Heart Sci J 2022; 3(2): 10-17

Contents list available at www.heartscience.ub.ac.id

Heart Science Journal

Journal Homepage : www.heartscience.ub.ac.id

Original Article

Percutaneous Coronary Intervention as Clinical Outcome Predictor for in-Hospital Adverse Events in STEMI Patients

Anita Suryo Santoso[1*], Mohammad Saifur Rohman[2], Ardian Rizal[2], Setyasih Anjarwani[2], Heny martini[2], Indra Prasetya[2]

[1] *Brawijaya Cardiovascular Research Center, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.*
[2] *Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.*

ARTICLE INFO

Keywords:
STEMI;
PCI;
Mortality;
Complications;
In-Hospital Adverse Events

ABSTRACT

Background : Achieving timely reperfusion for patients with ST segment Elevation Myocardial Infarction (STEMI) remains a challenging problem in developing countries. This study aimed to determine whether late PPCI is the main predictor for in-hospital adverse events in STEMI patients.

Method : This study will emphasize the incident of in-hospital adverse events and complications between early PPCI vs late PPCI vs non revascularization groups. A total of 568 STEMI patients were consecutively enrolled from Saiful Anwar General Hospital in between 2018-2021. Patients were subdivided to the timeframe provided by the 2017 ESC STEMI management guideline. The incidence of in-hospital adverse event were calculated as primary endpoints, development of immediate complications during hospitalizations were analyzed as secondary endpoints.

Results : Incidence of in-hospital mortality were significantly higher for patients treated without revascularization and lowest in early PPCI group (32.4% and 7.5% respectively, P 0.00). The odds ratio for mortality between early PPCI group and non-revascularization groups were significantly lowest (OR 0.17, 95% CI 0.13 – 0.41). Complications between each treatment groups were significantly different with early PPCI had the lowest incidence of in-hospital complications of cardiogenic shock, cardiac arrest, and VT/VF. Stratification of baseline characteristics and PCI category reveals that timing PPCI is the main predictor for in-hospital adverse events (HR 4.506, 95% CI 2.487-6.662, P 0.00).

Conclusion : Percutaneous coronary intervention is the main predictor for the incidence of in hospital mortality and complications in STEMI patients.

1. Introduction

Primary percutaneous coronary intervention (PPCI) is the mainstay treatment strategy for ST-segment elevation myocardial infarction (STEMI).[1] Current available guidelines highlighted the importance of early management in STEMI patients with strict time window of within 12 hours after onset, or within 24 hours after successful fibrinolytic.[2] Early reperfusion of Infarct-related artery (IRA) is the primary treatment goal in order to reduce infarct size and residual stenosis, improving and preserving left ventricular function, and preventing re-occlusion.[2,3] Evidently timing of reperfusion has become critical to salvage the damaged myocardium

However, in clinical setting it is challenging to follow the timeframe provided by the guidelines especially in developing countries.[4] The ability to perform early PPCI is heavily dependent on geographical condition and availability of PCI-capable hospital in an area.[5] Several studies mentioned that in developing countries only a third of STEMI patients receive early PPCI5,6. While the rest of the patients were treated with late PPCI or optimal medical therapy only.[4]

Many studies conducted in developing countries focused on the impact of early versus late reperfusion in Acute Myocardial Infarction. Aside from evaluating short-term and long-term outcome of patients with late presenter, these studies also investigate the optimal timing for PPCI in a relatively limited resources setting.[4-9]

Differential results provided in the literatures prompted a debate on the optimum time of PPCI in late presenting STEMI patients.[4-7,9-18] In Indonesia, limited studies are available in investigating the effect of late PPCI in STEMI patients. Therefore, we performed a descriptive analytic study using the Acute Coronary Syndrome (ACS) Registry in Saiful Anwar General Hospital Malang. This study will evaluate the effect of PPCI as a predictor of in-hospital clinical outcome in STEMI patients. In-hospital clinical outcome was

*Corresponding author at: Brawijaya Cardiovascular Research Center, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.
E-mail address: anita.surya.santoso@gmail.com (A. S. Santoso).

https://doi.org/10.21776/ub.hsj.2022.003.02.3
Received 9 February 2022; Received in revised form 30 February 2022; Accepted 15 March 2022
Available online 30 April 2021

defined as mortality during hospital stay within STEMI patients. Further, we analyze the impact of late PPCI in the development of complications contributing to the in-hospital clinical outcome. Additionally we also include a cost analysis and length of stay comparison in between STEMI patients receiving early PPCI vs late PPCI vs optimal medical therapy to fully comprehend the extent of PPCI in the treatment of STEMI.

2. Materials and Method

2.1 Study Design

This study is using retrospective cohort design in order to evaluate the difference of in hospital clinical outcome, complications, length of stay, and treatment cost between STEMI patients treated with early PPCI, late PPCI, and optimal medical therapy. The research protocol was approved by the Health Research Ethics Commission Saiful Anwar General Hospital.

2.2 Subjects

Subjects were STEMI patients pooled using Saiful Anwar General Hospital ACS Registry within duration of 4 years (2018-2021). Consecutive sampling is used as sampling method. The inclusion criteria were as follows: (1) age >18 years old; (2) willing to participate in the study; (3) all STEMI patients undergoing PPCI. Subjects were excluded if they fall into one or more of the following criteria: (1) incomplete data sets; (2) unstable angina pectoris and/or NSTEMI patients; (3) STEMI patients undergoing fibrinolytic without subsequent PPCI; (4) patients with underlying structural heart disease and/or accompanied with/without other underlying metabolic disorder.

2.3 Intervention category

Selected subjects were divided into three categories: (1) Patients receiving early PPCI defined as PCI performed within 12 hours onset of symptoms, PCI performed <90 minutes after failed fibrinolytic, and PCI performed >12 hours after onset of symptoms with unstable hemodynamic; (2) Patients receiving late PPCI defined as PCI performed >12 hours after onset of symptoms with stable hemodynamic, PCI performed >90 minutes after failed fibrinolytic, and PCI performed >48h after onset of symtoms; (3) Patients receiving optimal medical therapy defined as STEMI patients which did not undergo reperfusion treatment, e.g. PPCI and/or fibrinolytic. The grouping criteria was divided based on timeframe according to 2017 ESC Guideline for the management of acute myocardial infarction in patients presenting with ST-segment elevation.

2.4 Clinical Outcomes

The primary outcome was in hospital adverse events defined as all-cause mortality during hospitalization; the secondary outcomes were cardiovascular (CV) complications consisted of: (1) cardiogenic shock; (2) acute heart failure; (3) pneumonia; (4) stroke; (5) acute renal failure; (6) cardiac arrest; (7) arrhythmia defined as VT/VF, AF/SVT, TAVB/Junctional/Third degree AV Block. We also provide analysis regarding length of stay and treatment cost during hospitalization in each group.

2.5 Data Analysis

Baseline characteristics were analyzed using univariate analysis and the data were presented as mean ± standard deviation (SD). Independent t-test was performed to differentiate mean between intervention group. Normality test using Kolmogorov-Smirnov test was conducted to determine the normality and homogeneity of the data. Finally we performed multivariate logistic regression test to establish the relationship of PPCI as a predictor for in hospital adverse events in STEMI patients. Stratification and multivariate analysis was done to identify potential confounding factors and evaluate the strength between variables. All data were statistically analyzed using SPSS 22.0. P<0.05 was considered significant.

3. Results

A number of 795 patients were recorded in the Saiful Anwar General Hospital ACS registry in between 2018-2021 with 568 subjects were enrolled in the study. Between selected subjects, 387 patients had received early PPCI, 107 patients had received late PPCI, while 74 patients had received optimal medical therapy, i.e. did not receive PPCI and/or fibrinolytic. Percentage comparison between each category was shown in Figure 3.1.

The data showed significant reduction in the percentage of patients receiving early PPCI during 4 years timeframe, with 73.8% patients received early PPCI in 2018 and 56.8% patients received early PPCI in 2021. On the contrary, patients receiving late PPCI has substantially increased from 15.9% in 2018 and 30.7% in 2021 with significant rise occurred in the last two years. Patients receiving optimal medical therapy however, have been relatively steady in the past 4 years.

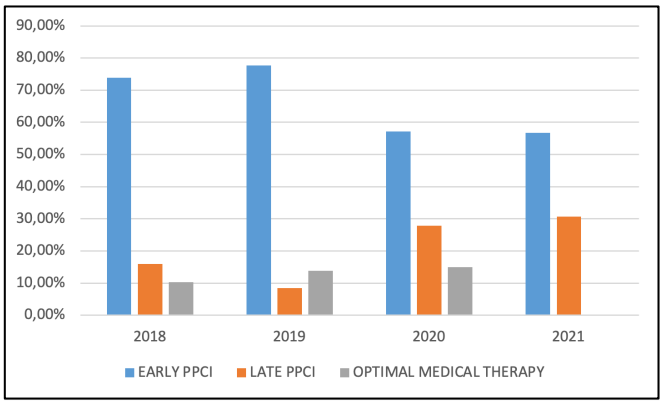

Figure 3.1 Comparison of patients in each category from 2018-2021

3.1 Baseline Characteristic Comparison

The percentage of subjects represented in baseline characteristics such as gender, age, and body weight was proportionally distributed in between each category. Significant results regarding onset within each category was also demonstrated (P=0.01). There were also no significant difference in between the percentage of cardiovascular risk factors i.e. smoking, diabetes, hypertension, dyslipidemia, family history of CAD, etc. within each category as shown in table 3.1. However, the proportion of patients presenting with KILLIP Class IV was substantially higher within optimal medical therapy category compared with late and early PPCI group (P=0.049). This result was also consistent with higher GRACE score (P=0.001) and Troponin I levels (P=0.043) in patients receiving optimal medical therapy. While other baseline parameters were evenly measured in between each category.

Table 3.2 Baseline characteristics of subjects in each category

Variable	Early PPCI	Late PPCI	Optimal Medical Therapy	P Value
Gender				
Male	237 (61.2%)	71 (66.4%)	45 (60.8%)	0.607
Female	150 (38.8%)	36 (33.6%)	29 (39.2%)	
Age (year)	57.73 ± 10.908	56.27 10.332	57.78 ± 11.414	0.454
Body weight (kg)	64.8 ± 9.667	64.22 14.718	63.71 ± 12.708	0.531
Funding				
BPJS	350 (90.6%)	99 (92.5%)	61 (82.4%)	0.178
Out of pocket	36 (9.1%)	8 (7.5%)	13 (17.6%)	
SKTM	1 (0.3%)	0 (0%)	0 (0%)	
Symptom onset (Hours)	9.01	12.25	13.04	0.001
Smoking	146 (37.7%)	36 (33.6%)	29 (39.2%)	0.687
Diabetes	152 (39.3%)	48 (44.9%)	34 (45.9%)	0.392
Hypertension	148 (38.8%)	36 (33.6%)	55 (39.2%)	0.607
Dyslipidemia	21 (5.4%)	8 (7.5%)	5 (6.8%)	0.699
Family History of CAD	24 (6.2%)	8 (7.5%)	5 (6.8%)	0.89
Asthma/COPD	6 (1.6%)	2 (1.9%)	0 (0.0%)	0.528
History angina	27 (7.0%)	5 (4.7%)	4 (5.4%)	0.646
History of AMI	75 (19.4%)	28 (26.2%)	17 (23.0%)	0.288
History of HF	34 (8.8%)	8 (7.5%)	10 (13.5%)	0.349
History of PAD	21 (5.4%)	8 (7.5%)	5 (6.8%)	0.699
History of CVA	7 (1.8%)	3 (2.8%)	1 (1.4%)	0.747
History of PCI	18 (4.7%)	4 (3.7%)	5 (6.8%)	0.636
History of CABG	5 (1.3%)	2 (1.9%)	2 (2.7%)	0.652
Vital Signs				
Systolic Blood Pressure	126.29 ± 31.584	131.3 ± 108.727	125.46 ± 29.236	0.287
Diastolic Blood Pressure	77.3 ±18.4	81.76 ± 59.922	78.23 ± 18.636	0.475
Heart Rate	84.2 ± 24.395	79.88 ± 21.344	88.73 ± 21.831	0.046
Killip Class				
I	295 (76.2%)	75 (70.1%)	43 (58.1%)	0.049*
II	34 (8.8%)	12 (11.2%)	12 (16.2%)	
III	16 (4.1%)	7 (6.5%)	8 (10.8%)	
IV	42 (10.9%)	13 (12.1%)	11 (14.9%)	
TIMI	4.5 ± 2.448	4.3 ± 2.673	5.12 ± 2.71	0.146
GRACE	115.88 ± 27.3	115.29 ± 31.17	129.59 ± 32.59`	0.001*
Crusade	37.11 ± 22.78	35.41 ± 21.33	39.17 ± 14.98	0.665
Hemoglobin (g/dL)	13.65 ± 8.24	17.6 ± 24.37	13.09 ± 2.55	0.606
Leukocyte	9764.4 ± 7948	9531 ± 8178.57	9937 ± 9567	0.945
Cholesterol	175.55 ± 54.08	177.09 ± 51.54	176.36 ± 46.41	0.966
Triglyceride	140.16 ± 82.32	147 ± 73.85	134 ± 64.89	0.569
Low density lipoprotein	124.11 ± 49.826	118.92 ± 50.01	119.30 ± 47.572	0.559
High density lipoprotein	43.31± 20.56	45.92 ± 38.67	46.31 ± 24.81	0.513
Ureum	41.29 ± 28.76	38.58 ± 25.06	47.79 ± 32	0.099
Creatinine	2.1 ± 8.9	1.35 ± 0.943	3.21 ± 8.98	0.312
Natrium	136 ±10.69	136 ± 4.21	136 ± 4.36	0.872
Kalium	5.18 ± 11.66	3.85 ± 0.59	9.51 ± 44.31	0.115
Random Blood Glucose	173.62 ± 108.637	155.25 ± 75.6	187 ± 118.26	0.113
Uric Acid	7.89 ± 9.96	13.22 ± 54.77	7.29 ± 2.88	0.186
Troponin I	9.54 ± 15.09	12.2 ± 18.5	14.63± 24.49	0.043*
CKMB	137.76 ± 155.79	133 ± 174.58	129 ± 157	0.908
HbA1c	6.99 ± 2.24	7.11 ± 2.3	7.36 ± 2.5	0.5
Systolic Ejection Fraction	49.02 ± 11.64	47.08 ± 13.142	45.14 ± 13.825	0.339
Loading antiplatelet				
Aspilet+clopidogrel	334 (86.3%)	98 (91.6%)	64 (87.7%)	0.343
Aspilet+ticagrelor	53 (13.7%)	9 (8.4%)	9 (12.3%)	

Table 3.2 Baseline characteristics of subjects in each category

Variable	(Early PCI)	(Late PCI)	Optimal Medical Therapy	P Value
ECG rhythm				
Sinus	351 (90.6%)	96 (89.7%)	67 (90.5%)	0.937
Atrial Fibrillation/atrial flutter	7 (1.8%)	3 (2.8%)	2 (2.7%)	
Junctional	2 (0.5%)			
Atrioventricular Block	10 (2.6%)	1 (0.9%)	0 (0.0%)	
Total Atrioventricular Block	10 (2.6%)	3 (2.8%)	0 (0.0%)	
Supraventricular Tachycardia	1 (0.3%)	3 (2.8%)	4 (5.4%)	
Ventricular Tachycardia	6 (1.6%)	0 (0.0%)	0 (0.0%)	
Drugs		1 (0.9%)	1 (1.4%)	
ACE inhibitor				
Beta Blocker	374 (96.6%)	105 (98.1%)	72 (97.3%)	0.717
High Intensity Statin	278 (71.8%)	81 (75.7%)	57 (77%)	0.532
	384 (99.2%)	107 (100%)	74 (100%)	0.494

Note. PPCI = primary percutaneous coronary intervention; PCI = percutaneous coronary intervention; BPJS = social health insurance administrator; SKTM = poor mark certificate; CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease; AMI = acute myocardial infarction; HF = heart failure; PAD = peripheral arterial disease; CVA = cerebrovascular accident; CABG = coronary artery bypass graft coronary syndrome; UAP = unstable angina pectoris.

3.2 Primary Clinical Outcome

The implication of PPCI in primary clinical outcome was demonstrated in figure 3.3. Incidence of all-cause mortality defined as in Hospital adverse event within early PCI category is significantly lower (7.5%) in comparison to both late PCI category (15%) and optimal medical therapy category (32.4%) with P value 0.000. Post hoc analysis between subgroups were also provided in table 3.3.

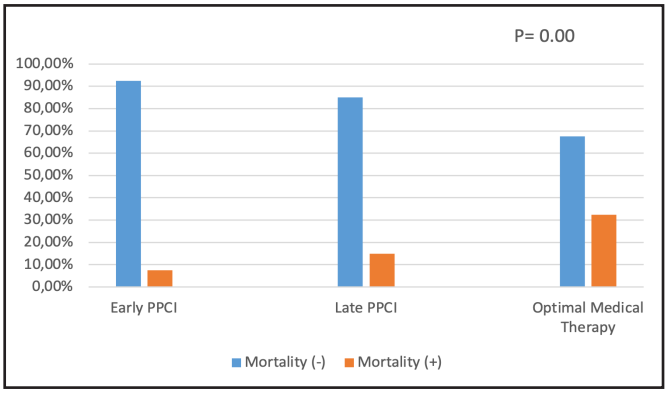

Figure 3.3 Mortality rate between treatment groups

Table 3.3 Post hoc analysis on impact of PPCI in between treatment groups

Category		Odd Ratio	95% CI
Early PPCI	Late PPCI	0.45	0.21 – 0.59
Early PPCI	Optimal Medical Therapy	0.17	0.13 – 0.41
Late PPCI	Optimal Medical Therapy	0.37	0.17 – 0.52

Note. PPCI = primary percutaneous coronary intervention; 95% CI = 95% confidence interval

3.3 Secondary Clinical Outcome

Several complications played important role towards the clinical outcome in STEMI patients. Therefore we analyze the most common complication occurred that were correlated to the primary clinical outcome. Further we also analyze the impact of each category towards the duration and cost during hospitalizations. The number of in hospital complications in each category was presented in table 3.3. Subsequent post-hoc analysis was presented in table 3.4. Also the impact of complications and in-hospital mortality was shown in table 3.5

Table 3.3 in-hospital complications in each category

Complication	Early PPCI	Late PPCI	Optimal Medical Therapy	p
Cardiogenic shock	140 (36.3%)	32 (29.9%)	24 (32.4%)	0.011*
Acute heart failure	67 (17.5%)	19 (17.8%)	14 (19.2%)	0.945
Pneumonia	27 (7%)	8 (7.5%)	5 (6.8%)	0.979
Stroke	9 (2.4%)	0 (0%)	1 (1.4%)	0.253
Acute renal failure	24 (6.3%)	3 (2.8%)	6 (8.1%)	0.271
Cardiac arrest	10 (2.6%)	16 (15%)	25 (33.8%)	0.00*
Arrhythmia				
VT/VF	15 (3.9%)	16 (15%)	25 (33.8%)	0.00*
AF/SVT	4 (1%)	1 (0.9%)	0 (0.0%)	0.681
TAVB/Junctional/AV Block grade II	14 (3.6%)	3 (2.8%)	0 (0%)	0.243
Length of stay (days)	5.68±2.974	5.96 ± 2.664	6.57±4.629	0.105
Cost	42.700.00 ± 14.270.000	45.400.000 ± 14.700.000	57.100.000 ± 55.690.000	0.003*

Note. PPCI = primary percutaneous coronary intervention; VT = ventricular tachycardia; VF = ventricular fibrillation; TAVB = total atrioventricular block; AV bock = atrioventricular block

Table 3.4 Post hoc analysis of complications in each category

Variable	Group 1	GRUP 2	P Value
Shock	Early PPCI	Late PPCI	0.000*
		Optimal Medical Therapy	0.001*
	Late PPCI	Early PPCI	0.000*
		Optimal Medical Therapy	0.608
	Optimal Medical Therapy	Early PPCI	0.001*
		Late PPCI	0.608
Cardiac arrest	Early PPCI	Late PPCI	0.000*
		Optimal Medical Therapy	0.000*
	Late PPCI	Early PPCI	0.000*
		Optimal Medical Therapy	0.003*
	Optimal Medical Therapy	Early PPCI	0.000*
		Late PPCI	0.003*
VT/VF	Early PPCI	Late PPCI	0.000*
		Optimal Medical Therapy	0.000*
	Late PPCI	Early PPCI	0.000*
		Optimal Medical Therapy	0.003*
	Optimal Medical Therapy	Early PPCI	0.000*
		Late PPCI	0.003*
Cost	Early PPCI	Late PPCI	0.709
		Optimal Medical Therapy	0.002*
	Late PPCI	Early PPCI	0.709
		Optimal Medical Therapy	0.041*
	Optimal Medical Therapy	Early PPCI	0.002*
		Late PPCI	0.041

Note. PPCI = primary percutaneous coronary intervention; VT = ventricular tachycardia; VF = ventricular

4. Discussion

In this study, we found that in between January 2018 – December 2021 early PCI comprised of 387 patients from the entire 568 subjects. Within 4 years of observation, early PPCI was gradually declining from 73.8%, 77.7%, 57.1%, and 56.8% with the most significant decline occurred in 2020 and 2021 (table 3.1). The decline in early PCI was followed by steady increase in the number of late PCI and non revascularized patients. Simultaneously mortality rate among STEMI patients were also gradually increased between 2020 and 2021 (figure 4.1). This phenomenon arises in concurrence with the COVID 19 pandemic. De Luca et al. compared the number of PCI in 2019 (non COVID) and 2020 (COVID) and found 18.9% decline of early PCI in 2020. The study also found 34% increase in >12 hours ischemic time and 17% increase in >30 minutes door to balloon time19. Another multicenter study in Italy also reported 48.4% decline within patients presenting with AMI and three-fold increase in mortality rate compared to 201920. The spread of COVID-19 is directly related with substantial decrease in the number of AMI patients undergoing primary PCI, and increase in significant ischemic time, higher time delay, and increase in door to balloon time.[21-23]

KILLIP Class, GRACE, and Troponin are significantly different variables within the baseline characteristics (table 3.2). Post infarct heart failure is correlated with higher in-hospital mortality, even can increase 4 fold compared with patients without heart failure. In this case, KILLIP Class is particularly useful for risk stratification. The risk of post infarct heart failure is the result of interaction between baseline characteristics and the medication prescribed. Thus the interaction is multifactorial in nature.

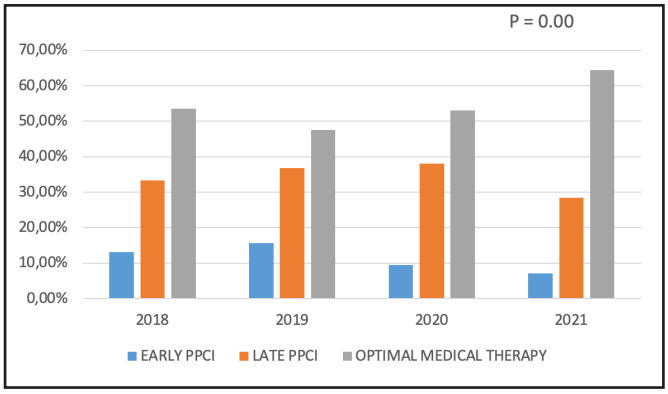

Table 4.1 Mortality rate in each category from 2018-2021. PPCI = primary percutaneous coronary intervention.

Our study demonstrated significant different in the number of in-hospital mortality within treatment groups (P 0.000). The proportion of in hospital mortality between early PCI, late PCI, and optimal medical therapy groups were 42%, 23.2%, and 34.8% respectively (table 3.3). Odds ratio were also substantially different among treatment groups, compared with optimal medical therapy group early PPCI had 83% mortality risk reduction (table 4.2). Based on current STEMI guideline, revascularization with PCI should be performed within 12 hours post onset24. However, in real setting, majority of patients presented to the hospital >12 h after the chest pain onset. Therefore, several studies tried to propose the benefit of late PCI.[25,26]

Table 3.2 Baseline characteristics of subjects in each category

Variables	Mortality (-)	Mortality (+)	P value
CULPRIT			
LAD	47%	84%	0.002*
LCx	8%	4%	
RCA	45%	12%	1.00
LESION			0.398
LM	12.7%	12%	0.105
LAD	78.8%	88%	0.609
LCx	66.1%	84%	0.038*
RCA	79.9%	88%	
Non complete revascularization	78.9%	96%	0.148
TIMI Flow			
0	1.2%	4.2%	
1	0.9%	4.2%	
2	15.7%	25%	
3	82.2%	66.7%	

Note. LM = left main; LAD = left anterior descending; LCx = left circumflex; RCA = right coronary artery; TIMI = thrombosis in myocardial infarction study group

Chinese STEMI patient guideline in 2016 recommended PCI in patients with clinical or proven ischemia presenting within 12-48 hours (recommendation class IIa, level of evidence B).[25] Similarly Bouisset al. analyzed data from 3 observational national studies, as a part of FAST-MI (French Registry of Acute ST-elevation and non ST-elevation Myocardial Infarction) program over the period of 1 month in 2005, 2010, and 2015. Researchers evaluated 1169 STEMI patients with late presentation (12 – 48 hours after onset).[26] Compared with 5104 early presenting STEMI patients, late presenters tend to show less beneficial profile risks. Late presenting STEMI patients were more likely to be older, female, diabetic, and have a history of long standing hypertension. History of stroke, heart failure, and cancer were also more prevalent in this subset of patients. Late presenting STEMI patients were less likely to come with chief complaint of typical chest pain, however they were most likely present with cardiogenic shock compared to early presenters. Several characteristics found in the literature were also likely contributed to the adverse outcome of these patients. Late presenting STEMI patients were less likely to receive thrombolysis therapy compared to early presenters. However, patients receiving delayed PCI were still demonstrate lower mortality rate compared with non revascularized patients.[27,28]

Most common complications developed during hospitalizations and correlated to the mortality were shock, acute heart failure, pneumonia, stroke, acute renal failure, cardiac arrest, and arrhythmia (VT/VF, AF/SVT, TAVB/junctional/Second degree AV Block).[29,30] Our study found 3 variables that were significantly different during the treatment groups (table 3.4), those were cardiogenic shock (P 0.011), cardiac arrest (P 0.00), and VT/VF rhythm (P 0.00). In which duration of stay were not significantly correlated to complications and primary clinical outcome (P 0.105). However treatment cost were significantly different among treatment groups (P 0.003). Patients treated with medical treatment only require substantially higher cost of IDR 57.100.000 ± 55.690.000. Our study also analyzed the effect of complications toward primary clinical outcome of mortality. 4 variables are significantly correlated to mortality, those were cardiogenic shock (P 0.00), acute heart failure (P 0.00), cardiac arrest (P 0.00), and VT/VF rhythm (P 0.00).

Baseline characteristics that were correlated with primary clinical outcome were family history of CHD (P 0.05), KILLIP Class (P 0.00), random blood glucose (P 0.007), HbA1C (P 0.002) (table 4.4). Lourdes Vincent et al. concluded that KILLIP Class were significantly

Table 4.4 Bivariate selection of baseline characteristics contributing to mortality

Variables	Coeficcient	Hazard Ratio	P Value	95% CI
Family History of CHD	1.172	3.229	0.177	0.590-17.678
History of CABG	-19.547	0.00	0.999	0.00-0.00
Rhythm presentation	0.409	1.505	0.136	0.879-2.577
KILLIP Class	1.073	2.924	0.00*	1.644-5.201
Random Blood Glucose	0.928	2.529	0.280	0.469-13.625
HbA1c	0.676	1.969	0.389	0.422-9.196
Category	3.519	4.680	0.001*	2.414-6.822
Complete vs Non complete revascularization	1.232	3.429	0.301	0.332-35.405
Culprit	-1.151	0.316	0.012*	0.129-0.775
TIMI Flow	-0.382	0.682	0.018*	0.497-0.938
GRACE	0.011	1.011	0.340	0.988-1.035
Heart Rate	0.00	1.00	0.981	0.968-1.033

Note. TIMI = thrombosis in myocardial infarction study group; CHD = coronary heart disease; CABG = coronary artery bypass grafting; 95 CI = 95% confidence interval

Table 4.5 Multivariate analysis of coefficient related to mortality

Variables	Coeficcient	HR	P Value	95% CI
Killip	1.180	3.256	0.00*	2.088-5.078
Revascularization Category	2.410	4.506	0.00*	2.487-6.662
Culprit lesion	2.055	1.348	0.004*	1.169-1.717
TIMI Flow		0.853	0.151	0.687-1.059

Note. HR = hazard ratio; 95% CI = 95% confidence interval; TIMI = thrombosis in myocardial infarction study group

correlated with higher in hospital mortality. They were also more likely to have anterior lesions and tend to develop in hospital complications.[30] Our study also found that patients with LAD lesion exerted higher mortality rate compared to other culprit lesions (table 4.3). However from multivariate analysis we were able to conclude that treatment groups were the single most significant predictor contributing to mortality with adjusted HR of 4.506 (P 0.00). Adjusted HR for treatment group was substantially higher compared to other significant factors related to mortality eg. KILLIP Class and culprit lesion (table 4.5).

Although our study provided clear evidence of positive outcome in early PPCI strategy, there were several limitations that could not be addressed in this study. Grouping of study subjects were based solely on broad category of early, late, and optimal medical therapy rather than using time series. Therefore, we were not able to pinpoint the effect of hourly delay in the primary clinical outcome, and concurrently the most optimal time to perform PPCI. We also limited our observation only during hospital stay, thus we did not measure the long-term effect early vs delayed PPCI vs non revascularized patients in terms of major adverse cardiac events (MACE). However, despite this limitations we were still able to conclude that early PPCI is the most appropriate strategy for STEMI patients to reduce in-hospital mortality and immediate lethal cardiovascular complications.

5. Conclusion

Our study concluded that PPCI is the most significant predictor for in-hospital adverse events of mortality in STEMI patients. Patients underwent early and delayed PPCI demonstrated substantially lower mortality rate compared with optimal medical therapy group, with early PPCI group shown the lowest mortality rate. PPCI was also a strong predictor for immediate lethal cardiovascular complications eg. Cardiogenic shock, cardiac arrest, and VT/VF rhythm. Finally, non revascularized patients had significantly higher treatment cost compared with patients receiving PPCI.

6. Declarations

6.1. Ethics Approval and Consent to participate
This study was approved by local Institutional Review Board, and all participants have provided written informed consent prior to involvement in the study.

6.2. Consent for publication
Not applicable.

6.3. Availability of data and materials
Data used in our study were presented in the main text.

6.4. Competing interests
Not applicable.

6.5. Funding source
Not applicable.

6.6. Authors contributions
Idea/concept: AS. Design: AS, MSR. Control/supervision: MSR, AR, SA, HM, IP. Literature search: AS, MSR. Data extraction: AS, MSR. Statistical analysis: AS, MSR. Results interpretation: AS, MSR. Critical review/discussion: MSR, AR, SA, HM, IP. Writing the article: AS. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

6.7. Acknowledgements
We thank to Brawijaya Cardiovascular Research Center.

References

1. Perhimpunan Dokter Spesialis Kardiovaskular Indonesia. Pedoman tata laksana sindrom koroner akut. Edisi ke-4. Jakarta: PERKI; 2418.

2. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, Caforio AL, Crea F, Goudevenos JA, Halvorsen S, Hindricks G. 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). European heart journal. 2018 Jan 7;39(2):119-77.

3. Bohula E, Morrow D. ST-elevation myocardial infarction: management. Dalam: Zipes DP, Libby P, Bonow RO, editors. Braunwald's Heart Disease: a Textbook of Cardiovascular Medicine. Edisi ke-11. Philadelphia, PA: Elsevier; 2018

4. Guo, Q., Huang, J., Shen, Y. et al. The role of late reperfusion in ST-segment elevation myocardial infarction: a real-world retrospective cohort study. BMC Cardiovasc Disord 24, 247 (2424). https://-doi.org/10.1186/s12872-024-01479-0

5. Chotechuang Y, Phrommintikul A, Kuanprasert S, et al. Cardiovascular outcomes of early versus delayed coronary intervention in low to intermediate-risk patients with STEMI in Thailand: a randomised trial. Heart Asia 2419;11:e011241. doi:10.1136/hearta-sia-2419-011241.

6. Huo Y. Current status and development of percutaneous coronary intervention in China. J Zhejiang Univ Sci B. 2410;11(8):631–3.

7. JW Wu, H Hu, D Li, LK Ma. In-hospital outcomes of delayed stenting in hemodynamically stable patients with ST-segment elevation myocardial infarction: the CCC (Care for Cardiovascular Disease in China) project. Cardiovasc Diagn Ther 2419;9(5):462-471 | http://dx.doi.org/10.31037/cdt.2419.08.10.

8. Kofoed, K. F., Kelbæk, H., Hansen, P. R., et al. Early Versus Standard Care Invasive Examination and Treatment of Patients With Non-ST-Segment Elevation Acute Coronary Syndrome. 2418; In Circulation (Vol. 138, Issue 24, pp. 2741–2750). Ovid Technologies (Wolters Kluwer Health). https://doi.org/10.1161/circulationa-ha.118.037152

9. Ki, Y.-J., Kang, J., Yang, H.-M., Woo Park, K., et al. Immediate Compared With Delayed Percutaneous Coronary Intervention for Patients With ST-Segment–Elevation Myocardial Infarction

Presenting ≥12 Hours After Symptom Onset Is Not Associated With Improved Clinical Outcome. 2431; Circ: Cardiovascular Interventions. https://doi.org/10.1161/circinterventions.124.009863

10. Neumann FJ, Uva MS, Ahlsson A, et al. ESC/EACTS Guidelines on myocardial revascularization European Heart Journal (2419) 40, 87–165

11. Menon V, Pearte CA, Buller CE, et al. Lack of benefit from percutaneous intervention of persistently occluded infarct arteries after the acute phase of myocardial infarction is time independent: insights from Occluded Artery Trial European Heart Journal (2409) 30, 183–191

12. Appleton DL, Abbate A. Benefits of coronary revascularization in stable patients in the short and long term after acute myocardial infarction. Interv. Cardiol. (2410) 2(1), 67–76

13. Fan Y, Bai X, Chen Y, et al. Late Percutaneous Coronary Intervention Prevents Left Ventricular Remodeling and Improves Clinical Outcomes in Patients With ST-Elevation Myocardial Infarction. Clin. Cardiol. 38, 2, 82–91 (2415)

14. Stiermaier. T, Eitel Ingo, Waha S et al. Myocardial salvage after primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction presenting early versus late after symptom onset. Int J Cardiovasc Imaging. Springer Science. 2417

15. Pedersen F, Butrymovich V, Short- and Long-Term Cause of Death in Patients Treated With Primary PCI for STEMI. Journal of the American College of Cardiology. Vol 64. No.24. 2414

16. Rentrop KP, Feit F. Reperfusion therapy for acute myocardial infarction: Concepts and controversies from inception to acceptance. Am Heart J 2415;170:971-980

17. Cohen M, Gensini GF, Maritz F, et al. Prospective Evaluation of Clinical Outcomes After Acute ST-Elevation Myocardial Infarction in Patients Who Are Ineligible for Reperfusion Therapy: Preliminary Results From the TETAMI Registry and Randomized Trial. Circulation. 2403;108[suppl III]:III-14-III-31

18. Mehta. S. Reducing system delays in treatment of ST elevation myocardial infarction and confronting the challenges of late presentation in low and middle income countries . Indian Heart J (2417)

19. Sarfraz Z, Sarfraz A, Sarfraz M, Nadeem Z, Hussain H, Bakhsh S, Patel G, Arshad J, Sattar Y. COVID-19 and Primary Percutaneous Coronary Intervention (PCI): Delayed Presentations and Outcomes for STEMI care.

20. Park DW, Yang Y. Delay, death, and heterogeneity of primary PCI during the COVID-19 pandemic: an international perspective. Journal of the American College of Cardiology. 2020 Nov 17;76(20):2331-3.

21. Spaccarotella C, Sorrentino S, Indolfi C. Reduction of hospitalisations and increased mortality for acute coronary syndromes during covid-19 era: Not all countries are equal. The Lancet Regional Health–Western Pacific. 2021 Jul 1;12.

22. Bhatt DL. Timely PCI for STEMI—still the treatment of choice. N Engl J Med. 2013 Apr 11;368(15):1446-7.

23. Xiu WJ, Yang HT, Zheng YY, Ma YT, Xie X. Delayed PCI 12 Hours after the Onset of Symptoms Is Associated with Improved Outcomes for Patients with ST-Segment Elevation Myocardial Infarction: A Real-World Study. Journal of interventional cardiology. 2019 Jun 18;2019.

24. Ali M, Lange SA, Wittlinger T, Lehnert G, Rigopoulos AG, Noutsias M. In-hospital mortality after acute STEMI in patients undergoing primary PCI. Herz. 2018 Dec;43(8):741-5.

25. García-García C, Ribas N, Recasens LL, Meroño O, Subirana I, Fernández A, Pérez A, Miranda F, Tizón-Marcos H, Martí-Almor J, Bruguera J. In-hospital prognosis and long-term mortality of STEMI in a reperfusion network.“Head to head” analisys: invasive reperfusion vs optimal medical therapy. BMC cardiovascular disorders. 2017 Dec;17(1):1-8.

26. Han H, Wei X, He Q, Yu Y, Ruan Y, Wu C, Cao Y, Herzog E, He J. Comparison of In-Hospital Mortality and Length of Stay in Acute ST-Segment-Elevation Myocardial Infarction Among Urban Teaching Hospitals in China and the United States. Journal of the American Heart Association. 2019 Nov 19;8(22):e012054.

27. Kastrati A, Coughlan JJ, Ndrepepa G. Primary PCI, Late Presenting STEMI, and the Limits of Time. Journal of the American College of Cardiology. 2021 Sep 28;78(13):1306-8.

28. Shahid M, Zarif HM, Farid MS, Abid MS, Akhtar B, Khan MR. Prognostic value of hyperglycemia on admission on in-hospital outcomes in patients presenting with ST-elevation myocardial infarction. Cureus. 2020 Feb;12(2).

29. Burlacu A, Tinica G, Nedelciuc I, Simion P, Artene B, Covic A. Strategies to lower in-hospital mortality in STEMI patients with primary PCI: analysing two years data from a high-volume interventional centre. Journal of interventional cardiology. 2019 Oct 1;2019.

30. Tran DT, Welsh RC, Ohinmaa A, Thanh NX, Kaul P. Temporal trends of reperfusion strategies and hospital mortality for patients with STEMI in percutaneous coronary intervention–capable hospitals. Canadian Journal of Cardiology. 2017 Apr 1;33(4):485-92.