Intern Emerg Med
DOI 10.1007/s11739-011-0596-5

IM - ORIGINAL

Early invasive strategy and outcomes of non-ST-elevation acute coronary syndrome patients: is time really the major determinant?

Cristina Giglioli · Emanuele Cecchi · Daniele Landi · Serafina Valente · Marco Chiostri · Salvatore Mario Romano · Valentina Spini · Laura Perrotta · Ignazio Simonetti · Gian Franco Gensini

Received: 3 November 2010 / Accepted: 19 April 2011

Abstract In non-ST-elevation acute coronary syndromes (ACS), an early invasive strategy is recommended for middle/high-risk patients; however, the optimal timing for coronary angiography is still debated. The aim of this study was to evaluate the prognostic implications of the time of angiography in ACS patients treated in accord with an early invasive strategy. We analyzed the relationship between the time of angiography and outcomes at follow-up in 517 ACS patients, of whom 482 were revascularized with percutaneous coronary intervention (PCI) (86.9%) or coronary artery by-pass graft (13.1%). We also evaluated the influence of clinical, biohumoral and angiographic variables on the patients' outcomes at follow-up. Among patients submitted to angiography at different time intervals from both hospital admission and symptom onset, significant differences neither in mortality nor in cardiac ischemic events at follow-up were observed. At univariate analysis, complete versus partial revascularization, longer hospital stay, higher TIMI risk score, diabetes mellitus, higher discharge creatinine and admission anemia were associated with mortality and cardiac ischemic events at follow-up; a lower left ventricular ejection fraction was associated with mortality; higher peak troponin I and previous PCI were associated with cardiac ischemic events at follow-up. At multivariate analysis longer hospital stay, higher discharge creatinine levels, and previous PCI were independent predictors of cardiac ischemic events at follow-up. Our evaluation in ACS patients treated with an early invasive strategy does not support the concept that angiography should be performed as soon as possible after symptom onset or hospital admission. Rather, an unfavorable long-term outcome is influenced principally by the clinical complexity of patients.

Keywords Acute coronary syndromes · Early invasive strategy · Timing of angiography · Prognosis

C. Giglioli (✉) · E. Cecchi · D. Landi · S. Valente · M. Chiostri · S. M. Romano · V. Spini · L. Perrotta · I. Simonetti · G. F. Gensini
Department of Heart and Vessels,
Azienda Ospedaliero-Universitaria Careggi,
Viale Morgagni, 85, 50134, Firenze, Florence, Italy
e-mail: cristinagiglioli@yahoo.it

Introduction

Current international guidelines on the management of non-ST elevation acute coronary syndromes (ACS) recommend, especially for high-risk patients, an early invasive strategy [1, 2], according to which patients quickly undergo coronary angiography, and, if necessary, early percutaneous coronary intervention (PCI) or surgical revascularization (CABG).

An early invasive strategy has been shown to improve long-term survival and reduce the risk of late myocardial infarction and rehospitalization [3–8] in comparison with a selectively invasive approach, according to which coronary angiography is performed only for recurrent ischemia or new-onset left ventricular dysfunction.

However, the optimal timing for coronary angiography in such patients is still unknown [8, 9], and in daily practice, there is a wide variation in interpreting the term "early". In some hospitals, ACS patients are rapidly transferred from the Emergency Department (ED) to the catheterization laboratory, whereas in others they may wait for coronary angiography up to a week, as suggested by FRISC II investigators [3].

Published online: 07 June 2011

According to recommendations of the American and European Guidelines, in the past few years, an early invasive strategy has been adopted systematically in all patients admitted to our Institution for non-ST-elevation myocardial infarction (NSTEMI) or unstable angina (UA) judged at high or middle risk according to a TIMI risk score ≥ 3 [10].

The aim of the present study was to evaluate the prognostic implications of the time of angiography in patients with ACS, treated in accord with an early invasive strategy, during a median 13-month follow-up. Moreover, we analyzed the influence of some clinical, biohumoral, angiographic and procedural variables on patient's long-term outcome.

Methods

From January 2005 to December 2006, 554 ACS patients were consecutively admitted to the Cardiac Step Down Unit (CSDU) of the University of Florence: 346 (62.4%) were directly addressed to our CSDU from the ED, while 208 (37.5%) were referred to our Institution from other hospitals.

Patients were enrolled in the study if they had ischemic symptoms lasting $\geq$10 min within 24–48 h before admission to the CSDU, or cardiac troponin I (TnI) or CK-MB level elevation above the upper limits of normal, or transient ST segment shift on an electrocardiogram.

Patients with an urgent indication for coronary angiography, such as those with signs and symptoms of acute heart failure, hemodynamic instability, persistence of ischemic symptoms despite medical therapy or life-threatening arrhythmias, were excluded from the study.

Out of 554 patients, 517 (93.3%) underwent coronary angiography. In 37 patients, this invasive procedure was not performed because of major contraindications, serious comorbidities, or very recent surgery. In 482 ACS patients submitted to angiography, revascularization was performed with either PCI (86.9%) or CABG (13.1%). In the remaining 35 patients, revascularization was not performed because it was unnecessary, it was refused by the patients, or it was contraindicated because of comorbidities. All patients were discharged with optimal medical therapy, including antithrombotic agents, statins, beta-blockers, and angiotensin-converting enzyme inhibitors, unless individually contraindicated.

Coronary angiography and angioplasty were performed using standard techniques, usually by the femoral or radial approach. All patients received a 325-mg of acetyl-salicylic acid and 300 mg of clopidogrel loading dose at admission in CSDU or in the catheterization laboratory. Glycoprotein IIb–IIIa inhibitors were used at the operator's discretion in 72 patients (17.2%).

For each patient, the timing of angiography, clinical, biohumoral (creatinine and hemoglobin on admission and at discharge, glycemia and TnI on admission and at the peak), angiographic, and procedural data were collected. Two different times of angiography were considered: with respect to angiography, "timing of angiography" was defined as the time interval from admission to CSDU while "delay of angiography" was the time interval from symptoms onset. Data regarding the delay of angiography were available in 487/517 patients. Two physicians collected by phone the follow-up data in 509 out of 554 patients (93%) after a median follow-up period of 13 months (25^{th}–75th percentile: 8–21 months). Apart from mortality, the cardiovascular events reported by the patients themselves, or by their relatives were then verified, in a blinded manner, by means of hospital records.

The study protocol was approved by the hospital ethics committee, and informed consent was obtained from each patient before enrolling in the study. Investigations were conducted in accordance with the Declaration of Helsinki.

UA and NSTEMI were diagnosed according to recent Guidelines [1, 11] (the normal value of TnI in our laboratory is <0.15 ng/ml).

Statistical analysis was performed using SPSS for Windows, version 11.5 (SPSS, Inc., Chicago, IL, USA). A P value < 0.05 was considered statistically significant. Data were expressed as frequencies and percentages, or median (25th–75th percentile). To evaluate differences in clinical, biohumoral and angiographic data, patients were divided into three groups of timing (<6, 6–24and >24 h) and delay (<24, 24–48 and >48 h) of angiography and χ^2 or Kruskal–Wallis tests were used for univariate analysis; post-tests (Z-score for discrete variables and Kruskal–Wallis, comparing one group with one another in turn, for continuous data) were performed when overall significance was less than 10%. Age (categorically divided into $\leq$75 and >75 years) and gender-adjusted Kaplan–Meier survival analyses were performed, as previously reported [12], to evaluate differences in mortality during follow-up in relation to both timing and delay of angiography within or beyond 24 h; these differences were assessed by means of a log-rank test. After assessment of risk proportionality, several univariate Cox regression analyses were performed to investigate relationships between clinical, biohumoral and procedural variables, and outcomes. To evaluate potential adjusted predictors of non-fatal cardiac ischemic events at follow-up, (angina or acute myocardial infarction), baseline variables, considered clinically relevant and showing a statistically significant association with outcome at univariate analysis, were entered into a multivariate Cox proportional regression analysis. Candidate variables were carefully chosen, considering the number of events, to ensure parsimony of the final model; both the timing and,

respectively, the delay of angiography were forced into the final models. Non-significant variables were dropped by means of backward selection.

Results

The study population consisted of 554 ACS patients, out of whom 391 were men, (70.8%), median age 73 years (25th-75th percentile 64–78).UA was diagnosed in 415 cases (74.9%) at admission, and in 250 cases (45.1%) at discharge. About 70% of the patients were hypertensive, and 43% of them were dyslipidemic.

The cardiovascular risk of our patients was estimated according to TIMI risk score: most of them (72.2%) were at intermediate risk (TIMI risk score 3–4), and 22.2% at high risk (TIMI risk score 5–7).

The distribution of ACS patients according to the timing and the delay of angiography was different in fact, considering the timing of angiography, 397 patients (76.8%) were submitted to angiography earlier than 24 h, and 120 (23.2%) later than 24 h from admission to the CSDU, while considering the delay of angiography, more than 60% of patients were submitted to angiography later than 24 h from symptom onset. Among the possible causes why patients were submitted to angiography later than 24 h from CSDU admission, the following were observed: arrival at our hospital during the night hours or during holidays ($n = 64$), presence of severe comorbidities ($n = 26$), pending arrival of relatives before giving consent ($n = 30$).

In Tables 1 and 2, data of ACS patients submitted to coronary angiography are reported in relation to the different timing of angiography (<6, 6–24 and >24 h) and delays of angiography (<24, 24–48 and >48 h). No significant difference in baseline characteristics was found in relation to the different timing and delays of angiography, except for a significantly lower percentage of patients with concomitant neoplasia and higher values of TnI at admission in the subgroup of those submitted to angiography earlier than 6 h from admission in the CSDU (Table 1), and for significantly higher values of TnI both at admission and at the peak in patients treated with a shorter delay from symptom onset (Table 2).

Tables 3 and 4 show angiographic and procedural data of patients submitted to coronary angiography, and treated with PCI according to the timing and delay of angiography.

No significant difference in angiographic and procedural variables was found in relation to the different timing and delays of angiography, except for a significantly higher percentage of patients in whom a complete revascularization was performed with a delay of angiography <24 h; moreover, in this group of patients, the culprit lesion was less frequently determined by a restenosis with respect to patients submitted to angiography later than 24 h from symptom onset (Table 4).

Moreover, no significant difference was observed in the pharmacological treatment in relation to the different timing and delays of angiography (data not shown).

The median follow-up length was 13.1 months (25th–75th percentile 8.4–21.0 months).

The in-hospital mortality as well as the mortality and the cardiac ischemic events at follow-up are summarized in Fig. 1.

No significant difference was observed in mortality during follow-up (Log Rank chi square 0.682; $P = 0.409$; Kaplan–Meier analysis adjusted for age and gender) (Fig. 2, Panel A) as well as in the incidence of angina and non-fatal myocardial infarction at follow-up (23.0 vs. 26.3%; $P = 0.545$) between patients submitted to angiography < or >24 h from admission in the CSDU (timing of angiography). Even when an earlier treatment (<6 h) was compared with a delayed one (>24 h), at logistic regression analysis, the timing of angiography was not a predictor of mortality (OR 1.69; 95% CI 0.54–5.23; $P = 0.365$). Similarly, at univariate analysis, the timing of angiography did not predict ischemic relapse at follow-up (OR 1.06; 95% CI 0.65–1.73; $P = 0.824$).

Similarly, no significant difference in ACS patients mortality was seen in relation to a delay of angiography < or > 24 h either in the acute phase (2.1 vs. 1.4%, respectively) or during follow-up (Log Rank chi square 0.584; $P = 0.445$; Kaplan–Meier analysis adjusted for age and gender) (Fig. 2, Panel B). Moreover, no significant difference was observed in the incidence of angina and myocardial infarction at follow-up among the two groups of patients (25.7 and 29.8% for patients treated with a delay of angiography < or > than 24 h, respectively).

Recurrence of cardiac ischemic events (angina or non-fatal myocardial infarction) at follow-up were significantly more frequent in patients with a previous PCI.

As far as the relationship between overall mortality and TnI is concerned, a positive trend between higher TnI levels at admission and an increased mortality was observed; moreover, increased mortality was also observed between patients with TnI at the peak >5.00 ng/mL versus those with normal values ($P < 0.05$).

Moreover, considering the relationship between other biohumoral data and mortality, serum creatinine and glucose values at admission were significantly higher in patients who died than in survivors [1.4 (95% CI 1.1–1.8) vs. 1.0 (95% CI 0.9–1.2) mg/dl; $P < 0.001$ and 1.21 (95% CI 1.00–1.62) vs. 1.04 (95% CI 0.91–1.27) g/dl; $P = 0.001$, respectively)]. Creatinine levels at discharge were significantly higher in dead patients than in survivors [1.3 mg/dl (95% CI 1.0–2.1) vs. 1.0 mg/dl (95% CI 0.9–1.2); ($P < 0.001$)]. Hemoglobin values were significantly

Table 1 Clinical and biohumoral characteristics of patients investigated in relation to timing of angiography

	<6 h (n = 352; 68.1%)	6–24 h (n = 45; 8.7%)	>24 h (n = 120; 23.2%)	P value (χ^2 or KW)
Age [years; median (IR)]	73 (63–78)	72 (64–78)	72 (63–78)	0.935
Males [% (95% CI)]	70.7 (66.0–75.5)	68.9 (55.4–82.4)	73.3 (65.4–81.2)	0.811
Body weight [kg; median (IR)]	74 (65–80)	75 (68–80)	75 (68–81)	0.971
Hypertension [% (95% CI)]	69.6 (64.8–74.4)	73.3 (60.4–86.3)	73.3 (65.4–81.2)	0.685
Diabetes mellitus [% (95% CI)]	28.7 (24.0–33.4)	15.6 (5.0–26.1)	29.2 (21.0–37.3)	0.164
Dyslipidemia [% (95% CI)]	41.2 (36.1–46.3)	44.4 (29.9–59.0)	48.3 (39.4–57.3)	0.388
Family history of CAD [% (95% CI)]	24.4 (19.9–28.9)	28.9 (15.6–42.1)	28.3 (20.3–36.4)	0.615
Smoking habit [% (95% CI)]	34.6 (29.7–39.6)	40.0 (25.7–54.3)	36.7 (28.0–45.3)	0.750
Chronic renal failure [% (95% CI)]	6.3 (3.7–8.8)	8.9 (0.6–17.2)	10.0 (4.6–15.4)	0.364
Neoplasia [% (95% CI)]	4.3 (2.2–6.4)	15.6 (5.0–26.1)*	5.8 (1.6–10.0)	0.008
Previous AMI [% (95% CI)]	33.5 (28.6–38.5)	40.0 (25.7–54.3)	30.0 (21.8–38.2)	0.471
Previous PCI [% (95% CI)]	31.3 (26.4–36.1)	37.8 (23.6–51.9)	43.3 (34.5–52.2)	0.052
TIMI Risk Score 1–2 [% (95% CI)]	4.0 (1.9–6.0)	6.7 (-0.6–14.0)	9.2 (4.0–14.3)	0.088
TIMI Risk Score 3–7 [% (95% CI)]	96.0 (94.0–98.1)	93.3 (86.0–100.6)	90.8 (85.7–96.0)	
Multivessel disease [% (95% CI)]	78.1 (73.8–82.4)	77.8 (65.6–89.9)	72.5 (64.5–80.5)	0.446
Admission LVEF [%;median (IR)]	55 (47–60)	53 (45–60)	55 (45–60)	0.891
Discharge LVEF [%;median (IR)]	55 (48–60)	53 (45–60)	55 (45–60)	0.761
Admission TnI [ng/ml; median (IR)]	0.12 (0.02 -1.33)†	0.14 (0.02–3.04)	0.04 (0.01–0.27)†	0.012
Peak TnI [ng/ml; median (IR)]	0.91 (0.17–6.32)	0.79 (0.14–5.18)	0.44 (0.10–1.92)	0.055
Admission creatinine [g/dl; median (IR)]	1.00 (0.90–1.20)	1.10 (0.90–1.25)	1.10 (0.90–1.30)	0.113
Discharge creatinine [g/dl; median (IR)]	1.00 (0.90–1.20)	1.00 (0.90–1.15)	1.00 (0.90–1.00)	0.796
Admission Hb [g/dl; median (IR)]	13.4 (11.9–14.4)§	12.7 (11.0–13.7)§	13.2 (12.0–14.2)	0.092
Discharge Hb [g/dl; median (IR)]	12.3 (11.0–13.4)	12.2 (10.7–13.1)	12.1 (11.0–13.1)	0.402
Admission glycemia [mg/dl; median (IR)]	104 (90–123)	110 (92–139)	106 (92–133)	0.273
Peak glycemia [mg/dl; median (IR)]	129 (110–166)	128 (108–160)	133 (109–165)	0.697
Discharge glycemia [mg/dl; median (IR)]	102 (92–130)	102 (91–124)	103 (91–124)	0.610

KW Kruskal–Wallis, *IR* interquartile range, *AMI* acute myocardial infarction, *PCI* percutaneous coronary intervention, *LVEF* left ventricle ejection fraction, *Tn* troponin, *Hb* hemoglobin

* Z-score 2.82, $P < 0.01$ versus timing <6 and >24 h

§ $P < 0.05$ timing <6 versus 6–24 h

† $P < 0.05$ timing <6 versus >24 h

lower in patients who die than in survivors both on admission and at discharge (11.8 vs. 13.1 g/dl; $P = 0.023$ and 11.0 vs. 12.2 g/dl; $P = 0.013$, respectively).

At univariate analysis, the following variables were unadjusted predictors of mortality and cardiac ischemic events at follow-up: length of CSDU stay (1 day increase), TIMI Risk Score (1 unit increase), diabetes mellitus, discharge creatinine (1 mg/dl increase), admission anemia, complete versus partial revascularization (Fig. 3). Moreover, a lower admission left ventricular ejection fraction (LVEF) was associated with mortality at follow-up, and a previous PCI and increased peak TnI were associated with cardiac ischemic events at follow-up. Both the timing of angiography (>24 vs. <24 h), and the delay of angiography (>24 vs. <24 h) were not significantly associated with either mortality or cardiac ischemic events at follow-up (Fig. 3).

At multivariate analysis, 12 variables, whose association with cardiac ischemic events at follow-up was clinically relevant or statistically significant, were found on two backward stepwise Cox regression analyses: in this model, the timing and delay of angiography were forced as covariates. The length of CSDU stay (1 day increase; HR 1.19, 95% CI 1.10–1.29, $P < 0.001$), the creatinine level at discharge (1 mg/dl increase; HR 1.61, 95% CI 1.02–2.55, $P = 0.043$), and a previous PCI (HR 1.91, 95% CI 1.32–2.75, $P < 0.001$) were independent predictors of cardiac ischemic events at follow-up when adjusted for the timing of angiography (>24 vs. <24 h; HR 0.74, 95% CI 0.41–1.22, $P = 0.259$). Similarly, length of CSDU stay (1 day increase; HR 1.19, 95% CI 1.10–1.29, $P < 0.001$), creatinine level at discharge (1 mg/dl increase; HR 1.77, 95% CI 1.07–2.92, $P = 0.026$), and a previous PCI (HR 1.95, 95% CI 1.34–2.82, $P < 0.001$) were also independent

Table 2 Clinical and biohumoral characteristics of patients investigated in relation to delay of angiography

	<24 h (n = 167; 34.3%)	24–48 h (n = 66; 13.6%)	>48 h (n = 254; 52.2%)	P value (χ^2 or KW)
Age [years; median (IR)]	70 (60–78)	72 (62–78)	73 (65–78)	0.242
Males [% (95% CI)]	72.5 (65.7–79.2)	66.7 (55.3–78.0)	72.4 (66.9–77.9)	0.625
Body weight [kg; median (IR)]	75 (67–82)	75 (65–80)	73 (67–81)	0.584
Hypertension [% (95% CI)]	71.9 (65.0–78.0)	69.7 (58.6–80.8)	70.1 (64.4–75.7)	0.911
Diabetes mellitus [% (95% CI)]	26.9 (20.2–36.7)	25.8 (15.2–36.6)	28.3 (22.8–33.9)	0.897
Dyslipidemia [% (95% CI)]	39.5 (32.1–46.9)	45.5 (33.4–57.5)	44.1 (38.0–50.2)	0.578
Family history of CAD [% (95% CI)]	28.1 (21.3–35.0)	24.2 (13.9–34.6)	24.4 (19.1–29.7)	0.664
Smoking habit [% (95% CI)]	35.3 (28.1–42.6)	30.3 (19.2–41.4)	37.8 (31.8–43.8)	0.517
Chronic renal failure [% (95% CI)]	7.8 (3.7–11.8)	3.0 (-1.1–7.2)	7.9 (4.6–11.2)	0.372
Neoplasia [% (95% CI)]	7.2 (3.3–11.1)	4.5 (-0.5–9.6)	3.1 (1.0–5.3)	0.161
Previous AMI [% (95% CI)]	29.9 (23.0–36.9)	30.3 (19.2–41.4)	35.4 (29.6–41.3)	0.449
Previous PCI [% (95% CI)]	31.7 (24.7–38.8)	47.0 (34.9–59.0)	33.9 (28.0–39.7)	0.079
TIMI Risk Score 1–2 [% (95% CI)]	3.6 (0.8–6.4)	4.5 (-0.5–9.6)	7.1 (3.9–10.2)	0.287
TIMI Risk Score 3–7 [% (95% CI)]	96.4 (93.6–99.2)	95.5 (90.4–100.5)	92.9 (89.8–96.1)	
Multivessel disease [% (95% CI)]	73.1 (66.3–79.8)	74.2 (63.7–84.8)	80.3 (75.4–85.2)	0.189
Admission LVEF [%;median (IR)]	55 (46–60)	55 (42–60)	55 (47–60)	0.716
Discharge LVEF [%;median (IR)]	55 (48–60)	55 (44–60)	55 (50–60)	0.797
Admission TnI [ng/ml; median (IR)]	0.37 (0.03–3.76)[§]	0.22 (0.03–1.83)[†]	0.05 (0.01–0.26)[§, †]	<0.001
Peak TnI [ng/ml; median (IR)]	1.30 (0.20–9.31)[§]	1.25 (0.26–5.66)[†]	0.44 (0.12–2.26)[§, †]	<0.001
Admission creatinine [g/dl; median (IR)]	1.00 (0.90–1.20)	1.00 (0.90–1.20)	1.00 (0.90–1.30)	0.898
Discharge creatinine [g/dl; median (IR)]	1.00 (0.90–1.20)	1.00 (0.90–1.15)	1.00 (0.90–1.20)	0.990
Admission Hb [g/dl; median (IR)]	13.4 (12.0–14.4)[§]	13.0 (11.9–14.4)§	13.3 (11.8–14.3)	0.786
Discharge Hb [g/dl; median (IR)]	12.3 (11.2–13.2)	11.8 (11.2–13.3)	12.3 (11.0–13.4)	0.705
Admission glycemia [mg/dl; median (IR)]	108 (93–126)	103 (89–126)	103 (90–126)	0.309
Peak glycemia [mg/dl; median (IR)]	130 (111–162)	128 (108–174)	132 (110–166)	0.984
Discharge glycemia [mg/dl; median (IR)]	104 (93–127)	100 (93–133)	102 (91–125)	0.875

KW Kruskal–Wallis, *IR* interquartile range, *AMI* acute myocardial infarction, *PCI* percutaneous coronary intervention, *LVEF* left ventricle ejection fraction, *Tn* troponin, *Hb* hemoglobin

[§] $P < 0.05$ delay <24 versus >48 h

[†] $P < 0.05$ delay 24–48 versus >48 h

predictors of cardiac ischemic events at follow-up when adjusted for a delay of angiography (>24 vs. <24 h; HR 1.11, 95% CI 0.74–1.66, $P = 0.630$).

Discussion

The main finding of the present study is that, considering the time to angiography from CSDU admission or the delay from the onset of symptoms, early coronary angiography does not affect either short-term or long-term outcome in these patients. Moreover, several clinical and biohumoral variables, indicative of each patient's risk, as well as the type of revascularization, are associated with both mortality and cardiac ischemic events during follow-up.

Our analysis in ACS patients does not support the need to perform coronary angiography as soon as possible after symptom onset or hospital admission, different from those patients presenting with an ST elevation myocardial infarction. Such finding can be explained, at least in part, by the pathogenesis of non-ST elevation ACS [1, 13–15] being generally due to a partially occlusive thrombus causing distal microembolization or, less frequently, to an occlusive thrombus in the presence of an extensive collateral blood supply. Both conditions allow the maintenance of some degree of myocardial perfusion, thus preventing extensive necrosis. The angiographic findings in our patients confirmed this explanation; in fact, only 8.4% of our patients showed a TIMI flow 0 in the culprit vessel.

Our results are in agreement with the primary end-point of the recently published TIMACS study [16], even though we used a different scoring system for patients' risk stratification, and different time intervals were used to consider an invasive strategy "delayed". The TIMACS study shows,

Table 3 Angiographic and procedural characteristics in relation to timing of angiography

	<6 h (n = 288; 68.7%)	6–24 h (n = 32; 7.6%)	>24 h (n = 99; 23.6%)	P value
Coronary artery disease				0.387
One vessel	20.2 (15.5–24.8)	25.0 (10.0–40.0)	28.3 (19.4–37.2)	
Two vessels	31.9 (26.6–37.3)	28.1 (12.5–43.7)	20.2 (12.3–28.1)	
Three vessels	38.9 (33.3–44.5)	40.6 (23.6–57.6)	41.4 (31.7–51.1)	
Left main	9.0 (5.7–12.3)	6.3 (-2.1–14.6)	10.1 (4.2–16.0)	
Pre-procedural TIMI flow				0.451
III	1.4 (0.0–2.7%)	3.1 (-2.9–9.2)	2.0 (-0.8–4.8)	
II	37.5 (31.9–43.1)	31.2 (15.2–47.3)	38.4 (28.8–48.0)	
I	54.5 (48.8–60.3)	56.3 (39.1–73.4)	46.5 (36.6–56.3)	
0	6.6 (3.7–9.5)	9.4 (-0.7–19.5)	13.1 (6.5–19.8)	
Coronary angioplasty				0.865
1 vessel	60.8 (55.1–66.4)	65.6 (49.2–82.1)	57.6 (47.8–67.3)	
2 vessels	24.7 (19.7–29.6)	28.1 (12.5–43.7)	30.3 (21.3–39.4)	
>2 vessels	14.5 (10.5–18.7)	6.3 (-2.1–14.6)	12.1 (5.7–18.6)	
Culprit vessel				0.212
LAD culprit	48.6 (42.8–54.4)	46.9 (29.6–64.2)	44.4 (34.7–54.2)	
Circumflex artery culprit	21.3 (16.5–25.9)	28.1 (12.5–43.7)	17.2 (9.7–24.6)	
RCA culprit	19.7 (15.2–24.4)	18.8 (5.2–32.3)	27.3 (18.5–36.0)	
Graft culprit	3.1 (1.1–5.1)	3.1 (-2.9–9.2)	8.1 (2.7–13.4)	
Left main culprit	7.3 (4.3–10.3)	3.1 (-2.9–9.2)	3.0 (-0.3–6.4)	
Restenosis	18.1 (13.6–22.5)	12.5 (1.0–24.0)	20.2 (12.3–28.1)	0.202
De novo lesions	79.5 (74.9–84.2)	81.3 (67.7–94.8)	72.7 (64.0–81.5)	
Undetermined	2.4 (0.7–4.2)	6.3 (-2.1–14.6)	7.1 (2.0–12.1)	
Treated vessels (n)	452	45	154	N/A
Complete revascularization	22.6 (17.7–27.4)	40.6 (23.6–57.6)	27.3 (18.5–36.0)	0.069
Vessels treated with:				0.475
BMS	21.9 (17.1–26.6)	12.5 (1.0–24.0)	17.2 (9.7–24.6)	
DES	67.0 (61.6–71.4%)	78.1 (63.8–92.4)	67.6 (58.5–76.9)	
Balloon	11.1 (7.5–14.7)	9.4 (-0.7–19.5)	15.2 (8.1–22.2)	
Both BMS and DES	5.9 (3.2–8.6%)	3.1 (-2.9–9.2)	5.1 (0.7–9.4)	0.788
Post-procedural TIMI flow				N/A
III	96.9 (94.9–98.9)	96.9 (90.8–102.9)	100 (100.0–100.0)	
II	0.7 (-0.3–1.7)	0	0	
I	0	0	0	
0	2.4 (0.7–4.2)	3.1 (-2.9–9.2)	0	
PCI failure	3.1 (1.1–5.1)	3.1 (-2.9–9.2)	0	0.205

Values reported are percentages and 95% confidence intervals when not otherwise specified

N/A not applicable, *TIMI* Thrombolysis in myocardial infarction, *LAD* left anterior descending, *RCA* right coronary artery, *BMS* bare metal stent, *DES* drug eluting stent

in patients treated with an early invasive strategy, a lower rate of refractory ischemia, an end-point not considered in our study.

Moreover, the results of our study also are in accord with those of a recent metanalysis in which no significant difference in mortality and occurrence of myocardial infarction was observed between ACS patients treated with a delayed versus an early invasive approach [17].

However, our findings do not agree with those reported by Tricoci et al. who found, in a larger number of patients, a decreased risk in the combined end-point mortality or myocardial infarction at 1-month follow-up in patients treated with an early invasive strategy [9]. Our results are also different from those reported by the ISAR-COOL investigators who found that a "very early" invasive strategy was associated with a significantly better outcome

Table 4 Angiographic and procedural characteristics in relation to delay of angiography

	<24 h (n = 130; 31.5%)	24–48 h (n = 56; 13.6%)	>48 h (n = 227; 54.9%)	P value
Coronary artery disease				0.476
One vessel	27.7 (20.0–35.4)	23.2 (12.2–34.3)	19.4 (14.2–24.5)	
Two vessels	27.7 (20.0–35.4)	25.0 (13.7–36.3)	30.8 (24.8–36.8)	
Three vessels	38.5 (30.1–46.8)	42.9 (29.9–55.8)	38.8 (32.4–45.1)	
Left main	6.1 (2.0–10.3)	8.9 (1.5–16.4)	11.0 (6.9–15.1)	
Pre-procedural TIMI flow				0.460
III	1.5 (-0.6–3.7)	1.8 (-1.7–5.3)	1.8 (0.1–3.5)	
II	34.6 (26.4–42.8)	32.2 (19.9–44.4)	40.1 (33.7–46.5)	
I	58.5 (50.0–66.9)	58.9 (46.0–71.8)	48.0 (41.5–54.5)	
0	5.4 (1.5–9.3)	7.1 (0.4–13.9)	10.1 (6.2–14.1)	
Coronary angioplasty				0.252
1 vessel	66.9 (58.8–75.0)	57.1 (44.2–70.1)	56.8 (50.4–63.3)	
2 vessels	24.6 (17.2–32.0)	26.8 (15.2–38.4)	27.3 (21.5–33.1)	
>2 vessels	8.5 (3.7–13.2)	16.1 (6.5–25.7)	15.9 (11.1–20.6)	
Culprit vessel				0.070
LAD culprit	49.2 (40.6–57.8)	48.3 (35.1–61.3)	46.3 (39.8–52.7)	
Circumflex artery culprit	23.9 (16.5–31.2)	26.8 (15.2–38.4)	15.0 (10.3–19.6)	
RCA culprit	20.0 (13.1–26.9)	10.7 (2.6–18.8)	27.3 (21.5–33.1)	
Graft culprit	2.3 (-0.3–4.9)	7.1 (0.4–13.9)	4.8 (2.1–7.6)	
Left main culprit	4.6 (1.0–8.2)	7.1 (0.4–13.9)	6.6 (3.4–9.8)	
Restenosis	13.8 (7.9–19.8)	16.1 (6.5–25.7)	21.6 (16.2–26.9)	0.007
De novo lesions	83.1 (76.6–89.5)	73.2 (61.6–84.8)	76.7 (71.1–82.2)	
Undetermined	2.4 (1.5–9.3)	6.3 (-1.3–8.4)	7.1 (0.8–5.3)	
Treated vessels (n)	184	92	368	N/A
Complete revascularization	33.1 (25.0–41.2)	25.0 (13.7–36.3)	21.1 (15.8–26.5)	0.045
Vessels treated with:				0.152
BMS	15.4 (9.2–21.6)	12.5 (3.8–21.2)	15.0 (10.3–19.6)	
DES	78.4 (71.4–85.5)	76.8 (65.7–87.8)	70.0 (64.1–76.0)	
Balloon	6.2 (54.8–71.4)	10.7 (2.6–18.8)	15.0 (10.3–19.6)	
Both BMS and DES	5.4 (1.5–9.3)	10.7 (2.6–18.8)	4.4 (1.7–7.1)	0.182
Post-procedural TIMI flow				N/A
III	98.5 (96.3–100.6)	94.6 (88.7–100.5)	98.2 (96.5–99.9)	
II	0	0	0.9 (-0.3–2.1)	
I	0	0	0	
0	1.5 (-0.6–3.7)	5.4 (-0.5–11.3)	0.9 (-0.3–2.1)	
PCI failure	1.5 (-0.6–3.7)	5.4 (-0.5–11.3)	1.8 (0.1–3.5)	0.213

Values reported are percentages and 95% confidence intervals when not otherwise specified

N/A not applicable, *TIMI* Thrombolysis in myocardial infarction, *LAD* left anterior descending, *RCA* right coronary artery, *BMS* bare metal stent, *DES* drug eluting stent

at 30 days [18]. The different end-points considered in our study (mortality and ischemic events at long term follow-up) may explain, at least in part, these different results.

The supposed advantages of very early angiography and intervention are (1) a faster identification of the culprit lesion that allows a rapid resolution of ischemia with revascularization [19, 20]; (2) for patients suitable for PCI, an early intervention may be less frequently associated with a more organized intracoronary thrombus, that results in a higher incidence of distal microembolization [8] or coronary dissection.

On the other hand, the supposed advantages of angiography deferred more than 24 h from hospital admission are (1) a better assessment of patients' general clinical status and comorbidities; (2) a more appropriate pre-interventional medical management able to reduce the thrombotic burden, distal microembolization, and renal complications.

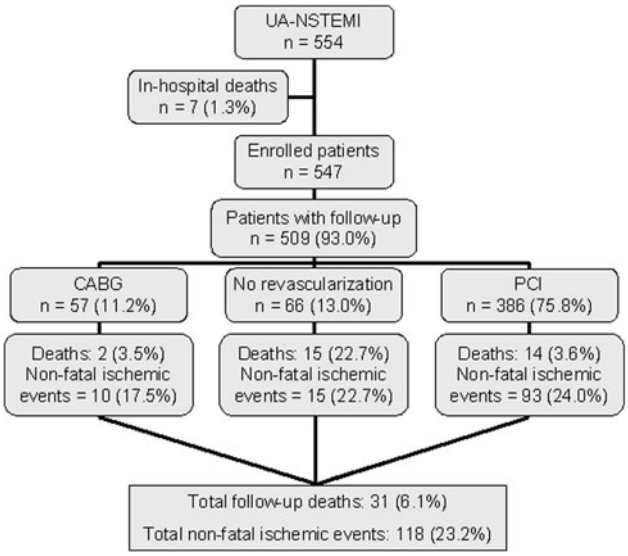

Fig. 1 Follow-up data of study population. *UA* unstable angina, *NSTEMI* Non-ST-elevation myocardial infarction, *CABG* coronary artery bypass graft, *PCI* percutaneous coronary intervention

Our analysis of ACS patients treated with an early invasive strategy confirms that the relationship between TnI levels and outcome is maintained even in patients undergoing early revascularization [1, 21–27], in agreement with FRISC II and GUSTO IV trials [3, 28]. However, in our population, TnI levels were not independently associated with mortality and cardiac ischemic events at long-term follow-up.

Our data confirm also the negative influence on ACS patients' outcome of high serum creatinine [29–32], glucose levels [33–36] and low hemoglobin concentration at admission [37–39], suggesting that an accurate assessment of comorbidities is very important for ACS patients' care, especially when an early invasive strategy is preferred.

The results of our study suggest that complete revascularization is beneficial on long-term outcome, which is at variance with previous reports [40, 41].

Moreover, in our study, a higher TIMI risk score and a longer hospital stay are associated with a worse outcome. A longer hospitalization is generally due to patients' comorbidities or post-procedural complications, and can be considered an indirect index of clinical complexity.

Our study has some limitations. First, it is an observational, single-center real-world study, and, although it faithfully reflects our daily practice, a larger number of patients should have been enrolled to detect a significant difference in mortality and cardiac ischemic events with a higher statistical power. Second, our patients were not randomized to two different times of angiography, even though no significant difference in clinical, biohumoral and angiographic characteristics were observed in the subgroups of patients according to different timing and delays of angiography.

In conclusion, even though our study shows an adherence of our Institution to an early invasive strategy as suggested by Guidelines, it does not support the concept that in ACS patients angiography should be performed as soon as possible after symptom onset or hospital admission. In fact, in our study a longer time to angiography does not produce a higher mortality or an increased incidence of cardiac ischemic events during follow-up. Instead, an unfavorable long-term outcome is influenced by the clinical complexity of patients, indirectly expressed by a higher

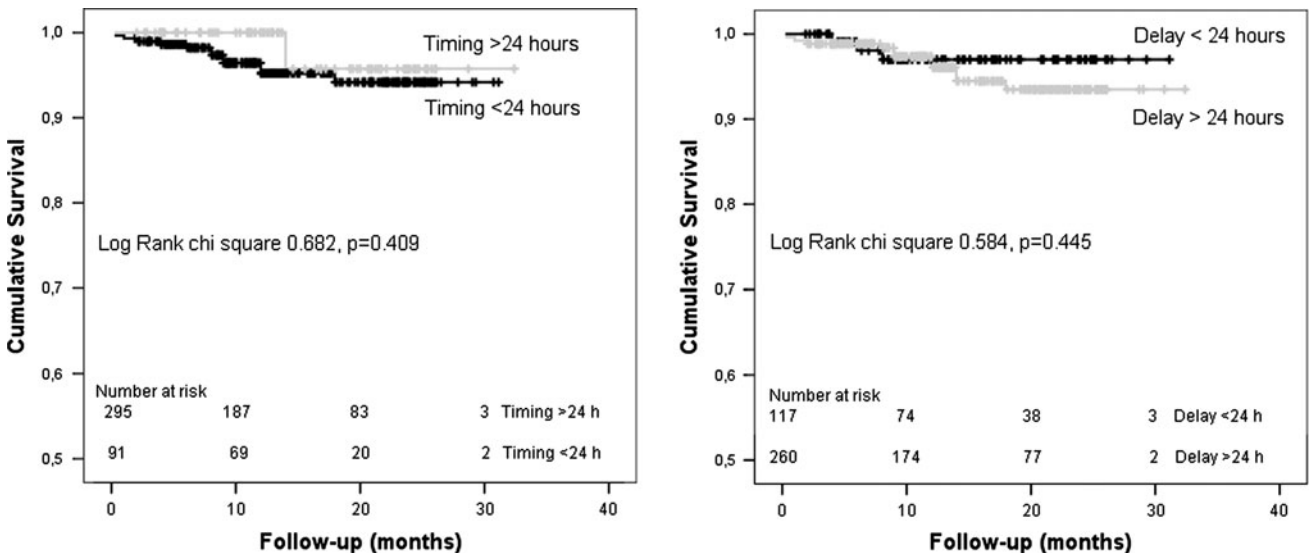

Fig. 2 Kaplan–Meier survival curves in relation to timing and delay of angiography (> vs. <24 h)

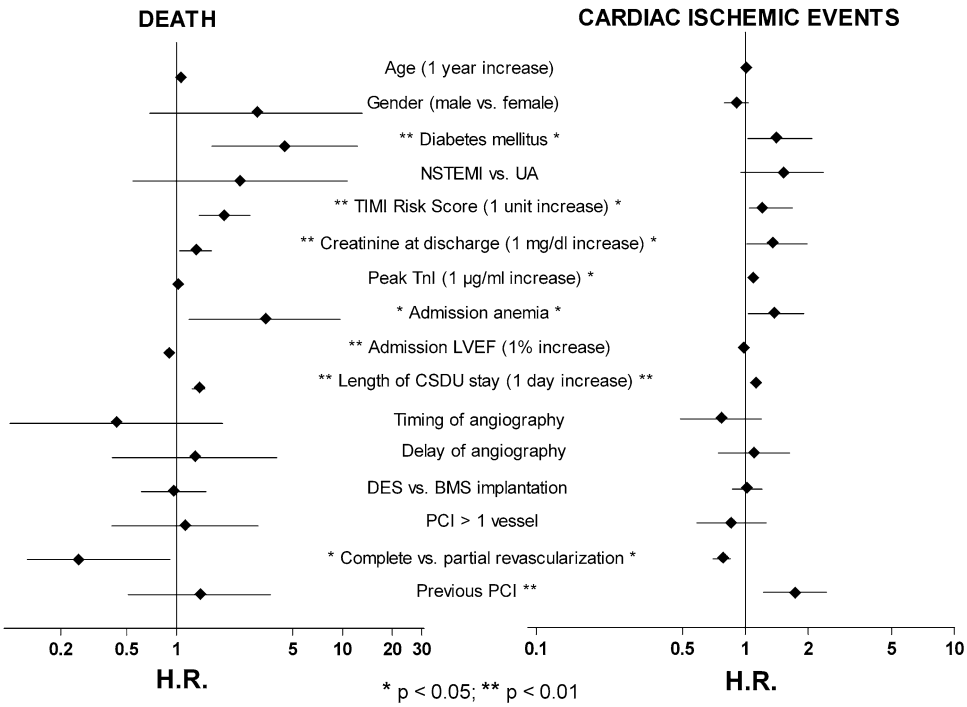

Fig. 3 Unadjusted hazard ratios and 95% CI's for death and cardiac ischemic events at follow-up. *NSTEMI* Non-ST-elevation myocardial infarction, *UA* unstable angina, *TIMI* thrombolysis in myocardial infarction, *TnI* troponin I, *LVEF* left ventricular ejection fraction, *CSDU* Cardiac step down unit, *DES* drug eluting stent, *BMS* bare metal stent, *PCI* percutaneous coronary intervention

TIMI risk score, a longer hospital stay, high serum creatinine concentrations, low hemoglobin levels, left ventricular dysfunction, diabetes mellitus, or a positive history for a previous PCI.

Conflict of interest None.

References

1. Anderson JL, Adams CD, Antman EM, Bridges CR, Califf RM, Casey DE Jr., Chavey WE II, Fesmire FM, Hochman JS, Levin TN, Lincoff AM, Peterson ED, Theroux P, Wenger NK, Wright RS, Smith SC Jr., Jacobs AK, Adams CD, Anderson JL, Antman EM, Halperin JL, Hunt SA, Krumholz HM, Kushner FG, Lytle BW, Nishimura R, Ornato JP, Page RL, Riegel B; American College of Cardiology; American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction); American College of Emergency Physicians; Society for Cardiovascular Angiography and Interventions; Society of Thoracic Surgeons; American Association of Cardiovascular and Pulmonary Rehabilitation; Society for Academic Emergency Medicine (2007) ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-Elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines for the Management of Patients With Unstable Angina/Non-ST-Elevation Myocardial Infarction) developed in collaboration with the American College of Emergency Physicians, the Society for Cardiovascular Angiography and Interventions, and the Society of Thoracic Surgeons endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation and the Society for Academic Emergency Medicine. J Am Coll Cardiol 50:e1–e157
2. Task Force Members, Bassand J-P, Hamm CW, Ardissino D, Boersma E, Budaj A, Fernández-Avilés F, Fox KAA, Hasdai D, Magnus Ohman E, Wallentin L, Wijns W, ESC Committee for Practice Guidelines (CPG), Vahanian A, Camm J, De Caterina R, Dean V, Dickstein K, Filippatos G, DalbyKristensen S, Widimsky P, McGregor K, Sechtem U, Tendera M, Hellemans I, Gomez JLZ, Silber S, Funck-Brentano C, Document Reviewers, DalbyKristensen S, Andreotti F, Benzer W, Bertrand M, Betriu A, De Caterina R, DeSutter J, Falk V, Ortiz AF, Gitt A, Hasin Y, Huber K, Kornowski R, Lopez-Sendon J, Morais J, Erik Nordrehaug J, Silber S, Steg PG, Thygesen K, Tubaro M, Turpie AGG, Verheugt F, Windecker S (2007) Guidelines for the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes: The task force for the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes of the European Society of Cardiology. Eur Heart J 28:1598–1660
3. Lagerqvist B, Husted S, Kontny F, Ståhle E, Swahn E, Wallentin L (2006) Fast Revascularisation during InStability in Coronary artery disease (FRISC-II) Investigators. 5-year outcomes in the FRISC-II randomised trial of an invasive versus a non-invasive strategy in non-ST-elevation acute coronary syndrome: a follow-up study. Lancet 368:998–1004
4. Fox K, Poole-Wilson P, Clayton T, Henderson R, Shaw T, Wheatley D, Knight R, Pocock S (2005) 5-year outcome of an interventional strategy in non-ST-elevation acute coronary syndrome: the British Heart Foundation RITA 3 randomised trial. Lancet 366:914–920
5. Cannon CP, Weintraub WS, Demopoulos LA, Vicari R, Frey MJ, Lakkis N, Neumann FJ, Robertson DH, DeLucca PT, DiBattiste PM, Gibson CM, Braunwald E (2001) TACTICS (Treat Angina with Aggrastat, Determine Cost of Therapy with an Invasive or Conservative Strategy)—thrombolysis in myocardial infarction 18 investigators comparison of early invasive and conservative strategies in patients with unstable coronary syndromes treated with the glycoprotein IIb/IIIa inhibitor tirofiban. N Engl J Med 344:1879–1887
6. Spacek R, Widimský P, Straka Z, Jiresová E, Dvorák J, Polásek R, Karel I, Jirmár R, Lisa L, Budesínský T, Málek F, Stanka P

(2002) Value of first day angiography/angioplasty in evolving Non-ST segment elevation myocardial infarction: an open multicenter randomized trial. The VINO Study. Eur Heart J 23:230–238
7. Mehta SR, Cannon CP, Fox KA, Wallentin L, Boden WE, Spacek R, Widimsky P, McCullough PA, Hunt D, Braunwald E, Yusuf S (2005) Routine vs selective invasive strategies in patients with acute coronary syndromes: a collaborative meta-analysis of randomized trials. JAMA 293:2908–2917
8. Bavry AA, Kumbhani DJ, Bhatt DL, Rassi AN, Askari AT (2006) Benefit of early invasive therapy in acute coronary syndromes. A meta-analysis of contemporary randomized clinical trials. J Am Coll Cardiol 48:1319–1325
9. Tricoci P, Lokhnygina Y, Berdan LG, Steinhubl SR, Gulba DC, White HD, Kleiman NS, Aylward PE, Langer A, Califf RM, Ferguson JJ, Antman EM, Newby LK, Harrington RA, Goodman SG, Mahaffey KW (2007) Time to coronary angiography and outcomes among patients with high-risk non ST-segment elevation acute coronary syndromes: results from the SYNERGY trial. Circulation 116:2669–2677
10. Morrow DA, Antman EM, Charlesworth A, Cairns R, Murphy SA, de Lemos JA, Giugliano RP, McCabe CH, Braunwald E (2000) TIMI risk score for ST-elevation myocardial infarction: a convenient, bedside, clinical score for risk assessment at presentation: an intravenous nPA for treatment of infarcting myocardium early II trial substudy. Circulation 102:2031–2037
11. Thygesen K, Alpert JS, White HD; Joint ESC/ACCF/AHA/WHF Task Force for the Redefinition of Myocardial Infarction, Jaffe AS, Apple FS, Galvani M, Katus HA, Newby LK, Ravkilde J, Chaitman B, Clemmensen PM, Dellborg M, Hod H, Porela P, Underwood R, Bax JJ, Beller GA, Bonow R, Van der Wall EE, Bassand JP, Wijns W, Ferguson TB, Steg PG, Uretsky BF, Williams DO, Armstrong PW, Antman EM, Fox KA, Hamm CW, Ohman EM, Simoons ML, Poole-Wilson PA, Gurfinkel EP, Lopez-Sendon JL, Pais P, Mendis S, Zhu JR, Wallentin LC, Fernández-Avilés F, Fox KM, Parkhomenko AN, Priori SG, Tendera M, Voipio-Pulkki LM, Vahanian A, Camm AJ, De Caterina R, Dean V, Dickstein K, Filippatos G, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL, Morais J, Brener S, Harrington R, Morrow D, Lim M, Martinez-Rios MA, Steinhubl S, Levine GN, Gibler WB, Goff D, Tubaro M, Dudek D, Al-Attar N; Joint ESC/ACCF/AHA/WHF Task Force for the Redefinition of Myocardial Infarction (2007)Universal definition of myocardial infarction. Circulation 116:2634–2653
12. Nieto FJ, Coresh J (1996) Adjusting survival curves for confounders: a review and a new method. Am J Epidemiol 143:1058–1068
13. DeWood MA, Stifter WF, Simpson CS, Spores J, Eugster GS, Judge TP, Hinnen ML (1986) Coronary arteriographic findings soon after non-Q-wave myocardial infarction. N Engl J Med 315:417–423
14. Braunwald E (1998) Unstable angina: an etiologic approach to management. Circulation 98:2219–2222
15. Prasad A, Mathew V, Holmes DRJr, Gersh BJ (2003) Current management of non-ST-segment-elevation acute coronary syndrome: reconciling the results of randomized controlled trials. Eur Heart J 24:1544–1553
16. Mehta SR, Granger CB, Boden WE, Steg PG, Bassand JP, Faxon DP, Afzal R, Chrolavicius S, Jolly SS, Widimsky P, Avezum A, Rupprecht HJ, Zhu J, Col J, Natarajan MK, Horsman C, Fox KA, Yusuf S, TIMACS Investigators (2009) Early versus delayed invasive intervention in acute coronary syndromes. N Engl J Med 360:2165–2175
17. Katritsis DG, Siontis GC, Kastrati A, van't Hof AW, Neumann FJ, Siontis KC, Ioannidis JP (2011) Optimal timing of coronary angiography and potential intervention in non-ST- elevation acute coronary syndromes. Eur Heart J 32:32–40
18. Neumann FJ, Kastrati A, Pogatsa-Murray G, Mehilli J, Bollwein H, Bestehorn HP, Schmitt C, Seyfarth M, Dirschinger J, Schömig A (2003) Evaluation of prolonged antithrombotic pretreatment ("cooling-off" strategy) before intervention in patients with unstable coronary syndromes: a randomized controlled trial. JAMA 290:1593–1599
19. Luchi RJ, Scott SM, Deupree RH (1987) Comparison of medical and surgical treatment for unstable angina pectoris. Results of a Veterans Administration Cooperative Study. N Engl J 316:977–984
20. Takaro T, Hultgren HN, Lipton MJ, Detre KM (1976)The VA cooperative randomized study of surgery for coronary arterial occlusive disease II. Subgroup with significant left main lesions. Circulation 54(6 Suppl):III107–III117
21. Antman EM, Transijevic MJ, Thompson B, Schactman M, McCabe CH, Cannon CP, Fisher GA, Fung AY, Thompson C, Wybega D, Braunwald E (1996) Cardiac-specific troponin I levels to predict the risk of mortality in patients with acute coronary syndromes. N Engl J Med 335:1342–1349
22. Henrikson CA, Howell EE, Bush DE, Miles JS, Meininger GR, Friedlander T, Bushnell AC, Chandra-Strobos N (2004) Prognostic usefulness of marginal troponin T elevation. Am J Cardiol 93:275–279
23. Nageh T, Sherwood R, Harris BM, Byrne JAQ, Thomas MR (2003) Cardiac troponin T and I and creatine kinase-MB as markers of myocardial injury and predictors of outcome following percutaneous coronary intervention. Int J Cardiol 92:285–293
24. Bertnchant JP, Polge A, Ledermamnn B, Genet L, Fabbro-Peray P, Raczka F, Brunet J, Poirey S, Wittenberg O, Pernel I, Nigond J (1999) Relation of minor cardiac Troponin I elevation to late cardiac events after uncomplicated elective successful percutaneous transluminal coronary angioplasty for angina pectoris. Am J Cardiol 84:51–57
25. Riccirdi MJ, Davidson CJ, Gubernikoff G, Beohar N, Eckman LJ, Parker MA, Bonow RO (2003) Troponin I elevation and cardiac events after percutaneous coronary intervention. Am Heart J 145:522–528
26. Bolognese L, Falsini G, Liistro F, Angioli P (2005) Myocardial damage during percutaneous interventions for non-ST-elevation acute coronary syndromes. Eur Heart J 7(Suppl. K):K15–K18
27. Bolognese L, Ducci K, Angioli P, Falsini G, Liistro F, Baldassarre S, Burali A (2004) Elevations in Troponin I after percutaneous coronary interventions are associated with abnormal tissue-level perfusion in high risk patients with non-ST segment elevation acute coronary syndromes. Circulation 110:1592–1597
28. Simoons ML, GUSTO IV-ACS Investigators (2001) Effect of glycoprotein IIb/IIIa receptor blocker abciximab on outcome in patients with acute coronary syndromes without early coronary revascularisation: the GUSTO IV-ACS randomised trial. Lancet 357:1915–1924
29. Brosius FC 3rd, Hostetter TH, Kelepouris E, Mitsnefes MM, Moe SM, Moore MA, Pennathur S, Smith GL, Wilson PW; American Heart Association Kidney and Cardiovascular Disease Council; Council on High Blood Pressure Research; Council on Cardiovascular Disease in the Young; Council on Epidemiology and Prevention; Quality of Care and Outcomes Research Interdisciplinary Working Group (2006) Detection of chronic kidney disease in patients with or at increased risk of cardiovascular disease: a science advisory from the American Heart Association Kidney And Cardiovascular Disease Council; the Councils on High Blood Pressure Research, Cardiovascular Disease in the Young, and Epidemiology and Prevention; and the Quality of Care and Outcomes Research Interdisciplinary Working Group:

developed in collaboration with the National Kidney Foundation. Circulation 114:1083–1087
30. Anavekar NS, McMurray JJ, Velazquez EJ, Solomon SD, Kober L, Rouleau JL, White HD, Nordlander R, Maggioni A, Dickstein K, Zelenkofske S, Leimberger JD, Califf RM, Pfeffer MA (2004) Relation between renal dysfunction and cardiovascular outcomes after myocardial infarction. N Engl J Med 351:1285–1295
31. Eagle KA, Lim MJ, Dabbous OH, Pieper KS, Goldberg RJ, Van de Werf F, Goodman SG, Granger CB, Steg PG, Gore JM, Budaj A, Avezum A, Flather MD, Fox KA, GRACE Investigators (2004) A validated prediction model for all forms of acute coronary syndrome: estimating the risk of 6-month postdischarge death in an international registry. JAMA 291:2727–2733
32. Avezum A, Makdisse M, Spencer F, Gore JM, Fox KA, Montalescot G, Eagle KA, White K, Mehta RH, Knobel E, Collet JP, GRACE Investigators (2005) Impact of age on management and outcome of acute coronary syndrome: observations from the Global Registry of Acute Coronary Events (GRACE). Am Heart J 149:67–73
33. Wilcox I, Freedman SB, Allman KC, Collins FL, Leitch JW, Kelly DT, Harris PJ (1991) Prognostic significance of a predischarge exercise test in risk stratification after unstable angina pectoris. J Am Coll Cardiol 18:677–683
34. Karlson BW, Herlitz J, Pettersson P, Hallgren P, Strömbom U, Hjalmarson A (1993) One-year prognosis in patients hospitalized with a history of unstable angina pectoris. ClinCardiol 16:397–402
35. Fava S, Azzopardi J, Agius-Muscat H (1997) Outcome of unstable angina in patients with diabetes mellitus. Diabet Med 14:209–213
36. García-Rubira JC, Cruz JM, López V, Plaza L, Navas JC (1994) Outcome of patients with diabetes and unstable angina. A subgroup analysis in the Spanish Multicentre Trial of trifusal in unstable angina. Grupo de Estudio del Trifusal en la Angina Inestable. Int J Cardiol 46:175–178
37. von Beckerath N, Taubert D, Pogatsa-Murray G, Schomig E, Kastrati A, Schomig A (2005) Absorption, metabolization, and antiplateleteffects of 300-, 600-, and 900-mg loading doses of clopidogrel: results of the ISAR-CHOICE (Intracoronary Stenting and Antithrombotic Regimen: Choose Between 3 High Oral Doses for Immediate Clopidogrel Effect) trial. Circulation 112:2946–2950
38. Lincoff AM, Kleiman NS, Kereiakes DJ, Feit F, Bittl JA, Jackman JD, Sarembock IJ, Cohen DJ, Spriggs D, Ebrahimi R, Keren G, Carr J, Cohen EA, Betriu A, Desmet W, Rutsch W, Wilcox RG, de Feyter PJ, Vahanian A, Topol EJ, REPLACE-2 Investigators (2004) Long-termefficacy of bivalirudin and provisional glycoproteinIIb/IIIablockade vs heparin and plannedglycoproteinIIb/IIIablockadeduringpercutaneouscoronaryrevascularization: REPLACE-2 randomized trial. JAMA 292:696–703
39. White H (2001) Thrombin-specific anticoagulation with bivalirudin versus heparin in patients receiving fibrinolytic therapy for acute myocardial infarction: the HERO-2 randomised trial. Lancet 358:1855–1863
40. Brener SJ, Milford-Beland S, Roe MT, Bhatt DL, Weintraub WS, Brindis RG (2008) Culprit-only or multivessel revascularization in patients with acute coronary syndromes: an American College of Cardiology National Cardiovascular Database Registry report. Am Heart J 155:140–146
41. Shishehbor MH, Lauer MS, Singh IM, Chew DP, Karha J, Brener SJ, Moliterno DJ, Ellis SG, Topol EJ, Bhatt DL (2007) In unstable angina or non-ST segment acute coronary syndrome, should patients with multivessel coronary artery disease undergo multivessel or culprit-only stenting. J Am Coll Cardiol 49:849–854