Reperfusion after primary angioplasty for ST-elevation myocardial infarction: predictors of success and relationship to clinical outcomes in the APEX-AMI Angiographic Study


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Aims
We studied the clinical, demographic, and angiographic factors associated with successful reperfusion and the relationship between angiographic indices and clinical outcomes in a subset of the APEX-AMI trial, which tested the efficacy of pexelizumab in ST-elevation myocardial infarction patients undergoing primary percutaneous coronary intervention (PCI).

Methods and results
Among 5745 patients enrolled in the trial, 1018 underwent independent quantitative angiographic evaluation by a core laboratory. Successful epicardial reperfusion was defined as TIMI (thrombolysis in myocardial infarction) flow grade 3 or corrected TIMI frame count (cTFC) <28 frames, and successful myocardial reperfusion as TIMI myocardial perfusion grade (TMPG) 2 or 3. TIMI 3 flow after PCI occurred in 85%, cTFC < 28 in 58% (mean cTFC was 27 ± 20), and TMPG 2 or 3 in 91%. Overall 90 day clinical outcomes were 2.7% for mortality and 8.2% for the composite of death, congestive heart failure (CHF), or shock. After adjustment for baseline characteristics, TMPG 2/3 after PCI was associated with younger age [odds ratio (OR) for 10 year increase 0.75, 95% confidence interval (CI) 0.59–0.96, \( P = 0.023 \)], pre-PCI TIMI flow 2/3 (OR 3.5, 95% CI 1.7–7.1, \( P = 0.001 \)), and ischaemic time [for every hour, OR 0.81 (0.69–0.96), \( P = 0.015 \)]. TMPG 2/3 after PCI was significantly associated with 90 day mortality (adjusted hazard ratio 0.26, 95% CI 0.09–0.78, \( P = 0.013 \)). Neither post-PCI TMPG nor TIMI flow grade was significantly associated with 90 day death/CHF/shock.

Conclusion
Younger age, patent infarct-related artery at presentation, and ischaemic time predicted higher likelihood of successful myocardial perfusion, which was associated with improved survival.

Keywords
Reperfusion • Primary PCI • Outcomes

Introduction
Primary percutaneous coronary intervention (PCI) for ST-elevation acute myocardial infarction (STEMI) is an increasingly adopted method of reperfusion in the USA and worldwide. When performed in a prompt and expert fashion, it is associated with a low incidence of death and other adverse events and enables early hospital discharge. Its success relates to
more frequent and durable reperfusion than that obtained with pharmacological therapy alone. The predictors and impact of successful angiographic reperfusion, at both the epicardial and myocardial levels, have not been described in the current era in patients undergoing primary PCI with contemporary techniques and adjunctive therapy.

Thus, we aimed to characterize the angiographic outcomes of primary PCI for STEMI in a large cohort of patients enrolled in the angiographic substudy of the Assessment of Pexelizumab in Acute Myocardial Infarction (APEX-AMI) trial. This trial tested the utility of pexelizumab, compared with placebo, in reducing the incidence of death, shock, and heart failure in patients with high-risk STEMI. In this pre-planned substudy we (i) explore the clinical and pre-PCI angiographic factors associated with successful primary angioplasty, as measured by markers of epicardial and myocardial reperfusion and (ii) evaluate the relationship between metrics of successful angiographic reperfusion and clinical outcomes.

Methods

The APEX-AMI trial has been described in detail. In brief, 5745 patients with high-risk STEMI <6 h in duration, with anterior MI or inferior MI demonstrating at least 8 mm of cumulative ST-segment deviation and expected to undergo primary PCI, were randomized to receive a bolus and infusion of the complement (C5 component) inhibitor pexelizumab or matching placebo prior to PCI. The primary endpoint, death at 30 days, was not associated with pexelizumab use. In this pre-planned substudy we (i) explore the clinical and pre-PCI angiographic factors associated with successful primary angioplasty, as measured by markers of epicardial and myocardial reperfusion and (ii) evaluate the relationship between metrics of successful angiographic reperfusion and clinical outcomes.

Angiographic assessment of reperfusion

All films, digitally acquired at 15 or 30 frames per second, were transferred to an independent angiographic core laboratory and the infarct-related artery (IRA) was analysed with the Pie Medical quantitative coronary angiography software (Maastricht, the Netherlands), maintaining the study blind. The extent of significant CAD in non-infarct arteries (>50% diameter stenosis) was visually estimated. Special instructions were given to investigators regarding the use of nitroglycerin before first and last injections, matching angles and use of low or moderate magnification to limit the need for panning and enable evaluation of myocardial reperfusion. Using standard techniques, the following parameters were assessed before and after PCI of the infarct-related vessel: epicardial reperfusion-antegrade flow using the thrombolysis in myocardial infarction (TIMI) scale; corrected TIMI frame counts (cTFC) using standard landmarks for each vessel; myocardial reperfusion, TIMI myocardial perfusion grade (TMPG) using the dynamic method; TIMPG 2 and 3 were grouped together and contrasted to TMPG 0/1.

Statistical analysis

Continuous and categorical variables are presented as means (± standard deviation) or medians (25th, 75th percentile) and as counts (percentage), where indicated, and were assessed with appropriate tests (i.e. Mann–Whitney U test, Fisher’s exact test). Variables were evaluated for normal distribution and transformed appropriately if necessary. Backward stepwise logistic regression models were developed (and confirmed with the forward approach) individually to identify the independent predictors of post-PCI TIMI 3 flow, cTFC < 28, and TMPG 2/3. The covariates considered in each of these models included age, gender, non-inferior/inferior infarct, diabetes mellitus, hypertension, prior MI, pre-PCI TIMI flow grade (grouped as 0/1 vs. 2/3), collateral grade (0–3 using Rentrop classification), baseline cumulative ST-segment deviation, use of glycoprotein IIb/IIIa inhibitors (GPIs), ischaemic time (hours from symptom onset to angiography), and randomized treatment. The discriminatory power for each model was assessed by the c-index.

The associations between post-PCI angiographic indicators (TIMI flow grade and TMPG) and time of (i) 90 day mortality and (ii) the 90 day composite of death, congestive heart failure (CHF), and cardio- genic shock were tested using Kaplan–Meier survival methods and multivariable Cox proportional hazard regression. Baseline covariates considered in the adjustment included age (10 year intervals), history of diabetes, systolic blood pressure (mmHg, 10 year intervals), heart rate (b.p.m., 10 year intervals), Killip class > 2, MI location (inferior vs. non-inferior), and STT-deviation on the baseline electrocardiogram (mm, 10 mm intervals). All tests were two-sided and used P < 0.05 as the level of statistical significance.

Results

There were 1018 patients in the angiographic substudy, of whom 950 (93.3%) underwent primary PCI. Of those 68 patients who did not undergo primary PCI, 23 (33.8%) patients underwent coronary artery bypass graft (CABG); 18 (26.5%) had no culprit lesion identified; six (8.8%) had a patent culprit artery; in four (5.9%), there were technical limitations; one (1.5%) did not undergo angiography; and 16 (23.3%) had no reason specified. Their salient clinical and angiographic characteristics are presented in Tables 1 and 2. Patients within the angiographic substudy were similar to others in APEX-AMI, except that they were slightly younger (P = 0.003) and more likely to have had prior coronary revascularization (P = 0.002). Within the angiographic substudy cohort, there was a relatively short time from symptom onset to angiography (median 175 min) and a high rate of utilization of GPIs (81.7%) (Table 1). These agents were administered prior to angiography in 34.2% of all users, whereas 65.8% of patients received GPIs during PCI. Ninety day outcomes were higher in patients enrolled in the overall trial than in those enrolled in the angiographic substudy [90 day death (5.2 vs. 2.7%, P = 0.001) and composite endpoint of death/CHF/shock (10.6 vs. 8.2%, P = 0.018)].

As expected, there was a high rate of TIMI 0/1 epicardial flow and perfusion grade in the culprit vessel accompanied by a high TIMI frame count prior to PCI (Table 2). Epicardial reperfusion, as measured by the presence of TIMI flow grade 3 post-PCI, occurred in 85%. The qualitative determination was supported by an average cTFC of nearly 27 frames. Myocardial reperfusion, as measured by TMPG 2/3, was optimal in 91% of patients, consistent with the short ischaemic time (Table 2).

Angiography revealed that the LAD was the culprit artery in 51.9% of patients, and 50.5% had multi-vessel disease. Intra-IRA collaterals were present in 3.3%, whereas inter-IRA collaterals were present in 3.3%.
were observed in 31.4%. There was a high frequency of stent usage (94.5%) with a balanced distribution of bare-metal (44.2%) and drug-eluting types (55.8%). After PCI, distal embolization was present in 4.8% of patients with TIMI 3 flow and in 16.8% of those with lesser degrees of epicardial reperfusion ($P < 0.001$). Predictors of successful epicardial and myocardial reperusions

Several factors were associated with the three measures of angiographic success (Table 3). After multivariable adjustment, the significant, independent predictors of achieving TIMI flow grade 3 after PCI were age [odds ratio (OR) (by 10 year intervals of increasing age) 0.70, 95% confidence interval (CI) (0.58–0.86), $P < 0.001$] and pre-PCI TIMI flow grade 2/3 [OR 2.03 (1.27–3.25), $P = 0.003$]. The likelihood of achieving TIMI flow grade 3 post-PCI was also inversely associated with ischaemic time [for every 60 min elapsed between symptom onset and angiography, OR 0.79 (0.69–0.90), $P < 0.001$; c-index 0.66, indicating moderate discriminatory power]. Three factors were significantly associated with achieving a final cTFC ≤ 28 frames: female gender [OR 1.79 (1.15–2.80), $P = 0.010$], ischaemic time [for every 60 min elapsed, OR 0.82 (0.73–0.93) $P = 0.002$], and pre-PCI TIMI flow grade 2/3 [OR 2.09 (1.39–3.14), $P = 0.001$; c-index 0.63]. Similarly, achieving myocardial perfusion (TMPG 2/3) was associated with age [OR (by 10 year intervals of increasing age) 0.75 (0.59–0.96), $P = 0.023$], having a patent artery prior to PCI (TIMI 2/3 flow), OR 3.45 (1.68–7.05), $P = 0.001$, and ischaemic time (for every 60 min elapsed, OR 0.81 (0.69–0.96), $P = 0.015$; c-index 0.65). Neither infarct location nor use of GPIs affected the rate of successful myocardial reperfusion.

Clinical events and markers of successful reperfusion

The relationship between angiographic indices of reperfusion and clinical outcome is shown in Figure 1 for 90 day death. In Figure 1A and B, a gradient in excess risk is evident for those patients with either suboptimal epicardial or myocardial reperfusion (TIMI flow grade < 3 or TMPG 0/1). This gradient in risk was especially marked among those who had both successful epicardial reperfusion and myocardial reperfusion (TIMI flow grade 3 and TMPG 2/3), $P = 0.002$ (Figure 1C). A similar relationship, although to a lesser and non-statistically significant extent, existed for the 90 day composite of death, CHF, or shock ($Figure 2, P = 0.094$). Optimal myocardial perfusion grade (TMPG 2/3) after PCI was associated with reduced 90 day mortality
Table 3  Selected baseline characteristics and process of care factors according to post-PCI angiographic indicators

<table>
<thead>
<tr>
<th></th>
<th>TIMI flow grade 0/1/2</th>
<th>TIMI flow grade 3</th>
<th>P-value</th>
<th>cTFC ≥ 28 frames</th>
<th>cTFC &lt; 28 frames</th>
<th>P-value</th>
<th>TMPG 0/1</th>
<th>TMPG 2/3</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>142</td>
<td>798</td>
<td>0.001</td>
<td>231</td>
<td>486</td>
<td>0.173</td>
<td>84</td>
<td>855</td>
<td>0.018</td>
</tr>
<tr>
<td>Age, year, median (25th, 75th percentile)</td>
<td>64 (53, 73)</td>
<td>59 (51, 68)</td>
<td>0.001</td>
<td>60 (52, 69)</td>
<td>59 (51, 70)</td>
<td>0.173</td>
<td>66 (52, 74)</td>
<td>59 (51, 69)</td>
<td>0.018</td>
</tr>
<tr>
<td>Female, %</td>
<td>24.6</td>
<td>20.8</td>
<td>0.307</td>
<td>30.3</td>
<td>16.0</td>
<td>0.014</td>
<td>24.1</td>
<td>21.2</td>
<td>0.956</td>
</tr>
<tr>
<td>Heart rate, b.p.m., median (25th, 75th percentile)</td>
<td>73.5 (63.8, 85)</td>
<td>75 (63, 85)</td>
<td>0.939</td>
<td>73 (61, 85)</td>
<td>72.5 (62, 81)</td>
<td>0.323</td>
<td>74.5 (65, 87.8)</td>
<td>74 (63, 85)</td>
<td>0.512</td>
</tr>
<tr>
<td>Systolic blood pressure, mmHg median (25th, 75th percentile)</td>
<td>132.5 (117, 150)</td>
<td>131 (116, 149)</td>
<td>0.737</td>
<td>130 (115, 147)</td>
<td>132 (116, 150)</td>
<td>0.210</td>
<td>130.5 (118, 154)</td>
<td>131 (115, 148)</td>
<td>0.561</td>
</tr>
<tr>
<td>Killip class &gt;2, %</td>
<td>4.2</td>
<td>1.1</td>
<td>0.007</td>
<td>2.2</td>
<td>1.0</td>
<td>0.226</td>
<td>2.4</td>
<td>1.4</td>
<td>0.481</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>20.4</td>
<td>13.8</td>
<td>0.040</td>
<td>15.6</td>
<td>14.0</td>
<td>0.571</td>
<td>22.6</td>
<td>13.8</td>
<td>0.029</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>45.8</td>
<td>49.2</td>
<td>0.445</td>
<td>47.6</td>
<td>47.5</td>
<td>0.982</td>
<td>53.6</td>
<td>48.5</td>
<td>0.379</td>
</tr>
<tr>
<td>Hyperlipidaemia, %</td>
<td>44.9</td>
<td>46.8</td>
<td>0.706</td>
<td>45.5</td>
<td>45.4</td>
<td>0.996</td>
<td>47.1</td>
<td>46.4</td>
<td>0.917</td>
</tr>
<tr>
<td>Prior MI, %</td>
<td>9.9</td>
<td>12.0</td>
<td>0.458</td>
<td>11.3</td>
<td>11.7</td>
<td>0.853</td>
<td>10.7</td>
<td>11.8</td>
<td>0.765</td>
</tr>
<tr>
<td>Prior PCI/CABG, %</td>
<td>12.7</td>
<td>13.2</td>
<td>0.875</td>
<td>10.4</td>
<td>13.2</td>
<td>0.289</td>
<td>10.7</td>
<td>13.5</td>
<td>0.480</td>
</tr>
<tr>
<td>Prior CHF, %</td>
<td>2.8</td>
<td>2.3</td>
<td>0.684</td>
<td>3.0</td>
<td>1.9</td>
<td>0.318</td>
<td>3.6</td>
<td>2.5</td>
<td>0.537</td>
</tr>
<tr>
<td>ST deviation, mm, median (25th, 75th percentile)</td>
<td>13 (9.5, 18.5)</td>
<td>13 (9.5, 19.5)</td>
<td>0.827</td>
<td>13 (9.5, 19.5)</td>
<td>13 (9.5, 19)</td>
<td>0.914</td>
<td>13 (9, 20)</td>
<td>13 (9.5, 19)</td>
<td>0.347</td>
</tr>
<tr>
<td>Inferior MI, %</td>
<td>45.3</td>
<td>40.7</td>
<td>0.307</td>
<td>52.9</td>
<td>49.5</td>
<td>0.394</td>
<td>42.7</td>
<td>40.7</td>
<td>0.723</td>
</tr>
<tr>
<td>GPIs use, %</td>
<td>85.2</td>
<td>84.6</td>
<td>0.849</td>
<td>85.7</td>
<td>83.3</td>
<td>0.415</td>
<td>89.3</td>
<td>84.2</td>
<td>0.218</td>
</tr>
<tr>
<td>Time from symptom onset to angiography (ischemic time), min, median (25th, 75th percentile)</td>
<td>207 (155–270)</td>
<td>165 (123–229)</td>
<td>&lt;0.001</td>
<td>192 (139–263)</td>
<td>163 (120–225)</td>
<td>&lt;0.001</td>
<td>199 (147–283)</td>
<td>171 (125–237)</td>
<td>0.013</td>
</tr>
<tr>
<td>Pre-PCI TIMI 2/3 flow, %</td>
<td>18.6</td>
<td>31.5</td>
<td>0.002</td>
<td>19.2</td>
<td>32.8</td>
<td>&lt;0.001</td>
<td>10.8</td>
<td>31.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Figure 1 (A) Relationship between thrombolysis in myocardial infarction (TIMI) flow grade and 90 day mortality, \( P(\text{log-rank}) = 0.024 \). Solid line, TIMI 0/1/2; dashed line, TIMI 3 flow grade. (B) Relationship between TIMI myocardial perfusion grade (TMPG) and 90 day mortality, \( P(\text{log-rank}) = 0.019 \). Solid line, TMPG 0/1; dashed line, TMPG 2/3. (C) Relationship between TIMI flow grade, TMPG, and 90 day mortality, TMPG 0/1 and TIMI 0/1/2 vs. TMPG 2/3 and TIMI 3, \( P(\text{log-rank}) = 0.002 \). Solid line, TMPG 0/1 and TIMI 0/1/2; dashed-dot line, TMPG 0/1 and TIMI 3; dotted line, TMPG 2/3 and TIMI 0/1/2; dashed line, TMPG 2/3 and TIMI 3.
Figure 2  (A) Relationship between TIMI flow grade and 90 day death/congestive heart failure/shock, P(log-rank) = 0.079. Solid line, TIMI 0/1/2; dashed line, TIMI 3 flow. (B) Relationship between TIMI myocardial perfusion grade and 90 day death/congestive heart failure/shock, P(log-rank) = 0.058. Solid line, TMPG 0/1; dashed line, TMPG 2/3. (C) Relationship between TIMI flow grade, TMPG, and 90 day death/congestive heart failure/shock; TMPG 0/1 and TIMI 0/1/2 vs. TMPG 2/3 and TIMI 3, P(log-rank) = 0.094. Solid line, TMPG 0/1 and TIMI 0/1/2; dashed-dot line, TMPG 0/1 and TIMI 3; dotted line, TMPG 2/3 and TIMI 0/1/2; dashed line, TMPG 2/3 and TIMI 3.
Reperfusion for ST-elevation MI

Discussion

The APEX-AMI angiographic substudy presents a contemporaneous large cohort of STEMI patients treated with primary angioplasty at a median of 2.9 h after symptom onset, who received aggressive concomitant medical therapy and underwent independent adjudication of reperfusion success. It affords an excellent opportunity to identify the clinical and angiographic parameters that help predict successful reperfusion with contemporary primary PCI, and reasserts the importance of successful reperfusion therapy in modulating clinical outcome. The key findings of our study are that: (i) in a cohort with a relatively short time from symptom onset, successful epicardial reperfusion (TIMI 3) was predicted mostly by younger age, the patency of the infarct artery prior to PCI, and shorter ischaemic interval; (ii) the success of myocardial reperfusion (TMPG 2/3) was similarly predicted by younger age, patency of the infarct artery prior to PCI and shorter ischaemic interval, and (iii) even in a STEMI cohort with an overall low mortality, myocardial reperfusion (TMPG) provides additive predictive capacity on mortality beyond the presence of epicardial reperfusion and independent of age, infarct location, and other classic predictors of mortality. Since age and ischaemic time are predictors of achieving optimal TMPG and the latter predicts mortality, the extent of myocardial reperfusion appears to be the link between the baseline demographic and angiographic characteristics and outcome. In aggregate, our study confirms the value of establishing or maintaining epicardial flow prior to PCI and encouraging patients to present early in the infarct course in order to promote successful reperfusion. These data, in patients reperfused with primary PCI, complement prior work relating angiographically successful reperfusion with outcomes in STEMI patients treated with fibrinolysis.8–10

Our data are in accord with the findings by De Luca et al.13 in 1791 patients treated with primary PCI. Successful reperfusion was predicted by shorter ischaemic time in their study and the relationship between mortality and ischaemic time showed that patients treated within 3 h had a 1 year mortality of ~4%. In a previous analysis of epicardial flow from the same cohort,14 a patent artery (TIMI 2/3 flow) prior to PCI was associated with very low mortality rate at 1 year, even when the delay from hospital arrival to PCI was more than the optimal 90 min.

This study adds new support to the concept that although epicardial reperfusion is necessary, it alone is not sufficient to ensure optimal outcomes after PCI. Hence myocardial reperfusion (TMPG) constitutes not only an angiographic parameter but also has an important relationship to immediate and subsequent mortality and morbidity. Indeed, a combination of TIMI 3 flow and TMPG 2/3 in our study was associated with a nearly 50% lower incidence of death or heart failure or shock at 90 days compared with patients neither one of these parameters of successful reperfusion. By itself, TMPG 2/3 was also an independent predictor of lower mortality at 90 days. Importantly, our data are in concert with those of Poli et al.15 who showed that those with TMPG 2/3 after PCI have a 55% chance of significant recovery of the infarcted territory function (less CHF and cardiogenic shock) prior to hospital discharge compared with only 18% in those with TMPG 0/1. Although skepticism has been levelled at the ability to accurately determine TMPG during regular clinical practice and the lack of ‘objective’ definitions, in our and other laboratories, the inter- and intra-observer concordance is usually >90%. It is noteworthy that there are two distinct methods for the evaluation of myocardial reperfusion, or ‘blush’. The van ’t Hof method15 uses densitometric evaluation of the intensity of myocardial blush, whereas our laboratory employs the dynamic method (entrance and exit of contrast from myocardium), as defined by Gibson et al.10 In a comparison of the two methods in the Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications (CADILLAC) study, TMPG 3 was found in 64% by the dynamic method and in only 17% by the densitometric method.16 Grouping of TMPG in 0/1 vs. 2/3 resolved some of the discrepancy. Moreover, what discrepancies exist rarely change the basic classification from optimal (TMPG 2/3) to suboptimal reperfusion (TMPG 0/1). These considerations and the results presented in this manuscript should encourage practitioners to identify the success of reperfusion at the epicardial and myocardial levels at the completion of the procedure and apply intensive and appropriate measures (such as intracoronary vasodilators) to improve them if not optimal.

The only other large STEMI study of primary angioplasty with independent angiographic assessment was CADILLAC, which was conducted between 1997 and 1999 in patients presenting within 12 h of symptom onset. Two analyses from this trial considered the frequency and predictors of successful reperfusion;17,18 TMPG and TIMI flow data were available in 1301 of the 2082 patients enrolled. TIMI 3 flow was achieved in 96%, but only 51% had TMPG 2/3 after PCI, compared with 85 and 91%, respectively, in our study. Furthermore, in contrast to our study, the CADILLAC Investigators found that TMPG 3 was less frequent in patients with LAD infarctions, but a multivariable analysis was not performed.17 More recently, from the same cohort, additional exploration was undertaken on the relation between infarct location and successful reperfusion.18 Patients with LAD infarctions had more severe systolic dysfunction prior to PCI, a lower rate of visible thrombus, and distal embolization, and yet achieved TIMI 3 flow less often (93.4 vs. 96.9% for RCA) and TMPG 2/3 (31 vs. 68% for RCA). Again, multivariable analysis for the prediction of TMPG 2/3 was not reported.

An important novel feature of our study, confirmed by multivariable analysis of 937 patients with LAD compared with RCA or LCX culprit vessels, is that an LAD culprit has equal reperfusion success at both the epicardial and myocardial levels compared with other territories. These differences between our findings and prior reports likely reflect the improved catheter-based technology, the lower rate of distal embolization, and the benefit of aggressive antiplatelet therapy as well as the accounting for other determinants of angiographic success. In addition, the more stringent entry requirement for non-anterior myocardial infarctions...
may have further contributed to this finding. We used a different methodology for the assessment of TMPG than in the CADILLAC trial, which makes comparisons between the trials less than optimal.

**Limitations**

The patients enrolled in the angiographic substudy were selected from high-volume tertiary care centres and may have benefited from an overall enhanced standard of care. It is reassuring however that their baseline characteristics were similar to the overall cohort. Moreover, the association between markers of reperfusion and clinical outcome reinforces the intrinsic validity of these findings. Because our findings are derived from a clinical trial of STEMI patients with anterior and high-risk inferior infarctions randomized <6 h of symptom onset, they are not necessarily generalizable to the broader cross-section of patients undergoing primary PCI. And although this is one of the largest angiographic studies of its kind, caution is needed in interpreting some of the results in small patient subsets.

**Conclusion**

We conclude that in a contemporary, large cohort of STEMI patients treated with primary PCI, successful epicardial reperfusion and myocardial reperfusion, assessed by systematic core laboratory assessment, correlate with excellent clinical outcomes. Because of the powerful predictive ability of TMPG, identification of successful myocardial reperfusion immediately following PCI may assist in the risk stratification of STEMI patients and in fashioning of appropriate therapeutic plans. The independent predictors of successful reperfusion, namely younger age, shorter ischaemic time, and pre-PCI patency of the infarct artery, emphasize the need for intensive research into novel pharmacological interventions capable of achieving pre-PCI arterial patency, as well as the necessity to educate prospective patients on the importance of early presentation. Importantly, our findings also underscore the importance of early and complete reperfusion, and the excellent clinical outcomes commensurate with this occurrence.

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**References**


