CARDIOVASCULAR MEDICINE

Influences of electrocardiographic ischaemia grades and symptom duration on outcomes in patients with acute myocardial infarction treated with thrombolysis versus primary percutaneous coronary intervention: results from the DANAMI-2 trial

M Sejersten, Y Birnbaum, R S Ripa, C Maynard, G S Wagner, P Clemmensen, for the DANAMI-2 Investigators

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Objective: To determine whether ischaemia grade (GI) on the presenting ECG and duration of symptoms can identify subgroups of patients who would derive more benefit than the general population of patients with ST segment elevation acute myocardial infarction (STEMI) from primary percutaneous coronary intervention (pPCI) over thrombolytic treatment (TT) in reducing mortality or reinfarction.

Methods: 1319 DANAMI-2 (Danish trial in Acute Myocardial Infarction-2) patients were classified as having grade 2 ischaemia (GI2; ST segment elevation without terminal QRS distortion) or grade 3 ischaemia (GI3; ST segment elevation with terminal QRS distortion in ≥ 2 adjacent leads), and were divided into early and late groups split by the median time (3 h) from symptom onset to treatment. Outcomes were 30-day mortality and reinfarction.

Results: Mortality was significantly higher for GI3 than for GI2 (9.7% v 4.8%, $p < 0.001$) and doubled for patients presenting late (GI2: 6.0% v 3.3%, $p = 0.01$; GI3: 12.5% v 4.7%, $p = 0.05$). Overall mortality did not differ significantly between pPCI and TT; however, a 5.5% absolute mortality reduction was seen in GI3 treated early with pPCI (1.4% v 6.9%, $p = 0.10$). Reinfarction rate was particularly high among GI3 patients presenting late and treated with TT (12.2%). pPCI in such patients significantly reduced the rate of reinfarction (0%, $p < 0.001$). Logistic regression analysis showed that age (odds ratio (OR) 1.09, 95% confidence interval (CI) 1.06 to 1.12, $p < 0.001$), prior angina (OR 2.56, 95% CI 1.44 to 4.54, $p = 0.001$), heart rate (OR 1.03, 95% CI 1.01 to 1.04, $p = 0.001$) and GI3 (OR 1.91, 95% CI 1.06 to 3.44, $p = 0.031$) were independently associated with mortality, whereas the sum of ST segment elevation was not.

Conclusions: GI3 is an independent predictor of mortality among patients with STEMI. Mortality increased significantly with symptom duration in both GI2 and GI3. pPCI may be especially beneficial for patients with GI3 presenting early, whereas patients with GI3 presenting late and treated with TT are at particular risk of reinfarction.

See end of article for authors' affiliations

Correspondence to:
Dr M Sejersten,
Department of Cardiology
B, 2142, H:S
Rigshospitalet,
Blegdamsvej 9, DK-2100
Copenhagen Ø, Denmark;
msejersten@webspeed.dk

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Primary percutaneous coronary intervention (pPCI) is considered to be superior to thrombolytic treatment (TT) for ST segment elevation acute myocardial infarction (STEMI).^{1–3} All studies have shown significant reduction of the combined end point of death and reinfarction. However, although meta-analysis showed a significant reduction of mortality with pPCI, none of the individual studies was powered enough to show a significant difference in mortality.⁴ In most studies few patients in the TT arm underwent catheterisation and PCI.^{2–5} As PCI after TT reduces the risk of reinfarction and the need for reintervention,^{1–3} and reinfarction is associated with high mortality,⁹ it is still unclear whether the disadvantage of TT can be overcome by routine catheterisation and early revascularisation to reduce the risk of reinfarction and its associated mortality, as suggested by the recent GRACIA-1 (routine invasive strategy within 24 hours of thrombolysis versus ischaemia-guided conservative approach for acute myocardial infarction with ST-segment elevation) trial.⁸ Moreover, pPCI has not been shown to have an advantage over TT in individual subgroups of patients. For example, a large-scale comparison between pPCI and TT on mortality of patients with non-anterior STEMI has not been

reported. Meta-analysis failed to show a significant reduction of mortality with TT relative to placebo in patients with inferior STEMI,¹ and a recent analysis of the Zwolle trial (395 patients) showed no advantage of pPCI over TT in patients with non-anterior STEMI.¹⁰ In addition, the difference in mortality between pPCI and TT was not significant for patients who needed to be transferred for PCI.^{1–3} In addition to those with cardiogenic shock,¹ there may be subgroups of patients with STEMI who derive greater absolute or relative benefit from pPCI over TT than the general STEMI population.

The ability to identify soon after presentation those patients with STEMI who would benefit most from pPCI may help in triage and improve the utilisation of resources.

Abbreviations: CI, confidence interval; DANAMI-2, Danish trial in Acute Myocardial Infarction-2; GI, ischaemia grade; GI2, grade 2 ischaemia; GI3, grade 3 ischaemia; GRACIA-1, routine invasive strategy within 24 hours of thrombolysis versus ischaemia-guided conservative approach for acute myocardial infarction with ST-segment elevation; OR, odds ratio; pPCI, primary percutaneous coronary intervention; STEMI, ST segment elevation acute myocardial infarction; TIMI, Thrombolysis in Myocardial Infarction; TT, thrombolytic treatment

For example, pPCI was recently shown to significantly reduce mortality as compared with TT only in patients with a high TIMI (Thrombolysis in Myocardial Infarction) risk score, whereas for those with a low score, the difference in mortality between pPCI and TT is not significant.¹¹ However, in this analysis the enrolment ECG was not included in the risk score. The ECG is an integral part of the diagnosis of STEMI. In addition, the enrolment ECG has been used to estimate final infarct size and prognosis in STEMI.^{12–13} The variables that have been used for risk assessment include the sum of ST segment elevation, the number of leads with ST segment elevation, the number of abnormal Q waves on presentation, QRS width and the ischaemia grading system.^{14–23} The ischaemia grade (GI) system consists of three grades (grade 1: tall upright T waves without ST segment elevation; grade 2 (GI2): ST segment elevation in ≥ 2 adjacent leads without terminal QRS distortion; and grade 3 (GI3): ST segment elevation with terminal QRS distortion in ≥ 2 adjacent leads) and is based on qualitative evaluation of changes occurring in the ST segment and the terminal portion of the QRS complex during the early stages of STEMI.²² Previous studies have shown that patients with STEMI with GI3 on the presenting ECG have a worse prognosis,^{15–16–23–24} larger infarct size,^{15–20–21–25–26} less benefit from TT^{15–25} and less viability in the infarcted zone²⁷ than patients with GI2. Moreover, when treated with TT, patients with GI3 have higher rates of reinfarction than patients with GI2.^{23–28} The rate of progression of necrosis over time is much faster in patients with GI3 than in those with GI2.^{22–29–30} Thus, it is plausible that pPCI would especially benefit patients with GI3 presenting within a relatively short time from onset of symptoms, whereas in those presenting late, myocardial necrosis is already completed and no difference will be found between pPCI and TT. It has previously been shown that even with pPCI, patients with GI3 have higher mortality than patients with GI2; however, the interaction with the time from onset of symptoms to presentation has not been investigated.²³

The purpose of the present study was to determine whether GI can identify a subgroup of patients with STEMI who would derive greater benefit from pPCI than from TT in reducing mortality or reinfarction. The secondary purpose was to determine whether GI is associated with the duration of symptoms in predicting the difference in outcome between pPCI and TT.

METHODS

Patient population and ECG analysis

The DANAMI-2 (Danish trial in Acute Myocardial Infarction-2) study was a randomised multicentre trial comparing TT with pPCI in 1572 patients with symptoms of STEMI.² Patients with chest pain lasting between 30 min and 12 h and a cumulative ST segment elevation of ≥ 4 mm were eligible for inclusion. A detailed description of inclusion and exclusion criteria for the DANAMI-2 trial has previously been published.³¹ Any necessary ethics approval was secured. The present analysis was conducted on the DANAMI-2 patients with a complete randomisation ECG and no ECG confounding factors. Patients were divided into an early and late treatment group prospectively defined as the median time from symptom onset to treatment (3 h).

ECG analysis

The randomisation ECGs were analysed according to the ischaemia grading system by a single investigator (YB) (fig 1). GI3 is defined as: (1) absence of an S wave below the TP–PR isoelectric line in ≥ 2 leads that usually have a terminal S configuration (leads V1 to V3); or (2) ST J point amplitude $\geq 50\%$ of the R wave amplitude measured from the TP–PR

Figure 1 Grade 1 of ischaemia includes patients with tall positive T waves but no ST segment elevation, and thus does not apply to patients with ST segment elevation acute myocardial infarction. Grade 2 of ischaemia includes patients with ST segment elevation without distortion of the terminal portion of the QRS complex. Grade 3 of ischaemia includes patients with ST segment elevation with distortion of the QRS complex in ≥ 2 adjacent leads defined as disappearance of the S wave in leads V1–V3 or appearance of ST segment elevation measured at the J point at $\geq 50\%$ of the R wave amplitude in the other leads.

baseline in ≥ 2 of all other leads. Patients meeting the ST segment elevation criteria but not the GI3 criteria were classified as having GI2.²² The ST segment measurements were performed in the ECG Core Laboratory at Rigshospitalet, Copenhagen. ST segment deviation was measured manually to the nearest 0.5 mm at the J point in 11 of the 12 ECG leads, excluding aVR, by using the TP segment as the isoelectric line. Alternatively, the PR segment was used if the TP segment was not distinct.

Angiographic data

For patients randomly assigned to pPCI, angiographic data were collected and differences between GI2 and GI3 presenting early and late were determined.

Outcomes

The predefined end points were 30-day all-cause mortality and reinfarction. Clinical reinfarction was diagnosed as any new infarction occurring after the index infarct and unrelated to angioplasty or coronary artery bypass surgery. In addition, the creatine kinase myocardial band level had to rise above a reference limit following normalisation after the index infarction or to increase at least 50% from the last non-normalised measurement. A detailed description of the DANAMI-2 end points has been reported previously.³¹ The DANAMI-2 end points were evaluated by an independent and blinded end point committee to eliminate bias.³²

Table 1 Baseline characteristics

	Grade 2 (n = 959)	Grade 3 (n = 360)	p Value
Age (years)	61.9 (12.6)	63.5 (12.3)	0.04
Men	72.4%	73.9%	0.69
Hypertension	20.2%	18.4%	0.45
Diabetes mellitus	6.6%	7.0%	0.80
Family history of heart disease	37.6%	32.7%	0.35
Prior myocardial infarction	11.7%	9.7%	0.31
Prior angioplasty	4.1%	4.5%	0.83
Prior angina	28.7%	22.8%	0.03
Prior stroke	2.8%	3.6%	0.46
Hyperlipidaemia	6.5%	5.3%	0.42
Current smoking	57.7%	64.6%	0.03
Heart rate (beats/min)	73.2 (17.4)	75.8 (18.4)	0.02
Systolic blood pressure (mm Hg)	135.2	135.4	0.91
Killip class $\geq$ II	7.7%	8.6%	0.59
Sum ST increase at baseline (mm)	10.2 (5.4)	16.9 (9.3)	<0.001
Anterior infarct location, V1–V4	53.9%	42.5%	<0.001
Time from symptom onset to treatment (h:min)	3:43 (2:22)	3:43 (2:19)	0.98
Randomly assigned to fibrinolysis	48.9%	49.2%	0.93

Data are mean (SD) or number (%).

Statistical analysis

Baseline demographics of patients with GI2 and GI3 were compared by the χ^2 statistic for categorical variables and Student's *t* test for continuous variables. The χ^2 test was used to compare angiographic data and end points at 30 days for the two patient groups. Backwards stepwise logistic regression was done to identify independent predictors of 30-day mortality or 30-day reinfarction. Variables included in the regression analysis were: age; sex; pPCI versus TT; history of hypertension, hyperlipidaemia, diabetes mellitus, prior angina, prior myocardial infarction, prior angioplasty and prior stroke; being a current smoker; grade of ischaemia; sum of ST segment elevation; ST segment elevation in the lead with maximum ST segment elevation; time from symptom onset to treatment; myocardial infarct location; heart rate; and Killip class.

RESULTS

Patient population

A total of 1319 patients (83.9% of the original DANAMI-2 study population) were included in the present analysis and 253 patients (16.1%) were excluded because of ECG confounding factors. Confounding factors were: (1) T wave inversion in leads with maximum ST segment elevation (*n* = 91); (2) missing randomisation ECG (*n* = 48); (3) right bundle branch block (*n* = 65); (4) incomplete ECG (*n* = 11); (5) no ST segment elevation (*n* = 11); (6) left bundle branch block (*n* = 10); (7) non-specific intraventricular conduction defect (*n* = 6); (8) left ventricular hypertrophy with secondary repolarisation changes (*n* = 5); (9) ventricular tachycardia or accelerated idioventricular rhythm (*n* = 4); (10) Wolff-Parkinson-White syndrome (*n* = 1); and (11) electronic ventricular paced rhythm (*n* = 1).

Overall, the excluded patients had a 12.6% 30-day mortality with no difference between patients treated with pPCI and patients with TT. Interestingly, only 0.7% of excluded patients treated with TT had a reinfarction at 30 days compared with 4.3% of patients treated with pPCI; however, this difference was not significant.

For 11 patients randomly assigned to pPCI (seven with GI2 and four with GI3) and in four patients randomly assigned to TT (two with GI2 and two with GI3), time between symptom onset and intervention was not available. Table 1 lists baseline characteristics.

Angiographic data

Table 2 lists TIMI (Thrombolysis In Myocardial Infarction) flow data before and after pPCI. Significantly more patients with GI2 than with GI3 had TIMI flow grade 3 before the

procedure, and this difference was especially apparent among those presenting early. The success rate of pPCI did not differ between the groups. However, more patients in both GI2 and GI3 presenting early achieved TIMI flow grade 3 than patients presenting late. Table 3 shows the number of diseased vessels for patients with GI2 and GI3.

Outcome

Patients with GI3 had a significantly higher 30-day mortality than patients with GI2 (9.7% *v* 4.8%, *p* < 0.001), and this difference was independent of treatment strategy (TT: 10.2% *v* 5.1%, *p* = 0.020; pPCI: 9.3% *v* 4.5%, *p* = 0.018). Mortality was significantly higher for both GI2 and GI3 patients treated more than 3 h after symptom onset than for patients treated early (GI2: 6.0 *v* 3.3%, *p* = 0.01; GI3: 12.5% *v* 4.7%, *p* = 0.05). Accordingly, mortality more than doubled for GI3 patients presenting late compared with patients with GI2 presenting either early or late and GI3 presenting early. Mortality increased for both pPCI and TT patients presenting late, but overall there was a trend towards 1–2% lower absolute mortality among pPCI-treated patients regardless of the GI, except in patients with GI3 presenting early ($\leq$ 3 h). In this group an absolute 5.5% mortality reduction (*p* = 0.10) was seen with pPCI as compared with TT (fig 2).

Overall, GI had no influence on the 30-day reinfarction rate (4.4% in GI2 *v* 3.9% in GI3, NS). The reinfarction rate was significantly lower among patients treated with pPCI than with TT in both patients with GI2 (1.6% *v* 7.2%, *p* < 0.001) and with GI3 (0% *v* 7.9%, *p* < 0.001), compatible with the main DANAMI-2 trial results.² In the group of patients with GI3 presenting late, the reinfarction rate was especially high (12.2%) for those treated with TT as compared with those treated with pPCI (0%) (fig 3). In contrast, neither GI nor duration of symptoms influenced the reinfarction rate in patients treated with pPCI, and time had no effect on reinfarction rate in patients with GI2.

Independent predictors of mortality by multivariate analysis were age (odds ratio (OR) 1.09, 95% confidence interval (CI) 1.06 to 1.12, *p* < 0.001), history of angina (OR 2.56, 95% CI 1.44 to 4.54, *p* = 0.001), heart rate (OR 1.03, 95% CI 1.01 to 1.04, *p* = 0.001) and GI3 (OR 1.91, 95% CI 1.06 to 3.44, *p* = 0.031). Only treatment type (pPCI *v* TT: OR 0.15, 95% CI 0.06 to 0.32, *p* < 0.001) and history of angina (OR 2.04, 95% CI 1.13 to 3.65, *p* = 0.017) were independent predictors of reinfarction.

DISCUSSION

The present study showed that the GI on the presenting ECG in patients with STEMI is a strong and independent predictor

Table 2 TIMI flow in patients randomly assigned to pPCI*

	Total (n = 673)			Early (n = 280)			Late (n = 382)		
	GI2 (n = 483)	GI3 (n = 179)	p Value	GI2 (n = 211)	GI3 (n = 69)	p Value	GI2 (n = 272)	GI3 (n = 110)	p Value
Before pPCI									
TIMI 01	69%	83.2%	0.003	66%	84.1%	0.02	71.5%	82.8%	NS
TIMI 2	11.8%	6.7%		11.3%	10.1%		12.2%	4.5%	
TIMI 3	19.2%	10.1%		22.7%	5.8%		16.3%	12.7%	
100% occlusion	61.4%	78.1%	<0.001	58.3%	78.3%	0.003	65.4%	80.9%	0.003
Collaterals	23.7%	27.9%	NS	22.3%	27.5%	NS	25.4%	29.1%	NS
TIMI 01 with collaterals	29.7%	28.2%	NS	28.4%	27.6%	NS	30.7%	28.6%	NS
After pPCI									
TIMI 01	1.9%	2.4%	NS	2.7%	0%	NS	1.3%	4.0%	NS
TIMI 2	10.3%	12.4%		6.8%	4.3%		13.1%	18.0%	
TIMI 3	87.8%	85.2%		90.5%	95.7%		85.6%	78.0%	
100% occlusion	0.8%	1.1%	NS	0.4%	0.6%	NS	1.3%	1.6%	NS

*Time was not available for 11 patients randomly assigned to primary percutaneous coronary intervention (pPCI). GI2, grade 2 of ischaemia; GI3, grade 3 ischaemia; TIMI, Thrombolysis in Myocardial Infarction.

Table 3 Number of diseased vessels and culprit artery in patients randomly assigned to pPCI*

	Total (n = 673)			Early (n = 280)			Late (n = 382)		
	GI2 (n = 483)	GI3 (n = 179)	p Value	GI2 (n = 211)	GI3 (n = 69)	p Value	GI2 (n = 272)	GI3 (n = 110)	p Value
Non-stenotic vessel	5.2%	1.7%	NS	6.3%	2.9%	NS	4.3%	0.9%	NS
1 Diseased vessel	67.5%	68.2%		71.7%	65.2%		64.2%	70.0%	
2 Diseased vessel	20.7%	21.8%		17.6%	24.6%		23.2%	20.0%	
3 Diseased vessel	6.5%	8.4%		4.4%	7.2%		8.3%	8.3%	
Left main artery	0.7%	1.7%	NS	0.5%	2.9%	0.043	0.8%	0.9%	NS
LAD	47.2%	43.8%		47.3%	33.3%		47.2%	50.5%	
Left circumflex artery	11.8%	9.0%		11.8%	7.3%		11.8%	10.1%	
Right coronary artery	36.1%	43.8%		35.5%	55.1%		36.6%	36.7%	
Diagonal artery	1.3%	0.6%		1.5%	0%		1.2%	0.9%	
Obtuse marginal artery	1.6%	1.1%		2.0%	1.4%		1.2%	0.9%	
Other artery	1.3%	0%		1.4%	0%		1.2%	0%	
Left main ($\geq 50\%$ diameter stenosis)	2.2%	5.5%	0.033	0.5%	5.8%	0.004	3.7%	5.5%	NS
Stent	93.8%	94.7%	NS	92.1%	94.2%	NS	95.2%	95%	NS
Glycoprotein IIb/IIIa	38.0%	45.3%	NS	38.4%	47.8%	NS	37.6%	43.6%	NS

*Time was not available for 11 patients randomly assigned to primary percutaneous coronary intervention (pPCI).

GI2, grade 2 ischaemia; GI3, grade 3 ischaemia; LAD, left anterior descending artery.

of mortality, irrespective of the reperfusion modality. In addition, a trend towards a larger absolute mortality reduction with pPCI in GI3 patients treated within 3 h of onset of symptoms was seen. Interestingly, the magnitude of ST segment elevation did not remain an independent predictor of mortality when the GI was included in the logistic regression analysis. Overall, reinfarction was independent of GI and the duration of symptoms but was significantly lower in patients treated with pPCI than with TT. If treated with TT, patients with GI3 presenting late (> 3 h) tended to have more reinfarctions. Thus, GI and timing may provide decision support for the choice of reperfusion strategy for patients with STEMI.

There were several significant differences in baseline characteristics between GI2 and GI3 patients. Age is known to be a strong predictor of outcome, which corresponds well with the finding of the present study, in which GI3 patients were slightly older. Previous studies^{15 16 23} have also shown that GI3 patients were older. Lower incidence of prior angina in GI3 may be associated with less myocardial protection by ischaemic preconditioning and may explain the difference in outcome between the groups, as suggested by Tamura *et al.*²⁵ However, some,^{15 25} but not all,^{23 24 33} prior studies have shown that fewer patients with GI3 have a history of angina. Thus, lack of ischaemic preconditioning cannot fully explain the

difference in prognosis between the GI2 and GI3 patients with STEMI. The incidences of hypertension and diabetes mellitus did not differ between the groups. In addition, the percentage of patients in Killip class $\geq$ II on enrolment, as well as enrolment mean heart rate and mean systolic blood pressure, were comparable.

In contrast to previous studies,^{15 16 23} more patients with GI3 were current smokers. Barbash *et al.*³⁴ have suggested that in smokers STEMI occurs at an earlier stage of coronary artery disease without pre-existing significant coronary lesions and therefore they respond better than non-smokers to TT. On the other hand, these findings may explain why smokers are more prevalent in the GI3 group. They are probably developing STEMI without being protected by pre-existing collaterals or ischaemic preconditioning.

In the present analysis, patients with GI3 had more ST segment elevation than patients with GI2, despite having a lower incidence of anterior STEMI. Other studies had similar findings.^{18 21 23 27} More ST segment elevation may reflect more severe ischaemia rather than a larger ischaemic area at risk as suggested in a previous study,²⁰ where the size of the perfusion defect by radionuclide imaging (ischaemic area at risk) was not different between GI2 and GI3. However, logistic regression analysis showed that both the sum of ST segment elevation and the magnitude of ST segment

Figure 2 Relationship between total mortality at 30 days, grades of ischaemia and duration from symptom onset to treatment. GI2, grade 2 ischaemia; GI3, grade 3 ischaemia; pPCI, primary percutaneous coronary intervention; TT, thrombolytic treatment.

Figure 3 Relationship between total reinfarction at 30 days, grades of ischaemia and duration from symptom onset to treatment. GI2, grade 2 ischaemia; GI3, grade 3 ischaemia; pPCI, primary percutaneous coronary intervention; TT, thrombolytic treatment.

elevation in the lead with maximum ST segment elevation were not independent predictors of mortality when the GI was included in the model. By using logistic regression analysis, Buber *et al*³⁵ have shown that GI3, but not the sum of ST segment elevation, was an independent predictor of ST segment resolution at 2 and 24 h and of the need for rescue PCI after TT. Moreover, GI was a better predictor than the sum of ST segment elevation in predicting final infarct size in patients receiving and not receiving TT.²⁰

The difference in the location of STEMI may be incidental or due to selection bias (that is, more patients presenting with anterior STEMI and GI3 were not randomly selected), as two previous studies^{16, 23} found no differences in the percentages of patients with anterior STEMI between patients with GI2 and with GI3, and one study found more patients with anterior STEMI in GI3.¹⁵

In the present study, as well as in the previous studies, the time from onset of symptoms to treatment did not differ between patients with GI2 and GI3^{15, 16, 21, 23}; thus, the difference in outcomes between the two groups cannot be explained by differences in ischaemic time.

In the present study we found no difference in the presence of collateral flow visible on angiography between GI2 and GI3. However, significantly fewer patients with GI3, especially among those presenting early, had complete spontaneous recanalisation of their culprit artery (TIMI flow grade 3) before the pPCI. More patients with GI3 had a completely occluded infarct-related artery with a TIMI flow grade of 0–1 on the initial angiogram. These findings are different from the angiographic data of two previous studies,^{23, 24} which both showed no differences in the preintervention TIMI flow grades between GI2 and GI3. Angiographic success of reperfusion therapy by either TT^{15, 21} or pPCI^{23, 24} has been reported to be comparable between GI2 and GI3 patients, as we have found in the present study.

In a previous study of patients with STEMI treated with TT, mortality increased for GI3 patients as the time from onset of symptoms to presentation increased, but not in GI2.¹⁶ Our results also showed that mortality depends on time, especially in GI3 patients. Pretreatment and predischARGE technetium-99m sestamibi single-photon emission computed tomography imaging in patients undergoing TT²⁰ and pPCI³⁰ have shown that salvage decreases as time from onset of symptoms to treatment increases only in GI3 patients, whereas in GI2 patients the association between salvage and time was not significant. Thus, with current therapy

myocardial salvage seems much smaller in patients with a GI3 pattern on the presenting ECG. As their myocardial salvage is highly dependent on the ischaemic time, patients with GI3 should achieve reperfusion as fast as possible.

Our data suggest a trend towards lower mortality (5.5% reduction) in GI3 patients presenting within 3 h of onset of symptoms and treated with pPCI. The relatively small number of patients in this subgroup may explain the lack of significance for this finding. This finding is of particular importance, as several studies suggested that within 2–3 h of onset of symptoms the effects of pPCI and TT on mortality are comparable.^{36, 37} The American Heart Association/American College of Cardiology guidelines recommend TT for patients presenting within 3 h of onset of symptoms if pPCI is expected to be delayed (> 90 min).¹ If confirmed in a larger population group, the presence of GI3 on the admission ECG may help in triaging patients for pPCI, especially if they present within 3 h of onset of symptoms.

In addition, patients with GI3 at presentation who presented more than 3 h after onset of symptoms and were treated with TT had a higher reinfarction rate (12.2%) than the other groups. In contrast, GI3 patients presenting late and treated with pPCI had no reinfarctions. Our data are supported by a previous study showing a higher risk of reinfarction among GI3 patients with STEMI treated with TT.²⁸ It seems that patients with GI3 presenting more than 3 h after onset of symptoms and treated with TT should undergo routine early coronary angiography to decrease their increased risk of reinfarction.

Conclusions

In conclusion, our study showed that GI on the presenting ECG is an independent predictor of mortality among patients with STEMI who are treated with either TT or pPCI. This simple qualitative “eyeballing” score is easy to use and does not mandate time-consuming measurements of the amount of ST segment elevation in each lead. Moreover, when incorporated into logistic regression analysis with the sum of ST segment elevation, GI remains an independent predictor of infarct size and outcome. This score should probably be incorporated into the risk assessment of patients with STEMI and may be included in the randomisation algorithms for clinical trials assessing treatment and prognosis in STEMI. Mortality increased significantly with duration of symptoms in both GI2 and GI3 patients, whereas the overall reinfarction rate was not affected. Overall, the risk of death and

reinfarction was lower with pPCI than with TT. However, our data suggest that pPCI may be especially beneficial for patients with G13 presenting early (≤ 3 h) after onset of symptoms, and that patients with G13 presenting late (> 3 h) and treated with TT are at increased risk of reinfarction. Further studies with a larger number of patients with the G13 pattern are needed to confirm our findings.

Authors' affiliations

M Sejersten, R S Ripa, P Clemmensen, Department of Cardiology B, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark
Y Birnbaum, Division of Cardiology, The University of Texas Medical Branch, Galveston, Texas, USA

C Maynard, Department of Health Services, University of Washington, Seattle, Washington, USA

G S Wagner, DCRI, Duke University Medical Center, Durham, North Carolina, USA

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