London Ambulance Service NHS Trust

Cardiac Arrest Annual Report: 2015/16

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Produced by:

Gurkamal Virdi, Scott Picton, Rachael Fothergill and Mark Whitbread

✉ 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

- During 2015/16, the London Ambulance Service NHS Trust (LAS) attended 10,116 patients in out-of-hospital cardiac arrest and attempted to resuscitate 4,389 of these.
- Survival rates remained consistent with the previous year with 9.0% of all patients where resuscitation was attempted surviving to hospital discharge and 31.5% surviving amongst the Utstein comparator group. These rates reflect the commitment of our staff in the pre-hospital management of cardiac arrest, as well as those of our colleagues at hospital.
- For patients whose arrest was witnessed by LAS clinicians (n=745), the overall Return of Spontaneous Circulation (ROSC) sustained to hospital and survival to discharge rates increased to 37.4% and 18.4% respectively (from 36.5% and 16.8% in 2014/15).
- Survival to hospital discharge rates for those conveyed to a Heart Attack Centre as part of a specialist pathway remains high at 48.9% (n=149/305).
- ROSC and survival to discharge rates when an APP was in attendance for a select group of patients (n= 1,289) were 34.2% and 11.3% respectively.
- A small reduction in ROSC sustained to hospital of 1.5% (to 29.9%) was observed for all patients who had resuscitation attempted and 1.7% (to 53.4%) within the Utstein comparator group.
- An initial shockable arrest rhythm was present in 19.3% of patients; a slight increase of 0.6% on the previous year.
- The average response time was 7 minutes and 47 seconds.
- 60.6% of those allocated a Red 1 category received a response within 8 minutes.
- Presumed cardiac aetiology remained the most prevalent cause of cardiac arrest (81.4%).
- The proportion of arrests with bystander initiated cardiopulmonary resuscitation (CPR) remains high at 62.2%. This is a slight reduction of 0.9% from the previous year and is the first time that the rate of bystander CPR has decreased since the LAS cardiac registry was established in 1998.
- Public access defibrillators were used to deliver at least one shock to 88 patients. Of these patients 73.9% sustained ROSC to hospital and 57.3% survived to be discharged from hospital.

1. Introduction

From 1st April 2015 to 31st March 2016 the London Ambulance Service NHS Trust (LAS) attended 10,116 patients who had suffered an out-of-hospital cardiac arrest. LAS clinicians attempted to resuscitate 4,389 (43.4%) patients. Resuscitation efforts were not undertaken on 5,727 (56.6%) patients, the vast majority of whom (n=4,687) were recognised as deceased on arrival of the LAS. 1,040 patients had a Do Not Attempt CPR (DNA-CPR) order, advanced directive or similar equivalent in place, or the patient's death was expected.

Data were sourced from the LAS cardiac arrest registry, which captures information from a range of clinical and operational sources including: Patient Report Forms (PRFs), vehicle Mobile Data Terminals (MDTs), 999 call logs and defibrillator data. Survival to hospital discharge information was collected using hospital patient records and national databases.

Appendix 1 presents patient demographic and outcome information for the area in which the cardiac arrest occurred. Survival figures for each receiving hospital can be found in Appendix 2. Appendix 3 is dedicated to the specific group of patients that were conveyed to a Heart Attack Centre (HAC) following successful resuscitation. Finally, Appendix 4 focuses on those under the age of 35.

A glossary of abbreviations and terms are included on page 11 for readers unfamiliar with the terminology used.

This report presents information regarding our clinical care and the outcomes of the 4,389 patients where resuscitation was attempted.

2. Overview of all patients where resuscitation was attempted

Table 1 (overleaf) provides an overview of patient demographics, clinical presentation, call and response information, and interventions provided by the LAS for patients where resuscitation was attempted.

The largest proportion of cardiac arrests patients were male (64.8%, n=2,845). The average age was 65, with males being on average 7 years younger than females (62 vs. 69). Three-quarters of cardiac arrests occurred in a private location, with the vast majority occurring at home.

In line with previous reports, two-thirds of arrests were witnessed: 49.1% (n=2,154) by a layperson/bystander and 17.1% (n=745) by LAS clinicians. Bystander CPR was performed on 62.2% (n=2,267) of patients, which was a slight decrease of 0.9% on the previous year's figure of 63.1%.

The average response time for all cardiac arrest patients was 7 minutes and 47 seconds. Nearly two-thirds (n=2,860) of patients were allocated a Red 1 response, 60.6% of whom received a response within 8 minutes.

Recognition of Life Extinct was undertaken on-scene by LAS staff or other Healthcare Professionals in 41.9% (n=1,840) of arrests. The remaining 58.1% (n=2,549) of patients were conveyed to hospital either with a cardiac output or with ongoing CPR.

Gender	
Male	64.8%; n=2,845
Female	35.1%; n=1,542
Unknown	0.1%; n=2

Age mean (median) in years	
Overall average	65 (68)
Male average	62 (65)
Female average	69 (74)

Race^□	
White	60.4%; n=2,649
Asian	7.6%; n=333
Black	7.3%; n=322
Mixed	0.2%; n=9
Other	4.3%; n=187
Unable to obtain	18.1%; n=794
Not documented	2.2%; n=95

Peak occurrence	
Time of day (hours)	08:00-11:59 22.3%; n=978
Day	Sunday/Monday 14.9%; n=653
Month	January 9.5%; n=419

Chief complaint (top 3)	
Cardiac arrest	50.9%; n=2,236
Unconscious/fainting	15.1%; n=661
Breathing problems	8.4%; n=368
Other	25.6%; n=1,124

Response times (mins)	
999 call - scene	07:47
999 call - CPR[#]	09:42
999 call - defibrillation[◊]	12:23

Response category□	
R1	65.2%; n=2,860
R2	28.9%; n=1,268
C1	1.2%; n=52
C2	3.0%; n=130
C3	1.3%; n=56
C4	0.5%; n=22

** Airway management refers to the application of an advanced airway intervention by LAS staff or other Healthcare Professionals.*

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

Location	
Private	76.0%; n=3,336
Public	24.0%; n=1,053

Private location breakdown	
Home	90.4%; n=3,015
Care home	9.6%; n=321

Public location breakdown	
Street	46.5%; n=490
Work	9.6%; n=101
Healthcare facility	8.5%; n=89
Public transport	6.3%; n=66
Social venue	5.3%; n=56
Shop/bank	4.8%; n=51
Park/Wood/River	4.2%; n=44
Hotel/Hostel	3.5%; n=37
Leisure centre/sports club	3.3%; n=35
Airport	2.5%; n=26
Other	5.5%; n=58

Witnessed□	
Bystander	49.1%; n=2,154
LAS	17.0%; n=745
Unwitnessed	33.8%; n=1,482
Not documented	0.2%; n=8

Bystander CPR (excl. LAS Witnessed)[#]	
Yes	62.2%; n=2,267/3,644
No	37.8%; n=1,377/3,644

Mechanical CPR□	
By APP	15.7%; n=690
By Team Leader/ other	8.3%; n=366
No	75.9%; n=3,333

Airway management*	
Airway placed	89.5%; n=3,928/4,389
ETT success rate	86.1%; n=1,411/1,639
SGA success rate	92.4%; n=3,142/3,401
$ETCO_2$ measured	98.3%; n=3,862/3,928

Resuscitation terminated on scene	
Yes, by LAS	39.7%; n=1,742
Yes, by other Healthcare Professional	2.2%; n=98
No	58.1%; n=2,549

~ Response category is not available for one case.

^View with caution as information is not reliably obtainable.

Table 1 – Overview of all cases where resuscitation was attempted (n=4,389).

3. Return of Spontaneous Circulation (ROSC) and Survival

3.1. Overall ROSC and survival rates

ROSC was sustained to arrival at hospital for 29.9% (n=1,311/4,389) of patients who had resuscitation was attempted. This figure represents a slight (1.5%) decrease from the previous year (see Figure 2). When compared to other English Ambulance Services our level of ROSC sustained to hospital is within the top 3 in the country (see Figure 4).

ROSC sustained to hospital	
Yes	29.9%; n=1,311
No	70.1%; n=3,077
Not Documented	0%; n=1

Table 2 – ROSC sustained to hospital where resuscitation was attempted.

The 9.0% rate of survival to hospital discharge has been maintained from 2014/15. Figure 4 shows that this rate is comparable to other English Ambulance Services and above the national average.

Survived to discharge [+]	
Yes	9.0%; n=388/4,317
No	91.0%; n=3,929/4,317

[+] *Denominator excludes patients with unknown survival outcomes (n=72).*

Table 3 – Survival to hospital discharge where resuscitation was attempted.

3.2. Utstein comparator group

The Utstein survival calculation[1,2] examines patients where resuscitation was attempted and where: the arrest was of a presumed cardiac aetiology, bystander witnessed, and in a shockable rhythm (VF/ VT) on arrival of the LAS.

Figure 1 shows that ROSC was sustained to hospital for 53.4% (n=299/560) of patients; a decrease of 1.7% from 55.1% reported in the previous year (see Figure 2). Again, the ROSC rate remains above the national average.

The survival to discharge rate has remained stable from the previous year with 31.5% (n=171/542) of patients in the Utstein group surviving to leave hospital alive (see Figure 1&3). The LAS performs favourably in comparison to other English Ambulance Services with only two other Services exceeding a 30% survival rate (see Figure 4).

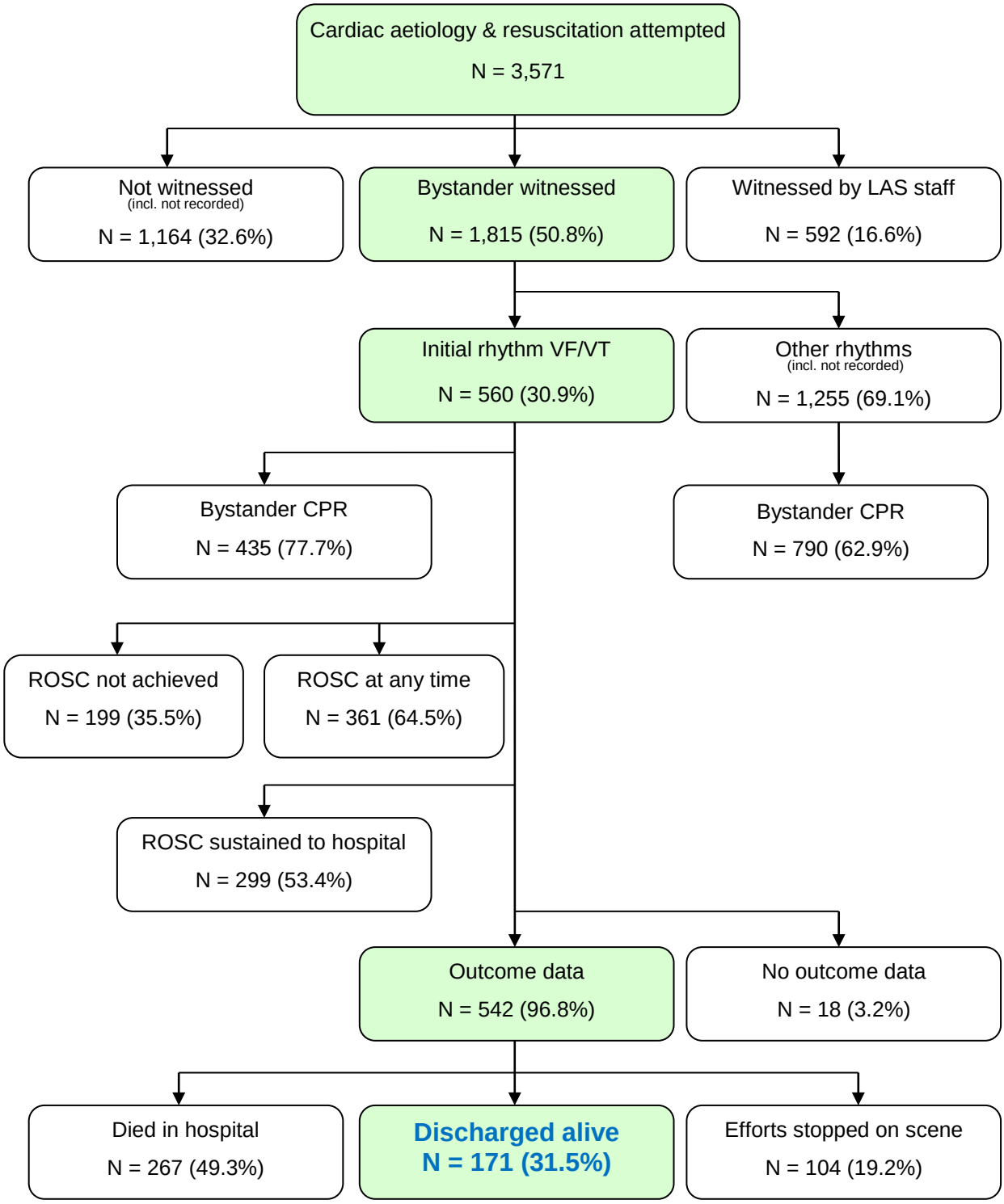

Figure 1 – Outcome for the Utstein comparator group

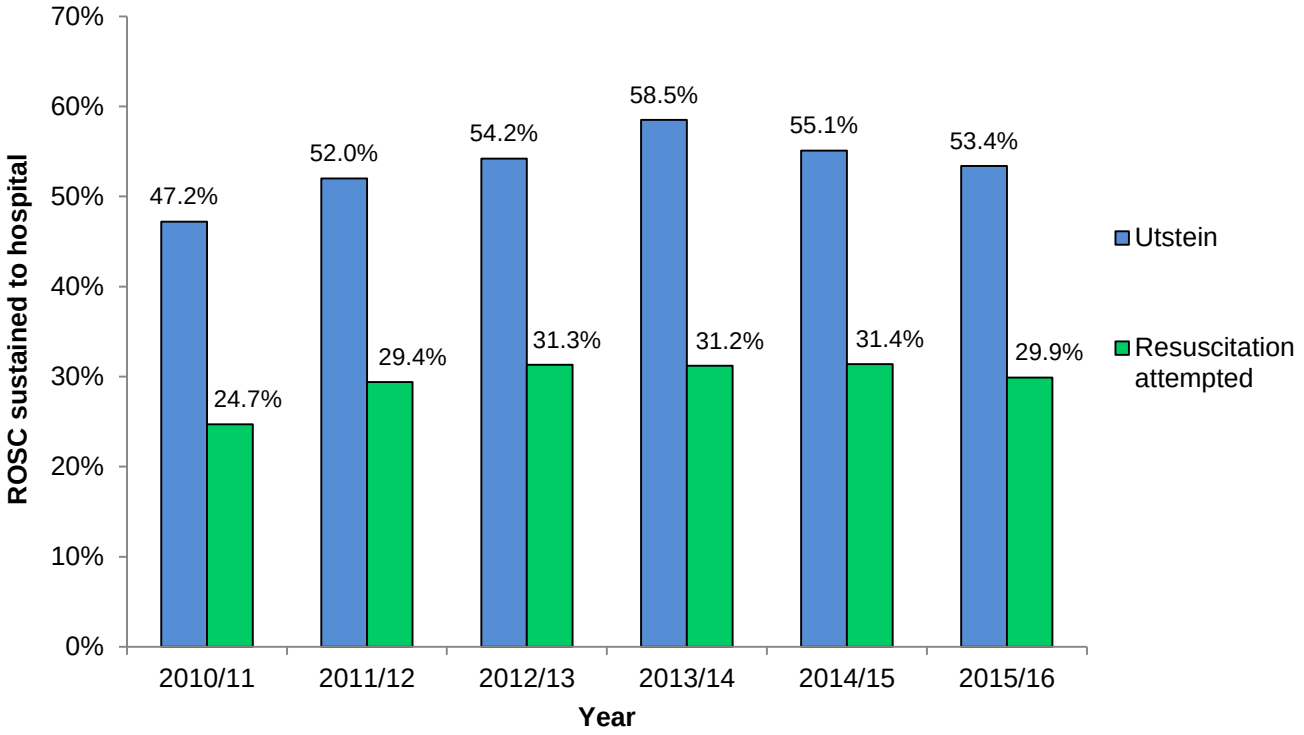

Figure 2 – ROSC sustained to hospital for the Utstein comparator group and all resuscitation attempted patients by year.

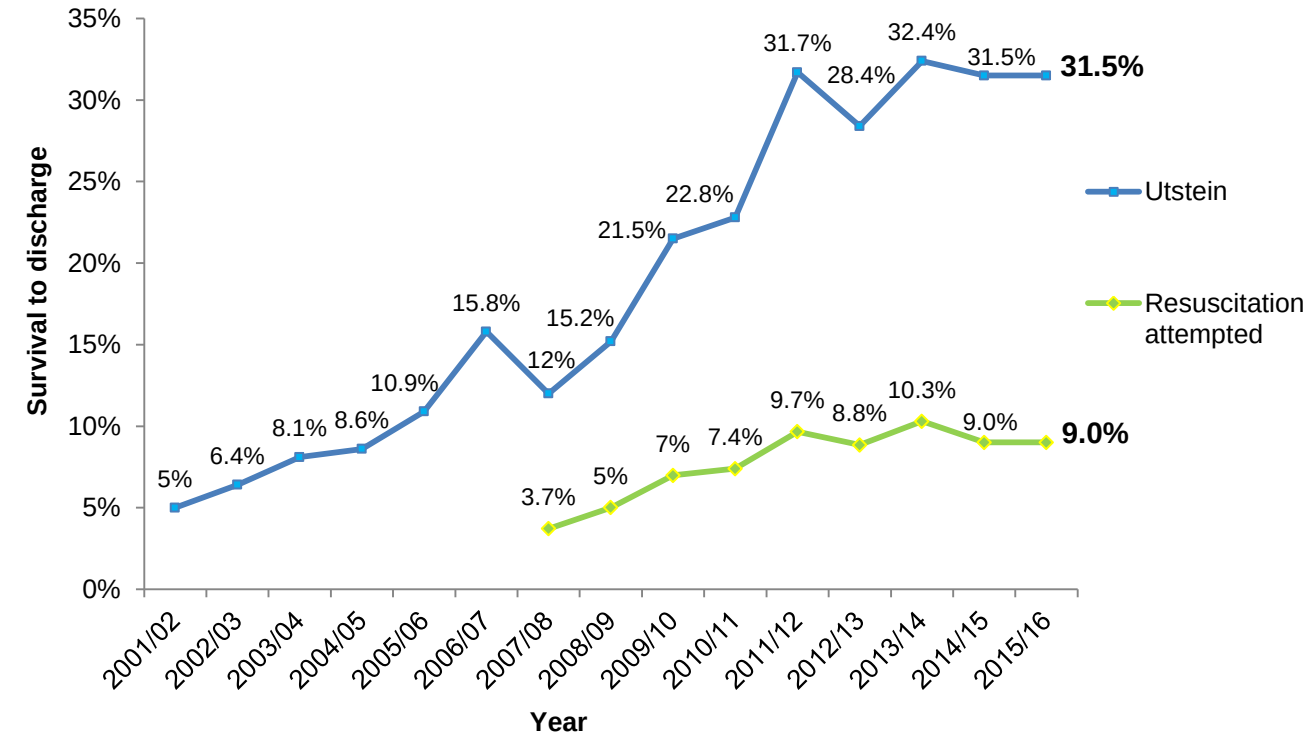

Figure 3 – Survival to discharge for the Utstein comparator group and all resuscitation attempted patients by year.

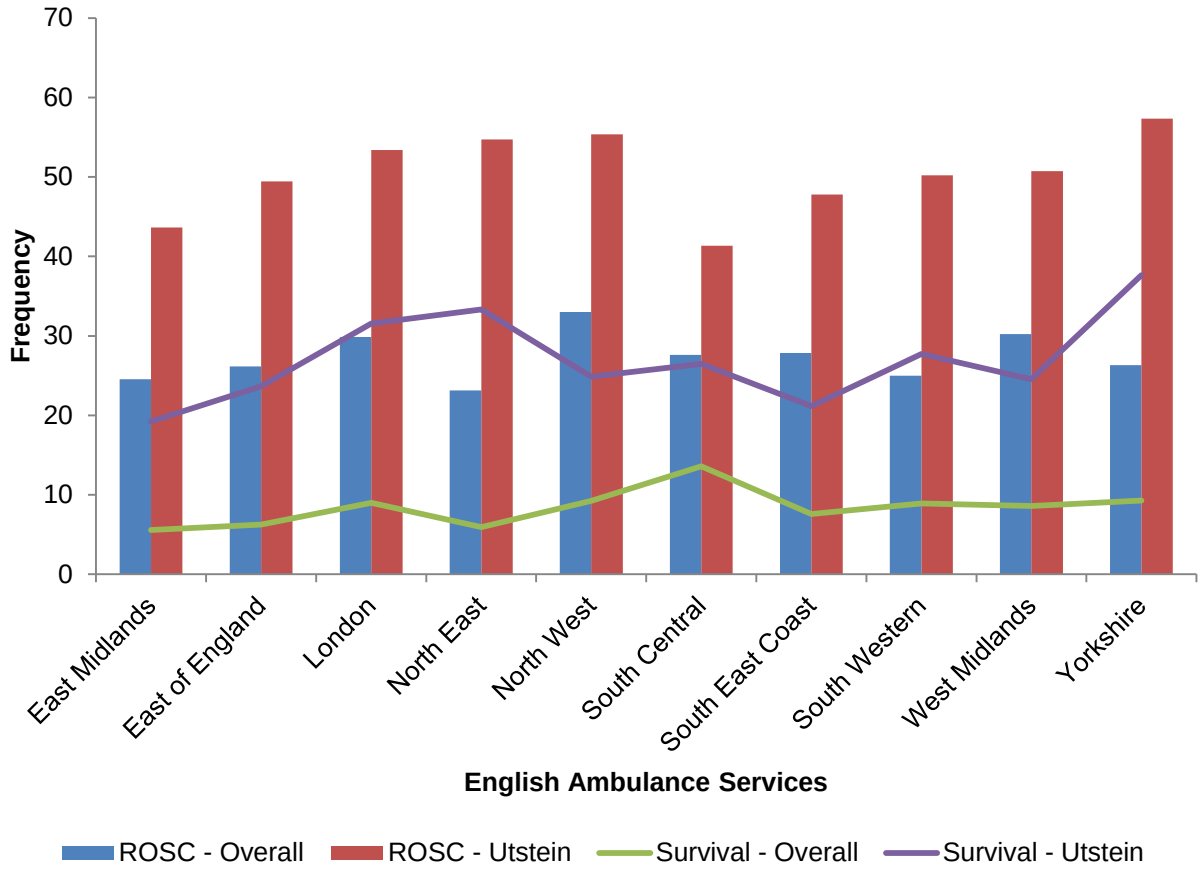

Figure 4 – ROSC sustained to hospital and survival comparisons to English Ambulance Services

4. Initial rhythm

An initial shockable rhythm of ventricular fibrillation or pulseless ventricular tachycardia (VF/VT) was present in 849 of the 4,389 patients (19.3%). Of the non-shockable rhythms, asystole was present in 2,331 (53.1%) patients and pulseless electrical activity (PEA) in 1,151 (26.2%). The initial rhythm was not recorded for 58 (1.3%) patients. Table 4 below shows that patients with an initial rhythm of VF/VT have considerably higher rates of ROSC and survival (54.4% and 34.3% respectively).

Initial rhythm*	n	ROSC sustained to hospital	Survival to discharge
Asystole	2,331	19.9%; n=465/2,331	1.0%; n=24/2,308
PEA	1,151	30.5%; n=351/1,151	5.6%; n=63/1,132
VF/VT	849	54.4%; n=462/849	34.3%; n=282/822

** Initial rhythm not documented in 58 cases.*

+ Denominator excludes patients with unknown survival outcomes (n=72).

Table 4 – Initial rhythm compared with ROSC sustained to hospital and survival to hospital discharge rates

5. Aetiology

Presumed cardiac aetiology was the predominant cause of cardiac arrest (81.4%; n=3,571). There has been a marked rise in the number of patients recognised to have other medical causes for their arrest (such as respiratory conditions/failure, glycaemic or metabolic, neurological issues, sepsis/infection and internal haemorrhage). This year 299 patients were identified with this year compared to 159 previously. The remaining aetiologies include trauma from external causes (such as penetrating and blunt injuries), asphyxia (such as respiratory obstruction and asphyxiation from hangings or suffocation), drowning, electrocution and overdose. Table 5 shows the disparate ROSC and survival rates for the various aetiologies.

Aetiology	n	ROSC sustained to hospital	Survived to discharge[+]
Presumed cardiac	3,571	30.8%; n=1,101	9.8%; n=344/3,512
Other Medical[⊗]	299	20.1%; n=60	4.7%; n=14/296
Trauma[⊗]	222	14.0%; n=31	2.7%; n=6/219
Asphyxial[⊗]	178	41.6%; n=74	5.2%; n=9/174
Overdose	102	39.2%; n=40	11.1%; n=11/99
Drowning	16	31.3%; n=5	25.0%; n=4/16
Electrocution	1	0%; n=0	0%; n=0/1

+ Denominators exclude patients with unknown survival outcomes.

[⊗]*This data cannot be compared with previous years due to differences in classification of aetiology following updated Utstein definitions.*

Table 5 – ROSC sustained to hospital and survival to hospital discharge rates by aetiology.

6. EMS only witnessed arrests

LAS staff witnessed 745 patients enter into cardiac arrest. 37.4% (n=279) achieved a ROSC that was sustained to hospital and 18.4% (n=133/723) survived to be discharged. Both rates are an improvement on the previous year; ROSC increased by 0.9% (from 36.5% in 2014/15) and survival by 1.6% (from 16.8% in 2014/15). Table 6 below shows the outcomes of patients by the initial presenting arrest rhythm.

LAS witnessed arrest rhythms*	n	ROSC sustained to hospital		Survived to discharge[+]	
Asystole	187	31.0%; n=58	(↑ 2.1%)	4.9%; n=9/183	(↓ 0.6%)
PEA	380	27.1%; n=103	(↑ 0.9%)	7.6%; n=28/369	(↑ 1.8%)
VF/ VT	155	68.4%; n=106	(↑ 3.2%)	59.5%; n=88/148	(↑ 5.7%)
All patients	745	37.4%; n=279/745	(↑ 0.9%)	18.4%; n=133/723	(↑ 1.6%)

** Initial rhythm not recorded in 23 cases.*

+ Denominator excludes patients with unknown survival outcomes

Table 6 – Outcome of LAS witnessed arrests.

Table 6 shows that the levels of ROSC sustained to hospital have increased across all rhythms with the greatest improvement for patients with VF/ VT - up by 3.2% to 68.4% (from 65.2% in 2014/15). With the exception of asystolic rhythms, survival to discharge increased with the largest improvement being observed amongst those presenting in VF/ VT (up by 5.7% to 59.5% from 53.8% in 2014/15) and 1.8% increase for PEA to 7.6% (from 5.8% in 2014/15).

7. Advanced Paramedic Practitioners (APPs)

Advanced Paramedic Practitioners (APPs) manage resuscitation efforts and provide enhanced care to patients. They are dispatched to cardiac arrests either automatically or following a comprehensive triage by an APP based in the Emergency Operations Centre (EOC) which ensures that an APP attends those who are most likely to benefit from advanced skills. In 2015/16, an APP was present with primacy of care in 1,289 of cases – a figure that has more than doubled since 2014/15. An overview of some of the additional assessment and interventions provided by APPs is presented in Table 7 below.

For patients where an APP was present, ROSC sustained to hospital rates were 34.2% (n=441) and survival to discharge rates were 11.3% (n=144/1270). Of note, an initial presenting rhythm of VF/VT was present in 27.0% (n=348/1289) of cases which is almost 8% higher than the rate reported for all resuscitation attempted patients (see section 4).

APP skills and patient outcomes	
Mechanical CPR:	53.5%; n=690
Ultrasound	37.8%; n=487
Double Sequential Defibrillation	1.5%; n=19
ROSC sustained to hospital	34.2%; n=441
Survival to discharge[+]	11.3%; n=144/1,270

+ Denominator excludes patients with unknown survival outcomes (n=19)

Table 7 – APP skills and patient outcomes.

8. Public Access Defibrillator (PAD) use

A PAD was deployed by members of the public to 143 cardiac arrest incidents, which is an increase from 116 in the previous year. In 55 cases the defibrillator was not used as it was either not indicated or ambulance staff arrived on scene prior to its use. For the remaining 88 deployments the defibrillator was applied and at least one shock delivered to the patient. Further information for patients where the defibrillator was used is given in Table 8 overleaf:

PAD use	
Bystander witnessed	96.6%; n=85
Bystander CPR	100%; n=88
ROSC sustained to hospital	73.9%; n=65
Survival to discharge[+]	57.3%; n=47/82

+ Denominator excludes patients with unknown survival outcomes (n=6)

Table 8 – PAD use and patient outcomes.

This year there has been considerable improvement in rates of bystander witnessed arrests and bystander CPR for patients where a PAD was used. Bystander witnessed rates have increased by 29.5% to 96.6% (from 67.1%), with bystander CPR undertaken in 100% of cases (an increase of 28.8% from 71.2%). There was a reduction in ROSC sustained to hospital by 2.8% (from 76.7%) and survival to discharge rates were marginally lower by 1.3% (from 58.6%).

9. Resuscitated patients conveyed to Heart Attack Centres (HACs)

During 2015/16, 317 cardiac arrest patients who had a STEMI achieved a stable ROSC on-scene and were conveyed directly to a HAC. The vast majority of patients had an initial rhythm of VF/ VT (66.9%; n=212), with asystole presenting in 18.0% (n=57) of cases and PEA in 14.8% (n=47). Survival to discharge for patients within this specialist pathway remains higher than other groups at 48.9% (n=149/305), although this is a marginal decrease of 0.7% on the previous year's rate of 49.6%.

A breakdown of survival and initial rhythm for these patients by all London HACs can be found in Appendix 3.

10. Discussion

The survival rates reported demonstrate that we have continued to provide a high standard of cardiac care and are maintaining outcomes for patients who have had an out-of-hospital cardiac arrest in London. Survival to hospital discharge rates have remained constant at 9.0% for all patients where resuscitation was attempted and at 31.5% for the Utstein comparator group. These rates reflect the commitment of our staff in the pre-hospital care and management of cardiac arrest, and of our colleagues at hospital who provide the ongoing treatment required to enable patients to leave hospital alive.

A small reduction in ROSC sustained to hospital rates (1.5% overall and 1.7% for the Utstein comparator group) was observed. It is possible that these reduced ROSC rates are reflective of our on-scene cardiac arrest management. Our clinicians are continuing to ensure that patients are conveyed to hospital only when appropriate and are remaining on scene to manage cardiac arrests where no reversible causes have been identified. As such, there has been a greater proportion of patients who have been recognised as life extinct on scene by both LAS staff and other Healthcare Professionals (41.9% vs 36.9% in 2014/15).

A further contributing factor to the reduction in ROSC rates may be the decline in bystander CPR, seen for first time since the cardiac registry was established in 1998. Although the reduction in bystander CPR is minimal (by less than 1%) it is not reflective of the year on year increasing trend previously observed.

In 2015/16, the LAS collaborated with the developers of the GoodSam app, which alerts lay members of the public as well as off-duty professionals to the location of a nearby cardiac arrest and public access defibrillator sites to enable early resuscitation efforts. As a result, a greater number of public access defibrillators have been deployed and a shock delivered and in these instances the provision of bystander initiated CPR has been at 100%.

Of note, the rates of ROSC and survival to discharge for LAS witnessed arrests have improved, suggesting that the quality of care delivered by staff remains excellent. In addition, the Advanced Paramedic Practitioner (APP) programme has continued to develop with additional staff recruited in 2015/16 and the introduction of enhanced APP triage at EOC. Consequently, this year, a greater number of arrests have had an APP in attendance (1289 vs 853). APPs are able to assist frontline staff in managing complex resuscitations. The survival rate for arrests where an APP was present was 11.3%, which is 2.3% higher than the overall rate of 9.0%. The ROSC and survival rates are a testament to both the ongoing efforts of clinicians prior to the arrival of the APP and the contribution of the APPs. It is recognised that ROSC and survival rates are likely to be higher due to the types of patients that APP's attend as they are able to select calls at triage to ensure their attendance has the greatest benefit. Furthermore, patients attended by an APP were more likely to have an initial rhythm of VF/VT (27% vs 19%), which will also increase the chances of gaining and sustaining ROSC and survival.

We have continued to feedback survival outcomes to our staff and recognise their efforts in resuscitating patients successfully. In 2015/16, the LAS Clinical Audit and Research Unit sent out 1,500 letters to clinical staff that attended cardiac arrest patients and provided lifesaving interventions at the scene and en-route to hospital. Furthermore, we sent over 350 letters to our Emergency Medical Dispatchers to recognise their crucial role in early recognition of cardiac arrest and initiation of dispatcher assisted bystander CPR.

2015/16 was a challenging year for the LAS with an increased demand and operational response pressures. Despite this, we managed an overall response for cardiac arrest patients of 7 minutes and 47 seconds.

Although a presumed cardiac aetiology accounts for 81.4% of cardiac arrests, there were a greater number of patients where another medical causes were identified (299 vs 159 in 2105/16). This is likely to be a result of greater awareness amongst LAS staff of conditions such as sepsis, and the presence of APPs in a larger proportion of arrests who bring greater assessment skills allowing the recognition of other medical conditions.

The proportion of resuscitations attempted reduced this year from 47.5% to 43.4%. Co-ordinate My Care (CMC) provides greater information to clinicians prior to their arrival at the patient regarding DNA-CPR, other valid advanced directives, and palliative care. Together with an enhanced focus on end of life care within our training, CMC has enabled staff to increasingly react to instances where resuscitation is not appropriate or in line with patient wishes. The impact of this can be seen in the increased numbers of resuscitation attempts that were either not started or discontinued (1,040 vs 448 in 2014/15).

The LAS has continued its involvement in gold-standard, high-quality cardiac research. During 2015/16, we recruited 457 patients to the Paramedic 2 trial – a randomised control trial examining the effectiveness of adrenaline use in cardiac arrest and its impact on short and long term patient outcomes. We are also participating in a second phase pilot of the Immediate Coronary Angiography after Ventricular Fibrillation Out-of-Hospital Cardiac Arrest (ARREST) trial.

Going forward into 2016/17, the LAS aims to launch a 5 year strategy aimed at improving cardiac arrest survival by focussing on key initiatives. These initiatives will focus on: bystander intervention, continued development of co-responder schemes, ongoing staff education, promotion of tools such as the cardiac arrest checklist and increasing defibrillator data availability.

References

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2. Perkins GD, Jacobs IG, Nadkarni VM, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: Update of the Utstein resuscitation registry templates for out-of-hospital cardiac arrest. Circulation, 2014; 110(21): 3385-3397.

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Glossary for abbreviations and terms

999 call - The time at which the call is connected to the ambulance service.

Advanced Paramedic Practitioner – a Paramedic with a greater range of assessment and interventional skills.

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.

Cardiac tamponade – A collection of blood in the sac that surrounds the heart.

Chief Complaint – The primary medical reason that the caller has called 999 as defined by the call triage system.

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.

Double sequential defibrillation – uses two defibrillators to provide multiple high energy shocks in refractory VF to help terminate the rhythm.

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

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.

Emergency Operations Centre (EOC) – The control centre responsible for receiving and triaging incoming 999 calls and co-ordinating an appropriate response.

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.

Mechanical CPR – A mechanical device used to undertake compressions.

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.

Response Category: R2 – Red 2 is used for calls where the complaint is serious but slightly less immediately time critical.

Response Category: C1 to C4 – Calls where the complaint is not life-threatening are given a Category C response based on the information provided by the caller regarding the patient's condition.

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.

ST Elevation Myocardial Infarction (STEMI) – A type of heart attack.

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).

Ultrasound – A technique used to assess the internal organs, specifically in cardiac arrest used to assess if there is motion in the heart walls or if there is the presence of fluid around the heart.

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

Incident CCG*	Number of patients	Age (years)	Male %		Median response (mins)	Bystander CPR#		Presumed cardiac		Shockable initial rhythm		ROSC sustained to hospital		Survived to discharge+	
Barking & Dagenham	89	62	74.2%	(66)	07:37	58.1%	(43/74)	82.0%	(73)	16.9%	(15)	31.5%	(28)	9.2%	(8/87)
Barnet	176	67	63.6%	(112)	08:45	64.6%	(95/147)	79.5%	(140)	18.2%	(32)	22.7%	(40)	10.9%	(19/175)
Bexley	103	64	71.8%	(74)	07:55	72.2%	(57/79)	79.6%	(82)	21.4%	(22)	24.3%	(25)	9.7%	(10/103)
Brent	199	66	61.8%	(123)	08:19	57.9%	(92/159)	79.4%	(158)	15.6%	(31)	27.6%	(55)	5.6%	(11/198)
Bromley	167	72	62.9%	(105)	08:14	63.4%	(85/134)	79.6%	(133)	12.6%	(21)	28.7%	(48)	5.4%	(9/167)
Camden	117	61	76.9%	(90)	07:08	67.0%	(67/100)	71.8%	(84)	20.5%	(24)	35.0%	(41)	9.5%	(11/116)
Central London	136	62	77.9%	(106)	07:07	66.7%	(74/111)	86.8%	(118)	30.1%	(41)	36.0%	(49)	13.5%	(18/113)
City & Hackney	148	61	62.2%	(92)	08:01	66.7%	(82/123)	75.7%	(112)	20.3%	(30)	31.1%	(46)	8.9%	(13/146)
Croydon	213	65	54.9%	(117)	07:40	65.6%	(118/180)	88.3%	(188)	17.8%	(38)	32.9%	(70)	8.3%	(17/206)
Ealing	185	67	67.6%	(125)	08:07	63.7%	(100/157)	85.4%	(158)	22.7%	(42)	31.9%	(59)	11.0%	(20/182)
Enfield	191	64	60.2%	(115)	07:49	61.9%	(99/160)	78.0%	(149)	20.4%	(39)	28.8%	(55)	9.0%	(17/189)
Greenwich	134	66	59.7%	(80)	07:30	54.6%	(59/108)	77.6%	(104)	17.9%	(24)	35.8%	(48)	9.8%	(13/133)
Hammersmith & Fulham	68	60	63.2%	(43)	07:57	60.8%	(31/51)	76.5%	(52)	25.0%	(17)	36.8%	(25)	12.1%	(8/66)
Haringey	122	62	59.0%	(72)	07:42	63.1%	(65/103)	75.4%	(92)	22.1%	(27)	29.5%	(36)	5.8%	(7/120)
Harrow	125	69	70.4%	(88)	07:58	57.3%	(63/110)	88.0%	(110)	26.4%	(33)	24.0%	(30)	11.3%	(14/124)
Havering	153	70	62.1%	(95)	07:40	71.4%	(85/119)	86.3%	(132)	17.0%	(26)	32.0%	(49)	6.9%	(10/144)
Hillingdon	181	66	63.0%	(114)	08:27	68.2%	(107/157)	81.8%	(148)	19.3%	(35)	31.5%	(57)	9.4%	(17/180)
Hounslow	146	66	68.5%	(100)	07:38	62.0%	(75/121)	80.1%	(117)	13.0%	(19)	26.0%	(38)	4.9%	(7/142)
Islington	117	60	71.8%	(84)	07:29	64.8%	(68/105)	73.5%	(86)	17.9%	(21)	29.1%	(34)	8.7%	(10/115)
Kingston	89	65	64.0%	(57)	06:37	60.3%	(47/78)	80.9%	(72)	24.7%	(22)	33.7%	(30)	10.6%	(9/85)
Lambeth	142	60	60.6%	(86)	07:50	63.9%	(76/119)	75.4%	(107)	14.1%	(20)	23.2%	(33)	7.4%	(10/135)
Lewisham	132	63	65.9%	(87)	08:49	54.3%	(57/105)	78.8%	(104)	14.4%	(19)	28.8%	(38)	7.7%	(10/130)
Merton	98	64	63.3%	(62)	06:38	55.7%	(49/88)	86.7%	(85)	20.4%	(20)	28.6%	(28)	9.4%	(9/96)
Newham	138	59	65.9%	(91)	06:59	55.9%	(66/118)	81.2%	(112)	21.0%	(29)	33.3%	(46)	9.5%	(13/137)
Redbridge	174	69	60.3%	(105)	07:27	65.0%	(91/140)	85.1%	(148)	16.1%	(28)	28.7%	(50)	5.8%	(10/172)
Richmond	90	67	71.1%	(64)	07:37	67.6%	(46/68)	85.6%	(77)	27.8%	(25)	28.9%	(26)	14.6%	(13/89)
Southwark	129	63	65.1%	(84)	07:25	56.3%	(58/103)	85.3%	(110)	17.8%	(23)	22.5%	(29)	8.1%	(10/124)
Sutton	99	67	69.7%	(69)	07:03	60.5%	(49/81)	84.8%	(84)	23.2%	(23)	31.3%	(31)	10.1%	(10/99)
Tower Hamlets	125	63	64.8%	(81)	07:31	59.8%	(64/107)	82.4%	(103)	18.4%	(23)	32.8%	(41)	11.3%	(14/124)
Waltham Forest	134	64	64.9%	(87)	08:37	67.0%	(77/115)	84.3%	(113)	17.2%	(23)	27.6%	(37)	6.0%	(8/134)
Wandsworth	132	62	59.8%	(79)	08:00	58.2%	(64/110)	79.5%	(105)	18.9%	(25)	28.8%	(38)	8.5%	(11/129)
West London	131	64	67.2%	(88)	07:50	49.1%	(53/108)	84.0%	(110)	23.7%	(31)	37.4%	(49)	16.0%	(21/131)

** Patients conveyed to non- London CCG's are excluded from the table.*
 # Figures exclude arrests witnessed by LAS staff.
+ Denominators exclude patients with unknown survival outcomes.

Appendix 2: Survival per Hospital

Hospital	2013/14			2014/15			2015/16*		
	Number of patients	Survival with ROSC sustained to hospital+		Number of patients	Survival with ROSC sustained to hospital+		Number of patients	Survival with ROSC sustained to hospital+	
Barnet	58	24.2%	(8/33)	77	21.4%	(6/28)	42	25.0%	(3/12)
Barts Health^	-	-	-	-	-	-	124	53.5%	(54/101)
Charing Cross	43	47.1%	(8/17)	31	7.7%	(1/13)	40	18.2%	(4/22)
Chelsea & Westminster	40	25.0%	(4/16)	35	25.0%	(4/16)	33	35.7%	(5/14)
Croydon	104	6.1%	(2/33)	106	5.6%	(2/36)	123	10.4%	(5/48)
Darent Valley	15	16.7%	(1/6)	12	14.3%	(1/7)	10	50.0%	(2/4)
Ealing	76	18.5%	(5/27)	66	9.7%	(3/31)	54	12.5%	(3/24)
Hammersmith	119	49.4%	(40/81)	94	38.7%	(29/75)	76	53.8%	(35/65)
Harefield	36	40.0%	(12/30)	61	58.8%	(30/51)	30	56.0%	(14/25)
Hillingdon	82	29.7%	(11/37)	100	25.0%	(10/40)	83	25.6%	(10/39)
Homerton	35	10.0%	(1/10)	48	13.6%	(3/22)	43	4.8%	(1/21)
King's College	181	51.1%	(46/90)	192	40.7%	(44/108)	167	39.3%	(33/84)
King George	69	16.7%	(5/30)	75	16.2%	(6/37)	56	4.8%	(1/21)
Kingston	63	4.0%	(1/25)	58	16.7%	(3/18)	63	24.0%	(6/25)
London Chest^	107	47.3%	(43/91)	124	56.5%	(61/108)	7	71.4%	(5/7)
Newham	81	11.1%	(2/18)	114	16.7%	(6/36)	77	6.7%	(2/30)
North Middlesex	107	14.3%	(6/42)	149	9.8%	(6/61)	119	8.0%	(4/50)
Northwick Park	127	9.3%	(4/43)	120	9.8%	(5/51)	126	22.8%	(13/57)
Princess Royal	87	31.4%	(11/35)	87	9.8%	(4/41)	66	17.9%	(5/28)
Queen Elizabeth	133	29.6%	(16/54)	150	12.5%	(7/56)	110	18.6%	(8/43)
Queen's Romford	146	12.3%	(7/57)	150	6.0%	(3/50)	129	4.7%	(2/43)
Royal Free	129	38.8%	(31/80)	110	41.2%	(28/68)	133	44.4%	(40/90)
Royal London	100	20.0%	(8/40)	122	20.0%	(12/60)	91	24.1%	(13/54)
St George's	188	42.6%	(46/108)	200	38.7%	(46/119)	183	39.0%	(41/105)
St Helier	59	9.1%	(2/22)	78	17.2%	(5/29)	41	21.4%	(3/14)
St Mary's	73	32.0%	(8/25)	81	30.0%	(9/30)	87	12.2%	(5/41)
St Thomas'	97	42.0%	(21/50)	114	39.0%	(23/59)	116	47.5%	(28/59)
The Heart^	24	70.0%	(14/20)	17	66.7%	(10/15)	1	0.0%	(0/1)
University College Hospital	51	42.1%	(8/19)	44	27.3%	(6/22)	35	26.1%	(6/23)
Lewisham	79	20.8%	(5/24)	80	19.0%	(4/21)	70	24.1%	(7/29)
West Middlesex	85	29.0%	(9/31)	79	23.5%	(8/34)	88	13.3%	(4/30)
Whipps Cross	106	21.2%	(11/52)	112	13.2%	(5/38)	86	17.1%	(6/35)
Whittington	51	19.2%	(5/26)	45	24.0%	(6/25)	39	21.4%	(3/14)

^ Following the closures of the London Chest and The Heart in April 2015, Barts Health opened its Heart Centre at their St. Bartholomew Hospital site.
** One patient was conveyed to hospital by another provider.*
+ Denominators exclude patients with unknown survival outcomes.

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

Heart Attack Centre	Number of patients	Initial rhythm			Survival to discharge+
		Asystole	VF/VT	PEA	
Barts Health^□	80	13.8% (11)	68.8% (55)	17.5% (14)	50.0% (38/76)
Hammersmith*	53	26.9% (14)	59.6% (31)	13.5% (7)	42.0% (21/50)
Harefield	21	19.0% (4)	66.7% (14)	14.3% (3)	55.0% (11/20)
King's College□	38	23.7% (9)	63.2% (24)	13.2% (5)	38.9% (14/36)
London Chest^	6	-	100.0% (6)	-	66.7% (4/6)
Royal Free	46	15.2% (7)	67.4% (31)	17.4% (8)	56.5% (26/46)
St George's	47	23.4% (11)	63.8% (30)	12.8% (6)	45.7% (21/46)
St Thomas'	25	4.0% (1)	84.0% (21)	12.0% (3)	58.3% (14/24)
The Heart^	1	-	-	100.0% (1)	0.0% (0/1)

^ Barts Heart Centre opened in April 2015 following the closures of the London Chest and The Heart.

□ The total percentages do not equal 100% due to rounding.

** 1 patient had no initial rhythm documented.*

+ Denominators exclude patients with unknown survival outcomes.

Appendix 4: Cardiac arrest patients under 35 years old

	Under 1	1-8	9-18	19-35
Number of patients:	63	28	39	294
Gender:				
Male	49.2% (31)	50.0% (14)	71.8% (28)	75.9% (223)
Female	47.6% (30)	50.0% (14)	28.2% (11)	24.1% (71)
Unknown	3.2% (2)	-	-	-
Arrest location:				
Private	90.5% (57)	85.7% (24)	53.8% (21)	49.7% (146)
Public	9.5% (6)	14.3% (4)	46.2% (18)	50.3% (148)
Witnessed[◊]:				
Bystander	34.9% (22)	50.0% (14)	38.5% (15)	34.7% (102)
LAS staff	6.3% (4)	14.3% (4)	17.9% (7)	13.9% (41)
Unwitnessed	54.0% (34)	35.7% (10)	41.0% (16)	51.0% (150)
Not Documented	4.8% (3)	-	2.6% (1)	0.3% (1)
Bystander CPR[#]:				
Yes	57.6% (34/59)	50.0% (12/24)	71.9% (23/32)	71.5% (181/253)
No	42.4% (25/59)	50.0% (12/24)	28.1% (9/32)	28.5% (72/253)
Initial rhythm[◊]:				
Asystole	66.7% (42)	67.9% (19)	59.0% (23)	63.9%(188)
PEA	12.7% (8)	21.4% (6)	15.4% (6)	18.7% (55)
VF/ Pulseless VT	1.6% (1)	3.6% (1)	15.4% (6)	16.3% (48)
Not Documented	19.0% (12)	7.1% (2)	10.3% (4)	1.0% (3)
ROSC sustained to hospital:				
Yes	15.9% (10)	28.6% (8)	23.1% (9)	28.9% (85)
No	84.1% (53)	71.4% (20)	76.9% (30)	71.1% (209)
Survived to discharge[+]:				
Yes	10.2% (6/59)	16.7% (4/24)	8.1% (3/37)	11.9% (34/286)
No	89.8% (53/59)	83.3% (20/24)	91.9% (34/37)	88.1% (252/286)

◊ Totals for 9-18 year olds within the initial rhythm group and 19-35 year olds within witnessed and rhythm category do not equal 100% due to rounding.

[#] Figures exclude arrests witnessed by LAS staff.

+ Denominators exclude patients with unknown survival outcomes.