**Characteristics of patients who are not resuscitated in out of hospital cardiac arrests and opportunities to improve community response to cardiac arrest**

Rajagopal S [a,b], Kaye CR [a], Lall R [a], Deakin CD [c,d], Gates S [a], Pocock H [d], Quinn T [e], Rees N [f], Smyth M [a,g], Perkins GD [a,b]*

Author affiliations:
[a] Clinical Trials Unit, University of Warwick, Coventry, CV4 7AL
[b] Heart of England NHS Foundation Trust, Birmingham, B9 5SS
[c] NIHR Southampton Respiratory Biomedical Research Unit, University Hospital Southampton, Southampton, SO16 6YD
[d] South Central Ambulance Service NHS Foundation Trust, c/o Bracknell Ambulance Station, Old Bracknell Lane West, Bracknell, Berkshire RG12 7AE, UK
[e] Joint Faculty of Health, Social Care and Education, Kingston University and St. George's, University of London, London SW17 0RE
[f] Pre-Hospital Emergency Research Unit, Welsh Ambulance Service NHS Trust
[g] West Midlands Ambulance Service NHS Foundation Trust, Brierley Hill, West Midlands, DY5 1LX

Corresponding author at Warwick Clinical Trials Unit, University of Warwick, Coventry CV4 7AL. Email g.d.perkins@warwick.ac.uk

**ABSTRACT**

**Aim:** This study explores why resuscitation is withheld when emergency medical staff arrive at the scene of a cardiac arrest and identifies modifiable factors associated with this decision.

**Methods:** This a secondary analysis of unselected patients who sustained an out of hospital cardiac arrest attended by ambulance vehicles participating in a randomized controlled trial of a mechanical chest compression device (PARAMEDIC trial). Patients were categorized as 'non-resuscitation' patients if there was a do-not-attempt-cardiopulmonary-resuscitation (DNACPR) order, signs unequivocally associated with death or resuscitation was deemed futile (15 minutes had elapsed since collapse with no bystander-CPR and asystole recorded on EMS arrival).

**Results**:Emergency Medical Services attended 11,451 cardiac arrests. Resuscitation was attempted or continued by Emergency Medical Service staff in 4,805 (42%) of cases. Resuscitation was withheld in 6,646 cases (58%). Of these, 711 (6.2%) had a do not attempt resuscitation decision, 4439 (38.8%) had signs unequivocally associated with death and in 1496 cases (13.1%) CPR was considered futile. Those where resuscitation was withheld due to futility were characterised by low bystander CPR rates (7.2 %) and by being female.

**Conclusions:** Resuscitation was withheld by ambulance staff in over one in ten (13.1%) victims of out of hospital cardiac arrest on the basis of futility. These cases were associated with a very low rate of bystander CPR. Future studies should explore strengthening the 'Chain of Survival' to increase the community bystander CPR response and evaluate the effect on the number of survivors from out of hospital cardiac arrest.

## INTRODUCTION

When cardiac arrest occurs there is sudden cessation of circulation to the brain and other vital organs. Irreversible death will occur within minutes unless circulation is restored. The technique of CPR was first described over 50 years ago and can be used to buy time whilst reversible causes of cardiac arrest are identified and treated.[1] Previous studies have estimated that there are approximately 60,000 out of hospital cardiac arrests (OHCAs) attended by Emergency Medical Services (EMS) in the UK.[2] More recent data indicate that resuscitation is only initiated or continued by EMS in approximately 28,000 cases.[3] This suggests that in more than 50% of cardiac arrests, resuscitation is withheld by EMS. Although some OHCAs occur in the presence of healthcare staff, most occur without such individuals present. Here, bystander CPR can improve survival chances by two to four fold.[4, 5] Increasing those trained in CPR in the community can dramatically impact survival and consistently features in regions reporting high survival rates. [6]

Despite its lifesaving potential, circumstances exist where attempting resuscitation is inappropriate. This includes the presence of do not attempt cardiopulmonary resuscitation orders (DNACPR), un-survivable injuries or clear evidence of death (e.g. rigor mortis, post mortem staining). Resuscitation is also withheld by EMS when there is no prospect of success. This is defined in national guidelines when over 15 minutes has passed since arrest onset, no bystander CPR is provided prior to EMS arrival and the patient is in asystole.[7]

Little is known about the characteristics of patients in whom resuscitation is withheld by EMS. This study aimed to explore the reasons for withholding resuscitation when EMS arrive at a cardiac arrest and sought to identify potentially modifiable factors associated with the decision to withhold resuscitation.

## METHODS

This study presents a secondary analysis of patients enrolled in the PARAMEDIC trial.[8] The population reported in this trial is larger than that reported in the PARAMEDIC trial as it includes patients assessed during the set up phase of the trial. The PARAMEDIC trial was registered on the International Standard Randomised Controlled Trial Number Registry (ISRCTN08233942) and received ethical approval from Coventry Resarch Ethics Committee: 09/H1210/69.

### Setting

The PARAMEDIC trial was a pre-hospital cluster randomised controlled trial of a mechanical chest compression device in adult out-of-hospital cardiac arrest.[8] The trial utilised 91 ambulance stations across four UK National Health Service (NHS) Ambulance Services. Ambulance vehicles were randomized to deliver manual cardiopulmonary resuscitation (CPR) or the LUCAS-2 device (Lund University Cardiopulmonary Assistance System) to eligible patients.[9] Dispatch centers were blinded to vehicle allocations and assigned the nearest ambulance or rapid response vehicle (RRV) to patients with possible cardiac arrest.

As per UK resuscitation guidelines, upon confirming cardiac arrest, EMS assessed the appropriateness of initiating resuscitation (or if it was bystander initiated, to continue it). If EMS clinicians are presented with a written DNACPR order, signs unequivocally associated with death(SUAD) or resuscitation was deemed futile (see Box 1) then EMS did not provide CPR. If resuscitation was appropriate, it was initiated according to standardised national guidelines based on European Resuscitation Council Guidelines.[7,10,11] Patients were then transported to an emergency department (with ROSC or on-going CPR) or declared deceased if no reversible causes of cardiac arrest were identified and the patient was in asystole 20 minutes after initiation of resuscitation.

**Box 1**

Signs unequivocally associated with death (SUAD):

1. Massive cranial and cerebral destruction
2. Hemicorporectomy or similar massive injury
3. Decomposition/putrefaction
4. Incineration
5. Hypostasis
6. Rigor mortis
7. Fetal maceration

Futile resuscitation

The combination of 15 minutes since the onset of cardiac arrest, no bystander CPR prior to arrival of the ambulance and asystolic for more than 30 s).

(JRCALC guidelines)

**Data collection**

Information collected detailed patient characteristics (age, sex), aetiology (presumed cardiac, respiratory, submersion, traumatic, other), location (home, public place), day and time of cardiac arrest, whether the arrest was witnessed (EMS, non-EMS, unwitnessed), ambulance response time, bystander CPR (present/absent) and whether ambulance staff attempted resuscitation or not. Reasons for withholding resuscitation were also recorded. Data were transcribed from ambulance service clinical records onto trial Case Report Forms, according to the Utstein 2003 template, and entered onto a central database.[12] As it may take a few minutes after EMS arrival to establish if resuscitation is appropriate, short resuscitation attempts (where EMS resuscitation duration was under 3 minutes) were categorized as non-resuscitation attempts. The period of data collection was April 2010 to June 2013.

Patients in whom resuscitation was not appropriate were divided into one of three 'non-resuscitation' categories; DNACPR, signs unequivocally associated with death or futile. A few patients were recorded as falling simultaneously into more than one non-resuscitation category. These patients were assigned to one non-resuscitation category based on a hierarchy as follows. Any patients with a DNACPR order, regardless of futility or signs unequivocally associated with death, were assigned to the DNACPR group. Patients with signs unequivocally associated with death or where futility criteria were met were assigned as signs unequivocally associated with death. The remaining non-resuscitation patients only fulfilled futile criteria.

## Statistical analysis

Data were analysed using SPSS version 22. Descriptive statistics were generated showing patient characteristics in the non-resuscitation (DNAR, signs unequivocally associated with death and futile) and resuscitation groups. Each non-resuscitation group was compared to the resuscitated group in a multinomial regression model. Using tolerance and variation inflation factor statistics to assess multicollinearity, the age variable and sub-categories of location and day of week were shown to introduce collinearity and violated the assumption of independence. Therefore these variables were removed from the model. The final model included sex, EMS response time, aetiology, time of day and bystander CPR with inclusion of 90.5% of the database. This model showed a good fit using the Hosmer and Lemeshow test. For each comparison, odds ratios and 95% confidence intervals (CI) were produced with the resuscitation group as the reference category. Odds ratios could not be calculated when there were no patients in a particular sub-group e.g. no DNACPR patients sustained traumatic or submersion aetiologies of arrest. These are denoted as not-applicable (N/A) in table 2.

## RESULTS

### Proportions of patients in whom resuscitation was or was not attempted

Overall, ambulance vehicles attended 11,451 OHCAs from April 15$^{th}$, 2010 to June 10$^{th}$, 2013. EMS attempted resuscitation in 4,805 cases (42%, Table 1). Resuscitation attempts were withheld in 6,646 cases (58%). Of these, 711 (6.2%) had a DNACPR, 4439 (38.8%) had SUAD, and CPR was considered futile in 1496 cases (13.1%). Information about patient and cardiac arrest event characteristics are summarised in Table 1.

**Table 1: Descriptive statistics table detailing the characteristics of resuscitated and non-resuscitated patients**

| Variables | Reason for not attempting resuscitation | | | | Resuscitation attempted 4805 (42.0%) | Overall Totals 11452 (100%) |
|---|---|---|---|---|---|---|
| | DNACPR 711 (6.2%) | SUAD 4439 (38.8%) | Futile 1496 (13.1%) | **Total Not resuscitated 6646 (58.0%)** | | |
| **1. Age (years)** | | | | | | |
| median | 83.0 | 75.0 | 81.0 | 78.0 | 74.0 | 76.0 |
| mean | 80.6 | 71.6 | 77.0 | 73.9 | 69.7 | 72.1 |
| range | 27-106 | 0-106 | 17-107 | 0-107 | 0-104 | 0-107 |
| **2. Sex** | | | | | | |
| Male | 306 (43.0%) | 2702 (60.9%) | 754 (50.4%) | 3762 (56.6) | 3025 (63%) | 6787 (59.4%) |
| Female | 404 (56.8%) | 1722 (38.8%) | 741 (49.5%) | 2867 (43.1) | 1775 (37.9%) | 4642 (40.6%) |
| Missing | 1 (0.1%) | 15 (0.3%) | 1 (0.07%) | 17 (0.3%) | 5 (0.1%) | 22 (0.2%) |
| **3. Aetiology** | | | | | | |
| Presumed Cardiac | 424 (59.6%) | 3600 (81.1%) | 1268 (84.8%) | 5292 (79.6%) | 3981 (82.9%) | 9273 (81.0%) |
| Traumatic | 0 | 101 (2.3%) | 15 (1.0%) | 116 (1.7%) | 111 (2.3%) | 228 (2.0%) |
| Respiratory | 53 (7.5%) | 251 (5.7%) | 79 (5.3%) | 383 (5.8%) | 344 (7.2%) | 727 (6.3%) |
| Submersion | 0 | 17 (0.4%) | 2 (0.1%) | 19 (0.3%) | 15 (0.3%) | 34 (0.3%) |
| Other | 214 (30.1%) | 208 (4.7%) | 60 (4.0%) | 482 (7.3%) | 180 (3.7%) | 662 (5.8%) |
| Missing/Unknown | 20 (2.8%) | 262 (5.9%) | 72 (4.8%) | 354 (5.3%) | 174 (3.6%) | 528 (4.6%) |
| **4. Location** | | | | | | |
| Home | 682 (95.9%) | 4181 (94.2%) | 1427 (95.4%) | 6290 (94.6%) | 3890 (81.0%) | 10180 (89.0%) |
| Public Place | 0 | 157 (3.5%) | 31 (2.1%) | 188 (2.8%) | 677 (14.1%) | 865 (7.6%) |
| Other | 28 (3.9%) | 92 (2.1%) | 34 (2.3%) | 154 (2.3%) | 235 (4.9%) | 389 (3.4%) |
| Missing | 1 (0.1%) | 9 (0.2%) | 4 (0.3%) | 14 (0.2%) | 3 (0.1%) | 17 (0.1%) |
| **Process** | | | | | | |
| **5. EMS response time**(*mean minutes:seconds, [SD])* | 08:27 [12:15] | 08:14 [09:35] | 07:35[06:45] | 08:07 [09:22] | 07:50 [10:41] | 08:00 [09:56] |
| **Median,IQR** | 06:11, 04:31 | 06:16, 04:32 | 06:08, 03:54 | 06:14, 04:24 | 06:23, 04:24 | 06:18, 04:25 |
| **6. Time of day** | | | | | | |
| Day (08:00-19:59) | 373 (52.5%) | 3223 (72.6%) | 880 (58.8%) | 4476 (67.3%) | 2940 (61.2%) | 7417 (64.8%) |
| Night (20:00-07:59) | 338 (47.5%) | 1216 (27.4%) | 616 (41.2%) | 2170 (32.7%) | 1865 (38.8%) | 4035 (35.2%) |
| Missing | 0 | 0 | 0 | 0 | 0 | 0 |
| **7. Day of week** | | | | | | |
| Monday | 92 (12.9%) | 710 (16.0%) | 222 (14.8%) | 1024 (15.4%) | 711 (14.8%) | 1735 (15.2%) |
| Tuesday | 90 (12.7%) | 603 (13.6%) | 226 (15.1%) | 919 (13.8%) | 652 (13.6%) | 1571 (13.7%) |
| Wednesday | 95 (13.4%) | 629 (14.2%) | 223 (14.9%) | 947 (14.2%) | 654 (13.6%) | 1601 (14.0%) |
| Thursday | 111 (15.6%) | 613 (13.8%) | 207 (13.8%) | 931 (14.0%) | 683 (14.2%) | 1614 (14.1%) |
| Friday | 122 (17.2%) | 586 (13.2%) | 190 (12.7%) | 898 (13.5%) | 668 (13.9%) | 1566 (13.7%) |
| Saturday | 106 (14.9%) | 650 (14.6%) | 202 (13.5%) | 958 (14.4%) | 724 (15.1%) | 1683 (14.7%) |
| Sunday | 95 (13.4%) | 648 (14.6%) | 226 (15.1%) | 969 (14.6%) | 713 (14.8%) | 1682 (14.7%) |
| Missing | 0 | 0 | 0 | 0 | 0 | 0 |
| **Witnesses and BCPR** | | | | | | |
| **8. Witnesses of** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **arrest** | | | | | | |
| EMS | 80 (11.3%) | 2 (0.0%) | 8 (0.5%) | 90 (1.4%) | 741 (15.4%) | 831 (7.3%) |
| Non-EMS | 254 (35.7%) | 98 (2.2%) | 177 (11.8%) | 529 (8.0%) | 2157 (44.9%) | 2686 (23.5%) |
| No witness | 254 (35.7%) | 4181 (94.2%) | 1191 (79.6%) | 5626 (84.7%) | 1522 (13.7%) | 7148 (62.4%) |
| Missing | 123 (17.3%) | 158 (3.6%) | 120 (8.0%) | 401 (6.0%) | 385 (8.0%) | 786 (6.9%) |
| **9. Bystander CPR** | | | | | | |
| Yes | 47 (6.6%) | 180 (4.1%) | 107 (7.2%) | 334 (5.0%) | 2093 (43.6%) | 2427 (21.2%) |
| No | 648 (91.1%) | 4182 (94.2%) | 1361 (91.0%) | 6191 (93.2%) | 2416 (50.3%) | 8608 (75.2%) |
| Missing | 16 (2.3%) | 77 (1.7%) | 28 (1.9%) | 121 (1.8%) | 296 (6.2%) | 417 (3.6%) |
| **10. Bystander CPR (BCPR) categories** | | | | | | |
| BCPR+witness | 24 (3.4%) | 13 (0.3%) | 25 (1.7%) | 62 (0.9%) | 1240 (25.8%) | 1302 (11.4%) |
| BCPRunwitnessed | 17 (2.4%) | 152 (3.4%) | 76 (5.1%) | 245 (3.7%) | 698 (14.5%) | 943 (8.2%) |
| No BCPR | 650 (91.4%) | 4182 (94.2%) | 1361 (91.0%) | 6193 (93.2%) | 2425 (50.5%) | 8619 (75.3%) |
| Missing | 20 (2.8%) | 92 (2.1%) | 34 (2.3%) | 146 (2.2%) | 442 (9.2%) | 588 (5.1%) |

**Patients where resuscitation was withheld due to a DNACPR**

Patients with a DNACPR were less likely to be male (odds ratio 0.42 (0.35 - 0.50), Table 2) compared to resuscitated patients. The arrest aetiology was more likely to be respiratory (7.5%, odds ratio 1.40 (1.02 - 1.93) or 'other'(e.g. end of life) (30.1%, odds ratio 10.45 (8.15-13.41). The time of emergency call was more likely to be at night (0.76, 95% CI 0.64-0.91) for DNACPR patients compared to resuscitated patients and they were less likely to receive bystander CPR. There was no difference in EMS response time (figure 1, odds ratio 1.00 (1.00-1.00)) or day of the week between those where resuscitation was withheld due to a DNACPR decision versus those in whom resuscitation was attempted.

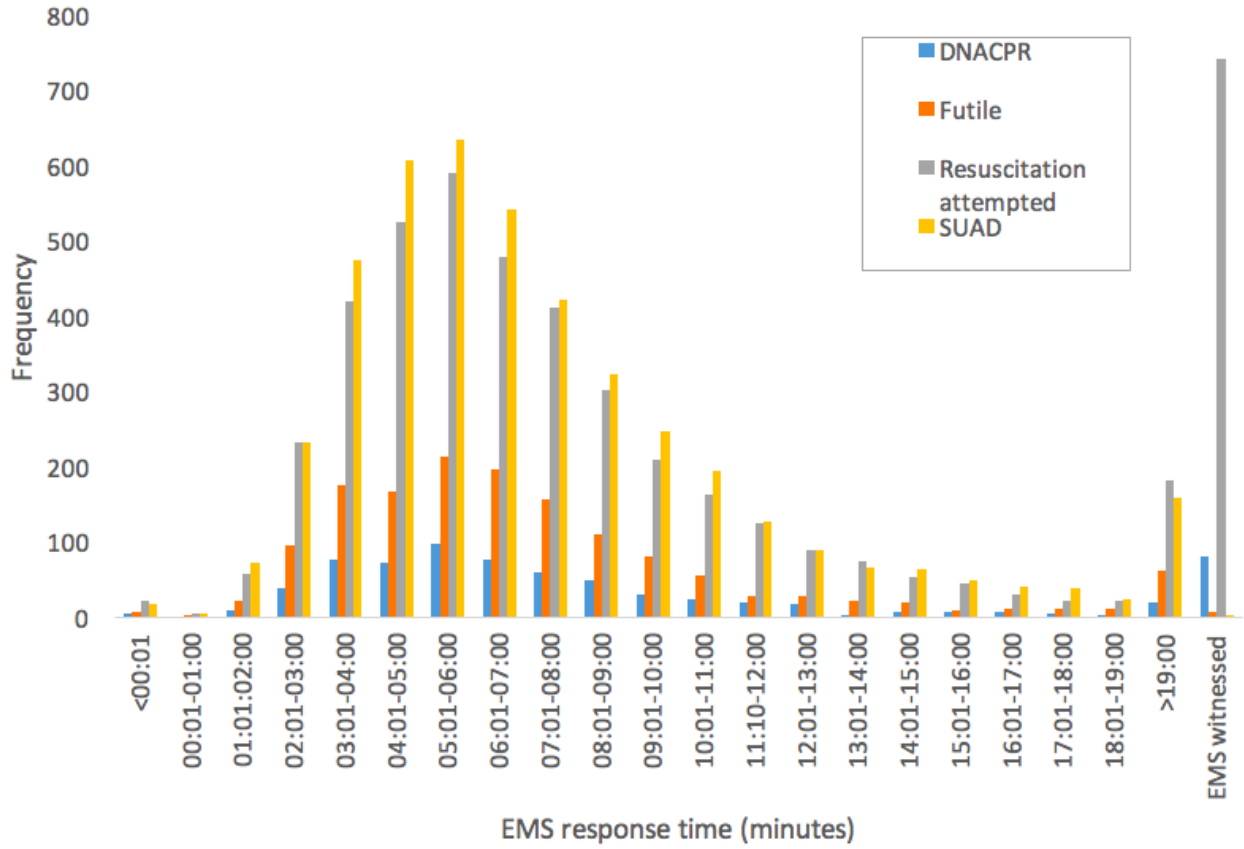
**Table 2 Multinomial regression analysis comparing resuscitated patients to non-resuscitated patients**

| **Covariates/Factors** | | **DNACPR** | | **SUAD** | | **Futile** | |
|---|---|---|---|---|---|---|---|
| | | **OR** | **95% CI** | **OR** | **95% CI** | **OR** | **95% CI** |
| **Sex** | **Male** | 0.42 ± | 0.348-0.497 | 0.92 | 0.834-1.021 | 0.62 ± | 0.542-0.703 |
| | **Female (ref)** | - | - | - | - | - | - |
| **EMS response time** | | 1.00 | 1.000-1.000 | 1.00 | 1.000-1.000 | 1.00 | 1.000-1.000 |
| **Aetiology** | **Respiratory** | 1.40 ± | 1.020-1.928 | 0.70 ± | 0.583-0.849 | 0.66 ± | 0.507-0.860 |
| | **Submersion** | N/A | - | 1.15 | 0.512-2.578 | 0.40 | 0.088-1.840 |
| | **Traumatic** | N/A | - | 0.98 | 0.708-1.345 | 0.44 ± | 0.247-0.766 |
| | **Other** | 10.45± | 8.145-13.410 | 1.15 | 0.908-1.443 | 0.97 | 0.710-1.333 |
| | **Cardiac (ref)** | - | - | - | - | - | - |
| **Day/Night** | **Day** | 0.76 ± | 0.637-0.908 | 1.80 ± | 1.625-2.000 | 0.97 | 0.849-1.105 |
| | **Night (ref)** | - | - | - | - | - | - |
| **BCPR** | **BCPR witnessed** | 0.09 ± | 0.057-0.133 | 0.006 ± | 0.004-0.011 | 0.05 ± | 0.024-0.055 |
| | **BCPR** | 0.09 ± | 0.055-0.149 | 0.13 | 0.108-0.157 | 0.20 | 0.156-0.257 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **unwitnessed** | | | | | | |
| | **No BCPR (ref)** | - | - | - | - | - | - |

Odds ratio (OR), Reference (ref), Not applicable (N/A), Non-significant (N/S), Bystander CPR (BCPR)

**Figure 1: The relationship between EMS response time and whether resuscitation was attempted or withheld**




**Patients where resuscitation was withheld as there were signs unequivocally associated with death**

Gender did not influence whether a patient was in the resus group or the signs unequivocally associated with death group (Table 2). Cardiac arrests were less likely to be respiratory in origin (odds ratio 0.70 (0.58-0.85), Table 2) and the emergency call was more likely to be in the day than the night (odds ratio 1.80 (1.63-2.00)). Bystander CPR was rarely performed irrespective of whether cardiac arrest was witnessed (odds ratio 0.006 (0.004-0.01)) or un-witnessed (odds ratio 0.13 (0.11-0.16).There was no difference in EMS response time (figure 1, odds ratio 1.00 (1.00-1.00)) or day of the week between those where resuscitation was withheld due to unequivocal evidence of death, versus those in whom resuscitation was attempted.

**Patients where resuscitation was withheld as resuscitation attempts considered futile**

Male patients were less likely to have resuscitation withheld due to futility than females (odds ratio 0.62 (0.54-0.70). The aetiology was less likely to be traumatic (odds ratio 0.44 (0.25-0.77), Table 2) or respiratory (odds ratio 0.66 (0.51-0.86) in origin in futile arrests. Bystander CPR was infrequently performed. For witnessed arrests, bystander CPR was performed in 1.7% of cases (odds ratio 0.05(0.02-0.06) compared with 5.1% of cases where the arrest was un-witnessed (odds ratio 0.20 (0.16-0.26). There was no difference in EMS response time (figure 1) or day of the week between those where resuscitation was withheld due to futility versus those in whom resuscitation was attempted.

**DISCUSSION**

The most important finding is that for over one in ten patients (13.1%) who sustain an out of hospital cardiac arrest, resuscitation is not attempted by EMS as the chances of survival are judged as negligible by the time of assessment. These patients are characterised by having collapsed for a duration over 15 minutes when no bystander CPR is attempted such that the cardiac rhythm has degenerated to asystole. It is possible that some could be saved with bystander CPR provision. Extrapolating these findings across the UK[3] and Europe,[13] represents 7,800 and 65,000 patients respectively each year where enhancing the community response to cardiac arrest to deliver bystander CPR may increase the number of potentially salvageable patients upon arrival of emergency services. If survival rates were similar to the national average (8%) then an additional 390 people would survive to leave hospital each year in the UK.

Bystander CPR is a critical step in the Chain of Survival, increasing the chances that a victim will survive by two to four fold, which translates to one additional life for every 30 patients who receive bystander CPR. [4, 5] Despite clear evidence of benefit, The rates of bystander CPR vary between communities from 10 – 75%.[14] Barriers to bystanders being willing to initiate CPR include socioeconomic deprivation, difficulty in diagnosing cardiac arrest, panic, fear of disease, fear of harming the victim or fear of performing CPR incorrectly.[15-17] Victim characteristics associated with less willingness for bystander CPR initiation include being unknown to the rescuer, appearing unkempt, evidence of drug use, the presence of blood, or vomit.[15] However, as the vast majority of OHCAs occur in the home, it is possible that bystander characteristics are more important than victim factors. Compared to conventional CPR (which includes mouth-to-mouth ventilation), compression only CPR may further reduce reluctance to initiate resuscitation.[18] Training communities to perform CPR can increase bystander CPR rates and overall survival.[6] Training ambulance dispatch staff to provide compression-only CPR telephone instructions both reduces time to first compression and increases chances of bystander CPR initiation. Additionally, one study increased rates of bystander CPR from 48% to 62% by using mobile phone technology to enable trained volunteers to be dispatched to the scene of an cardiac arrest, with one study showing a subsequent.[19]

It is well established that post-menopausal women and men of the same age have similar lifetime risks of cardiovascular disease, although presentation between them can vary.[20, 21] This study identified but cannot explain why fewer women than men had resuscitation initiated by ambulance staff. This is consistent with other epidemiological data showing a greater proportion of males receive resuscitation from ambulance staff.[22] The OPALS

study found that women were older than men (median age 74 versus 69 years, $p < 0.01$), had fewer witnessed arrests (43% vs. 49%; $p < 0.01$), were less likely to have shockable rhythms (24% vs. 42%; $p < 0.01$), and had lower rates of bystander CPR (12% vs. 17%; $p < 0.01$). Further research may help to explain the apparent inequality in resuscitation rates between the sexes.

Whilst resuscitation can be lifesaving, there are some situations where attempting resuscitation will not reverse the dying process.[23] In this study, 6.2% had a DNACPR preventing resuscitation being attempted. These patients were older on average, more were females and it was more likely for emergency calls to be placed at night compared to patients where resuscitation was attempted. Despite having a DNACPR in place, nearly one in twenty still received bystander CPR, suggesting scope for better communication to carers, family or EMS and better systems response at death. The largest proportion of patients in whom resuscitation was withheld were those with signs unequivocally associated with death (38.8%). Given the low proportion of patients with traumatic cardiac arrest, it is likely that most had signs suggesting that death had occurred some time prior to EMS arrival (e.g. rigor mortis, post-mortem staining). This is consistent with high numbers of unwitnessed arrests and greater probability of being discovered during the day.

This study has important implications when considering the epidemiology and outcome from cardiac arrest. A systematic review of 67 studies found the proportion of patients in whom resuscitation is attempted varies between countries from 33% to 100%.[24] This will have significant impact on reported numbers of EMS treated arrests and their outcomes. Calculation of survival to include patients in the denominator who have a low chance of survival will impact survival figures. For example the PARAMEDIC trial found survival amongst EMS treated arrests was 6.6% compared to 2.7% for all patients attended by EMS. Reporting survival rates as the total number of survivors per 100,000 population may be a better measure of overall system effectiveness. The same applies to reporting of bystander CPR rates which also varies between and within countries. In the present study, the bystander CPR rate was 43% in EMS treated cardiac arrests but only 20% of all arrests (treated and untreated).

This study was conducted in the context of a clinical trial which had comprehensive systems for case ascertainment and data quality checks. Ambulance vehicles were dispatched to unselected cases of cardiac arrest, therefore the population of patients evaluated were representative of those treated for cardiac arrest by the National Health Service. The proportion of patients where resuscitation was attempted (42%) is lower than previous data have suggested which may reflect temporal changes or more comprehensive data capture in this study. This index, open-label trial, allocated ambulance vehicles to manual or mechanical CPR arms. The trial carefully monitored resuscitation threshold between intervention (mechanical CPR) and control (manual CPR) arms and found no evidence of interaction with the likelihood that resuscitation would be attempted. However the present study was not able to fit multinomial regression models to include location or age due to multicollinearity. The variables included in the model were based on validated Utstein guidelines. Our evaluation was based on the reasons for withholding resuscitation reported by EMS clinicians. Clinical staff record the circumstances leading to the decision to withhold CPR and document the absence of bystander CPR, time from collapse to arrival >15 min and

provide a print out of asystole on ECG for 30 s when declaring that resuscitation is futile. We did not independently verify the information reported by EMS clinicians. Furthermore, we did not seek information from secondary sources (e.g. call logs, qualitative interviews). It is therefore possible that other unmeasured factors may have influenced resuscitation decisions. Future studies should consider exploring in greater depth the reasons why resuscitation is withheld to gain a better understanding of the decision making process and whether any other factors may influence decisions.

**Conclusions**

Resuscitation was withheld by ambulance staff on the basis of futility in 13.1% of victims of out of hospital cardiac arrest. These cases were associated with very low rates of bystander CPR (7.2%). Efforts to strengthen the 'Chain of Survival' to increase the community bystander CPR response and evaluate the effect on the numbers of survivors from out of hospital cardiac arrest.

**Conflict of interest statement**

All authors except SR revceived funding from the National Institute for Health Research for the PARAMEDIC trial. Some authors have also received funding from the Resuscitation Council UK (GDP, CD) and British Heart Foundation (GDP).

**Author contributions**:

RS, RL, CK and GDP designed the study. SG, CD, NR, HP, MS, RS, TQ, GDP, CK contributed to data collection. RS and RL analysed the data. RS and CK developed the first draft of the paper which was revised by all co-authors for important intellectual content prior to final approval by all authors.

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