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Outcomes from out-of-hospital cardiac arrest in the Wellington region of New Zealand. Does use of the Fire Service make a difference?

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Abstract

Aims Survival from community cardiac arrest in the Wellington region was analysed and compared with similar data reported nationally and internationally. In particular, the impact of a dual fire and ambulance service response was studied.

Method A retrospective comparative study was undertaken of out-of-hospital cardiac arrests in the Wellington region between 1 July 2007 and 31 December 2009. Data was collected from Wellington Free Ambulance and hospital records in accordance with the Utstein template. The New Zealand Fire Service provided details of firefighter attendance and timings. The primary outcome measure was survival to hospital discharge.

Results Overall survival to hospital discharge was 11% (37/339) whilst survival from initial ventricular fibrillation or tachycardia (VF/VT) was 21% (34/161). Initial VF/VT was more common in witnessed than unwitnessed arrests (57% v. 35%, p=0.001) and this mirrored survival in these groups (15% vs 6%, p=0.01). Survival to hospital discharge was also associated with younger age and shorter emergency service response time. Bystanders attempted CPR in 55% and the fire service in 50% but neither intervention influenced outcome. Although, when activated, the fire service arrived on average 1–2 minutes ahead of the ambulance, the dual response did not influence survival to hospital admission or discharge.

Conclusion Survival from out-of-hospital cardiac arrest in Wellington is similar to that of other New Zealand cities and better than that reported from several large centres overseas. The combined fire and ambulance response was not shown to have any beneficial impact on survival over and above that achieved by the ambulance service alone. System changes are proposed to try and improve survival from community cardiac arrest in Wellington.

Survival from out of hospital cardiac arrest remains low internationally, despite attempts to optimise clinical guidelines. Factors that correlate with improved outcome include bystander CPR and time to defibrillation.[1,2–4]

A study undertaken in Melbourne, Australia showed that response time could be significantly decreased if a combined fire and ambulance response system was used[5] and this has been mirrored in similar studies conducted in Stockholm and Canada.[6,7] Programmes which dispatch firefighters (or even the police[8]) as a first response team have long been in place in the USA and Canada[9] and these systems have improved survival rates from out-of-hospital cardiac arrest.[6,7]

Wellington Free Ambulance (WFA) serves an area of approximately 4000 square kilometres and a population of 473,700 (Greater Wellington Regional Council, June 2008). It attends three to four cardiac arrests each week.[10] Emergency 111 calls are received by the Ambulance Communication Centre and in cases of respiratory or cardiac arrest, these calls can be transferred manually to the New Zealand Fire Service (NZFS) dispatch centre.

NZFS personnel are trained in CPR and the use of AEDs (automatic external defibrillators). This training is undertaken by instructors within the fire service and is accredited by the New Zealand Qualifications Authority. All fire vehicles in the Wellington region carry an AED and basic first aid supplies including oxygen, bag and mask ventilators, oropharyngeal airways and bandages.

The study hypothesis was that the NZFS response to cardiac arrest would be faster than that of WFA, and that this would result in improved survival to hospital discharge. Secondary endpoints were a return of spontaneous circulation (ROSC) and survival to hospital admission.

Methods

Emergency medical services (EMS) system—When a 111 call consistent with cardiac arrest is received by the ambulance communication centre, the dispatcher activates the nearest available ambulance and can then choose to dispatch either a second ambulance or a fire appliance. This decision was based upon the location and availability of the second ambulance at the time. To activate a fire appliance, the ambulance dispatcher called the fire dispatch centre directly to request assistance. Since 7th July 2009, the two dispatch centres have been linked by an Intercad system. Ambulances are normally staffed by two paramedics and fire appliances by four firefighters.

Study period—All out-of-hospital cardiac arrests attended by EMS over the period 1 July 2007 to 31 December 2009 were included in the study.

All adult patients (aged over 16 years) suffering out of hospital cardiac arrest where any type of resuscitation was started were included in the study. Exclusion criteria included cardiac arrests resulting from trauma, suicide or hanging, and those occurring in the presence of paramedics.

For each case, data was collected from the New Zealand Resuscitation Council Registry in accordance with the Utstein template.[11] For each case within the registry, fire service dispatch records were accessed to determine whether that service had been used and if so, its response time.

Data collected—Standard Utstein definitions[11] were used. A witnessed cardiac arrest was one that was seen or heard by another person. If this person was a member of EMS, then the event was classified as EMS-witnessed. Bystander CPR was recorded if the paramedic believed that CPR was performed prior to arrival by a member of the public, either because this was occurring on arrival or it was said that CPR had been performed. The presenting rhythm was the first monitored cardiac rhythm when a defibrillator was attached to the patient.

Survival to hospital admission was defined as survival to admission beyond the emergency department.

Survival to discharge was survival to discharge alive from the hospital acute care unit, regardless of neurological status or destination.

The ambulance response time was defined as the difference between the time the ambulance dispatcher received the 111 call and the time the crew reported arrival at the scene. Both of these times were rounded to the nearest minute. For statistical analysis, response times were categorised as 0–4 minutes, 5–8 minutes, 9–12 minutes, 13–16 minutes and greater than 16 minutes.

The fire response time was defined as the difference between the fire dispatcher receiving the request for assistance and the fire crew reporting arrival at the scene. This data was taken from the fire dispatch system log.

Statistical analysis—A Chi-squared test was used to compare outcomes and presenting rhythms for witnessed and unwitnessed cardiac arrests. Multinomial logistic regression was used to examine factors associated with survival to hospital discharge and survival to hospital admission. P-values <0.05 were

considered statistically significant. All statistical tests were performed using PASW 18.0 (SPSS, Chicago, Il.).

Results

During the study period there were 362 attempted resuscitations. In 23 cases the cardiac arrest occurred with a paramedic in attendance, leaving 339 out-of-hospital cardiac arrests (OHCA) in the study. Details of these cases are provided in Table 1 and Figure 1. Overall, in 37 cases (11%) the victim survived to hospital discharge.

Table 1. Community cardiac arrests, Wellington, 2007–2009

Variables	Whole cohort N=339	Witnessed arrests N=192 (57%)
Age	67 (IQR 53–77)	67 (53–78)
Gender	230 Male (68%)	138 Male (72%)
Bystander CPR	186 (55%)	114 (59%)
Ambulance response time (to nearest minute)	9 (IQR 7–11)	9 (7–11)
Fire Service used	169 (50%)	80 (42%)
Presenting rhythm		
VF/VT	161 (47%)	110 (57%)
Asystole	120 (35%)	45 (23%)
PEA	58 (17%)	37 (19%)
Outcomes		
ROSC	141 (42%)	94 (49%)
Admitted to Hospital	123 (36%)	83(43%)
Discharged	37 (11%)	29 (15%)

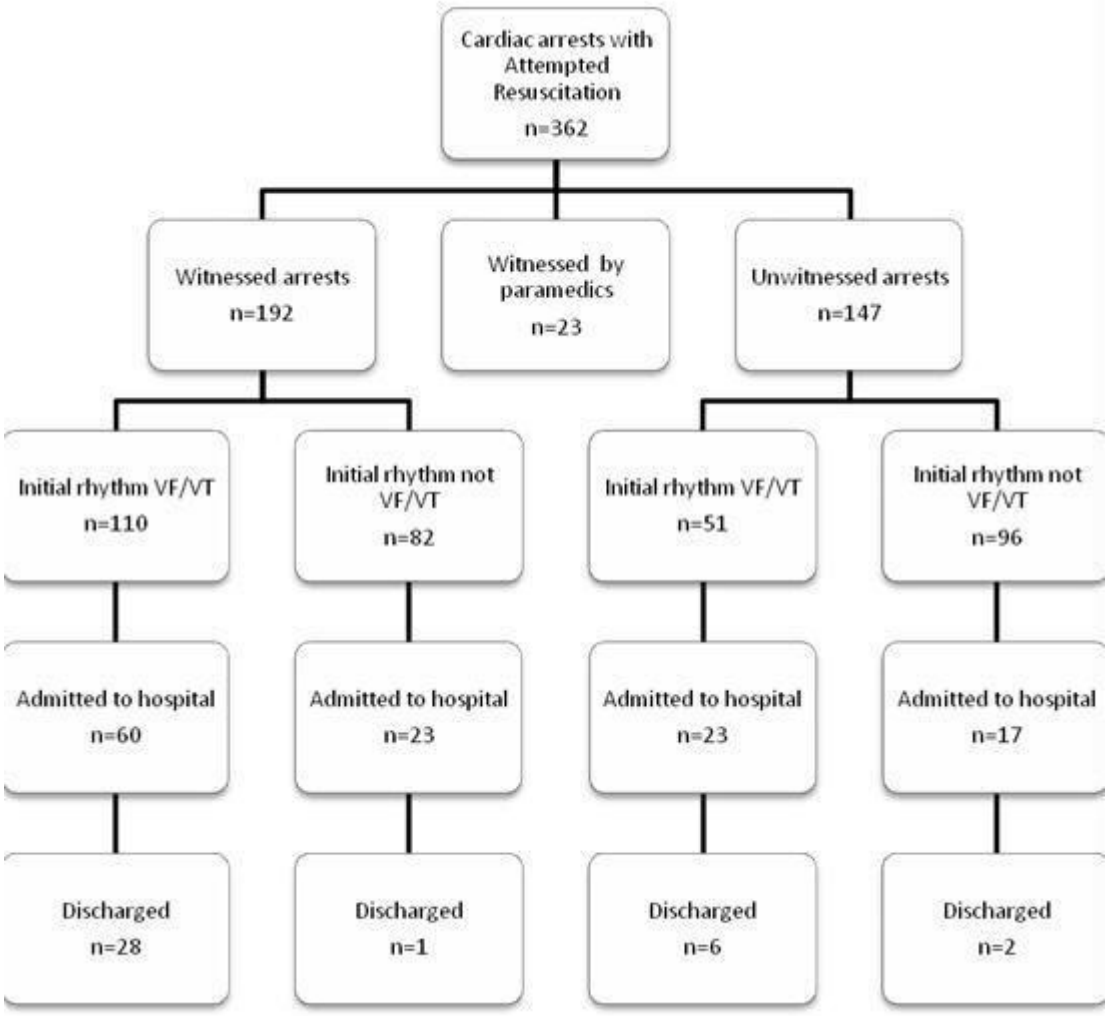
In 192 cases (57%) the cardiac arrest was witnessed. Of these witnessed cases, 29 (15%) survived to hospital discharge, significantly greater than for unwitnessed cardiac arrests (8 survivors, 5%, p=0.01, Chi-squared test). Ventricular fibrillation (VF) or ventricular tachycardia (VT) was more likely to be the presenting rhythm in witnessed arrest compared with unwitnessed arrest (110/192 (57%) of witnessed arrests versus 51/147 (35%) of unwitnessed arrests, p = 0.001, Chi-squared test). A total of 161 patients presented with an initial rhythm of VF/VT, and in this group 34 survived (21%).

Cardiac arrest survival data from other centres in New Zealand and overseas are summarised in Table 2.

While paired comparison of fire and ambulance response times to the same calls demonstrates that the fire response was faster, with a mean of 6.5 minutes (standard deviation 2.5) for fire versus 9.7 minutes (standard deviation 5.0) for ambulance, the level of documentation regarding the function of the fire service at the cardiac arrest and the times derived from control centres without synchronised clocks did not allow us to accurately determine which vehicle arrived first in all cases.

From the limited number of cases for which documentation was available, we estimate that there was an average delay of 2 minutes from dispatch of the ambulance to the dispatch of a fire crew to the scene, such that the fire service arrived only a minute or two before the ambulance.

Figure 1. All treated cardiac arrests in the Wellington region from 1 June 2007 to 31 December 2009 reported in the Utstein style



A comparison of the cases attended by the ambulance service alone, and by the ambulance and fire services is given in Table 3. While this shows no difference in ROSC, survival to admission or survival to discharge between the two groups, the cardiac arrests attended by both fire and ambulance services were less likely to have been witnessed, less likely to have received bystander CPR, and were more likely to have a presenting rhythm of asystole than those attended by the ambulance service alone.

To take into consideration the differences in bystander witnessed events, bystander CPR rates and initial presenting rhythm between the events attended by fire and ambulance versus ambulance alone, we conducted a multinomial logistic regression analysis of characteristics associated with both survival to hospital admission and to hospital discharge.

The results of this are shown in Table 4. Survival to hospital admission was associated significantly with the presenting rhythm, witnessing of the arrest and ambulance response time, while survival to hospital discharge was associated with the presenting rhythm, patient age and ambulance response time. After correcting for these variables, the use of the fire service was not shown to be a significant determinant of outcome within this model.

Table 2. Survival to hospital discharge following out-of-hospital cardiac arrest: national and international comparisons

Overall survival to discharge	Survival to discharge VF/VT (witnessed or unwitnessed)
Auckland 12%[12]	
Christchurch 11%[13]	
New York 2.1%[14]	New York 7.3%[14]
Victoria 4%[15]	
Queensland 6%[16]	
London 6%[18]	
Perth 7%[17]	Perth 11%[17]
Denver 8%[19]	London 15%[18]
Wellington 11%	Victoria 16%[15]
Oslo 13%[20]	**Wellington 21%**
Copenhagen 16%[21]	Denver 27%[19]
Seattle/King County 15%[22]	Oslo 31%[20]
	Copenhagen 39%[21]
USA (35 centres) 8%[22]	Seattle/King County 46%[23]
	USA (35 centres) 18%[22]

Table 3. Data for Fire-and-Ambulance versus Ambulance alone

Variables	Fire and Ambulance n=169	Ambulance alone n=170	P value
Age	62 (IQR52-77)	68 (IQR 55-78)	0.41
Bystander CPR	73 (43%)	113(66%)	0.001
Witnessed	75 (44%)	117 (69%)	0.001
Presenting rhythm			
VT/VF	76 (45%)	85 (50%)	0.002
Asystole	71 (42%)	49 (29%)	
PEA	22 (13%)	36 (21%)	
Outcomes			
ROSC	68 (40%)	73 (43%)	0.61
Admitted to hospital	58 (34%)	65 (38%)	0.45
Discharged	18 (11%)	19 (11%)	0.87

Table 4. Multivariate analysis of characteristics associated with survival to hospital admission and to hospital discharge

Characteristic	Admitted to Hospital p value	Discharged p value
Presenting rhythm	0.0001	0.0001
Bystander witnessed	0.05	0.13
Age	0.41	0.001
Gender	0.14	0.54
Ambulance response time	0.04	0.05
Fire attendance	0.65	0.51
Bystander CPR	0.77	0.71

Discussion

Survival from out-of-hospital cardiac arrest in the Wellington region—Survival to discharge from hospital following community cardiac arrest in Wellington has been studied over a 2.5-year period and is compared with similar data from other national and international centres in Table 2. Previous survival figures for all cardiac arrest rhythms in Auckland[12] and Christchurch[13] are very similar to the 11% reported from Wellington in this paper but a number of reputable centres overseas have lower overall survival and a few cities report better outcomes in this category.

It is well established that an initial rhythm of VF or VT is associated with a more favourable outcome from cardiac arrest and this is endorsed by the survival data for VF/VT arrest contained in Figure 1. Some centres have ceased to report survival from non-shockable cardiac rhythms and many also exclude unwitnessed arrests in the VF/VT category.[24] Taking that into account, the authors consider that 21% survival to hospital discharge from out-of-hospital VF/VT in the Wellington region is more favourable than that reported internationally from a number of centres with well developed EMS systems.

Factors affecting survival—In common with other studies,[2,3,17] survival to hospital admission was associated significantly with a presenting rhythm of VF/VT, witnessing of the arrest, and ambulance response time.[2,4,25] Survival to hospital discharge was also associated with the presenting rhythm but increasing patient age had an adverse effect which has been reported to continue after leaving hospital.[26]

The rate of bystander CPR was 55% but this was not found to be a significant determinant of outcome, which raises a question regarding the effectiveness of CPR undertaken by lay people. This finding has highlighted a potential shortfall in the recognition of cardiac arrest and performance of CPR by lay persons in the region and an initiative to address this has been introduced by Wellington Free Ambulance.

In the Wellington region, use of a dual fire and ambulance response, as opposed to ambulance response alone, has not been shown to improve survival from cardiac arrest. This is disappointing as basic life support (BLS) teams consisting of either fire, police, or BLS ambulance staff working with advanced paramedics have achieved improved outcomes in other centres.[5–8,27,28]

Several factors may have contributed to an apparent lack of benefit in Wellington and these need to be considered:

- There was inconsistency in the activation of a dual response by ambulance dispatchers. No standard criteria for co-responding fire and ambulance to the scene had been agreed and dispatchers may have considered manpower to be a more important factor than the speed of response. It is now agreed that fire and ambulance services in the Wellington region will be activated simultaneously in response to all cardiac arrest calls.
- Communication between the ambulance and fire dispatchers is not automated. One of the major limitations in this study was the inability to reliably determine which service arrived on scene first. Although accurate dispatch-to-arrival times were available separately from the fire and ambulance communication centres, a precise comparison of response times for the two services was not possible because their clocks were not synchronised. This problem has now been rectified. The defibrillator clocks for both services are also being synchronised. Although fire personnel arrived more rapidly overall, we have not been able to demonstrate any survival benefit from this.
- Better documentation of the event by both firefighters and paramedics is essential if the initial rhythm, bystander CPR, treatments given, and timings are to be accurately recorded. The Fire Service has now designed a form to enable more accurate documentation of cardiac arrests by its personnel. More details of fire service actions at the arrest will also be incorporated into future ambulance reports and data will be downloaded from automated defibrillators used by the fire service. Data collection will continue indefinitely as outcome from prehospital cardiac arrest is one of the new multidisciplinary performance indicators established for New Zealand ambulance services.
- Although the ambulance service assists with the resuscitation training of firefighters, there has been no regular joint training to improve coordination between the two groups on scene. This is under discussion but as a first step, resuscitation guidelines have been shared between the services.

Ambulance and fire service data (Table 3) reveal a significant reduction in witnessed arrests and bystander CPR when fire and ambulance staff both attended the cardiac arrest. This finding may be explained by a paucity of information regarding bystander involvement from firefighters who were already on scene.

Another unexpected finding was a significantly higher proportion of asystole in patients attended by both fire and ambulance staff. This initial rhythm would have been documented by paramedics and during the period of the study, the fire service was most commonly activated because of an anticipated delay in paramedic arrival. It is known that the incidence of asystole increases with time during cardiac arrest.

The principle of the 'Chain of Survival'[1] emphasises that the earlier the emergency services, CPR, defibrillation, and advanced life support are activated, the better is the outcome for the patient.

Other centres have reported similar ambulance response times and survival[20,29] so a well coordinated dual-service response is required in Wellington to improve both.

Ways of achieving this are currently under discussion but automatic dual activation for cardiac arrest call, synchronised timings, and more comprehensive documentation are being introduced. The focus will remain a reduction in call-to-shock times for both fire and ambulance services.

Although our ambulance call-to-arrival times are similar to those in several European countries, they do not compare favourably with those quoted by some groups in North America where call-to-first-shock times of 5–6 mins have been associated with survival-to-discharge rates of 16% (for all cardiac rhythms).[22,23]

Conclusion

Survival from out-of-hospital cardiac arrest in Wellington is similar to that of other New Zealand cities and better than that reported from several large centres overseas. Survival to hospital discharge was higher when the emergency service response time was short, the initial cardiac rhythm was shockable and the patient was younger.

Patients whose arrest was witnessed were more likely to reach hospital alive. The activation of a combined fire and ambulance response was not shown to have any beneficial impact on survival over and above that achieved by the ambulance service alone. As a result, system changes are being introduced to try and improve data collection and survival from community cardiac arrest in Wellington.

Competing interests - none.

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