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Original Article

The impact of the COVID-19 pandemic on the delivery of primary percutaneous coronary intervention in STEMI

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Abstract: Objectives: The clinical environment has been forced to adapt to meet the unprecedented challenges posed by the COVID-19 pandemic. Intensive care facilities were expanded in anticipation of the pandemic where the consequences include severe delays in elective procedures. Emergent procedures such as Percutaneous Coronary Intervention (PCI) in acute myocardial infarction (AMI) in which delays in timely delivery have well established adverse prognostic effects must also be explored in the context of changes in procedure and public behaviour associated with the COVID-19 pandemic. The aim for this single centre retrospective cohort study is to determine if door-to-balloon (D2B) times in PCI for ST Elevation Myocardial Infarction (STEMI) during the United Kingdom's first wave of the COVID-19 pandemic differed from pre-COVID-19 populations. Methods: Data was extracted from our single centre PCI database for all patients that underwent pPCI for STEMI. The reference (Pre-COVID-19) cohort was collected over the period 01-03-2019 to 31-05-2019 and the exposure group (COVID-19) over the period 01-03-2020 to 31-05-2020. Baseline patient characteristics for both populations were extracted. The primary outcome measurement was D2B times. Secondary outcome measurements included: time of symptom onset to call for help, transfer time to first hospital, transfer time from non-PCI to PCI centre, time from call-to-help to PCI centre, time to table and onset of symptoms to balloon time. Categorical and continuous variables were assessed with Chi squared and Mann-Whitney U analysis respectively. Procedural times were calculated and compared in the context of heterogeneity findings. Results: 4 baseline patient characteristics were unbalanced between populations with statistical significance ($P<0.05$). The pre-covid-19 cohort was more likely to have suffered out of hospital cardiac arrest (OHCA) and had left circumflex disease, whereas the 1st wave cohort were more likely to have been investigated with left ventriculography and be of Afro-Caribbean origin. No statistically significant difference in in-hospital procedural times was found with D2B, C2B, O2B times comparable between groups. Pre-hospital delays were the greatest contributors in missed target times: the 1st wave group had significantly longer delayed time of symptom onset to call for help (Control: 31 mins; IQR [82.5] vs 1st wave: 60 mins; IQR [90.0], $P=0.001$) and time taken from call for help to arrival at the PCI hospital (control: 72 mins; IQR [23] vs 1st wave: 80 mins; IQR [66.5], $P=0.042$). Conclusion: Enhanced infection prevention and control procedures considering the COVID-19 pandemic did not impede the delivery of pPCI in our single centre cohort. The public health impact of the pandemic has been demonstrated with times being significantly impacted by patient related delays. The recovery of public engagement in emergency medical services must become the focus for public health initiatives as we emerge from the height of COVID-19 disease burden in the UK.

Keywords: Primary percutaneous coronary intervention, COVID-19, ST-elevation myocardial infarction

Introduction

Background

In response to the rising cases of COVID-19 infection in the UK, a nationwide lockdown for England was imposed on the 23rd of March 2020 marking the 'first wave' in the surge of COVID-related deaths which peaked to 21,687 on the 12th April [1]. Anticipating this, the National Health Service (NHS) undertook a major operation to redirect services to meet the

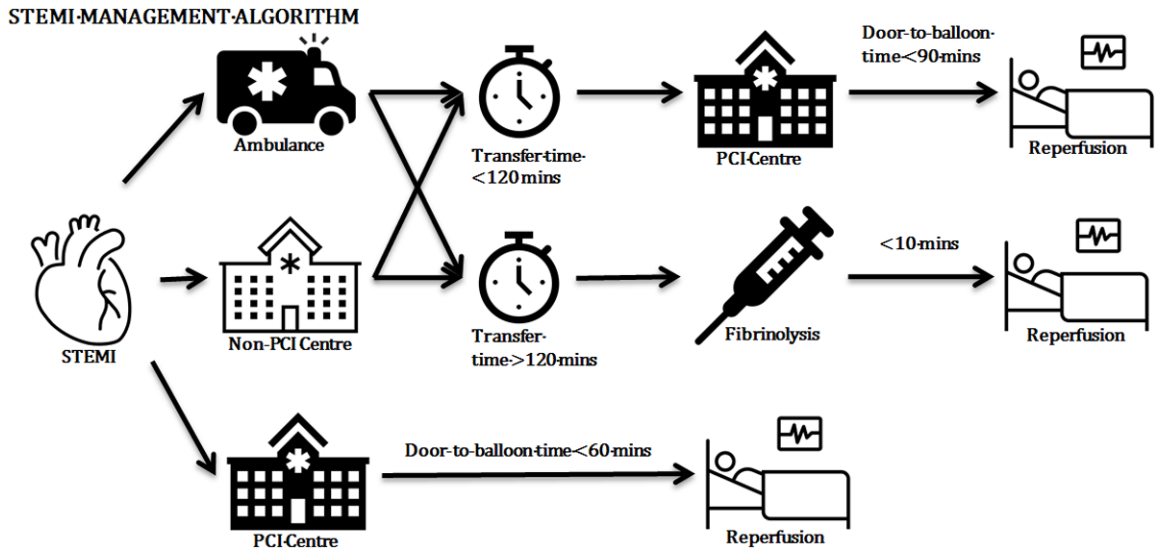

Figure 1. ESC ACS STEMI guidelines. Adapted from [26] 11: Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, Byrne RA, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization The Task Force on myocardial revascularization of the European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS) Developed with the special contribution of the European Association for Percutaneous Cardiovascular Interventions (EAPCI). [cited 2020 Nov 6]; Available from: www.escardio.org/guidelines. Figure: Modes of patient's medical contact, components of ischaemia time, and flowchart for reperfusion strategy selection; p.113.

demand in intensive care. Non-urgent procedures were postponed and emphasis was placed on the accident and emergency services with initiatives such as the NHS '111 First campaign' which aimed to appropriately triage patients seeking emergency medical treatment [2]. Inadvertently, this led to a reduction in A&E attendances for potentially life-threatening conditions such as Myocardial Infarction which decreased by 50% in March alone [3]. MI related hospital admissions have been found to have decreased by 35% compared to 2019 data [4], with a 23% decrease in STEMI admissions and 42% decreased in NSTEMI admissions [5]. Consequences of delays in the timely management of myocardial infarction have been well documented: increased reinfarction risk, increased length of hospital stay, morbidity burden, and increased cardiovascular mortality [6, 7]. In line with the European Society of Cardiology and the American Heart Association, pPCI is recommended as first line for the management of all STEMI patients [8, 9]. Current data has found that the number of pPCI procedures undertaken by major PCI centres in the UK has declined by 28% during the first wave of the pandemic [10] although the data on the pandemic's impact on procedural times have been mixed.

ECS STEMI management

For patients presenting to EMS with confirmed STEMI, the ECS has developed the following guidelines and target times: upon first contact with medical services that if transport time to a PCI centre is less than 120 mins patients should receive pPCI with a door-to balloon time of less than 90 minutes. For those in which transfer time will exceed 120 minutes they should be managed with fibrinolysis with the aim of a door-to-needle time of less than 10 minutes [9] (**Figure 1**).

COVID-19 ACS specialty guidelines

The NHS, BCIS, British Cardiovascular Society (BCS) and British Heart Rhythm Society (BHRS) collaborated to publish best practice guidelines for the optimal management of patients with cardiovascular disease in the context of COVID-19 changes to practice. As with other medical specialties, it was recommended that all elective procedures be delayed with the emergent delivery of pPCI as first line in STEMI/high-risk NSTEMI preserved. Thrombolysis may be considered in unstable COVID-19 patients with concomitant STEMI [11]. It should also be noted that PCI was categorised as an aerosol generating procedure (AGP) requiring level 2 PPE [12].

Aims

Considering emerging evidence reporting the adverse impact of the COVID-19 pandemic on excess cardiovascular mortality and delays in treatment of ACS, our study aims to determine if procedural times for pPCI in the emergent management of STEMI have been negatively impacted. The primary aim will be to establish D2B times and the proportion of our COVID-19 first wave cohort who were compliant with the ESC guideline recommended <90 minutes. Secondary end points measured include; time of symptom onset to call for help, transfer time to first hospital, transfer time from non-PCI to PCI centre, time from call-to-help to PCI centre, time to table and onset of symptoms to balloon time. The results will be interpreted in the context of the COVID-19 pandemic and compared to a control cohort from a pre-COVID-19 population to establish potential causality and comment on implications for current clinical practice.

Materials and methods

The study period for this retrospective observational cohort study was selected based on the UK's 'First wave' as defined by the Office of national statistics data for COVID-19 related deaths. All data was extracted from our tertiary Cardiac Centre local database for all patients that underwent pPCI for STEMI/NSTEMI. Patient data is inputted at the time of the procedure and records patient characteristics and times required for the calculation of systemic procedural times: time of symptom onset, time patient called for help, time of arrival at the PCI hospital, time to table and time of balloon inflation.

Data collection

Patients included in the exposure (first wave) group were retrospectively collected from the period 01-03-2020 to 31-05-2020 (n=174), the reference control cohort were collected from the period 01-03-2019 to 31-05-2019 (n=149).

Research indicators

All consecutive STEMI patients who underwent primary PCI were eligible for inclusion where predefined inclusion criteria were met. All adult patients coded as having a STEMI who underwent pPCI and for whom procedural times could be calculated were included. No patients were lost due to missing data. Procedural times were calculated in minutes from patient reported time of symptom onset and physician recorded times of arrival to hospital, time to table and time to first balloon inflation. STEMI is defined as patients who have presented with clinical symptoms characteristic of an AMI with at least >1 mm elevation in 2 adjacent limb leads or >2 mm ST elevation in 2 adjacent precordial leads identified on Electrocardiography (ECG). Patients with NSTEMI who underwent PCI were excluded (**Table 1**).

Outcome measures

The primary outcome measured for this analysis was D2B time. This can be defined as the time taken from the patient arriving at the PCI centre to the time of reperfusion marked by PCI balloon inflation. The secondary outcomes measured included other procedural times which have been categorised as pre-hospital, EMS, inter-hospital, and systematic delays. The standards for the procedural times included in this study have been set based on current national and international guidelines (**Table 2**).

Baseline patient characteristics

The following patient demographic data was extracted: age, sex, ethnicity, BMI. Risk factors reflecting the burden of pre-existing cardiovascular disease per patient were also gathered: smoking history, hypertension, hypercholesterolaemia and diabetes mellitus. Data fields for procedural details included the vessel attempted, left ventricular ejection fraction, and the use of GPIIb/IIIA antagonists.

Ethics

The data was collected for the purpose of a Barts Health Trust CEU approved clinical audit. Data was anonymised prior to any statistical analyses by the authors. After ethical consideration it was determined that formal ethical approval was not required for this study.

Statistical analysis

To determine the population distribution, the mean and standard deviation (SD) was calculated for baseline patient characteristics

Table 1. Audit metric

Audit Theme	Timeliness
Numerator	Call to balloon time <150 mins in STEMI undergoing pPCI Door to balloon time <90 mins in STEMI undergoing pPCI where first presentation is to Non-PCI centre Door to balloon time <60 mins in STEMI undergoing pPCI where direct transfer to PCI hospital
Denominator	All adults (>18) undergoing pPCI for STEMI where a call-to-balloon time could be calculated All adults (>18) undergoing pPCI for STEMI where a door-to balloon time could be calculated
Exposure Group	All adult STEMI undergoing pPCI (01-03-2020 to 31-05-2020)
Control Group	All adult STEMI undergoing pPCI (01-03-2019 to 31-05-2019)
Baseline patient characteristics measured	Age Sex Ethnicity Diabetes Mellitus BMI Smoking History Raised cardiac enzymes/markers Previous MI/CABG/PCI CS Out of Hospital Cardiac Arrest Medical History: Hypercholesterolaemia, Hypertension, Peripheral vascular disease, Cerebrovascular events, Valvular heart disease, History of Renal Disease LVEF TIMI GPIIb/IIIa Athero-thrombus removal device used Vessel Attempted
Secondary outcomes measured	Time of symptom onset to call for help Transfer time to first hospital Transfer time from non-PCI centre to PCI centre Time from call for help to PCI centre Time to table Onset to balloon time

Table 2. Primary and secondary outcome measures

Primary outcome			Standard	Evidence Base
Door to balloon time		The time taken from arrival at the PCI centre to reperfusion marked by PCI balloon inflation	D2B <90 minutes	ESC Guidelines [24]
Secondary Outcome			**Standard**	**Evidence Base**
Pre-Hospital Delay	Decision time	Time taken from the patients' self-reported onset of symptoms to the time taken for the patient to contact EMS	Patient delay-no standard set	
	Call to door time	Time taken from the patient's first contact with EMS to time of admittance at the PCI centre	<30 minutes in 90% of patients	NHS England: Category 2 Targets, no formal standard set but 'recommended' [25]
EMS delays	Time from call for help to PCI centre	Time taken from when the patient contacts EMS to their arrival at the PCI centre	Patient delay-no standard set	
	Transfer time to first hospital	Time taken from the patient first contacting EMS to arrival at the first hospital	No standard set	
Inter-hospital delay	Transfer time from non-PCI to PCI centre	The time taken from first admittance to non-PCI centre to time of admittance at PCI centre	≤90 minutes	ESC Guidelines [24]
Systematic delays	Call to balloon time	The time taken from when the patient contacts EMS to the time of reperfusion marked by PCI balloon inflation	<150 minutes	ESC Guidelines [24]
	Time to table	The time taken from arrival at the PCI centre to the patient on the Catheterization Lab table	No standard set	
	Onset of symptoms to balloon time	The time taken from the onset of symptoms to reperfusion marked by the inflation of the PCI balloon	No standard set	
	Call for help to balloon time	The time taken from the patients first contact with EMS to reperfusion marked by the inflation of the PCI balloon.	Patient delay-no standard set	

PCI: Percutaneous coronary intervention, EMS: Emergency medical Services.

Table 3. Baseline patient characteristics

		Group				*P*-value
		1st Wave		Control		
		Count	%	Count	%	
Sex	Female	33	22.10%	43	24.70%	0.588
	Male	116	77.90%	131	75.30%	
Age	Median Age [IQR]	61 [59-64]		60 [58-64]		0.658
Ethnicity	Asian	47	31.50%	61	35.10%	0.005[*,b]
	Black	20	13.40%	6	3.40%	
	Caucasian	77	51.70%	104	59.80%	
	Oriental	2	1.30%	3	1.70%	
	Other	3	2.00%	0	0.00%	
BMI	Mean BMI	27.62±3.96		28.55±20.61		0.242
Cardiac enzymes/markers raised	No	30	20.40%	25	14.70%	0.199
	Unknown	69	46.90%	96	56.50%	
	Yes	48	32.70%	49	28.80%	
Previous MI	No	127	85.20%	140	80.50%	0.476
	Unknown	5	3.40%	6	3.40%	
	Yes	17	11.40%	28	16.10%	
Previous CABG	No	148	99.30%	168	96.60%	0.113[b,c]
	Unknown	1	0.70%	1	0.60%	
	Yes	0	0.00%	5	2.90%	
Previous PCI	No	129	86.60%	145	83.30%	0.469[b]
	Unknown	2	1.30%	1	0.60%	
	Yes	18	12.10%	28	16.10%	
Diabetes	Diabetes (diet controlled)	7	4.70%	9	5.20%	0.839[b]
	Diabetes (insulin)	5	3.40%	9	5.20%	
	Diabetes (oral medication)	36	24.20%	34	19.50%	
	Diabetic status unknown	4	2.70%	3	1.70%	
	Newly diagnosed	1	0.70%	2	1.10%	
	Not diabetic	96	64.40%	117	67.20%	
Smoking history	Current smoker	41	27.50%	62	36.00%	0.396
	Ex-smoker	24	16.10%	26	15.10%	
	Never smoked	55	36.90%	58	33.70%	
	Unknown	29	19.50%	26	15.10%	
History of renal disease	Chronic renal failure	3	2.00%	1	0.60%	0.150[b,c]
	Creatinine >200	0	0.00%	3	1.70%	
	Functioning transplant	0	0.00%	2	1.10%	
	No renal disease	113	75.80%	138	79.30%	
	Unknown	33	22.10%	30	17.20%	
Medical History	No medical History	48	32.20%	54	31.00%	0.820[b]
	Unknown	11	7.40%	17	9.80%	0.447
	Hypertension	71	47.70%	81	46.60%	0.973[b]
	Hypercholesterolaemia	62	41.60%	68	39.10%	0.644
	Peripheral Vascular Disease	4	2.70%	4	2.30%	0.824[b]
	Cerebrovascular event	2	1.30%	2	1.10%	0.876[b]
	Valvular Heart Disease	0	0.00%	1	0.60%	0.354[b,c]
Family history of CAD	No	106	71.10%	128	73.60%	0.073
	Unknown	16	10.70%	28	16.10%	
	Yes	27	18.10%	18	10.30%	

Out of Hospital Cardiac Arrest	No	147	98.70%	159	91.40%	0.003[*,b]
	Yes	2	1.30%	15	8.60%	
GP IIb/IIIa drug(s) used during procedure	Unknown	12	8.10%	20	11.50%	0.350[b]
	Abciximab	2	1.30%	2	1.10%	
	Eptifibitide	74	49.70%	70	40.20%	
	None	61	40.90%	82	47.10%	
Vessel Attempted	LADprox	63	42.30%	60	34.50%	0.15
	LADother	26	17.40%	26	14.90%	0.541
	LMain	5	3.40%	3	1.70%	0.347[b]
	LCX	18	12.10%	37	21.30%	0.029[*]
	RCA	56	37.60%	70	40.20%	0.627
	Multivessel	18	12.10%	20	11.50%	0.87
LVEF	Good (LVEF≥50%)	34	22.80%	51	29.30%	0.16
	Moderate (LVEF 30-49%)	44	29.50%	34	19.50%	
	Not measured	30	20.10%	47	27.00%	
	Poor (LVEF<30%)	13	8.70%	14	8.00%	
Diagnostic Interventions Undertaken	None	0	0.00%	2	1.15%	
	Coronary Angiography	149	100.00%	172	98.85%	0.353[b,c]
	Left ventriculography	85	57.00%	65	37.40%	0.000[*]
	IVUS	16	10.70%	10	5.70%	0.1
	Aortography	1	0.70%	0	0.00%	0.279[b,c]
Athero-thrombus removal device used	Export Catheter Use	10	6.70%	16	9.20%	0.405
	None	139	93.30%	157	90.80%	
Flow in IRA PostOp (ACS)	TIMI 0	1	0.70%	2	1.30%	0.544[a,b]
	TIMI 1	2	1.50%	0	0.00%	
	TIMI 2	3	2.20%	4	2.60%	
	TIMI 3	126	94.00%	145	95.40%	
	Unknown	2	1.50%	1	0.70%	

Results are based on nonempty rows and columns in each innermost subtable. [a]More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid. [b]The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid. [*]The Chi-square statistic is significant at the .05 level. [c]The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid.

between COVID-19 and pre-COVID-19 cohorts. Inflated SDs was strongly suggestive that the data was not normally distributed. Therefore, nonparametric tests were used to determine the degree of homogeneity between groups through the comparison of baseline patient characteristics. Continuous variables were presented as median, IQR and Mean and standard deviation. Categorical variables have been presented as count and as a percentage of the population. Chi squared analysis was used for categorical variables, and Mann Whitney-U analysis for continuous variables. A *P* value of <0.05 was considered statistically significant. Procedural times were analysed initially by displaying the data as box and whisker plots for the identification of significant outliers. Of the outliers identified for each variable only those ± ≥3 SD units of the upper and lower quartile were excluded. Outliers 1.5 SD units away from upper and lower quartiles have been included to better reflect the degree of variance in procedural times between individuals. Results for the primary and secondary outcome measures were calculated for comparison in the context of heterogeneity based on the statistical significance of baseline patient characteristics between groups.

Results

Population

Consecutive STEMI patients that underwent pPCI for STEMI at Barts Heart Centre were included in this analysis. A total of 323 patients were included in this study. 174 patients were included in the 'first wave' cohort with the data

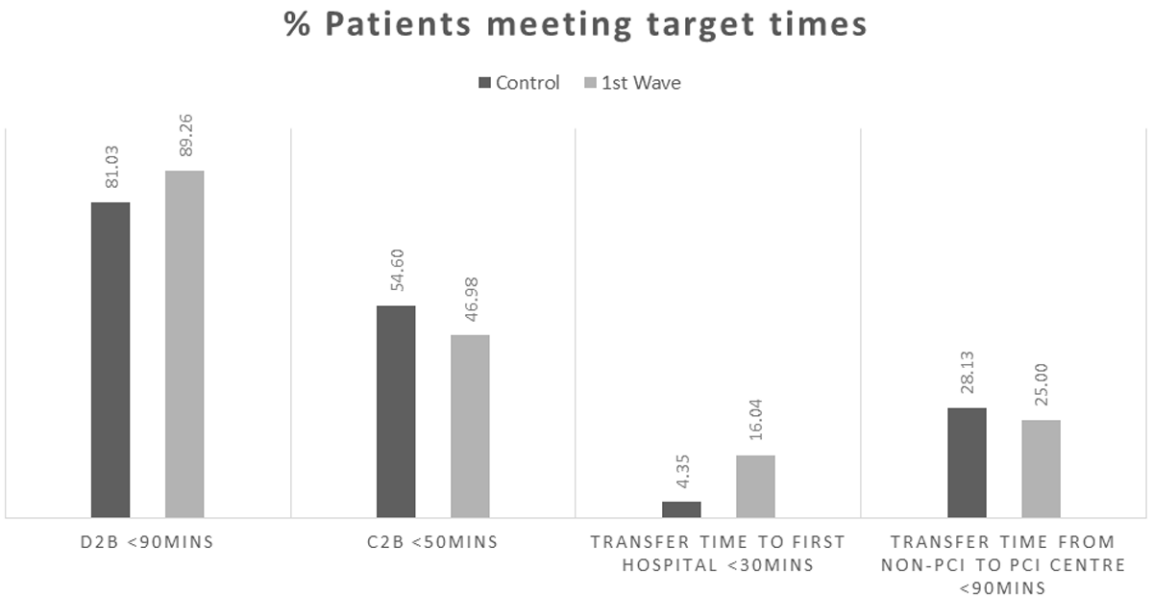

Figure 2. Percentage patients meeting target times. Figure demonstrating the percentage of patients meeting target times including door-to-balloon (D2B) times, call-to-balloon (C2B) times, rransfer time to first hospital and transfer time from non-PCI to PCI centre.

collection period from 01-03-2020 to 31-05-2020 and 149 patients were included in the control cohort (01-03-2019 to 31-05-2019). Males were over-represented in both cohorts (Control: n=131 (75.3%), 1st wave: n=116 (77.9%)). Median ages in the 1st wave population and cohort population were 61; IQR [59-64] and 60; IQR [58-64] respectively.

Patient characteristics

4 of the measured characteristics were unbalanced with statistical significance between groups. A greater incidence of OHCA (6.6% vs 1.3%; P=0.003) and left circumflex artery culprit lesions were present in the control group (21.3% vs 12.1% P=0.029). Of the diagnostic investigations utilised, left ventriculography was more frequently conducted in the 1st wave cohort (57.0% vs 37.4% P=0.00). Ethnicity was also heterogenous with a statistically significant increase in patients of afro-Caribbean origin in the 1st wave cohort (13.4% vs 3.4% P=0.005) (**Table 3**).

Procedural times

Patient related delays: When compared to control, the patients in the first wave group took significantly longer to decide to contact emergency medical services reflected by an extended time from symptom onset to call for help (Control median 31 mins; IQR [82.5] vs 1st wave median 60 mins; IQR [90.0], P=0.001) (**Figure 3**). A transfer time to first hospital of <40 mins was seen in 6.96% in Control vs 17.92% in 1st wave groups (**Figure 2**).

EMS delays: The time taken from when the patients called for help to their arrival at the PCI hospital was significantly increased in the 1st wave cohort (control median 72 mins; IQR [23] vs 1st wave median =80 mins; IQR [66.5], P=0.042) (**Figure 4**). The time taken from the patient's initial contact with EMS to arrive at the first hospital (PCI or non-PCI centre) was not statistically significant between groups (Control median 65 mins; IQR [30] vs 1st wave median 60 mins; IQR [55], P=0.342).

Inter-hospital transfer delays: Most patients in both cohorts were directly transported to a PCI Hospital (Control n=124 vs 1st wave n=107). Of those that first admitted to a non-PCI centre, transfer times to PCI centre were comparable between cohorts (Control median 120 mins; IQR [98.25] vs 1st wave median 180 mins; IQR [175.75], P=0.055). The time taken to transfer patients from a non-PCI to PCI centre in <90 minutes was only achieved in 28.13% of control group and 25% of 1st wave group (**Figure 2**).

In-hospital delays: All measurable procedural times (Time from arrival at PCI Hospital to cath-

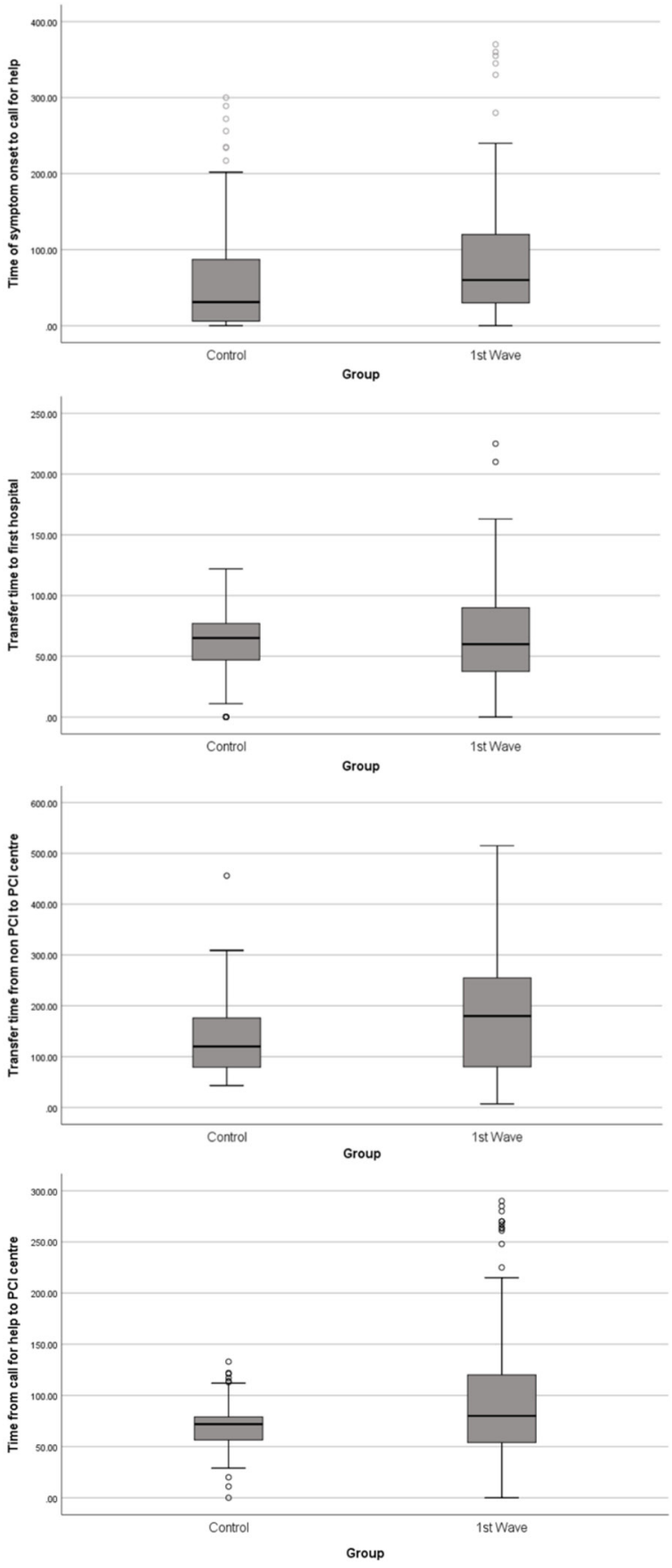

Figure 3. Pre-Hospital, EMS and Inter-Hospital transfer delays. The figure demonstrating Pre-Hospital, EMS and Inter-Hospital transfer delays. PCI: Percutaneous coronary intervention. Procedural times are displayed in minutes. Outliers 3 SD units above the upper quartile or below the lower quartile were excluded.

eterisation lab table, D2B, O2B and C2B) were not statistically significant between groups and have been displayed as box plots (**Figure 4**). The ESC and NICE target for D2B of <90 mins was achieved in 81.03% in the control cohort and 89.26% in the 1st wave group (**Figure 2**). A C2B time of <150 mins was met in 54.6% vs 46.98 in control vs 1st wave groups.

Discussion

The main findings from this study reflect the successful adaptation of our in-hospital procedures to approach service provision in the context of the COVID-19 pandemic. All our measurable in-hospital procedural times during the first wave of the pandemic remained grossly unchanged when compared to 2019 data with a greater proportion of patients meeting the <90 minute target for D2B time from our pre-COVID-19 baseline (1st wave: 89.26% vs Control: 81.03%). Furthermore, the D2B time in our single centre was marginally superior to the national performance in pPCI delivery as per BCIS audit data for the period 01/04/2019-31/03/2020 which was 89.1% [13]. Potential delays due to the decontamination of theatres, time taken to don personal protective equipment, and awaiting COVID-19 PCR results have had minimal adverse effects on the timely

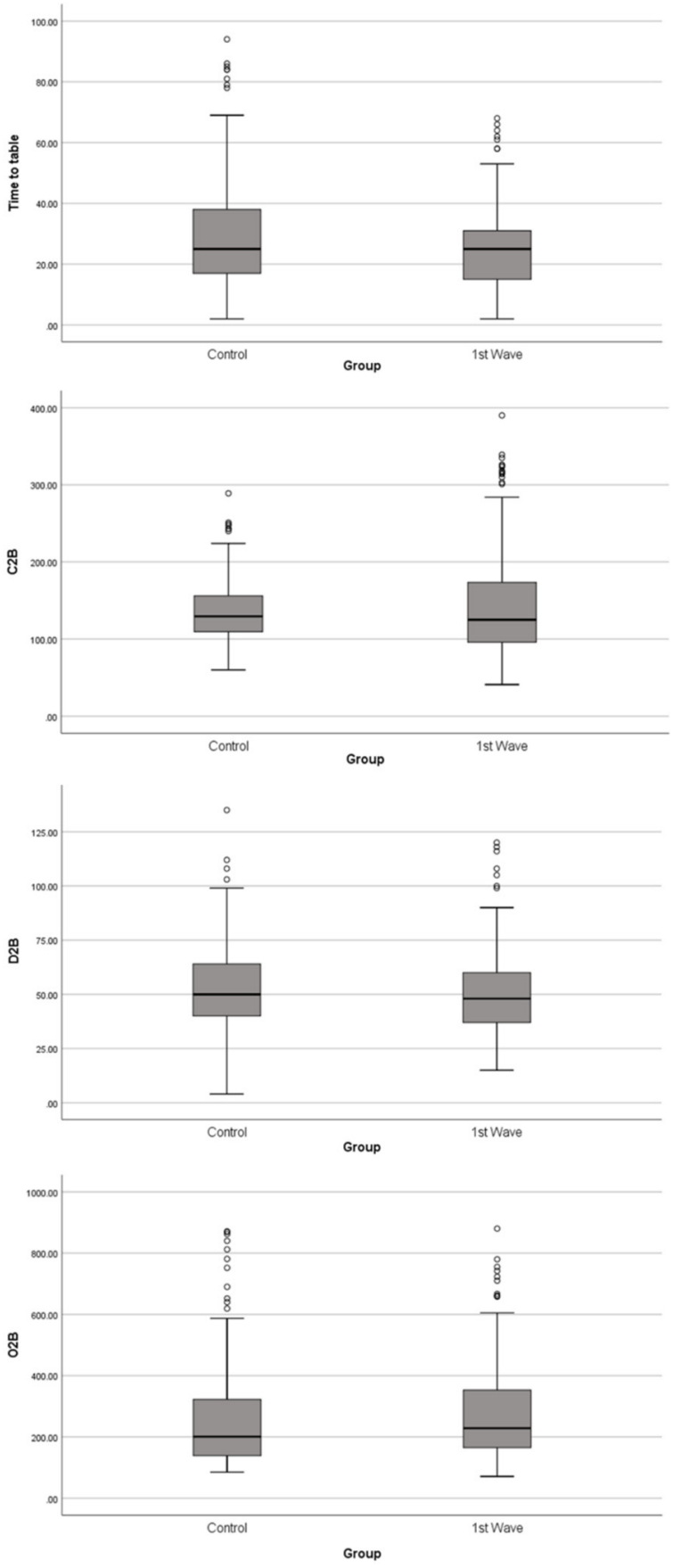

Figure 4. In-hospital delays. The figure demonstrating in hospital delays. D2B: Door-to-balloon times; O2B: Onset of symptoms to balloon time; C2B: Call to balloon time. Procedural times are displayed in minutes. Outliers 3 SD units above the upper quartile or below the lower quartile were excluded.

delivery of pPCI. Current evidence on the impact of the pandemic on the delivery of pPCI is mixed. The largest national study to date found a 30% increase in D2B times to 47 minutes post-lockdown from 37 minutes in 2017-2019 [14]. Inter-hospital variability must be acknowledged with various single centre studies experiencing delays or neutral impacts on D2B times but significantly prolonged C2B times [15, 16].

Historically, there has been scope for improvement in compliance with ESC recommended C2B times of less than 150 minutes in the UK. Despite this, the performance in both of our cohorts was insignificant upon heterogeneity analysis (1st Wave: 46.98% vs Control: 54.6%) and not too dissimilar to the national pre-COVID-19 and COVID-19 (69.2% and 67.5% respectively) percentage meeting this target [13, 17]. As a high-volume PCI centre, it must be considered that C2B times are often prolonged when compared to smaller centres as they have greater capacity to perform opportunistic procedures [18]. Notably, the contribution of patient related decision delays was significant despite not being reflected in C2B times.

The most significant delays were seen in the time taken from the patient experiencing symptoms to the time taken for

them to contact EMS (1st wave Median 60 mins; IQR [90] vs Control Median 31 mins; IQR [82.5] in control). The impact of 'Covid fear' has been observed in many areas of medicine. Specifically, its impact on cardiovascular services has led to 7,102 excess deaths attributed to ischaemic heart disease [19], increase in incomplete referral pathways with patients waiting on average 4.1 weeks longer for treatment in the previous year [20]. Government initiatives such as the 'NHS 111 first' campaign, aimed to appropriately triage patients during the pandemic to avoid precious emergency services from becoming overwhelmed [2]. This alongside widely publicised reports of hospitals working at catastrophic levels, may underly the public's reluctance to engage in emergency medical services despite experiencing otherwise worrying symptoms. As we move out of the worst of the pandemic in the UK, the role for Public Health initiatives to reassure patients is evident. Increased awareness of 'red flag' symptoms requiring emergency medical consultation must be promoted to recover the public's attendance to hospital for life threatening conditions such as myocardial infarction and reduction in excess cardiovascular deaths.

The only other significant difference between cohorts was seen in the time taken to transfer patients from non-PCI to PCI centre. A wide scale mobilisation of ambulances was mounted to meet the increasing demand during the 1st wave of the COVID-19 pandemic as well as the utilisation of alternative vehicles such as taxis that were repurposed to transport ambulatory patients [21]. National data also found a delay associated with patient transfers with an estimated delay in C2B in inter-hospital transfer patients by a median of 63 minutes [13]. This delay may reflect the logistical challenges of transporting patients safely during the pandemic and further highlighting the importance of efficient risk stratification and early identification of patients meeting criteria for emergent PCI upon arrival at the first hospital i.e. high-risk NSTEMI.

Consistent with existing national studies, the number of PCI's undertaken for STEMI was decreased by 14% in our first wave cohort when compared to control. NICOR data found a 21% decrease in PCI for NSTEMI and STEMI [5]. Despite this, the number of same day PCI procedures was found to have increased nationally during the first wave. This may reflect the impact of delayed presentations thus necessitating emergent PCI and the decreased likelihood of those experiencing milder symptoms to not only present but to also be experiencing infarcts requiring same day PCI.

Considering international studies investigating procedural times in STEMI during COVID-19, our study has come to similar conclusions. Similarly, delays in reperfusion have been attributed to patient hesitance in contacting EMS [16, 22] with one European study reporting an excess ischaemic time of 1.7 times that of pre-COVID-19 levels [23]. Conversely, our study found that EMS delays had minimal impact on overall perfusion time, further highlighting inter-hospital variability and the need for further studies to determine optimal guidelines for pPCI in the context of the COVID-19 pandemic.

Limitations

This is a single centre retrospective observational cohort study with multiple limitations. The populations were non-randomised, however consecutive sampling aimed to mitigate the risk of selection bias. Missing registry data limited the interpretation of the results with some data incalculable due to an incomplete dataset. There is risk of hidden confounding variables that were unmeasured and therefore unaccounted for in statistical analysis. Our data is representative of a high-volume PCI centre in London, England and due to limited sample size may not be generalisable to larger populations. The long-term patient outcomes have not been measured and therefore the overall impact of the pandemic on these patients cannot be commented on.

Conclusion

In line with ESC guidelines the timely delivery of pPCI for STEMI has been maintained in our centre during the first wave of the pandemic. Current alterations in our in-hospital procedures in the context of COVID-19 therefore are sustainable in the long term. Given the important prognostic ramifications of delayed reperfusion in these patients, any potential cause for prolonged ischaemic time must be addressed.

We found this was most greatly attributable to the patient related delays in deciding to contact EMS. Therefore, considering widescale vaccination in the UK the role for public health initiatives aimed at restoring public engagement with EMS for life threatening conditions must come to the forefront.

Disclosure of conflict of interest

None.

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