# In-Hospital and Long-Term Outcomes of ST-Segment Elevation Myocardial Infarction Patients Undergoing Primary Percutaneous Coronary Intervention

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## ABSTRACT

**Introduction:** We evaluated in-hospital and long-term outcomes of patients who underwent primary percutaneous coronary intervention (PCI) in a tertiary center.

**Patients and Methods:** We examined 1550 patients (mean age= 58.5 years, 83.1% male) admitted with acute ST-segment elevation myocardial infarction (AMI) who underwent primary PCI and were followed-up prospectively. The primary outcomes were in-hospital death and major adverse cardiac events (MACE) at follow-up.

**Results:** The mean duration of ischemia at admission was 2.85 ± 2.49 hours; 10.3% of the patients were Killip class III or IV. The mean door-to-device time was 43 (29-52) minutes. During hospitalization, all-cause mortality occurred in 73 patients (4.7%). Multivariate analysis revealed that advanced age, impaired left ventricular ejection function, high Killip functional class, hemoglobin level at admission, ventricular arrhythmias, and advanced atrioventricular block were independent predictors of poor prognosis (OR= 1.07, 0.93, 15.34, 1.44, 3.79, and 4.26 respectively). Among discharged patients with a median 49.5 (25-73) months follow-up, 12.4% of them died, 12.5% had a recurrent myocardial infarction (MI), and 2.3% had a cerebrovascular accident. The strongest independent MACE predictors were impaired left ventricular function, poor glomerular filtration rate, low albumin level, and a history of cerebrovascular disease (HR= 0.97, 0.99, 0.65, and 2.50, respectively). Secondary outcomes were contrast-induced acute kidney injury (16.7%), ventricular arrhythmias (6.1%), advanced atrioventricular block (3.7%), atrial fibrillation (7.6%), and major bleeding (1.6%).

**Conclusion:** AMI still has a poor long-term prognosis. These results emphasize the advantages of rapid, non-delayed revascularization. Patients should be followed-up closely after discharge in both the short- and long-term.

**Key Words:** Angioplasty; myocardial infarction; reperfusion; myocardial revascularization; in hospital mortality

## Primer Perkütan Koroner Girişim Yapılan ST-Segment Yükselmeli Miyokart Enfarktüsü Hastalarının Hastane İçi ve Uzun Dönem Takipleri

## ÖZET

**Giriş:** Üçüncü basamak merkezde, primer perkütan koroner girişim (PKG) uygulanan hastaların hastane içi ve uzun dönem sonuçları değerlendirildi.

**Hastalar ve Yöntem:** Primer PKG uygulanan ve prospektif olarak takip edilen akut ST-segment yükselmeli miyokart enfarktüsü (AME) ile başvuran 1550 hasta (ortalama yaş= 58.5 yıl, %83.1 erkek) incelendi. Hastane içi ölüm ve takiplerdeki majör advers kardiyak olaylar (MAKO) birincil sonlanım olarak kabul edildi.

**Bulgular:** Başvuru anındaki ortalama iskemi süresi 2.85 ± 2.49 saat olup ortalama kapı cihaz süresi 43.2 ± 20.3 dakika olarak izlendi. Hastanede yatış sırasında, hastaların %4.7'sinde (n= 73) tüm nedenlere bağlı ölüm görüldü. İleri yaş, düşük ejeksiyon fraksiyonu, yüksek Killip fonksiyonel sınıfı, başvuru anındaki hemoglobin düzeyi, ventriküler aritmi ve ileri atriyoventriküler blok varlığı kötü prognozun bağımsız prediktörleri olarak belirlendi (OR= 1.07, 0.93, 15.34, 1.44, 3.79 ve 4.26 sırasıyla). Medyan takip süresi 49.5 (25-73) ay olup takip sırasında hastaların %12.4'ünde tüm nedenlere bağlı ölüm, %12.5'inde tekrarlayan miyokart enfarktüsü (ME) ve %2.3'ünde serebrovasküler olay izlendi. En güçlü bağımsız MAKO belirleyicileri, sol ventrikül disfonksiyonu, düşük glomerüler filtrasyon hızı, düşük albümin seviyesi ve geçirilmiş serebrovasküler hastalık öyküsü olarak belirlendi (sırasıyla HR= 0.97, 0.99, 0.65 ve 2.50). İkincil sonlanım noktalarından kontrast ilişkili akut böbrek hasarı %16.7, ventriküler aritmiler %6.1, ileri atriyoventriküler blok %3.7, atriyal fibrilasyon %7.6 ve majör kanama %1.6 sıklıkla izlendi.

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**Sonuç:** AME sonrası uzun dönem takiplerde hastalar halen zayıf prognoz göstermektedir. Bu sonuçlar gecikme olmaksızın ivedi revaskülarizasyonun avantajlarını vurgulamaktadır. Taburculuk sonrası hem kısa hem de uzun vadede hastalar istenmeyen olaylar açısından yakın takip edilmelidir.

**Anahtar Kelimeler:** Anjiyoplasti; miyokard infarktüsü; reperfüzyon; miyokardiyal revaskülarizasyon; hastane içi mortalite

## INTRODUCTION

Despite the significant improvement both in diagnosis and treatment, cardiovascular diseases remain the most common cause of death worldwide[1]. Among these, acute myocardial infarction (AMI) is the most lethal form and the most frequent cardiovascular emergency that requires prompt intervention.

Primary percutaneous coronary intervention (PCI) is established as the primary treatment option for AMI, according to current guidelines[2]. Primary PCI reduces the duration of ischemia and minimizes the jeopardized myocardium by rapidly restoring the blood flow in the culprit coronary artery. With the spread of the catheter laboratories network and public awareness, the proportion of patients who can access primary PCI both in Turkey and other European countries has grown, and with the increment in operator experience, significant improvement in the success of procedures has been achieved. In large national registries in Europe, the 1-year mortality rates have decreased to approximately 10% in the primary PCI era[3,4].

Comprehensive epidemiological studies on the outcomes of patients who underwent primary PCI after AMI in developed countries, such as Sweden, Norway, Germany, Poland, England, and the Netherlands have been reported[5-8]. In recent studies, although there has been improvement in in-hospital and short-term survival rates, with the ease of access to primary PCI, it has been observed that patients frequently experience undesirable cardiovascular events during long-term follow-up. In-hospital mortality and long-term major cardiovascular events can be predicted based on the patients' clinical presentation, demographics, and adverse events that occur pre-, peri-, and post-angioplasty procedures.

There have been few studies from Turkey reporting the characteristics of patients who presented with AMI and the risk factors affecting both in-hospital and long-term survival. Turkey's last nationwide acute coronary syndrome registry was TUMAR, which reflected the period before the primary PCI era[9]. A novel Turkish national, multicenter study that would provide cohort characteristics and 2-year outcomes of AMI patients was planned recently[10].

The aim of this study was to report the in-hospital and long-term follow-up outcomes of patients who underwent primary PCI with AMI at a referral center in Istanbul, Turkey.

## PATIENTS and METHODS

### Study Population

We included 1706 consecutive patients who were admitted with angina or equivalent symptoms between March 2013 and December 2019, and who were diagnosed with ST-segment elevation myocardial infarction (STEMI) in the emergency department, and who then underwent primary PCI. The study protocol adhered to the tenets of the Helsinki Declaration and was approved by the clinical research ethics committee (date: October 4, 2019, and number: B 08.06 YÖK 2.İ.Ü.E.50.0.05.00/7). All patients older than 18 years who presented with ST-segment elevation in at least two contiguous leads or who were newly diagnosed with left/right bundle branch block were included in this study. Patients were admitted to emergency services within 12 hours after the onset of symptoms related to AMI and were treated with primary PCI. Patients who were admitted within 12-24 hours after symptom onset also underwent primary angiography, if they had ongoing ischemia, malign arrhythmia, or heart failure symptoms. Non-ischemic heart disease and patients who were not able to undergo coronary angiography due to a clinical condition or who were unwilling to undergo the procedure were excluded.

### Coronary Angiography and Percutaneous Coronary Interventions

Patients with STEMI received 300 mg chewable aspirin and a P2Y12 inhibitor at a loading dose (600 mg clopidogrel, 180 mg ticagrelor, 60 mg prasugrel). After the loading dose, aspirin was maintained at 81-100 mg/daily, clopidogrel at 75 mg/daily, ticagrelor at 90 mg/bid, and prasugrel at 10 mg/daily.

In the vast majority of cases, the femoral artery was the access route, although in cases with anticoagulation, peripheral artery disease, morbid obesity, or if patients requested, the right radial artery was used for access. Intracoronary heparin was performed with a dosage of 70-100 U/kg to achieve an activated clotting time of 250-300. As a routine, except in cases with cardiogenic shock and ongoing angina, only culprit lesion revascularization was performed. Coronary bypass surgery was recommended to patients who had critical unprotected left main coronary stenosis, critical three-vessel disease, and high-risk coronary anatomy. Pre-dilatation and post-dilatation using a balloon, manual thrombus aspiration, and GpIIb/IIIa inhibitor usage were left to the operator's discretion.

**Definitions and Data Collection**

Patient demographics, medical history, clinical characteristics, procedures, medications, adverse events, and clinical complications were recorded. Follow-up was performed during routine office visits and additional clinical evidence was obtained by telephone calls. Retrospective data were collected from the hospital's database and patients' files. The procedure was considered successful in cases where the residual obstruction fell below 30% at the lesion responsible for the thrombolysis in myocardial infarction (TIMI) III flow after angioplasty. Coronary blood flow after primary PCI was classified using TIMI flow patterns (0, I, II, and III). Angiographic TIMI flow II and below were evaluated as "no-reflow" after recanalization. The Cockcroft-Gault equation was used to calculate the glomerular filtration rate[11]. The Killip classification was used to assess the severity of heart failure[12].

The primary outcome was all-cause in-hospital mortality and major adverse cardiovascular events (MACE), including all-cause mortality, recurrent MI, cerebrovascular events, and hospitalization related to decompensated heart failure. Only STEMI and MI without ST-segment elevation were defined as recurrent MI.

Ventricular or atrial arrhythmias, recurrent revascularization, non-surgical bleeding, contrast-related acute kidney injury, and mechanical complications were considered secondary endpoints. Major bleeding was standardized using the TIMI bleeding classification. Contrast-related acute kidney injury (CI-AKI) was defined as an increase in serum creatinine levels of at least 0.5 mg/dL or a relative increase of 25% within 72 hours after primary PCI[13].

**Statistical Analysis**

Continuous variables were expressed as mean ± standard deviation or median value. Categorical variables were expressed numerically and as a percentage. Continuous variables were compared with Mann-Whitney and student t-test. Categorical variables were compared with Chi-square tests. Multivariable logistic regression analysis was used to determine the independent predictors associated with primary outcomes. All data were processed using the 'Statistical Package for Social Sciences for Windows 22.0 (SPSS, Chicago, IL, USA)' program, and $p< 0.05$ was considered statistically significant.

## RESULTS

Of 1706 patients, 1550 patients were enrolled in this study, and 161 were excluded because of the presence of less than 50% stenosis and TIMI III flow on coronary angiography and the unavailability of clinical follow-up data. Of the remaining patients, 83.1% (n= 1288) were male patients, and the mean age was 58.5 ± 11.7 years. Baseline characteristics and angiographic records are presented in Tables 1-2. The average time from the onset of patients' symptoms to admission to the emergency room was 3.0 ± 2.6 hours and the median door-to-device time was 43 (29-52) minutes.

Of the procedures overall, 2.8% (n= 43) were considered unsuccessful according to the TIMI frame score. Of the patients, 0.5% (n= 8) underwent emergency coronary bypass surgery. Among primary PCI procedures, 97.9% successfully ended with a TIMI frame score >2. Hemodynamic support with an intra-aortic balloon pump was required in 16 patients and a temporary pacemaker was used in 24 patients. In 44.2% (n= 685) of the procedures, intracoronary and/or parenteral GpIIb/IIIa antagonists were administered. Mechanical thrombus aspiration was performed in 29.9% (n= 463) of patients (Table 2).

**In-Hospital Mortality**

The proportion of patients with in-hospital mortality was 4.7% (n= 73) among patients who underwent primary PCI for STEMI. Table 2 shows the common characteristics of patients who died in-hospital: 78.1% (n= 57) of the patients who died in-hospital were male patients and 22.9% (n= 16) were female patients. There was no statistically significant difference between the sex in terms of in-hospital mortality (p= 0.242). There was no statistically significant difference in MI type or the culprit vessel in terms of in-hospital mortality (p= 0.216; 0.723, respectively).

Table 3 shows the results of the correlation and multivariate logistic regression analyses of the in-hospital mortality cohort, to determine variables associated with in-hospital mortality. Advanced age, total ischemia time, high Killip score (III and IV) at admission, hemoglobin level at admission, development of ventricular arrhythmias (ventricular tachycardia and ventricular fibrillation, VT/VF), advanced atrioventricular block, and impaired left ventricular ejection fraction (LVEF) were associated with in-hospital mortality in the final model (OR= 1.07, 1.12, 15.34, 1.44, 3.79, 4.26, and 0.93 respectively).

**In-Hospital Complications**

Of the patients, 16.7% (n= 259) developed CI-AKI, defined by >25% increase in serum creatinine levels or an absolute increase in creatinine ≥0.5 mg/dL within 48 hours. These patients had significantly higher in-hospital mortality rates (p< 0.001). New onset atrial fibrillation, VT/VF, and high-degree atrioventricular block developed in 7.6% (n= 119), 6.1% (n= 95), and 3.7% (n= 57) of overall patients, respectively. Both new onset AF, VT/VF, and high -degree atrioventricular block occurred more significantly among the in-hospital mortality group (p= 0.048, <0.001, and <0.001, respectively). Non-coronary artery bypass graft-related major bleeding complications, according

**Table 1. Baseline characteristics**

| | In Hospital | | | After Discharge | | |
|---|---|---|---|---|---|---|
| **Variables** | **Mortality** | **Alive Discharge** | **p** | **MACE** | **Event-free Survival** | **p** |
| Number of patients, n | 73 | 1477 | | 390 | 1087 | |
| Onset of admission (h) | 4.3 ± 3.4 | 2.9 ± 2.5 | <0.001 | 3.2 ± 2.9 | 2.9 ± 2.5 | 0.024 |
| Men, n (%) | 57 (78.1) | 1231 (83.3) | 0.242 | 311 (80.8) | 920 (84.2) | 0.116 |
| Age (years) | 67.7 ± 13.9 | 58.0 ± 11.4 | <0.001 | 60.1 ± 12.8 | 57.4 ± 10.8 | <0.001 |
| Systolic blood pressure (mmHg) | 99.2 ± 28.5 | 129.2 ± 24.2 | <0.001 | 126.8 ± 25.1 | 130.1 ± 23.9 | 0.022 |
| Diastolic blood pressure (mmHg) | 61.3 ± 16.6 | 78.7 ± 13.6 | <0.001 | 77.9 ± 14.1 | 79.0 ± 13.5 | 0.166 |
| Heart rate (beats/min) | 95.3 ± 29.9 | 77.9 ± 17.7 | <0.001 | 78.9 ± 19.8 | 77.6 ± 17.0 | 0.217 |
| Anterior MI, n (%) | 35 (47.9) | 600 (40.7) | 0.216 | 157 (40.8) | 443 (40.6) | 0.952 |
| Killip function, n (%) | | | <0.001 | | | 0.036 |
| I | 6 (8.2) | 1175 (79.6) | | 296 (76.9) | 879 (80.5) | |
| II | 9 (12.3) | 199 (13.5) | | 50 (13) | 149 (13.6) | |
| III | 21 (28.8) | 65 (4.4) | | 23 (6) | 42 (3.8) | |
| IV | 37 (50.7) | 38 (2.6) | | 16 (4.2) | 22 (2) | |
| Cardiac arrest before admission, n (%) | 11 (15.1) | 17 (1.2) | <0.001 | 2 (0.5) | 15 (1.4) | 0.177 |
| Cardiogenic shock, n (%) | 38 (52.1) | 36 (2.4) | <0.001 | 15 (3.9) | 21 (1.9) | 0.031 |
| Hypertension, n (%) | 29 (39.7) | 531 (36) | 0.512 | 173 (44.9) | 358 (32.8) | <0.001 |
| Diabetes mellitus, n (%) | 27 (37) | 398 (26.9) | 0.061 | 131 (34) | 267 (24.5) | <0.001 |
| Hyperlipidemia, n (%) | 18 (24.7) | 497 (33.6) | 0.111 | 175 (45.5) | 322 (29.5) | <0.001 |
| Smoking, n (%) | 23 (31.5) | 737 (49.9) | 0.002 | 184 (47.8) | 553 (50.6) | 0.336 |
| Family history, n (%) | 7 (9.6) | 349 (23.6) | 0.005 | 78 (20.3) | 271 (24.8) | 0.070 |
| Previous MI, n (%) | 19 (26) | 259 (17.5) | 0.065 | 94 (24.4) | 165 (15.1) | <0.001 |
| Previous PCI, n (%) | 18 (24.7) | 318 (21.5) | 0.527 | 109 (28.3) | 209 (19.1) | <0.001 |
| Previous CABG, n (%) | 6 (8.2) | 47 (3.2) | 0.021 | 17 (4.4) | 30 (2.7) | 0.109 |
| Previous CVA, n (%) | 8 (11) | 40 (2.7) | <0.001 | 21 (5.5) | 19 (1.7) | <0.001 |
| COPD, n (%) | 8 (11) | 178 (12.1) | 0.779 | 64 (16.6) | 114 (10.4) | 0.001 |
| Hemodialysis, n (%) | 0 (0) | 4 (0.3) | 0.656 | 4 (1) | 0 (0) | 0.001 |
| Estimated GFR< 60 mL/min/1.73m$^3$, n (%) | 32 (43.8) | 198 (13.4) | <0.001 | 86 (22.3) | 112 (10.3) | <0.001 |
| Estimated GFR (mL/min/1.73m$^3$) | 65.0 ± 21.5 | 83.9 ± 22.0 | <0.001 | 78.2 ± 24.4 | 85.9 ± 20.7 | <0.001 |

Data are presented as percentage, mean ± standard deviation or median (interquartile range). MACE: Major adverse cardiovascular events, MI: Myocardial infarction, PCI: Percutaneous coronary intervention, CABG: Coronary artery bypass graft, CVA: Cerebrovascular accident, COPD: Chronic obstructive pulmonary disease, GFR: Glomerular filtration rate.

to TIMI classification, and blood transfusion rates were significantly higher in patients who died in-hospital (p= 0.016; p= 0.008, respectively). There were 6 patients with pericardial tamponade requiring pericardiocentesis, and 2.8% (n= 42) of patients developed local vascular complications related with the puncture site (Table 4).

Three patients were diagnosed with ventricular septal rupture and one patient was diagnosed with free wall rupture after STEMI. All patients underwent surgery and none of them survived. Further, ten patients were diagnosed with chordae tendineae or papillary muscle rupture and seven of them were discharged alive (Table 4).

**Long-Term Outcomes**

For 1477 survivors who were discharged alive, the median follow-up duration was 49.50 (25-73) months, and 25.1% (n= 390) patients experienced MACE. All-cause mortality during

**Table 2. Timelines and angiographic characteristics**

| | In Hospital | | | After Discharge | | |
|---|---|---|---|---|---|---|
| **Variables** | **Mortality** | **Alive Discharge** | **p** | **MACE** | **Event-free Survival** | **p** |
| Number of patients, n | 73 | 1477 | | 390 | 1087 | |
| Admission to wire (min) | 48.6 ± 22.2 | 42.9 ± 20.2 | 0.026 | 44.4 ± 19.9 | 42.4 ± 20.3 | 0.097 |
| Infarct related artery, n (%) | | | 0.723 | | | 0.328 |
| LMCA | 5 (6.8) | 8 (0.5) | | 4 (1) | 4 (0.4) | |
| LAD | 33 (45.2) | 605 (41) | | 156 (40.5) | 449 (41.1) | |
| Cx | 15 (20.5) | 269 (18.2) | | 61 (15.8) | 208 (19) | |
| RCA | 25 (34.2) | 601 (40.7) | | 168 (43.6) | 433 (39.7) | |
| Graft vessels, n (%) | 4 (5.5) | 25 (1.6) | 0.016 | 10 (2.6) | 14 (1.3) | 0.079 |
| Multivessel disease, n (%) | 33 (45.2) | 565 (38.2) | 0.564 | 11 (2.9) | 40 (3.7) | 0.456 |
| Thrombus aspiration, n (%) | 22 (30.1) | 441 (29.9) | 0.959 | 150 (39) | 291 (26.6) | <0.001 |
| GIIbIIIa antagonist, n (%) | 34 (46.6) | 651 (44.1) | 0.675 | 193 (50.1) | 458 (41.9) | 0.005 |
| Balloon dilatation, n (%) | 51 (81) | 899 (63.6) | 0.005 | 230 (64.2) | 669 (63.4) | 0.777 |
| Stent implantation, n (%) | 55 (75.3) | 1280 (86.6) | 0.010 | 320 (83.1) | 952 (87.2) | 0.047 |
| DES, n (%) | 30 (41) | 764 (51.7) | 0.486 | 147 (46.2) | 617 (65) | <0.001 |
| CABG, n (%) | 6 (8.2) | 49 (3.3) | 0.027 | 9 (2.3) | 40 (3.7) | 0.212 |
| LVEF, % | 34.5 ± 8.3 | 46.9 ± 8.4 | <0.001 | 45.1 ± 9.6 | 47.6 ± 7.9 | <0.001 |
| Contrast media volume (mL) | 278.9 ± 112.7 | 228.4 ± 77.1 | <0.001 | 236.1 ± 83.4 | 225.7 ± 74.7 | 0.024 |
| IABP, n (%) | 4 (5.4) | 12 (0.8) | 0.363 | | | |
| Unsuccessful PCI, n (%) | 10 (13.7) | 33 (2.2) | <0.001 | 9 (2.3) | 24 (2.2) | 0.873 |
| Potent antiplatelet usage, n (%) (ticagrelor & prasugrel versus clopidogrel) | - | - | - | 115 (29.9) | 541 (49.5) | <0.001 |

Data are presented as percentage, mean ± standard deviation or median (interquartile range). MACE: Major adverse cardiovascular events, LMCA: Left main coronary artery, LAD: Left anterior descending artery, Cx: Circumflex artery, RCA: Right coronary artery, DES: Drug eluting stent, CABG: Coronary artery bypass graft, LVEF: Left ventricular ejection fraction, IABP: Intraaortic balloon pump, PCI: Percutaneous coronary intervention.

the follow-up period in patients discharged alive was 12.4% (n= 193). In total, 195 (12.5%) patients were hospitalized for recurrent MI and 36 (2.3%) of them had a cerebrovascular accident (CVA) during the follow-up period. The Kaplan-Meier survival curves for overall MACE, all-cause mortality, recurrent MI, and CVA are shown in Figure 1. Of the patients, 3.2% (n= 50) presented with stent thrombosis, and 7.2% (n= 113) of the survivors had restenosis at the index stent. Of survivors, 16.1% underwent revascularization at any time point during the follow-up period and 4% (n= 62) of patients required surgical revascularization.

For survivors, the prognostic factors associated with MACE were evaluated considering temporal parameters of events via the Cox regression analysis. Independent predictors of MACE after discharge were impaired left ventricular function (HR= 0.97; 95% CI, 0.958-0.984, p= <0.001), poor glomerular filtration rate (HR= 0.99; 95% CI, 0.987-0.998, p= 0.006), low albumin level (HR= 0.65; 95% CI, 0.479-0.899, p= 0.009), history of cerebrovascular disease (HR= 2.50; 95% CI, 1.457-4.319, p= 0.001), previous MI (HR= 1.52; 95% CI, 1.130-2.062, p= 0.006) and CI-AKI (HR= 1.44; 95% CI, 1.074-1.930, p= 0.015). Table 5 shows the adjusted hazard ratios for the risk of MACE during follow-up of patients who survived STEMI.

## DISCUSSION

With the widespread worldwide use of primary PCI, advances have been observed in the course of STEMI. However, the optimal pharmacological treatment, the interventional strategy to use, and the revascularization timing of critical stenosis outside the target vessel remain controversial. Indeed, differences in survival and event-free follow-up data from different regions and even from different hospitals in the same regions

**Table 3. Factors associated with in-hospital mortality (multivariate analysis)**

| | Multivariable Analysis | | |
|---|---|---|---|
| | **OR** | **95% CI** | **p** |
| Age | 1.072 | 1.033-1.112 | <0.001 |
| Previous CVA | 2.645 | 0.680-10.284 | 0.160 |
| Previous CABG | 2.538 | 0.736-8.754 | 0.140 |
| Killip function III-IV | 15.344 | 6.563-35.874 | <0.001 |
| Cardiac arrest before admission | 1.767 | 0.494-6.318 | 0.381 |
| Onset of admission | 1.123 | 1.018-1.239 | 0.020 |
| Admission to wire | 1.010 | 0.994-1.026 | 0.233 |
| Estimated GFR | 0.995 | 0.976-1.015 | 0.641 |
| Hemoglobin at admission | 1.449 | 1.162-1.808 | 0.001 |
| New onset AF | 1.060 | 0.385-2.915 | 0.910 |

Variable(s) entered on step 1: Age, previous CVA, previous CABG: Killip function, cardiac arrest before admission, onset of admission, admission to wire, estimated GFR, Hemoglobin at admission, new-onset AF, VT/VF, High degree AV block, LVEF, Fall in hemoglobin, albümin. OR: Odds ratio, CVA: Cerebrovascular accident, CABG: Coronary artery bypass graft, GFR: Glomerular filtration rate, AF: Atrial fibrillation.

**Table 4. Events of in-hospital mortality group**

| | In Hospital | | | After Discharge | | |
|---|---|---|---|---|---|---|
| **Variables** | **Mortality** | **Alive Discharge** | **p** | **MACE** | **Event-free Survival** | **p** |
| CI-AKI, n (%) | 41 (56.2) | 218 (14.8) | <0.001 | 70 (18.2) | 148 (13.6) | 0.028 |
| New-onset AF, n (%) | 10 (13.7) | 109 (7.4) | 0.048 | 37 (9.6) | 72 (6.6) | 0.052 |
| VT/VF, n (%) | 23 (31.5) | 72 (4.9) | <0.001 | 24 (6.2) | 48 (4.4) | 0.150 |
| High degree AV block, n (%) | 12 (16.4) | 45 (3) | <0.001 | 16 (4.2) | 29 (2.7) | 0.141 |
| TIMI major bleeding (non-CABG related), n (%) | 3 (4.1) | 15 (1) | 0.016 | 8 (2.1) | 7 (0.6) | 0.016 |
| Blood transfusion, n (%) | 3 (4.1) | 13 (0.9) | 0.008 | 4 (1) | 9 (0.8) | 0.698 |
| Pericardial tamponade, n (%) | 1 (1.4) | 5 (0.3) | 0.166 | | | |
| Local vascular complications, n (%) | 4 (5.5) | 38 (2.6) | 0.135 | | | |
| Mechanical Complications | | | | | | |
| Ventricular septal rupture, n (%) | 3 (4) | 0 | N/A | | | |
| Chordae tendineaa/papillary muscle rupture, n (%) | 3 (4.1) | 7 (0.4) | N/A | | | |
| Free wall rupture, n (%) | 1 (1.3) | 0 | N/A | | | |

Data are presented as percentage, mean ± standard deviation or median (interquartile range). CI-AKI: Contrast-induced acute kidney injury, AF: Atrial fibrillation, VT: Ventricular tachycardia, VF: Ventricular fibrillation, AV: Atrioventricular, CABG: Coronary artery bypass graft, MACE: Major adverse cardiovascular events.

are significant. In our study, we reported the in-hospital and post-discharge long-term follow-up data of patients who underwent primary PCI with a diagnosis of STEMI in our tertiary hospital, which is one of the reference centers servicing a significant number of patients in Eastern Europe.

In the post-fibrinolytic PCI era, many studies have demonstrated the effects of Killip functional class, age, heart rate, anterior MI, and LVEF on prognosis as mortality predictors. Taniwaki et al.,[14] in a cohort of 1665 STEMI patients who underwent primary PCI, reported that advanced age, female sex, high heart rate, hypertension, diabetes mellitus (DM), impaired left ventricular function, previous MI, high Killip functional class, and flow less than TIMI III after angioplasty, were associated with increased mortality and recurrent MI. Liosis et al.[15] reported that renal failure was the most important predictor of in-hospital mortality in STEMI. In a prospective study

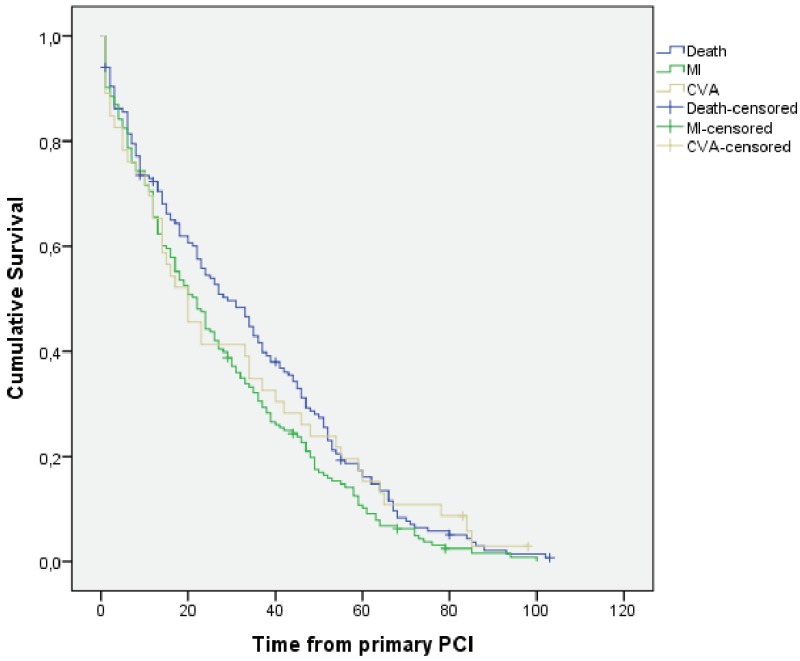


**Figure 1.** Kaplan-Meier survival curve represents MACE according to time.
CVA: Cerebrovascular accidents, PCI: Percutaneous coronary intervention.

**Table 5. Independent variables predicting MACE (multivariate analysis)**

| | Multivariable Analysis | | |
|---|---|---|---|
| | **HR** | **95% CI** | **p** |
| Age | 1.000 | 0.989-1.012 | 0.959 |
| DM | 1.145 | 0.886-1.479 | 0.301 |
| HT | 1.271 | 0.982-1.645 | 0.069 |
| Previous MI | 1.527 | 1.130-2.062 | 0.006 |
| Previous CVA | 2.509 | 1.457-4.319 | 0.001 |
| Killip function III-IV | 1.231 | 0.816-1.856 | 0.321 |
| Onset of admission | 1.007 | 0.964-1.051 | 0.761 |
| Estimated GFR | 0.992 | 0.987-0.998 | 0.006 |
| Thrombus Aspiration | 0.885 | 0.676-1.160 | 0.376 |
| DES | 0.932 | 0.721-1.204 | 0.588 |
| LDL | 1.000 | 0.996-1.003 | 0.810 |
| Albumin | 0.656 | 0.479-0.899 | 0.009 |
| LVEF | 0.971 | 0.958-0.984 | <0.001 |
| New-onset AF | 0.903 | 0.582-1.400 | 0.649 |
| Potent antiplatelet usage (ticagrelor&prasugrel versus clopidogrel) | 0.794 | 0.594-1.062 | 0.120 |
| Contrast-induced AKI | 1.440 | 1.074-1.930 | 0.015 |

Variable(s) entered on step 1: Age, DM, HT, previous MI, previous CVA: Killip function III-IV, the onset of admission, estimated GFR, thrombus Aspiration, DES, LDL, albumin, LVEF, new-onset AF, potent antiplatelet usage (ticagrelor&prasugrel versus clopidogrel), contrast-induced AKI.
HR: Hazard ratio, DM: Diabetes mellitus, HT: Hypertension, MI: Myocardial infarction, CVA: Cerebrovascular accident, GFR: Glomerular filtration rate, DES: Drug-eluting stent, LDL: Light density lipoprotein, LVEF: Left ventricular ejection fraction, AF: Atrial fibrillation, AKI: Acute kidney injury.

by Zorbozan et al.,[16] an increase in mortality was observed in patients over 71.5 years of age and with systolic blood pressure <95 mmHg. Our data showed no effect of gender on in-hospital mortality, and although there were more primary events in females, this was not statistically significant. The mean age of the patients with MACE was significantly higher, although age was not found to be a strong predictor for estimating primary outcomes. However, age was the most important variable for predicting in-hospital mortality. In our study, although DM and hypertension did not affect in-hospital mortality, they increased the frequency of primary events during follow-up, as also found in the Comfortable AMI and Examination studies[14]. In a multi-center study in which patients who had a cardiac arrest and underwent CPR before primary PCI were examined, an increase in mortality was observed in the first one-year follow-ups, and the difference was not statistically significant in longer follow-up periods[17]. In our study, in-hospital mortality increased significantly in patients who presented with cardiopulmonary resuscitation and cardiogenic shock. Although there was a significant increase in the in-hospital mortality in patients with Killip classes III and IV as compared to patients with Killip classes I or II, the difference was no longer significant in follow-up after discharge. A high Killip score was found to be a strong predictor of in-hospital mortality.

Renal failure in AMI patients was a risk factor that increased mortality on its own, independent of other variables. In a comprehensive analysis of 12.532 patients included in the Grace study, impairment in renal functions increased mortality rates and reduced the success of reperfusion in STEMI patients who underwent both primary PCI and fibrinolytic treatment[18]. Impaired renal function is associated with increased in-hospital mortality and post-discharge MACE, and also increases the risk of CI-AKI. Advanced age, low glomerular filtration rate, and increased contrast agent use are also risk factors for CI-AKI. Advanced age, low baseline glomerular filtration rate, heart failure, and hemodynamic instability are predictors of CI-AKI in patients with STEMI. In the subgroup study of the HORIZONS-AMI trial, 16.1% (n= 479) of 2.968 STEMI patients developed CI-AKI. Major bleeding and MACE were observed at a significantly higher rate in the 30-day and three-year follow-up in patients who developed CI-AKI. CI-AKI was an independent predictor of MACE (hazard ratio, HR= 1.56; 95% CI= 1.23-1.98; p= 0.0002), major bleeding (HR= 2.07; 95% CI= 1.57-2.73; p< 0.0001), and mortality (HR= 1.80; 95% CI= 1.19-2.73; p= 0.005)[19]. Difficult lesions and hemodynamically unstable patients with high mortality risk, requiring multivessel revascularization, may increase the time of the procedure and the amount of contrast agent used, and more adverse outcomes may be observed in this group of patients. According to our study data, CI-AKI after primary PCI is an independent predictor of in-hospital mortality and post-discharge MACE. (HR= 5.16; 95% CI= 2.50-10.61; p< 0.001; and HR= 1.53; 95% CI= 1.15-2.02; p= 0.003, respectively)[20].

New-generation drug-eluting stents (DES) yielded better primary outcomes in recent studies with long-term follow-up. New-generation DES achieved improved outcomes by reducing repeated revascularization without increasing the risk of stent thrombosis[21,22]. Recent guidelines strictly recommend the use of new-generation DES over bare-metal stents (BMS) in the setting of AMI[2]. In the five-year follow-up of the clinical outcomes in patients with STEMI treated with everolimus-eluting stents (EES) versus BMS (Examination study), conducted in 1504 STEMI patients, the risk of stent thrombosis was found to be similar, and a decrease in all-cause mortality was observed in the EES group[22]. There was no difference between the EES and BMS groups in terms of stent thrombosis, and the concern for stent thrombosis disappeared with the use of second-generation DES during primary PCI. Although DES implantation did not affect in-hospital outcomes according to our data, the frequency of MACE shifted slightly in favor of the BMS, but no statistically significant difference was found in the Cox regression analysis.

Manual thrombus aspiration, performed to prevent distal embolization caused by a heavy thrombus load and increase microvascular perfusion, has not been shown to be superior to conventional PCI as a clinical outcome in recent randomized controlled studies, and it has been reported to increase the risk of cerebrovascular events[23-25]. In our study, there was no obvious benefit of thrombus aspiration; however, thrombus aspiration could slightly increase the risk of MACE outcomes, since it was used in patients with intense thrombosis who presented with stent thrombosis, which is a highly expected adverse event.

In addition to standard dual antiplatelet therapy, GpIIb/IIIa antagonist inhibits the aggregation function of platelets, reducing thrombotic complications, and resulting in a decrease in the incidence of death, MI, and recurrent revascularization[26]. Additionally, adding tirofiban to clopidogrel and aspirin therapy did not result in a significant difference in the incidence of major and minor bleeding, according to a recent study[27]. GpIIb/IIIa antagonists were more often used in the group of patients who experienced MACE. This may be because GpIIb/IIIa antagonists are more frequently used in complicated cases, such as a heavy thrombus burden, distal embolization during balloon dilatation, and side branch loss. However, GpIIb/IIIa antagonist usage was not a predictor for MACE.

In a study of 9932 patients who received antiplatelet therapy, the primary outcome was less often seen in patients who were using ticagrelor than those using clopidogrel (HR= 0.72;

95% CI= 0.57-0.91; p< 0.02) or prasugrel (HR= 0.65; 95% CI, 0.48-0.89; p= 0.02). There was no superiority of prasugrel over clopidogrel in reducing the primary endpoints (HR= 1.09; 95% CI= 0.86-1.39; p> 0.99)[28]. Prasugrel and ticagrelor did not show an increased risk of stroke as compared with clopidogrel. In terms of major bleeding, fewer events were observed in the ticagrelor group than in the prasugrel group[28,29]. In our study, mortality, MI, and CVA were observed more frequently in the clopidogrel group, and potent P2Y12 inhibitors, such as prasugrel and ticagrelor, were reported to reduce these outcomes as compared to clopidogrel; however, no significant difference was observed between prasugrel and ticagrelor.

### Study Limitations

The main limitations of the study were that it had a retrospective design and was conducted in a single center; however, multicenter prospective studies on primary angioplasty in STEMI have already been performed. Another limitation is that stent selection, thrombus aspiration, and antiplatelet treatment regimens were left to the discretion of the physician, instead of being randomized across the patients.

## CONCLUSION

Contemporarily, primary PCI is an essential and main treatment option for STEMI patients. If it is performed in accordance with current guidelines it is a safe and life-saving method gradually improving outcomes. There is a risk of adverse cardiovascular events in patients presenting with STEMI, and close follow-up of patients after discharge should not be limited only to the early period but should be closely monitored by stating their additional risks. With effective primary and secondary cardiovascular prevention in the community, a decrease in the frequency of STEMI and a higher rate of event-free survival in patients with STEMI can be targeted.

**Ethics Committee Approval:** The approval for this study was obtained from İstanbul University Cerrahpaşa Rectorate Cardiology Institute Ethics Committee (Decision no: B 08.06 YOK 2.İ.Ü.E.50.0.05.00/7, Date: 10.04.2019)

**Informed Consent:** This is retrospective study, we could not obtain written informed consent from the participants.

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