Cardiac Arrest Annual Report: 2013/14

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Produced by:

Gurkamal Virdi, Paul Nicholas and Rachael Fothergill

✉ CARU.Enquiries@lond-amb.nhs.uk

Clinical Audit and Research Unit, Clinical and Quality Directorate, London Ambulance Service NHS Trust, 8-20 Pocock Street, London, SE1 0BW.

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Key findings

- 9,805 cardiac arrest patients were attended by the LAS in 2013/14, with resuscitation attempted for 4,317 patients.

- Survival to discharge rates have increased and represent the highest rates observed since we started collecting data in 1998.

  - The overall survival rate for all patients where resuscitation was attempted is now 10.3% (up from 9.3% in 2012/13).

  - The Utstein survival rate is 32.4%; an increase of 4% from 28.4% in 2012/13.

- Rates of return of spontaneous circulation (ROSC) sustained to arrival at hospital for all patients has remained relatively stable around 31%. For the Utstein group there has been an increase in patients sustaining ROSC to hospital of 4.3% to 58.5% (from 54.2% in 2012/13).

- More patients received bystander cardiopulmonary resuscitation (CPR) this year than ever before, with 55.8% of patients receiving CPR prior to LAS arrival.

- The percentage of patients whose arrest was witnessed has also increased steadily, with nearly half of patients having a witnessed arrest (48.6%).

- The presence of an initial shockable rhythm has increased slightly to 21.5%. Patients with a shockable rhythm have both high rates of ROSC sustained to hospital (57.4%) and survival to discharge (36.3%).

- Presumed cardiac aetiology was the most frequent cause of cardiac arrest (85.7%). Patients in this group had a ROSC to hospital rate of 32.1% and 11.2% survived to discharge.

- A greater number of patients who achieved ROSC with evidence of myocardial infarction were taken to a Heart Attack Centre (HAC) compared to the previous year (297 vs. 277). These patients have a survival rate of 47.6%; considerably higher than the survival rate of presumed cardiac patients in general.

- Patients where a public access defibrillator was used (n=18) also have an incredibly high rate of ROSC sustained to hospital (77.8%) and survival to discharge rate (58.8%).

1. Introduction

9,805 patients suffered an out-of-hospital cardiac arrest in London between 1st April 2013 and 31st March 2014. The care that out-of-hospital cardiac arrest patients receive from Emergency Medical Services (EMS) influences their immediate survival chances as well as their long term outcomes. This report presents key information regarding the response and treatment that patients received from the London Ambulance Service NHS Trust (LAS), the factors present on arrival of LAS staff that may affect survival, and the outcome of patients.

Data has been sourced from the LAS cardiac arrest registry. The registry captures information from Patient Report Forms (PRFs), vehicle Mobile Data Terminals (MDTs), 999 call logs and defibrillator data. Survival to discharge from hospital information is collected using national databases and individual hospital records.

A breakdown of figures by LAS Complex and receiving hospital can be found in Appendices 1 and 2 respectively. Appendix 3 is dedicated to a specific group of cardiac arrest patients that are conveyed to a Heart Attack Centre (HAC) as part of a specialist care pathway. Appendix 4 displays information according to the Clinical Commissioning Group (CCG) area in which the cardiac arrest occurred. Appendix 5 presents figures specifically for cases where defibrillators were utilised in public places. Finally, Appendix 6 focuses on cardiac arrest patients under the age of 35.

A glossary of abbreviations and terms are included on page 14 for readers unfamiliar with the medical or operational terminology used in the ambulance service.

2. Overview

Of the 9,805 out-of-hospital cardiac arrest patients attended, a resuscitation effort was not undertaken in 56.0% (n=5,488) of cases. The vast majority of patients were recognised as deceased on arrival (92%; n=5,046), with the remaining 8% (n=442) having a Do Not Attempt CPR (DNA-CPR) order - or similar equivalent - in place, or the patient's death was expected.

Resuscitation was attempted by LAS staff for 44.0% (n=4,317) of all cardiac arrest patients. The remainder of this report focuses on these patients.

Table 1 (overleaf) shows that the typical out-of-hospital cardiac arrest patient where resuscitation was attempted was male in his mid-60's. The arrest occurred in the morning during winter at a private location. A high priority response in less than 7 minutes was provided. The arrest was most likely of a cardiac cause, witnessed by a bystander with CPR commenced prior to the LAS arrival, and an asystolic rhythm was observed on initial assessment.

Gender	
Male	63.1%; n=2,725
Female	36.9%; n=1,591
Unknown	0%; n=1

Age (years)	
Overall average	66
Male average	64
Female average	69

Race^	
White	62.6%; n=2,702
Mixed	0.4%; n=16
Asian	8.2%; n=352
Black	8.0%; n=347
Other	3.9%; n=170
Unable to obtain	15.3%; n=661
Not documented	1.6%; n=69

Peak occurrence	
Time of day (hours)	08:00-11:59 (24.1%; n=1,039)
Day	Monday (15.9%; n=687)
Month	December (10.3%; n=446)

Response category	
R1	61.0%; n=2,633
R2	32.3%; n=1,395
C1	1.4%; n=59
C2	4.0%; n=172
C3	0.8%; n=35
C4	0.5%; n=23

Response times (median in minutes)	
999 call - scene	06:40
999 call - CPR#	08:12
999 call - defibrillation#	11:34

Location	
Private	77.7%; n=3,356
Public	22.3%; n=961

Witnessed	
Bystander	48.6%; n=2,097
LAS staff	18.3%; n=791
Unwitnessed	33.0%; n=1,423
Not documented	0.1%; n=6

Bystander CPR#	
Yes	55.8%; n=1,967/3,526
No	44.2%; n=1,559/3,526

Initial rhythm	
Asystole	50.0%; n=2,157
PEA	27.3%; n=1,178
VF/pulseless VT	21.5%; n=927
Not documented	1.2%; n=55

Aetiology	
Presumed cardiac	85.7%; n=3,700
Other medical	4.5%; n=195
Trauma	4.1%; n=175
Asphyxiation	3.3%; n=143
Drowning	0.6%; n=28
Overdose	1.8%; n=76

Airway management*	
Airway placed	86.2%; n=3,721/4,317
ETT success rate	82.7%; n=1,354/1,637
SGA success rate	90.5%; n=2,674/2,954
ETCO$_2$ measured	95.9%; n=3,568/3,721

Recognised as life extinct on scene	
Yes, by LAS	31.4%; n=1,354
Yes, by other Healthcare Professional	3.6%; n=157
No	65.0%; n=2,806

^ *Due to the critical condition of cardiac arrest patients, definitive race information is not always possible to obtain and therefore this data should be viewed with caution.*

Figures for bystander CPR and 999 call - CPR exclude arrests witnessed by LAS staff. 999 call - defibrillation calculations are based on patients with an initial rhythm of VF/VT only.

* *Airway management refers to the application of an advanced airway intervention, including endotracheal tube (ETT) and supraglottic airway device (SGA). End tidal carbon dioxide (ETCO$_2$) is measured to assess the accurate placement of these devices.*

Table 1 – Profile characteristics of all cases where resuscitation was attempted (n=4,317).

3. Outcomes of resuscitation attempted patients

3.1. Outcomes of all resuscitation attempted patients

ROSC was sustained to hospital for 31.2% (n=1,346/4,317) of patients. The rate of survival to discharge was 10.3% (n=436/4,239[i]); an increase of 1% from the 9.3% reported in 2012/13. Figures 2 and 3 (page 6) show the improvements seen over time for rates of ROSC sustained to hospital and survival to discharge.

ROSC sustained to hospital	
Yes	31.2%; n=1,346
No	68.8%; n=2,969
Not Documented	0%; n=2

Survived to discharge[i]	
Yes	10.3%; n=436/4,239
No	89.7%; n=3,803/4,239

Table 2 – ROSC sustained to hospital and survival to discharge for all cases where resuscitation was attempted.

3.2. Utstein comparator group

The Utstein method for calculating survival is an internationally recognised measure that is used to compare patient outcomes amongst EMS providers. It examines a subset of patients where resuscitation has been attempted and requires the presence of the following factors: the arrest was witnessed by a bystander, the patient's heart was in a shockable rhythm on arrival of the EMS (VF/pulseless VT), and the arrest is of a presumed cardiac aetiology. In 2013/14, the LAS attended a total of 605 patients that met the Utstein criteria.

Figure 1 shows that ROSC was sustained to hospital for 58.5% of patients (n=354) and survival to discharge was achieved for 32.4% (n=187/578); representing increases of 4.3% and 4% respectively from 2012/13. Both the ROSC sustained to hospital and survival to discharge figures are the highest observed to date (see Figures 2 and 3).

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[i] Denominator excludes patients with unknown survival outcomes (n=78).
[ii] For bystander CPR analysis, LAS staff witnessed arrests are excluded.

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│      Cardiac aetiology & resuscitation attempted │
│                                                  │
│                  N = 3,700                       │
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| Not witnessed (incl. not recorded) N = 1,165 (31.5%) | Bystander witnessed N = 1,871 (50.6%) | Witnessed by LAS staff N = 664 (17.9%) |

| Initial rhythm VF/VT N = 605 (32.3%) | Other rhythms (incl. not recorded) N = 1,266 (67.7%) |

| Bystander CPR N = 417 (68.9%) | Bystander CPR N = 676 (53.4%) |

| ROSC not achieved N = 178 (29.4%) | ROSC at any time N = 427 (70.6%) |

ROSC sustained to hospital

N = 354 (58.5%)

| Outcome data N = 578 (95.5%) | No outcome data N = 27 (4.5%) |

| Died in hospital* N = 330 (57.1%) | **Discharged alive*** **N = 187 (32.4%)** | Efforts stopped on scene* N = 61 (10.6%) |

* The percentages do not equal 100% due to rounding.

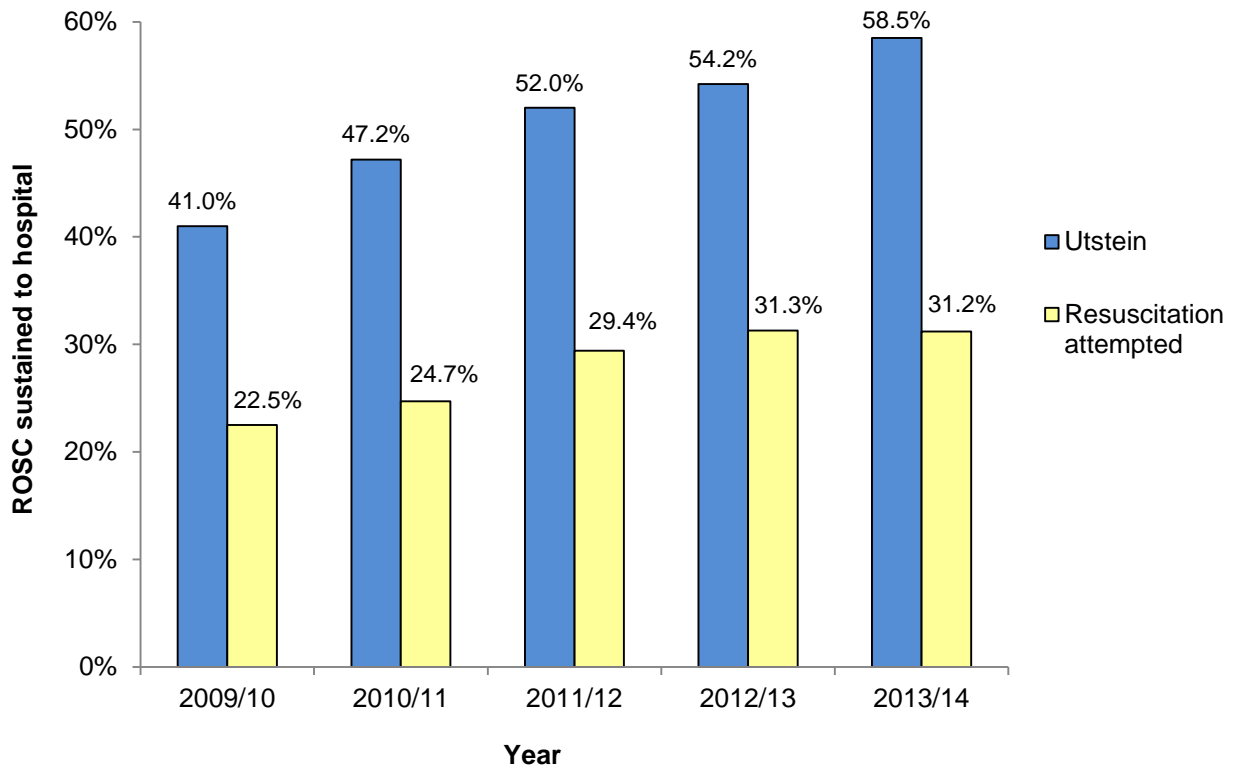Figure 1 – Outcome for the Utstein comparator group.

Figure 2 – ROSC sustained to hospital for the Utstein comparator group and all resuscitation attempted patients by year.
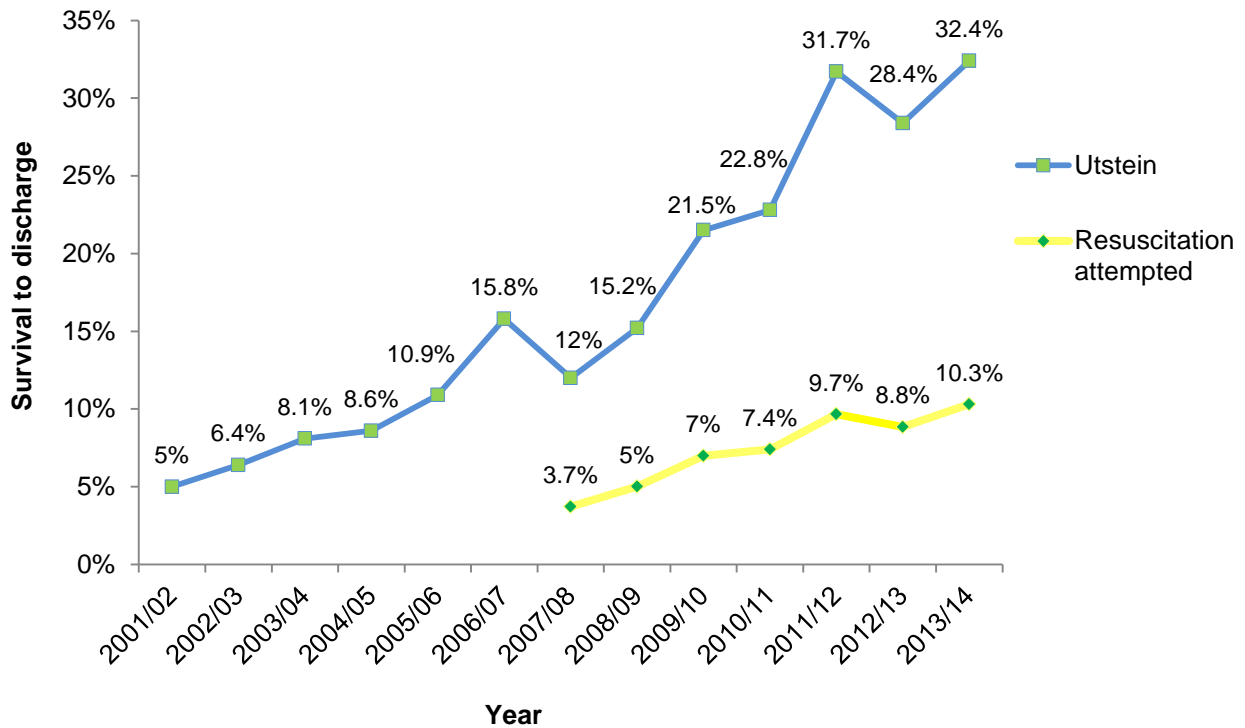

Figure 3 – Survival to discharge for the Utstein comparator group and all resuscitation attempted patients by year.

4. Factors influencing improvements in outcomes of resuscitation attempted patients

Multiple factors influence ROSC and survival to discharge rates; many of which are outside the control of the EMS as they will be linked to patients underlying co-morbidities, aetiology of the arrest, presentation of the patient and situational factors (such as location, whether a witness was present, and whether bystander CPR was undertaken). This section describes how these factors have influenced the improved rates of ROSC sustained to hospital and survival to discharge reported in section 3.

4.1. Location

The largest proportion of cardiac arrests where resuscitation was attempted occurred in a private location (77.7%; n=3,356). The remaining 22.3% (n=961) occurred within public areas, with the street being the most common location (10.7%; n=461). Survival from cardiac arrests is highest in leisure centres or sports clubs (44.1%), followed by those arrests that occur at work (33.3%).

Private locations (n=3,356)	Frequency	Survival to Discharge[+]
Home	68.9%; n=2,974	8.4%; n=248/2,945
Care home	8.8%; n=382	2.6%; n=10/380

Public locations (n=961)	Frequency	Survival to Discharge[+]
Street	10.7%; n=461	15.6%; n=67/429
Work	1.9%; n=80	33.3%; n=26/78
Public transport	1.5% n=64	21.0%; n=13/62
Healthcare facility (e.g. GP surgery, walk in centre)	1.7%; n=75	18.9%; n=14/74
Social Venue (e.g. Pub, Restaurant, Cinema)	1.2%; n=50	20.4%; n=10/49
Hotel/ Hostel	0.9%; n=39	13.9%; n=5/36
Shop/ Bank	0.8%; n=36	8.8%; n=3/34
Leisure Centre/ Sports Club	0.8%; n=34	44.1%; n=15/34
Parkland/ Woodland	0.5%; n=23	31.8%; n=7/22
Airport	0.4%; n=18	27.8%; n=5/18
Stairwell	0.4%; n=17	25.0%; n=4/16
Other (e.g. School, Prison, Place of Worship)	1.5%; n=64	14.5%; n=9/62

+ Denominators exclude patients with unknown survival outcomes.

Table 3 – Location of cardiac arrests where resuscitation was attempted.

4.2. Bystander CPR[ii] & witnessed arrests

Figure 4 shows that there has been an increase in bystander CPR and witnessed arrests over the last 5 years, with 2013/14 demonstrating the highest levels to date at 55.8% and 48.6% respectively. These increases together are important as outcomes are observed to be better when bystander CPR is initiated in patients with a witnessed arrest (see Figure 5).
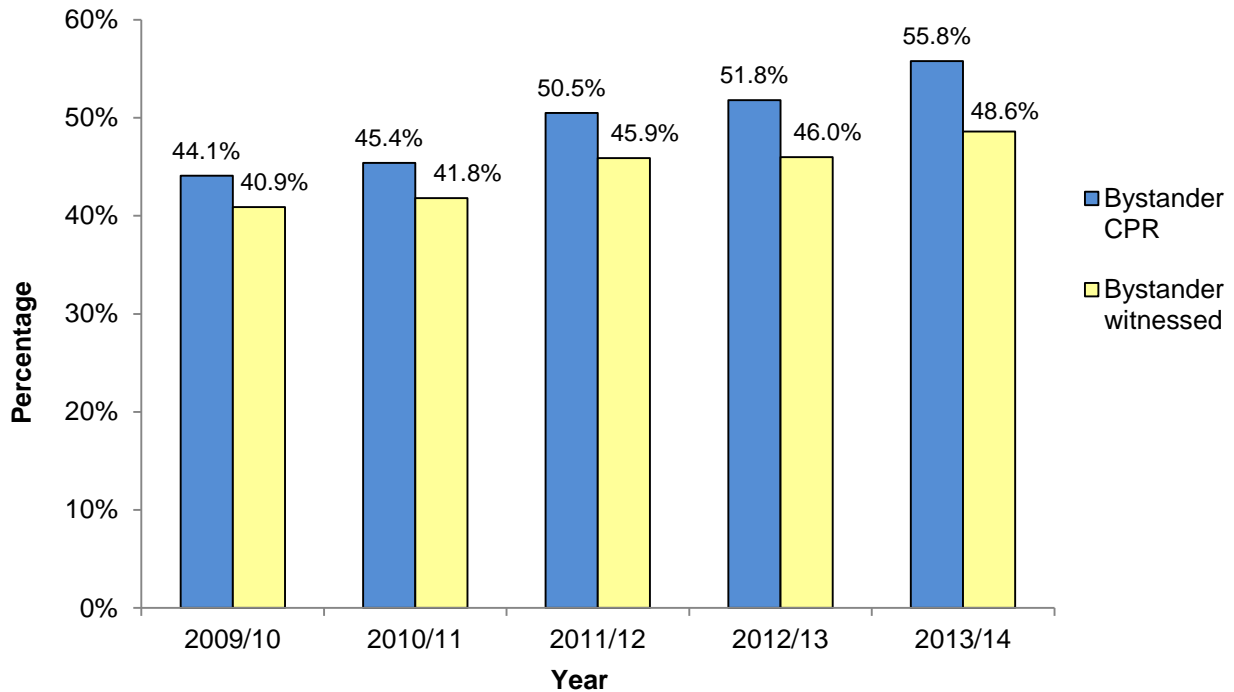

Figure 4 – Rates of bystander CPR and witnessed arrests for all resuscitation attempted patients.
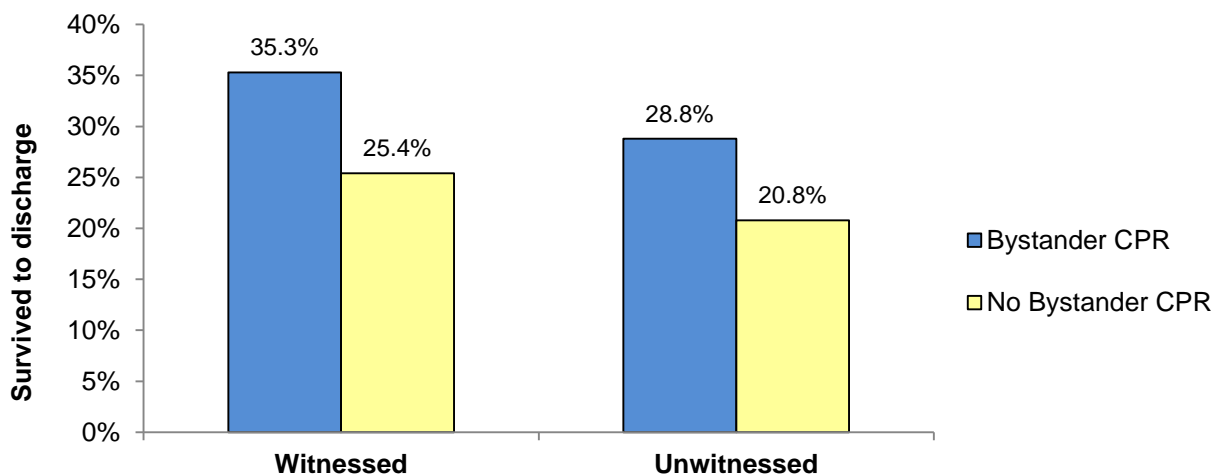

Figure 5 – Survival rates by witnessed and bystander CPR for all resuscitation attempted patients with a shockable rhythm.[iii]

[ii] For bystander CPR analysis, LAS staff witnessed arrests are excluded.
[iii] Shockable rhythm only is examined to enable homogeneity of data.

4.3. Initial rhythm[iv]

Patients where resuscitation was attempted with an initial rhythm of VF/pulseless VT were considerably more likely to be associated with ROSC sustained to hospital (57.4%; n=532/927) and survive to hospital discharge (36.3%; n=325/896). Patients with an initial rhythm of PEA had nearly half this rate of ROSC sustained to hospital (29.3%; n=345/1178) and a substantially lower survival to discharge rate (4.2%; n=49/1,155). Asystolic patients had the lowest rate of ROSC sustained to hospital (20.5%; n=442/2,157) and survival to discharge (2.2%; n=46/2,137).
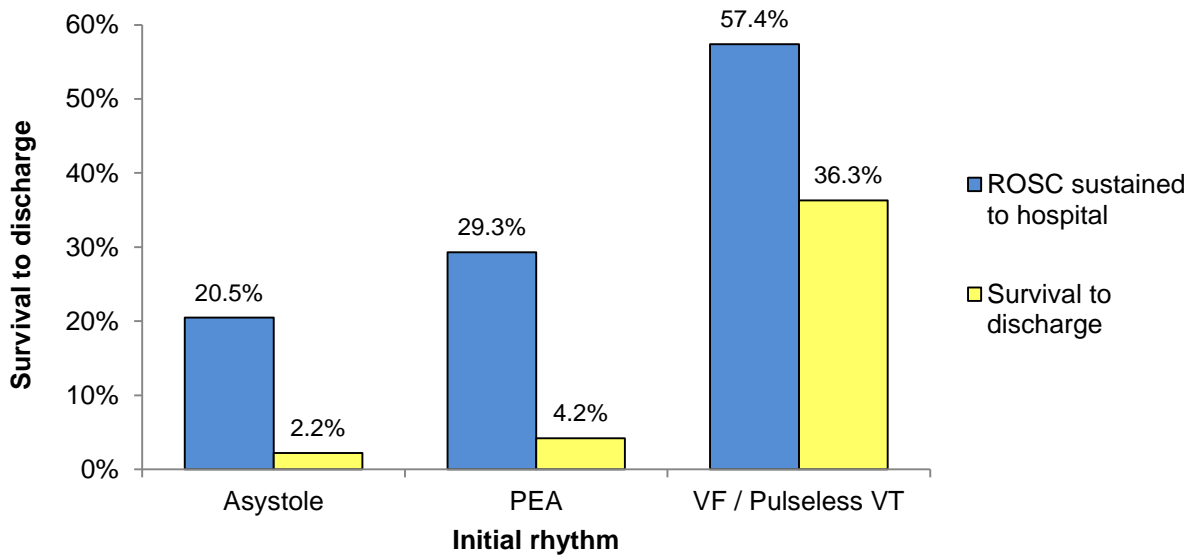
Figure 6 – Initial rhythm compared to ROSC sustained to hospital and survival to discharge for all resuscitation attempted patients.

4.4. Aetiology

Of all patients for whom resuscitation was attempted, the most frequent aetiology of arrest was presumed cardiac (85.7%; n=3,700/4,317), and this group of patients has one of the highest rates of ROSC sustained to hospital and survival to discharge (32.1% and 11.2% respectively). The remaining aetiologies are a mix of disparate origins, including other medical causes, traumatic arrests caused by external causes (such as penetrating and blunt injuries, burns and electrocution), asphyxiation (such as respiratory obstruction and hanging), drowning and overdose. As the causes are so varied and relatively low in number, the ROSC sustained to hospital and survival to discharge rates are equally divergent, as are the initial rhythms in which these patients present (see Table 4).

[iv] Not documented values are excluded from initial rhythm analysis and survival data does not include patients with unknown outcomes.

Cause		No.	Initial Rhythm^			ROSC sustained to hospital#	Survived to discharge# +
			Asystole	PEA	VF/VT		
Presumed cardiac		3,700	48.2% (1,782)	26.6% (983)	24.4% (904)	32.1% (1,188)	11.2% (407/3,640)
Other Medical⊗	Terminal illness	111	62.2% (69)	35.1% (39)	2.7% (3)	16.2% (18)	0% (0/111)
	Asthma/COPD	33	45.5% (15)	45.5% (15)	3.0% (1)	48.5% (16)	12.1% (4/33)
	Infection	11	45.5% (5)	54.5 (6)	-	27.3% (3)	0% (0/11)
	Pulmonary embolism	10	50.0% (5)	30.0% (3)	20.0% (2)	40.0% (4)	0% (0/10)
	Internal bleeding	9	55.6% (5)	33.3% (3)	11.1% (1)	22.2% (2)	0% (0/9)
	Stroke	6	16.7% (1)	66.6% (4)	16.7% (1)	0% (0)	0% (0/6)
	Neonatal	8	50.0% (4)	-	-	0% (0)	12.5% (1/8)
	Hypothermia	4	-	25.0% (1)	75.0% (3)	0% (0)	0% (0/4)
	Lung failure	2	-	100% (2)	-	50% (1)	0% (0/2)
	Anaphylaxis	1	-	100% (1)	-	0% (0)	0% (0/1)
	Total	*195*	*53.3% (104)*	*37.9% (74)*	*5.6% (11)*	*22.6% (44)*	*2.6% (5/195)*
Trauma⊗	Road Traffic Collision	64	46.9% (30)	48.4% (31)	1.6% (1)	14.1% (9)	1.7% (1/59)
	Stabbing	35	48.6% (17)	34.3% (12)	2.8% (1)	5.7% (2)	0% (0/35)
	Fall from height	34	61.8% (21)	38.2% (13)	-	8.8% (3)	0% (0/33)
	Hit by train	8	62.5% (5)	25.0% (2)	-	0% (0)	0% (0/8)
	Fall down stairs	7	71.4% (5)	28.6% (2)	-	42.9% (3)	0% (0/6)
	Crush injury	6	66.6% (4)	16.7% (1)	16.7% (1)	0% (0)	0% (0/6)
	Haemorrhage	5	20.0% (1)	80.0% (4)	-	80.0% (4)	20.0% (1/5)
	Blunt assault	4	100% (4)	-	-	25.0% (1)	0% (0/4)
	Burns	3	33.3% (1)	66.7% (2)	-	0% (0)	0% (0/3)
	Shooting	3	66.7% (2)	-	-	0%	0% (0/3)
	Electrocution	3	33.3% (1)	-	66.7% (2)	33.3% (1)	33.3% (1/3)
	Head injuries	2	50.0% (1)	50.0% (1)	-	50.0% (1)	0% (0/2)
	Evisceration	1	100.0% (1)	-	-	0% (0)	0% (0/1)
	Total	*175*	*53.1% (93)*	*38.9% (68)*	*2.9% (5)*	*13.7% (24)*	*1.8% (3/168)*
Asphyxiation	Obstruction	67	56.7% (38)	32.8% (22)	6.0% (4)	47.8% (32)	7.6% (5/66)
	Hanging	62	77.4% (48)	21.0% (13)	-	33.9% (21)	8.1% (5/62)
	Suffocation	9	100% (9)	-	-	22.2% (2)	11.1% (1/9)
	Smoke inhalation	5	60% (3)	40% (2)	-	60% (3)	0% (0/3)
	Total	*143*	*68.5% (98)*	*25.9% (37)*	*2.8% (4)*	*40.6% (58)*	*7.9% (11/140)*
Drowning		28	85.7% (24)	14.3% (4)	-	25.0% (7)	7.7% (2/26)
Overdose		76	73.7% (56)	15.8% (12)	3.9% (3)	32.9% (25)	11.4% (8/70)

^ *Not documented values (n=55) are excluded from initial rhythm analysis.*

 # Please view with caution due to small numbers.

+ Denominators exclude patients with unknown survival outcomes.

⊗*This data cannot be compared to previous years due to differences in classification of aetiology.*

Table 4 – Aetiology of all cases where resuscitation was attempted.

4.5. Post cardiac arrest patients conveyed to Heart Attack Centres (HACs)

Patients who have suffered a cardiac arrest of presumed cardiac origin and present with a STEMI on a 12-lead ECG post ROSC are eligible to be conveyed to any of the 8 London HACs on a specialist pathway. The HAC will undertake immediate angiography with a view to carrying out rapid primary Percutaneous Coronary Intervention (pPCI) to unblock the coronary arteries as necessary.

During 2013/14, there were a total of 297 patients that were treated under this pathway pan-London. The rate of ROSC that was sustained to a HAC was very high (91.9%; n=273) as crews are required to stabilise a patient prior to conveyance to a HAC. Survival to discharge amongst patients treated using this pathway was 47.6% (n=137/288). A breakdown of survival and initial rhythm for these patients by all 8 London HACs can be found in Appendix 3.

5. Discussion

The survival rates of all patients on whom resuscitation was attempted and the Utstein comparator group (10.3% and 32.4% respectively) have surpassed the previously highest rates recorded in 2011/12. Furthermore, over the past 15 years, there has been an almost eight-fold increase in survival rates for cardiac arrest patients treated by the LAS. Rates for each year have sometimes fluctuated, but when combined they undisputedly show an upward trend (see Figure 3).

An increase was also seen in ROSC sustained to arrival at hospital in the Utstein comparator group of over 4% to 58.5% this year (from 54.2% in 2012/13). This is partly a reflection of the efforts made by our staff to deliver effective resuscitation practices to achieve cardiac output and to stabilise patients to increase the chances that ROSC is sustained until arrival at hospital. The LAS have continued to enhance pre-hospital cardiac arrest care through updated guidelines, including a change to deliver a full energy shock of 360 joules to patients. Enhanced training to staff on basic and advanced life support skills and the management of cardiac arrest on scene have also been a continued focus. To this end the LAS has introduced the concept of Crew Resource Management (CRM) into training to help minimise the effects of human error in a situation by using effective communication and leadership; vital skills in managing a complex cardiac arrest scene.

Rates of bystander CPR have continued to increase yearly, which may also influence the improvements in survival rate. In all patients where resuscitation was attempted, an increase of around 4% was observed in bystander CPR rates from the previous year to a record high of 55.8% (see Figure 4). The LAS has supported the delivery of education to members of the public in CPR techniques for over 10 years, and in 2013/14 alone the LAS provided Heartstart training courses teaching basic lifesaving skills to 19,944 people in London. Furthermore, to encourage bystanders to commence CPR, our Emergency Medical Dispatchers continue to provide instructions for compression-only CPR to callers.

Initial presenting rhythms of VF/pulseless VT have increased slightly to 21.5% from 20.6% in 2012/13. Patients presenting with VF/pulseless VT rhythms are more likely to survive, with patients in initially non-shockable rhythms having considerably poorer prognoses (see Figure 6).

The initiation of bystander CPR is crucial as the risk of asystole increases proportionally to downtime without CPR since the onset of the arrest.

Furthermore, it is imperative that bystanders have immediate access to an automated external defibrillator (AED) as early defibrillation has a positive effect on outcomes[1,2]. In 2013/14, 18 patients were delivered a shock from a public access AED prior to LAS arrival and an impressive 58.8% survived (see Appendix 5). To further support the chances of a defibrillator being available, the LAS have continued to build on the success of our existing network of public access AEDs by installing even more in public places over the past year. There are now over 2,000 sites with at least one AED present in London. The LAS supports these defibrillator sites through its Defibrillator Accreditation Scheme to ensure that all installed AEDs are maintained to the required standard and have enough people with the knowledge to use them. The LAS has also launched a major campaign entitled 'Shockingly Easy', which aims to promote public access defibrillator use and install a further 1000 AEDs across public places in London.

Survival by aetiology varies quite widely as shown in Table 4. The most frequent cause of arrests is presumed to be cardiac in nature (n=3,700) and many of the patients that survive their cardiac arrest are from this group (n=407; 11.2%). Furthermore, patients who have a presumed cardiac cause clearly evidenced by the presence of a STEMI on their ECG and are conveyed to a HAC as detailed in section 4.5 have a much higher survival rate of 47.6%. Patients in this group with an initial shockable rhythm fare better with an overall survival rate of 59.4% compared to initially non-shockable patients (13.3%). However, both figures are higher than the survival from initial shockable and non-shockable rhythms in general (36.3% versus 3.6% respectively).

Patients suffering traumatic cardiac arrests have a very low survival rate, with only three patients (out of 175) surviving to discharge in total. As part of our efforts to improve traumatic arrest outcomes the LAS have adopted a new protocol based on an algorithm aimed at ensuring the effective management of traumatic arrests[3].

It is perhaps expected that there were no survivors of the 111 patients that were in the end stages of terminal illness when resuscitation was attempted. Many of these patients have no official document detailing their wishes, making it difficult for staff to make the decisions necessary in the interests of the patient. Staff will often have to rely on a combination of evidence such as palliative care documentation, district nursing notes, or the presence of certain medication and equipment, to make an informed decision on whether to commence resuscitation. 'Co-ordinate My Care' – a national system holding details of palliative care records – has been introduced to aid staff in such decisions. In 2014/15, we hope to link this system to our MDT to ensure staff are alerted to these patients' care decisions en route to scene. We also aim to introduce palliative care nurses (supported by Marie Curie) into the Clinical Hub to help support and advise staff in these difficult circumstances on scene.

One area that still requires improvement is the frequency at which we download data from the defibrillator utilised by LAS staff. Valuable information is captured by the defibrillator that can be used to assist in ongoing patient care, provide individualised feedback to staff and for service improvement in general. A simplified and secure method of transferring event files from the defibrillator to a centralised database must be identified to resolve this issue.

Looking forward, there are major changes that will affect cardiac arrest treatment and outcomes. The most prominent of these is the introduction of the new clinical role of Advanced Paramedic

Practitioner (APP) from May 2014. Where possible, the APPs are dispatched to cardiac arrests of all causes and automatically take over primacy of care, utilising CRM to effectively manage resuscitation efforts. APPs will most likely attend at least one cardiac arrest each shift, which enables a specialism to develop as in general staff only attend a few cardiac arrests per year. The benefits of this specialised response to cardiac arrest has been trialled in a pilot study, which showed encouraging results, but we will be able to build a larger and better defined picture with the data we collect as the APP role develops[4]. APPs also carry mechanical CPR devices that aid rapid extrication to hospital in certain groups of patients without the detrimental effects of providing manual CPR whilst moving the patient and en route to hospital. Ultrasound is another tool available to APPs, enabling reversible causes such as a pulmonary embolus, coronary artery occlusion, or cardiac tamponade to be identified rapidly. APPs also have access to ventilator devices for use post ROSC to reduce the effects of hypoxaemia. In addition to these clinical skills, the APPs also provide feedback and debrief crews after each event.

The LAS will continue to actively participate in cardiac arrest research. We will provide data to the Out-of-Hospital Cardiac Arrest Outcomes (OHCAO) project aimed at building a national registry where the epidemiology and outcome of cardiac arrests can be better understood at a national and regional level. Furthermore, data from one month will be provided to the European Registry of Cardiac Arrest (EURECA ONE); the first time epidemiological, treatment and outcome data has been examined at a European level. In 2014/15, the LAS will participate in PARAMEDIC 2 - a randomised double blind controlled trial that will examine adrenaline use in cardiac arrest patients, and its impact on patient survival and neurological capacity.

We are very pleased that our survival rates continue to increase; the fact that this year represents our highest survival rates to date constitutes a great achievement for the LAS. Our efforts in the pre-hospital environment are reflected in our enhanced rate of ROSC sustained to hospital, of which our staff should be proud. We hope that the continued rollout of new initiatives for our cardiac arrest patients will build upon our current high standard of care and result in even higher survival rates in the coming years.

References

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Acknowledgements

Glossary for abbreviations and terms

Advanced Life Support – Includes skills such as advanced airway management, manual defibrillation, cannulation and drug administration.

Angiography – A procedure performed at a Heart Attack Centre to check the blood flow in the coronary arteries.

Automated External Defibrillator (AED) – A portable defibrillator that automatically diagnoses if the heart is in a rhythm that can be shocked and if so delivers a shock.

Basic Life Support – Includes skills such as CPR, manual airway positioning and AED use.

Bystander – A lay person or non-Emergency Medical Service personnel.

Complex – Each of the three LAS Areas are subdivided into several smaller operational areas known as Complexes. Please note that these do not necessarily align with Clinical Commissioning Group areas.

Defibrillators – The LAS use portable defibrillators to help diagnose the heart's rhythm and deliver a pre-set charged shock of 360J. LAS staff use both AEDs and manual defibrillators, and are able to use an override to enable CPR to be continued whilst the AED is charging.

Electrocardiogram (ECG) – The LAS use 12-lead ECGs to diagnose STEMIs.

Emergency Medical Dispatchers (EMDs) – Staff based in the LAS Emergency Operations Centre that answer 999 calls and dispatch resources to patients.

Emergency Medical Technician (EMT) – A clinical grade below that of a paramedic with 4 different levels (1-4). EMT Level 4s are able to place the SGA advanced airway in cardiac arrest patients.

Endotracheal Tube (ETT) – Type of advanced airway that some paramedic staff are able to place.

End-Tidal Carbon Dioxide ($ETCO_2$) – Measurement of gas exchange in lungs which enables a clinician to accurately tell whether an airway device has been placed correctly, and allows other information such as effectiveness of compressions and ventilations to be ascertained. ETCO2 measurement is compulsory for patients where an advanced airway has been placed.

Heart Attack Centre (HAC) – Specialist centres in London hospitals to which patients suffering a STEMI are taken directly for angiography and primary Percutaneous Coronary Intervention (pPCI).

Initial rhythm – The rhythm that the heart is in on initial presentation to LAS staff.

Mobile Data Terminal (MDT) – The device used by clinical staff to receive incoming call information and navigate to the location.

Paramedic – A majority of clinical staff are paramedics and are able to perform advanced airway management, cannulation and administration of drugs to cardiac arrest patients.

Patient Report Form (PRF) – The document used by the LAS to record all aspects of patient care and treatment.

Primary Percutaneous Coronary Intervention (pPCI) – A surgical procedure performed at a Heart Attack Centre which seeks to unblock arteries by means of insertion of a catheter into the affected artery and inflating a small balloon to re-open it. The opened artery is then held in place with a small stent.

Recognition of Life Extinct (ROLE) – The LAS will recognise if life is extinct if there are signs unequivocal with life present or there is evidence of a prolonged period of cardiac arrest with no attempt at basic life support (BLS) prior to the arrival of the LAS. ROLE can be used upon arrival of a clearly deceased patient, or after resuscitation has been attempted.

Response Category: R1 – Red 1 is used for calls where the patient is not breathing, and are classed as the most time critical. In line with national definitions, 999 call is the time at which the call is connected to the ambulance service for these calls. Red 1 forms part of a Category A - an immediately life threatening - response.

Response Category: R2 – Red 2 is used for calls where the complaint is serious but slightly less immediately time critical. In line with national definitions, 999 call is defined as the time at which the chief complaint is established or one minute elapses, whichever comes first. Red 1 forms part of a Category A - immediately life threatening - response.

Response Category: C1 to C4 – All other calls are given a Category C response based on the information provided by the caller regarding the patient's condition. The 999 call time definition is the same as R2 calls.

Return of Spontaneous Circulation (ROSC) – Refers to a return of cardiac output by the heart after a period of cardiac arrest. ROSC sustained to hospital is the most widely used measure for out-of-hospital cardiac arrests and indicates the patient had ROSC at handover to hospital staff.

Supraglottic Airway Device (SGA) – Type of advanced airway that all clinical staff from EMT4 upwards have the skill to place.

Survival to Discharge – The patient was successfully discharged from a hospital to a non-hospital environment (therefore excluding transfers from one hospital to another).

Utstein – Refers to the internationally recognised criteria for outcomes. The patients in this group are all witnessed having a cardiac arrest by a bystander, all present with an initially shockable rhythm of VF or pulseless VT and have a presumed cardiac aetiology.

Witnessed – Either seen or heard by a bystander or seen by LAS staff.

Appendix 1: Response times and patient outcomes per Complex

Cluster	Complex	Number of patients	Median times (mins)			ROSC sustained to hospital	Resuscitation attempted survival	Utstein survival
			999 call - scene	999 call - CPR^	999 call – Defibrillation#			
North West	Hillingdon	152	06:42	08:41	12:21	31.6% (48)	11.4% (17/149)	40.0% (10/25)
	Kenton	209	06:40	08:06	09:36	30.6% (64)	6.3% (13/207)	25.0% (8/32)
	Brent	240	06:56	08:12	10:04	27.9% (67)	12.3% (29/236)	37.0% (10/27)
West	Hanwell	182	06:32	08:07	10:37	33.5% (61)	14.0% (25/179)	28.6% (8/28)
	Isleworth	147	06:46	08:00	10:41	34.7% (51)	11.7% (17/145)	30.4% (7/23)
	Fulham	134	07:04	08:54	12:44	32.1% (43)	9.7% (13/134)	27.8% (5/18)
North Central	Friern Barnet	170	06:47	08:35	11:36	32.4% (55)	9.5% (16/169)	27.3% (9/33)
	Chase Farm	100	06:48	08:00	10:41	27.0% (27)	10.0% (10/100)	57.1% (4/7)
	Edmonton	226	07:01	08:20	13:06	32.3% (73)	8.0% (18/224)	25.9% (7/27)
	Camden**	196	06:38	08:52	11:52	33.2% (65)	14.4% (28/194)	39.3% (11/28)
East Central	City & Hackney	149	06:39	08:05	13:07	25.5% (38)	4.1% (6/145)	4.8% (1/21)
	Newham	133	06:08	07:38	13:36	29.3% (39)	6.8% (9/132)	27.3% (3/11)
	Tower Hamlets	86	06:55	07:57	10:42	31.4% (27)	12.9% (11/85)	54.5% (6/11)
North East	Whipps Cross*	307	06:35	07:55	10:20	33.6% (103)	10.6% (32/301)	29.6% (8/27)
	Romford	217	06:57	08:34	12:39	35.9% (78)	6.7% (14/208)	14.3% (3/21)
South East	Greenwich	202	06:09	07:41	10:42	35.6% (72)	14.9% (30/202)	48.1% (13/27)
	Bromley	202	06:16	08:06	11:20	26.7% (54)	11.4% (23/201)	39.4% (13/33)
	Barnehurst	165	06:43	08:17	11:35	28.5% (47)	12.2% (20/164)	40.0% (8/20)
	Deptford**	302	06:37	08:13	11:26	27.5% (83)	12.6% (37/293)	45.2% (19/42)
South West	New Malden	146	07:00	08:23	13:23	36.3% (53)	8.4% (12/143)	21.1% (4/19)
	St Helier	177	06:15	08:19	12:35	33.9% (60)	12.9% (22/171)	43.8% (14/32)
	Wimbledon	121	05:55	07:13	09:07	34.7% (42)	11.8% (13/110)	33.3% (5/15)
	Croydon	224	06:52	08:08	11:32	26.3% (59)	5.9% (13/220)	23.3% (7/30)

^ 999 call - CPR calculations exclude arrests witnessed by LAS staff.
# 999 call - defibrillation calculations are based on patients with an initial rhythm of VF/VT only.
* Whipps Cross Complex falls under both North East and East Central clusters - but has been included solely under North East in this table.
** Due to Complex mergers part way through the year, Islington Complex figures are included in Camden Complex. Waterloo and Oval Complex figures are included in Deptford Complex.

Appendix 2: Survival per Hospital

Hospital	2011/12[+] Number of Patients	2011/12[+] Survival with ROSC sustained to hospital		2012/13[+] Number of Patients	2012/13[+] Survival with ROSC sustained to hospital		2013/14[+] Number of Patients	2013/14[+] Survival with ROSC sustained to hospital	
Barnet	78	7.7%	(2/26)	60	10.0%	(2/20)	58	24.2%	(8/33)
Central Middlesex	37	10.0%	(1/10)	20	0%	(0/6)	21	0.0%	(0/1)
Charing Cross	36	30.0%	(3/10)	46	33.3%	(9/27)	43	47.1%	(8/17)
Chase Farm *	47	23.1%	(3/13)	55	8.0%	(2/25)	24	36.4%	(4/11)
Chelsea & Westminster	44	27.8%	(5/18)	24	17.6%	(3/17)	40	25.0%	(4/16)
Croydon	133	25.0%	(12/48)	117	14.3%	(7/49)	104	6.1%	(2/33)
Darent Valley	17	28.6%	(2/7)	17	33.3%	(2/6)	15	16.7%	(1/6)
Ealing	56	27.6%	(8/29)	63	3.8%	(1/26)	76	18.5%	(5/27)
Hammersmith	156	57.5%	(46/80)	113	40.5%	(32/79)	119	49.4%	(40/81)
Harefield	36	56.7%	(17/30)	41	40.5%	(15/37)	36	40.0%	(12/30)
Hillingdon	100	18.0%	(9/50)	84	33.3%	(14/42)	82	29.7%	(11/37)
Homerton	43	11.1%	(2/18)	59	23.1%	(6/26)	35	10.0%	(1/10)
King's College	159	46.6%	(41/88)	180	32.0%	(32/100)	181	51.1%	(46/90)
King George	66	10.5%	(2/19)	61	6.5%	(2/31)	69	16.7%	(5/30)
Kingston	67	20.0%	(6/30)	63	9.5%	(4/42)	63	4.0%	(1/25)
London Chest	69	66.1%	(39/59)	87	45.8%	(33/72)	107	47.3%	(43/91)
Newham	103	15.6%	(5/32)	88	14.8%	(4/27)	81	11.1%	(2/18)
North Middlesex	82	38.2%	(13/34)	89	18.9%	(10/53)	107	14.3%	(6/42)
Northwick Park	114	13.6%	(6/44)	152	7.7%	(5/65)	127	9.3%	(4/43)
Princess Royal	79	14.8%	(4/27)	64	19.4%	(6/31)	87	31.4%	(11/35)
Queen Elizabeth	128	27.3%	(12/44)	121	34.5%	(20/58)	133	29.6%	(16/54)
Queen's	125	5.3%	(2/38)	166	14.9%	(7/47)	146	12.3%	(7/57)
Royal Free	89	46.7%	(28/60)	115	45.2%	(33/73)	129	38.8%	(31/80)
Royal London	92	34.2%	(13/38)	98	30.8%	(12/39)	100	20.0%	(8/40)
St George's	150	37.4%	(34/91)	171	37.9%	(36/95)	188	42.6%	(46/108)
St Helier	63	7.1%	(2/28)	59	4.3%	(1/23)	59	9.1%	(2/22)
St Mary's	62	23.8%	(5/21)	68	11.1%	(3/27)	73	32.0%	(8/25)
St Thomas'	97	36.6%	(15/41)	89	40.0%	(16/40)	97	42.0%	(21/50)
The Heart	19	76.5%	(13/17)	21	72.2%	(13/18)	24	70.0%	(14/20)
University College Hospital	41	33.3%	(6/18)	62	28.6%	(6/21)	51	42.1%	(8/19)
Lewisham	106	28.2%	(11/39)	100	26.7%	(8/30)	79	20.8%	(5/24)
West Middlesex	103	20.5%	(8/39)	91	25.0%	(9/36)	85	29.0%	(9/31)
Whipps Cross	115	18.2%	(6/33)	98	7.3%	(3/41)	106	21.2%	(11/52)
Whittington	37	22.2%	(2/9)	70	31.0%	(9/29)	51	19.2%	(5/26)
Other Hospitals	8	0.0%	(0/4)	3	-	-	9	50.0%	(2/4)

+ Denominators exclude patients with unknown survival outcomes.
*Please note that Chase Farm A&E closed on the 9th December 2013.

Appendix 3: Rhythm and survival per Heart Attack Centre for post ROSC patients with a STEMI

Heart Attack Centre	Number of Patients	Initial Rhythm			Survival to discharge[+]
		Asystole	**VF/VT**	**PEA**	
Hammersmith	42	16.7% (7)	66.6% (28)	16.7% (7)	52.5% (21/40)
Harefield	26	26.9% (7)	65.4% (17)	7.7% (2)	42.3% (11/26)
King's College	44	13.6% (6)	77.3% (34)	9.1% (4)	52.3% (23/44)
London Chest	72	12.5% (9)	72.2% (52)	15.3% (11)	36.6% (26/71)
Royal Free	43	9.3% (4)	76.7% (33)	14.0% (6)	47.6% (20/42)
St George's *	37	13.9% (5)	75.0% (27)	11.1% (4)	51.4% (18/35)
St Thomas'	20	10.0% (2)	85.0% (17)	5.0% (1)	58.8% (10/17)
The Heart	13	-	84.6% (11)	15.4% (2)	61.5% (8/13)

* One patient had no initial rhythm documented.
+ *Denominators exclude patients with unknown survival outcomes.*

Appendix 4: Patient characteristics, response times, and outcomes per Clinical Commissioning Group

Incident CCG	Number of Patients	Age	Male %	Median 999 Call - Scene (mins)	Bystander CPR*		ROSC sustained to hospital	Survived to discharge[+]	
Barking & Dagenham	101	65	63.4% (64)	06:34	51.3%	(39/76)	34.7% (35)	8.2%	(8/97)
Barnet	200	69	57.0% (114)	07:13	56.9%	(95/167)	38.0% (76)	9.0%	(18/199)
Bexley	123	72	63.4% (78)	06:44	52.6%	(51/97)	33.3% (41)	9.8%	(12/123)
Brent	162	67	66.7% (108)	06:52	64.2%	(86/134)	26.5% (43)	8.1%	(13/161)
Bromley	206	70	61.7% (127)	06:25	50.6%	(85/168)	32.0% (66)	15.1%	(31/205)
Camden	127	63	66.9% (85)	05:51	58.3%	(63/108)	31.5% (40)	18.1%	(23/127)
Central London	122	59	74.6% (91)	07:10	59.0%	(62/105)	36.1% (44)	14.3%	(17/119)
City & Hackney	111	64	64.9% (72)	06:15	63.0%	(58/92)	22.5% (25)	3.7%	(4/108)
Croydon	190	67	60.0% (114)	06:39	61.0%	(94/154)	24.7% (47)	5.3%	(10/189)
Ealing	195	65	65.1% (127)	06:42	55.8%	(87/156)	32.8% (64)	12.6%	(24/190)
Enfield	182	67	62.6% (114)	06:57	56.9%	(87/153)	24.7% (45)	8.9%	(16/180)
Greenwich	142	65	58.5% (83)	05:59	50.9%	(59/116)	31.0% (44)	14.8%	(21/142)
Hammersmith & Fulham	72	64	69.4% (50)	06:49	60.0%	(36/60)	27.8% (20)	12.5%	(9/72)
Haringey	127	63	64.6% (82)	06:57	40.4%	(42/104)	33.1% (42)	7.1%	(9/126)
Harrow	121	67	64.5% (78)	06:40	55.2%	(53/96)	24.8% (30)	7.5%	(9/120)
Havering	160	71	58.8% (94)	06:58	56.0%	(70/125)	37.5% (60)	9.7%	(15/154)
Hillingdon	168	68	63.7% (107)	06:23	58.6%	(78/133)	34.5% (58)	10.8%	(18/166)
Hounslow	153	64	64.7% (99)	07:15	47.7%	(61/128)	34.0% (52)	12.5%	(19/152)
Islington	98	60	55.1% (54)	07:11	59.8%	(49/82)	38.8% (38)	13.7%	(13/95)
Kingston	72	72	69.4% (50)	06:53	49.2%	(29/59)	36.1% (26)	7.5%	(5/67)
Lambeth	157	63	63.1% (99)	06:38	50.8%	(64/126)	25.5% (40)	9.7%	(15/155)
Lewisham	116	64	58.6% (68)	06:18	56.4%	(53/94)	22.4% (26)	9.6%	(11/114)
Merton	91	68	65.9% (60)	06:30	62.5%	(45/72)	35.2% (32)	11.8%	(10/85)
Newham	161	64	59.6% (96)	06:30	54.3%	(70/129)	24.2% (39)	4.4%	(7/159)
Redbridge	162	67	65.4% (106)	06:32	66.2%	(88/133)	37.0% (60)	9.5%	(15/158)
Richmond	63	68	63.5% (40)	07:03	66.1%	(37/56)	23.8% (15)	4.8%	(3/62)
Southwark	146	64	62.3% (91)	06:48	36.3%	(45/124)	26.0% (38)	14.2%	(20/141)
Sutton	110	69	60.0% (66)	07:00	59.0%	(49/83)	34.5% (38)	12.3%	(13/106)
Tower Hamlets	94	63	77.7% (73)	06:09	60.8%	(48/79)	37.2% (35)	12.1%	(11/91)
Waltham Forest	134	69	60.4% (81)	06:56	60.2%	(62/103)	33.6% (45)	10.5%	(14/133)
Wandsworth	136	63	63.2% (86)	06:14	56.5%	(65/115)	36.8% (50)	11.6%	(15/129)
West London	106	67	59.4% (63)	06:42	53.3%	(48/90)	26.4% (28)	7.6%	(8/105)
Out of London	9	64	55.6% (5)	10:26	100.0%	(9/9)	44.4% (4)	0%	(0/9)

LAS staff witnessed arrests are excluded from bystander CPR analysis.
+ Denominators exclude patients with unknown survival outcomes.

Appendix 5: Defibrillators in public places

Across London there are 2,322 active sites where at least one Public Access Defibrillator (PAD) is present for use by members of the public. In 2013/14, there were 27 occasions where the defibrillator was brought to a patient's side for use in cardiac arrest. For 9 cases the defibrillator pads were applied to a patient but no shock given, either due to the presence of a non-shockable rhythm or the arrival of ambulance personnel on scene. The defibrillator pads were applied and at least one shock delivered to 18 patients; further information is presented in the table below.

Patient Demographics	
Number of patients:	18
Average age:	65
Age range:	52-81
Gender:	Male (83.3%; n=15) Female (16.7%; n=3)

Event Information	
Bystander witnessed:	83.3%; n=15
Bystander CPR:	94.4%; n=17
Average number of PAD shocks:	2
Range of PAD shocks:	1-6
ROSC sustained to hospital:	77.8%; n=14
Survival to discharge[+]:	58.8%; n=10/17

+ Denominator excludes patients with unknown survival outcomes (n=1).

Appendix 6: Cardiac arrest patients under 35 years old

	Under 1	1-8	9-18	19-35
Number of patients:	58	34	29	215
Gender:				
Male	56.9% (33)	58.8% (20)	55.2% (16)	67.0% (144)
Female	41.4% (24)	41.2% (14)	44.8% (13)	33.0% (71)
Unknown	1.7% (1)	-	-	-
Arrest location:				
Private	89.7% (52)	88.2% (30)	62.1% (18)	66.0% (142)
Public	10.3% (6)	11.8% (4)	37.9% (11)	34.0% (73)
Witnessed:				
Bystander	20.7% (12)	26.5% (9)	34.5% (10)	36.3% (78)
LAS staff	8.6% (5)	11.8% (4)	13.8% (4)	13.5% (29)
Unwitnessed	69.0% (40)	61.7% (21)	51.7% (15)	50.2% (108)
Not Documented	1.7% (1)	-	-	-
Bystander CPR*:				
Yes	58.5% (31/53)	53.3% (16/30)	80.0% (20/25)	57.5% (107/186)
No	41.5% (22/53)	46.7% (14/30)	20.0% (5/25)	42.5% (79/186)
Rhythm:				
Asystole	75.9% (44)	82.4% (28)	48.3% (14)	65.1% (140)
PEA	8.6% (5)	11.8% (4)	27.6% (8)	15.4% (33)
VF/ Pulseless VT	-	2.9% (1)	24.1% (7)	18.1% (39)
Not Documented	15.5% (9)	2.9% (1)	-	1.4% (3)
ROSC sustained to hospital:				
Yes	3.4% (2)	5.9% (2)	37.9% (11)	28.8% (62)
No	96.6% (56)	94.1% (32)	62.1% (18)	71.2% (153)
Survived to discharge[+]:				
Yes	5.4% (3/56)	0% (0/34)	14.8% (4/27)	13.4% (28/209)
No	94.6% (53/56)	100% (34/34)	85.2% (23/27)	86.6% (181/209)

LAS staff witnessed arrests are excluded from bystander CPR analysis.
+ Denominators exclude patients with unknown survival outcomes.