The epidemiology of out-of-hospital cardiac arrest in Australia and New Zealand: A binational report from the Australasian Resuscitation Outcomes Consortium (Aus-ROC).

Janet Bray[1,2], Stuart Howell[1], Stephen Ball[2,3], Tan Doan[4], Emma Bosley[4,5], Karen Smith[1,6,7], Bridget Dicker[8,9], Steven Faddy[10], Melanie Thorrowgood[11], Andy Swain[12], Andrew Thomas[13], Alexander Wilson[14], Carol Shipp[15], Tony Walker[6], Paul Bailey[3], Judith Finn[1,2,3] for the Aus-ROC Epistry Management Committee

Affiliations:

1. Department of Epidemiology and Preventive Medicine, Monash University, Victoria, Australia
2. Prehospital, Resuscitation and Emergency Care Research Unit (PRECRU), Curtin University, Western Australia, Australia
3. St John Western Australia, Western Australia, Australia
4. Queensland Ambulance Service, Queensland, Australia
5. School of Clinical Sciences, Queensland University of Technology, Queensland, Australia
6. Ambulance Victoria, Victoria, Australia
7. Department of Community Emergency Health and Paramedic Practice, Monash University, Victoria, Australia
8. St John New Zealand, Auckland, New Zealand
9. Auckland University of Technology, Auckland, New Zealand
10. NSW Ambulance, New South Wales, Australia
11. SA Ambulance Service, South Australia, Australia
12. Wellington Free Ambulance, Wellington, New Zealand
13. St John Ambulance NT, Northern Territory, Australia
14. ACT Ambulance, Australian Capital Territory, Australia
15. Ambulance Tasmania, Tasmania, Australia

Corresponding author: Janet Bray, Monash University janet.bray@monash.edu

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Abstract

Introduction: The Australasian Resuscitation Outcomes Consortium (Aus-ROC) out-of-hospital cardiac arrest (OHCA) Epistry (Epidemiological Registry) now covers 100% of Australia and New Zealand (NZ). This study reports and compares the Utstein demographics, arrest characteristics and outcomes of OHCA patients across our region.

Methods: We included all OHCA cases throughout 2019 as submitted to the Epistry by the eight Australian and two NZ emergency medical services (EMS). We calculated crude and age-standardised incidence rates and performed a national and EMS regional comparison.

Results: We obtained data for 31,778 OHCA cases for 2019: 26,637 in Australia and 5,141 in NZ. Crude incidence was 107.9 per 100,000 person-years in Australia and 103.2/100,000 in NZ. Overall, the majority of OHCAs occurred in adults (96%), males (66%), private residences (76%), were unwitnessed (63%), of presumed medical aetiology (83%), and had an initial monitored rhythm of asystole (64%). In non-EMS-witnessed cases, 38% received bystander CPR and 2% received public defibrillation. Wide variation was seen between EMS regions for all OHCA demographics, arrest characteristics and outcomes. In patients who received an EMS-attempted resuscitation (13,664/31,778): 28% (range across EMS=13.1% to 36.7%) had return of spontaneous circulation (ROSC) at hospital arrival and 13% (range across EMS=9.9% to 20.7%) survived to hospital discharge/30-days. Survival in the Utstein comparator group (bystander-witnessed in shockable rhythm) varied across the EMS regions between 27.4% to 42.0%.

Conclusion: OHCA across Australia and NZ has varied incidence, characteristics and survival. Understanding the variation in survival and modifiable predictors is key to informing strategies to improve outcomes.

Keywords: heart arrest, resuscitation, epidemiology, emergency medical services; out-of-hospital cardiac arrest, registry.

Introduction

Out-of-hospital cardiac arrest (OHCA) registries are critical to monitoring and benchmarking local emergency medical services (EMS) performance. To do this, the internationally-recognised Utstein definitions and templates provide important guidance, definitions and methods for standardisation.[1, 2]

In our region, the Australasian Resuscitation Outcomes Consortium (Aus-ROC) Australian and New Zealand OHCA Epistry (epidemiological registry) began in 2015,[3] with six contributing regional EMS covering 64% of the Australian population and 100% of the New Zealand population.[4] At that time, we reported an overall crude incidence of 102.5 per 100,000 person-years and, in those receiving an attempted resuscitation by EMS, survival to hospital discharge/30-days of 12.1%.[5] We also saw significant regional variation in incidence, outcomes and in the known predictors of OHCA survival.[6] Since that time, the Epistry has grown to now cover 100% of both countries. Given this change, it is now timely to report on and compare the characteristics and patient outcomes for our entire region.

This study aims to describe and compare OHCA data nationally and across EMS regions. Such information is important to informing national and regional initiatives to improve OHCA patient outcomes.

Method

Study design and setting

This is a retrospective, population-based study of OHCA across Australia and New Zealand for the year 2019. The over-arching ethics approval for the Epistry was provided by the Monash University Human Research Ethics Committee.

Data collection

The data were sourced from the Aus-ROC Australian and New Zealand OHCA Epistry, which has been described in detail elsewhere.[3] In brief, the Epistry collects data from individual registries across all eight Australian and two New Zealand EMS. In both countries, each EMS services a specific region. In Australia each EMS covers an individual state or territory, whereas in New Zealand one EMS (St John New Zealand) covers most of the country (with the other EMS covering the Greater Wellington region). In total, the Epistry covers a land area of 7.96 million km^2 and a population of approximately 30 million people (Table 1). Except for two Australian regions, each participating EMS provides details of all attended OHCA. The Northern Territory (NT) and the Australian Capital Territory (ACT) EMS only provide data for cases where resuscitation was attempted. The data are collected in accordance with Utstein definitions,[1, 2] and are subject to ongoing quality control measures to ensure harmonisation in the data provided from the participating EMS. For the purpose of this paper, attempted resuscitation is defined as cardiopulmonary resuscitation (CPR) or defibrillation provided by EMS. This definition excludes patients that had a return of spontaneous circulation (ROSC) following bystander defibrillation prior to EMS arrival.

Patient demographics and arrest characteristics are described along with three OHCA outcomes: any ROSC in the prehospital setting (prehospital ROSC), ROSC on arrival to hospital (event survival) and survival to hospital discharge or 30 days[7]. Survival to hospital discharge or 30 days was not available for the NT or the ACT at the time of this study. Survival to hospital discharge data for two Australian states, Queensland (QLD) and New South Wales (NSW), were provided as collated data directly from the services, as permission to provide individual survival data from these regions had not yet been received. Regional

variation was assessed through comparisons between Australia and New Zealand and across the EMS regions.

Statistical analysis

Continuous data are reported as medians and interquartile range (IQR), while categorical data are presented as counts with percentages. Annual crude incidence rates (per 100,000) were calculated for both attended OHCAs and cases where resuscitation was attempted. Age-standardised incidence rates (ASIR) were calculated only for all attended OHCA. For both countries, population estimates on the 30th of June 2019 were used to calculate incidence rates (the Estimated Residential Populations from the Australian Bureau of Statistics and the Subnational Population Estimates from Statistics New Zealand). ASIR were standardised to the Australian Estimated Resident Population (ERP) as at 30th June 2011 using the direct method. The NT and ACT were excluded from the calculation of incidence rates for all attended OHCA as they only provided data for cases where resuscitation was attempted.

Comparisons across EMS are made using the Kruskal-Wallis and Pearson's chi-square tests for continuous and categorical measures, respectively. In cross-national comparisons (Australia vs New Zealand), variance estimates and associated p-values were adjusted for clustering within each EMS. Pearson's chi-square statistic was corrected for clustering using the second order correction of Rao and Scott.[8] Given the lack of non-parametric tests for clustered data, p-values for continuous measures were obtained using ordinary least squares regression (OLS), with cluster-robust estimates of standard errors to adjust for within cluster correlations. Response time was log-transformed prior to analysis to meet the distributional assumptions of OLS. All analyses were conducted using Stata version 16.0

(StataCorp, College Station, TX, USA). Statistical significance was assessed at the 5% alpha level.

RESULTS

Attended OHCA cases

There were 31,778 OHCA cases reported to the Epistry in 2019. Of these, 26,637 occurred in Australia and 5,141 in New Zealand. Crude incidence rate and ASIR for OHCA were similar between the two countries (Table 1); although New Zealand had a slightly higher proportion of OHCAs in children aged <18 years (3.4% vs 1.9%, p<0.001). No differences were seen in the presumed aetiologies between Australia and New Zealand, with the majority presumed to be the result of a medical aetiology (82.7% in Australia and 84.6% in New Zealand).

When compared to Australia, New Zealand had greater proportions of arrests occurring in public places (17.5% vs 13.6%, p=0.007), and less unwitnessed OHCAs (58.5% vs 66.3%, p<0.001). Initial monitored rhythms were also different (p=0.007), with New Zealand having a higher proportion of initial shockable rhythms (20.9% vs 12.1%) and pulseless electrical activity (PEA, 14.5% vs 11.5%), and Australia having higher rates of asystole (73.6% vs 61.6%). In non-EMS-witnessed cases, New Zealand had slightly longer EMS response times (median 9.5 vs 8.3 minutes, p<0.001), but there was no significant difference in bystander defibrillation (2.5% vs 1.8%, p=0.09) and bystander CPR rates (36.8 vs. 38.6%, p=0.37), compared to Australia.

Attempted EMS resuscitation cases

Resuscitation by EMS was attempted in 43.5% (n=11,596) of cases in Australia and in 40.1% (n=2,061) of cases in New Zealand, with similar age distributions in the two countries (Table

2). In these cases, compared to Australia, New Zealand had more males (70.5% vs 67.4, p<0.001), and higher proportions of OHCAs occurring in public locations (21.9% vs 18.6%, p<0.001), witnessed by EMS or bystanders (66.5% vs 58.9%, p<0.001), and presumed medical aetiologies (91.6% vs 85.2%, p<0.001). There was a significant difference in initial rhythm (p<0.001), with New Zealand having a higher proportion of patients with a shockable rhythm (43.2% vs 24.3%), lower proportion of asystole (33.0% vs 49.6%), but similar proportion of PEA (20.9% vs 21.1%) compared to Australia. In non-EMS witnessed cases, New Zealand had a slightly longer EMS response time (median 8.6 vs 8.0 minutes, p=0.04), and similar rates of bystander CPR (74.9% vs. 75.9%, p=0.46) and bystander defibrillation (4.2% vs 3.4%, p=0.24) as Australia.

OHCA outcomes in attempted resuscitation cases

Overall, New Zealand had significantly higher rates of prehospital ROSC (42.6% vs 33.7%, p = 0.001), event survival (32.8% vs 27.1%, p=0.01), and survival to hospital discharge/30 days (16.1% vs 12.5%, p<0.001) than Australia (Table 2). However, there were no significant differences in event survival or survival to hospital discharge/30 days in the Utstein comparator group (i.e. bystander-witnessed with an initial shockable rhythm).

Comparisons across EMS regions for attempted resuscitation cases

EMS in our region cover varying population sizes and densities (Table 3). In cases with an attempted resuscitation, there was marked variation across the EMS regions for patient demographics, arrest characteristics and outcomes (Tables 3 and 4).

Prehospital ROSC ranged across regions between 21.4% to 49.6% (p<0.001) and event survival from 13.1% to 36.7% (p<0.001). Across regions reporting survival to hospital

discharge/30-days, this outcome ranged from 9.9% to 20.7% (p<0.001). Outcomes for the Utstein comparator group also varied significantly (event survival 23.8% to 58.2%, p<0.001; survival to discharge or 30-days 27.4% to 42.0, p=0.007); however, results for four regions (NT, ACT, Tasmania and Wellington) should be interpreted with caution due to their lower case numbers. When cases of pre-EMS ROSC with bystander defibrillation were included for regions collecting this information, survival to discharge or 30-days in the Utstein comparator group increased in most regions but still significantly varied between regions (30.6% to 42.9%, p=0.01).

Discussion

We now have established a bi-national OHCA Epistry, with data that covers the entire populations of both Australia and New Zealand. In 2019, there were 31,778 OHCAs (26,637 in Australia and 5,141 in New Zealand) reported to the Epistry, with 13.3% of those with attempted EMS resuscitation surviving to hospital discharge or 30-days. Similar to other international registries,[9-11] we found notable regional variation, seen both between our two countries and across EMS regions, for incidence, arrest characteristics, and patient outcomes. Some of this variation is plausibly explained by regional differences in the underlying populations and EMS practices, and some may be amendable to intervention.

The crude incidence of OHCA in our countries is high (Australia 107.9/100,000 and NZ 103.2/100,000) when compared to the global average of international reports (83.7/100,000[12]), and varies across EMS regions (range 101.7-120.6/100,000). Some of this variation may be related to differences in the case ascertainment of the contributing EMS, as some on the individual EMS registries have greater resources and are using sophisticated search strategies. Another possible explanation is that there are differences in the

underlying populations. For example, it is now well established in our region that lower socioeconomic status areas have higher OHCA incidence.[13] Recently we have also noted differences within regions in how much the underlying population demographics and risk factors contribute to the regional variation seen in incidence. For example, a Victorian study found almost all of the regional variation in adult OHCA incidence of presumed cardiac aetiology was explained by differences in the age, sex, level of education and prevalence of smoking in the underlying population.[14] Whereas, a recent Queensland study, which included all OHCAs, found no impact for age and sex. We are currently using the Epistry data to identify areas within our EMS regions that may benefit the most from public health initiatives, such as heart attack warning signs campaigns in regions with high incidence[15] or CPR training in regions with high incidence and low bystander CPR. We are also planning on conducting simulations of the benefits of interventions in high-risk locations (e.g. high OHCA incidence and low bystander CPR)[16] in order to identify regions where intervention are most needed and likely to improve survival.

Some of the other regional differences in OHCA demographics and arrest characteristics in our data may also be explained by underlying population demographics and geographic characteristics. For example, the population of Tasmania has the oldest median age (42 years) and more females (98 males for every 100 females), whereas the Northern Territory has the youngest (33 years) population and more males (107 males for every 100 females).[17] These differences in population demographics are reflected in the age and sex of OHCAs seen in each region, and are likely to explain some of the differences in arrest characteristics and outcomes. For example, younger OHCAs are more likely to have non-medical aetiologies (e.g. trauma and hangings) which are associated with worse patient outcomes,[18] as is seen

in OHCAs in the Northern Territory in our data. There are also significant differences in the underlying population densities of each region, and in the levels of remoteness in the regions our EMS serve. This is likely to impact on the location of the arrest, EMS response times and other factors important to survival, such as first monitored rhythm.[19] We are currently determining the best method of risk adjustment to apply to our data so that we can explore this regional variation in more detail. This model will account for differences in EMS, case mix and the known interplay of variables. For example, variation in EMS response times impacts greatly on survival for arrests that occur in public, are witnessed and receive bystander CPR.[20] This risk adjusted model will then be used to conduct spatial analysis[21, 22] to explore the regional variation further and to examine other novel factors likely to influence survival in our region (e.g. population density[19] and socioeconomic status[13]). A recent risk adjusted model was developed and validated for OHCAs in England and demonstrated excellent predictive performance.[23]

We also aim to examine the impact of differences in EMS practice and policies in our two countries.[4, 24] A recent paper from the North American Resuscitation Outcomes Consortium identified EMS organisation goals and values as associated with OHCA outcomes.[25] We aim to repeat this study in our region, and explore how we might improve modifiable factors. For example, while all emergency call taking systems in our countries provide dispatcher-assisted CPR instructions, the use of AED location registries in the emergency call is more variable.[4]

There is also room to improve the population's education in our region. Public CPR training rates in our region are low (~56%[26]) and vary by region (range 47% to 67%[26]). This training is not currently mandatory in either country.[27] There is also a large deficit in the public's

understanding about what a defibrillator is,[28] as well as low willingness and confidence to use one.[26] As is seen by the increase in survival with the inclusion of cases with bystander defibrillation and ROSC before EMS arrival in our data (Figure 1), we believe improving public access defibrillation and rates of bystander CPR are the two biggest opportunities to improve OHCA survival in our region.[29] There are currently two large randomised control trials (RCTs) targeting high-risk regions underway in our region, the first examining the impact of community CPR training (FirstCPR Cluster RCT, ACTRN12621000367842) and the second heart attack education (Heart Matters Step-wedge RCT, NCT04995900). Moving forward there will also be the opportunity to compare outcomes in regions that have recently introduced first responder programs.

Limitations

At this stage, there are some limitations to our data. Some EMS only collect data from OHCA cases who receive an attempted resuscitation, and not all services currently collect survival to hospital discharge or 30-days. However, this only applies to 2.6% of the Australian population. At this time we are unable to collect data on post-resuscitation care,[30-32] neurological outcomes[33] or quality-of-life,[34] but are currently seeking funding to conduct a series of snapshot-style audits to monitor post-resuscitation care and collect data on quality of life.

Conclusion

In summary, the Aus-ROC Epistry now covers the entire region of Australia and New Zealand, with significant variation in OHCA characteristics and outcomes between our countries and EMS regions. Some of this variation is likely to be explained by differences in

the underlying populations, EMS practices and policies, and levels of public education. It is now our intention to explore and explain this variation in more detail, and to identify regions where interventions will result in the greatest impact.

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Australasian Resuscitation Outcomes Consortium Epistry Management Committee

Janet Bray, Stuart Howell, Stephen Ball, Tan Doan, Emma Bosley, Karen Smith, Bridget Dicker, Steven Faddy, Melanie Thorrowgood, Andy Swain, Andrew Thomas, Alexander Wilson, Carol Shipp, Tony Walker, Paul Bailey, Judith Finn, Tony Smith, Stephen Bernard, Hugh Grantham, Damien Norsworthy, Howard Wren, Keith Driscoll, Mike McDermott, Abhishek Ranjan, Richard Larsen, Samuel Perillo, Con Georgakas, Jeff Waters, Peter Cameron, Graham Nichol, and Gavin Perkins.

Members of the Aus-ROC Epistry Management Committee who are not authors on the manuscript should be listed as collaborators.

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Figure Legend

Figure 1. Survival to discharge or 30 days for the Utstein comparator group with and without patients with return of spontaneous circulation from a public access defibrillation prior to emergency medical service arrival.

Table 1: Characteristics and incidence for attended OHCA cases by country for 2019*.

	Australia N=26,637	**New Zealand** N=5,141	**p-value**
Population served	25,365,745	4,979,300	-
Geographic area (km^2)	7,688,220	268,315	-
Population density (persons per km^2)	3.3	18.5	
Crude incidence (per 100,000 persons)	107.9	103.2	-
EMS regions:			
Victoria	102.3		
South Australia	120.6		
Western Australia	103.8		
Queensland	106.4		
Tasmania	115.2		
New South Wales	108.5		
Northern Territory	N/A		
Australian Capital Territory	N/A		
St John New Zealand		103.5	
Wellington (New Zealand)		101.7	
Age-standardised incidence (per 100,000 persons)	98.8	100.0	-
EMS Attempted resuscitation: n (%)	11,596 (43.5)	2061 (40.1)	0.14
Crude incidence EMS attempted resuscitation (per 100,000 persons)	45.7	41.4	-
Age (years) (median, IQR)	68 (52-80)	66 (52-78)	0.06
Children, < 18y: n (%)	511 (1.9)	174 (3.4)	<0.001
Adults, 18+ y: n (%)	25,678 (98.1)	4967 (96.6)	
Male: n (%)	17,628 (66.4)	3414 (66.5)	0.72
Location: n (%)			
Private residence	20,249 (76.1)	3768 (73.3)	0.007
Public place	3627 (13.6)	902 (17.5)	
Other	2720 (10.2)	471 (9.2)	
Witness status: n (%)			
EMS	2045 (8.0)	513 (10.0)	<0.001
Bystander	6553 (25.7)	1619 (31.5)	
Unwitnessed	16,899 (66.3)	3008 (58.5)	
Bystander CPR for non-EMS witnessed cases: n (%)	9316 (38.6)	1702 (36.8)	0.37
First monitored rhythm: n (%)			0.007
Shockable (VF/VT/US)	2926 (12.1)	941 (20.9)	
PEA	2773 (11.5)	651 (14.5)	
Asystole	17,733 (73.6)	2767 (61.6)	
Unknown non-shockable	678 (2.8)	134 (3.0)	
Bystander defibrillation for non-EMS witnessed cases: n (%)	448 (1.8)	115 (2.5)	0.09
Medical aetiology: n (%)	22,014 (82.7)	4254 (84.6)	0.17

	Australia N=26,637	New Zealand N=5,141	p-value
Aetiology: n (%)			
Medical	22,014 (82.7)	4254 (84.6)	
Drowning	211 (0.8)	57 (1.1)	
Hanging	1563 (5.9)	306 (6.1)	
Overdose/poisoning	1014 (3.8)	80 (1.6)	
Trauma	1796 (6.7)	332 (6.6)	
Electrocution	21 (0.1)	1 (0.0)	
EMS response time (minutes) (median, IQR) for non-EMS witnessed cases	8.3 (6.0-12.9)	9.5 (6.9-14.4)	<0.001

* Missing data is provided in the Supplementary Material and is subtracted from denominators.

EMS: emergency medical services; CPR: Cardiopulmonary resuscitation; VF/VT/US/PEA: Ventricular fibrillation/ventricular tachycardia/unknown shockable/Pulseless Electrical Activity; IQR: Interquartile range.

Table 2: Summary table of OHCA cases that received attempted resuscitation from EMS personnel by country in 2019.

	Australia N=11,596	New Zealand N=2061	P value
Age (years) (median, IQR)	66 (50-78)	64 (52-76)	0.14
Children, <18 years: n (%)	366 (3.2)	80 (3.9)	0.10
Adults, 18+ years: n (%)	11,158 (96.8)	1981 (96.1)	
Male: n (%)	7818 (67.4)	1451 (70.5)	<0.001
Location: n (%)			
Private residence	8146 (70.3)	1466 (71.1)	<0.001
Public place	2156 (18.6)	452 (21.9)	
Other	1285 (11.1)	143 (6.9)	
Witness status: n (%)			
EMS	1729 (15.5)	353 (17.1)	<0.001
Bystander	4848 (43.4)	1018 (49.4)	
Unwitnessed	4597 (41.1)	690 (33.5)	
Bystander CPR for non-EMS witnessed cases: n (%)	7318 (75.9)	1279 (74.9)	0.46
First monitored cardiac rhythm: n (%)			
Shockable (VF/VT/US)	2785 (24.3)	870 (43.2)	<0.001
PEA	2423 (21.1)	422 (20.9)	
Asystole	5685 (49.6)	666 (33.0)	
Unknown non-shockable	565 (4.9)	57 (2.8)	
Bystander defibrillation for non-EMS witnessed cases: n (%)	335 (3.4)	71 (4.2)	0.24
Medical Aetiology: n (%)	9877 (85.2)	1855 (91.6)	<0.001
Aetiology: n (%)			
Medical	9877 (85.2)	1855 (91.6)	
Drowning	108 (0.9)	17 (0.8)	
Hanging	487 (4.2)	68 (3.4)	
Overdose/poisoning	435 (3.7)	28 (1.4)	
Trauma	673 (5.8)	57 (2.8)	
Electrocution	13 (0.1)	1 (0.0)	
EMS response time (minutes) (median, IQR) for non-EMS witnessed cases	8.0 (6.0-11.0)	8.6 (6.5-11.7)	0.04
Prehospital ROSC: n (%)			
Yes	3907 (33.7)	879 (42.6)	
No	7689 (66.3)	1182 (57.4)	0.001
ROSC on hospital arrival: n (%)			
Yes	3141 (27.1)	677 (32.8)	0.01
No	8452 (72.9)	1384 (67.2)	
Missing	3 (0.0)	0 (0.0)	
Survival to hospital discharge/30 days: n (%)			
Yes	1348 (12.5)	331 (16.1)	<0.001*
No	9438 (87.3)	1683 (81.7)	
Missing	22 (0.2)	47 (2.3)	

	Australia N=11,596	New Zealand N=2061	P value
Outcomes: bystander witnessed, shockable rhythm			
	N=1743	N=542	
Survived event (ROSC on hospital arrival): n (%)			
Yes	856 (49.9)	275 (48.7)	0.74
No	859 (50.1)	290 (51.3)	
Survival to hospital discharge/30 days: n (%)			
Yes	565 (34.2)	165 (29.2)	0.06*
No	1082 (65.5)	386 (68.3)	
Missing	4 (0.2)	14 (2.5)	

*P-values were not adjusted for clustering within EMS as individual level data was not available for all Australian states. Data for New South Wales and Queensland were drawn from their respective annual reports; data was not available for Northern Territory or the Australian Capital Territory. Missing data were subtracted from denominators (where missing data is not provided).

EMS: emergency medical services; CPR: Cardiopulmonary resuscitation; VF/VT/US/PEA: Ventricular fibrillation/ventricular tachycardia/unknown shockable/Pulseless Electrical Activity; IQR: Interquartile range; ROSC: return of spontaneous circulation

Table 3: Characteristics of OHCA cases that that received an attempted resuscitation by emergency medical services in 2019.

	Victoria (n=3127)	SA (n=927)	WA (n=1168)	QLD (n=2307)	NT (n=84)	ACT (n=151)	Tasmania (n=239)	NSW (n=3593)	SJ NZ (n=1791)	Wellington (n=270)
Population	6,596,880	1,752,681	2,623,259	5,093,884	246,143	426,285	534,575	8,087,379	4,455,900	523,000
Geographic area (km^2)	227,444	984,321	2,527,013	1,729,742	1,347,791	2,358	68,401	801,150	260,726	7,589
Population density (persons per km^2)	29.0	1.8	1.0	2.9	0.2	180.8	7.8	10.1	17.1	68.9
Crude incidence (per 100,000 persons)	47.4	52.9	44.5	45.3	34.1	35.4	44.7	44.4	40.2	51.6
Age (years) (median, IQR)*	67 (51-79)	68 (52-79.5)	62 (47-76)	65 (49-76)	48.5 (34.5-61)	60 (45-75)	68 (57-76)	67 (52-79)	64 (52-76)	65.5 (53-75)
Children,<18y: n (%)	86 (2.8)	18 (2.0)	40 (3.4)	95 (4.1)	7 (8.3)	2 (1.4)	3 (1.3)	115 (3.2)	69 (3.8)	11 (4.1)
Adults, 18+ y: n (%)	3037 (97.2)	902 (98.0)	1128 (96.6)	2211 (95.9)	77 (91.7)	143 (98.6)	231 (98.7)	3429 (96.8)	1722 (96.2)	259 (95.9)
Male: n (%)	2109 (67.5)	620 (66.9)	795 (68.1)	1562(67.7)	54 (64.3)	97 (64.2)	166 (69.5)	2415(67.2)	1264(70.6)	187 (69.3)
Location: n (%)*										
Private residence	2099 (67.1)	657 (70.9)	809 (69.3)	1712 (74.2)	54 (64.3)	104 (68.9)	186 (77.8)	2525 (70.3)	1283 (71.6)	183 (67.8)
Public place	587 (18.8)	190 (20.5)	222 (19.0)	393 (17.0)	20 (23.8)	16 (10.6)	43 (18.0)	685 (19.0)	381 (21.3)	71 (26.3)
Other	441 (14.1)	80 (8.6)	137 (11.7)	196 (8.5)	10 (11.9)	31 (20.5)	7 (2.9)	383 (10.7)	127 (7.1)	16 (5.9)
Unknown/Missing	0	0	0	6 (0.3)	0	0	3 (1.3)	0	0	0
Witness by: n (%)*										
EMS	480 (15.4)	121 (13.0)	167 (14.3)	361 (15.6)	7 (8.3)	19 (12.6)	35 (14.6)	539 (15.0)	313 (17.5)	40 (14.8)
Bystander	1305 (41.7)	401 (43.3)	481(41.2)	935 (40.5)	33 (39.3)	47 (31.1)	91 (38.1)	1555 (43.3)	871 (48.6)	147 (54.4)
Unwitnessed	1320 (42.2)	404 (43.6)	519 (44.4)	894 (38.7)	44 (52.4)	40 (26.5)	76 (31.8)	1300 (36.2)	607 (33.9)	83 (30.7)
Unknown/Missing	22 (0.7)	1 (0.1)	1 (0.1)	117 (5.1)	0	45 (29.8)	37 (15.5)	199 (5.5)	0	0
Bystander CPR for non-EMS witnessed cases: n (%)*										
Yes	1938 (73.2)	589 (73.1)	783 (78.2)	1445 (74.2)	51 (66.2)	108 (81.2)	125 (61.3)	2279 (74.6)	1096 (74.1)	183 (79.6)
No	669 (25.3)	216 (26.8)	217 (21.7)	461 (23.7)	26 (33.8)	8 (6.1)	79 (38.7)	645 (21.1)	382 (25.9)	47 (20.4)
Unknown/Missing	40 (1.5)	1 (0.1)	1 (0.1)	40 (2.1)	0	16 (12.1)	0	130 (4.3)	0	0
Bystander defibrillation for non-EMS witnessed cases: n (%)*	76 (2.9)	53 (6.6)	36 (3.6)	36 (1.9)	4 (5.2)	7 (5.3)	25 (12.3)	98 (3.2)	58 (3.9)	13 (5.6)

	Victoria (n=3127)	SA (n=927)	WA (n=1168)	QLD (n=2307)	NT (n=84)	ACT (n=151)	Tasmania (n=239)	NSW (n=3593)	SJ NZ (n=1791)	Wellington (n=270)
First monitored rhythm: n (%)*										
Shockable (VT/VF/US)	735 (23.7)	233 (25.4)	265 (22.9)	558 (24.4)	27 (32.5)	33 (24.3)	63 (27.8)	871 (24.5)	768 (44.0)	102 (38.1)
PEA	768 (24.8)	223 (24.3)	212 (18.3)	597 (26.1)	10 (12.0)	17 (12.5)	45 (19.8)	551 (15.5)	373 (21.3)	49 (18.3)
Asystole	1506 (48.5)	446 (48.6)	633 (54.8)	1088 (47.7)	44 (53.0)	61 (44.8)	119 (52.4)	1788 (50.3)	555 (31.8)	111 (41.4)
Unknown non-shockable	93 (3.0)	16 (1.7)	46 (4.0)	40 (1.7)	2 (2.4)	25 (18.4)	0	343 (9.6)	51 (2.9)	6 (2.2)
Aetiology: n (%)										
Medical*	2713 (86.8)	799 (86.2)	944 (80.8)	1914 (83.0)	58 (69.1)	135 (89.4)	224 (93.7)	3090 (86.0)	1612 (90.0)	243 (90.0)
Drowning	14 (0.4)	2 (0.2)	17 (1.5)	31 (1.3)	5 (5.9)	0 (0.0)	1 (0.4)	38 (1.1)	16 (0.9)	1 (0.4)
Hanging	107 (3.4)	42 (4.5)	73 (6.2)	121 (5.2)	11 (13.1)	8 (5.3)	0 (0.0)	125 (3.5)	59 (3.3)	9 (3.3)
Overdose/poisoning	124 (4.0)	24 (2.6)	52 (4.4)	82 (3.6)	1 (1.2)	1 (0.7)	4 (1.7)	147 (4.1)	23 (1.3)	5 (1.8)
Trauma	167 (5.3)	59 (6.4)	80 (6.9)	157 (6.8)	6 (7.1)	7 (4.6)	7 (2.9)	190 (5.3)	46 (2.6)	11 (4.1)
Electrocution	2 (0.1)	1 (0.1)	2 (0.2)	2 (0.1)	3 (3.6)	0 (0.0)	0 (0.0)	3 (0.1)	0 (0.0)	1 (0.4)
Unknown/Missing	0	0	0	0	0	0	3 (1.3)	0	35 (1.9)	0
EMS Response time (minutes) (median, IQR) for non-EMS witnessed cases*	7.6 (5.9-10.2)	8.5 (6.3-12.0)	9.0 (7.0-13.0)	8.0 (6.0-11.0)	7.0 (6.0-10.0)	6.0 (4.0-9.0)	10.5 (8.1-17.3)	8.0 (6.0-11.0)	8.6 (6.5-11.7)	8.3 (6.5-11.1)

* $p<0.05$

SA: South Australia; WA: Western Australia; QLD: Queensland; NT: Northern Territory; ACT: Australian Capital Territory; NSW: New South Wales: SJ NZ: St John New Zealand; EMS: emergency medical services; CPR: Cardiopulmonary resuscitation; VF/VT/US/PEA: Ventricular fibrillation/ventricular tachycardia/unknown shockable/Pulseless Electrical Activity; IQR: Interquartile range; ROSC: return of spontaneous circulation.

Table 4: OHCA outcomes for cases that received an attempted resuscitation by emergency medical services in 2019.

	Victoria	South Australia	Western Australia	Queensland	Northern Territory	Australian Capital Territory	Tasmania	New South Wales	SJ NZ	Wellington
All attempted resuscitation cases										
	N=3127	N=927	N=1168	N=2307	N=84	N=151	N=239	N=3593	N=1791	N=270
Prehospital ROSC: n (%)*	1138 (36.4)	340 (36.7)	283 (24.2)	803 (34.8)	18 (21.4)	71 (47.0)	91 (38.1)	1163 (32.4)	745 (41.6)	134 (49.6)
ROSC at hospital: n (%)*										
Yes	961 (30.7)	241 (26.0)	213 (18.2)	681 (29.5)	11 (13.1)	54 (35.8)	72 (30.1)	908 (25.3)	578 (32.3)	99 (36.7)
No	2163 (69.2)	686 (74.0)	955 (81.8)	1626 (70.5)	73 (86.9)	97 (64.2)	167 (69.9)	2685 (74.7)	1213 (67.7)	171 (63.3)
Missing	3 (0.1)	0	0	0	0	0	0	0	0	0
Survival to hospital discharge/30 days: n (%)*					-	-				
Yes	409 (13.1)	107 (11.5)	115 (9.9)	318 (14.4)	-	-	28 (11.7)	371 (11.8)	275 (15.4)	56 (20.7)
No	2702 (86.4)	816 (88.0)	1053 (90.1)	1892 (85.6)	-	-	209 (87.5)	2766 (88.2)	1469 (82.0)	214 (79.3)
Missing	16 (0.5)	4 (0.4)	0	0			2 (0.8)	0	47 (2.6)	0
Survival to hospital discharge/30 days, including AED+ROSC prior to EMS arrival: n (%)*										
Yes	436 (13.8)	112 (12.0)	135 (11.3)	328 (14.8)	-	-	32 (13.2)	-	304 (16.6)	57 (21.0)
No	2703 (85.7)	817 (87.6)	1054 (88.6)	1892 (85.2)	-	-	209 (86.0)	-	1474 (80.7)	214 (79.0)
Missing	16 (0.5)	4 (0.4)	0	0	-	-	2 (0.8)	-	48 (2.6)	0
Bystander witnessed, shockable rhythm										
	N=485	N=147	N=177	N=319	N=21	N=18	N=38	N=539	N=496	N=69
ROSC at hospital: n (%)*										
Yes	266 (58.2)	83 (56.5)	66 (37.3)	167 (52.4)	5 (23.8)	8 (44.4)	21 (55.3)	240 (44.6)	236 (47.6)	39 (56.5)
No	191 (41.8)	64 (43.5)	111 (62.7)	152 (47.6)	16 (76.2)	10 (55.6)	17 (44.7)	298 (55.4)	260 (52.4)	30 (43.5)
Missing	0	0	0	0	0	0	0	0	0	0

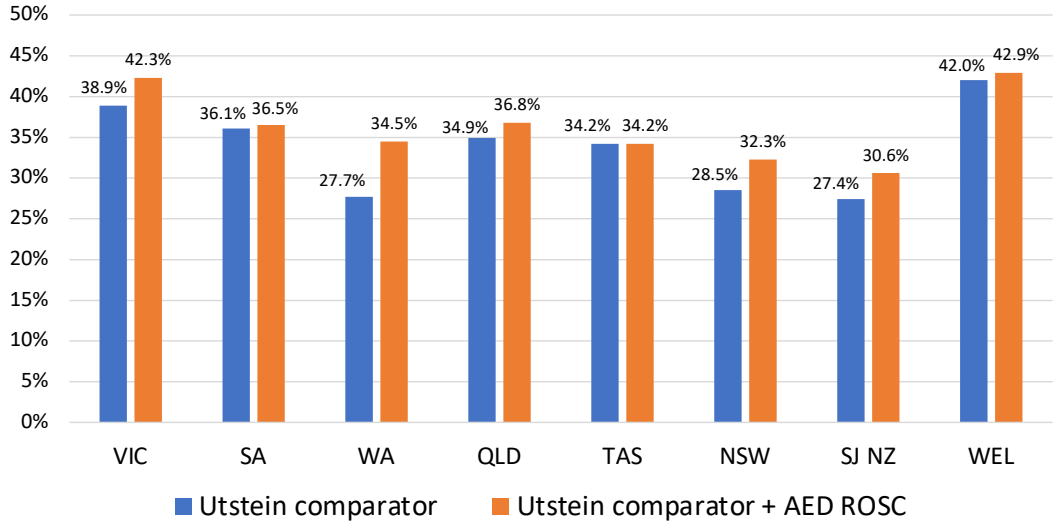
	Victoria	South Australia	Western Australia	Queensland	Northern Territory	Australian Capital Territory	Tasmania	New South Wales	SJ NZ	Wellington
Survival to hospital discharge/30 days: n (%)*#										
Yes	178 (38.9)	53 (36.1)	49 (27.7)	117 (34.9)	-	-	13 (34.2)	154 (28.5)	136 (27.4)	29 (42.0)
No	279 (61.1)	90 (61.2)	128 (72.3)	218 (65.1)	-	-	25 (65.8)	344 (69.1)	346 (69.8)	40 (58.0)
Missing	0	4 (2.7)	0	0	-	-	0	41 (7.6)	14 (2.8)	0
Survival to hospital discharge/30 days, including AED+ROSC prior to EMS arrival: n (%)*#										
Yes	205 (42.3)	54 (36.5)	68 (34.5)	127 (36.8)	-	-	13 (34.2)	185 (32.3)	161 (30.6)	30 (42.9)
No	280 (57.7)	90 (60.8)	129 (65.5)	218 (63.2)	-	-	25 (65.8)	344 (60.0)	350 (66.5)	40 (57.1)
Missing	0	4 (2.7)	0	0	-	-	0	44 (7.7)	15 (2.9)	0

*p<0.05.

Survival data for Queensland and NSW are sourced from the EMS. Survival data are not available for Northern Territory or the Australian Capital Territory.

SJ NZ: St John New Zealand; ROSC: return of spontaneous circulation; AED: Automatic external defibrillator

Figure 1. Survival to discharge or 30 days for the Utstein comparator group with and without patients with return of spontaneous circulation from a public access defibrillation prior to emergency medical service arrival.



VIC: Victoria; SA: South Australia; WA: Western Australia; QLD: Queensland; TAS: Tasmanian; NSW: New South Wales; SJ NZ: St John New Zealand; WEL: Wellington.