London Ambulance Service NHS Trust

Cardiac Arrest Annual Report: 2016/17

October 2017

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Contents

London Ambulance Service NHS Trust

Cardiac arrest overview

2016-2017

Cardiac arrest patients

10,430 +3%

-0.8% Resuscitation attempted 43%

Outcomes for resuscitation attempted

29.4% Overall ROSC to hospital -0.5%

9.5% Overall survival +0.5%

+1.1% 54.5% Utstein ROSC to hospital

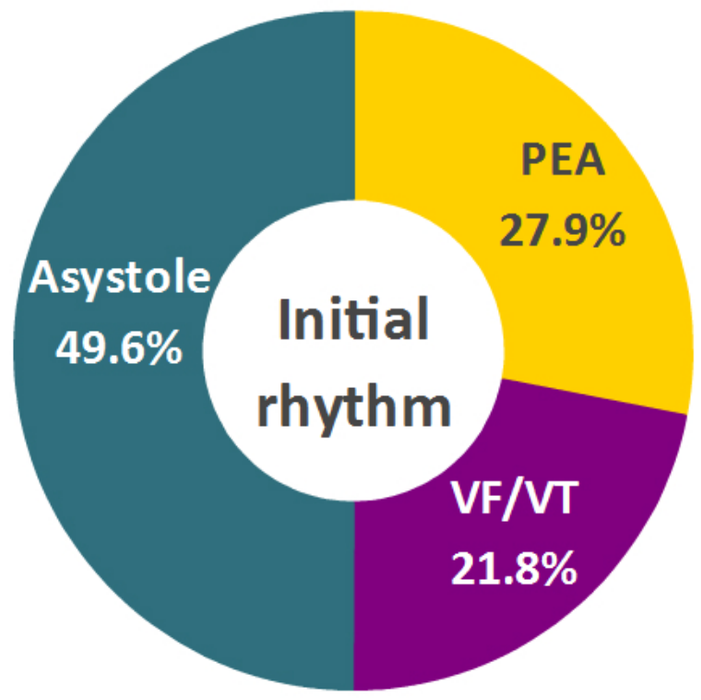
-2% 29.5% Utstein survival

Patient details

64% Male 62 years

36% Female 68 years

76% Private location	24% Public location
47% Bystander witnessed	18% LAS witnessed
	35% Unwitnessed



On-scene skills

89% -0.5% Successful airway placement

24% Mechanical CPR

Resuscitation efforts

47% Terminated on scene

53% Continued to hospital

78% Conveyed to an Emergency Department (ED)

22% Conveyed to a Heart Attack Centre (HAC)

Response details

00:07:39

'999' call to arrive scene
8 seconds quicker than last year

00:09:31

'999' call to LAS CPR
11 seconds quicker than last year

00:11:17

'999' call to LAS defibrillation
Over 1 minute quicker than last year

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1. Introduction

From 1st April 2016 to 31st March 2017 the London Ambulance Service NHS Trust (LAS) attended 10,430 patients who had suffered an out-of-hospital cardiac arrest. LAS clinicians attempted to resuscitate 4,448 (42.6%) patients. Resuscitation efforts were not undertaken on 5,982 (57.4%) patients, the vast majority of whom (n=4,469) were recognised as deceased on arrival of the LAS. 1,513 patients had a Do Not Attempt Cardio-Pulmonary Resuscitation (DNA-CPR) order, advanced directive or similar equivalent in place, or the patient's death was expected.

Data were sourced from the Clinical Audit and Research Unit's (CARU) 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 is collected using hospital patient records and national databases.

This report presents information regarding the clinical care provided and the outcomes of the 4,448 patients where resuscitation was attempted.

2. Profile of arrests

Characteristics	
Gender, n (%)	
Male	2,856 (64.2%)
Female	1,580 (35.5%)
Unknown	12 (0.3%)
Age, mean (median) in years	
Overall average	64 (69)
Male average	62 (66)
Female average	68 (73)
Race □, n (%)	
White	2,701 (60.7%)
Asian	350 (7.9%)
Black	335 (7.5%)
Mixed	26 (0.6%)
Other	183 (4.1%)
Unable to obtain	776 (17.4%)
Not documented	77 (1.7%)

Peak occurrence	
Time of day (hh:mm)	08:00-11:59 22.1% (n=985)
Day	Friday 15.0% (n=666)
Month	January 10.5% (n=465)

Chief complaint, n (%)	
Cardiac arrest	2,317 (52.1%)
Unconscious/fainting	655 (14.7%)
Breathing problems	342 (7.7%)

Location □, n (%)	
Private location	**3,365 (75.7%)**
Home	3,093 (91.9%)
Care home	272 (8.1%)
Public location	**1,083 (24.3%)**
Street	503 (46.4%)
Work	83 (7.7%)
Healthcare facility	139 (12.8%)
Public transport	75 (6.9%)
Social venue	68 (6.3%)
Shop/bank	43 (4.0%)
Park/wood/river	41 (3.8%)
Hotel/Hostel	35 (3.2%)
Leisure centre/sports club	31 (2.9%)
Airport	21 (1.9%)
Other	44 (4.1%)

Response^	
Response times, minutes	
'999' call – scene	07:39
'999' call – LAS CPR	09:31
'999' call – LAS defibrillation	11:17
Response category □, n (%)	
R1	2,868 (64.5%)
R2	1,288 (29.0%)
C1	44 (1.0%)
C2	146 (3.3%)
C3	87 (2.0%)
C4	14 (0.3%)
Red response <8 mins	
Red 1	1,776/2,868 (61.9%)
Red 2	796/1,288 (61.8%)

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

^ *Overall response times and Red 1 responses are measured using the time the call was connected by the operator. Red 2 calls are afforded up to 240 seconds prior to the clock starting as part of an NHS England initiative to help determine the chief complaint.*

Table 1: Profile of cardiac arrests where resuscitation was attempted (n=4,448)

3. Witnessed arrests and bystander CPR rates

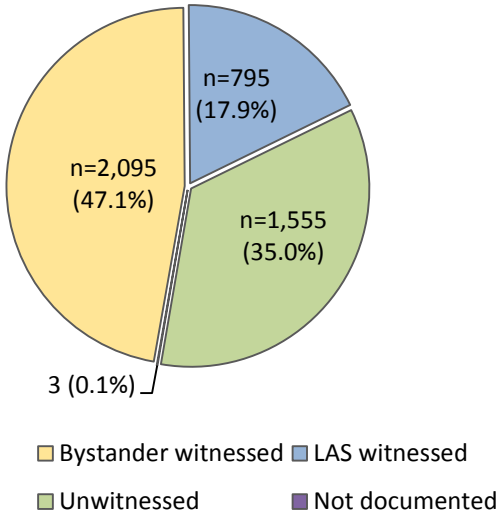


Figure 1: Witnessed arrests

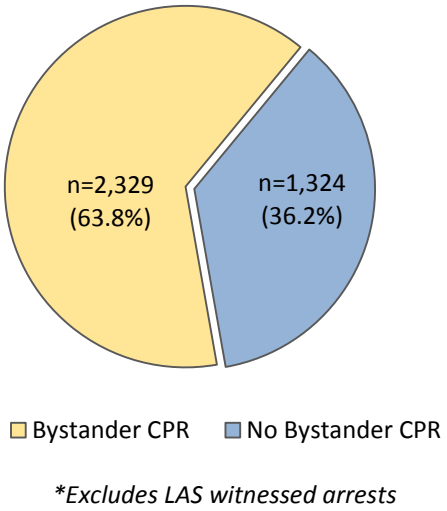


Figure 2: Bystander CPR*

- Overall, **47.1%** of patients who received LAS resuscitation attempts were **bystander witnessed**, which is a 2.0% decrease from 2015/16 (49.1%).
- **63.8%** of patients received **bystander CPR**. This represents an increase of 1.6% from 2015/16 (62.2%).

4. Patient outcomes

4.1. Resuscitation efforts

Resuscitation efforts◊, n (%)	
Continued to hospital	2,340 (52.6%)
Conveyed to an ED	1,819 (77.7%)
Conveyed to a HAC~	521 (22.3%)
Terminated on-scene	2,107 (47.4%)

◊ Excludes one patient who was successfully resuscitated and refused conveyance.
~ Includes all patients regardless of whether a STEMI was identified or if ROSC was obtained.

Table 2: Outcome of resuscitation efforts at scene

- **52.6%** of patients were **conveyed** to hospital with either a Return of Spontaneous Circulation (ROSC) or ongoing CPR.
- **Resuscitation** efforts were **terminated** on-scene for **47.4%** of patients, which is an increase of 5.4% from last year.

4.2. ROSC and Survival

Patient outcomes focus primarily on two measures: ROSC that is sustained to arrival at hospital, and survival to hospital discharge. Patient outcomes are reported for two groups:

1. Overall group: all patients where resuscitation was attempted.
2. Utstein[1,2] comparator group: a sub-group of resuscitation attempted patients where the arrest was of a presumed cardiac cause, bystander witnessed, and in a shockable rhythm (VF/VT) on arrival of the LAS.

4.2.1. ROSC sustained to hospital

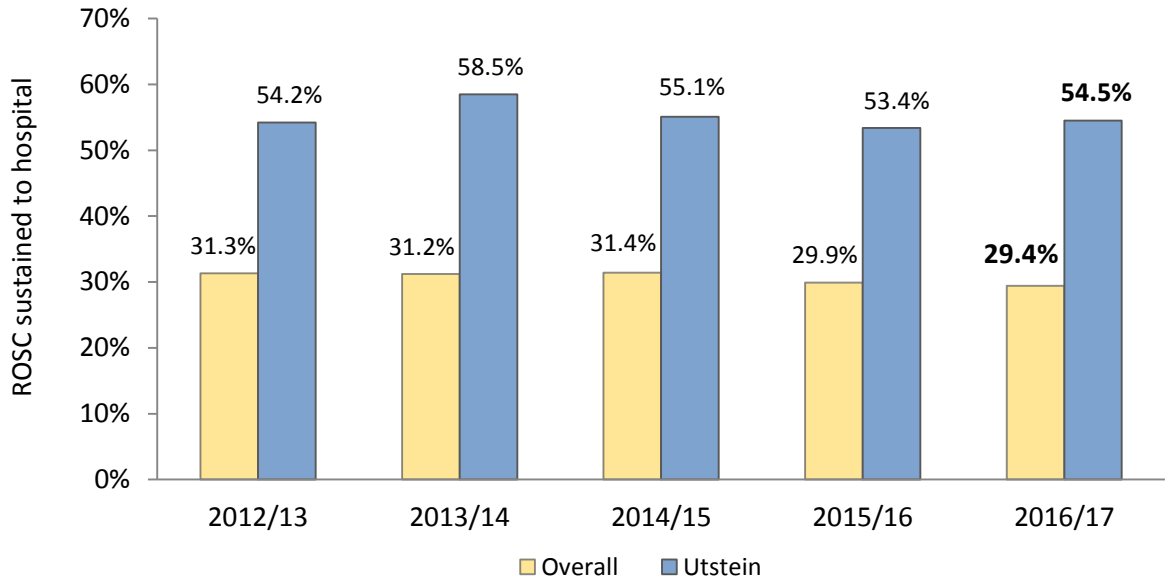


Figure 3: ROSC sustained to hospital per year for all resuscitation attempted patients ('overall'), and the Utstein comparator group

- In 2016-17, **overall** ROSC sustained to hospital rates were **29.4%** (n=1,307). Although this represents a 0.5% decrease from last year (29.9%), ROSC rates for this group have remained relatively stable over the last 5 years (Figure 3).
- For the **Utstein** comparator group, ROSC sustained to hospital arrival increased by 1.1% from 53.4% in 2015/16 to **54.5%** (n=330/606).

4.2.2. Survival to hospital discharge

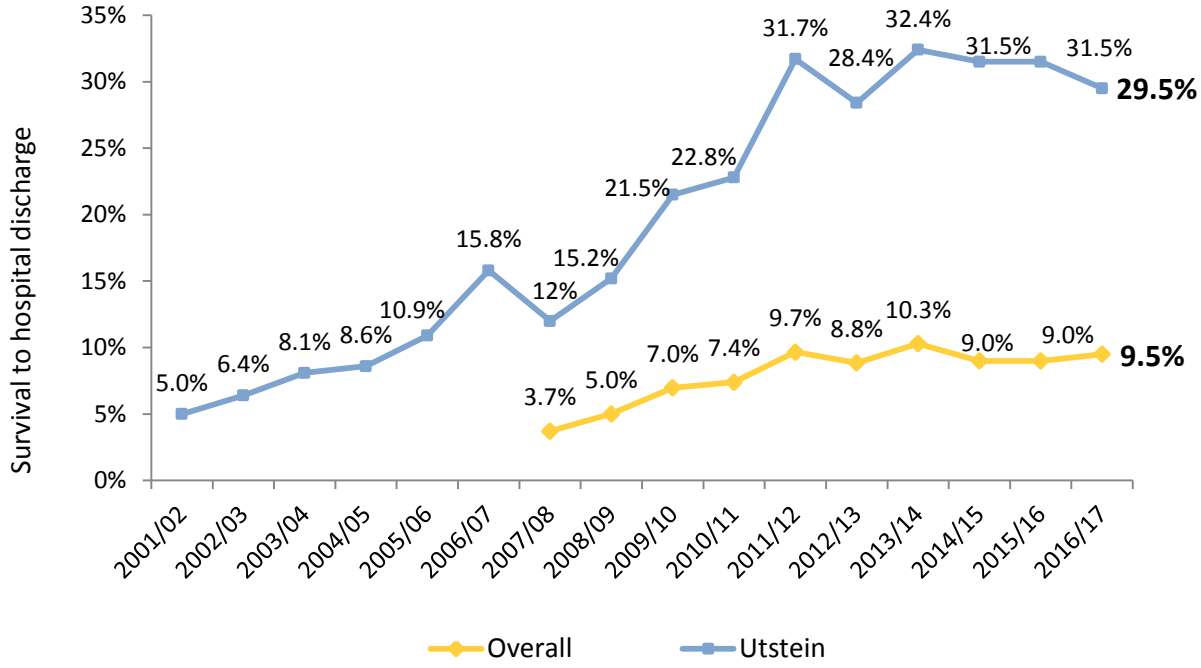


Figure 4: Survival to hospital discharge per year for all resuscitation attempted patients ('overall') and the Utstein comparator group

- The **overall** survival to hospital discharge rate was **9.5%** (n=415/4,357); an increase of 0.5% compared with the last two years (9.0%). 91 cases were excluded from the denominator as the survival outcome was unknown.
- The **Utstein** survival rate was **29.5%** (n=172/583) representing a decrease of 2.0% from the last two years rate of 31.5% (Figure 4 and 5). It is worth noting that, although survival for the Utstein group has increased considerably over time, it has seen small fluctuations.

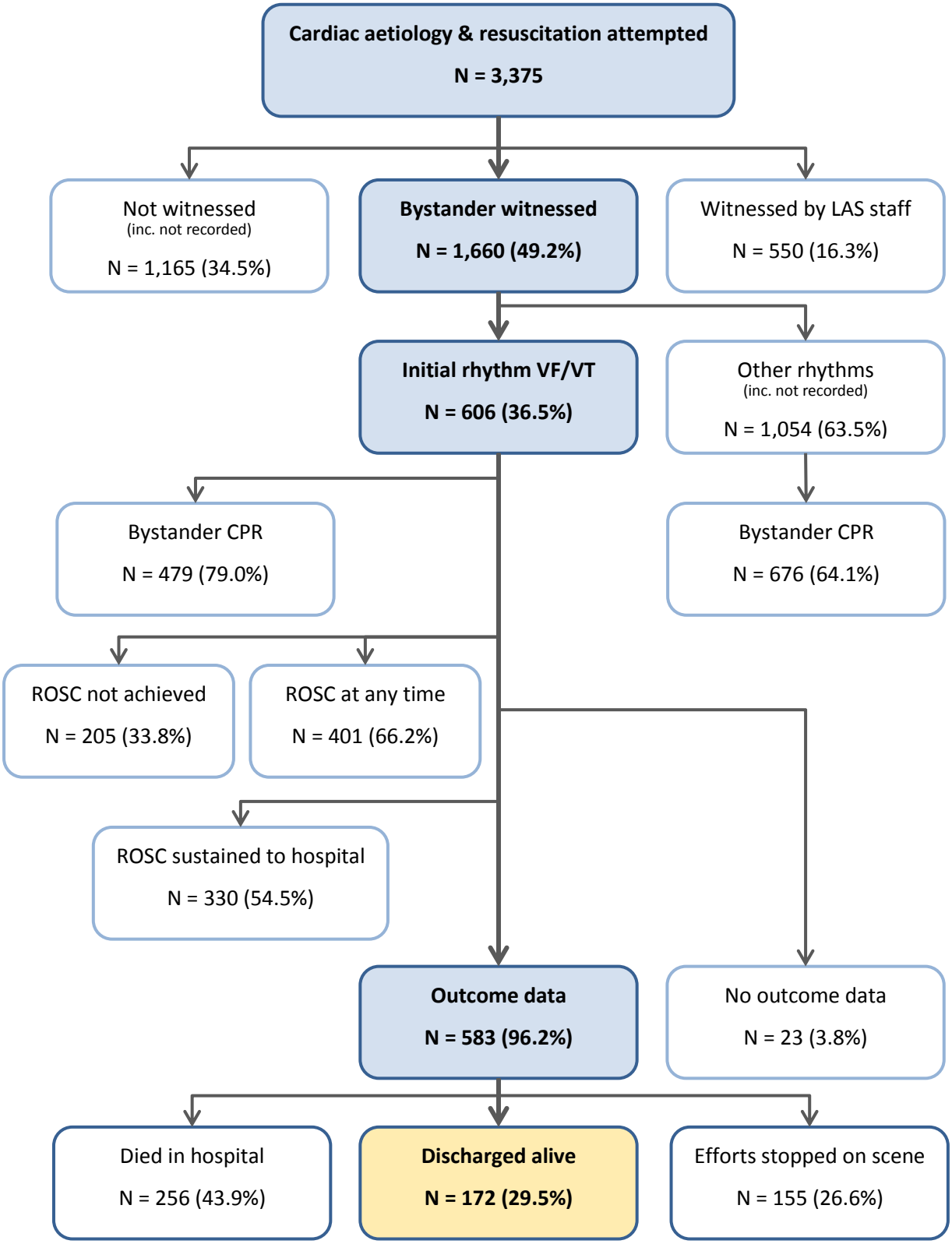


Figure 5: Outcomes for the Utstein comparator group

5. Factors influencing outcomes

5.1. Outcomes from Public Access Defibrillator (PAD)

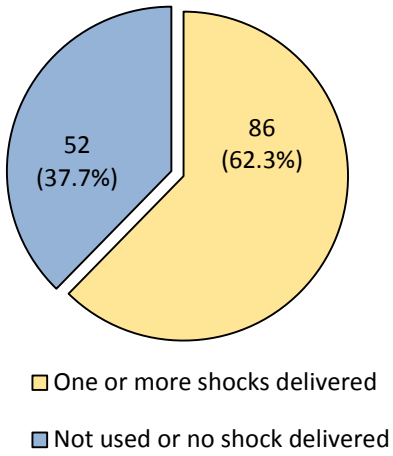
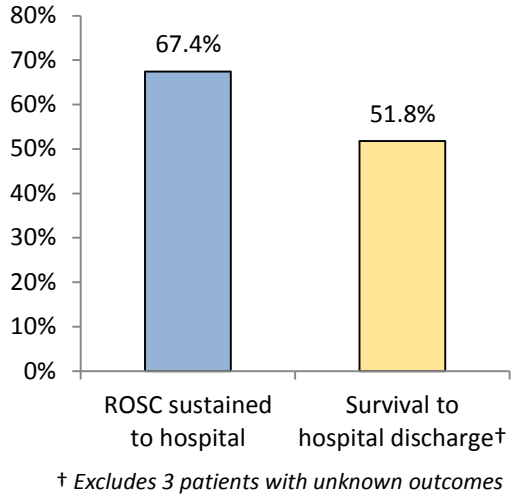


Figure 6: Deployment of a PAD



† *Excludes 3 patients with unknown outcomes*

Figure 7: Patients outcomes post-PAD use

- A member of the public deployed a PAD for 138 cardiac arrests, with **one or more shocks** being delivered to **86** patients.
- Of the 86 patients where a PAD was used to deliver a shock, **93.0%** arrests (n=80) were **bystander witnessed**, which is a 3.6% decrease compared with last year. However, **bystander CPR** rates among this group remained high at **98.8%** (n=85/86).
- **ROSC** sustained to hospital for cases where a PAD was used to deliver a shock was **67.4%** (n=58/86); a 6.5% decrease compared with last year (73.9%).
- A similar trend was observed for **survival** to hospital discharge, which decreased by 5.5% (from 57.3% in 2015/16) to **51.8%** (n=43/83) this year.

5.2. Aetiology and outcomes

Aetiology	Overall n (%)	ROSC sustained to hospital n (%)	Survival to discharge† n (%)
Presumed cardiac	3,375 (75.9)	1,023 (30.3)	368/3,313 (11.1)
Other medical	538 (12.1)	157 (29.2)	27/531 (5.1)
Trauma	200 (4.5)	24 (12.0)	4/190 (2.1)
Asphyxial	204 (4.6)	73 (35.8)	7/199 (3.5)
Overdose	103 (2.3)	26 (25.2)	9/97 (9.3)
Drowning	27 (0.6)	4 (14.8)	0/27 (0.0)
Electrocution	1 (0.0)	0 (0.0)	0/1 (0.0)

† *Denominators exclude patients with unknown survival outcomes (n=91).*

Table 3: Patient aetiology with ROSC and survival

- **Presumed cardiac aetiology** was the predominant cause of cardiac arrest (75.9%), with the highest ROSC sustained (30.3%) and survival to discharge (11.1%) of all aetiologies.

5.3. Initial rhythm and outcomes

The initial rhythm recorded on-scene by LAS clinicians refers to the first heart rhythm present upon their arrival.

Initial rhythm*	Number of patients		ROSC sustained to hospital		Survival to discharge†	
	n (%)	Change^	n (%)	Change^	n (%)	Change^
Asystole	2,208 (49.6)	↓3.5%	368 (16.7)	↓3.2%	35/2,179 (1.6)	↑0.6%
PEA	1,243 (27.9)	↑1.7%	405 (32.6)	↑2.1%	64/1,216 (5.3)	↓0.3%
VF/VT	971 (21.8)	↑2.5%	524 (54.0)	↓0.4%	310/936 (33.1)	↓1.2%

** Not documented in 26 cases.*

^ Increase or decrease in percentage from 2015/16.

† *Denominator excludes patients with unknown survival outcomes (n=91).*

Table 4: Initial rhythm with ROSC and survival

- **Asystole (49.6%)** remains the predominant initial rhythm although it has decreased this year by 3.5% compared with 53.1% in 2015/16.
- **PEA** has increased slightly by 1.7% from 26.2% in 2015/16 to **27.9%** this year.
- The proportion of **VF/VT** has increased by 2.5% to **21.8%** from 19.3% in 2015/16. Patients presenting in VF/VT have a **higher rate** of **ROSC** sustained to hospital (54.0%) and **survival** to hospital discharge (33.1%) compared with other initial rhythms.

5.4. LAS witnessed arrests

LAS witnessed	Number of patients*		ROSC sustained to hospital		Survival to discharge†	
	n (%)	Change^	n (%)	Change^	n (%)	Change^
Asystole	187 (23.5)	↓1.6%	47 (25.1)	↓5.9%	16/184 (8.7)	↑3.8%
PEA	411 (51.7)	↑0.7%	119 (29.0)	↑1.9%	30/406 (7.4)	↓0.2%
VF/VT	185 (23.3)	↑2.5%	132 (71.4)	↑3.0%	110/179 (61.5)	↑2.0%
All patients	795 (17.9)	↑0.9%	306 (38.5)	↑1.1%	161/781 (20.6)	↑2.2%

** Not documented in 12 cases.*

^ Increase or decrease in percentage from 2015/16.

† Denominator excludes patients with unknown survival outcomes (n=14).

Table 5: Outcome of LAS witnessed arrests

- LAS clinicians witnessed **795** patients suffer a cardiac arrest. Both **ROSC** sustained to hospital and **survival** to hospital discharge rates have **increased** (by 1.1% and 2.2% respectively) in this group compared with last year (37.4% and 18.4%).
- **Asystolic** rhythms have seen the largest changes with a 5.9% decrease in **ROSC** sustained to hospital from 31.0% to **25.1%** this year. Conversely, the **survival** to discharge rate for this group has increased by 3.8% from 4.9% in 2015/16 to **8.7%**.

6. Extended skills

6.1. Airway management

A successful advanced airway includes the placement of an endotracheal tube (ETT) and/or supraglottic airway (SGA). To determine the patency of the airway following application of the airway device, end-tidal CO_2 ($EtCO_2$) is measured.

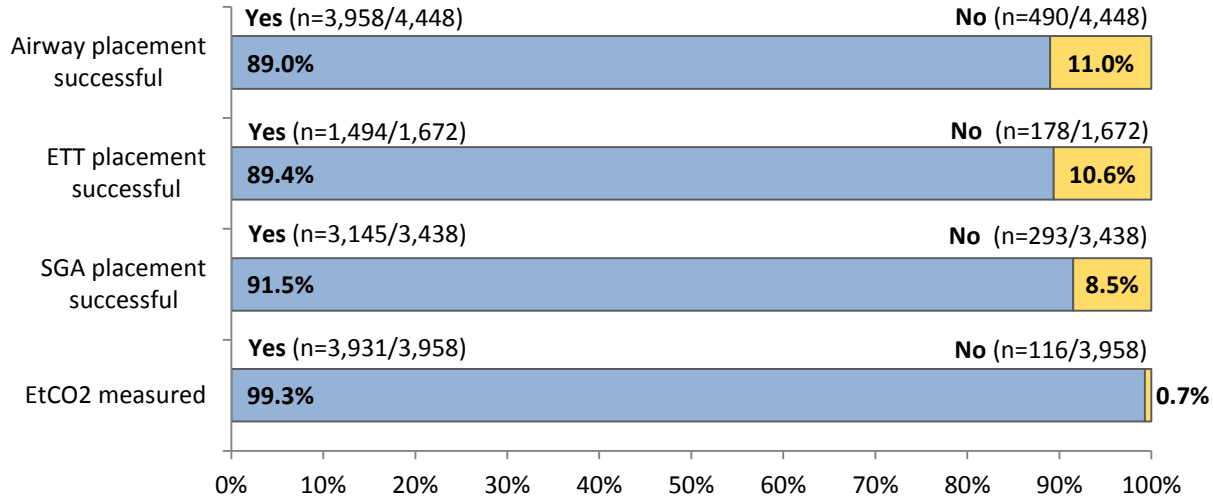


Figure 8: Airway management

- **Advanced airways** were successfully placed in **89.0%** of patients.
- An **ETT** was placed successfully for **89.4%** of patients, an increase of 3.3% from last year's success rate of 86.1%.
- The **SGA** success rate fell slightly from last year by 0.9% from 92.4% to **91.5%**.
- This year, **$EtCO_2$** measurements increased to **99.3%** (up from 98.3%). An $EtCO_2$ was not present for just 0.7% of cases where an airway was placed.

6.2. Mechanical CPR

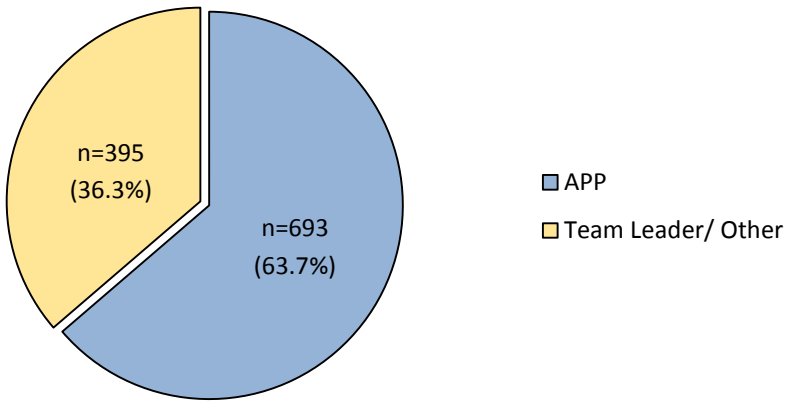


Figure 9: Mechanical CPR breakdown by user

- Mechanical CPR was used for **1,088** patients to enable consistent CPR throughout resuscitation or during transportation.
- In almost **two-thirds** of cases where the mechanical CPR was used, this was performed by an **Advanced Paramedic Practitioner (APP)**.

7. Advanced Paramedic Practitioners (APPs)

Advanced Paramedic Practitioners (APPs) manage resuscitation efforts and provide enhanced care to patients. APPs are dispatched to cardiac arrests either automatically or following a comprehensive triage by an APP based in the Emergency Operations Centre (EOC), who ensures APPs attend those who are most likely to benefit from advanced skills.

APP skills and patient outcomes	n	%	Change^
Mechanical CPR	693	46.5	↓7.0%
Ultrasound	714	48.0	↑10.2%
Double Sequential Defibrillation	33	2.2	↑0.7%
ROSC sustained to hospital	515	34.6	↑0.4%
Survival to discharge†	176	12.1	↑0.8%

† *Denominator excludes patients with unknown survival outcomes (n=33).*

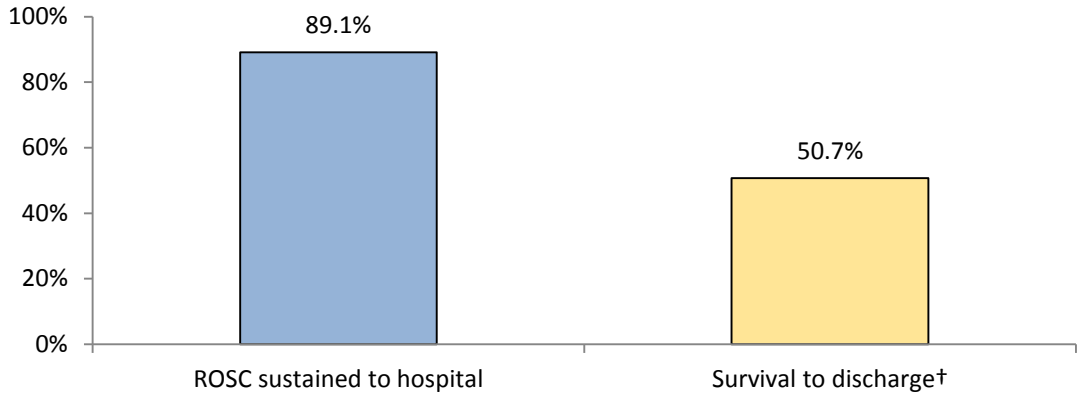
^ *Increase or decrease in percentage from 2015/16.*

Table 6: APP skills and patient outcomes

- An **APP** was present and assumed primacy of care for **1,489** cases, a 15.5% increase compared with 2015/16.
- **Mechanical CPR** was used for **46.5%** of patients, which is a 7.0% decrease since last year.
- For almost half of patients attended by an APP **(48.0%),** a portable **ultrasound** was used to assess the heart. This is a 10.2% increase from last year.
- **Double sequential defibrillation** was used for **33** patients (an increase from 19 patients last year).
- **ROSC** sustained to hospital and **survival** to hospital discharge were **higher** in cases where an APP was present (34.6 and 12.1%) compared with the overall LAS figures (29.4% and 9.5% respectively). Of note, when an APP was in attendance, the rate of **VF/VT** was **30.2%**, which is 8.2% higher than the percentage reported for all resuscitation attempted patients.

8. Resuscitated patients conveyed to a Heart Attack Centre (HAC) following a STEMI

Cardiac arrest patients who have a ST-elevation Myocardial Infarction (STEMI) and have achieved stable ROSC on-scene are conveyed to a HAC as part of a specialist pathway.



† Denominator excludes patients with unknown survival outcomes (n=17).

Figure 10: Outcomes of resuscitated patients conveyed to a HAC following a STEMI

- **368** patients had a STEMI, achieved ROSC and were transported to HAC following a cardiac arrest.
- The **majority** of these patients had an initial rhythm of **VF/VT** (74.2%, n=273) whilst PEA and asystole accounted for 15.2% (n=56) and 10.6% (n=39) of cases.
- **Survival** to hospital discharge for patients within this specialist pathway remains higher than other groups at **50.7%,** which is 1.8% higher than 2015/16 (48.9%).
- A breakdown of survival and initial rhythm for patients conveyed to specific London HACs can be found in Appendix 3.

9. Quality improvement activity

- As part of our ongoing aim to improve cardiac arrest survival, we have committed to the following key initiatives as part of our 5-year Clinical Strategy 2016-2021:
    - Supporting bystander intervention and increased PAD access with public engagement and education
    - Continued development of co-responder schemes
    - Enhanced staff education and promotion of tools, such as the cardiac arrest checklist
    - Improved defibrillator data availability, which increased this year to 9%.
- The LAS has continued to provide educational updates to staff via Core Skills Refresher sessions, bulletins, and case studies in internal publications such as the Clinical Update and the learning from experience Insight magazine.
- A key area of focus in the last year was minimising any delays in the time taken to defibrillate the heart, with the LAS implementing the following:
    - The 'See it – Shock it' campaign to remind staff of the different presentations of VF and pulseless VT and the need to deliver a shock immediately. An infographic poster was released on the staff Facebook group and on station notice boards to support the campaign, and a quick reference leaflet was distributed to all staff members.
    - Following a Preventing Future Deaths notice from a London Coroner, the LAS implemented changes to defibrillation practice to minimise any delays in delivering shocks to patients. As part of the changes, staff were advised when arriving on scene to use defibrillators in Automated External Defibrillator (AED) mode and to only move to manual mode if further resources were present with staff supporting rhythm crosschecks. The AED mode has been encouraged as a default should staff be uncertain of the rhythm.
    - Staff were reminded of the importance of accurate pad placement.
- During 2016/17, CARU sent out 1,309 letters to clinical staff who attended cardiac arrest patients, who survived to hospital discharge, in recognition of the lifesaving interventions provided at scene and en-route to hospital.
- Additionally, 301 letters were sent out to our Emergency Medical Dispatchers in appreciation of their crucial role in the early recognition of cardiac arrests and initiation of dispatcher assisted bystander CPR.
- Monthly care packs and $EtC0_2$ reports have been disseminated across the Trust to improve clinical care at a local level.

- The LAS has continued involvement in high-quality cardiac research:
    - We recruited 1,017 patients during 2016/17 to the Paramedic 2 trial – a randomised clinical trial investigating the effectiveness of adrenaline use during cardiac arrest and its impact on short and long-term patient outcomes. Recruitment into this trial is near completion and we are looking forward to learning more from the results in due course.
    - With supportive findings from the ARREST pilot study[3], we are proceeding with a large-scale randomised clinical trial in collaboration with Guys & St Thomas' NHS Foundation Trust and King's College Hospital NHS Foundation Trust. We aim to fully determine the potential benefit of conveying cardiac arrest patients, once ROSC is achieved, directly to a HAC. This is irrespective of whether the patient has a STEMI on their 12 lead ECG.

10. Conclusion

The factors that influence out-of-hospital cardiac arrest patient outcomes are complex. Inherent patient characteristics and co-morbidities as well as early access to care will all contribute to the outcomes at scene and later at hospital. In this report, our patient characteristics remained largely unchanged from previous years, however an increase in an initial shockable VF/VT rhythm was observed this year. Prior to the arrival of our staff, members of the public initiated early interventions with more bystanders performing CPR. The LAS provided a rapid response to patients, and timely defibrillation upon arrival. Furthermore, our clinicians provided advanced skills with airway management, mechanical CPR and portable ultrasound (where possible), and utilised specialist pathways as appropriate to the patients' condition.

This year, there was a small reduction in ROSC sustained to hospital in the overall group of patients where resuscitation was attempted (29.4% vs. 29.9%). Interestingly, survival to hospital discharge has increased to 9.5% (from 9.0% in 2015/16) for this group. It is likely that the reduced ROSC rates and improved survival 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.

ROSC sustained to hospital rates have increased to 54.5% for the Utstein comparator group (from 53.4% in 2015/16). Despite this, there was a decrease of 2% in survival for the Utstein group to 29.5% from 31.5% last year. The factors that may influence this decrease in survival will reflect both pre-hospital and in-hospital care, as well as inherent patient presentation. Given that the Utstein comparator group is relatively small in number, variations in survival rates are more noticeable and fluctuations in the survival rates have been observed previously. The LAS will continue to monitor patient outcomes and progress our commitment to improving survival from out-of-hospital cardiac arrest as part of our Clinical Strategy 2016-2021. A key area for improvement is the downloading of defibrillator files. The LAS should continue to pursue the technology and infrastructure to enable clinicians to download files directly from the defibrillators.

11. 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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Acknowledgments

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Glossary for abbreviations and terms

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

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

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

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.

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 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. $EtCO_2$ 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.

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 – All other calls 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.

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: 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	101	63	63.4%	(64)	07:58	66.3%	(53/80)	71.3%	(72)	10.9%	(11)	20.8%	(21)	5.9%	(6/101)
Barnet	200	69	59.0%	(118)	08:12	70.9%	(122/172)	76.5%	(153)	20.0%	(40)	19.5%	(39)	4.6%	(9/196)
Bexley	141	64	59.6%	(84)	08:01	66.0%	(70/106)	78.0%	(110)	22.0%	(31)	26.2%	(37)	7.9%	(11/139)
Brent	193	65	66.8%	(129)	07:37	73.3%	(118/161)	71.0%	(137)	17.1%	(33)	26.4%	(51)	6.7%	(13/193)
Bromley	162	67	56.8%	(92)	08:03	56.7%	(76/134)	79.6%	(129)	24.7%	(40)	33.3%	(54)	10.1%	(16/158)
Camden	129	60	66.7%	(86)	07:32	58.0%	(58/100)	77.5%	(100)	27.1%	(35)	28.7%	(37)	13.2%	(17/129)
Central London	139	63	75.5%	(105)	07:04	70.9%	(83/117)	74.1%	(103)	28.8%	(40)	36.0%	(50)	15.0%	(20/133)
City & Hackney	148	61	68.9%	(102)	07:24	53.2%	(66/124)	77.0%	(114)	23.0%	(34)	30.4%	(45)	12.4%	(18/146)
Croydon	195	64	68.2%	(133)	07:54	63.9%	(99/155)	76.4%	(149)	22.1%	(43)	29.7%	(58)	8.6%	(16/186)
Ealing	175	66	60.6%	(106)	07:49	72.2%	(104/144)	80.0%	(140)	19.4%	(34)	27.4%	(48)	7.0%	(12/173)
Enfield	183	66	61.7%	(113)	09:01	67.1%	(100/149)	85.8%	(157)	24.6%	(45)	21.9%	(40)	9.4%	(17/181)
Greenwich	138	62	69.6%	(96)	07:44	63.7%	(72/113)	70.3%	(97)	20.3%	(28)	31.9%	(44)	8.9%	(12/135)
Hammersmith & Fulham	89	64	66.3%	(59)	06:46	57.5%	(42/73)	70.8%	(63)	28.1%	(25)	24.7%	(22)	13.6%	(12/88)
Haringey	122	61	69.7%	(85)	08:21	57.4%	(54/94)	74.6%	(91)	23.8%	(29)	26.2%	(32)	12.5%	(15/120)
Harrow	130	68	66.2%	(86)	07:26	71.3%	(77/108)	82.3%	(107)	26.2%	(34)	38.5%	(50)	18.5%	(24/130)
Havering	157	70	63.7%	(100)	08:22	59.8%	(76/127)	77.7%	(122)	22.3%	(35)	37.6%	(59)	7.2%	(11/152)
Hillingdon	154	67	66.9%	(103)	07:13	64.0%	(80/125)	78.6%	(121)	21.4%	(33)	26.6%	(41)	7.8%	(12/153)
Hounslow	126	64	64.3%	(81)	07:28	57.0%	(57/100)	73.0%	(92)	23.0%	(29)	34.1%	(43)	11.3%	(14/124)
Islington	117	62	61.5%	(72)	07:23	64.3%	(63/98)	66.7%	(78)	18.8%	(22)	29.9%	(35)	10.4%	(12/115)
Kingston	83	67	62.7%	(52)	07:08	61.4%	(43/70)	73.5%	(61)	26.5%	(22)	28.9%	(24)	6.1%	(5/82)
Lambeth	167	64	65.9%	(110)	07:00	63.1%	(89/141)	74.9%	(125)	18.0%	(30)	25.7%	(43)	10.4%	(17/163)
Lewisham	130	63	62.3%	(81)	07:36	57.3%	(63/110)	76.9%	(100)	17.7%	(23)	35.4%	(46)	10.2%	(13/128)
Merton	85	66	63.5%	(54)	06:16	59.4%	(41/69)	76.5%	(65)	27.1%	(23)	37.6%	(32)	13.3%	(11/83)
Newham	149	60	63.1%	(94)	07:17	63.1%	(82/130)	76.5%	(114)	20.1%	(30)	33.6%	(50)	7.7%	(9/142)
Redbridge	160	66	58.8%	(94)	07:59	57.6%	(76/132)	76.3%	(122)	23.8%	(38)	28.8%	(46)	11.1%	(17/153)
Richmond	94	67	67.0%	(63)	07:21	68.4%	(54/79)	72.3%	(68)	27.7%	(26)	29.8%	(28)	6.8%	(7/91)
Southwark	142	60	60.6%	(86)	07:23	56.4%	(66/117)	76.1%	(108)	16.2%	(23)	28.9%	(41)	7.9%	(11/140)
Sutton	115	67	74.8%	(86)	07:38	67.8%	(59/87)	82.6%	(95)	32.2%	(37)	36.5%	(42)	12.4%	(14/113)
Tower Hamlets	118	59	62.7%	(74)	06:38	64.5%	(60/93)	64.4%	(76)	20.3%	(24)	26.3%	(31)	11.4%	(13/114)
Waltham Forest	154	64	61.0%	(94)	08:18	70.4%	(88/125)	78.6%	(121)	16.9%	(26)	29.2%	(45)	5.9%	(9/152)
Wandsworth	119	64	58.8%	(70)	07:31	60.8%	(62/102)	68.1%	(81)	16.8%	(20)	28.6%	(34)	6.9%	(8/116)
West London	118	64	61.9%	(73)	07:13	60.6%	(63/104)	81.4%	(96)	23.7%	(28)	30.5%	(36)	12.3%	(14/114)

** Patients conveyed to non- London CCGs (n=12) and where CCG was missing (n=3) are excluded from the table.*

^Overall response times are measured from the time the call was connected by the operator.

 # Figures exclude arrests witnessed by LAS staff.

+ Denominators exclude patients with unknown survival outcomes.

Appendix 2: Patients with ROSC sustained to hospital who survived to discharge

Hospital name	2014/15			2015/16*			2016/17		
	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	77	21.4%	(6/28)	42	25.0%	(3/12)	41	12.5%	(2/16)
Barts Health^	-	-	-	124	53.5%	(54/101)	133	57.8%	(67/116)
Charing Cross	31	7.7%	(1/13)	40	18.2%	(4/22)	31	21.4%	(3/14)
Chelsea & Westminster	35	25.0%	(4/16)	33	35.7%	(5/14)	19	25.0%	(2/8)
Croydon	106	5.6%	(2/36)	123	10.4%	(5/48)	87	15.8%	(6/38)
Darent Valley	12	14.3%	(1/7)	10	50.0%	(2/4)	15	20.0%	(1/5)
Ealing	66	9.7%	(3/31)	54	12.5%	(3/24)	44	18.8%	(3/16)
Essex Cardiothoracic Centre	-	-	-	-	-	-	5	66.7%	(2/3)
Hammersmith	94	38.7%	(29/75)	76	53.8%	(35/65)	82	52.1%	(37/71)
Harefield	61	58.8%	(30/51)	30	56.0%	(14/25)	40	46.9%	(15/32)
Hillingdon	100	25.0%	(10/40)	83	25.6%	(10/39)	63	27.3%	(6/22)
Homerton	48	13.6%	(3/22)	43	4.8%	(1/21)	39	26.3%	(5/19)
King's College	192	40.7%	(44/108)	167	39.3%	(33/84)	189	41.7%	(45/108)
King George	75	16.2%	(6/37)	56	4.8%	(1/21)	47	0.0%	(0/17)
Kingston	58	16.7%	(3/18)	63	24.0%	(6/25)	56	8.3%	(2/24)
Newham	114	16.7%	(6/36)	77	6.7%	(2/30)	70	7.1%	(2/28)
North Middlesex	149	9.8%	(6/61)	119	8.0%	(4/50)	89	24.2%	(8/33)
Northwick Park	120	9.8%	(5/51)	126	22.8%	(13/57)	98	26.9%	(14/52)
Princess Royal	87	9.8%	(4/41)	66	17.9%	(5/28)	60	12.5%	(4/32)
Queen Elizabeth	150	12.5%	(7/56)	110	18.6%	(8/43)	101	18.6%	(8/43)
Queen's Romford	150	6.0%	(3/50)	129	4.7%	(2/43)	107	8.0%	(4/50)
Royal Free	110	41.2%	(28/68)	133	44.4%	(40/90)	132	47.7%	(41/86)
Royal London	122	20.0%	(12/60)	91	24.1%	(13/54)	78	22.6%	(7/31)
St George's	200	38.7%	(46/119)	183	39.0%	(41/105)	168	42.9%	(48/112)
St Helier	78	17.2%	(5/29)	41	21.4%	(3/14)	53	17.4%	(4/23)
St Mary's	81	30.0%	(9/30)	87	12.2%	(5/41)	76	23.7%	(9/38)
St Peters Chertsey	-	-	-	-	-	-	4	25.0%	(1/4)
St Thomas'	114	39.0%	(23/59)	116	47.5%	(28/59)	129	38.5%	(30/78)
University College Hospital	44	27.3%	(6/22)	35	26.1%	(6/23)	33	40.0%	(8/20)
Lewisham	80	19.0%	(4/21)	70	24.1%	(7/29)	51	11.5%	(3/26)
West Middlesex	79	23.5%	(8/34)	88	13.3%	(4/30)	66	0.0%	(0/24)
Whipps Cross	112	13.2%	(5/38)	86	17.1%	(6/35)	89	16.2%	(6/37)
Whittington	45	24.0%	(6/25)	39	21.4%	(3/14)	35	7.1%	(1/14)

** Patients conveyed to non- London hospitals (n=4) and one patient taken to Great Ormond Street Hospital are excluded from the table.*

^ Barts Health opened its Heart Centre at their St. Bartholomew Hospital site in April 2015.

+ 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	96	12.5% (12)	69.8% (67)	17.7% (17)	51.6% (48/93)
Essex Cardiothoracic Centre*	5	0% (0)	80.0% (4)	20.0% (1)	50.0% (2/4)
Hammersmith□	54	9.3% (5)	74.1% (40)	16.7% (9)	52.8% (28/53)
Harefield	26	7.7% (2)	84.6% (22)	7.7% (2)	42.3% (11/26)
King's College	53	13.2% (7)	73.6% (39)	13.2% (7)	45.7% (21/46)
Royal Free	53	13.2% (7)	69.8% (37)	17.0% (9)	54.7% (29/53)
St George's	55	5.5% (3)	81.8% (45)	12.7% (7)	51.9% (27/52)
St Peters Chertsey[#]	1	0% (0)	100% (1)	0% (0)	0.0% (0/1)
St Thomas'	25	12.0% (3)	72.0% (18)	16.0% (4)	50% (11/22)

** Essex Cardiothoracic Centre extended their catchment area and inclusion criteria in January 2017.*

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

 # St Peters Chertsey accepted patients from the LAS in July 2016.

+ 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:	66	27	52	302
Gender:				
Male	57.6% (38)	66.7% (18)	75.0% (39)	78.1% (236)
Female	39.4% (26)	33.3% (9)	23.1% (12)	21.2% (64)
Unknown	3.0% (2)	-	1.9% (1)	0.7% (2)
Arrest location:				
Private	83.3% (55)	77.8% (21)	53.8% (28)	53.3% (161)
Public	16.7% (11)	22.2% (6)	46.2% (24)	46.7% (141)
Witnessed[◊]:				
Bystander	24.2% (16)	33.3% (9)	48.1% (25)	39.1% (118)
LAS staff	15.2% (10)	14.8% (4)	11.5% (6)	16.6% (50)
Unwitnessed	60.6% (40)	51.9% (14)	40.4% (21)	44.4% (134)
Bystander CPR[#]:				
Yes	64.3% (36/56)	78.3% (18/23)	73.9% (34/46)	67.1% (169/252)
No	35.7% (20/56)	21.7% (5/23)	26.1% (12/46)	32.9% (83/252)
Initial rhythm[◊]:				
Asystole	78.8% (52)	77.8% (21)	63.5% (33)	58.9% (178)
PEA	12.1% (8)	22.2% (6)	21.2% (11)	28.1% (85)
VF/ Pulseless VT	1.5% (1)	-	13.5% (7)	12.3% (37)
Not Documented	7.6% (5)	-	1.9% (1)	0.7% (2)
ROSC sustained to hospital:				
Yes	19.7% (13)	7.4% (2)	28.8% (15)	25.5% (77)
No	80.3% (53)	92.6% (25)	71.2% (37)	74.5% (225)
Survived to discharge[+]:				
Yes	11.5% (7/61)	3.8% (1/26)	6.3% (3/48)	10.5% (30/287)
No	88.5% (54/61)	96.2% (25/26)	93.8% (45/48)	89.5% (257/287)

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

[#] Figures exclude arrests witnessed by LAS staff.

+ Denominators exclude patients with unknown survival outcomes.