UNJUSTIFIED VARIATIONS IN PATIENT MANAGEMENT FOR ACUTE MYOCARDIAL INFARCTION IN THE RHÔNE-ALPES REGION OF FRANCE

René Ecochard
Muriel Rabilloud
Cyrille Colin
François Delahaye
Corinne Ducreux
Danielle Cao
Yves Matillon
Guy de Gevigney
On behalf of the PRIMA Group[1]
Hospices Civils de Lyon

Abstract

Objectives: To examine determinants of use of cardiac procedures after acute myocardial infarction and identify variation factors.
Methods: Observational prospective cohort study of 2,519 patients in 48 centers with a two-level logistic-regression analysis.
Results: Elderly patients were less likely to undergo pre- and inhospital thrombolysis (odds ratios, 0.71 and 0.64; 95% CI, 0.62–0.81 and 0.58–0.69, respectively). The elderly, females, and patients with heart failure on admission were less likely to undergo noninvasive tests (0.74, 0.62, and 0.51; 95% CI, 0.67–0.81, 0.46–0.83, and 0.38–0.68, respectively) and coronary angiography (0.38, 0.53, and 0.67; 95% CI, 0.34–0.42, 0.38–0.74, and 0.52–0.86, respectively) but not revascularization. Hospital factors were more difficult to interpret.
Conclusions: Elderly, women, and heart failure patients underwent fewer cardiac procedures than lower-risk patients. Physicians should change their attitude toward these groups and use advanced procedures, bearing in mind the patients' needs rather than good procedural outcomes.

Keywords: Myocardial infarction, Coronary angiography, Factor analysis, Medical practice

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Physicians routinely make the difficult choice about which patients with acute myocardial infarction (AMI) should undergo thrombolysis, noninvasive procedures, invasive diagnostic procedures, or revascularization. For more than 10 years, investigators have documented substantial variations in the use of these cardiac procedures (18;20;21;28;31;32;33), but they failed to demonstrate that variations in procedure rates between hospitals are caused only by differences in case mix.

In fact, the process appears to select low-risk patients for interventions rather than those at higher risk who, nevertheless, would be the most likely to benefit from these interventions (27). Moreover, the type of medical care that patients receive may depend on where they are initially admitted since admission to a hospital with onsite catheterization facilities was shown to be associated with a high rate of cardiac procedures (10).

A collaborative effort among hospitals delivering cardiovascular care in a given region may begin by measuring variation to improve quality (9). Having this goal in mind, we underwent an analysis of the variations in patient management for myocardial infarction in all hospital settings taking care of patients with myocardial infarction in three departments of the French Rhône-Alpes region.

We thus aimed to examine determinants of use of cardiac procedures after AMI in this region and to identify the main factors of unjustified variation calling for actions toward healthcare providers.

METHODS

Study Population

All 48 hospital settings taking care of patients with AMI in the Isère, Loire, and Rhône Departments of the Rhône-Alpes region of France (population: 3,169,000) accepted to participate in this prospective cohort study. A total of 2,519 patients admitted to these centers between September 1, 1993 and January 31, 1995 were followed for 30 days.

Inclusion criteria were: patients with AMI diagnosed by the physicians in charge, residents of the region, hospitalized in one of the three departments, and must be French citizens. Patients whose myocardial infarction occurred more than 28 days prior to hospitalization, those with postoperative myocardial infarction, and those less than 15 years old were excluded from the study.

All patients gave their written informed consent, and the study was approved by the local ethics committee.

Characteristics

Two sets of characteristics were collected:

1. Patients baseline characteristics: age and gender; cardiac history of prior myocardial infarction and/or angina pectoris; comorbidities such as peripheral arterial disease, cerebrovascular accident or transient ischemic attack, severe and/or treated metabolic or endocrinologic disease, chronic renal failure, chronic pulmonary disease, severe and/or treated liver disease, systemic disease, cancer, neurologic disease, psychiatric disorder, alcoholism, drug abuse; infarction characteristics such as congestive heart failure (Killip class ≥ 2) on admission and during the first 5 days (17), myocardial infarct location, and maximum creatine phosphokinase (CPK) level adjusted for laboratory upper normal values. Characteristics available only for patients undergoing a coronary angiography: presence of recurrent ischemia (clinically diagnosed) and/or stenosis of the left main coronary artery, the left anterior descending coronary artery, the left circumflex coronary artery, or the right coronary. Disease was considered present when there was at least 50% stenosis in the left main coronary artery or 70% stenosis in another artery.

2. Original admitting hospital characteristics: hospital status such as teaching versus nonteaching, private (private for-profit, private nonprofit) versus public hospital (teaching hospital or other status). The admitting hospital was chosen by the patient or the paramedic system and was not assigned or determined by randomization. We also checked the availability of onsite catheterization facilities.

Among the 2,519 patients hospitalized for AMI, the mean age was 68 ± 14 years; 32% were women. Age was significantly higher in women than in men (76 ± 12 years, median: 78 vs. 64 ± 14 years, median 64; $p < .001$). The percentages of patients older than 75 years were 61% among women and 21% among men. Sixteen percent of the patients had a previous myocardial infarction and 22 had a history of angina pectoris. Recorded cardiovascular risk factors were smoking (26%), hypertension (42%), hyperlipidemia (8%), and diabetes mellitus (16%). At least one comorbidity was found in more than 80% of the patients: severe and/or treated metabolic or endocrinologic disease (11%), peripheral arterial disease (9%), chronic pulmonary disease (8%), cerebrovascular accident or transient ischemic attack (5%), or other, less frequent diseases.

Cardiac Procedures

For the purpose of this analysis, all procedures performed in a patient within 30 days after the index myocardial infarction were taken into account. These procedures were attributed to the original admitting hospital even if they were actually performed after a transfer to another facility. The study concerned the following procedures: a) prehospital or inhospital thrombolysis, which was, but rare exceptions, the only emergency reperfusion procedure used during the studied period in the region; b) two noninvasive diagnostic procedures—exercise stress test or scintigraphy—performed either alone or before coronary angiography; c) coronary angiography; and d) two revascularization procedures, percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass grafting (CABG).

Statistical Analysis

The primary analysis examined the case mix according to hospital characteristics. For each group of hospitals, mean age and proportion of patients presenting each baseline characteristic were calculated. Student's t test and chi-square test were used to identify differences in baseline characteristics between patients admitted to different hospital groups. A similar univariate analysis was performed to compare procedure rates between hospital groups.

A further analysis compared the procedure rates using a statistical model for case-mix adjustment. We used a two-level logistic-regression analysis with specified predictor variables to predict each of two binary outcomes: the use of prehospital or inhospital thrombolysis, noninvasive tests, coronary angiography, and revascularization after coronary angiography. The analysis of cardiac revascularization procedure was limited to patients undergoing coronary angiography. At the first level of the logistic regression, we introduced all patients' baseline characteristics, and at the second level all hospitals' characteristics (12;13;19).

We calculated odds ratios and 95% confidence intervals (CI). The effects of age were presented over 10 years to show the change in risk when the patient was 10 years older. To compare hospitals, nonteaching state hospitals and hospitals without onsite revascularization facilities were used as references.

Univariate analyses were performed using the S-PLUS® statistical package (MathSoft, Inc., Seattle, WA). The two-level logistic-regression analyses were performed using MLn version 1.0 (29). Significance was defined as $p < .05$ in all analyses.

RESULTS

Case Mix

The difference in case mix between hospitals of different characteristics reflected the existence of a biased triage process; the older the patients, the more likely they were to be referred to private nonprofit or teaching hospitals than to other hospitals ($p < .001$) (Table 1). Female patients were significantly less likely to be referred to teaching hospitals than to other hospitals ($p < .001$). Patients with comorbidities were more likely to be referred to state hospitals than to private hospitals. Patients admitted to hospitals with onsite catheterization facilities were young, more likely to be men, and less likely to have comorbidities or heart failure than patients admitted to hospitals without such facilities (Table 1).

Differences between patients with CPK more than four times the highest normal value were not interpreted, because thrombolysis frequently results in high CPK levels. The frequency of recurrent ischemia in patients undergoing coronary angiography did not differ significantly between hospital types.

Crude Procedure Rates

Table 2 presents the crude procedure rates according to hospital type and to the availability of onsite catheterization facilities. Emergency medical service providers initiated thrombolytic therapy before admission in 208 of the 2,519 patients (8.3%), while 692 of the remaining 2,311 patients (30%) underwent thrombolysis after admission. Among all 2,519 patients, 626 (25%) underwent at least one noninvasive test and 983 (39%) underwent coronary angiography. Among these, 392 (39%) underwent a revascularization procedure, either PTCA (281 cases), CABG (101 cases), or both (10 cases). Most of the crude procedure rates differed according to the type of hospital and to the availability of onsite catheterization facilities. These crude rates were unadjusted for case mix, and thus were difficult to interpret.

Procedure Rates Adjusted for Case Mix

In the logistic regression model for case-mix adjustment, the odds ratios can be interpreted directly as variation of practice, the analysis having being adjusted on all observed baseline characteristics.

Figure 1 shows odds ratios (OR) and 95% CI for factors influencing the use of cardiac procedures. Older patients were significantly less likely to undergo prehospital thrombolysis (OR, 0.71; 95% CI, 0.62–0.81), inhospital thrombolysis (0.64; 0.58–0.69), noninvasive tests (0.74; 0.67–0.81) and coronary angiography (0.38; 0.34–0.42).

Females were less likely to undergo noninvasive tests and coronary angiography (OR, 0.62; CI, 0.46–0.83 and 0.53; 0.41–0.69, respectively), as well as patients with comorbidities (0.53; 0.38–0.74 and 0.60; 0.43–0.83, respectively) and heart failure (0.51; 0.38–0.68 and 0.67; 0.52–0.86, respectively).

Prior angina or myocardial infarction was significantly associated with less noninvasive tests (OR, 0.62; CI, 0.46–0.83 and 0.58; 0.39–0.86, respectively). The odds of undergoing coronary angiography were more than two times greater among patients admitted to hospital with these facilities.

Among patients having been selected for coronary angiography, the frequency of revascularization was not correlated with age, sex, or comorbidities but was inversely related to past history of myocardial infarction (OR, 0.58; CI, 0.36–0.92) and to elevated CPK levels (0.45; 0.32–0.64), but positively correlated with recurrent ischemia (2.02; 1.38–2.96), left anterior descending stenosis (1.82; 1.30–2.56), or right coronary stenosis (1.78; 1.30–2.44). Heart failure did not increase the probability of revascularization (0.75; 0.5–1.14). The rate

Table 1. Case Mix According to Hospital Type and to Onsite Catheterization Facilities

Variable	Type of hospital					Availability of coronary angiography		
	Private for-profit	Private nonprofit	Teaching hospital	Other status hospital	Significance	Yes	No	Significance
Number of patients	257	108	1,091	1,063		1,039	1,480	
Clinical characteristics								
Mean age (years)	66	69	69	67	<.001	66	69	<.001
Female sex (%)	33	35	27	36	<.001	25	36	<.001
Prior myocardial infarction (%)	11	15	17	15	NS	17	15	NS
Prior angina (%)	28	30	26	29	NS	28	27	NS
Comorbidities[a] (%)	84	82	90	90	<.001	86	91	<.001
Anterior location (%)	38	42	39	38	NS	39	39	NS
Non–Q-wave infarction (%)	10	13	10	14	<.05	11	13	NS
Heart failure on admission (%)	25	36	33	33	NS	30	36	<.01
Worsening of heart failure within the first five days (%)	10	14	15	20	<.001	14	19	<.01
CPK >4 times laboratory's value (%)	64	56	68	62	<.01	66	62	<.05

Abbreviation: CPK = creatine phosphokinase.
[a]Comorbidities; peripheral arterial disease, cerebrovascular accident or transient ischemic attack, severe and/or treated metabolic or endocrinologic disease, chronic renal failure, chronic pulmonary disease, severe and/or treated liver disease, systemic disease, cancer, neurologic disease, psychiatric disorder, alcoholism, drug abuse.

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Table 2. Procedure Rates According to Hospital Type and to Onsite Catheterization Facilities

| Procedures	Type of hospital					Availability of coronary angiography		
	Private for-profit	Private nonprofit	Teaching hospital	Other status hospital	Significance	Yes	No	Significance
Prehospital thrombolysis (%)	6	7	12	5	<.001	13	5	<.001
Inhospital thrombolysis (%)	24	26	35	27	<.001	34	27	<.001
Noninvasive tests (%)	14	23	39	11	<.001	38	27	<.001
Coronary angiography (%)	40	35	46	32	<.001	49	32	<.001
Percutaneous transluminal coronary angioplasty (%)	15	9	16	7	<.001	18	7	<.001
Coronary artery bypass grafting (%)	8	4	5	4	NS	6	3	.005
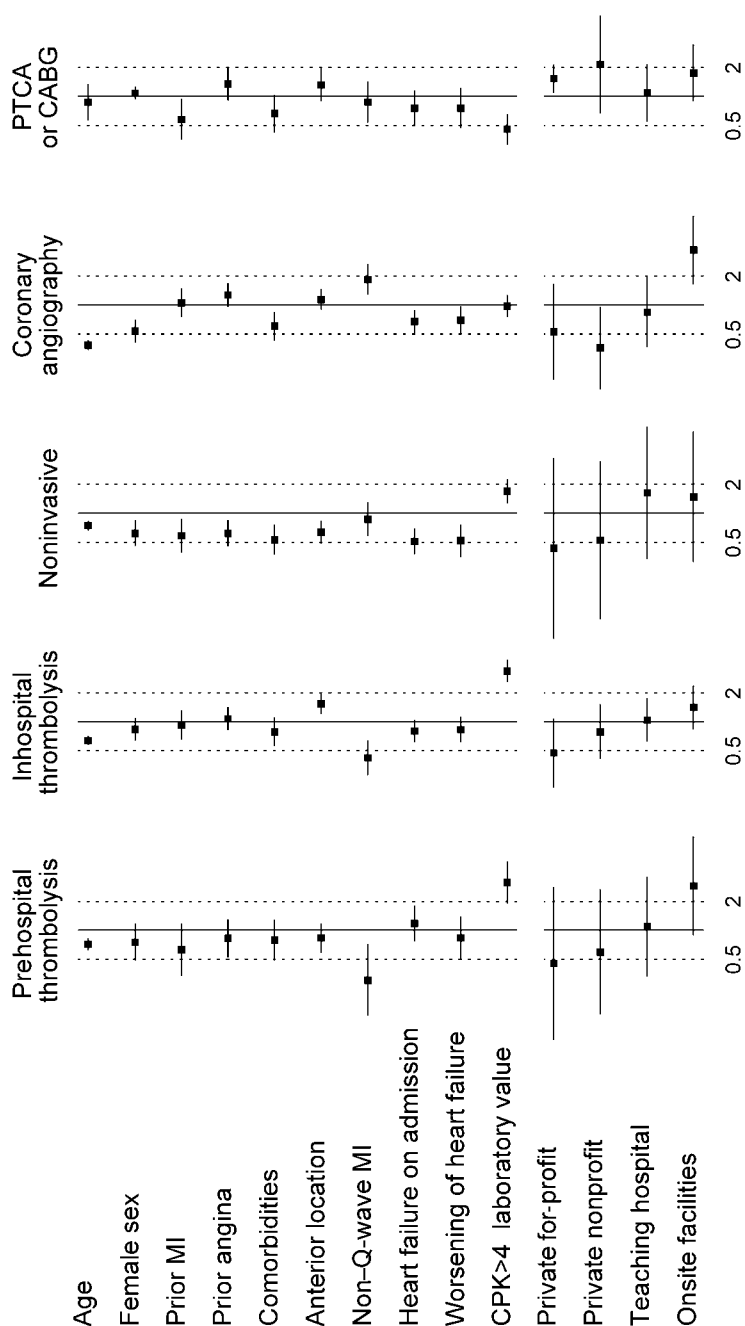
Figure 1. Factors influencing the use of cardiac procedures during 30 days following myocardial infarction in the Rhône-Alpes region of France (odds ratios and 95% confidence intervals). All patients were included in the analysis of pre- and inhospital thrombolysis, noninvasive procedures, and coronary angiography. The analysis of cardiac revascularization procedures was limited to the patients who underwent coronary angiography. To the left of each vertical line are the factors for which the patients are less likely to undergo the procedure. PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass grafting.

of revascularization procedures was significantly higher for patients admitted to private for-profit hospitals.

DISCUSSION

Clinical trials and practice guidelines have identified clinical criteria for use of coronary angiography and revascularization procedures after AMI (2;30). It has been shown that patients with recurrent ischemia, high-grade arrhythmia, or congestive heart failure are at high risk for death and may benefit from coronary angiography and revascularization procedures (24;25;34) and that old age alone is not a contraindication for the procedures' use (1;5;23).

In our analysis, young patients, men, and patients without comorbidities were more likely to be admitted to hospitals with onsite catheterization facilities, and furthermore, were more likely to undergo noninvasive tests and coronary procedures. Patients with heart failure were significantly less likely to undergo both noninvasive tests and coronary angiography. These observations reflect the same prehospital and inhospital attitude toward patients: lower procedure rates with age, gender bias, and paradoxical selection of low-risk patients for interventions rather than those at higher risk. Physicians appeared to select the patients likely to have good procedural outcomes rather than those who would derive the most benefit from the procedure.

The low use of coronary angiography in elderly patients was frequently observed (6;13;14;22;27), but older age did not appear to be associated with higher risks due to cardiac procedures, and large observational studies have found more benefit of revascularization in older patients (1;5).

Gender bias was also observed by several authors (3;7;15;22;28). Some thought that this bias was justified by better prognosis in women (22), while others found that, after adjusting for severity and age, women were more likely than men to die in hospital and less likely to receive coronary angiography and revascularization (15).

In our analysis adjusted for case mix, patients with heart failure were less likely to undergo coronary angiography. Early death before coronary angiography was not sufficient to justify the observed difference. The same observation was made by other authors (10;27), despite the fact that large observational studies have found more benefit of revascularization in patients with severe heart failure (1;4;5;8;34).

The odds of undergoing coronary angiography were more than two times greater among patients admitted to hospitals with this facility. Other studies have also found the availability of onsite facilities to be an independent predictor of the use of coronary angiography or revascularization (4;10;26;27). Thus, the convenience of having facilities available could outweigh the needs of the patients. Nevertheless, other factors could explain the higher use of procedures in hospitals with onsite revascularization facilities, such as the degree of specialization of the admitting physician. Jollis et al. (16) found that cardiologists use more resources and achieve better outcomes than other physicians in caring for elderly patients with myocardial infarction. In this context, note that odds ratios overestimate the relative risks, especially with event rates greater than 20%.

The determinants of revascularization use among patients undergoing coronary angiography appeared more closely consistent with previously published guidelines (2). The frequency of revascularization was two times greater among patients with recurrent ischemia than among other patients. The site of the coronary artery stenosis was the primary determinant of revascularization use. A multicenter randomized trial of invasive versus conservative treatment of patients with inducible ischemia showed a better outcome among patients treated aggressively (11). Patients with heart failure seemed to derive more benefit from revascularization than do those with normal function (1;5;8), but in our study

this factor did not appear to increase the revascularization rate. Moreover, in our adjusted study the rate of revascularization procedures was significantly higher for patients admitted to private for-profit hospitals, without a clear difference of case mix as explanation. A clearer division of the patients into three groups of low, medium, and high risk of death would have shown a clearer relation between the risk stratification and the medical practice.

POLICY IMPLICATIONS

Observation of clinical practices in a whole region has shown that the use of active testing and treatment procedures seemed to follow subjective risk evaluations. This calls for educational actions toward the local health providers to further improve the quality of care in patients with myocardial infarction: physicians are advised to change their attitude toward elderly, women, and patients with heart failure and use advanced procedures.

Our findings also call for similar studies in other similarly well-equipped regions. Similar results will highlight the need for the health system to promote risk assessments and treatment procedures based on the patients' needs rather than on the probability of good procedural outcomes.

NOTE

[1] The PRIMA centers included the following:

Isère: Bourgoin-Jallieu, la Côte Saint-André, Grenoble (Centre hospitalier universitaire, Clinique des Eaux Claires), la Mure, le Pont de Beauvoisin, Saint-Laurent du Pont, Saint- Marcellin, Saint-Martin d'Hères, Vienne, Voiron (Centre hospitalier général, Clinique de Chartreuse).

Loire: Feurs, Firminy, Montbrison, Rive de Gier, Roanne, Saint-Chamond, Saint-Etienne (Clinique la Croix, Hôpital Bellevue, Hôpital de la Charité, Höpital Nord, Hôpital de Saint-Jean-Bonnefond, Polyclinique Beaulieu), Saint-Galmier, Saint-Just et Saint-Rambert.

Rhône: Condrieu, Givors, Lyon and surroundings (Centre hospitalier Lyon-Sud, Clinique Charcot, Clinique du Grand Large, Clinique des Minguettes, Clinique Mutualiste E. André, Clinique de la Roseraie, Clinique de la Sauvegarde, Clinique du Tonkin, Hôpital Cardiovasculaire et Pneumologique, Hôpital A. Charrial, Hôpital de la Croix-Rousse, Hôpital Desgenettes, Hôpital E. Herriot, Hôpital de l'Hôtel-Dieu, Hôpital de Sainte-Foy-lè-Lyon, Hôpital Saint Joseph, Infirmerie protestante, Polyclinique de Rillieux), Tarare, Villefranche-sur-Saône.

Coordinating center: F. Delahaye, C. Colin, R. Ecochard, G. de Gevigney.

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