



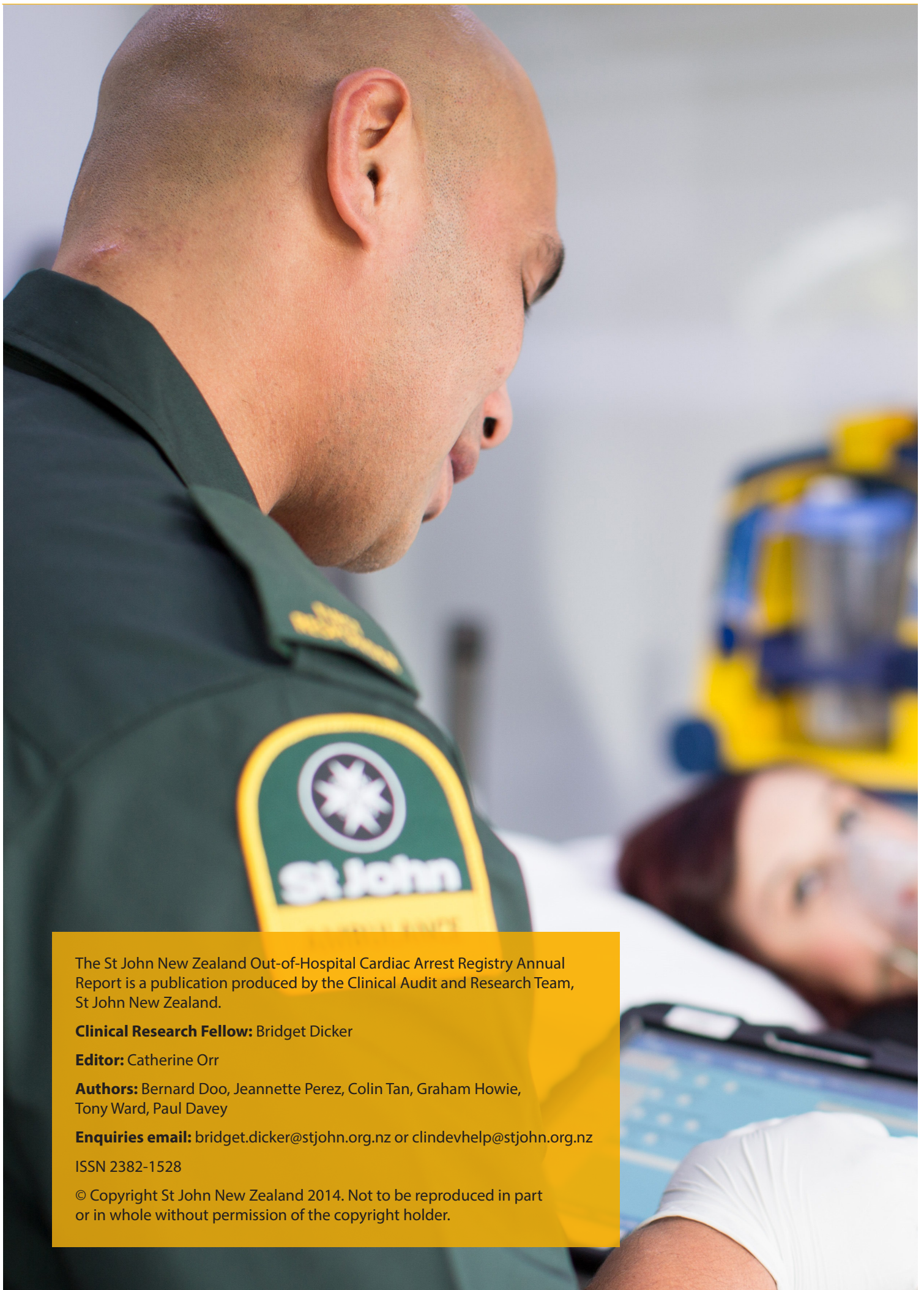
Out-of-Hospital Cardiac Arrest Registry

Annual Report 2013/2014



St John

first to care



The St John New Zealand Out-of-Hospital Cardiac Arrest Registry Annual Report is a publication produced by the Clinical Audit and Research Team, St John New Zealand.

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From the Chief Executive Officer



Innovations in ambulance service provision over the last few years have produced significant improvements in patient care. During my time back at St John I have been pleased to see numerous examples of excellent patient care and practice across the country.

Our aim now is to be able to provide evidence that what we do does make a difference by introducing a number of clinical quality measures. One of the most important outcome measures for an ambulance service is being able to track cardiac arrest survival to discharge, and I am delighted that we have been able to publish this first ever national report showing these results.

ONE OF THE MOST IMPORTANT OUTCOME MEASURES FOR AN AMBULANCE SERVICE IS BEING ABLE TO TRACK CARDIAC ARREST SURVIVAL TO DISCHARGE.

At St John, improving outcomes from cardiac arrest is a team effort - from our 111 Call Handlers and Dispatchers, our public first aid trainers, to our frontline staff - all play a part in improving survival. And increasingly partner agencies such as the New Zealand Fire Service are ensuring that patients in cardiac arrest are reached in the shortest time possible by responders trained in CPR and with access to a defibrillator.

Furthermore, community directed programmes such as the HEARTsafe initiative are providing CPR training to the community as well as providing ready access to defibrillators. The whole focus is to provide the right care at the right time by providing faster response times, having the right people on scene and ready access to a defibrillator as quickly as possible, leading to a greater chance of survival.

I believe that the publication of this report, will act as a real catalyst for further improvements in out of hospital cardiac arrest survival to discharge. What a great opportunity this presents for us all. ■

Peter Bradley
Chief Executive Officer

From the Clinical and Community Programmes Director



Measurement of the clinical quality delivered following an Out-of-Hospital Cardiac Arrest (OHCA) is one of these new Clinical Quality Indicators. Working collaboratively with our colleagues in the District Health Boards we have been able to gather holistic data in relation to patient outcomes. This first report on OHCA outcomes demonstrates that our clinical care compares favourably to similar service providers, but there are areas for improvement. Findings from this report will be used to inform training and clinical treatment strategies as St John continues to make improvements to patient outcomes from OHCA.

This report has given us insight into the many challenges facing our diverse populations and where we need to focus our attention.

I look forward to our next report in 2015. ■

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

Norma Lane
*Clinical and Community
Programmes Director*

St John is a patient focused organisation caring for sick and injured New Zealanders. The Clinical Development team spearheads this patient focus with a primary goal of delivering the best clinical care to our patients.

To ensure this high standard of patient care, we have developed a suite of seven new key Clinical Quality Indicators for the ambulance sector. Development of these Clinical Quality Indicators provides us with a quality framework that is focused on health outcomes. This gives us clear measures to enable benchmarking with other similar service providers both nationally and internationally.

Treatment strategies for OHCA may include evaluating the efficacy of new devices such as mechanical CPR and protocols such as active cooling. St John is also ideally placed to link across the volunteer sector and our community programmes teams who act as community leaders in first aid by working in communities to equip them with the skills to provide swift intervention. Connecting those patients suffering from cardiac arrests with a member of the public who has both the skills and access to vital equipment can make a real difference when time is of the essence.

The St John Emergency Ambulance Service

St John is New Zealand's largest emergency ambulance service (EAS) serving almost four million people, approximately 90% of the population. The service operates across 97% of New Zealand's geographical area and the only area not covered by St John is the greater Wellington and Wairarapa region. This area is served by the Wellington Free Ambulance service.

The organisation calls on more than 1,400 paid and over 3,000 volunteer ambulance officers to provide patient care. 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 a single emergency number, 111, and are directed by telecommunications company Spark to one of three emergency agencies. Around 20% of emergency calls are for an ambulance, over 1,000 calls

every day. St John owns and runs the 111 Clinical Control Centres in Auckland, Christchurch and a third in Wellington, in a joint venture with Wellington Free Ambulance.

Responding to cardiac arrests

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 and takes precedence over all other calls. 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 or 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 automated external defibrillator (AED) if available and guides them through the process of performing cardiopulmonary resuscitation (CPR).

Once the ambulance officers reach the patient, they may continue the resuscitation attempt. Depending on the qualification of the responding staff, they may also provide advanced life support such as advanced airway management, drug therapy, physiologic monitoring and post-cardiac arrest care.

The cardiac arrest protocols used by ambulance officers on scene have been developed by the National Ambulance Sector Clinical Working Group (1). 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 Guidelines (1). ■



About this Report

Sudden cardiac arrest is a considerable public health issue, with ischaemic heart disease being the second most prevalent cause of death in New Zealand (2). 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 survival (4). Knowledge of New Zealand OHCA outcomes is a key driver to help identify and address deficiencies and seek improvements in clinical care.

KNOWLEDGE OF NEW ZEALAND OHCA OUTCOMES IS A KEY DRIVER TO HELP IDENTIFY AND ADDRESS DEFICIENCIES AND SEEK IMPROVEMENTS IN CLINICAL CARE.

The data presented in this report is for all OHCA attended by the St John EAS in the nine month period from 1 October 2013 to 30 June 2014. The St John OHCA Registry was formalised in September 2013, therefore this first report does not represent a full year's worth of data. The data for this report was extracted from the registry on 18 August 2014. Future reports will be aligned to the St John financial reporting year and contain data from 1 July to 30 June.

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). As this is the inaugural report the current findings are not compared to historical registry data. Where possible comparisons are instead drawn with Ambulance Victoria in Australia, South Western Ambulance Service in the UK, Wellington Free Ambulance and London Ambulance Service (8-12). These ambulance services were selected for this purpose as the definitions and collection variables that are used in the St John OHCA Registry are closely aligned with those used by these services.

The data quality within this report is reflective of this being the first generation of data capture. There is an ongoing quality improvement process to ensure the continued validity of future cardiac arrest registry reports.

The data presented in this report is aligned to enable comparisons with other services and primarily relates to events that were either 'attended' or where there was a 'resuscitation attempted' by St John EAS staff. Attended refers to all OHCA where St John EAS staff were present regardless of whether or not a resuscitation attempt was made. Resuscitation attempted refers only to those events where St John EAS staff 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 (hospital admission) and discharge from hospital alive (survival to discharge).

Descriptive statistics were performed with statistical software InStat (Graphpad, v3.10) and tests were chosen depending on whether the data fitted a normal distribution with equivalent variances in the standard deviation. Tests 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 tables (13-17). The population figures provided are for the end of June 2013, with the population of the St John response area being 3,978,590. Unless otherwise stated all analysis is inclusive of St John EAS staff witnessed events. If it is unrecorded whether the patient is a child or an adult then these events are excluded from the analysis. ■



Executive Summary

Incidence

St John attended 2,740 OHCA events in the nine month period from 1 October 2013 to 30 June 2014. Of these patients 94% were adults, 3% were children and in 3% of cases the data was unrecorded. The overall proportion of OHCA where a resuscitation attempt was made by St John EAS staff was 51%. Rural populations had a significantly higher incidence of OHCA per 100,000 person-years than urban populations, more than double at 159.8 versus 78.4. There was variation between the Northern, Central and South Island St John response regions with the Northern Region having a lower incidence per 100,000 person-years than both the Central and South Island Regions, 78.5 versus 101.5 and 99.6 respectively (See Incidence and demographics, [page 14](#)).

Demographics

Of the cardiac arrests attended by St John, 66% of patients were male with the median age being 65 years old for males and 69 for women. The most common aetiology of OHCA in adults where resuscitation was attempted was that of a presumed cardiac cause, which constituted 76% of events. OHCA occurring in children was rare with only 3% of all OHCA attended occurring in children. The most common precipitating events for OHCA in children where resuscitation was attempted were sudden unexpected death in infants (SUDI) (30%) and respiratory arrest (30%). When the incidence of OHCA attended by St John was standardised to the New Zealand ethnic populations, Māori were disproportionately affected with a higher mean incidence of OHCA per 100,000 person-years (128.3) compared with all other ethnic groups (less than 85) (See Incidence and demographics, [page 14](#)).

Time to emergency response

The time taken from when the 111 call is answered in the Clinical Control Centre to when an ambulance arrives is one of the key performance indicators for the St John EAS. For OHCA where resuscitation was attempted by St John EAS staff, the median time from when a call was picked up in the Clinical Control Centre to the arrival of an ambulance at a cardiac arrest patient was 8 minutes for urban areas. The response time for rural areas was slightly longer with a median response time of 11 minutes (See The chain of survival, [page 19](#)).

Bystander CPR and time to defibrillation

Of the cardiac arrests where resuscitation was attempted by St John EAS, 65% occurred in a private residence and approximately 20% occurred in public. Arrests that occurred in public were more likely to be witnessed and have bystander CPR than those that occurred in a private residence. Of the OHCA where resuscitation was attempted, 64% of these had bystander CPR performed prior to ambulance arrival.

OF THE OHCA WHERE RESUSCITATION WAS ATTEMPTED, 64% OF THESE HAD BYSTANDER CPR PERFORMED PRIOR TO AMBULANCE ARRIVAL.

The time taken to defibrillation for a patient in cardiac arrest can have a significant impact on survival. Patients that had an initial shockable rhythm that were defibrillated by a public access defibrillator prior to EAS arrival had a greater survival to hospital discharge (29%) than patients that received the first defibrillation by St John EAS staff (19%) (See The chain of survival, [page 19](#)).

Return of spontaneous circulation

One of the benchmarks for the evaluation of the treatment of OHCA by EAS is the pre-hospital ROSC rate. Rates of ROSC for OHCA in adults where resuscitation was attempted by St John EAS staff varied according to witnessed status. Those events witnessed by EAS had the highest rate of ROSC at 54%, followed by bystander witnessed at 43%, and unwitnessed at 20%. Following an OHCA where resuscitation was attempted, the overall percentage of adult patients transported with ROSC was 33% (See Outcomes, [page 23](#)).

Outcomes from all-cause cardiac arrest

There was variation in outcome according to presenting rhythm, with those patients with a shockable rhythm having the greatest rate of hospital admission at 49% followed by 25% for pulseless electrical activity and 12% for asystole. Adult patients who had a shockable rhythm where the cardiac arrest was witnessed by ambulance officers had a hospital admission rate of 76% and survival to hospital discharge rate of 56%. Survival from OHCA is the foremost factor in benchmarking the performance of EAS internationally. Overall survival to hospital discharge for OHCA events in adults where resuscitation was attempted by St John EAS staff was 15%. (See Outcomes, [page 23](#)).

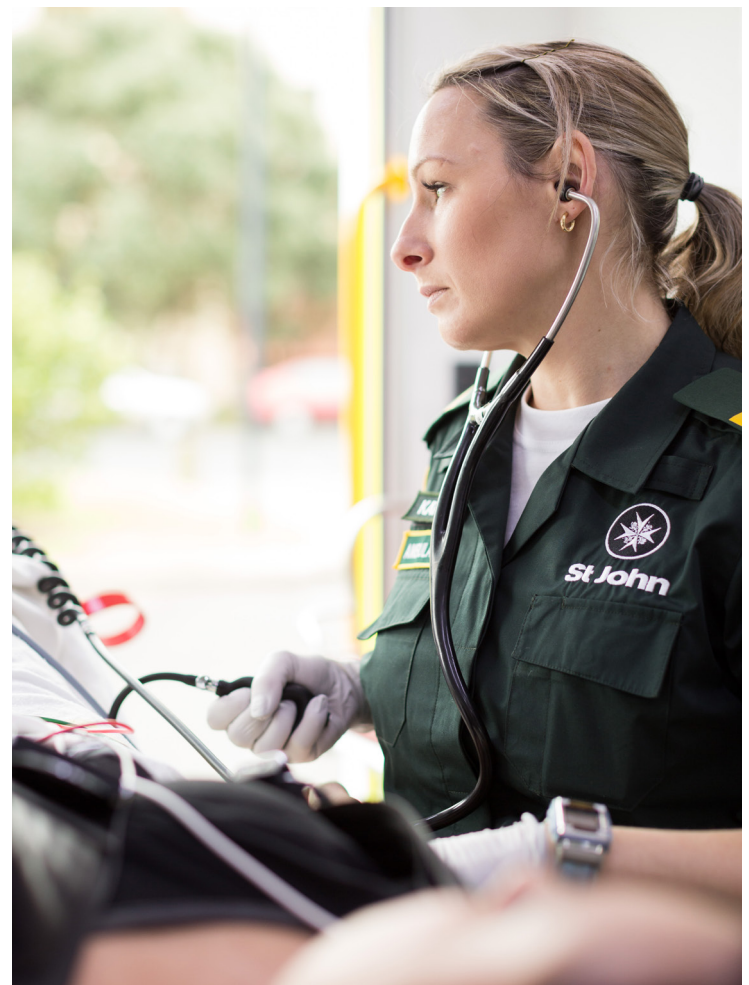
Benchmarking

St John New Zealand OHCA outcomes were benchmarked against Ambulance Victoria, South Western Ambulance Service, Wellington Free Ambulance and London Ambulance Service (8-12). St John ranked fifth out of five for urban response time and fourth out of five for hospital admission rates. St John ranked second out of the five for hospital discharge status. Overall the outcomes for OHCA attended by St John are similar to those internationally (8-12). (See Benchmarking **page 12**).

OVERALL SURVIVAL TO HOSPITAL DISCHARGE FOR OHCA EVENTS IN ADULTS WHERE RESUSCITATION WAS ATTEMPTED BY ST JOHN EAS STAFF WAS **15%**

Conclusion

This inaugural report from the St John OHCA Registry represents a major step forward in the monitoring and review of cardiac arrest events attended by St John. St John compares favourably to similar ambulance services internationally, but there are areas for improvement. Findings from this report will inform clinical planning as St John continues to improve patient outcomes from OHCA. ■





The St John Out-of-Hospital Cardiac Arrest Registry

In April 2013, St John reviewed its OHCA data collection and reporting. The review identified several areas where processes could be improved. These were: aligning data collection points with international standards; developing a national policy and process for data collection and collaborating with District Health Boards (DHBs) to collect in-hospital patient outcome data.

As a result of the review a new St John national policy for OHCA data collection and management was implemented. The policy mandated a number

of improvements to OHCA data capture including the use of an updated OHCA data form and the storage of data in a single national OHCA Registry. The St John OHCA Registry was formally established in September 2013. Since the registry was established, pre-hospital data for all cardiac arrests attended by St John has been successfully captured for over 2,700 patients.

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

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 aligned with Ambulance Victoria, major contributors to the Australian Resuscitation Outcomes Consortium (Aus-ROC) (5, 8). See Tables 1, 2 and 3.

Data Capture

This report reflects data recorded between 1 October 2013 and 30 June 2014 (nine months). 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).

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
- DHB patient outcome reporting.

Computer Aided Dispatch (CAD)

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

Table 1: 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	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 staff or
	Patients who have a pulse on arrival of St John EAS staff following successful bystander defibrillation

Table 2: 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 a hospital patient 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 staff, 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

Table 3: Participating co-responders dispatched to OHCA within the St John EAS jurisdiction	
1	First response groups
2	New Zealand Fire Service
3	PRIME doctors and nurses
4	St John operational staff at events
5	St John Patient Transfer Service
6	Other response capable St John personnel

On scene collection

Ambulance officers on scene attending a patient in cardiac arrest are required to record specific data. This is recorded on a paper cardiac arrest data form. The cardiac arrest data form and a copy of the patient care record are scanned and emailed, using a secure email server, to the cardiac arrest data officer.

District Health Board (DHB) patient outcome data

Each patient that 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 St John OHCA Registry is in its infancy in its current form, having been formalised in September 2013. The data quality is reflective of this being the first generation of data capture. There is an ongoing quality improvement process to ensure the continued validity of future cardiac arrest registry reports.

Reconciliation of paper cardiac arrest data forms with CAD 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.

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 St John New Zealand, Ambulance Victoria in Australia, South Western Ambulance Service in the UK, Wellington Free Ambulance and London Ambulance Service where applicable (8-12).

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, 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 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 the cardiac arrest data form fields, CAD data fields and hospital outcome data fields were captured in full.

Almost all paper cardiac arrest data forms are completed in full by EAS staff. However, for the ethnicity field the option exists for EAS crew to select "unknown" therefore ethnicity data is only fully established for 70% of entries. This result is not surprising as following cardiac arrest the patient is often unconscious and it may not be possible to accurately determine this.

There are currently no data linkage systems between the in-hospital records and the ambulance sector, therefore hospital data is manually collected and entered into the registry. In order to retrieve this data from the receiving hospitals the DHB is supplied with a patient's National Health Identifier (NHI) number, however, often this number is not able to be captured by EAS staff. Currently 6% of the registry data on survival to discharge is missing due to this.

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.

Benchmarking

Benchmarking outcomes from OHCA is one of the key measures of the clinical quality of an EAS and is fundamental to making improvements in OHCA survival (4). The outcomes of OHCA for international benchmarking compare median response times, rates of hospital admission and rates of survival to hospital discharge.

BENCHMARKING OUTCOMES FROM OHCA IS ONE OF THE KEY MEASURES OF THE CLINICAL QUALITY OF AN EAS AND IS FUNDAMENTAL TO MAKING IMPROVEMENTS IN OHCA SURVIVAL.

In this report the results from St John EAS are compared to Ambulance Victoria, South Western Ambulance Service, Wellington Free Ambulance and London Ambulance Service (8-12). These ambulance services were selected for this purpose as the definitions and collection variables that are used by the St John OHCA Registry are closely aligned with those used by them.

Table 4: Benchmarking all-cause events. (Resuscitation attempted events)

Ambulance Service	Data collection Period	Total events	Median response time (minutes)	Hospital admission	Hospital discharge
St John	1 October 2013 to 30 June 2014	1,385	8 (urban) 11 (rural & remote)	29%	15%
Wellington Free Ambulance (12)	1 July 2012 to 30 June 2013	201	7.1 (urban) 5 (rural)	48%	18%
Ambulance Victoria (Data for adults only) (8)	1 July 2012 to 30 June 2013	2,561	7.8 (urban) 11 (rural & remote)	30%	10%
London Ambulance Service (9)	1 April 2012 to 31 March 2013	4,466	7 (Red 1 calls)	31%	9%
South Western Ambulance Service (10, 11)	1 April 2012 to 31 March 2013	2,635	5.4 (Cat A calls, April 2013 data only as annual data is not available)	25%	8%

When benchmarked against the other EAS (Table 4) St John ranked fifth out of five for urban response time and fourth out of five for hospital admission rates. St John ranked second for hospital discharge status. Overall the outcomes for OHCA attended by St John are similar to those in the international community (8-12). ■



Incidence and Demographics

Incidence of all adult and paediatric events

St John is New Zealand's largest emergency ambulance service providing care to 3.97 million people, approximately 90% of New Zealand's population. Of this 3.97 million, the proportion of the population that is paediatric (younger than 16 years old) is estimated at 845,890 (21%) (13). In the nine month period from 1 October 2013 to 30 June 2014 St John EAS attended 2,740 OHCA events of which 2,587 were adult, 83 were paediatric and 70 were not classified.

The adult incidence rate was 110 per 100,000 person-years, which is comparable to other international reported rates. In particular, this is similar to Ambulance Victoria and the London Ambulance Service which reported incidence rates of 115.4 and 121.7¹ per 100,000 person-years in 2013 respectively (3, 8, 9). See Figure 1.

The mean paediatric incidence rate was 13.1 per 100,000 person-years (Figure 1). This is higher than the incidence reported by Ambulance Victoria: 6.8 per 100,000 person-years for the 2012 to 2013 period (3, 8). The finding of a higher incidence rate in children is in line with the difference reported in OECD Health Status Data (2011), which indicated infant mortality rates were 1.37 times higher in New Zealand than Australia (19). The low total number of paediatric events (83 over the nine month period) does, however, contribute to a large variation in the reported incidence rate.

The proportion of OHCA events in adults where resuscitation was attempted was 51% (n=1,313). This is similar to Ambulance Victoria and the London Ambulance Service where resuscitation was attempted in 49% and 44%² of OHCA events in adults.

IN THE NINE MONTH PERIOD FROM 1 OCT 2013 TO 30 JUN 2014 ST JOHN EAS ATTENDED 2,740 OHCA EVENTS.

The mean adult incidence rate for events where resuscitation was attempted was 55.8 per 100,000 person-years, which is similar to Ambulance Victoria which had an incidence rate of 56.0 per 100,000 person-years. In the OHCA events where resuscitation was withheld by St John EAS staff the main reason was that resuscitation was unlikely to be successful, such as a long period of time passing since the cardiac arrest.

Compared to adults, a resuscitation attempt was made in a proportionally higher percentage of OHCA events in children, 68% of all OHCA events attended. The incidence of OHCA in paediatrics where resuscitation was attempted was 8.8 per 100,000 person-years. This is also higher than Ambulance Victoria (Ambulance Victoria=5.4 per 100,000 person-years) most likely due to a greater overall incidence of OHCA in children attended by St John EAS (8).

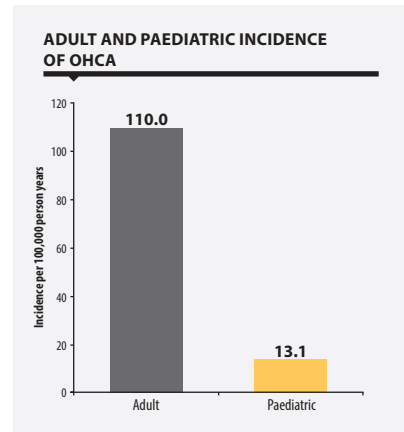


Figure 1: Adult and paediatric incidence of OHCA, per 100,000 person years. (All events)

Demographics of adults

Of the OHCA events in adults attended by St John the majority of patients were male (66%) compared to female (34%). The median age of cardiac arrest was significantly different between genders, with males having a lower median age at 65 years versus females at 69 years ($P < 0.0001$). See Figure 2.

Demographics of paediatrics

The incidence of OHCA in children attended by St John is very low, with only 83 events being recorded over the nine month reporting period. The median age was not significantly different between genders, 8 months for males and 7 months for females ($P = 0.853$). There was a higher proportion of cardiac arrest in boys (70%) compared to girls (30%). The higher incidence of cardiac arrest in boys aligns with the 2013 New Zealand Child and Youth Mortality Review Report that showed a higher mortality rate for male children compared to female (65.3% vs 34.7%) (20).

¹ Incidence for all ages calculated on a total population of London of 8,308,400 (18).

² All ages; data not available for adult only

Over half of the cardiac arrests in this population were in patients aged younger than two. This is reflective of SUDI and respiratory arrest being significant contributing factors to OHCA in children. Resuscitation was attempted in 68% (n=56) of events, a proportionally higher percentage of attempts than for adults.

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 groups (17). 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 compared with non-Māori, 128.3 versus less than 85 (17). This aligns with New Zealand Ministry of Health figures which indicate that Māori are disproportionately affected by ischaemic heart disease, with Māori adults nearly twice as likely (1.8 times) to be diagnosed with ischaemic heart disease as non-Māori adults (21). Conversely, people of Asian ethnicity had the lowest incidence of OHCA attended by St John EAS. See Figure 3.

Note: Due to the critical condition of cardiac arrest patients, information on definitive ethnicity is not always possible to obtain. Therefore these data should be viewed with caution (see missing data statement **page 12**).

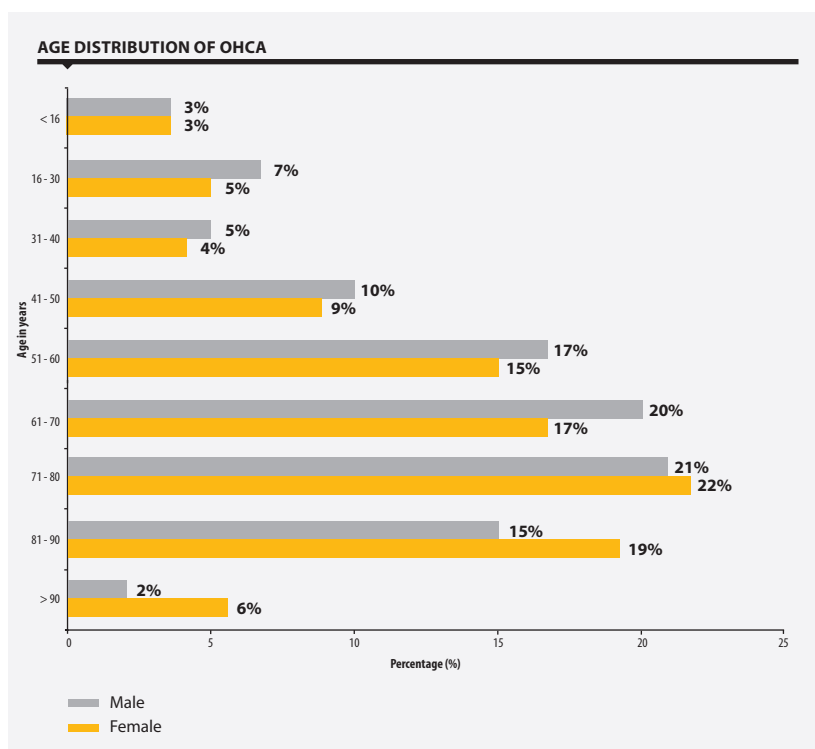


Figure 2: Age distribution of OHCA (all events)

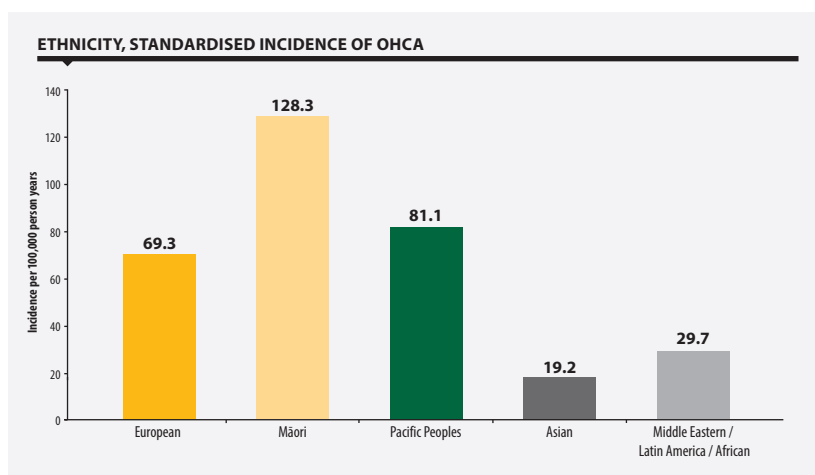


Figure 3: Ethnicity, standardised incidence of OHCA, per 100,000 person-years. (All events)

Incidence across rural/remote and urban areas

The population within the St John jurisdiction is classified as urban or rural/remote based on the Statistics New Zealand definitions (14). 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 (73%) (15). However, there is a significantly higher incidence rate per 100,000 person-years for rural areas, 159.8, when compared to urban areas, 78.4 ($P < 0.0001$). See Figure 4.

A difference between urban versus rural OHCA incidence is also reported by other ambulance services, for example by Ambulance Victoria (8). There is limited evidence to demonstrate why such a finding exists, although this is in line with both the New Zealand National Health Committee report and the Australian Institute of Health and Welfare, which also demonstrate that cardiovascular disease is more prevalent in rural populations compared with metropolitan populations (22, 23).

Incidence across regions of New Zealand

The response areas covered by St John are divided into three regions, Northern, Central and South Island. Northern Region covers the area from Hauraki to the Far North, Central Region covers the area from Horowhenua to the Waikato and South Island Region covers the entire South Island.

The incidence of OHCA per 100,000 person-years was calculated based on population estimates from Statistics New Zealand (16). There was a significant difference in the incidence of OHCA between regions, with Northern Region having a lower incidence per 100,000 person-years than both Central and South Island Regions, 78.5 compared to 101.5 and 99.6 respectively ($P < 0.0001$). See Figure 5. It is unknown why there is a difference in the incidence amongst regions. One possibility is that this is due to the rural/urban population spread within the regions, with the South Island and Central regions having a higher proportion of rural areas than the Northern region.

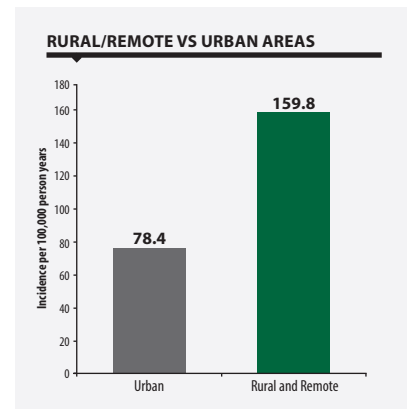


Figure 4: Rural/remote versus urban areas, incidence of OHCA per 100,000 person-years. (All events)

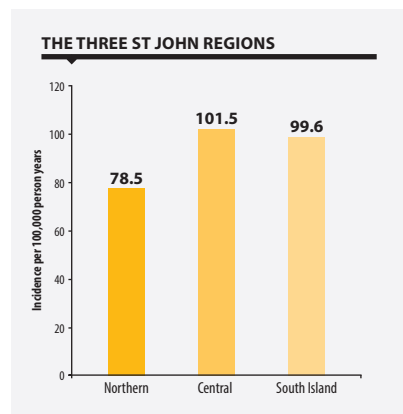


Figure 5: The three St John regions, incidence of OHCA per 100,000 person-years. (All events)



Heat map of OHCA events in the three St John regions

On the heat map of OHCA events in the three St John regions red represents the highest concentration of OHCA followed by yellow and then green (Figure 6). The following heat map represents only where the majority of events occur and is focused on areas of population density.³

THE MOST COMMON CAUSE OF OHCA WAS LIKELY TO BE FROM HEART DISEASE.

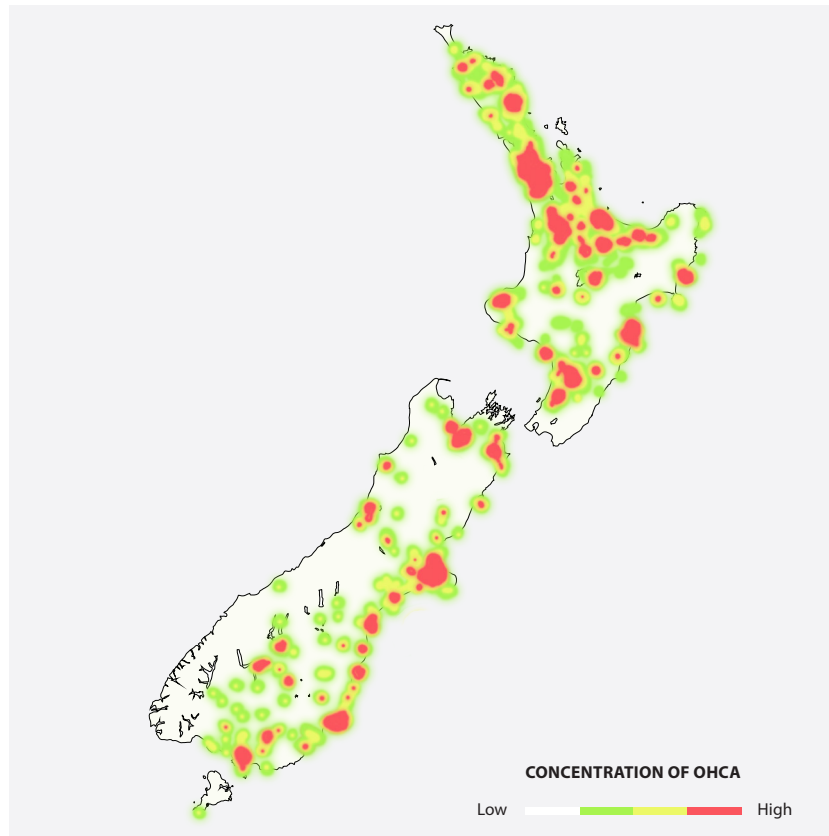


Figure 6: Concentration of OHCA events across the three St John regions.

Precipitating events for adults

St John EAS staff 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 76% of events. Other common precipitating events included respiratory arrest (7%), trauma (5%), hanging (3%). There were three events precipitated by asthma and two events precipitated by anaphylaxis, and these are included in respiratory and other non-cardiac categories respectively (Figure 7).

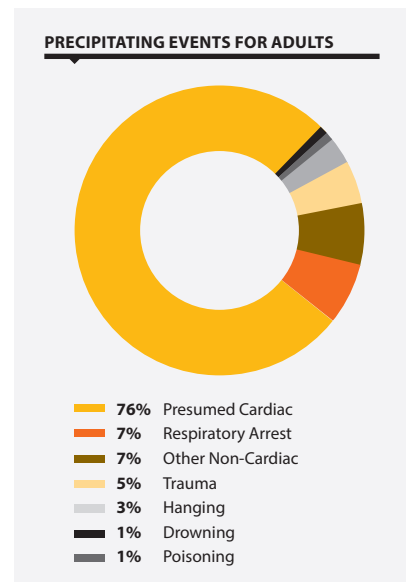


Figure 7: Precipitating events for adults. (Resuscitation attempted events)

³ Heat map is not standardised to incidence per 100,000 person-years.

Precipitating events for paediatrics

In paediatrics OHCA is rare with a total of only 56 events in children where resuscitation was attempted during the nine month reporting period. Of these, the equal leading causes of OHCA in paediatrics were SUDI and respiratory arrest, each contributing 30% of the events where resuscitation was attempted. Other common causes included hanging (9%), trauma (13%), presumed cardiac (9%), drowning (5%), and other non-cardiac (4%). See Figure 8. Asthma is included within the respiratory category, and there were two events precipitated by asthma. There were no cases of OHCA due to anaphylaxis or poisoning. 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 year (20).

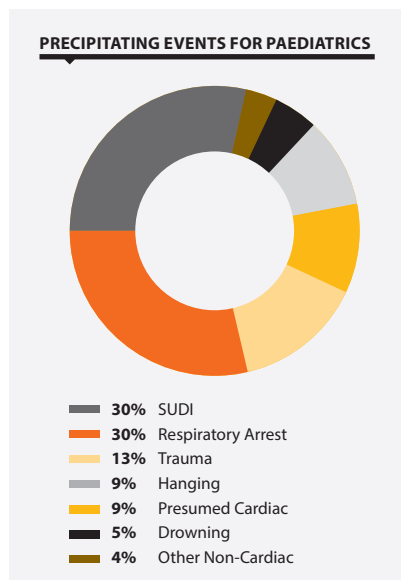


Figure 8: Precipitating events for paediatrics. (Resuscitation attempted events)

Arrest location

The most common place for an OHCA to occur is in a person's private residence, with 65% of events where resuscitation was attempted occurring at private residences.

NEARLY 20% OF ALL CARDIAC ARRESTS OCCURRED IN A PUBLIC PLACE.

The second most common place for an OHCA to occur is in public, which includes the workplace, the street, a shopping centre or similar. Nearly 20% of all OHCA where resuscitation was attempted occurred in a public place. See Figure 9.

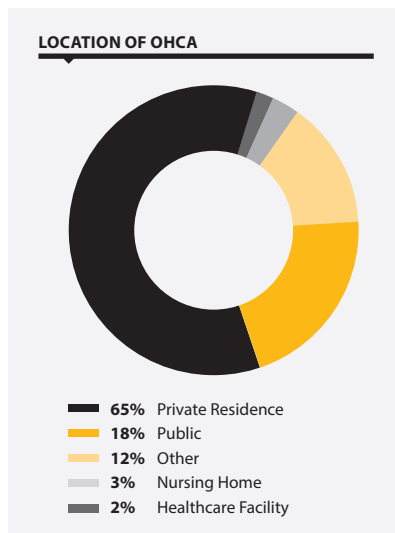


Figure 9: Location of OHCA. (Resuscitation attempted events)

The total number of OHCA where resuscitation was attempted that occurred at healthcare facilities and nursing homes were 21 and 47 respectively. The low number of cases at these two localities creates a large variance in the survival rates. Therefore comparisons of survival in relation to location can only be accurately made between the two predominant locations, private residence and in public.

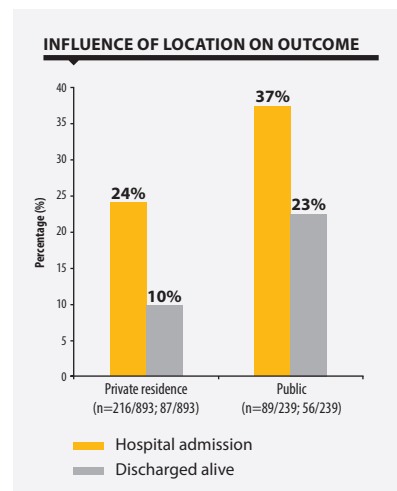


Figure 10: Influence of location on outcome. (Resuscitation attempted events)

Cardiac arrests where resuscitation was attempted by EAS were more likely to have been witnessed and have bystander CPR performed when the OHCA occurred in public (56%) as opposed to those that occurred at a private residence (39%). Survival from OHCA is substantially influenced by witnessed status and bystander CPR action (4). This is reflected in the significantly higher rates of survival to hospital discharge observed in the group of patients that suffered a cardiac arrest in public compared to those who were at a private residence at the time, 23% versus 10% (P < 0.0001). See Figure 10. ■

The Chain of Survival

The gold standard in resuscitation optimises the key links in the chain of survival (4):

- Immediate recognition of cardiac arrest and activation of the emergency response system
- Early CPR with an emphasis on chest compressions
- Rapid defibrillation
- Effective advanced life support.



1 Immediate Recognition



2 Early CPR



3 Rapid Defibrillation



4 Advanced Life Support

Recognition and activation of the emergency response

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.

THE GOLD STANDARD IN RESUSCITATION OPTIMISES THE KEY LINKS IN THE CHAIN OF SURVIVAL.

For OHCA where resuscitation was attempted by St John EAS, the median response time for cardiac arrests in urban areas for the nine month reporting period was eight minutes (n=989) and for rural areas this was 11 minutes (n=374), Figures 11 and 12. These are similar response times to the four services against which St John is benchmarked (8-12). See Table 5.

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

Ambulance service	Median response time (minutes)
St John	8 (urban) 11 (rural & remote)
Wellington Free Ambulance (12)	7.1 (urban) 5 (rural)
Ambulance Victoria (Data for adults only) (8)	7.8 (urban) 11 (rural & remote)
London Ambulance Service (9)	7 (Red 1 calls)
South Western Ambulance Service (UK) (10, 11)	5.4 (Cat A calls, April 2013 data only as annual data is not available)

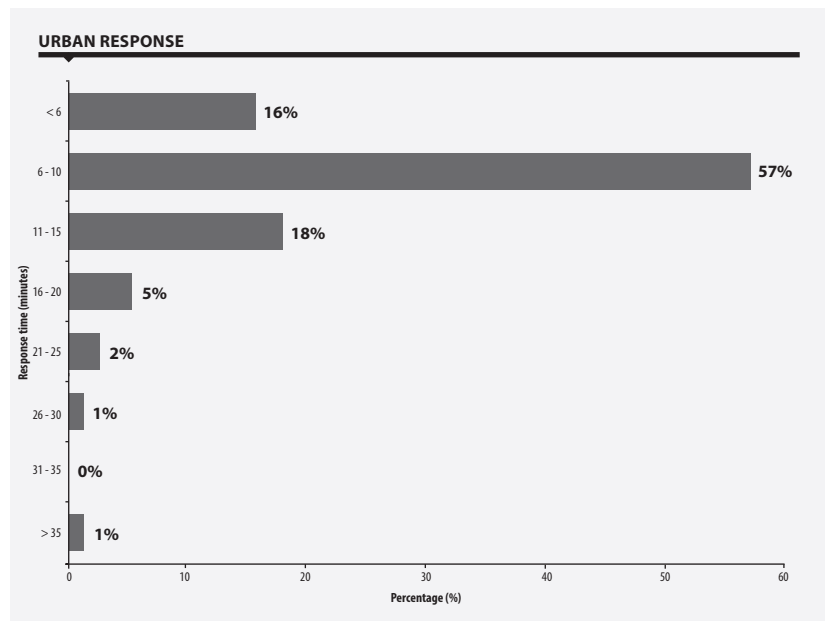


Figure 11: Urban response, time from call to arrival of ambulance. (Resuscitation attempted events)

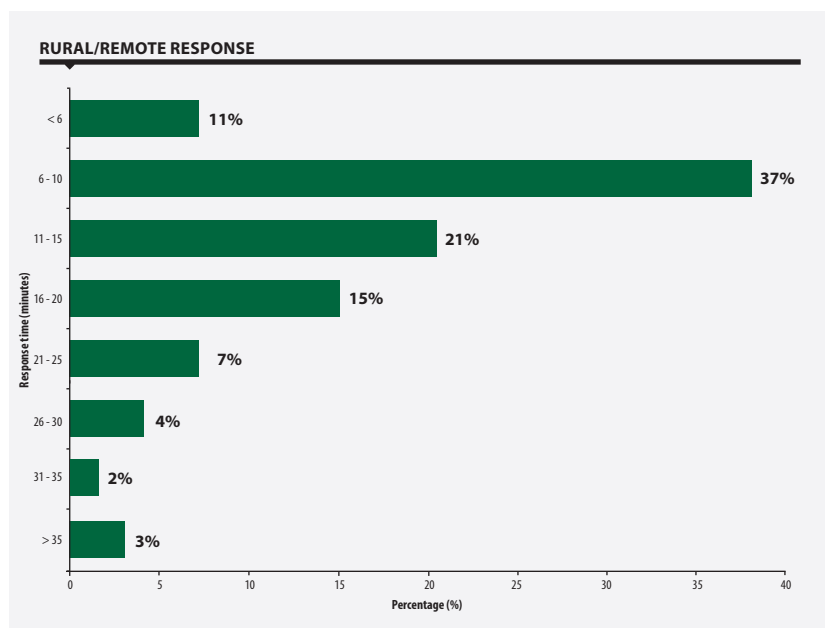


Figure 12: Rural/remote response, time from call to arrival of ambulance. (Resuscitation attempted events)

Early CPR with an emphasis on chest compressions

The chance of survival from an OHCA is greatly increased if a bystander performs early and effective CPR. For suspected cardiac arrest, St John emergency Call Handlers provide instructions to the caller on how to perform CPR.

THE CHANCE OF SURVIVAL FROM AN OHCA IS GREATLY INCREASED IF A BYSTANDER PERFORMS EARLY AND EFFECTIVE CPR.

Call Handler assisted CPR, community first aid training, YouTube videos and the St John CPR smartphone application are all used to increase the rate of bystander CPR in New Zealand. Of the OHCA where resuscitation was attempted, 64% of these had bystander CPR performed prior to ambulance arrival. The rates of bystander CPR for OHCA where resuscitation was attempted by St John were similar regardless of whether the cardiac arrest was witnessed or unwitnessed with the person found subsequently, 63% versus 68% (Figure 13).

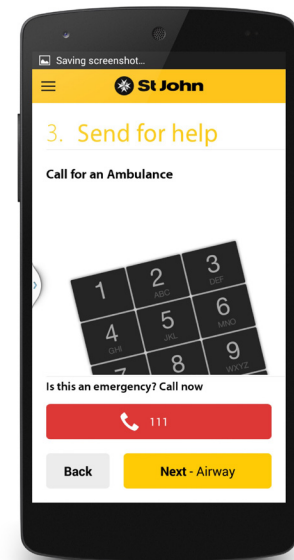
This is comparable to rates of bystander CPR reported internationally: Ambulance Victoria 70% (bystander witnessed) and London Ambulance 52% (witnessed and unwitnessed combined) (8, 9).

Time to defibrillation

The time taken to 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 surviving (24). This makes the community and bystander response integral to survival from OHCA.

Nearly 20% of cardiac arrests occur in public, therefore public access defibrillators have a large role to play in early defibrillation. The goal of the St John **HEARTsafe** programme is to enhance the rate of early defibrillation by encouraging communities to install AEDs in public, training people in the use of AEDs, and teaching people CPR.

THERE HAVE BEEN OVER 40,000 DOWNLOADS OF THE ST JOHN CPR APP.



To download the CPR App go to: www.stjohn.org.nz/First-Aid/CPR-App/

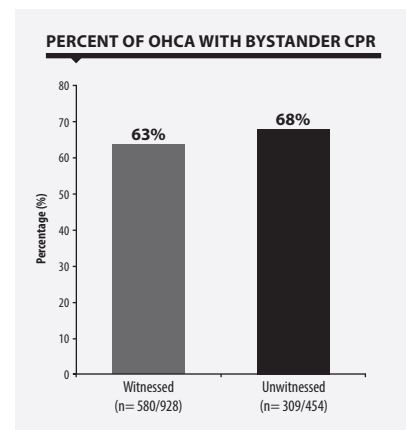
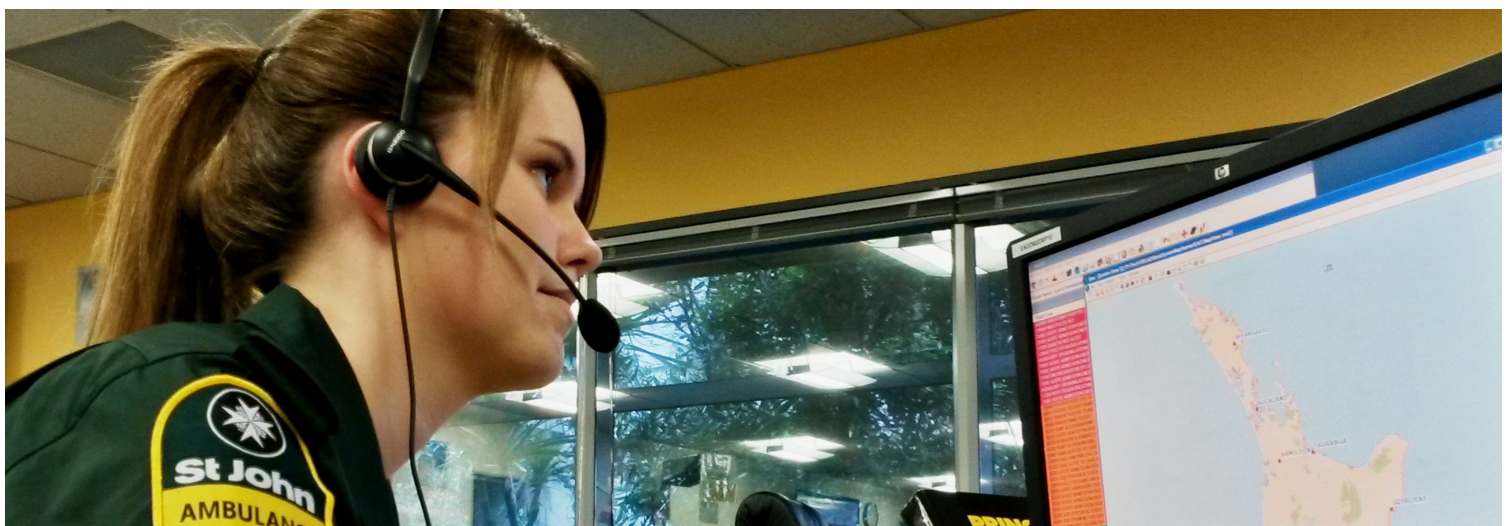


Figure 13: Percent of OHCA with bystander CPR. (Resuscitation attempted events)





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. Of those patients who had an initial shockable rhythm and resuscitation attempted by St John EAS staff, the highest hospital admission rate was recorded in patients who were defibrillated using public access defibrillators prior to EAS arrival. This was 53% compared to 43% of patients who were first defibrillated after EAS arrival. However, the total number of patients defibrillated using public access defibrillators was extremely low constituting only 3% (n=17) of events where the patient had an initial shockable rhythm.

St John has implemented a number of systems 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. A cardiac arrest is allocated the highest priority response by the Clinical Control Centres and the closest resource is immediately dispatched. This may be an emergency ambulance or any trained responder including St John Patient Transfer Service, New Zealand Fire Service, first response groups or PRIME doctors or nurses. By dispatching the closest resource, defibrillation and CPR can occur in the quickest possible time, which may be sooner than EAS arrival.

SINCE DECEMBER 2013, THE FIRE SERVICE HAS BEEN FUNDAMENTAL IN THE EARLY DEFIBRILLATION OF 47 CARDIAC ARREST PATIENTS PRIOR TO THE ARRIVAL OF ST JOHN EAS.

The New Zealand Fire Service has been a recent addition to the pool of professionals available to co-respond to OHCA. Since this arrangement was put in place in December 2013, the Fire Service has been fundamental in the early defibrillation of 47 cardiac arrest patients prior to the arrival of St John EAS. Of these patients, 21% had ROSC on hospital admission and 19% survived to hospital discharge. ■

Outcomes

Return of spontaneous circulation in adults

One of the benchmarks for the evaluation of the treatment of OHCA by EAS is the pre-hospital ROSC rate. St John EAS staff recorded ROSC as having occurred if the patient showed clear signs of life for more than 30 seconds, in the absence of chest compressions. Signs of life include any of the following: normal breathing, palpable pulse, normal end tidal CO₂ or normal movement. Although ROSC rates are recorded for benchmarking purposes, overall ROSC rates represent a surrogate marker of resuscitation success and alone are an inadequate measure of outcome.

For the nine month reporting period the overall rate of ROSC for OHCA where resuscitation was attempted by St John EAS was 54% for ambulance officer witnessed events, 43% for bystander witnessed events and 20% for unwitnessed events (Figure 14).

The percentage rates of ROSC were similar to those observed by Ambulance Victoria, 60% for ambulance officer witnessed, 49% bystander witnessed and 22% for unwitnessed (8).

One of the contributing factors in patient survival is good quality of chest compressions during CPR. Ongoing delivery of CPR during the transport of a patient following an OHCA may compromise the quality of the CPR being delivered (25).

Therefore, in the majority of OHCA events, it is more appropriate to continue resuscitation at the scene of the arrest until either 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 15). The overall percentage of patients transported with CPR was 3%, transported with ROSC was 33% and died at scene was 63%.

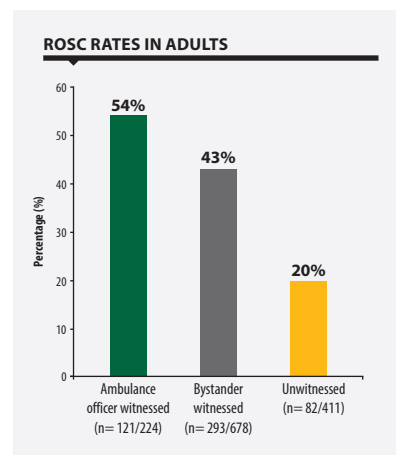


Figure 14: Witnessed versus unwitnessed OHCA, ROSC rates in adults. (Resuscitation attempted events)

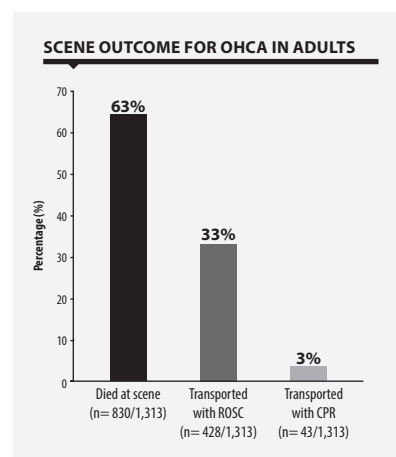


Figure 15: Scene outcome for OHCA in adults. (Resuscitation attempted events)



Adult survival from all-cause cardiac arrest

Survival from OHCA is the foremost factor in benchmarking the performance of EAS internationally. See Figure 16.

FOR OHCA EVENTS IN ADULTS WHERE RESUSCITATION WAS ATTEMPTED, THE RATE OF HOSPITAL ADMISSION WAS 30%

THE RATE OF SURVIVAL TO HOSPITAL DISCHARGE IN ADULTS WHERE RESUSCITATION WAS ATTEMPTED WAS 15%

Table 6: Benchmarking hospital admission rates. (Resuscitation attempted events)

Ambulance service	Hospital admission
St John (Adults only)	30%
Wellington Free Ambulance (12)	48%
Ambulance Victoria (Adults only) (8)	30%
London Ambulance Service (9)	31%
South Western Ambulance Service (UK) (10, 11)	25%

The inaugural results from the St John OHCA registry demonstrate that in OHCA events in adults where resuscitation was attempted, the rate of hospital admission was 30% (Table 6). This rate is comparable to the other services against which St John was benchmarked.

The rate of survival to hospital discharge in adults where resuscitation was attempted was 15%, which is also similar to other services benchmarked against (Table 7).

Table 7: Benchmarking hospital discharge rates. (Resuscitation attempted events)

Ambulance service	Hospital discharge
St John (Adults only)	15%
Wellington Free Ambulance (12)	18%
Ambulance Victoria (Adults only) (8)	10%
London Ambulance Service (9)	9%
South Western Ambulance Service (UK) (10, 11)	8%

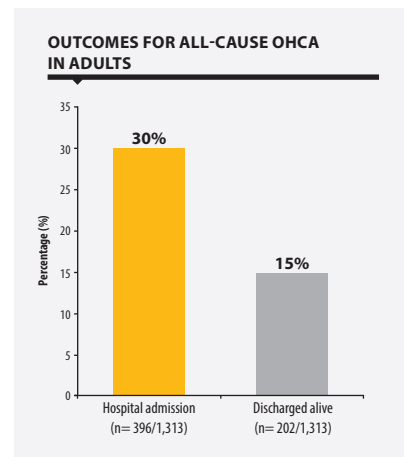


Figure 16: Outcomes for all-cause OHCA in adults. (Resuscitation attempted events)



Adult outcomes from shockable rhythms

Patients who 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. Adult patients who had resuscitation attempted by St John EAS staff and presented with a shockable rhythm had a greater rate of hospital admission than those with a non-shockable rhythm (49% shockable vs 25% PEA or 12% asystole). Similarly, adult patients presenting with a shockable rhythm had a greater chance of being discharged alive from hospital than those with a non-shockable rhythm (32% shockable versus 6% PEA or 2% asystole). See Figure 17.

IMMEDIATE INTERVENTION OF DEFIBRILLATION CAN LEAD TO THE GREATEST SURVIVAL OUTCOMES.

If a patient is in a shockable rhythm and the arrest is witnessed by ambulance officers, the immediate intervention of defibrillation can lead to the greatest survival outcomes. Of the adult patients who had a shockable presenting rhythm where the arrest was witnessed by St John ambulance officers, the rate of hospital admission was 76% (n= 66) and survival to hospital discharge was 56% (n=49).

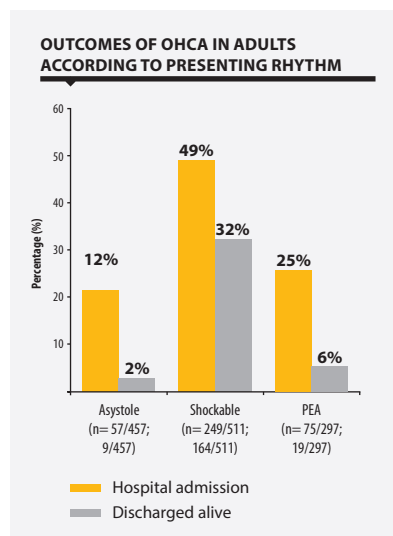


Figure 17: Outcomes for OHCA in adults according to presenting rhythm. (Resuscitation attempted events)

Paediatric survival from all-cause OHCA

In children OHCA is rare with a total of only 56 events where resuscitation was attempted by St John EAS for the nine month reporting period. 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 5% (n=3) of the children who had resuscitation attempted by St John EAS staff presented with a shockable rhythm. The most common precipitating event for OHCA in children is SUDI for which there were no survivors. Overall the rate of hospital admission for children where resuscitation was attempted by St John EAS was 14% (n=8) and survival to hospital discharge was 9% (n=5). However, due to the low total number of paediatric events these rates may vary significantly.

Conclusion

The data presented in this inaugural report indicates that the service provided by St John in treating OHCA is of a high quality and compares favourably with other services we have benchmarked against. As the first report on the outcomes of OHCA it represents a baseline against which future data can be measured and compared. The data in this report will become the basis for discussion on clinical improvements as part of ongoing service planning and continual improvement at St John. As a result, new processes, technologies and research strategies may be implemented and the impact of these strategies can be measured against this baseline. Measuring changes in outcomes year-on-year will enable St John to be at the forefront of 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 infants
EMT	Emergency medical technician	VF	Ventricular fibrillation
ICP	Intensive care paramedic	VT	Ventricular tachycardia

Definitions

Adult	Patients aged 16 years of age or older.
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 staff	St John ambulance staff responded to a medical emergency in an official capacity as part of an organised medical response team.
Resuscitation attempted	This is the subset of patients following cardiac arrest where resuscitation was attempted by St John EAS staff.
Hospital admission	The patient had sustained ROSC to handover at hospital.
Paediatric	Patients aged less than 16 years of age.
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.
ROSC	The patient showed 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.
Shockable rhythm	Ventricular fibrillation, ventricular tachycardia or unknown shockable (AED).
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.

The St John New Zealand OHCA Registry Group

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Hawke's Bay
District Health Board

Hutt Valley
District Health Board

Lakes
District Health Board

MidCentral
District Health Board

Nelson Marlborough
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Northland
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Waikato
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Wairarapa
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Waitemata
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West Coast
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Whanganui
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St John

first to care

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