ST-Segment Elevation Myocardial Infarction (STEMI) Treatment Protocol: A 3 Year Clinical Audit

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Abstract

Aim
Reperfusion by primary percutaneous coronary intervention (PPCI) is the preferred treatment in clinical guidelines for the treatment of STEMI, if performed expediently. Chemical thrombolysis is recommended otherwise. Our aim was to assess the conformity to national standards in a cohort of STEMI patients presenting to St. James's hospital (SJH), over a 3 year period.

Methods
Patients were identified from the SJH PPCI database. Those patients with acute STEMI confirmed on admittance to St. James's Hospital from 30/6/17 to 30/6/20 were included.

Results
During this time period, 1161 patients were admitted to SJH with confirmed STEMI. The time from first ECG to reperfusion was 120 minutes or less (national guidelines) in 758/1161 (65.3%) patients. The median time to reperfusion for those transferred directly from the field was 1:29 (hr:min) versus 2:11 ($P<0.01$) in those brought to a regional centre first. Thrombolytic therapy was administered to 27/309 (8.7%) patients who exceeded the guidelines of 90 minutes from ECG to arrival at catheterisation laboratory.

Conclusion
This retrospective audit demonstrates that centres are currently struggling to achieve national standards in relation to STEMI care. Transferring patients to PPCI centre directly from the field can result in significantly earlier reperfusion.

Introduction

Timely primary percutaneous coronary intervention (PPCI) has become the international mainstay of treatment for acute ST segment elevation myocardial infarction (STEMI)[1]. Mechanical thrombolysis has taken over as the treatment of choice after the realisation that the preceding treatment (chemical thrombolysis) was ineffective at achieving reperfusion in a significant number of patients and can be complicated by severe bleeding [2]. When timely PPCI is not possible (the expected delay from STEMI diagnosis to wire cross time is >120 minutes), chemical thrombolysis is recommended by the guidelines [1,5].

It has been shown extensively in the literature, that the timeliness of reperfusion in patients with STEMI, can impact on mortality [3]. The FITT-STEMI trial (2018), for example, found that for patients in cardiogenic shock without out-of-hospital cardiac arrest, every 10 minute treatment delay between 60 –180 minutes from first medical contact resulted in an additional 3.3 deaths per 100 PCI patients [4].

The current Irish guidelines outlined in the Optimal Reperfusion Service (ORS) protocol (Heart Attack Care in Ireland 2014/2016[5,6]), advise that the treatment window for considering PPCI should be within 120 minutes from first medical contact to reperfusion. This allows for a 90 minute pre-hospital drive time and 30 minutes in hospital preparation prior to wire cross. If this is unable to be achieved, patients should be administered chemical thrombolysis within 30 minutes of diagnostic ECG and transferred directly to a PCI facility.

There are multifaceted challenges involved in achieving timely reperfusion, from the geographic distances and variation in the quality of road networks leading to SJH, to the organisational and communication delays involved in referring patients and finally the timeliness of administering treatment in the hospital.

St. James's hospital (SJH) is the designated PPCI centre serving the Dublin Mid Leinster (DML) region. The hospitals in this region include: Wexford General Hospital (region 1), St. Luke's General Hospital Kilkenny (region 2), Midland Regional Hospital Tullamore (region 3), Midland Regional Hospital Mullingar (region 4), Midland Regional Hospital Portlaoise (region 5), Naas General Hospital (region 6), Tallaght University Hospital (region 7), St. Vincent's University Hospital (region 8), St. Columcille's Hospital, Loughlinstown and St. Michael's Hospital, Dun Laoghaire. The regions are numbered based on their distances from SJH, with region 1 being situated the farthest away. Both St. Vincents and Tallaght hospitals can take 'walk in' or 'in house' STEMI patients on weekdays from 9am – 5pm. Currently, patients can only be thrombolysed in hospital. There is no facility for this, in ambulances or in primary care facilities.

The primary aim of this study was to assess the adherence of the St. James's / DML STEMI protocol with the national guidelines between the years of 2017-2020. We also aimed to disseminate our findings to those involved in the pre-procedural management of patients with STEMI, in the hope of improving the future outcomes of STEMI patients.

Methods

Patients were identified from the St. James's hospital PPCI database, derived from the National Heartbeat Portal. Mandatory data points (62) including time of onset, reperfusion time and in-hospital clinical outcomes are recorded for every patient attending for PPCI in Ireland. This data is transferred to the electronic national database, currently held by the National Office of Clinical Audit (NOCA). Individual data collection is undertaken by the clinical cardiology team and verified by a dedicated cardiology specialist nurse. Data accuracy was further verified by review of the clinical records by the study team.

We included all patients who had acute STEMI confirmed on admittance to St. James's Hospital from 30/6/17 to 30/6/20.

Patient data was collected by review of the PPCI database and of the hospital paper and electronic records.

The study design was observational, and no clinical interventions were performed. Therefore, according to the local policies, approval of the local ethics committee was waived. Permission to carry out the study was obtained from St. James's hospital Research and Innovation department.

A retrospective review of the PPCI database was conducted to establish the overall conformance to national guidelines with respect to the ECG to reperfusion time. This was then extended to attempt to identify the variation in times for the different hospitals in the DML region and finally to investigate the differences in times for patients transferred directly from the field versus those transferred from the emergency department (ED) of other hospitals. The hospital regions are each represented in number format (see appendix).

Statistical analysis was performed using SPSS 27 software. The descriptive statistics were expressed using the median values, N (the total number of individuals in the population) and the interquartile range. An independent samples T test was used to assess for statistical difference between two variables. Boxplots were used to represent the data graphically.

Results

The total number of patients with confirmed STEMI who were accepted to SJH over the study period was 1161. Thrombolysis was given to 29 of these patients, either pre arrival to SJH or in SJH. In the group of non Thrombolysed patients, 653 (57.7%) were admitted directly from the field via ambulance whereas 405 (35.8%) were transferred from the ED of another hospital. Sixty-one (5.4%) of this non thrombolysed group self-presented to SJH ED, whereas 8 (0.7%) patients were already inpatients in SJH and in 5 (0.4%) cases the admitting code was unknown.

When examining the conformity to national standards in relation to time to reperfusion, we noted that of this total study group of 1161 patients, 758 (65.3%) had a time from first diagnostic ECG to reperfusion of less than or equal to 120 minutes, the limit set out in the national guidelines. In the Heart Attack Care in Ireland 2014 report, this same indicator reflecting timeliness of reperfusion was reported to be 68% of patients. This was under the initial targets set out in the Heart Attack Care in Ireland 2014 document (75% for 2013, 80% for 2014)[5]. The Heart Attack Care in Ireland 2016 report documented an improvement of this figure to 71% of patients[6].

In relation to patients who were transferred from the ED of another hospital, only 168/410 (40.1%) had reperfusion within 120 minutes. This closely correlates to the figure of 41%, quoted in the Heart Attack Care in Ireland 2016 report[6].

The median time from first diagnostic ECG to reperfusion differs based on the patient's admission code. This is illustrated in figure 1 and table 1. The time to reperfusion for those admitted directly from the field via ambulance (N=653) was found to be 89 minutes (P=<0.01) with an interquartile range (IQR) of 78 minutes. This is compared with a median time of 132 minutes (P=<0.01) (IQR=51) for those transferred from the ED of another hospital (N=403), which exceeds the 120 minute timeframe described in the guidelines. For those patients who were inpatients in SJH at the time of the STEMI (N=8), the median time to reperfusion was 89 minutes (IQR=69) whereas for those who self-presented to the SJH ED (N=61), the median time was 76 minutes (IQR=47).
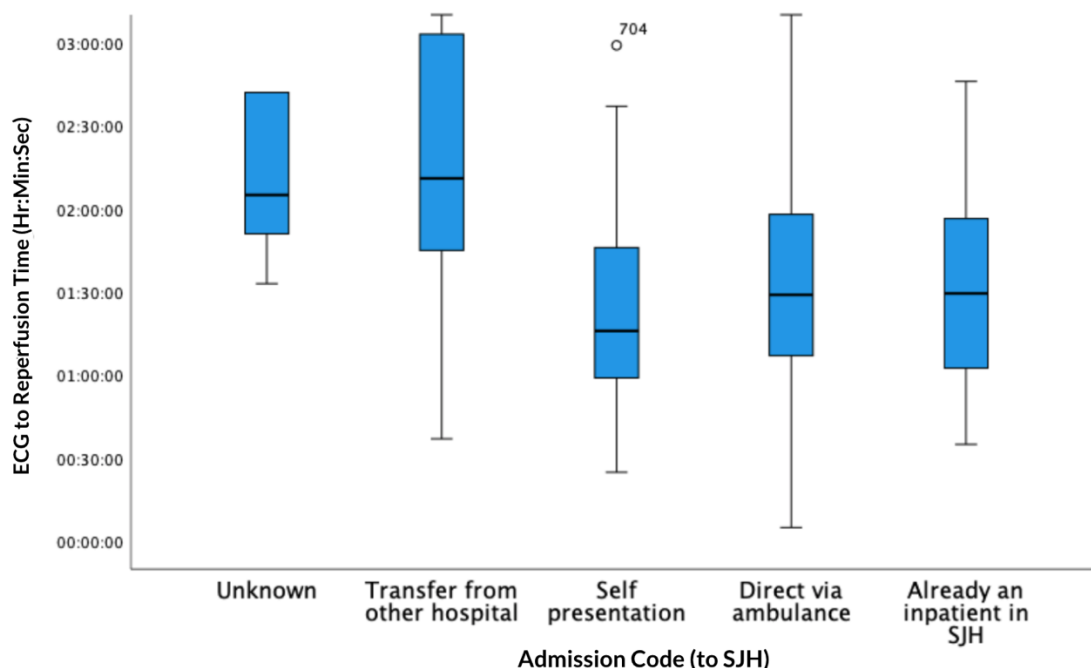
Figure 1: Boxplot of reperfusion time by Admission code.

Table 1: Reperfusion time by admission code.

	Transfer from other hospital (N=403)	Direct from field (N=653)	P value *
Median Time (Hr:Min)	2:11	1:29	<0.01
Interquartile range (Hr: Min)	1:29	0:51	<0.01
Age (mean)	63	62	<0.01
Sex (female)	99 (24.6%)	137 (21.0%)	<0.01

P values calculated using independent samples T test to assess for statistical differences between variables

The time from diagnostic ECG to reperfusion was then analysed with respect to the regional referral regions from where the STEMI was referred. This data is illustrated in table 2 and figure 2.

Referral region 1 had the longest median time to reperfusion of all the regions at 2 hours 25 minutes, which is in keeping with its status as the region the farthest from St. James's (146km). However, region 1 also had the highest proportion of patients going directly to the PPCI centre from the field (68.9%). This is important as when the patient was brought first to the region 1 ED, their median time to reperfusion was over 4 hours. Similarly, region 1 also had the highest proportion of thrombolysed patients (15/27) in the cohort. The area served by hospital region 2, while being situated the second farthest distance from SJH (123km), had the fourth best median time to reperfusion. This is likely reflective of the large proportion of patients who were admitted directly from the field (62.7%). Furthermore, region 2 had the second highest proportion of thrombolysed patients (6/27).

Regions 4 (2:18) (median time to reperfusion), 5 (2:09) and 3 (2:13) were all above the limit of 120 minutes set out in the guidelines. Despite this, region 3 and region 4 each only accounted for two of the thrombolysis cases, while region 5 had no incidences of administering thrombolysis. They also had the lowest proportions of patients to go directly to SJH from the field.

Regions 8 (1:32) and 7 (1:23), had the lowest median times to reperfusion of the cohort as would be expected given their proximity to SJH.

Table 2: of time to reperfusion by referral region.

	Total group median time to reperfusion (IQR) [N]	Direct via Ambulance: Median time to reperfusion (IQR) [N]	Transfer from hospital ED: Median time to reperfusion(IQR) [N]	P value*	Number of thrombolysis patients (N=27)	Distance from SJH (km)	% direct from field
Region 1	2:25 (0:41) [N=45]	2:13 (0:43) [N=31]	4:06 (2:42) [N=14]	<0.001	15 (55.6%)	146	68.9%
Region 4	2:18 (1:13) [N=78]	2:04 (1:06) [N=34]	2:33 (1:23) [N=44]	0.058	2 (7.4%)	80.7	40.5%
Region 3	2:13 (0:55) [N=66]	1:53 (0:35) [N=24]	2:33 (1:20) [N=42]	0.038	2 (7.4%)	97.7	36.2%
Region 2	2:12 (1:36) [N=58]	1:53 (0:32) [N=35]	3:36 (1:57) [N=23]	<0.001	6 (22.2%)	123	62.7%
Region 5	2:09 (0:50) [N=72]	1:45 (0:34) [N=28]	2:20 (0:50) [N =44]	<0.001	0	80.2	39.4%
Region 6	1:40 (0:47) [N=157]	1:31 (0:31) [N=95]	2:01 (1:01) [N=62]	<0.001	0	31.6	60.6%
Region 8	1:32 (0:48) [N=234]	1:25 (0:41) [N=151]	1:48 (1:02) [N=83]	<0.001	0	7.9	63.7%
Region 7	1:23 (0:46) [N=120]	1:11 (0:25) [N=66]	1:46 (1:08) [N=54]	0.003	0	9.8	55.4%

* P values calculated using independent samples T test to assess for significant difference between two variables – those admitted direct via ambulance and those transferred from hospital ED.

Figure 2: Boxplot of time to reperfusion by referral region.
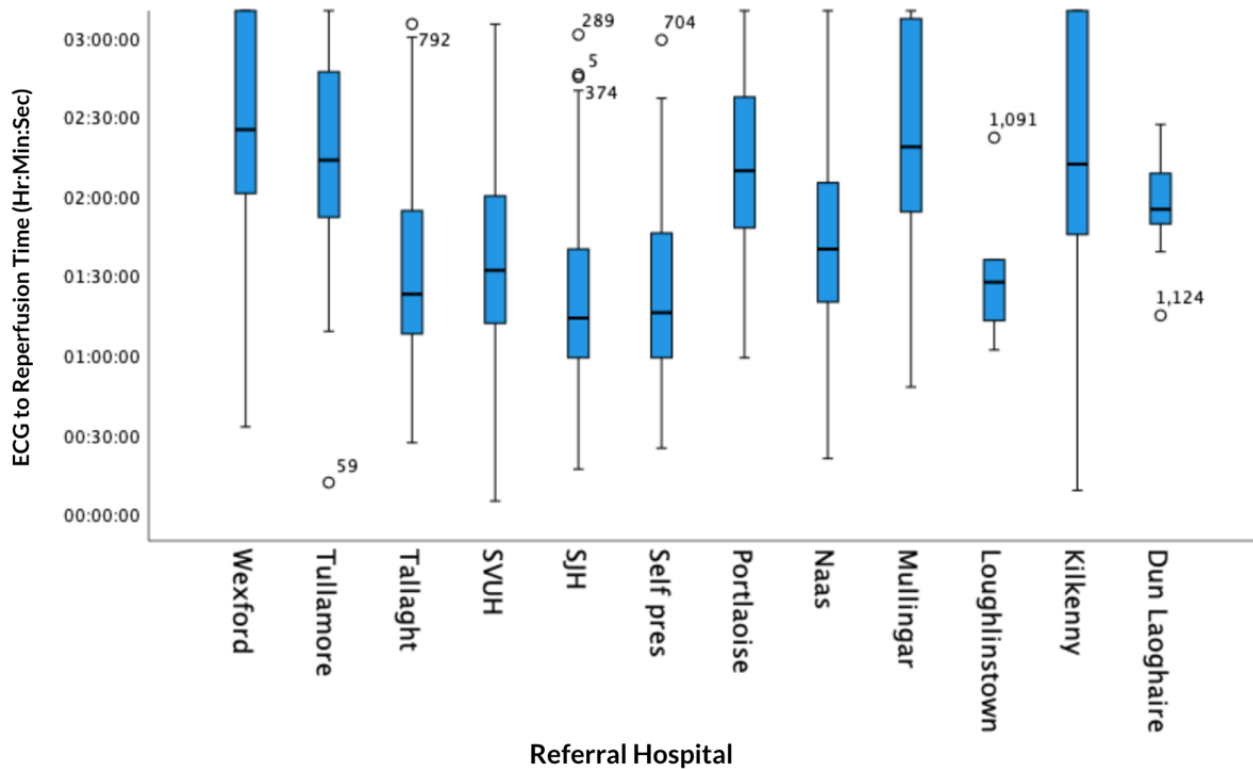
This review also reports an increased use of radial access in PCI from 59% in 2014 to 86% in 2016 (Noted in the Heart Attack Care in Ireland 2016 report) and now 97.3% (1130 / 1161) in our study timeframe from 2017-2020.

Of the 1161 patients with confirmed STEMI who were accepted to SJH over the study period, 490 were referred from a peripheral ED to SJH and as such, had the potential to receive thrombolysis. A majority of those patients (309/490) (63.1%), took over the recommended time (national guidelines) from first positive ECG to arrival at catheterisation laboratory of 90 minutes. Thrombolysis was administered in 27 of these 309 patients (8.7%). Two further patients were given thrombolysis in SJH.

Discussion

PPCI has emerged as the gold standard for treatment of patients experiencing STEMI, if performed within the time limit set out in international guidelines. If the patient is deemed unlikely to arrive at the PPCI centre within the allotted time, they should receive chemical thrombolysis in their local hospital [5]. It has been extensively documented in the literature that delays in achieving reperfusion in these patients can result in increased mortality [3,4].

The national clinical programme for ACS (Acute Coronary Syndrome) in Ireland (2010) was set up with the aim of improving morbidity and mortality by standardising the care of all ACS patients across the country. The initial focus was to develop an Optimal Reperfusion Service (ORS) protocol for the care of STEMI patients. One of the main aims of the programme was to improve the timeliness of PCI therapy. The performance of the protocol was measured in the Heart Attack Care in Ireland reports 2014 / 2016[5,6]. While the times to reperfusion in the reports did not meet the initial targets set out, there was an improvement noted between 2014 (68%) and 2016 (71%). The results of this review indicate however, that in the DML region, this trend has not continued and in the years from 2017 to 2020, the overall percentage of those less than or equal to 120 minutes to reperfusion has in fact decreased (65.3%).

Furthermore, this study indicates there is a large disparity in the reperfusion times for those who were transferred directly from the field and those who were transferred from the ED of another hospital. Incidentally, the regions that had a higher proportion of patients transferred directly from the field, tended to have better median times to reperfusion with respect to their distances from SJH. Therefore, an increased emphasis on transferring patients directly from the field to the PPCI facility is needed.

For those patients who are first brought to the regional ED, there is a clear geographical impact in the variation of time to reperfusion seen. Other factors almost certainly play a role however, as the relationship between distance and time is not linear.

The other variables involved could include for example, a delay in diagnosis, delay in organising and initiating transport and variation in the quality of local road networks. Cooperation and communication with the regional hospitals could help to elucidate these reasons and address them.

In comparison to the results of the Heart Attack Care in Ireland reports 2014 / 2016[5,6], our study reports an increase in the percentage of patients whose PPCI was performed by radial access, as this route has become the international norm.

This review also establishes that the current levels of thrombolysis administration are far below that which the guidelines would suggest for STEMI patients who are thought to be >90 minutes from a PPCI centre. Merely 8.7% of those potentially eligible received thrombolysis during our study period. We posited that this was likely multifactorial, with the fear of complications associated with thrombolysis and the underestimation of the transfer time to PCI centre being among the main factors. Again, interaction and discussion with the local parties involved in making these decisions would likely aid our understanding of this issue.

Potential limitations of this study include, that we were unable to determine the impact of factors such as quality of road networks and impaction of traffic congestion in assessing transfer time from regional hospitals. This may have skewed the perceived differences between regions.

The results of this retrospective review will be disseminated to all relevant parties involved in the pre-procedural management of STEMI patients. This includes the ambulance service and the individual regional hospitals. This will hopefully prompt a discussion into methods of improving the timeliness of PCI therapy, the proportion of patients transferred directly from the field to PPCI centre, the rates of thrombolysis and the overall standard of STEMI care.

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Declaration of Conflicts of Interest:
No conflicts of interest declared.

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