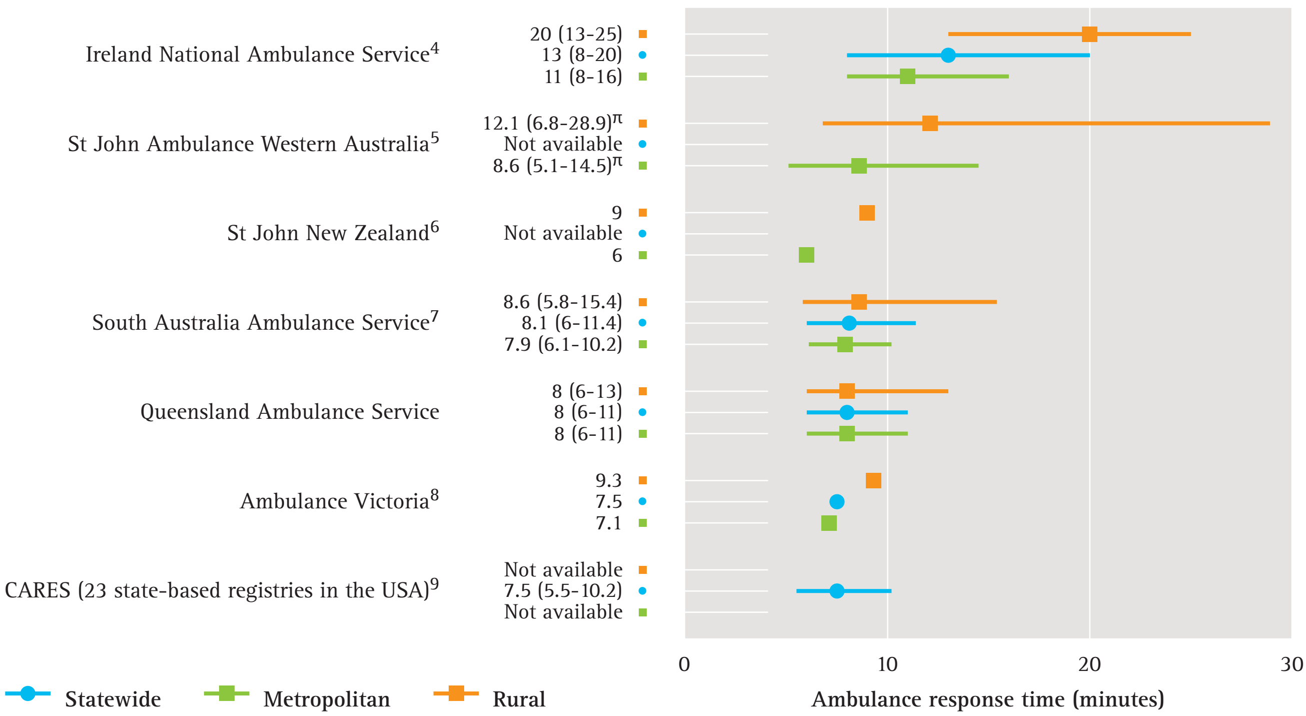


Figure 15. Ambulance response time, metropolitan versus rural areas.

Figure 16. Ambulance response time reported by various ambulance services. The numbers outside the brackets indicate median. The numbers inside the brackets indicate IQR (where available), $^{\pi}$except for St John Ambulance Western Australia, which reported 10th percentile and 90th percentile. All ambulance services reported data for the calendar year 2018 or financial year 2018/2019, with the exception of St John New Zealand (2017/2018) and South Australia Ambulance Service (2016/2017).



7

Critical Care Paramedic attendance

For OHCA, the QAS 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, chest compressions), and Critical Care Paramedics (CCPs) who are authorised to perform further procedures and administer additional drugs (e.g. endotracheal intubation, atropine, amiodarone). A typical response to an OHCA involves the concurrent deployment of ACPs and CCPs, where available.

Statewide, more than three-quarters (77.7%) of cases were attended by CCPs. CCP attendance was associated with survival benefit (Figure 17). Specifically, patients attended by CCPs had a significantly higher rate of event survival than those not attended by CCPs (35.6% versus 19.4%, $p < 0.001$). These patients also had higher rates of survival to discharge and 30-day survival (Figure 17). Of note, patients attended by CCPs generally also received initial care from ACPs prior to CCP arrival.

Varying prehospital characteristics between the two patient groups might have explained the differences in survival. Understanding these differences allows for well-informed interpretation of the findings. A comparison of demographic and prehospital characteristics between cases attended by CCPs and those not attended by CCPs are shown in Table 2. Younger age, arrest witnessed by bystanders, and arrest occurring in metropolitan areas are known predictors of favourable outcomes.[10]

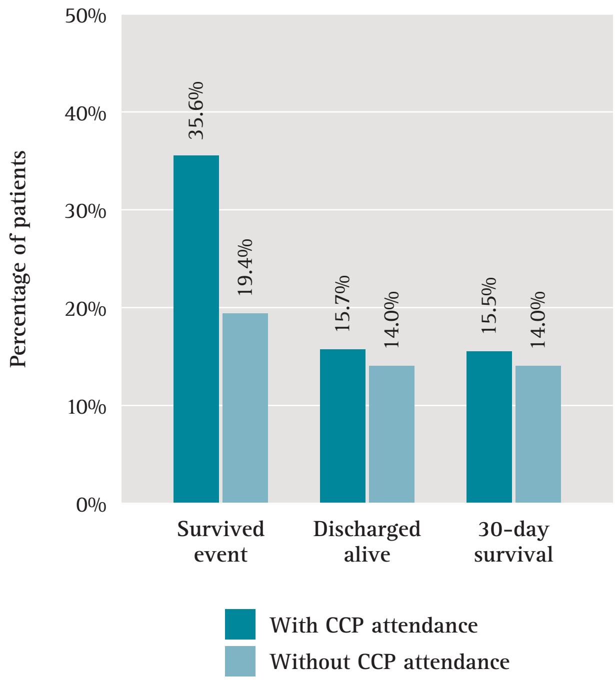


Figure 17. **Survival outcomes, with versus without CCP attendance.**

In this report, patients where a CCP attended had a greater proportion of these favourable factors than those without CCPs (Table 2). It is important to note that CCPs are more prevalent in metropolitan areas of Queensland, explaining the higher proportion of metropolitan cases in the CCP group. Patients attended by CCPs also had shorter time intervals from paramedic arrival at scene to cannulation (9 versus 11 minutes, $p = 0.002$) and to adrenaline administration (13 versus 14 minutes, $p = 0.031$) (Table 2). It is possible that these shorter time intervals in the CCP group was a result of there being additional paramedic personnel present on scene and available to perform interventions. Another factor that might have positively affected survival in patients attended by CCPs was patient viability, as ACPs usually request the attendance of CCPs where active resuscitation is in progress and where they consider it may be of benefit to the patient. Furthermore, the survival benefit associated with the presence of CCPs might be attributable to non-technical factors such as advanced clinical decision making and leadership skills.[11]

Table 2. Difference in demographic and prehospital characteristics between patients with and without CCP attendance

Characteristic	Cases with CCPs	Cases without CCPs	*p*-value
Number of patients	1673	480	n/a
Age (median, IQR)	63 (46-75)	64 (51-78)	**0.014**
Male	67.7%	65.0%	0.271
Witness status			
Bystander-witnessed	40.8%	35.4%	**0.039**
Paramedic-witnessed	16.0%	16.9%	0.673
Bystander CPR	63.9%	60.7%	0.213
Initial shockable rhythm	28.3%	24.4%	0.202
Metropolitan	67.4%	29.2%	**<0.001**
Time on scene (median, IQR)*	42 (33-53)	30 (23-44)	**<0.001**
Time to cannulation (median, IQR)*	9 (7-14)	11 (7.5-15)	**0.002**
Time to adrenaline (median, IQR)*	13 (9-18)	14 (11-18)	**0.031**

*All time variables are in minutes.

Bold *p*-values indicate statistically significant ($p < 0.05$).

n/a, not applicable.

8

Survival outcomes of the Utstein patient group

Substantial variation exists in the methods of calculating and reporting survival outcomes among emergency ambulance services across Australia and worldwide, dependent upon the different patient inclusion criteria used (e.g. Utstein template, government reporting criteria, targeted analysis).

It is therefore important to have a consistent denominator for survival calculations to provide comparable measures of survival outcomes across different emergency ambulance services. The Utstein template is the most widely used criteria for uniform reporting of OHCA survival outcomes globally.[12] Accordingly, we are reporting this to enable comparison nationally and internationally of our results. The following criteria define the Utstein patient group: all-cause, resuscitation attempted, initial shockable rhythm, and bystander-witnessed.

In 2018, there were 337 cardiac arrests attended by QAS paramedics that met these criteria. For this patient group, the rates of event survival, survival to discharge, and 30-day survival were 51.0%, 36.2% and 36.2%, respectively (Figure 18). These figures compare favourably with other ambulance services in Australia and worldwide (Figure 19), which given the State's challenging geography is a notable achievement.

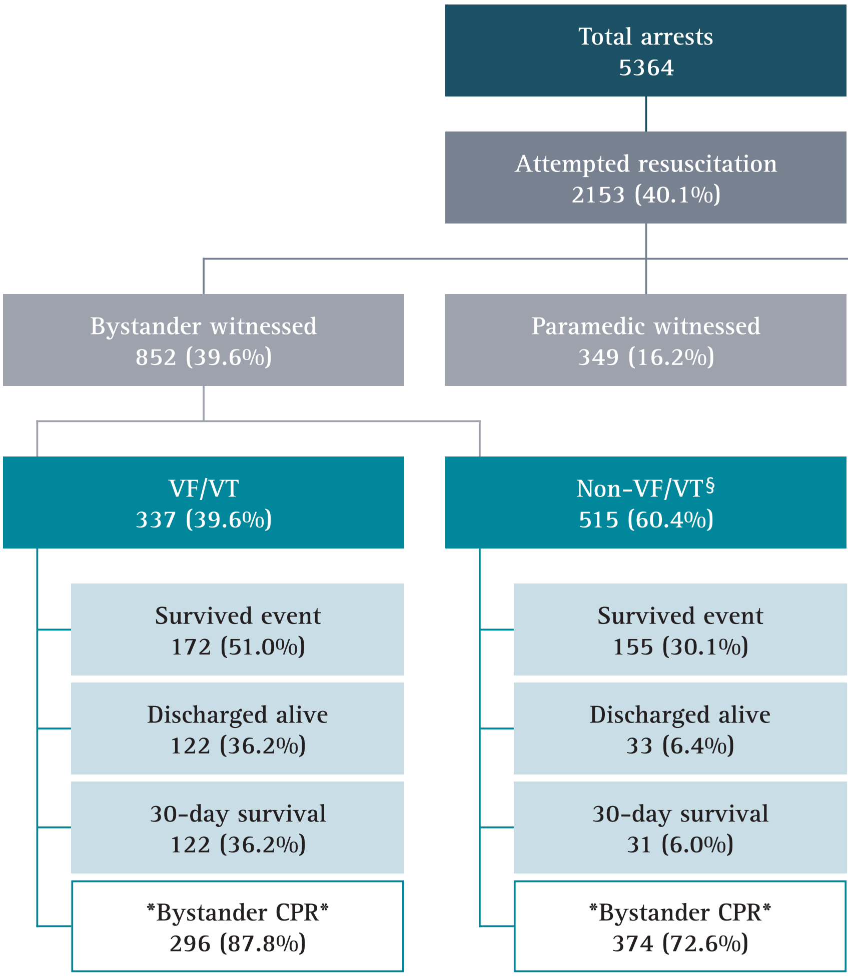


Figure 18. Breakdown of OHCA events in 2018 according to paramedic-attempted resuscitation, witness status and initial cardiac arrest rhythm. δIncludes unknown witness status. §Includes unknown initial rhythm.

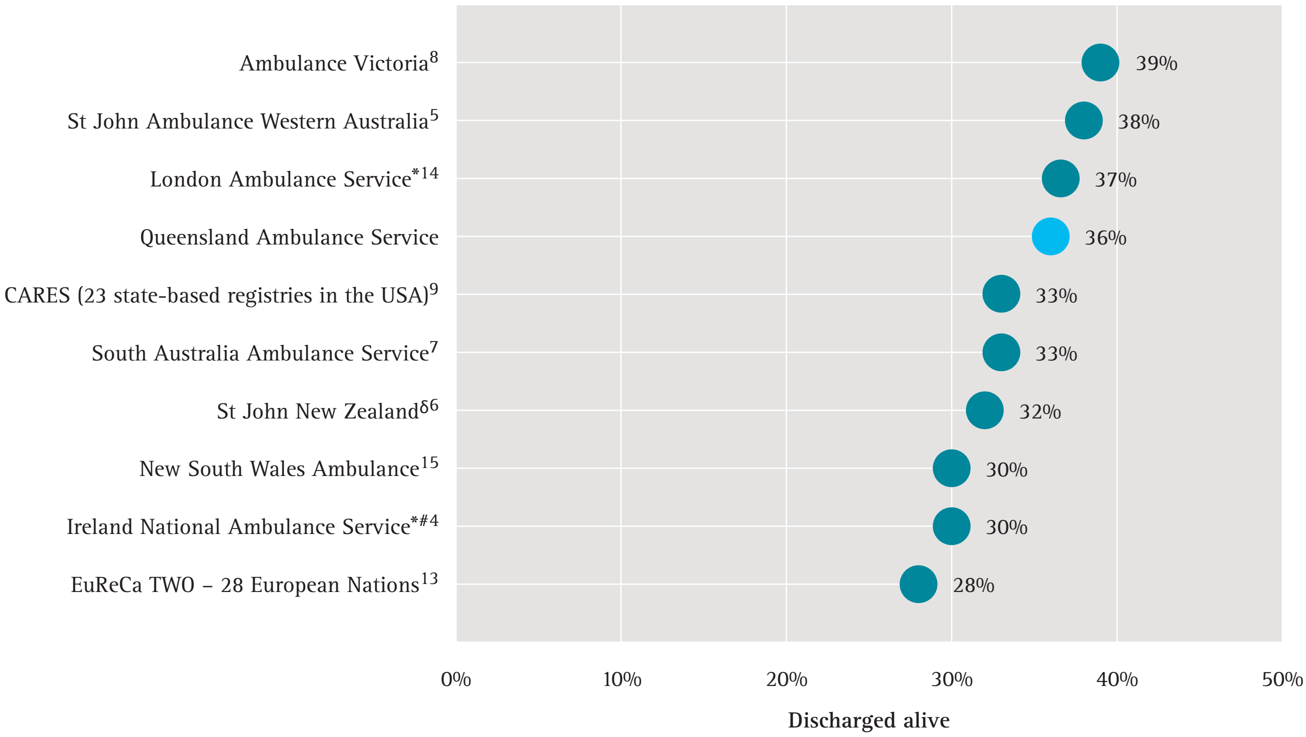


Figure 19. Survival outcomes (discharged alive) of the Utstein patient group reported by various ambulance services. All ambulance services reported data for the calendar year 2018 or financial year 2018/2019, with the exception of EuReCa TWO (2017), South Australia Ambulance Service (2016/2017), St John New Zealand (2017/2018), and New South Wales Ambulance (2017). δ30-day survival. *Only included arrests of cardiac aetiology. #Only included adults (> 17 years).

9

CPR induced consciousness

CPRIC is a phenomenon in which patients regain consciousness during CPR. Whilst available minimal data suggest that CPRIC is rare, accounting for less than 1% of all OHCA cases, it has been observed with increasing frequency.[16] With increased focus on high quality CPR, the occurrence of CPRIC is likely to continue to increase. CPRIC provides challenges to paramedics, potentially impeding successful resuscitative efforts. Patients gaining consciousness during CPR can interfere with the resuscitation by pushing and grabbing the resuscitator, withdrawing from the compressions, and pulling out airway-securing devices.[17]

Patient consciousness can also lead to CPR being interrupted more frequently for pulse checks.[17] The QAS Clinical Practice Guidelines emphasise that the goal of treatment is to manage the patient's awareness and/or pain in order to facilitate CPR, and enable defibrillation and other resuscitation interventions to occur safely, effectively and humanely.

Despite its increasing frequency and important clinical implications, there remains a scarcity of knowledge regarding CPRIC. Accordingly, there is a pressing need to improve our understanding of this growing phenomenon. Given the shortage of knowledge regarding CPRIC, the QAS with Luke Adams (CCP) has undertaken research to investigate the prevalence of this unique presentation, factors determining its manifestation, and the characteristics and outcomes of these patients. This information will be valuable to inform guideline development for the most effective management of these patients.

Between January 2007 and December 2018, the QAS OHCA database captured a total of 23,011 adult OHCA patients who had resuscitation attempted by paramedics. These patients underwent keyword searching and manual review of records to identify those with CPRIC signs. A total of 52 patients were identified as CPRIC (Figure 20). This accounted for 0.23% of all adult arrests with resuscitation attempted by paramedics for the entire study period.

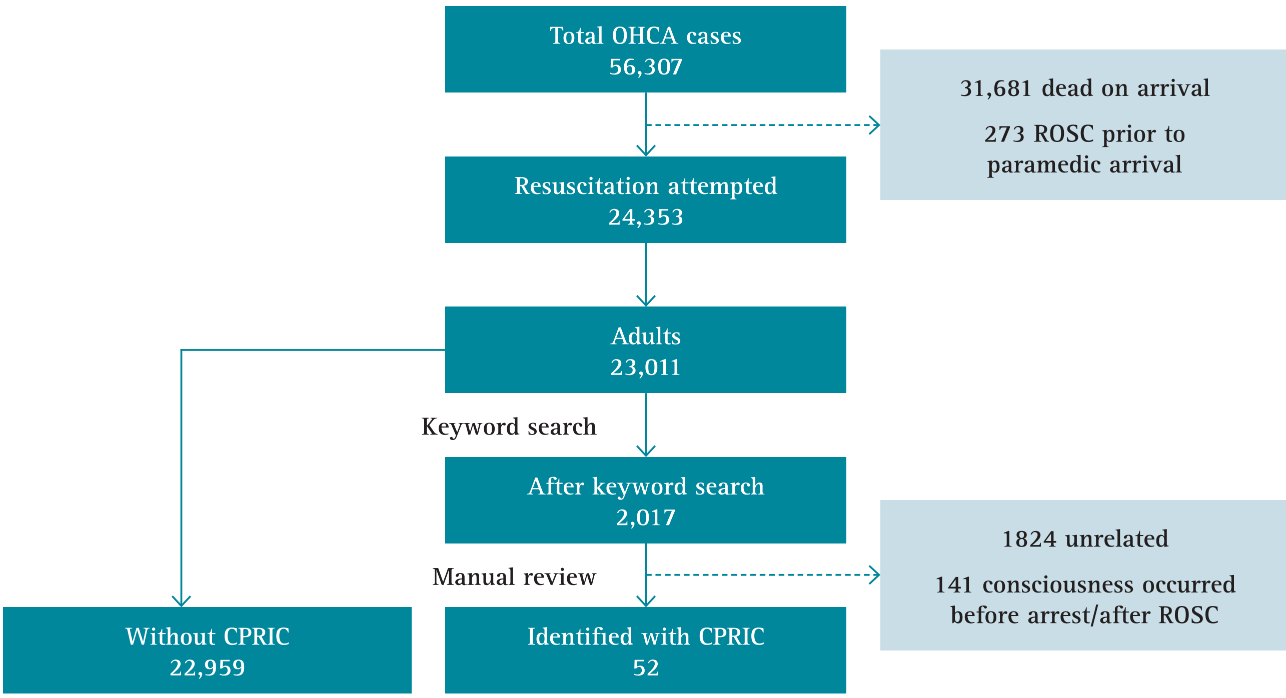


Figure 20. Diagram of included CPRIC patients.

Table 3 compares the characteristics of patients with and without CPRIC. In comparison to those without CPRIC, patients with CPRIC more often had an arrest of cardiac aetiology (96.2% versus 69.1%, $p < 0.001$), more often experienced an arrest in a public location (28.8% versus 12.1%, $p = 0.001$), more frequently presented with an initial shockable rhythm (73.1% versus 27.9%, $p < 0.001$), and were more often witnessed by paramedics (61.5% versus 17.7%, $p < 0.001$) (Table 3). Patients with CPRIC also had significantly higher rates of event survival (51.9% versus 28.6%, $p = 0.001$), survival to hospital discharge (46.2% versus 15.1%, $p < 0.001$), and survival to 30-days (46.2% versus 14.7%, $p < 0.001$) than those without CPRIC (Figure 21).

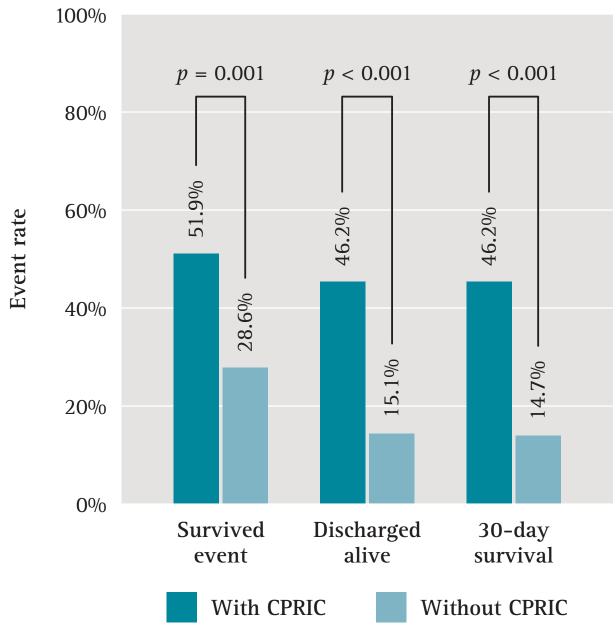


Figure 21. Survival outcomes, patients with CPRIC versus without CPRIC.

Table 3. Comparison of characteristics of patients with and without CPRIC

Characteristic	With CPRIC	Without CPRIC	*p*-value
Total number of patients	52	22,959	n/a
Age (median, IQR)	60 (53-68)	65 (50-78)	0.074
Male	73.1%	67.6%	0.457
Cardiac aetiology	96.2%	69.1%	**<0.001**
Witness status			
Paramedic-witnessed	61.5%	17.7%	**<0.001**
Bystander-witnessed	34.6%	40.1%	0.397
Unwitnessed	3.8%	39.9%	**<0.001**
Initial shockable rhythm	73.1%	27.9%	**<0.001**
Paramedic response time (median, IQR)*	8 (5-10)	8 (6-11)	0.238
Arrest in public places	28.8%	12.1%	**0.001**
Arrest during daytime‡	71.2%	61.4%	0.159
Bystander CPR	85.0%	68.8%	0.149
Metropolitan	63.5%	59.2%	0.572

*Time interval is in minutes.

‡07:00 to 19:00.

Bold *p*-values indicate statistically significant ($p < 0.05$).

n/a, not applicable.

The most common sign of CPRIC was combativeness/agitation (18/52, 34.6% of patients), followed by groaning (10/52, 19.2%) and eye opening/rolling (8/52, 15.4%) (Figure 22). The majority (40/52, 76.9%) of patients exhibited more than one sign of CPRIC (Figure 23). Pharmacological intervention to manage CPRIC was given to six (11.5%) patients, with midazolam (0.5 mg - 2.5 mg, intravenous) being the most common medication (given to four patients, either alone or in combination with intravenous fentanyl 25 mcg). One patient was given morphine (2.5 mg, intravenous), and one was given ketamine (50 mg, intravenous) in combination with suxamethonium (150 mg, intravenous).

Cardiac aetiology, paramedic-witnessed arrest, arrest occurring in public locations, initial shockable rhythm, and younger age were independent factors associated with the occurrence of CPRIC (Figure 24).

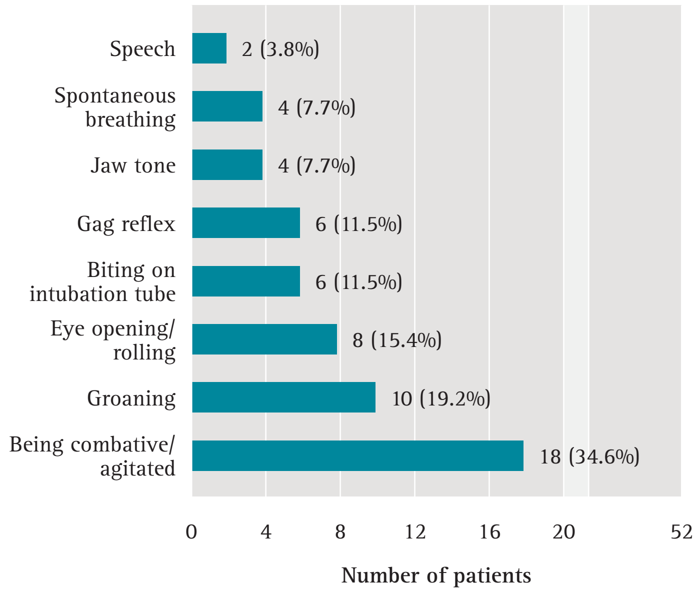


Figure 22. **Reported signs of CPRIC.**

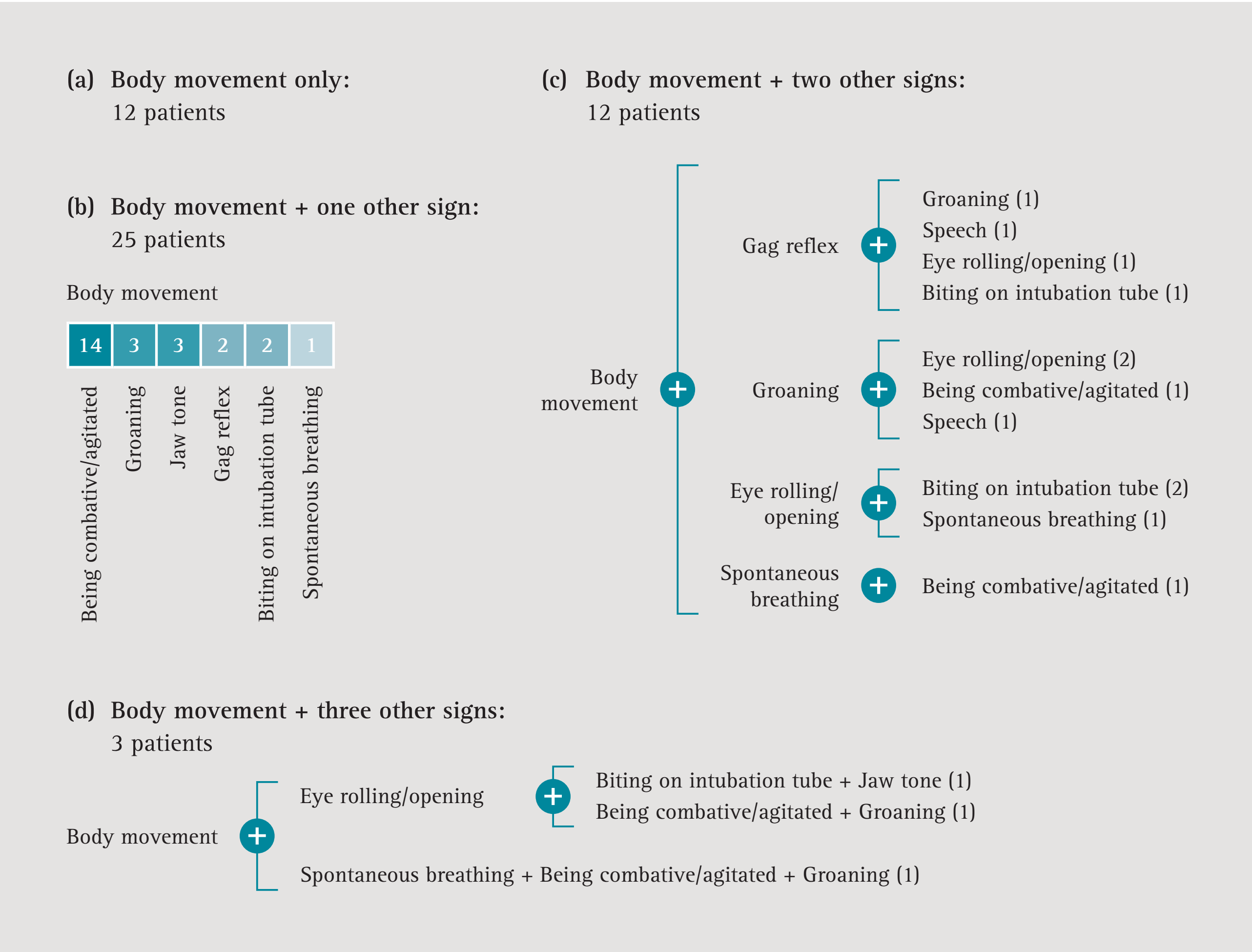


Figure 23. **Signs of CPRIC displayed by the included patients.** The numbers indicate number of patients.

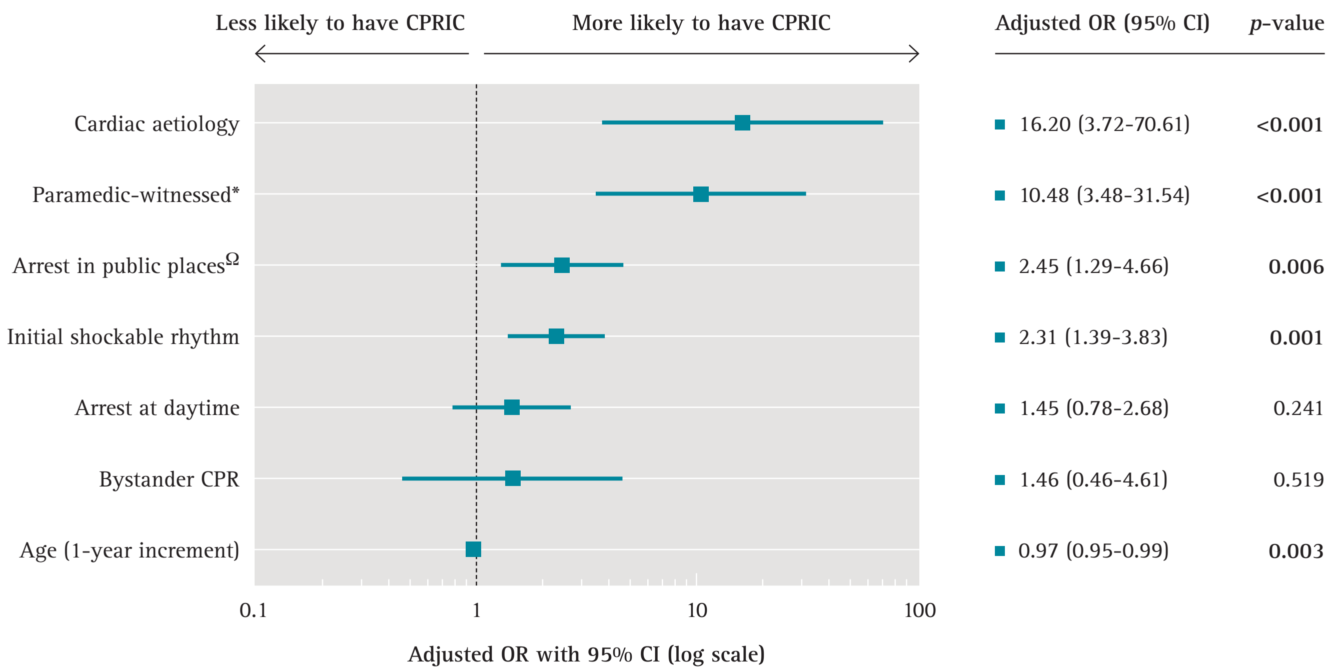


Figure 24. Factors associated with the occurrence of CPRIC. *In comparison to bystander-witnessed and unwitnessed arrests. ΩIn comparison to arrests occurring in places other than public locations. Bold *p*-values indicate statistically significant ($p < 0.05$). Results were obtained from a multivariate logistic regression model.

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Conclusions

This report demonstrates the outstanding results that arise from the treatment delivered to OHCA patients by QAS paramedics. Despite the unique challenges of delivering services to a large, decentralised population in Queensland, our survival outcomes compare favourably with other ambulance jurisdictions nationally and internationally, and shows the consistently high quality of care provided across a vast geographic region.

In addition, this report provides a novel investigation into the prevalence of CPRIC among an entire population-based cohort of OHCA patients and describes this phenomenon in a collection of patients with CPRIC. Given the universal acceptance of the importance of high quality CPR, this is an important first step in improving our understanding of what will continue to be a growing phenomenon. By describing the signs of CPRIC and identifying patient characteristics that are associated with CPRIC onset, the findings are valuable to inform the development of evidence-based guidelines for CPRIC identification and management.

Ongoing, systematic analysis of data about OHCA is essential to the planning, implementation and evaluation of effective prehospital care. The findings of this report form the basis for identification of ongoing opportunities for continual service improvement, and demonstrate to the emergency medical dispatchers and paramedics of the Service the tangible impact of the expert care that they provide to OHCA patients in Queensland.

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