Survival of resuscitated cardiac arrest patients with ST-elevation myocardial infarction (STEMI) conveyed directly to a Heart Attack Centre by ambulance clinicians

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Objective: This study reports survival outcomes for patients resuscitated from out-of-hospital cardiac arrest (OHCA) subsequent to ST-elevation myocardial infarction (STEMI), and who were conveyed directly by ambulance clinicians to a specialist Heart Attack Centre for expert cardiology assessment, angiography and possible percutaneous coronary intervention (PCI).

Methods: This is a retrospective descriptive review of data sourced from the London Ambulance Service’s OHCA registry over a one-year period.

Results: We observed excellent survival rates for our cohort of patients with 66% of patients surviving to be discharged from hospital, the majority of whom were still alive after one year. Those who survived tended to be younger, to have had a witnessed arrest in a public place with an initial cardiac rhythm of VF/VT, and to have been transported to the specialist centre more quickly than those who did not.

Conclusion: A system allowing ambulance clinicians to autonomously convey OHCA STEMI patients who achieve a return of spontaneous circulation directly to a Heart Attack Centre is highly effective and yields excellent survival outcomes.

1. Introduction

There is growing evidence that rapid access to angiography and emergency percutaneous coronary intervention (PCI) for patients resuscitated from out-of-hospital cardiac arrest (OHCA) secondary to ST-elevation myocardial infarction (STEMI) is associated with improved survival as reviewed by Kern and Rahman. It has also been reported that conscious STEMI patients resuscitated from cardiac arrest and treated with PCI can be expected to have the same prognosis as those treated with PCI who have not suffered a cardiac arrest.

Whereas the benefits of ambulance services directly conveying STEMI patients to the catheter laboratory for reperfusion therapy have been previously documented, the role of the ambulance service in the direct admission of those whose STEMI has been complicated by OHCA has not been fully explored.

Ambulance services in the UK traditionally convey OHCA patients directly to a hospital Emergency Department (ED). In late 2010, the London Ambulance Service embarked on a new clinical care pathway enabling ambulance clinicians to bypass the nearest ED and transfer STEMI patients with a return of spontaneous circulation (ROSC) following an OHCA directly to the catheter laboratory of the nearest Heart Attack Centre (HAC) for immediate angiography and emergency PCI if indicated. Decisions to convey these patients to a HAC are made at the sole discretion of the ambulance clinicians, based on their clinical observations and 12-lead electrocardiogram (ECG) interpretation.

This study reports, over a one year period, the outcome of direct ambulance service admissions for this select group of patients with the aim of demonstrating the effectiveness of this pathway and the ability of ambulance clinicians to make such conveyance decisions.

2. Methods

2.1. Design

This is a retrospective descriptive review of data sourced from the London Ambulance Service’s (LAS) OHCA registry over a...
one-year period (1st April 2011 – 31st March 2012). Ethics approval was not required as this study reports audit data.

2.2. Patient population

All adult patients (≥ 18 years of age) were included if they were conveyed directly to one of eight HACs in London after experiencing an OHCA, had a ROSC, and ST-elevation was visible in two or more adjacent ECG leads (as interpreted by the attending clinician).

2.3. System overview

The LAS serves Greater London’s population of 8.2 million people. It operates from 69 ambulance stations covering an area of 1579 square kilometres (609 square miles). Each year the LAS receives over 1.5 million calls for emergency help and responds to over 1 million incidents. All emergency vehicles are staffed by ambulance clinicians who are paramedics or emergency medical technicians trained in advanced or basic life support respectively and as a minimum can recognise ST-elevation when present on a 12 lead ECG. A minimum of two units are dispatched for high priority calls; a fast response vehicle (car, motorcycle or bicycle) is automatically activated to ensure a rapid response, followed by an ambulance. At the time of this study the LAS did not initiate pre-hospital therapeutic hypothermia in this patient group. All LAS clinicians operate to the European Resuscitation Council guidelines with specific local protocols for use of automated external defibrillators in manual mode and provision of a period of two-minute CPR prior to the delivery of defibrillation in un-witnessed cardiac arrests.

2.4. The new pathway

Introduced in September 2010, the new pathway enables OHCA patients with ROSC and evidence of STEMI to be transported directly to a HAC. This pathway is implemented irrespective of the patient’s level of consciousness and whether or not ROSC is sustained to admission. Patients who suffer an OHCA with no evidence of ST-elevation continue to be transported to the nearest of 35 ED hospitals. Ambulance clinicians decide whether or not to convey patients to a HAC by making reference to their clinical findings and interpretation of the 12-lead ECG.

2.5. Data collection

The cardiac arrest registry contains data for approximately 10,000 out-of-hospital cardiac arrests that occur each year in London. It was established to monitor the quality of care delivered to patients and to identify potential areas for improvement.

Information is obtained from multiple sources including the LAS Emergency Operations Centre (where emergency calls are received), data terminals of dispatched vehicles, the clinical record completed by the attending LAS clinician, and data captured from automated external defibrillators where available. The registry provides a clinical record for each OHCA patient including information on aetiology, perceived suitability for resuscitation, age, gender, location, presenting cardiac rhythm, bystander intervention, ROSC, and ambulance response times.

Using the combined sources of hospital records and a national database we were able to obtain data relating to whether or not patients survived to hospital discharge, and both 30-days and 1 year post discharge.

All data were collected and stored following Good Clinical Practice guidelines and the relevant legislations governing the use of patient data.

2.6. Analysis

Descriptive statistics were used to summarise data for all patients included in this study. T-tests were used to investigate differences between survival groups for continuous variables and Chi square analysis for categorical variables. A p value of less than <0.05 was considered significant. Statistical analyses were undertaken using SPSS 19.0 (SPSS Inc., Chicago, IL, USA).

3. Results

During the study period a total of 206 adult (≥ 18 yr age) OHCA patients who achieved ROSC and had clear evidence of ST-elevation on the 12-lead ECG were conveyed directly to a HAC by LAS clinicians. All patients were admitted to the HAC within 125 min of the call for emergency help (median 63 min).

66% of patients survived to be discharged from hospital; 98% of these survived 30 days post-discharge, and 97% were still alive at one year (Table 1).

Those who survived to be discharged from hospital differed significantly from non-survivors on a number of variables: they tended to be younger (mean: 59 vs. 68 years); to have had a witnessed arrest in a public place with an initial cardiac rhythm of VF/VT, and to have had shorter intervals from emergency call to arrival at HAC (mean: 56 vs. 75 min) (Table 2).

4. Discussion

Survival in our cohort of resuscitated OHCA STEMI patients who were taken directly to a HAC was much higher than expected considering the survival rates we have reported historically for those taken to hospital (12–32%), and is similar to other reports of comparable patients directly admitted for PCI. The finding that two-thirds of our patients survived to hospital discharge, with the majority being alive one year later, demonstrates the effectiveness of a system that enables ambulance services to convey a high-risk group of STEMI patients directly for immediate access to angiography and potential PCI. Moreover, our findings support a unique role whereby ambulance clinicians have complete autonomy over decisions to transfer patients directly to a HAC. We hope that these findings will encourage other ambulance services and their local HACs to adopt a similar approach to ours.

Unfortunately, due to the restrictions on access to hospital data afforded to UK ambulance services and a lack of linkage between the ambulance and hospital systems, we were unable to obtain data relating to how many patients received PCI. Nonetheless, regardless of whether PCI was delivered, it is possible that the very act of providing patients with rapid access to the specialist cardiac staff and facilities that are available at a HAC 24 h a day, 7 days a week, may itself play an important role in the favourable outcomes that we report.
Table 2
Differences between survivors and non-survivors for key event and patients characteristics.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Direct to HAC (n=206)</th>
<th>Differences between survivors and non-survivors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) Mean ± S.D.</td>
<td>62 ± 13.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>170 (82.5)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Female</td>
<td>36 (17.5)</td>
<td></td>
</tr>
<tr>
<td>Witnessed arrest, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bystander</td>
<td>103 (50.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Crew</td>
<td>75 (36.4)</td>
<td></td>
</tr>
<tr>
<td>Bystander CPR, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>87 (66.4)</td>
<td>n.s.</td>
</tr>
<tr>
<td>No</td>
<td>44 (33.6)</td>
<td></td>
</tr>
<tr>
<td>Initial arrest rhythm, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asystole</td>
<td>13 (6.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>VF/pVT</td>
<td>176 (85.4)</td>
<td></td>
</tr>
<tr>
<td>PEA</td>
<td>15 (7.3)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>2 (1.0)</td>
<td></td>
</tr>
<tr>
<td>Emergency call – arrival at scene (mins) Median (range)</td>
<td>6 (0–17)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Emergency call – arrival at HAC (mins) Median (range)</td>
<td>63 (28–125)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ROSC sustained to hospital, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>202 (98.0)</td>
<td>n.s.</td>
</tr>
<tr>
<td>No</td>
<td>2 (1.0)</td>
<td></td>
</tr>
<tr>
<td>Not known</td>
<td>2 (1.0)</td>
<td></td>
</tr>
</tbody>
</table>

*a Excludes crew witnessed arrests.

For the reasons given above, we were also unable to report the neurological status of our survivors. A review of 17 studies reported an overall neurologically intact survival rate of 87% of OHCA STEMI survivors, so we could reasonably expect a large proportion of survivors in our sample to have a good level of neurological functioning.

In general, cardiac arrests that occur in the presence of emergency personnel are expected to have a better prognosis than those witnessed by bystanders. The fact that 36% of our patients were in the ‘crew witnessed’ category may be a factor in our results. However, this information is important in two respects. First, our clinicians could easily have been led to take patients with a recent cardiac arrest to the nearest hospital, but instead they continued to follow protocol, often bypassing the nearest ED, to take patients to a HAC despite the fact that they had just had a cardiac arrest. Second, it highlights the importance of preparing ambulance clinicians conveying patients with STEMI that they should have a high expectation of cardiac arrest and be ready to deal with it.

Two patients in our study achieved ROSC during the pre-hospital management phase that was not sustained to HAC admission. However, these patients did receive ongoing CPR to admission. Although arguably these patients may be different from those for whom ROSC was sustained, we included them in the analyses because, whether sustained or not, ROSC is part of the inclusion criteria triggering use of the pathway. One of these patients survived to discharge and the other did; excluding them from the analyses would have made little difference to our results. The fact that one of these patients did survive, suggests that achieving ROSC at any time, even if it is not sustained, is important and is something that would be worth exploring further with a larger dataset.

As an additional benefit for OHCA patients in London, the LAS plans to supplement existing cardiac care with the use of pre-hospital therapeutic hypothermia in the near future. It is hoped that by delivering a comprehensive package of cardiac care, combining mild therapeutic hypothermia alongside immediate access to angiography and PCI even higher survival rates will be achieved.

5. Conclusion

Our study demonstrates excellent survival outcomes for patients with STEMI complicated by OHCA after direct conveyance to a HAC with the intention of immediate PCI. Our data further supports the role of ambulance clinicians in making autonomous clinical referral decisions.

Conflicts of interest statement

None declared.

Acknowledgments

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References