Cardiologists' Use of Clinical Information for Management Decisions for Patients with Unstable Angina:

A Policy Analysis

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Previous studies of management of unstable angina have revealed substantial differences in management between different hospitals, especially with respect to the use of coronary angiography. Physicians in a hospital with angiography facilities were more inclined to perform angiography than were physicians in hospitals without these facilities, even when differences in patient populations were taken into account. The authors compared the management strategies of 18 cardiologists, working in hospitals with and without angiography facilities, using a series of paper-case summaries, in order to assess the contribution of individual variability between physicians to practice differences. Physicians who worked in a hospital with in-house angiography facilities were more inclined to request angiography in similar case summaries, but the inter-individual variation exceeded the between-hospital variation. The variation in individual policies with respect to the decision to initiate coronary angiography could be associated with differences in weighting clinical information. These results confirm that practice variations may have many causes: variability in patients' characteristics, variations in how physicians react to these, differences in the availability of services, and variability in thresholds for action. *Key words*: unstable angina; coronary angiography; policy analysis; practice variation. **(Med Decis Making 1997;17:292–297)**

Differences in rates of use of medical services have been reported between countries,[1,2] between regions within countries,[3,4] within different practice settings,[5,6] and among physicians in different specialties.[7] This variability has been attributed to cultural differences, different patient populations, variations in specialty and organization, diversity of practice sizes, and differences in availability of and access to medical services.[8]

Studies of practice variations have influenced the public's perception of the medical profession.[9,10] One explanation for the variability in practice that has received considerable attention is the "uncertainty hypothesis," put forward by Wennberg: the observed heterogeneity in the use of medical services is assumed to result from uncertainty about optimal treatment.[11]

In many ways, the management of patients with unstable angina can be regarded as an area of uncertainty. Different definitions are used.[12–14] Many new modes of therapy have been introduced in the past two decades. Medical treatment with nitroglycerin and β-blockers has been extended with calcium antagonists, platelet inhibitors, and anticoagulants.[15–17] Furthermore, cardiac catheterization followed by bypass surgery or angioplasty, is used frequently in addition to medical treatment.[18,19] Although guidelines for angiography have been proposed,[20] there are no well-established rules for weighing the pertinent factors, except for so-called "refractory angina," where medical treatment fails to control the symptoms.[21,22]

In a previous prospective follow-up study, we found management of unstable angina to vary considerably both in and between two hospitals in Rot-

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terdam.[23] In that study, special attention was paid to the decision to schedule patients for coronary angiography, a key point in the management of patients with unstable angina since subsequent decisions to initiate angioplasty or bypass surgery will be based on the findings at angiography. By deciding not to perform coronary angiography, the cardiologist implicitly discards, or at least postpones, any plans for revascularization. We found that cardiologists in a hospital that had in-house angiography facilities were twice as likely to perform angiography compared with their counterparts in another hospital without such facilities (43% vs 25%). On the other hand, physicians in a hospital without in-house angiography facilities were more likely to order additional exercise testing. This variability could be associated with differences in patient populations, but is more likely to be due to the effects of availability of equipment on utilization. After statistically correcting for patient characteristics using multivariable modeling, the hospital odds ratio for coronary angiography decreased from 2.3 to 1.8. This shows that differences in patient populations cannot explain the variability between hospitals.

Individual variability in the use of clinical information has been demonstrated for many conditions.[24–26] The prospective study did not collect physician-specific information. It is conceivable that the average policy in a hospital is not representative of the management decisions of the individual cardiologists. The variability between individual cardiologists may very well exceed inter-hospital differences.

A policy-capturing study[27]—with a fixed series of written case summaries—was set up to estimate the relative contributions of the following three factors to the variability in management decisions: 1) differences in patient characteristics; 2) differences in access to in-house angiography facilities; and 3) differences between cardiologists. In addition, we examined whether practice differences between cardiologists could be explained by variability in how physicians react to patients' characteristics, i.e., different judgment policies.

Methods

Participating cardiologists were asked to rate the need for (changes in) medication, the need for angiography, and the need for exercise testing in a series of 12 written case summaries. Linear modeling was employed to evaluate associations between the inclinations to use various management alternatives expressed by each cardiologist and the characteristics of the patients, the cardiologist, and the hospital in which the cardiologist was working.

PARTICIPATING PHYSICIANS

Eighteen cardiologists in Rotterdam took part in this study. Eleven of them were affiliated with a university hospital that had in-house angiography facilities; the remaining seven worked in three different community hospitals without in-house angiography facilities.

CASE SUMMARIES

Each cardiologist evaluated 12 case summaries. Each summary described a patient's condition 48 hours after being admitted to the hospital with a diagnosis of unstable angina. In the case summaries, seven clinical features were systematically varied. These seven variables were based on the results of a prospective cohort study of 417 consecutive patients admitted with suspected unstable angina, designed to describe variations in management and outcome.[23] All variables had been shown to influence the decision to order coronary angiography in patients with unstable angina. Variable selection and phrasing (in Dutch) were further tested in six try-out analyses with two cardiologists, who did not participate in the final study. No difficulties were encountered in the final version of the cases.

Variables used in the case summaries were: 1) history of myocardial infarction (present or absent); 2) risk factors for cardiovascular disease (none, hypercholesterolemia only, or smoking and a family history positive for coronary disease); 3) amount of anti-anginal medication at presentation (none, β-blockers only, or multiple-drug therapy); 4) mode of onset of the present complaints (sudden onset versus gradual progression of pain); 5) ECG changes during pain at presentation (present or absent); 6) pain during the first 48 hours in hospital (recurrent or absent); and 7) ECG changes in the hospital (present or absent). Variables 2 and 3 had three levels, all others had two levels. A fractional factorial design of 12 cases was used.[28]

PROCEDURE

Each participating cardiologist received one trial case summary and the full series of 12 case summaries in a single session. Case summaries were presented in a random sequence, which was the same for all participants.

For each case summary, the cardiologist was asked to express his or her inclination to use the following management alternatives (presented in this order): 1) coronary angiography; 2) exercise tolerance test; and 3) additional medication. The likelihood of using these services was to be expressed

Table 1 • Management Alternatives for Patients Admitted with Unstable Angina*

	Selected Management Alternatives (n = 12)		
	Angiography	Exercise Test	Additional Medication
In-house angiography facilities			
Cardiologist 1	7	4	4
Cardiologist 2	2	1	3
Cardiologist 3	7	4	7
Cardiologist 4	6	4	7
Cardiologist 5	8	3	2
Cardiologist 6	1	5	7
Cardiologist 7	6	3	5
Cardiologist 8	6	3	9
Cardiologist 9	5	2	6
Cardiologist 10	6	0	6
Cardiologist 11	5	5	5
No facilities for in-house angiography			
Cardiologist 12	4	8	5
Cardiologist 13	8	4	10
Cardiologist 14	4	5	5
Cardiologist 15	3	8	3
Cardiologist 16	0	6	5
Cardiologist 17	2	10	10
Cardiologist 18	2	6	6

*The numbers indicate frequencies of positive answers (4 or more on a 7-point scale).

on a seven-point scale ranging from 1 "definitely not" to 7 "definitely."

ANALYSIS

Judgment analysis[29] provides a means of elucidating important physician- and patient-related factors in medical decisions. We used linear modeling to study the (main) effects of patients, hospitals, and cardiologists on the inclination to use the various management alternatives. Differences in ratings between hospitals were tested using F-statistics. To estimate the contributions of the three components, a second analysis was done in which patients, hospitals, and cardiologists were treated as random effects. Maximum-likelihood estimates of the corresponding variance components were obtained using procedure MIXED in SAS. In order to correct for individual differences in response styles, the analysis was repeated using standardized ratings, by subtracting a cardiologist's overall mean rating from each score, and dividing it by the corresponding overall standard deviation.

The decision to order angiography after clinical observation was analyzed in detail using conjoint analysis, with the response on the seven-point scale as the dependent variable and the clinical characteristics as independent variables. All clinical features were coded using indicator variables. For each individual cardiologist, the contribution of each variable was obtained, relative to the total sum of regression weights. Procedure TRANSREG in SAS was used for the conjoint analysis.

Results

FREQUENCY OF USE

As the analyses of the standardized ratings did not lead to different conclusions, only the results of the analyses of the original, unstandardized ratings are reported here.

The average seven-point ratings over all 12 case summaries (1 = "definitely not" to 7 = "definitely") for the management option "intensified medication" did not differ between cardiologists working in the hospital with in-house facilities for angiography and cardiologists working in hospitals without those facilities: 4.2 versus 4.2, respectively ($p = 1.00$, F-test). There were significant differences between the hospitals, however, in ratings for "angiography" (4.0 vs 2.9, $p < 0.01$) and "exercise test" (2.9 vs 4.3, $p < 0.01$).

Considerable discrepancies in ratings were found between individual cardiologists, taking into account differences between hospital. Some cardiologists expressed a tendency to order angiography and subsequent coronary interventions for almost every patient, whereas others appeared reluctant to initiate invasive therapy.

Table 1 contains a summary, for each of the participating cardiologists, of management alternatives with positive ratings (4 or higher on the seven-point scale), listed by hospital type. Cardiologists 1, 5, and 13 expressed an inclination to order angiography in the majority of cases, whereas physicians 6 and 16 would prefer other options to angiography in managing similar patients.

Table 2 contains the estimated variance components for the three set of ratings. For all three management alternatives, there was significant between-patient variability, exceeding the variance components to be attributed to cardiologists and hospitals. For "additional medication," the estimated between-hospital variance was zero. For "angiography," the variability between cardiologists was twice as high as the between-hospital variance. On the other hand, for "exercise testing," the estimated between-hospital variance exceeded the between-cardiologist variability.

INDIVIDUAL ANGIOGRAPHY

The decision to initiate angiography after 48 hours was analyzed in detail. Eighteen conjoint analyses

were performed, one for each cardiologist, to examine associations between clinical variables and the likelihood to order coronary angiography. The results are summarized in figure 1.

A distinction was made between variables that were available at admission (history of myocardial infarction, presence of risk factors for cardiovascular disease, amount of antianginal medication at presentation, mode of onset of pain, and ECG changes during pain at presentation) and variables that became available after hospital admission (in-house history: ECG and pain within 48 hours after admission). In figure 1, the cardiologists are ranked according to the relative contributions of in-house history to their inclinations to initiate coronary angiography. The sum of the weights for the recurrence of pain and ECG changes during the first 48 hours in the hospital contributed from approximately zero (physicians to the left) to 75% to the total weight (physicians to the right). Differences in weight could not systematically be associated with hospital type, nor with the individual differences in tendency to express intention to order angiography.

Discussion

In this policy-capturing study, we confirmed a difference between cardiologists previously found in two hospitals with respect to use angiography in patients admitted with unstable angina. We also demonstrated a large between-subject variability, suggesting that practice variations could be traced back to differences in setting (higher angiography rates and lower rates for exercise tests by cardiologists working in hospital with in-house facilities), differences in clinical characteristics (as contained in the case summaries), differences in the weights attached to these characteristics by individual cardiologists, and differences in the individual propensities towards specific management alternatives.

One might question whether decisions made about case vignettes represent actual behaviors, since case vignettes fail to mimic the complicated patient–doctor interaction. Written case summaries have been applied in many studies on practice variations.[5,25–26,30,31] Paper cases do not allow the physician to obtain additional patient information, which he or she might have requested otherwise, and which can change his or her approach. This has to be balanced against the advantage of isolating judgment from the process of gathering information and the benefits of comparing physicians in their judgment of similar cases. Kirwan et al.[32] reported a remarkable similarity between judgments of disease activity in rheumatoid arthritis made based on "paper" cases and those made based on actual patients.

Table 2 • Variance Components in Ratings for Management Alternatives for Patients Admitted with Unstable Angina*

Source of Variance	Management Alternative		
	Angiography	Exercise Test	Additional Medication
Hospital type	0.6 (1.0)	1.0 (1.5)	0.0 (0.0)
Cardiologists	1.2 (0.5)	0.3 (0.2)	0.6 (0.3)
Patients	1.7 (0.8)	2.2 (1.0)	2.0 (0.9)
Residual	2.9 (0.3)	3.0 (0.3)	3.4 (0.4)

*Maximum likelihood estimates (standard errors) based on ratings of 12 patient summaries by 18 cardiologists from two hospital types (with and without facilities for in-house angiography).

Our findings seemed to support this similarity: the likelihood of angiography, for example, shifted appropriately when patient characteristics were varied. In addition, the decisions could be associated to the same patient characteristics in paper cases as in real patients, and the trend towards more angiography in hospitals with angiography facilities was observed in clinical practice as well as in this policy analysis.[23]

Our limitation to 12 cases was based on practical considerations. The try-outs had shown us that a limited number of vignettes was needed to enable

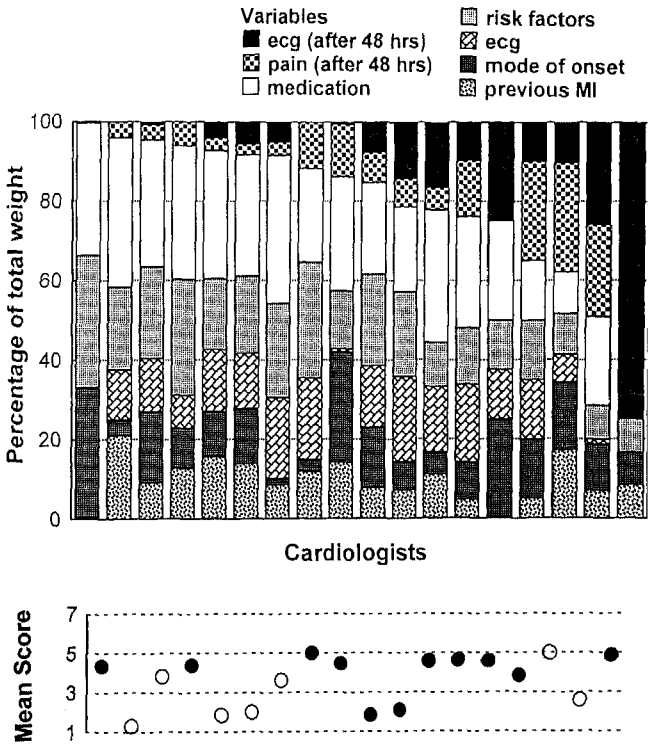

FIGURE 1. Individual weights and mean scores for the inclination to use coronary angiography after 48 hours. Cardiologists are ranked by the weights attached to information available after 48 hours of in-hospital observation (ECG and recurrent pain). The weights were derived from individual policy analyses. The bottom graph shows the mean scores of the individual cardiologists. The solid black dots indicate cardiologists working in hospitals with in-house facilities for angiography.

the physicians to complete the set in a reasonable amount of time. Albeit small, this number was sufficient to allow us to estimate the relative contributions of cases summaries, hospital settings, and individual cardiologists. The number was too small to estimate individual profiles reliably. Practical limitations prevented us from incorporating even more clinical variables known or assumed to influence the respective management decisions studied. Because of the large number of variables already included, we also refrained from adding "distractor" variables. We therefore cannot estimate the relative contributions of patient characteristics not included in the design, such as other (non-cardiac) illnesses.

The study population was limited to 18 cardiologists working at various departments in a few hospitals in one city. It remains uncertain whether these observations can be generalized to other cardiologists. Due to the small and unrepresentative number of cases, the estimated relative variance components cannot be generalized to all management decisions for patients with unstable angina.

Our findings replicate results from similar studies in other clinical areas. Differences in weighting clinical variables have been consistently demonstrated for a number of other medical technologies.[24-26,30,33,34] Several studies have shown that judgment policies can be described with a small number of clinical variables.[25,34] Strengths of treatment preferences and regression weights need not coincide: Holzman and colleagues[24] found little relationship between the regression weights and the likelihood of prescription of estrogen-replacement therapy for menopausal women; Gillis et al.[33] reported that physicians who relied on the same psychoactive drugs for psychiatric illnesses based their decision whether or not to give those drugs on different patient characteristics.

The findings in this study are in line with the findings of Poses and colleagues.[35] These authors, analyzing treatment strategies for patients with pharyngitis, suggested that practice variations may result both from variability in patients' characteristics and from variability in how physicians react to patients' characteristics.

Both Poses et al.'s and our conclusions are in contrast with popular beliefs about practice variations, which suggest that practice variations are caused by seemingly idiosyncratic, if not irrational, physician decision processes, which are substantially unrelated to the underlying severity of the relevant illness.[36-39] This view implies that physicians do not know what they are doing, an inference that cannot be confirmed by this and other studies.[3-5] The notion that variation is unrelated to patients' characteristics has been stretched into the belief that physicians' decisions are unrelated to patients' characteristics, which in its turn supports the validity of nonrandomized comparisons of treatment. Wennberg has stated that the difference between patients who receive different treatments may be small and that in any case, modern multivariate statistical methods would make it easy to adjust for residual differences that do exist. In general, he believes that correcting for age alone may be sufficient to adjust for most illness-related differences in populations.[39]

Although the individual variation in the likelihood to perform angiography or to order additional exercise testing was large, the observed responses could be associated systematically with differences in patient characteristics. Similarly, in two other studies,[3,4] variability between physicians could be attributed to lack of consensus, but also to differences in severity of patients' conditions and to the practice settings. Our observations that cardiologists responded to variations of patient characteristics and that their responses were modified by practice setting (the presence of facilities for in-house angiography) support the conclusions of other reports, indicating that comparisons of the use of health services in different populations should always be controlled for patient variation.[4,5] Nevertheless, a considerable amount of variation could be attributed to a less appropriate variability in the availability of services, individual thresholds for action, and differences in the weights attached to clinical variables.

While all physicians use clinical characteristics in their decision making, they vary in the weights they assign to individual variables. A proper identification of these judgment strategies may be of interest, for several reasons. First, if individual physicians are confronted with the relative weights that they are using in making judgments and decisions, they may gain insight into their own decision making processes, which may help them to reflect on and modify their policies.[40] Second, such an analysis can provide insight into the potential factors causing disagreement, facilitating communication between clinicians when discussing the need for coronary angiography for a specific patient. Third, it may be of help in medical teaching, when it is perceived that part of the whole set of textbook variables may be rejected as superfluous by subsequent experience.

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