Safety and feasibility of an early (<48hour) discharge pathway for low-risk patients following primary percutaneous coronary intervention for ST-elevation myocardial infarction.

[1,2,3]Krishnaraj S Rathod PhD, [3]Katrina Comer BS, [3]Oliver Casey-Gillman BSc, [3]Lizzie Moore BSc, [3]Gordon Mills BSc, [3]Gordon Ferguson BSc, [4]Sotiris Antoniou MRPharmS MSc, [3]Riyaz Patel PhD, [4]Sadeer Fhadil MPharm, [4]Tasleem Damani MPharm, [4]Paul Wright MPharm MSc, [2,3]Mick Ozkor MD, [2,3]Oliver P Guttmann MD, [1,2,3]Andreas Baumbach MD, [2,3]R.Andrew Archbold MD, [2,3]Andrew Wragg PhD, [2,3]Ajay K Jain MD, [1,2,3]Fizzah A Choudry PhD, [1,2,3]Anthony Mathur PhD, [1,2,3] Daniel A Jones PhD

[1]Centre for Cardiovascular Medicine and Devices, Willian Harvey Research Institute, Queen Mary University of London

[2] Barts Interventional Group, Barts Heart Centre, Barts Health NHS Trust, London

[3] Department of Cardiology, Barts Heart Centre, Barts Health NHS Trust, London

[4] Department of Pharmacy, Barts Heart Centre, Barts Health NHS Trust, London

Corresponding author:

Dr D Jones

Department of Cardiology

Barts Heart Centre, St. Bartholomew's Hospital, West Smithfield,

London EC1A 7BE

Phone number: 02037658707

Email: daniel.jones@qmul.ac.uk

Word count:

Abstract

Background: Regional heart attack services have improved clinical outcomes following ST elevation myocardial infarction (STEMI) by facilitating early reperfusion by primary percutaneous coronary intervention (PCI). Early discharge after primary PCI is welcomed by patients and increases efficiency of healthcare.

Objectives: We assessed the safety and feasibility of a novel early hospital discharge (EHD) pathway for low-risk STEMI patients.

Methods: Between March 2020 and June 2021, 600 patients who were deemed low risk for early major adverse cardiovascular events (MACE) were selected for inclusion in the pathway and were successfully discharged <48 hours. Patients were reviewed by a structured telephone follow-up at 48 hours post discharge by a cardiac rehabilitation nurse, and for a virtual follow-up at 2, 6, 8 weeks and at 3 months.

Results The median length of hospital stay was 24.6 hours (interquartile range 22.7- 30.0) hours (pre pathway median 65.9 (48.1-120.2) hrs). After discharge all patients were contacted with none lost to follow up. During median follow-up of 271 days (IQR: 88-318 days), there were 2 deaths (0.33%), both due to COVID-19 (>30 days after d/c) with 0% cardiovascular mortality and MACE rates of 1.2%. This compared favourably to a historic group of 700 patients meeting pathway criteria that remained in hospital >48 hours (>48 hr control group) (Mortality 0.7%, MACE 1.9%) both in unadjusted and propensity matched analysis.

Conclusions Selected low-risk patients can be discharged safely following successful primary PCI using a pathway which is supported by a structured, multidisciplinary virtual follow-up schedule.

Introduction

Provision of primary percutaneous coronary intervention (PCI) by regional heart attack centres and improved pharmacological therapies have reduced the morbidity and mortality associated with ST-elevation myocardial infarction (STEMI) (1). Delivery of primary PCI, while cost-effective, consumes constrained healthcare resources, an important contributory factor to which is the period of post-procedure hospitalisation (2). Early discharge after primary PCI is welcomed by patients and increases efficiency of healthcare resource utilisation. There is, however, a potential safety concern regarding very early hospital discharge following STEMI. Early discharge also limits opportunities for patient education and optimisation of secondary prevention strategies. Current European guidelines recommend that discharge at 48-72 hours after STEMI should be considered in low-risk patients if early rehabilitation and adequate follow-up are arranged (3). A recent meta-analysis of five randomised controlled trials which assessed discharge at 2-3 days after primary PCI (4) and an observational study which reported 48-hour discharge in 49.3% of 2,779 patients support the concept of safe discharge at these timeframes following primary PCI (5). The observation that major adverse cardiac events (MACE) are rare after 24-hours post STEMI (7) (8) (9) amongst carefully selected patients suggests that it may be possible to curtail the period of post-procedure hospital stay further without compromising safety.

The emergence of the global COVID-19 pandemic, has strained resources with reduced staffing and bed availability, while increasing concerns about risk of exposure related to time in hospital. These unique circumstances provided the opportunity for us to design and implement a novel early (<48 hour) hospital discharge (EHD) pathway, which included structured virtual follow-up, for low-risk patients following primary PCI. In this study, we assessed the safety and feasibility of the EHD pathway for patients who were discharged after primary PCI from a high-volume heart attack centre in London.

Methods

Study design and patient population

The specific aims of this study were, 1) to determine whether or not the use of an EHD protocol was effective in achieving early (within 48-hour) hospital discharge, 2) to determine the safety of hospital discharge at <48 hours post-STEMI, 3) and to determine the feasibility and benefits of implementing a structured, multidisciplinary (MDT) virtual follow-up schedule for this group of patients (Figure 1). Virtual follow-up was conducted via a smartphone application or telephone if not available.

This was a prospective, observational study of patients who underwent primary PCI at Barts Heart Centre, London, UK. Barts Heart Centre is the tertiary cardiovascular centre for north central and north east London. It serves a mature network of 10 district general hospitals and is the single provider of primary PCI for the region's population of 6.1 million people. Patients with suspected STEMI are delivered to the unit for primary PCI by the London Ambulance Service either directly from the community (about 70% of STEMI pathway activations) or following attendance at one of the local hospital Emergency Departments, without the need for prior discussion with the centre. Patients who suffer a cardiac arrest and/or who require intubation and ventilation are included in this pathway.

Patients who were diagnosed with STEMI and who survived to hospital discharge following Primary PCI between October 2018 to June 2021 were included in this study. The patients were split into 3 groups, patients discharged on the EHD pathway, "EHD group" (600 patients between April 2020-June 2021), a ">48 hour control" group (700 patients meeting the EHD pathway criteria who were discharged at >48hours between October 2018-June 2021) and a "standard care" group (560 patients who were discharged on normal pathways between April 2020-June 2021 (patients not meeting EHD criteria who were discharged >48hours during the same time period as the EHD pathway). The standard care group was used to show that the criteria used to determine suitability for the EHD selected "low-risk" patients for pathway inclusion.

Ethics

The study was registered as a clinical audit with the Barts Quality and Safety Board. The study protocols were approved by the Barts Heart Centre Board and conformed to the ethical guidelines of the 1975 Declaration of Helsinki. All data was anonymised with removal of patient identifiers prior to analysis.

Criteria for early discharge

Eligibility criteria for early discharge were based upon our pre-existing policy for 48-72 hour discharge and upon recommendations for early hospital discharge from the European Society of Cardiology. The inclusion criteria are listed below:

- Left ventricular ejection fraction (LVEF) $\geq$40%
- Successful primary PCI (which achieved TIMI III flow)
- Absence of bystander disease requiring inpatient revascularisation
- No recurrence of ischaemic symptoms
- Absence of heart failure or haemodynamic instability (i.e, Killip class 1)
- No significant arrhythmias (ventricular fibrillation, ventricular tachycardia, or atrial fibrillation/flutter requiring prolongation of stay for ventricular rate control) post procedure
- Mobile, with suitable social circumstances for discharge

Patients were considered for early discharge by the primary PCI operator. Patients who met the eligibility criteria were discharged at 24-48 hours post procedure, depending upon their admission time and subsequent clinical course. Admissions during the morning, for example, facilitated 24-hour discharge while patients who presented during the evening or night-time were typically discharged after about 36 hours for practical reasons.

Procedures

The interventional strategy was at the discretion of the operator, including whether or not to use aspiration thrombectomy, direct stenting, pre- and post-dilatation, and intravascular imaging and, in the case of patients who had bystander disease, whether or not to perform culprit-only or multi-vessel PCI. The right radial artery was used preferentially to gain arterial access. All patients received a loading dose of Aspirin 300 mg and either Ticagrelor 180 mg or

Clopidogrel 600 mg prior to the procedure. Maintenance antiplatelet therapy comprised 75 mg Aspirin per day plus either 90 mg Ticagrelor twice daily or 75 mg Clopidogrel per day. Dual anti-platelet therapy was recommended for 12 months unless oral anticoagulation was indicated or there was a high risk of bleeding. Anticoagulation during PCI was achieved by the administration of 100 U/kg unfractionated Heparin followed by further doses to maintain the activated clotting time above 250 seconds. Glycoprotein IIb/IIIa inhibitors were used at the operator's discretion according to local guidelines which specified their use as a treatment option in cases of high intracoronary thrombus burden. As these were all emergency procedures, pre-existing anticoagulation was uninterrupted. All patients underwent cardiac rhythm monitoring for at least 12 hours post procedure. Haemodynamic observations were recorded every four hours in stable patients.

Early discharge pathway

Patients were discharged 24-48 hours after admission if they met eligibility criteria throughout their hospital stay. Due to the shorter stay in hospital, patients on the EHD pathway were given cardiac rehabilitation counselling post discharge (48hr phone call) with patients on standard pathways receiving this as planned. Blood pressure machines were provided to EHD patients if they did not already have them to facilitate medication up-titration otherwise all other aspects were similar to standard care.

Follow-up post discharge was delivered by a MDT team consisting of cardiac rehabilitation nurses, advanced clinical practitioners (ACPs), specialist cardiac pharmacists and consultant cardiologists. Structured telephone follow-up was undertaken at 48 hours post discharge by an experienced cardiac rehabilitation nurse who assessed symptoms, heart rate and blood pressure recordings, understanding of medications, and compliance, and explained the cardiac rehabilitation plan and follow-up schedule. Patients were contacted again for follow-up by a cardiology ACP at two- and eight-weeks, and by a specialist cardiovascular pharmacist (for up-titration) at six weeks with a review by a interventional cardiologist at three months. All of these follow-up appointments were conducted remotely (Virtual follow-up) using a dedicated smartphone-based healthcare application (*Ortus-iHealth*), which was downloaded by patients from the Apple App Store or from Google Play prior to their discharge. The application enables patient upload of clinical information (heart rate, blood pressure, blood

glucose, weight, and temperature), two-way messaging and video consultations. Follow-up consultations were conducted using the video call function. Patient data were stored on a secure EU-based cloud server.

Data collection

Baseline clinical characteristics and procedural information were entered prospectively into a cardiac procedure database immediately after primary PCI in accordance with British Cardiovascular Intervention Society (BCIS) standards. Data collected included age, gender, ethnicity, history of myocardial infarction (MI), PCI, coronary artery bypass graft surgery (CABG), chronic kidney disease (CKD), hypertension, diabetes mellitus, hypercholesterolaemia and smoking, number of diseased vessels, infarct-related artery, and use of aspiration thrombectomy, intracoronary imaging, post-dilatation, and GPIIb/IIIa inhibitor. Left ventricular systolic function was assessed by left ventriculogram during the procedure and/or by echocardiogram prior to discharge. Clinical events during follow-up were assessed from electronic hospital and general practitioner records and from patients during structured virtual follow-up visits. Patient satisfaction with the EHD pathway were also recorded at each follow-up visit. The EHD pathway was introduced shortly before the first wave of the COVID-19 pandemic struck the UK. All patients admitted to Barts Heart Centre were screened for COVID-19 by nasal and nasopharyngeal swab polymerase chain reaction testing and the results recorded.

Study endpoints

The primary outcome measure was MACE rate after hospital discharge. MACE were defined as a composite of all-cause mortality, recurrent myocardial infarction, and target lesion revascularisation. MACE were assessed up to 1st July 2021, and patient follow-up was censored at the time of death. Satisfaction with out-patient pathways was assessed in patients during their follow-visits using a bespoke questionnaire designed to assess satisfaction.

Statistical analysis

Patients were classified into 3 groups based on length of hospital stay and study time-period. These 3 groups were

1). The “EHD group”: 600 patients discharged on the EHD pathway between April 2020-June 2021

2). The “>48 hour control” group: 700 patients meeting EHD pathway criteria who were discharged at >48hours between October 2018-June 2021

3). The “Standard care” group: 560 patients who were discharged on normal pathways between April 2020-June 2021 (i.e patients not meeting EHD criteria who were discharged >48hours during the same time period as the EHD pathway).

Baseline patient-, procedural-, and post-procedural characteristics were compared between the groups. Categorical data are summarised using absolute values (percentage). Normally distributed, continuous data are presented as mean ± standard deviation (SD) or, where skewed, as median (25th to 75th centile). Normally distributed continuous variables were compared using Student t tests, and the Mann-Whitney U test was used to compare non-normally distributed continuous variables. Categorical data were compared using the Pearson chi-squared test. Kaplan-Meier product limits for cumulative probability of suffering one of the clinical end-points were calculated and the log rank test was used to test for a statistically significant difference between the groups. Time was measured from the first admission for a procedure to outcome (MACE and all cause mortality).

Propensity score: A propensity score analysis was performed using a non-parsimonious logistic regression model, as previously described between EHD and >48hr control groups. Variables included in the model including age, gender, diabetes mellitus, hypertension, hypercholestrolaemia, previous CABG, previous PCI, restenosis, previous MI, previous cerebrovascular accident (CVA), peripheral vascular disease (PVD), multi-vessel disease, stent length and width, chronic renal failure (CRF), ejection fraction, glycoprotein (GP) IIb/IIIA inhibitor use. A regression adjustment which incorporated the propensity score into a proportional hazard model as a covariate was then performed. The C-Score was 0.80 indicating good discrimination.

Matching

After ranking propensity score in an ascending order, a nearest neighbour 1:1 matching algorithm was used with callipers of 0.2 standard deviations of the logit of the propensity

score. Each EHD and >48 hour control patient was used in at most one matched pair, to create a matched sample with similar distribution of baseline characteristics between observed groups. STATA version 10 was used for propensity matching with SPSS for Mac version 19.0 used for all other analyses.

Results

Patient characteristics (Table 1)

Between April 2020 and June 2021 six hundred patients were discharged on the EHD pathway. In the EHD group, the mean age was 59.2 ± 11.8 years and 86.0% were men, 25.0% had diabetes mellitus, and 56% were caucasian. 24.8% had a history of previous revascularisation (20.8% PCI and 4.0% CABG), with 14.8% having a history of prior myocardial infarction. The median symptom to balloon time was 80 (30-240) minutes and the median door to balloon time was 50 (38-78) minutes.

Patients discharged on the EHD pathway were similar to patients in the >48 hour historic control group (Table 1) aside from higher rates of previous revascularisation in the EHD group. However as expected when compared to the higher risk standard care group, patients in the EHD group tended to be younger, with lower rates of renal disease, prior PVD/stroke and less likely to present in cardiogenic shock, cardiac arrest and with anterior MI (table S1).

Procedural characteristics (Table 2)

Patient in the EHD group were likely to have single vessel disease with an RCA or Cx culprit. Low rates of multi-vessel disease were seen however 15% underwent multi-vessel intervention at the time of primary PCI. High rates of left ventriculography were seen (87.5%) highlighting the requirement for early LV assessment and difficulty in immediate echocardiography. OP staged procedures (PCI, PW or CABG) were planned in 23% of patients.

The EHD and historic >48 control groups were similar in terms of procedural characteristics (Table 2) aside from higher rates of LAD intervention and multi-vessel PCI in the histporic >48hour group. As expected compared to the standard care group, the EHD group had higher rates of single vessel disease, non-LAD culprits, procedural success and higher rates of preserved LV systolic function with lower incidences of severe LV impairment (Table S2).

Length of stay

Overall, the median length of stay for patients on the EHD was 24.6 hours (IQR 22.7 - 30.0) with a minimum of 17 and a maximum of 40 hours (Figure 2), with 48% discharged within 24hrs, 76% within 30 hrs and 100% within 40hrs. Importantly 70% (420 patients) stayed one less night in hospital compared to normal pathways. The median length of stay for the >48hour control group was 56.1 hrs (IQR: 48-75.0) (See Central Illustartion) with the standard care group having a much longer median length of stay of 78.9 hours (range 56.1 – 130.2 hours).

The introduction of the EHD pathway resulted in a significant reduction in the overall length of stay for all patients presenting with STEMI undergoing primary PCI over the study period. The median length of stay for all STEMI patients was 3.0 days (IQR 2.0-6.0 days) from October 2018 to March 2020. Following the introduction of the EHD pathway, from April 2020 to June 2021 the median length of stay was 2 days (1-3 days) ($p<0.0001$), significantly reduced from pre pathway introduction (Figure 3 and Figure S1). Length of stay varied between patients however 420 patients stayed 1 less night in hospital with the remaining staying approximately 8-12 less hours, resulting in approximate cost savings of £450,000, based on cost per 24hrs of a CCU bed.

Outcomes

Nosocomial infection with COVID-19: No patients on the pathway contracted COVID-19 during their in-patient stay, this was assessed at the 2-week follow-up period to allow for the definitive assessment of nosocomial transmission. This compared to 7.5% of patients testing positive for COVID-19 during their hospital stay in the standard care group, although no definite nosocomial transmission was proven in any case.

Clinical outcomes: The median follow-up was 271 days (OQR: 88-318 days). In the EHD group, there were 2 deaths (0.33%), both due to COVID-19 with 0% cardiovascular mortality. The MACE rates in the early d/c group were 1.2% (2 deaths, 3 unscheduled revascularisations and 2 further MI presentations) (Figure 4) with MACCE rates of 1.5% (2 CVA, + above). 8.5% patients had presentations with chest pains (troponin negative), with 0 patients being

admitted with heart failure. There were 7.3% with non-chest pain related admissions (including, anxiety, LRTI, encephalitis, abscess, PR bleeding and suicidal ideation).

Outcomes for EHD versus > 48 hour historic control: In comparison mortality rates in the historic >48 control group, were 0.7% (p=0.349), with MACE rates of 1.9% (p=0.674). Re-admission rates for non-cardiac chest pains or non-cardiac issues were 7% (p=0.723). To account for confounding variables and bias between the EHD and historic >48 control groups, propensity score matching was performed to adjust for differences in demographic and procedural variables producing a total of 1160 patients (580 in the EHD group and 580 in the historic >48 hour group group). The baseline demographics and procedural variables were well balanced in the 2 propensity-matched cohorts. In the propensity-matched cohorts, no difference in rates of mortality (0.34% vs 0.69%, p=0.410), or MACE (1.2% vs 1.9%, p=0.342) were seen over follow-up (Central Illustration).

Outcomes for EHD versus standard care group: In comparison, in the standard pathway group, there were 22 deaths (4.1%) reported, of which 2.2% were cardiovascular. The MACE rates in the control group were 8.6% (4.1% mortality, 2.1% unscheduled revascularisations and 2.4% MI) and the MACCE rates were 9.4% (0.8% CVA in addition to the above). 10% patients had admissions with trop negative chest pain, and 2.2% had admissions with heart failure. 11.0% had non-chest pain related admissions (including, GI bleeding, LRTI, mechanical fall and acute confusion).

Patient satisfaction: 100% of patients were followed-up by the EHD pathway. This contrasts with 31% DNA before pathway introduction (October 2018 to March 2020). During the study period unless attending for staged procedures or investigations such as echocardiography, no patients on the EHD pathway returned for physical clinic follow-up. All of the follow-up was done remotely. Patient feedback showed that 85% were ‘satisfied’ or ‘very satisfied’ with the overall quality of the EHD pathway. 75% reported cost savings and 62.5% saved time off work owing to the virtual nature of the follow-up pathway. This compared to 73% satisfaction seen in patients followed up via standard pathways (combined >48 hour control and standard care groups) (P<0.001).

Discussion

This is the first prospective observational study to demonstrate the safety and feasibility of an early discharge pathway (<48 hours) for patients who are at low-risk of complications after STEMI which was treated successfully by primary PCI. The median time to discharge in this group of patients was 25 hours. Importantly comparable outcomes (mortality, MACE) were seen to a historic low risk patient group that met pathway criteria but were previously discharged at timeframes longer than 48 hours providing reassurance about pathway safety. Furthermore, all-cause mortality, cardiovascular mortality, and MACE rates were significantly lower in patients discharged on the EHD pathway compared to a standard discharge group highlighting that low-risk patients were selected for early discharge confirming suitability of pathway inclusion criteria. Amongst the patients discharged at 24 hours, however, the event rate was low with only two deaths, both of which were caused by COVID-19 and occurred more than 30 days after hospital discharge. Neither death could, therefore, be predicted or would have been prevented by following the standard discharge protocol. Moreover, there were no cases of nosocomial COVID-19 infection in this patient group and all patients were followed up with early post-discharge consultations in a structured, multidisciplinary programme which achieved an 85% patient satisfaction rate. While the implementation of this pathway was driven by the necessity to adapt to the COVID-19 pandemic in order to shorten hospital admission times, optimise resource utilisation and decrease risk of nosocomial infection, it has the potential to change standard practice in this patient population.

Current guidelines suggest the discharge of low-risk patients post primary PCI for STEMI at 48-72 hours based on meta-analyses and large observational studies (3) (4) (5). This study showed that it is possible to implement earlier discharge at 24-48 hours after primary PCI using a discharge pathway that significantly reduced median length of stay to 29.5 hours compared to 78.9 hours for patients discharged on standard care pathways. Overall, this resulted in a reduction in median length of stay for all patients who were treated by primary PCI from 3 days to 2 days, freeing up hospital beds for the use of other patients who required care in our heart attack centre. Time of Admission did mean varied length of stay for patients discharged on the pathway but 336 patients stayed 1 less night in hospital with the remaining

staying 12 less hours, meaning potential use of bed capacity by other patients. This resulted in costs savings of nearly £400,000. Our data confirmed the safety of discharge at 24-48 hours post primary PCI in low-risk patients in line with previous small series showing lower rates of MACE between 24 and 48 hours post STEMI (9) (8) (7) .

Existing guidelines recommend that patient risk be determined on an individual basis, according to cardiac risk, comorbidities, functional status, and social support (3). Cardiac risk has previously been based on criteria such as age, LV ejection fraction, single or 2- vessel disease, and successful PCI with no persistent arrhythmia. Criteria used in this cohort were based on this guidance with pre-existing risk scores used to identify low risk patients following primary PCI (10) (11) and reflected local hospital policy for 48-hour discharge as previously published (5). Our study validates the chosen criteria, including patients with successful and uncomplicated primary PCI procedures, cardiac rhythm and haemodynamic stability, LV ejection fraction >40%, and no requirement for inpatient revascularisation, as safe for discharge at the 24 hour time point.

Reduced length of stay can, however, mean less opportunity for patient education and up-titration of secondary preventative medication. Once discharged from hospital, timely outpatient review encompassing symptom reassessment, advanced physical assessment, medication and cardiovascular risk management is a key component of patient care. We designed a structured and multidisciplinary follow-up programme to address this issue that included a telephone call at 48 hours from a specialist nurse in cardiac rehabilitation, with virtual follow-up by cardiac ACPs and pharmacists at 2, 6 and 8 weeks and interventional cardiologist at 12 weeks. We utilised a virtual platform with the ability to collect a number of outcomes such as heart rate, blood pressure, blood glucose enabling safe up-titration of secondary preventative therapies. All patients were followed up on this pathway with no patients lost to follow-up and the programme received excellent patient feedback. We would therefore propose that the low event rate observed in the 24-hour discharge group was directly linked to appropriate patient selection and a robust follow-up programme. Preventing delayed follow-up using video consultations, reducing clinic appointment travel, costs and potential COVID19 exposure to patients

We have presented data to demonstrate the safety and feasibility of an early discharge pathway for STEMI in a selected patient group. The pathway was designed and implemented in response to the challenge of the COVID-19 pandemic which provided a unique opportunity for its evaluation. Our data has important implications for healthcare costs as well as service provision. With the implementation of this pathway overall median length of stay was reduced from 3 days prior to its introduction to 2 days. This equates to a cost saving of 400 bed days in the coronary care unit over the time period studied. This is not only cost effective but would also free beds for improving wider interventional service delivery to address the ever-increasing workload of regional heart attack centres. The demonstrated low event rate in this patient group offers a strong rationale for a change in standard practice for STEMI care.

Limitations

Despite this being novel data for 24-hour discharge in the STEMI population, it remains a relatively small single centre observational and non-randomised study and therefore there are biases and confounders with patients with predicted poorer prognosis self-selecting into the standard discharge group. However, the low event rate and mortality in the selected group offers opportunity to improve resource utilisation for a large cohort of STEMI patients.

Conclusion

Driven by the necessity to adapt to the pandemic, we report the safe and successful implementation of an early post MI discharge pathway with an integrated and structural multidisciplinary virtual follow up schedule. This has shortened hospital admission times, decreasing the risk of nosocomial infections and optimised resource utilization, while at the same time enhancing the quality of post discharge care with high levels of patient satisfaction.

Clinical Perspectives

Competency in Patient Care: It is possible using clinical criteria to successfully implement of an early (<48 hour) post MI discharge pathway with an integrated and structural multidisciplinary virtual follow up schedule. This shortened hospital admission times, decreasing the risk of nosocomial infections and optimised resource utilization, while at the same time enhancing the quality of post discharge care with high levels of patient satisfaction.

Translational Outlook: Although this is a single centre study, this virtual pathway is suitable for adoption throughout heart attack centres worldwide potentially resulting in large reductions in beds days and resultant cost savings.

Table 1. Baseline patient characteristics

	EHD Pathway n = 600	>48 hour Control n = 700	P value
Age (mean ± SD)	59.2 ± 11.8	57.5 ± 12.1	0.100
Male sex	516 (86.0%)	599 (85.6%)	0.498
BMI	26.3 ± 8.0	29.8 ± 11.4	0.769
Caucasian ethnicity	336 (56.0%)	357 (51%)	0.076
Initial Presentation			
Direct Admission	459 (76.5%)	567 (81.0%)	0.376
Cardiac arrest before primary PCI	16 (2.7%)	22 (3.1%)	0.350
Cardiogenic shock before primary PCI	0 (0.0%)	0 (0.0%)	1.000
Symptom to balloon time (minutes)*	80 (30-240)	76 (28-232)	0.279
Door to balloon time (minutes)*	50 (38-73)	54 (41-75)	0.137
Systolic Blood Pressure (mmHg)	134 ± 23	149 ± 31	0.621
Heart Rate (bpm)	88 ± 15	91 ± 18	0.409
Medical History			
Hypertension	240 (40.0%)	295 (42.1%)	0.211
Hypercholesterolemia	240 (40.0%)	295 (42.1%)	0.456
Diabetes mellitus	150 (25.0%)	182 (26.0%)	0.458
Current or Ex Smoker	360 (60.0%)	446 (63.7%)	0.234
Previous myocardial infarction	89 (14.8.%)	99 (14.2%)	0.353
Previous PCI	125 (20.8%)	113 (16.1%)	0.029
Previous CABG	24 (4.0%)	14 (2.%)	0.046
Hx of Stroke or Transient Ischaemia Attack	16 (2.7%)	22 (3.1%)	0.202
Peripheral Arterial disease	18 (3.0%)	19 (2.7%)	0.106
Chronic kidney disease	24 (4.0%)	21 (3.0%)	0.632
Chronic obstructive pulmonary disease	60 (10.0%)	67 (9.6%)	0.150
Lab Profile			
Haemoglobin (g/dL)	11.0 ± 4.1	10.8 ± 3.7	0.279
eGFR (mls/min)	68 ± 14.6	71 ± 16.2	0.486
Troponin (ng/dl)	387 ± 88.2	427± 109.0	0.341

*Median (interquartile range). SD, standard deviation; IQR, interquartile range; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft surgery.

Table 2. Procedural characteristics

	EHD Pathway n = 600	> 48hr Control n = 700	P value
Arterial access: Radial artery	564 (94.0%)	644 (92.0%)	0.110
Femoral artery	36 (6.0%)	56 (8.0%)	
Culprit vessel: Left main stem	0 (0.0%)	0 (0.0%)	0.005
Left anterior descending artery	241 (40.2%)	345 (49.3%)	
Circumflex artery	131 (21.8%)	128 (18.2%)	
Right coronary artery	216 (36.0%)	221 (31.6%)	
Saphenous Vein Graft	12 (2.0%)	6 (0.9%)	
Multi-vessel disease	187 (31.2)	296 (42.3)	
Thrombosis of pre-existing stent	11 (1.8%)	8 (1.1%)	0.179
Baseline TIMI flow 0-1	383 (63.8%)	428 (61.1%)	0.275
Glycoprotein IIb/IIIa inhibitor use	234 (39.0%)	265 (37.9%)	0.312
Aspiration thrombectomy use	14 (2.3%)	9 (1.3%)	0.297
Multi-vessel PCI	90 (15.0%)	140 (20.0%)	0.019
Post PCI TIMI 3 flow	600 (100.0%)	700 (100%)	1.000
Left ventricular systolic dysfunction: None	210 (35.0%)	217 (31.0%)	0.292
>45%	252 (42.0%)	322 (46.0%)	
$\geq$ 40%	138 (23.0%)	162 (23.0%)	
< 40%	0 (0.0%)	0 (0.0%)	

Figure Legends

Figure 1. Barts Heart Attack Centre Early Hospital Discharge Pathway.

Figure demonstrating the early discharge pathway and follow-up . ACP = Advanced Clinical Practioner, AMI = Acute Myocardial Infarction, CABG = Coronary Artery Bypass Grafting, DVLA = Driving Vehicles Licencing Agency, F/U = Follow up, NSVT = Non-sustatined Ventricular Tachycardia, LVEF = Left Ventricular Ejection Fraction, PCI = Percutaneous Coronary Intervention, TTE = Transthoracic Echocardiography, VF = Ventricular Fibrillation and VT = Ventricular Tachycardial,

Figure 2. Length of stay for patients following the early discharge pathway.

Showing a box and whisker plot (median, min-maximum values) and a scatter plot showing the distribution of each individual's length of hospital stay.

Figure 3. Overall length of stay for patients over the study period.

Pre-Pathway refers to patients admitted between October 2018-April 2020. Post pathway is April 2020- June 2021. Box and whisker plot (median, 10-90th centile). Comparison performed using Mann-Whitney non-parametric test (*** = $p<0.0001$).

Figure 4. Kaplan Meier curves showing cumulative probability of MACE

This figure compares outcome over 6 months comparing the EHD and >48 hour control patient groups. EHD = Early Hospital Discharge. >48 hour control refers to patients discharged >48 hours that met pathway criteria either pre or post pathway introduction.

Central Illustration: The Barts Early Hospital Discharge (EHD) Pathway. This figure shows A). The difference in length of stay between the EHD and standard low risk pathways (> 48 hour control) (Box and whisker plot showing min and max), B). Outcomes over follow-up period for the EHD and control groups.

References

1. Peterson ED., Ohman EM, Brindis RG et al. Development of systems of care for ST-elevation myocardial infarction patients: evaluation and outcomes. 2007. Circulation 2007; 116: e64-e67.
2. Newby LK, Eisenstein EL, Califf RM et al. Cost effectiveness of early discharge after uncomplicated acute myocardial infarction. N Engl J Med 2000; 342: 749-755.
3. Ibanez B, James S, Agewall S et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J 2018; 39: 119-177.
4. Gong W, Li A, Ai H et al. Safety of early discharge after primary angioplasty in low-risk patients with ST-segment elevation myocardial infarction: A meta-analysis of randomised controlled trials. Eur Jr of Prev Cardiol 2018;25: 807-815.
5. Jones DA, Rathod KS, Howard JP et al. Safety and feasibility of hospital discharge 2 days following primary percutaneous intervention for ST-segment elevation myocardial infarction. Heart 2012; 98: 1722-1727.
6. Driggin E, Madhavan MV, Bikdeli B et al. Cardiovascular considerations for patients, health care workers, and health systems during the COVID-19 pandemic. J Am Coll Cardiol 2020; 75: 2352-2371.
7. Newby LK, Hasselblad V, Armstrong PW et al Time-based risk assessment after myocardial infarction. Implications for timing of discharge and applications to medical decision-making. Eur Heart J 2003; 24: 182-189.
8. Howard JP, Jones DA, Gallagher S, et al. Is it safe to discharge patients 24 h after uncomplicated successful primary percutaneous coronary intervention. Heart 2012
9. Jirmár R, Widimský P, Capek J et al. Next day discharge after successful primary angioplasty for acute ST elevation myocardial infarction. An open randomized study “Prague-5”. Int Heart J 2008; 49: 653-659.
10. De Luca, G, Suryapranata H, Van’t Hof AWJ et al. Prognostic assessment of patients with acute myocardial infarction treated with primary angioplasty: implications for early discharge. Circulation 2004; 109: 2737-2743.
11. Halkin A, Singh M, Nikolsky E et al. Prediction of mortality after primary percutaneous coronary intervention for acute myocardial infarction: the CADILLAC risk score. J Am Coll Cardiol 2005; 45: 1397-1405.