



St John

Here for Life

Out-of-Hospital Cardiac Arrest Registry

Annual Report 2015/16





Clinical Audit and Research

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Publication date: November 2016

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ISSN 2382-1582

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Contents

Surviving cardiac arrest	5
From the Chief Executive Officer	6
From the Director of Clinical Operations	7
The St John emergency ambulance service	8
About this report	9
Executive summary	10
Benchmarking executive summary	11
The St John Out-of-Hospital Cardiac Arrest (OHCA) Registry	12
Incidence and demographics	14
The chain of survival	20
System response	21
Outcomes	26
Abbreviations	32
Definitions	32
The St John New Zealand OHCA Registry Group	33
Acknowledgements	33
References	34

List of figures

Figure 1: Age distribution of OHCA.	15
Figure 2: Age, standardised incidence of OHCA per 100,000 person-years.	15
Figure 3: Distribution of OHCA according to ethnicity.	16
Figure 4: Ethnicity, standardised incidence of OHCA per 100,000 person-years.	16
Figure 5: The three St John regions, incidence of OHCA per 100,000 person-years.	17
Figure 6: Concentration of OHCA events across the three St John regions.	19
Figure 7: Precipitating events for adults.	19
Figure 8: Precipitating events for children.	19
Figure 9: Location of OHCA for adults.	19
Figure 10: Urban response, time from call to arrival of ambulance.	23
Figure 11: Rural and remote response, time from call to arrival of ambulance.	23
Figure 12: Bystander CPR rates for all-cause OHCA in adults	25
Figure 13: Scene outcome for all-cause OHCA in adults	27
Figure 14: Outcomes for all-cause OHCA in adults.	27
Figure 15: Benchmarking for all-cause OHCA in adults, survived event rates.	27
Figure 16: Benchmarking for all-cause OHCA in adults, survival to hospital discharge.	27
Figure 17: Outcomes for OHCA in adults according to presenting rhythm.	28
Figure 18: Outcomes for OHCA in adults where the arrest is bystander witnessed, has a shockable presenting rhythm and is of presumed cardiac aetiology.	29
Figure 19: Benchmarking hospital discharge rates in adults where the arrest is bystander witnessed, has a shockable presenting rhythm and is of presumed cardiac aetiology.	29
Figure 20: Rural/remote versus urban areas, influence of location on outcome.	30
Figure 21: The three St John regions, influence of region on outcome.	30
Figure 22: Private residence and public, influence of location on outcome.	30

List of tables

Table 1: Outcomes for adults. Benchmarking all-cause events.	11
Table 2: Benchmarking survival to hospital discharge rates in adults where the arrest is bystander witnessed, has a shockable presenting rhythm and is of presumed cardiac aetiology.	11
Table 3: Inclusion criteria.	12
Table 4: Exclusion criteria.	12
Table 5: Benchmarking response times.	22
Table 6: Abbreviations	32
Table 7: Definitions	32

Case study: Surviving cardiac arrest

Teacher Robyn Shore was in the right place at the right time

A cardiac arrest is a brush with almost certain death. If it does happen, then as teacher Robyn Shore can tell you, there are few better places to be than learning first aid at St John's Hamilton offices.

When Robyn had her cardiac arrest, she was among St John staff who knew exactly what to do, and more importantly a defibrillator was in the next room. Robyn says, "I don't remember feeling funny. I came to with people all around me. I felt nothing and didn't know what was happening."

For St John First Aid Tutor Christina Saunderson the class on January 26 was business as usual. Christina has been a St John Tutor working part-time for three years. Such is her passion for the role, she relocated from Wellington to take up a fulltime position in Hamilton a year ago. Christina had already noticed Robyn, who has a keen and engaging sense of humour. At one point that morning Robyn slumped at her desk. At first Christina thought Robyn was pretending, but she quickly noticed that Robyn's breathing was strange, a sign of cardiac arrest, and leapt into action.

Christina cleared the room, told someone to ring 111 and with the help of a couple of Robyn's colleagues, put Robyn into position to begin CPR (cardiac pulmonary resuscitation). As she did this she was calling for fellow tutor Craig Williams to fetch the defibrillator. Christina focused on doing good CPR and remembers thinking, "Is she still with me?"

When Craig brought the defibrillator into the room, they prepped the machine and gave Robyn one shock and then continued CPR for another minute and a half. Robyn started breathing



Survivor Robyn Shore thanks first aid tutors Christina Saunderson and Craig Williams for saving her life

on her own and opened her eyes. Christina then put her on her side and covered her with a blanket and got a pillow for her head, just as the ambulance crew arrived. Without their speedy intervention, Robyn's chance of reaching hospital alive was slim.

Robyn remembers coming to in the training room, confused and wanting to get up. The ambulance crew transported her to Waikato Hospital's Emergency Department. Tests revealed that Robyn had not had a heart attack, but her heart's electrical system which controls the rate and rhythm of the heartbeat had failed, causing an irregular rhythm that led to Robyn's heart stopping.

Robyn says, "All the doctors told me I was the luckiest lady alive that day. If it had happened at home or when I was driving or at school in front of the children, if it had happened somewhere else, I wouldn't be here."

The impact is still with Robyn, a person with strong Christian beliefs. "I believe there was a reason for how it happened. I was dead, but not really dead, as Christina was pushing my heart, keeping it going."

Robyn now has an implanted cardiac defibrillator that monitors her heartbeat and if an irregular beat is detected, it is programmed to shock her heart back to its normal rhythm. After six weeks of recovery Robyn started back at school for short periods and after eight weeks returned to teaching fulltime at Koromatua School in the Temple View district of Hamilton.

Once back on her feet, she met up with Christina. They both felt emotional as they recalled the close brush with death. They hugged. It was heartfelt and they now share a life-changing experience. This experience is not as rare as people think. Five New Zealanders a day experience an out-of-hospital cardiac arrest.

Robyn didn't leave it there. Three months after the sudden cardiac arrest she completed the first aid course. After publicity about Robyn's story, an anonymous donor gave \$3000 to equip Koromatua School with its own defibrillator. With their St John training, Robyn and her colleagues are ready to respond to any future cardiac arrest. ■

From the Chief Executive Officer



This report presents evidence that shows our care and treatment of patients experiencing an out-of-hospital cardiac arrest continues to be of a high standard. When it comes to the internationally accepted key measure of quality, the numbers of patients who survive to hospital discharge, St John compares favourably. For these patients, St John has a survival rate of 16%, the London Ambulance Service 9% and Ambulance Victoria, 10%.

Every day in New Zealand approximately five people are treated for an out-of-hospital cardiac arrest (OHCA). From the moment, they go into cardiac

arrest, there are many individuals who contribute to their survival—from members of the public who witness the event and perform cardiopulmonary resuscitation (CPR) or use an automated external defibrillator (AED), to 111 Call Handlers, ambulance personnel (including volunteers), co-responders such as the New Zealand Fire Service and hospital personnel.

Every day in New Zealand approximately five people are treated for an out-of-hospital cardiac arrest (OHCA).

Benchmarking outcomes from OHCA is one of the key measures of clinical quality of an emergency ambulance service and is fundamental to improving survival rates. To provide the best evidence-based patient care, St John measures and compares our patient outcomes against our previous data and the performance of other ambulance services, and uses the resulting clinical insights to continually improve. As both the provider of ambulance services and a number of community education programmes,

St John is in a unique position to improve a number of aspects in the chain of survival.

This report is about what the data tells us. But behind the data are individuals who have experienced a traumatic event. For some this has resulted in death. Our thoughts are with their family and whānau. Our goal is to ensure that over time more people survive cardiac arrest. ■

Peter Bradley
Chief Executive Officer

From the Director of Clinical Operations



We are delighted to present the third Out-of-Hospital Cardiac Arrest (OHCA) Registry annual report.

St John New Zealand continues to deliver high standards of care and our performance compares favourably with ambulance services overseas.

Often the public attention is on the emergency service response. Equally important to St John are our community programmes where we build awareness of the need for quick action and train people to carry out those actions with confidence.

A particular focus has been on Māori communities, who experience a high rate of heart disease. Our teams are working

with marae across the country to improve access to defibrillators and to run our 3 Steps for Life programme that trains people to take the three key actions to respond when someone has a sudden cardiac arrest.

Through our partnership with ACC there has been great progress on the St John in Schools programme to teach school students basic first aid and CPR. This year St John has engaged with 110,000 children nationwide and is on track to teach 480,000 children over the next four years. For the coming year ASB is joining as a partner and from July 2016 the programme becomes ASB St John in Schools.

This year the introduction of the electronic Patient Report Form (ePRF) system has made the collation of data much easier and will provide opportunities for further insights into how we can improve our service.

St John is Here for Life and I want to thank our staff, partners, sponsors and the many members of the public who support St John to carry out our mission to save lives and improve health outcomes for our patients. ■

A handwritten signature in black ink that reads 'Norma Lane'.

Norma Lane
Director of Clinical Operations

The St John emergency ambulance service

St John is New Zealand's largest emergency ambulance service (EAS) serving around four million people or approximately 90% of the population.

The service operates across 97% of New Zealand's geographical area while Wellington Free Ambulance services the Wellington and Wairarapa regions.

The organisation calls on more than 1,600 paid and over 3,000 volunteer ambulance officers to provide care to the more than 400,000 patients treated each year. Ambulance officers in New Zealand may be vocationally trained (National Diploma, NZQA Level 4 – 6), hold a three-year Bachelor of Health Science degree in paramedicine or hold post-graduate qualifications in advanced resuscitation. St John ambulance officers, both paid and volunteer, are supported through ongoing clinical education.

In an emergency New Zealanders dial 111 and are directed by telecommunications company Spark to one of three emergency agencies. Every day around 1,300 of these calls are for an ambulance. St John owns and runs the 111 Clinical Control Centres in Auckland and Christchurch and helps run a third in Wellington, in a joint venture with Wellington Free Ambulance.

Responding to a cardiac arrest

When an emergency ambulance call comes in, St John Call Handlers use the medical priority dispatch system (MPDS) to triage calls and determine the appropriate level of response to a call. A colour coded response system is used, based on international best practice.

An immediately life threatening call, such as a cardiac arrest, is allocated a 'purple' response, takes precedence over all other calls and the closest responder is immediately dispatched. This may be an emergency ambulance or any other co-responder including the St John Patient Transfer Service, New Zealand Fire Service, local first response groups or Primary Response in Medical Emergencies (PRIME) doctors and nurses. An intensive care paramedic qualified in advanced life support is also sent to all suspected cardiac arrests, when available.

For a suspected cardiac arrest, the St John Call Handler instructs the caller to use an AED if available and guides them through the process of performing CPR.

Once ambulance officers reach the patient, they may continue the resuscitation attempt. Depending on the qualification of

the responding personnel, they may also provide advanced life support such as advanced airway management, drug therapy, physiologic monitoring and post-cardiac arrest care.

A cardiac arrest is allocated a 'purple' response and the closest responder is immediately dispatched.

The cardiac arrest protocols used by ambulance officers have been developed by the National Ambulance Sector Clinical Working Group¹. In situations where resuscitation is not feasible, or clearly not in the best interest of the patient, St John ambulance officers may elect not to start a resuscitation attempt. When a resuscitation attempt is underway, it may later be stopped by ambulance officers following the written protocols within the St John Clinical Procedures and Guidelines¹. ■



About this report

Cardiac arrest remains a considerable public health issue, with ischaemic heart disease being the second most prevalent cause of death in New Zealand².

Survival to hospital discharge rates for Out-of-Hospital Cardiac Arrest (OHCA) are highly variable internationally and can range from less than 4% to greater than 20%³. Benchmarking survival from OHCA is a key measure of the clinical quality of an EAS and fundamental to making improvements in OHCA survival⁴. Knowledge of New Zealand OHCA outcomes is a key driver to help identify and address areas for improvement in clinical care.

The data presented in this report is for all OHCA attended by the St John EAS in the period from 1 July 2015 to 30 June 2016. The data for this report was extracted from the registry on 26 September 2016.

The data is collated in the registry using a reporting template based on international definitions outlined in the Utstein style of reporting and the variables developed by the Australian Resuscitation Outcomes Consortium (Aus-ROC)⁵⁻⁷.

Where possible comparisons are drawn with Wellington Free Ambulance, Ambulance Victoria, London Ambulance Service, St John Ambulance Western Australia and King County Emergency Medical Services (EMS) in Washington USA⁷⁻¹¹. These services were selected as the definitions and collection variables that are used in the St John OHCA Registry are similar to those used by these services.

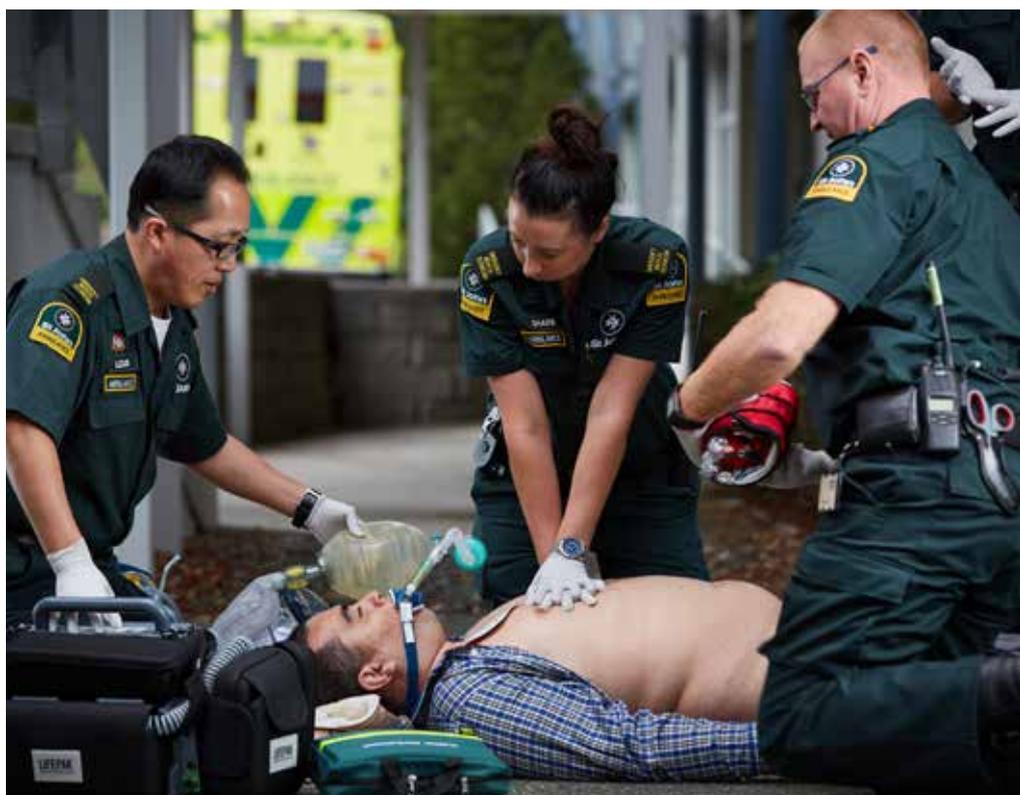
The data presented in this report primarily relates to events that were either 'attended' or where there was a 'resuscitation

attempted' by St John EAS personnel. 'Attended' refers to all OHCA where St John EAS personnel were present regardless of whether or not a resuscitation attempt was made. 'Resuscitation attempted' refers only to those events where St John EAS personnel were present and an attempt at resuscitation was made. The outcomes of OHCA for international benchmarking compare median response time, return of spontaneous circulation (ROSC) sustained to handover at hospital (survived event) and discharged from hospital alive (survival to discharge).

Descriptive statistics were performed with statistical software SPSS (IBM v23) and tests were chosen depending on whether the data fitted a normal distribution with equivalent variances in the standard deviation. Results were determined to be significant if $p < 0.05$.

All population figures in this report are derived from Statistics New Zealand population data using the online population tools or population tables¹²⁻¹⁵. The population figures provided are for the end of June 2015, with the population of the St John response area being 4,141,960.

Unless otherwise stated all analysis is inclusive of cardiac arrests witnessed by St John EAS personnel. If it is unrecorded whether the patient is a child or an adult, then these events are assumed to be adults and are included in the adult category. ■



Executive summary



5 people a day

(approx) are treated for an out-of-hospital cardiac arrest in New Zealand (nearly 2000 per year)

32% female, 68% male



60%

of patients had bystander CPR performed



The median time in which a St John ambulance reaches a patient is **7 minutes** in urban communities and **11 minutes** in rural and remote communities



70%

of events were co-responded to and attended by the New Zealand Fire Service



6%

of patients that had a cardiac arrest in public were defibrillated with a public access defibrillator



29%

of patients survived the event (had a pulse on arrival at hospital)



16% of patients survived to hospital discharge

Response to all-cause, out-of-hospital cardiac arrest in adults where a resuscitation attempt was made by the responding EAS

Benchmarking executive summary

The outcomes of OHCA for international benchmarking compare the median response time, event survival rate and rate of survival to hospital discharge (Table 1).

A specifically selected subgroup of patients is also used to benchmark against other ambulance services. This subgroup is referred to as the "Utstein comparator group" by the London Ambulance Service and requires the criteria outlined in Table 2 to be met⁷.

When benchmarked against the other EAS for all-cause events St John ranked second for hospital discharge status. Overall the outcomes for OHCA attended by St John are similar to those in the international community⁷⁻¹¹

The definitions and collection variables that are used in the St John OHCA Registry are similar to those used by the other EAS benchmarked against. However, there may be differences between the services for inclusion criteria.

Where known, these differences are highlighted within the footnote. The time period reported for each of the services may also differ depending on the availability of data at the time of publication of this report. ■

Table 1: Outcomes for adults. Benchmarking all-cause events (resuscitation attempted).

Ambulance Service	Data collection Period	Total events (resuscitation attempted)	Median response time (minutes)	Survived event (ROSC sustained to hospital handover)	Survived to hospital discharge
St John	1 July 2015 to 30 June 2016	1,983	7 (urban) 11 (rural and remote)	29%	16%
Wellington Free Ambulance ⁸	1 July 2015 to 30 June 2016	226	8 (urban) 13 (rural and remote)	37%	14%
Ambulance Victoria ^{∞9}	1 July 2014 to 30 June 2015	5,573	8 (urban) 10 (rural and remote)	30%	10%
London Ambulance Service* ⁷	1 April 2014 to 31 March 2015	4,665	8 (urban) N/A (rural and remote)	31%	9%
St John Ambulance Western Australia ^{†11}	1 July 2015 to 30 June 2016	1,020	8 (urban) N/A (rural and remote)	24%	11%
King County EMS ¹⁰	1 July 2014 to 30 June 2015	905	6 (urban) 8 (rural)**	48%	19%

Table 2: Benchmarking survival to hospital discharge rates in adults where the arrest is bystander witnessed, has a shockable presenting rhythm and is of presumed cardiac aetiology (resuscitation attempted)[#].

Ambulance Service	Data collection Period	Survived to hospital discharge
St John	1 July 2015 to 30 June 2016	35%
Wellington Free Ambulance ⁸	1 July 2015 to 30 June 2016	31%
Ambulance Victoria ⁹	1 July 2014 to 30 June 2015	32%
London Ambulance Service* ⁷	1 April 2014 to 31 March 2015	32%
St John Ambulance Western Australia ^{†11}	1 July 2015 to 30 June 2016	38%
King County EMS ¹⁰	1 July 2014 to 30 June 2015	48%

* Data in both Table 1 and Table 2 for London Ambulance Service is inclusive of children.

† Data in both Table 1 and Table 2 for St John Ambulance Western Australia is only available for urban events.

** Rural = 7 Cases.

∞ Data in Table 1 for Ambulance Victoria does not include EAS witnessed events.

Data for all services in Table 2 excludes EAS witnessed events.

The St John Out-of-Hospital Cardiac Arrest Registry

The St John OHCA Registry was formally established in September 2013. Since the registry was established, pre-hospital data for cardiac arrests attended by St John has been successfully captured for more than 11,000 patients.

The St John OHCA Registry is overseen by Dr Bridget Dicker, St John Clinical Research Fellow and Auckland University of Technology Senior Lecturer.

Eligibility

St John captures data on all OHCA events attended by the St John EAS. St John defines a cardiac arrest as a patient who is unconscious and pulseless with either agonal breathing or no breathing.

Inclusion and exclusion criteria are described in Table 3 and Table 4.

Data capture

This report reflects data recorded between 1 July 2015 and 30 June 2016. The data is collated in the registry using a reporting template based on international definitions outlined in the Utstein style of reporting and the variables developed by the Australian Resuscitation Outcomes Consortium (Aus-ROC)^{5,6}.

In the data collection process there are three separate points where data is acquired:

- Computer Aided Dispatch (CAD) and supporting systems
- On scene by the ambulance officers in attendance
- District Health Board (DHB) patient outcome reporting.

Table 3: Inclusion criteria (All of the following).

1	Patients of all ages who suffer a documented cardiac arrest
2	Occurs in New Zealand where St John or one of its participating co-responders is the primary treatment provider
3	<ul style="list-style-type: none"> ➤ Patients of all ages who on arrival of the St John EAS are unconscious and pulseless with either agonal breathing or no breathing or ➤ Patients of all ages who become unconscious and pulseless with either agonal breathing or no breathing in the presence of St John EAS personnel or ➤ Patients who have a pulse on arrival of St John EAS personnel following successful bystander defibrillation.

Table 4: Exclusion criteria (Any of the following).

1	Patients who suffer a cardiac arrest in a hospital facility where St John EAS may be in attendance but are not the primary treatment providers
2	Patients who suffer a cardiac arrest during an inter-hospital transfer where St John EAS may be providing transport but are not the primary treatment providers
3	Bystander suspected cardiac arrest where the patient is not in cardiac arrest on arrival of the St John EAS personnel, and where a successful attempt at defibrillation did not occur or no other evidence verifying a cardiac arrest state is present
4	Patients who suffer a cardiac arrest where Wellington Free Ambulance is the primary treatment provider

Computer aided dispatch

Patient and event details are collected by the Clinical Control Centre when a 111 call is received and an ambulance is dispatched, with data being entered into the computer aided dispatch (CAD) system. Data specifically related to cardiac arrest is obtained from the CAD system and transferred into the St John OHCA Registry.

On scene collection

Ambulance officers on scene attending a patient in cardiac arrest are required to record specific data. This is recorded on either a paper cardiac arrest data form or an electronic Patient Report Form (ePRF). The cardiac arrest data form and a copy of the patient care record are either scanned and emailed, using a secure email server, to the cardiac arrest data officer or if using the ePRF submitted electronically to a secure server.

DHB patient outcome data

Each patient who has been transported to hospital following a cardiac arrest has a record held by that DHB. Outcome data is requested from each DHB on a monthly basis by the cardiac arrest data officer.

Data quality

The registry is subject to quality improvement processes which involve continual auditing of existing data and updating of the registry entries as appropriate.

Reconciliation of paper cardiac arrest data forms with CAD system information enables the number of missing cardiac arrest event reports to be verified. During transcription from the paper data form into the registry, automated validation rules and error messages limit errors. A quality control audit of a random sample of 10% of cases is also undertaken every three months to validate

the accuracy of data entry within the registry. Implementation of the ePRF system was completed in March 2016 and, as such, data validation and quality control processes for this system are currently being refined.

Registry reports are generated on a monthly and quarterly basis and these are analysed for variances in the numbers of cases and patient outcomes. These results are compared with international data from EAS that are similar to St John. In this report, comparison is made between Wellington Free Ambulance, Ambulance Victoria, London Ambulance Service, St John Ambulance Western Australia and King County EMS where applicable⁷⁻¹¹.

Missing data

Since the registry's inception there have been improvements made to the proportion of missing data. The overall fraction of missing pre-

hospital data is now relatively low, which is reflective of an EAS culture that values continuous monitoring to improve patient outcomes.

There are three aspects that are monitored to quantify data completeness within the registry. The first is whether the event was recorded within the CAD system data set, the second whether or not a paper cardiac arrest data form was completed by the responding EAS crew and lastly whether or not all of the appropriate data fields were captured in full.

Almost all paper cardiac arrest data forms are completed in full by EAS personnel. However, for the ethnicity field the option exists for EAS crews to select "unknown" therefore ethnicity data is only fully established for 80% of paper entries. However, within the ePRF platform both the cardiac arrest data form and the ethnicity fields are compulsory. The ethnicity

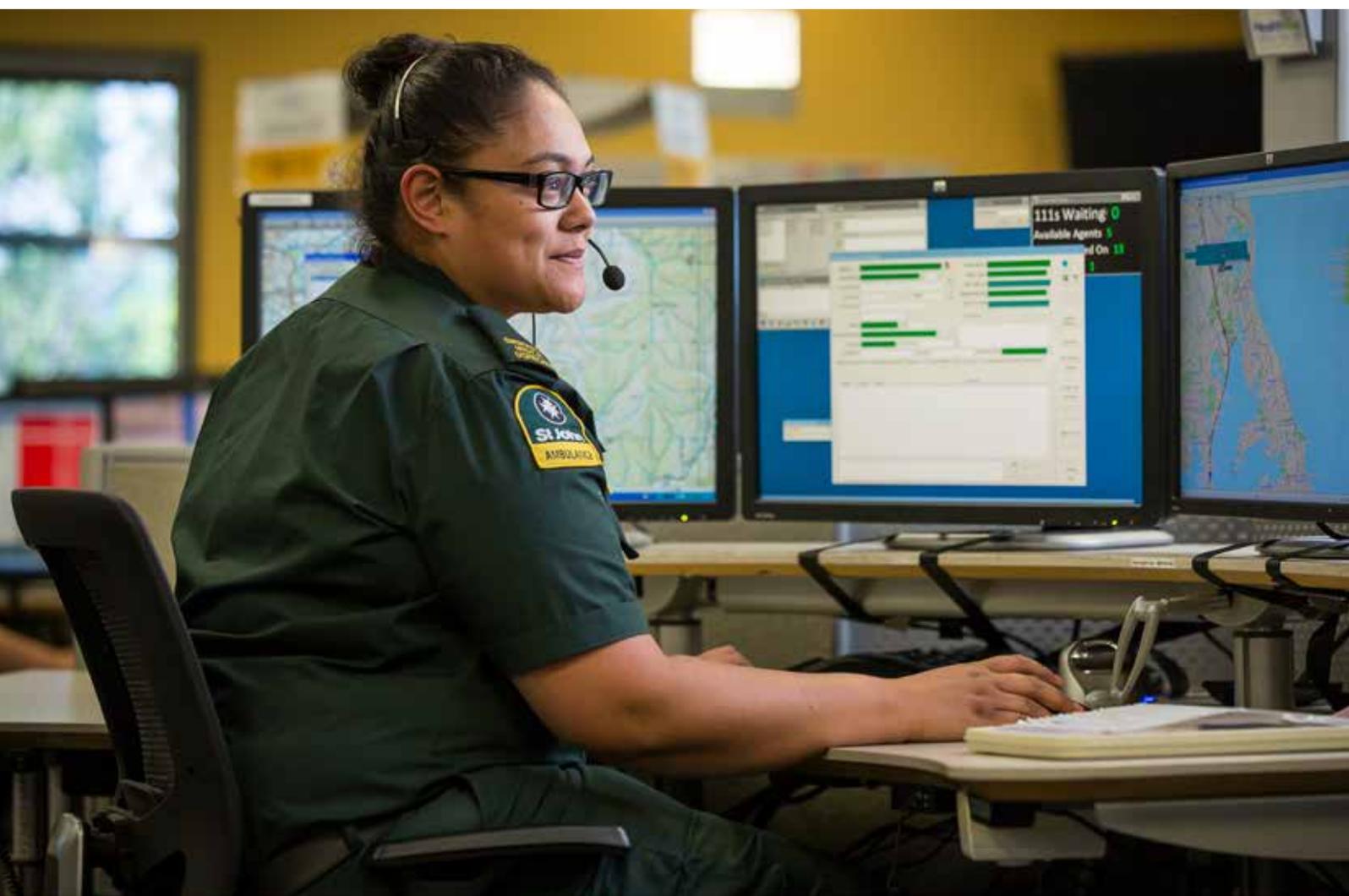
capture from the ePRF data is greater than 97%.

Ethical review

The St John OHCA Registry has been approved by both the New Zealand Health and Disability Ethics Committee (Ethics reference 13/STH/192) and the Auckland University of Technology Ethics Committee (Ethics reference 13/367).

The registry is also subject to St John internal research governance processes that include a locality review and locality authorisation as per the Standard Operating Procedures for Health and Disability Ethics Committees.

The St John OHCA Registry is held on a secure server which requires active directory permissions. At no stage is data that could identify individual patients or individual hospitals released from this registry. ■



Incidence and demographics

Incidence of all events occurring in adults and children

St John is New Zealand's largest emergency ambulance service providing care to more than four million people or approximately 90% of New Zealand's population. Of this group of people, it is estimated that 873,300 (21%) are children younger than 16 years old^{14, 15}. In the period from 1 July 2015 to 30 June 2016 St John EAS attended 4,341 OHCA events of which 97% (n=4,213) were adults and 3% (n=128) were children.

The adult incidence rate for St John was 128.9[‡] per 100,000 person-years compared to Ambulance Victoria and the London Ambulance Service that reported incidence rates of 118.6 and 118.0* per 100,000 person-years respectively in 2014^{7, 9}.

The incidence rate for children was 14.7 per 100,000 person-years. This is higher than the incidence rate of 7.4 per 100,000 person-years reported by Ambulance Victoria for the 2014 to 2015 period⁹. The finding of a higher incidence rate for children in New Zealand is in line with the difference reported in OECD Health Status Data (2012), which indicated infant mortality rates were 1.42 times higher in New Zealand than Australia¹⁶. The low total number of events occurring in children (n=128) does however, contribute to a large variation in the reported incidence rate.

The proportion of OHCA events occurring in adults where resuscitation was attempted was 47% (n=1,983). This is similar to Ambulance Victoria and the London Ambulance Service where resuscitation was attempted in 44% and 46%† of OHCA events in adults respectively^{7, 9}.

Demographics of adults

Of the OHCA events in adults attended by St John 65% of patients were male and 35% were female. The median age was different between genders, with males having a lower median age at 66 years versus females at 70 years (Figure 1).

The overall standardised incidence rate for males was nearly twice that for females at 137.3 versus 72.3 per 100,000 person-years. When standardised to individual age groups, males in all age groups had a higher incidence of OHCA per 100,000 person-years compared with females (Figure 2).

Demographics of children

The incidence of OHCA in children attended by St John is very low, with only 128 events being recorded over the one year reporting period. Due to the low incidence of cardiac arrest within the 12-month period, demographics were instead analysed on cumulative data for a 33-month period (n=314, 1 October 2013 to 30 June 2016). Over this period the median age

was not significantly different between genders at 11 months for males and 10 months for females. There was a higher proportion of cardiac arrest in boys (59%) compared to girls (41%). The higher incidence of cardiac arrest in boys aligns with the tenth New Zealand Child and Youth Mortality Review Report (2014), which showed a higher mortality rate for male children compared to female children (65.3% versus 34.7% of childhood deaths)¹⁷.

Over the 33-month period, resuscitation was attempted in 68% of events (n=212), a proportionally higher percentage of attempts than for adults.

‡ Incidence for adults based on a total adult population of 3,268,645¹⁵

* Incidence for all ages calculated on a total population of London of 8,674,000

† All ages; data not available for adult only

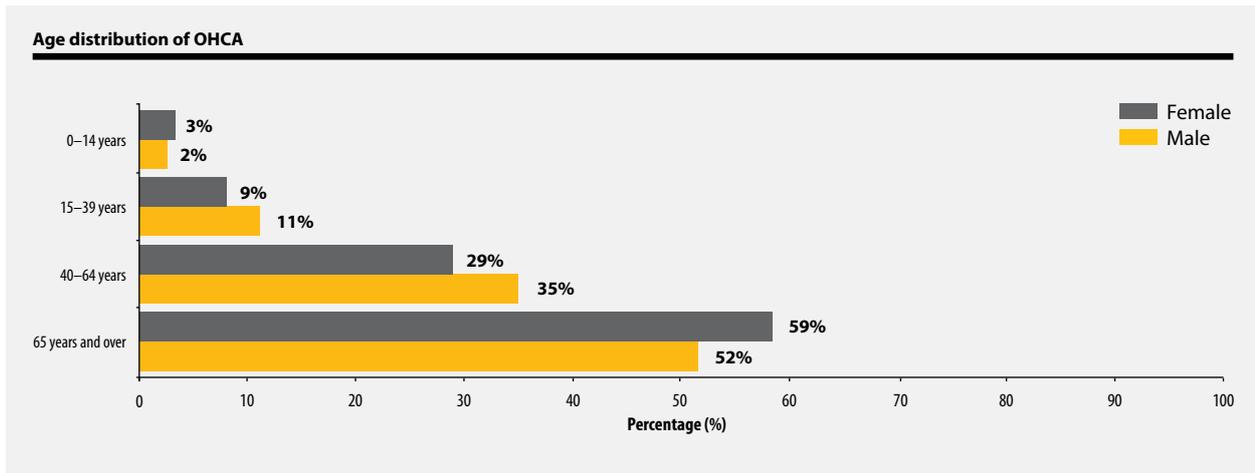


Figure 1: Age distribution of OHCA (All events).

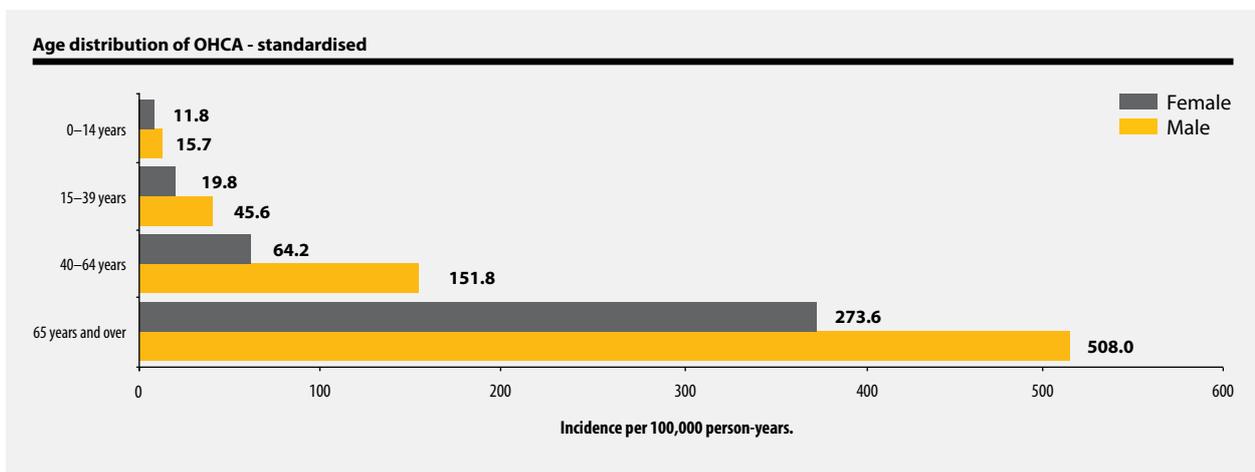


Figure 2: Age, standardised incidence of OHCA per 100,000 person-years (All events).



Ethnicity

The majority of all OHCA events attended by St John EAS were for patients of European ethnicity, as defined by the Statistics New Zealand population groups¹³ (Figure 3).

When standardised to the New Zealand ethnic population groups, as a fraction of the parent population, Māori had a disproportionately higher incidence of OHCA per 100,000 person-years (114.1) compared with non-Māori (less than 80)¹³. This aligns with New Zealand Ministry of Health figures which indicate that Māori are disproportionately affected by ischaemic heart disease. Māori adults are 1.8 times more likely to be diagnosed with ischaemic heart disease than non-Māori adults¹⁸. Conversely, people of Asian ethnicity had the lowest standardised incidence of OHCA (Figure 4).

Note: Within the ethnicity field the option exists for EAS crews to select “Unknown” therefore ethnicity data is only fully established for 85% of entries. The category of “Other” (n=554) is also not indicated within the graph. Therefore, this data should be viewed with caution.

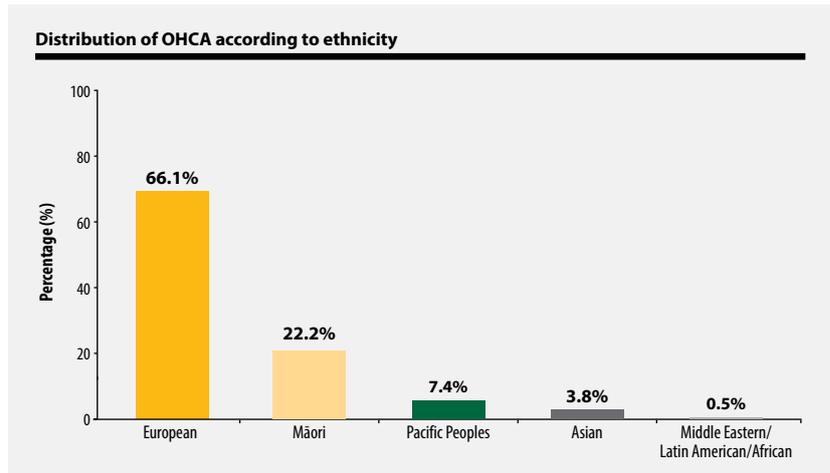


Figure 3: Distribution of OHCA according to ethnicity (All events).

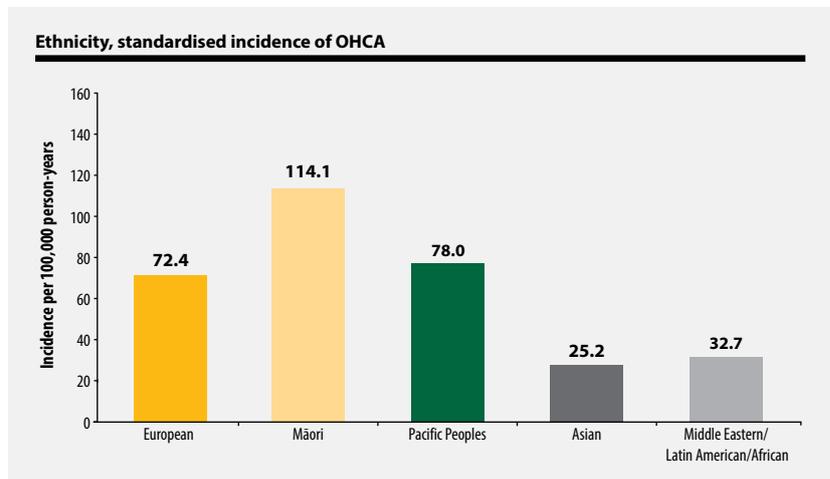


Figure 4: Ethnicity, standardised incidence of OHCA per 100,000 person-years (All events).



Incidence across urban and rural/remote areas

The population within the St John jurisdiction is classified as urban or rural and remote as per Table 7 at the end of this report. A larger proportion of the New Zealand population is based within metropolitan centres and consequently a greater portion of OHCA events attended by St John occurred within metropolitan localities (72%). The incidence rate for the urban population was 104.4 per 100,000 person-years and the rural/remote population was 112.0 per 100,000 person-years.

Incidence across regions of New Zealand

The response areas covered by St John are divided into three regions, northern, central and South Island Region. Northern Region (n=1,635) covers the area from Hauraki to the Far North, central region (n=1,496) covers from Horowhenua to the Waikato and South Island region (n=1,159) covers the entire South Island¹⁵.

The incidence of OHCA per 100,000 person-years was calculated based on population estimates from Statistics New Zealand. There was a significant difference in the incidence of OHCA between regions ($p < 0.05$) (Figure 5). It is unknown why there is a difference in the incidence between regions.

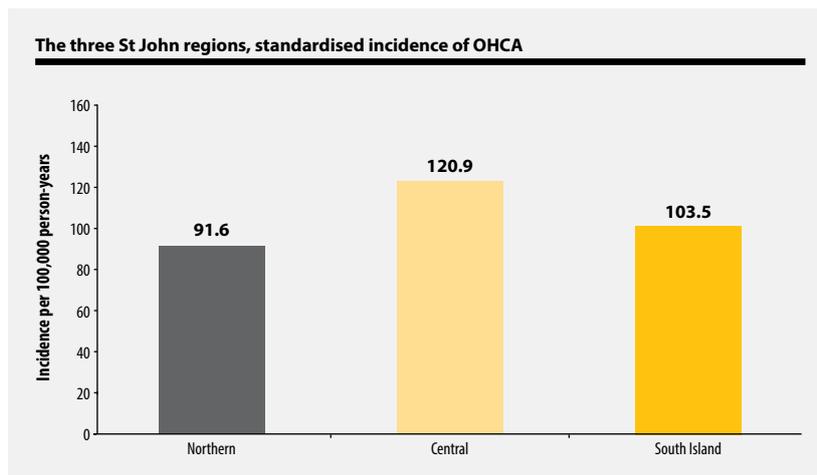


Figure 5: The three St John regions, incidence of OHCA per 100,000 person-years. (All events)





Heat map of OHCA events in the three St John regions

Red represents the highest concentration of OHCA on the heat map of OHCA events in the three St John Regions, followed by yellow and then green (Figure 6). The heat map in Figure 6 represents where the majority of events occur and is focused on areas of population density*.

Precipitating events for adults

St John EAS personnel presume an OHCA to be of cardiac cause unless it is known or likely to have been caused by trauma, drowning, poisoning or any other non-cardiac cause. The most common aetiology of OHCA in adults where resuscitation was attempted was that of a presumed cardiac cause, which constituted 79% of events.

Other common precipitating events included respiratory arrest (6%), trauma (4%) and hanging (3%) (Figure 7).

Precipitating events for children

The occurrence of OHCA in children is rare therefore cumulative data for a 33-month period from 1 October 2013 to 30 June 2016 was used for the analysis of precipitating events. During the 33-month period there were a total of 199 events in children where resuscitation was attempted. Of these, the leading cause of OHCA in children was sudden unexpected death in infancy (SUDI) at 33%, followed by respiratory arrest at 22% (Figure 8). These findings are consistent with those of the New Zealand Mortality Review Data Group, which show that the incidence

of SUDI in New Zealand is one of the highest among industrialised countries and the leading cause of death in children aged less than one year¹⁷.

Arrest location

The most common place for an OHCA to occur is in a person's home, with 67% of events where resuscitation was attempted occurring at home. The second most common place for an OHCA to occur is in a public area (21%), which includes the workplace, the street, a shopping centre or similar (Figure 9). ■

* Heat map is not standardised to incidence per 100,000 person-years

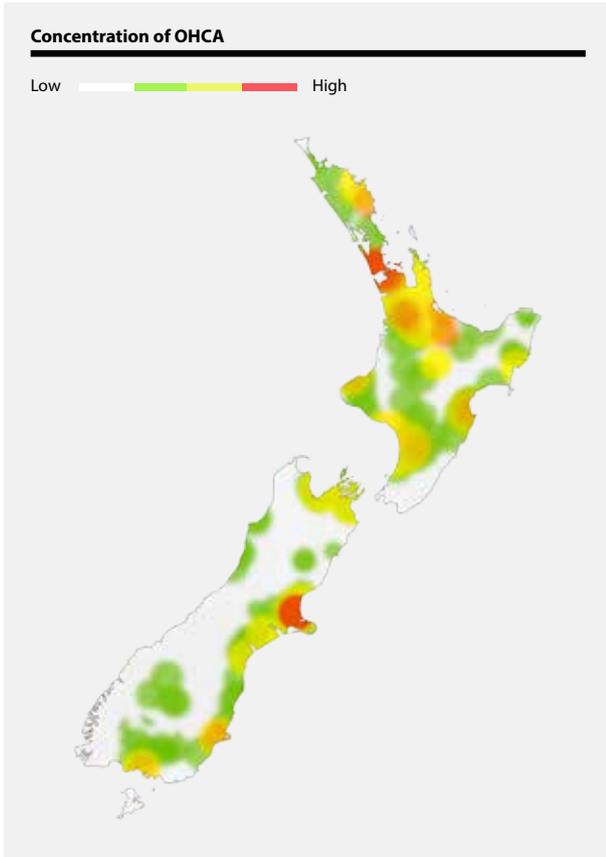


Figure 6: Concentration of OHCA events across the three St John regions.

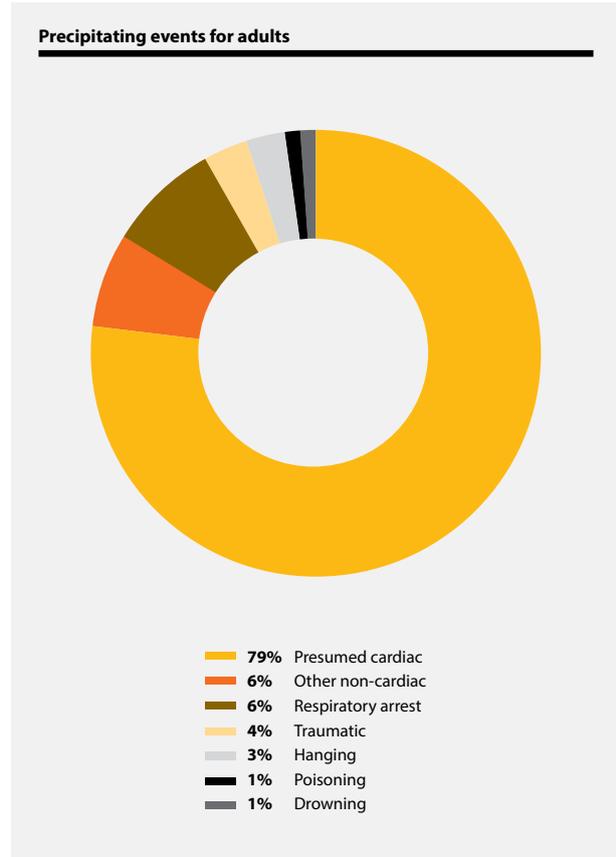


Figure 7: Precipitating events for adults (resuscitation attempted).

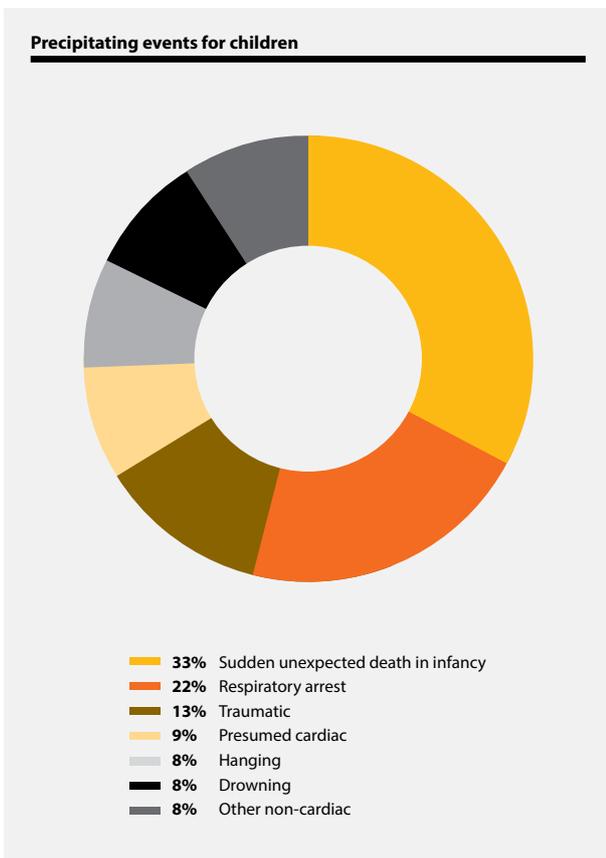


Figure 8: Precipitating events for children (33-months, resuscitation attempted).

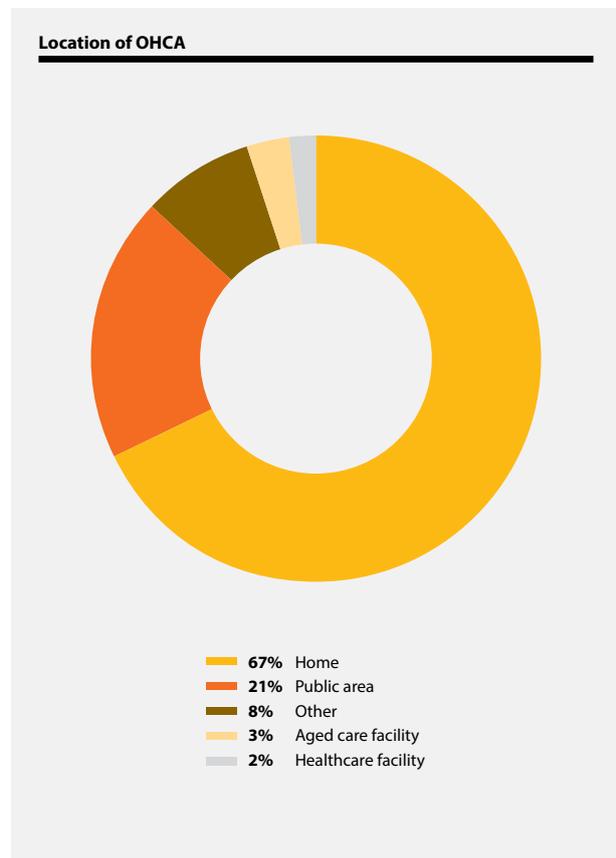


Figure 9: Location of OHCA for adults (resuscitation attempted).

The chain of survival

The gold standard in resuscitation optimises the key links in the chain of survival¹⁹:

- Early recognition and call for help
- Early bystander CPR
- Early defibrillation
- Early advanced life support and standardised post-resuscitation care. ■



1 Early recognition



2 Early CPR



3 Early defibrillation



4 Early advanced life support

System response

King County EMS uses the phrase “It takes a system to save a victim”²⁰. The meaning of this statement is that it is the complex combination of all the elements and agencies in the pathway of a patient in cardiac arrest that leads to survival. This includes:

- the community response
- Clinical Control Centre personnel
- New Zealand Fire Service and other co-responders
- EAS, including first responders, emergency medical assistants, emergency medical

technicians, paramedics, intensive care paramedics, education personnel, clinical support personnel, quality improvement personnel and managers

- hospital personnel.

St John is continually working to improve the many elements within this complex pathway by focusing on factors that primarily affect the chain of survival: early recognition and call for help, early bystander CPR, early defibrillation, early advanced life support and standardised post-resuscitation care.

St John is working to improve patient outcomes by focusing on factors that affect the chain of survival





Early recognition and call for help

The first step in the chain of survival is that bystanders in the community recognise a patient in cardiac arrest and phone 111 for an ambulance. Following on from this the next crucial time period is the time taken from when the call is answered in the Clinical Control

Centre to when an ambulance arrives. This is one of the key performance indicators for St John EAS and the target is to get trained personnel with a defibrillator to the patient in the shortest time possible.

For OHCA where resuscitation was attempted by St John EAS, the median response time (from

call pick up in the Clinical Control Centre to arrival of the ambulance on scene) for cardiac arrests was seven minutes in urban areas (n=1,459) and 11 minutes for rural and remote areas (n=550) (Figure 10 and Figure 11). These are similar response times to the international services against which St John is benchmarked⁷⁻¹¹ (Table 5).

Table 5: Benchmarking response times (resuscitation attempted events).

Ambulance service	Median response time (minutes)
St John	7 (urban)
	11 (rural and remote)
Wellington Free Ambulance ⁸	8 (urban)
	13 (rural and remote)
Ambulance Victoria ⁹	8 (urban)
	10 (rural and remote)
London Ambulance Service ⁷	8 (urban)
	N/A (rural and remote)
St John Ambulance Western Australia ¹¹	8 (urban)
	N/A (rural and remote)
King County EMS ¹⁰	6 (urban)
	8 (rural and remote)**

** Rural cases n=7

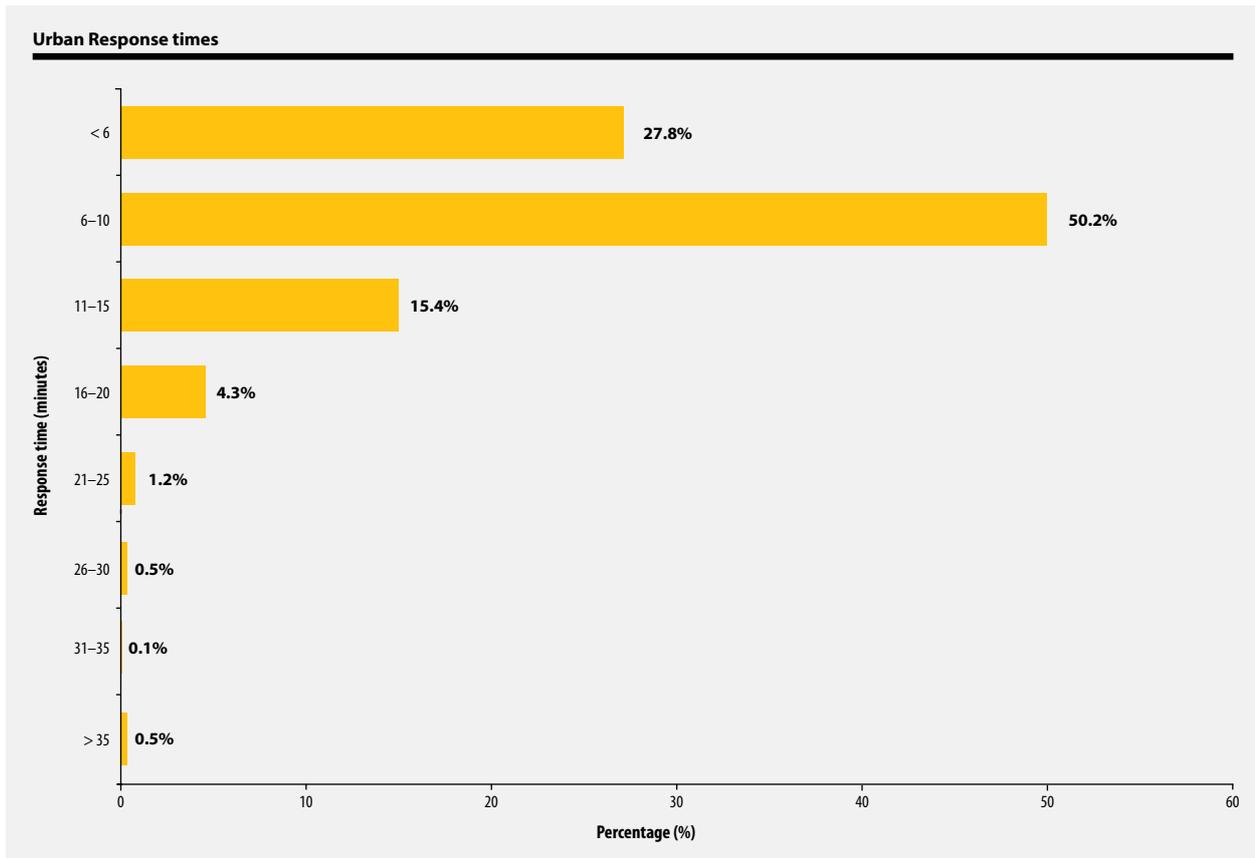


Figure 10: Urban response, time from call to arrival of ambulance (resuscitation attempted).

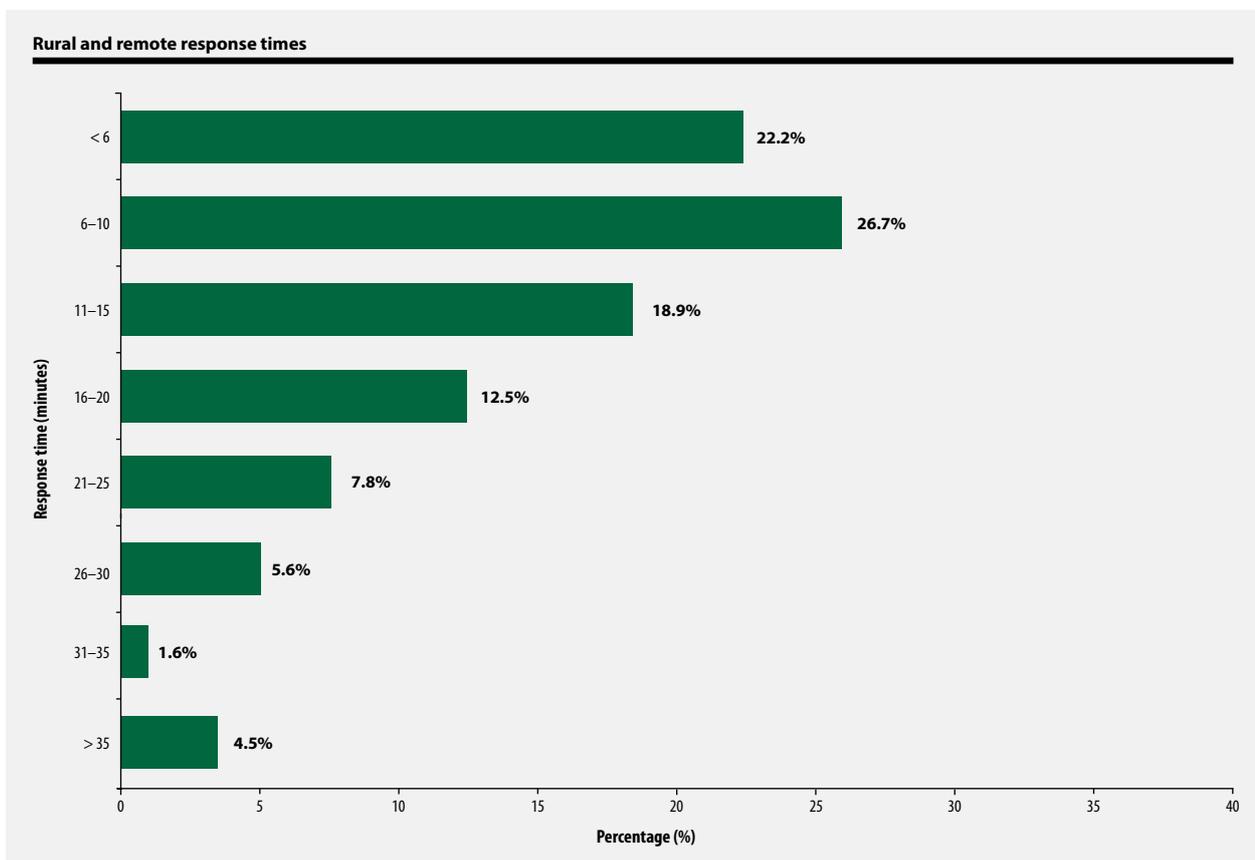


Figure 11: Rural and remote response, time from call to arrival of ambulance (resuscitation attempted).

The community response

For every minute of cardiac arrest without CPR or defibrillation a patient's chance of survival falls by 10–15%²¹. This makes the community and bystander response integral to survival from OHCA. If CPR is started before an ambulance arrives, the patient's chance of survival dramatically increases—any CPR is better than no CPR. Similarly, the time until defibrillation for a patient in cardiac arrest can also have a significant impact on survival. Patients who are defibrillated within the first three to five minutes of cardiac arrest have the greatest chance of surviving²².

To make improvements to the rate of bystander CPR and AED use, St John supports a number of community initiatives. These initiatives include, the 3 Steps for Life community awareness program, the ASB St John in Schools program and the National Marae OHCA project.

3 Steps for Life

www.stjohn.org.nz/3stepsforlife

3 Steps for Life is designed to give all New Zealanders the confidence and awareness to take action when somebody suffers a cardiac arrest by

- 1 Calling 111
- 2 Starting CPR
- 3 Using an AED (automated external defibrillator).

This initiative is an opportunity for our people to deliver free community awareness sessions with the potential to save up to 500 lives a year. All St John personnel with an Authority to Practise at Emergency Medical Technician level (or above), along with certified St John tutors, can volunteer to run a one-hour CPR and AED 3 Steps for Life awareness session for local community groups such as sports clubs, retirement villages and marae communities.



ASB St John in Schools

St John recognises that children also have a role to play in a community response to an OHCA. Between 1 July 2015 and 30 June 2016 the ASB St John in Schools programme has trained approximately 24,393 children in CPR and there are more than 7,300 St John Youth members engaged in learning first aid and CPR.

National Marae OHCA project

In this and previous reports, it is noted that Māori are more at risk of cardiac arrest than non-Māori. The St John Pou Takawaenga (liaison officers) are working with marae around New Zealand to engage with Māori and support them with access to AEDs and training in CPR and AED use. During the period of this report, the Pou Takawaenga have engaged with more than 60 marae and have delivered the 3 Steps for Life sessions to nearly 100 people since the programme's launch in June 2016.

Online resources

St John has developed several online videos and a smartphone application which are freely available to the public to help them learn CPR and how to use an AED.

The St John CPR App

www.stjohn.org.nz/cprapp

Learn how to do CPR and to use an AED, 3 Steps for Life

www.stjohn.org.nz/3stepsforlife

A friends and family kit for learning CPR is also available

from the St John Online Shop (<https://www.stjohn.org.nz/Shop/First-Aid-Kits-and-Supplies/First-Aid-Info-and-resources>). This kit is designed to be shared and it is estimated that for every kit sold an additional two and a half people are trained.

For every minute of cardiac arrest without CPR or defibrillation a patient's chance of survival falls by 10–15%

Rates of bystander CPR

In addition to the community response, Clinical Control Centre personnel play a pivotal role in the rates of early bystander CPR. As soon as St John emergency Call Handlers suspect a patient is in cardiac arrest they provide instructions to the caller over the phone on how to perform CPR.

Of the OHCA where resuscitation was attempted, 60% of these had bystander CPR performed prior to ambulance arrival (witnessed and unwitnessed combined). This figure is similar to the previous year's result (64%) (Figure 12). This is also comparable to rates of bystander CPR reported internationally: Ambulance Victoria 78% (bystander witnessed) and London Ambulance 63% (witnessed and unwitnessed combined)^{7,9}

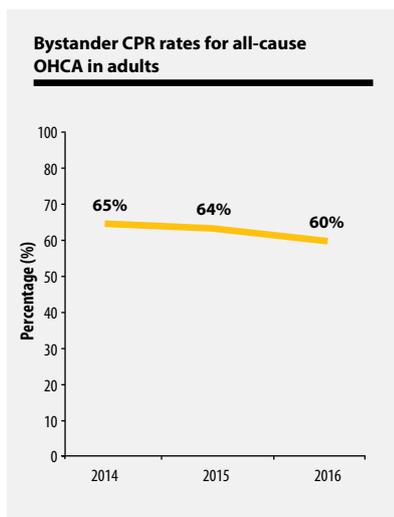


Figure 12: Bystander CPR rates for all-cause OHCA in adults (resuscitation attempted).

Time to defibrillation

More than 20% of cardiac arrests occur in a public area, therefore public access defibrillators and community first aid training have a large role to play in early defibrillation. If a St John emergency Call Handler suspects they are dealing with a cardiac arrest, one of the first questions they ask is if an AED is available. If so, they provide instructions on how to use it, as well as on how to perform CPR.

When a defibrillator is used by bystanders before the arrival of emergency services, patient outcomes dramatically improve with 56% of these patients surviving to hospital discharge. In comparison 13% of patients survived to hospital discharge if a defibrillator was not used prior to EAS arrival. However, the total number of patients defibrillated using public access defibrillators was extremely low constituting only 6% (n=25) of events that occurred in public (n=409).

With time to defibrillation crucial, St John has in place strong protocols to ensure that patients in cardiac arrest are reached in the shortest time possible by responders trained in CPR and with access to a defibrillator. Clinical Control Centre staff give a cardiac arrest the highest priority and dispatch the closest resource immediately.

This may be an emergency ambulance or any trained responder including the St John Patient Transfer Service, the New Zealand Fire Service, first response groups or PRIME doctors and nurses in rural areas. By dispatching the closest resource,

defibrillation and CPR can occur in the quickest possible time, which may be sooner than EAS arrival.

The New Zealand Fire Service

Since December 2013 the New Zealand Fire Service has been part of the team of professionals available to co-respond to an OHCA. During this reporting period (1 July 2015 to 30 June 2016), the Fire Service attended more than 70% (n=1,394) of adult OHCA events where a resuscitation attempt was made by EAS.

Early CPR is one of the key links in the chain of survival and in 15% of adult OHCA events where resuscitation was attempted by EAS the New Zealand Fire Service arrived on scene first to provide early CPR and use an AED prior to ambulance arrival.

The New Zealand Fire Service has been fundamental in the early defibrillation of 95 adult patients in cardiac arrest prior to the arrival of St John EAS. Of these patients, 38% survived the event (had a pulse sustained to hospital handover) and 28% survived to hospital discharge. ■



Outcomes

Scene outcome for OHCA in adults

One of the contributing factors to patient survival is good quality chest compressions during CPR. Performing CPR during the transport of a patient following an OHCA may compromise the quality of the CPR being delivered¹⁹. Therefore, in the majority of OHCA events, it is appropriate to continue resuscitation at the scene of the arrest until either return of spontaneous circulation (ROSC) occurs or resuscitation is ceased. This is reflected in the scene outcomes observed in adult

patients where resuscitation was attempted by St John EAS (Figure 13). The overall percentage of patients transported with CPR in place was 3%, transported with return ROSC was 30% and died at the scene was 67%.

Adult outcome from all-cause cardiac arrest

Survival from OHCA is the foremost factor in benchmarking the performance of EAS internationally. The results from the St John OHCA registry show an event survival rate (ROSC sustained to hospital handover) of 29% (Figure 14). This

is similar to the previous reporting periods as shown in Figure 14 and this result is benchmarked with other services in Figure 15.

The rate of survival to hospital discharge in adults where resuscitation was attempted was 16%. This rate remains similar to previous years (Figure 14). The rate of survival to discharge is benchmarked with other services in Figure 16.



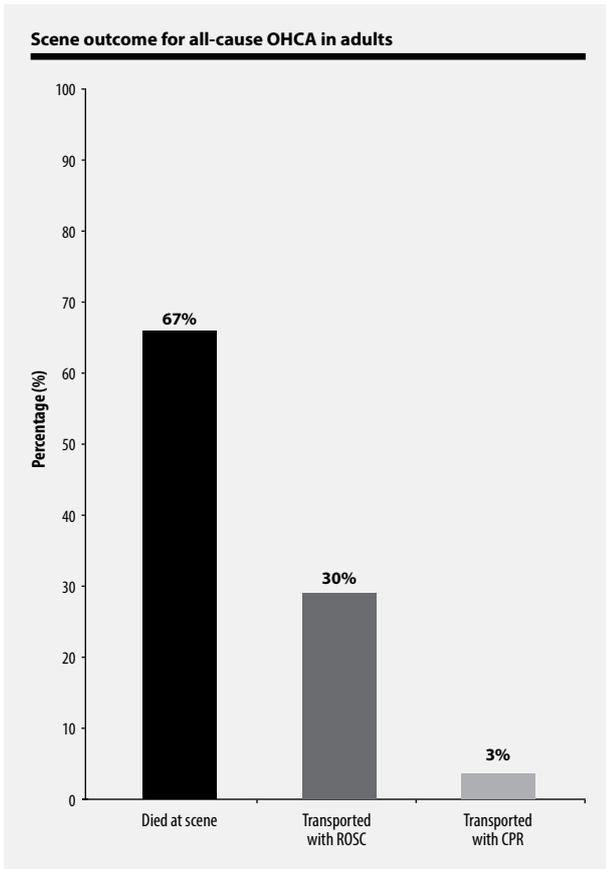


Figure 13: Scene outcome for all-cause OHCA in adults (resuscitation attempted).

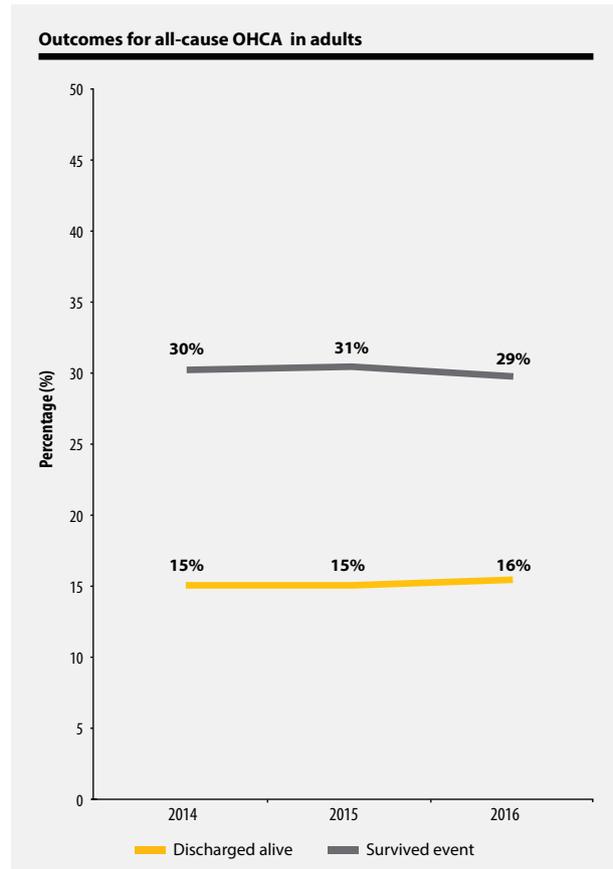


Figure 14: Outcomes for all-cause OHCA in adults (resuscitation attempted).

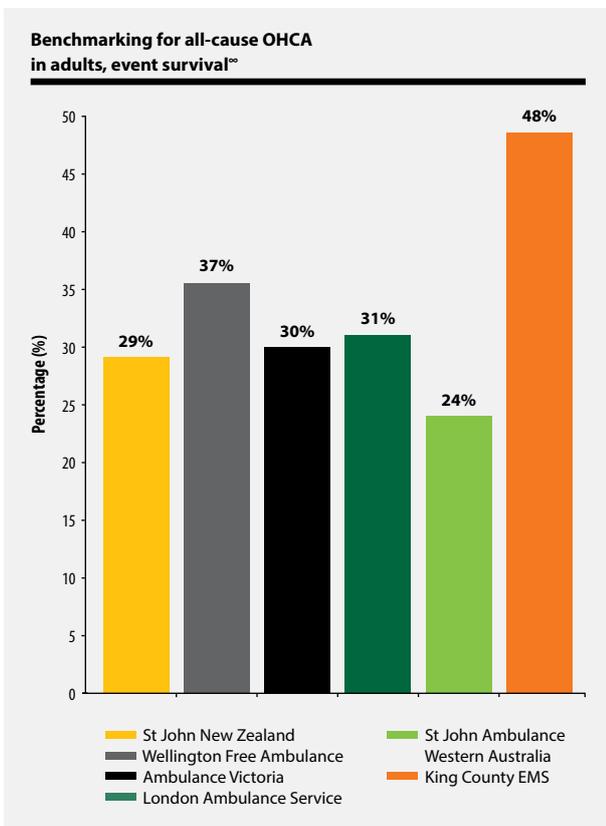


Figure 15: Benchmarking for all-cause OHCA in adults, survived event rates (resuscitation attempted).

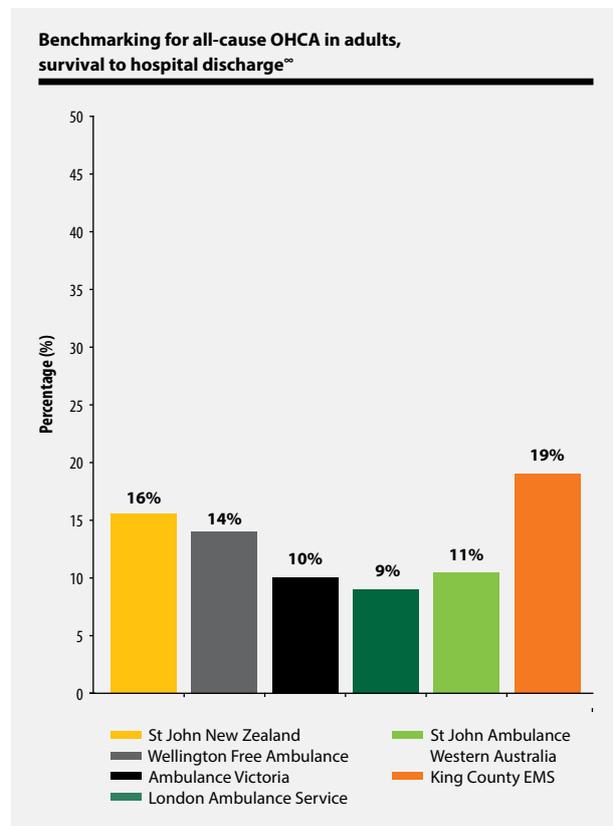


Figure 16: Benchmarking for all-cause OHCA in adults, survival to hospital discharge (resuscitation attempted).

∞ Data for Ambulance Victoria does not include EAS witnessed events.

Adult outcomes according to presenting rhythm

Patients that present with a shockable rhythm such as ventricular fibrillation (VF) or ventricular tachycardia (VT), have a markedly greater chance of survival than patients who present with a non-shockable rhythm such as pulseless electrical activity (PEA) or asystole.

Due to the small number of patients for some of the categories of presenting rhythms, outcomes according to presenting rhythm were analysed on cumulative data for a 33-month period (n=5,277, 1 October 2013 to 30 June 2016).

Adult patients who had resuscitation attempted by St John EAS personnel and presented with a shockable rhythm had an event survival rate of 49%. This compares with 27% for those in PEA and 11% for those in asystole. Similarly, adult patients presenting with a shockable rhythm had a greater chance of being discharged alive from hospital at 33%. This compares with 6% for those in PEA and 2% for those in asystole (Figure 17).

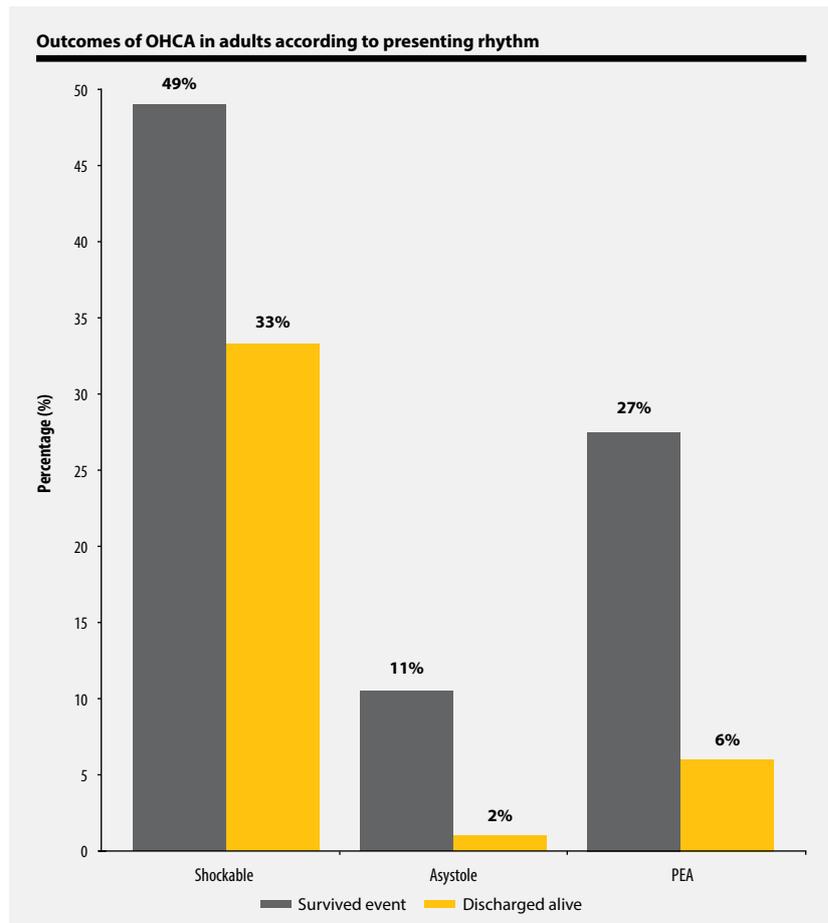


Figure 17: Outcomes for OHCA in adults according to presenting rhythm. (Resuscitation attempted events over a 33-month period)



If a patient presents with a shockable rhythm and the arrest is witnessed by ambulance officers, the immediate intervention of defibrillation can lead to the greatest survival outcomes. For the 33-month period analysed (1 October 2013 to 30 June 2016), of the adult patients who had a shockable presenting rhythm where the arrest was witnessed by St John ambulance officers (n=313), the rate of event survival was 71% and survival to hospital discharge was 58%.

Adult outcomes by selected subgroup

A specifically selected subgroup of patients, who are considered to be the most likely to survive, is sometimes used to benchmark against other ambulance services. This subgroup is referred to as the “Utstein comparator group” by the London Ambulance Service and requires the following criteria to be met: that a resuscitation is attempted by the EAS, the arrest is bystander witnessed, the patient

has a shockable presenting rhythm and the incident is of presumed cardiac aetiology⁷. The number of cardiac arrests attended by St John that met these criteria was 576 which constituted 29% of all events where resuscitation was attempted by St John (Figure 18).

For this selected subgroup survival to hospital discharge rate was 40% and this result is benchmarked against other services in Figure 19.

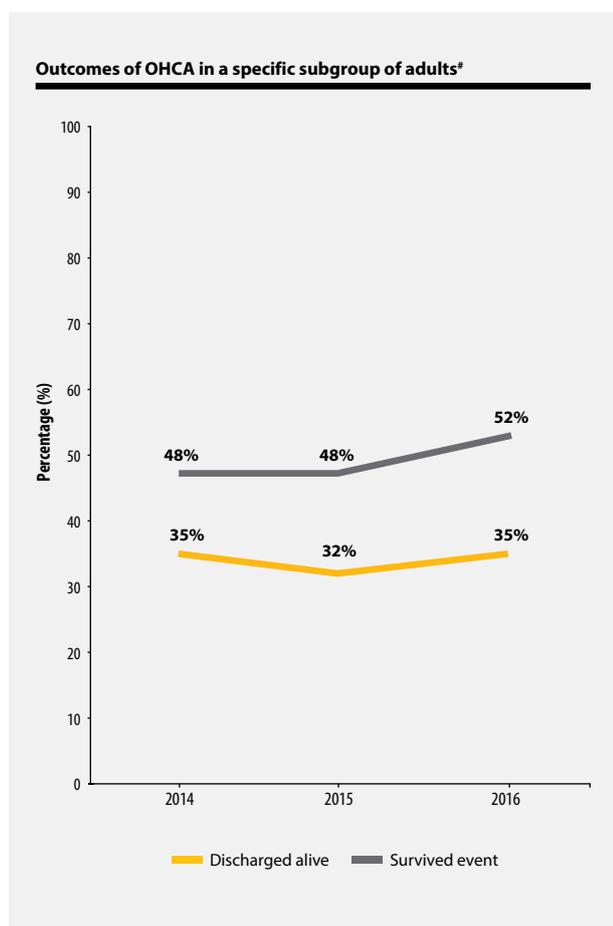


Figure 18: Outcomes for OHCA in adults where the arrest is bystander witnessed, has a shockable presenting rhythm and is of presumed cardiac aetiology (resuscitation attempted).

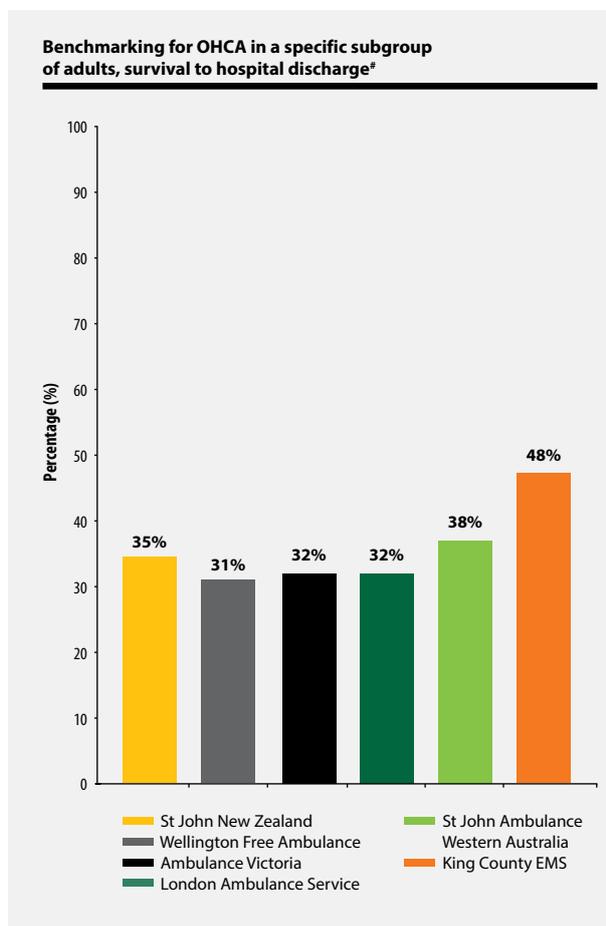


Figure 19: Benchmarking hospital discharge rates in adults where the arrest is bystander witnessed, has a shockable presenting rhythm and is of presumed cardiac aetiology (resuscitation attempted).

Data for all services in Figures 18 and 19 excludes EAS witnessed events.

Adult outcomes according to rurality

As only a small number of cardiac arrests occur annually in rural areas, outcomes for event survival and survival to discharge are measured across a 33-month period from 1 October 2013 to 30 June 2016. Patients that had a cardiac arrest in a rural or remote location had a significantly lower percentage of event survival and survival to discharge ($p < 0.05$) when compared to patients that had a cardiac arrest in an urban location (Figure 20).

Adult outcomes according to region

As only a small number of cardiac arrests occur annually in each region, outcomes for event survival and survival to discharge at a regional level are measured across a 33-month period from 1 October 2013 to 30 June 2016. There was no significant difference in event survival between regions. However, there was a significant difference in survival to discharge between the Northern and Central Regions ($p < 0.05$) (Figure 21). Further work is required to understand the difference in the survival to hospital discharge between regions.

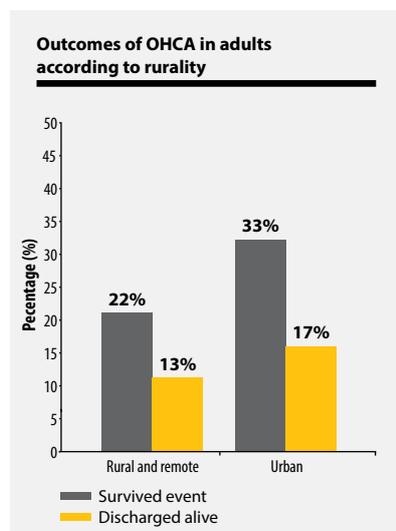


Figure 20: Rural/remote versus urban areas, influence of location on outcome (33-months, resuscitation attempted).

Adult outcomes according to location

Comparisons of survival in relation to location were made between the two predominant locations, private residence and in a public area.

Cardiac arrests where resuscitation was attempted by EAS were more likely to have been witnessed when the OHCA occurred in a public area (75%) as opposed to those that occurred at a private residence (59%). Events where resuscitation was attempted were also more likely to have bystander CPR performed when the OHCA occurred in a public area (70%) as opposed to those that occurred at a private residence (57%).

Survival from OHCA is substantially influenced by whether a cardiac arrest is witnessed and bystander CPR is performed¹⁹. This is reflected in the higher rates of survival to hospital discharge observed in the group of patients that suffered a cardiac arrest in a public area (26%) compared to those who were at a private residence at the time (11%) (Figure 22).

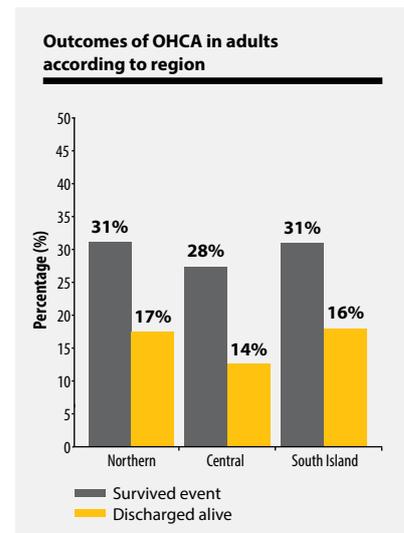


Figure 21: The three St John regions, influence of region on outcome (33-months, resuscitation attempted).

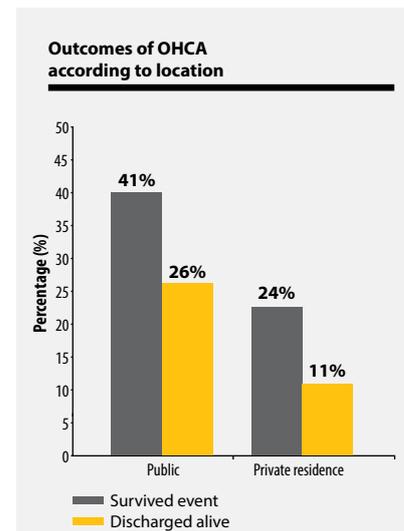


Figure 22: Private residence and public, influence of location on outcome (resuscitation attempted).

Outcomes from all-cause OHCA occurring in children

OHCA occurring in children is rare with a total of only 106 events attended by St John EAS for this reporting period. Due to the low incidence of cardiac arrest within the 12-month period, outcomes were instead analysed on cumulative data for a 33-month period (n=314, 1 October 2013 to 30 June 2016).

The precipitating causes for OHCA in children and the factors affecting survival differ markedly from adults. In children the presenting rhythm is seldom shockable. Only 6% (n=13) of children who had resuscitation attempted by St John EAS personnel (n=212) presented with a shockable rhythm. The most common precipitating event

for OHCA in children is sudden unexpected death in infancy SUDI (n=70) for which there was one survivor. Overall the rate of event survival for children where resuscitation was attempted by St John EAS was 16% (n=34) and survival to hospital discharge was 7% (n=15). However, due to the low total number of events in children these rates must be interpreted with caution because there is insufficient data to have confidence in the results.

Conclusion

The data presented in this report indicates that the service provided by St John in treating OHCA continues to be of a high quality and compares favourably with other emergency ambulance services internationally. The data in this report will drive discussion

on clinical improvements as part of ongoing service planning and continual improvement within St John. As a result, new processes, technologies and research strategies may be implemented and the impact of these strategies can be measured. Measuring changes in outcomes year-on-year enables St John to improve the treatment of OHCA, ultimately leading to higher patient survival rates. ■



Abbreviations

AED	Automated external defibrillator	MPDS	Medical priority dispatch system
CAD	Computer aided dispatch	OHCA	Out-of-hospital cardiac arrest
CPR	Cardiopulmonary resuscitation	PEA	Pulseless electrical activity
DHB	District Health Board	PRIME	Primary response in medical emergencies
EAS	Emergency ambulance service	ROSC	Return of spontaneous circulation
ECG	Electrocardiogram	SUDI	Sudden unexpected death in infancy
EMS	Emergency Medical Services	VF	Ventricular fibrillation
EMT	Emergency medical technician	VT	Ventricular tachycardia
ICP	Intensive care paramedic		

Definitions

Adult	Patients aged 16 years of age or older.
Asystole	The absence of any cardiac electrical activity.
Children	Patients aged less than 16 years of age.
EAS attended	This is the population of all patients following cardiac arrest where St John EAS was in attendance regardless of whether emergency treatment is provided.
EAS personnel	Where St John ambulance personnel respond to a medical emergency in an official capacity as part of an organised medical response team.
Presumed cardiac aetiology	An OHCA is presumed to be of cardiac aetiology, unless it is known or likely to have been caused by trauma, drowning, poisoning or any other non-cardiac cause.
Return of spontaneous circulation	The patient shows clear signs of life in the absence of chest compressions for more than 30 seconds. Signs of life include any of the following: normal breathing, palpable pulse, normal end tidal CO ₂ or normal movement.
Resuscitation attempted	The performance of CPR by or under the direction of responding staff, or the delivery of a shock at any time (including before ambulance arrival).
Shockable rhythm	Ventricular fibrillation, ventricular tachycardia or unknown shockable (AED).
Survived event	The patient has sustained ROSC to handover at hospital.
Survival to discharge	The patient has been discharged from hospital alive.
Witnessed event	A witnessed cardiac arrest is one that is seen or heard by another person.

Urban service area	Main urban centres with a population greater than 15,000. This includes responses that occur within a city boundary as per specified cluster of mesh blocks on the NZ Geographical Information Systems (GIS) service area map. For the purposes of this analysis this is inclusive of areas denoted by Statistics NZ as main urban area or satellite urban area ¹² .
Rural and remote service area	Rural and remote areas with a population of less than 15,000. This includes responses occurring in areas surrounding urban cities, minor urban/provincial centres and very rural and remote locations as per specified cluster of mesh blocks on the NZ GIS service area map. For the purposes of this analysis this is inclusive of areas denoted by Statistics NZ as any of the following: independent urban area, rural area with high urban influence, rural area with moderate urban influence, rural area with low urban influence or highly rural/remote area ¹² .

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Acknowledgements

St John would like to thank the following DHBs for the provision of in-hospital patient outcome data:

*Auckland
District Health Board*

*Bay of Plenty
District Health Board*

*Canterbury
District Health Board*

*Capital and Coast
District Health Board*

*Counties Manukau
District Health Board*

*Hawke's Bay
District Health Board*

*Hutt Valley
District Health Board*

*Lakes
District Health Board*

*MidCentral
District Health Board*

*Nelson Marlborough
District Health Board*

*Northland
District Health Board*

*South Canterbury
District Health Board*

*Southern
District Health Board*

*Tairāwhiti
District Health Board*

*Taranaki
District Health Board*

*Waikato
District Health Board*

*Wairarapa
District Health Board*

*Waitemata
District Health Board*

*West Coast
District Health Board*

*Whanganui
District Health Board*

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