JACC Vol. 31, No. 5
April 1998:957–63

CLINICAL STUDIES

MYOCARDIAL INFARCTION

Trends in the Quality of Care for Medicare Beneficiaries Admitted to the Hospital With Unstable Angina

HARLAN M. KRUMHOLZ, MD, FACC,*†‡§ DANIEL M. PHILBIN, JR., MD,* YUN WANG, MS,§
VIOLA VACCARINO, MD, PHD,† JAIME E. MURILLO, MD,*
MICHAEL L. THERRIEN, MD, FACC,‖¶ JEANNE WILLIAMS, RN,§
MARTHA J. RADFORD, MD, FACC§¶

New Haven, Middletown, Hartford and Farmington, Connecticut

Objectives. **We sought to 1) determine the proportion of appropriate elderly patients admitted to the hospital with unstable angina who are treated with aspirin and heparin; 2) identify patient factors associated with the Agency for Health Care Policy and Research (AHCPR) guideline-based use of aspirin and heparin; and 3) compare practice patterns and patient outcomes before and after publication of the AHCPR guidelines.**

Background. **Improving the care of patients with unstable angina may provide immediate opportunities to mitigate the adverse consequences of unstable angina. However, despite the importance of this diagnosis, there is a paucity of information on the patterns of treatment and outcomes across diverse sites and recent trends in practice that have occurred, especially since the publication of the AHCPR practice guidelines.**

Methods. **We performed a retrospective cohort study using data created from medical charts and administrative files. The sample included 300 consecutive patients admitted to one of three Connecticut hospitals in the period 1993 to 1994 and 150 consecutive patients admitted in 1995 with a principal discharge diagnosis of unstable angina or chest pain.**

Results. **Of the 384 patients ≥65 years old who had no contraindications to aspirin on hospital admission, 276 (72%) received it. Of the 369 patients ≥65 years old who had no contraindications to heparin on admission, 88 (24%) received it. Among the 321 patients ≥65 years old who had no contraindications to aspirin at hospital discharge, 208 (65%) were prescribed it. When 1995 was compared with 1993 to 1994, the use of aspirin (odds ratio [OR] 2.3, 95% confidence interval [CI] 1.3 to 4.0) and heparin (OR 2.8, 95% CI 1.6 to 4.9) on hospital admission significantly increased, and the use of aspirin at discharge (OR 1.4, 95% CI 0.8 to 2.4) increased. Concomitantly, there was a significant reduction in 30-day readmission (OR 0.52, 95% CI 0.27 to 0.99).**

Conclusions. **Our results indicate an improvement in the care and outcomes of elderly patients with unstable angina, but there remain opportunities for further improvement.**

(J Am Coll Cardiol 1998;31:957–63)

In May 1994, an expert panel convened by the Agency for Health Care Policy and Research (AHCPR) published the Clinical Practice Guideline for the care of patients with unstable angina (1). The panel intended its guidelines, which were publicized and distributed across the United States, to decrease unnecessary variation in practice patterns by critically evaluating the published medical data and endorsing specific treatment strategies. The document's strongest recommendations concern hospital admission and treatment with aspirin and heparin for patients at intermediate or high risk of complications. Patients at low risk of complications are considered suitable for outpatient management.

Improving the care of patients with unstable angina may provide immediate opportunities to mitigate its adverse consequences. However, despite the importance of this diagnosis, there is a paucity of information on the patterns of treatment and outcomes across diverse sites. Accordingly, we sought to compare the practice patterns and outcomes for elderly patients with unstable angina admitted to the hospital. Older patients represent more than half of all patients admitted with this condition and are considered by the Guidelines to have at

From the *Section of Cardiovascular Medicine, Yale School of Medicine and †Section of Chronic Disease Epidemiology, School of Epidemiology and Public Health, Yale University; and ‡Center for Outcomes Research and Evaluation (CORE), Yale–New Haven Hospital, New Haven; §Connecticut Peer Review Organization, Middletown; ‖St. Francis Hospital and Medical Center/Hoffman Heart Institute of Connecticut, Hartford; and ¶University of Connecticut School of Medicine, Farmington, Connecticut. This study was supported in part by the Patrick and Catherine Weldon Donaghue Medical Research Foundation Hartford. Dr. Krumholz is a Paul Beeson Faculty Scholar. The analyses on which this publication is based were performed under Contract Number 500-96-P549, entitled "Utilization and Quality Control Peer Review Organization for the State of Connecticut," sponsored by the Health Care Financing Administration, Department of Health and Human Services. The content of this publication does not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products or organizations imply endorsement by the U.S. Government. The authors assume full responsibility for the accuracy and completeness of the ideas presented. This article is a direct result of the Health Care Quality Improvement Program initiated by the Health Care Financing Administration, which has encouraged identification of quality improvement projects derived from analysis of patterns of care, and therefore required no special funding on the part of this Contractor. Ideas and contributions to the authors concerning experience in engaging with the issues presented are welcomed.

Manuscript received July 11, 1997; revised manuscript received January 9, 1998, accepted January 15, 1998.

Address for correspondence: Dr. Harlan M. Krumholz, Yale University School of Medicine, 333 Cedar Street, P.O. Box 208025, New Haven, Connecticut 06520-8025. E-mail: harlan.krumholz@Yale.edu.

Published by Elsevier Science Inc.

0735-1097/98/$19.00
PII S0735-1097(98)00022-9

JACC Vol. 31, No. 5
April 1998:957–63

Abbreviations and Acronyms

AHCPR = Agency for Health Care Policy and Research
aPTT = activated partial thromboplastin time
CI = confidence interval
ECG = electrocardiogram, electrocardiographic
HCFA = Health Care Financing Administration
ICD = International Classification of Diseases
OR = odds ratio

least an intermediate risk of an adverse outcome and thus to merit hospital admission (1,2). Our specific aims were 1) to determine the proportion of appropriate patients who were treated with aspirin and heparin; 2) to identify patient factors associated with the use of aspirin and heparin; and 3) to compare practice patterns and patient outcomes before and after the publication of the AHCPR Guideline.

Methods

Selection of quality indicators. Representatives from the three participating hospitals and the Connecticut Peer Review Organization convened to develop quality indicators based on the AHCPR Clinical Practice Guideline (1). Consensus was achieved for three quality indicators: the administration of aspirin on hospital admission, heparin on admission and the prescription of aspirin at hospital discharge. Each process was evaluated in a restricted sample of patients who were considered to be ideal candidates for the intervention. For the evaluation of aspirin on admission, we developed a restricted cohort by excluding patients with the following contraindications: hemorrhagic disorder or bleeding, thrombocytopenia (platelets <100,000), anemia (hematocrit <30%), allergy or sensitivity to aspirin and terminal illness. Because this indicator was used to evaluate the relatively short-term use of aspirin for the treatment of an acute condition, we did not exclude patients with minor contraindications. Similarly, for the use of heparin, we excluded patients with a hemorrhagic disorder or bleeding, thrombocytopenia (<100,000), anemia (<30%), prothrombin time >14 s on admission, allergy or sensitivity to heparin, terminal illness or current warfarin therapy. Finally, for the use of aspirin at discharge, we excluded patients with any of the aspirin contraindications on admission, creatinine >3 mg/dl or the prescription of warfarin at discharge. In this case, we broadened our exclusions because the use of aspirin at discharge is intended to be long term for secondary prevention. We also determined the proportion of patients treated with intravenous heparin who achieved a therapeutic partial thromboplastin time (46 to 72 s) within 24 h of admission. The therapeutic window was based on the recommendation of the AHCPR Guideline (1).

Hospital selection. The three hospitals invited to participate in this project represented the range of facilities in Connecticut: one had cardiac catheterization facilities and cardiac surgery facilities; one had cardiac catheterization facilities only; and one had no such facilities. The bed capacity of the hospitals ranged from 85 to 700. All hospitals had intensive care units and were staffed by cardiologists.

Study sample. From Medicare's National Claims History File, we identified patients with a principal discharge diagnosis of unstable angina, coronary artery disease or chest pain (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] codes 411.x, 413.x, 786.50] at the three study hospitals. From the calendar year 1994, 100 consecutive patients with unstable angina were identified for review. For institutions with less than 100 cases, cases from 1993 were also included. From the calendar year 1995, 50 consecutive patients with unstable angina were identified and reviewed. Patients were excluded if the diagnosis of presumed unstable angina could not be validated by medical record review. The coding of unstable angina was considered correct if the patient was admitted nonelectively for presumed ischemic heart disease (based on the admitting notes) and had chest pain within 24 h of hospital admission. We excluded patients who died within 6 h of presentation to the hospital or were transferred within 6 h of presentation to the hospital.

Data sources. *Medical record review.* Medical records were abstracted by trained nurses and medical record technicians. The data that were abstracted included detailed demographic, clinical and process of care information. These data were abstracted directly into standardized forms and then entered into a computerized data base. Extensive training sessions and detailed data definitions for each field were used to minimize abstraction errors and variability. A random subsample of each abstractor's cases was reabstracted and assessed at weekly team meetings to improve reliability.

Administrative data. The Health Care Financing Administration's (HCFA) MEDPAR file for Connecticut provided the primary administrative data source for this analysis. This publicly available file contains discharge abstracts for all Medicare inpatients discharged from Connecticut hospitals and was the source of information on readmission. In addition, the Medicare Enrollment Database provided information on mortality.

Variables. Variables included age, gender, race, history of hypertension, diabetes, smoking, history of myocardial infarction, history of congestive heart failure, previous coronary revascularization, history of stroke, history of chronic obstructive pulmonary disease, medications on admission, presence of chest pain on admission, duration of symptoms before admission, presence of congestive heart failure on admission, vital signs, admission laboratory tests (blood urea nitrogen, creatinine, hematocrit, PT), thrombolytic therapy on the first day, shock, intubation and Killip class. Systolic blood pressure, pulse and respiratory rate were taken as the highest value recorded within 24 h of admission. Renal dysfunction was defined as blood urea nitrogen >40 mg/dl or creatinine >2.0 mg/dl. Only the electrocardiogram (ECG) in the first period (1993 to 1994) was interpreted by a physician. Outcome variables included aspirin and intravenous heparin on admission and aspirin at discharge. All admission and discharge

medications were reviewed for the use of aspirin (all formulations were considered). Heparin that was administered for prevention of deep vein thrombosis or for intravenous flushes (dose ≤12,000 U/day) was not considered to be for systemic heparinization. Other outcome variables included mortality within 30 days of admission and readmission within 30 days of discharge.

Statistical analysis. First, we created analytic programs to represent the logic of each of the quality indicators. The results are presented for the entire cohort and by hospital. Second, we evaluated the bivariate association between the appropriate treatment of patients eligible for each quality indicator and a constellation of variables that included demographic (age, gender and race), clinical (coronary artery disease risk factors, past medical history, cardiac medications on admission, cardiac history and acuity of presentation) and ECG characteristics. Then we developed stepwise logistic regression models to identify factors independently associated with satisfactory performance on each indicator. Candidate variables were selected from the variables identified in the bivariate analysis as having an association at $p < 0.10$ or clinical relevance, or both. All models were constructed with an entry significance level of 0.01 and an exit significance level of 0.05.

Next, we compared the performance of the quality indicators in 1993 to 1994 to those in 1995 using the chi-square test. We also repeated the logistic regression models and forced in an indicator for the time period. We selected the sample size to be able to detect moderate (or larger) differences in the use of aspirin and heparin between the periods. We estimated, for example, that we would have >80% power to detect an absolute change over time of 15% in the use of aspirin (from 60% to 75%) or heparin (from 20% to 35%).

Finally, we evaluated 30-day mortality and readmission in the two periods, unadjusted and after adjusting for age, Killip class, diabetes mellitus and renal function. For all models, we constructed and examined partial residual plots to evaluate potential problematic areas of model fit (3). Goodness of fit was also evaluated (4). In addition, we calculated an area under the receiver operating curve for each model to evaluate the discriminating power of the fitted model (5). For the evaluation of aspirin at discharge, we repeated the analysis after excluding patients with the principal discharge diagnosis code of chest pain (ICD-9-CM code 786.50), because these patients may not be known or considered to have coronary artery disease.

Results

Study sample. There were 450 patients who met the criteria for the study sample, including 300 in the first period (1993–1994) and 150 in the second period (1995). The most common principal discharge diagnosis for the cohort was 411.1 (54.2%), followed by 786.50 (33.6%), 413.9 (11.6%), 411.81 (0.2%) and 411.89 (0.4%).

The demographic and preadmission characteristics of the study sample are shown in Table 1. The patients were elderly (mean age 76.4 ± 7.3 years, median 76, range 65 to 100) and predominately female (64.4%). The majority of the patients had a history of coronary artery disease, as indicated by a history of angina (69.8%) or myocardial infarction (34.4%); 43.1% of patients were taking aspirin as a preadmission medication.

Overall, the patients were hemodynamically stable. Only one of the patients was considered to be in shock. A total of 69 patients (15.3%) had a heart rate >100 beats/min; 16 (4%) had a respiratory rate >30 breaths/min; and 36 (8%) had a systolic blood pressure <125 mm Hg. Heart failure was present in 79 patients (18%). No patient required ventilatory support. The initial ECG was interpreted as normal for 51 of the cohort (17%) from the first period. For 43% of these patients, the ECG was obtained within 20 min of presentation to the hospital. The length of hospital stay for the study sample was 4.7 ± 2.8 days. The readmission rate within 30 days of discharge was 15%, and the mortality rate within 30 days of admission was 2%.

When the two periods were compared, there were no substantial or significant differences in demographic characteristics. From a clinical perspective, the patients in the second period were less likely to have a history of angina, myocardial infarction, heart failure or reperfusion therapy. However, the patients in the second period had a similar preadmission use of aspirin. The length of hospital stay for the first period was 5.1 ± 3.1 days compared with 4.0 ± 1.9 days in the second period ($p < 0.001$).

Aspirin on admission. Of the 450 patients in the sample, 384 were considered ideal candidates for the acute use of aspirin. Of these patients, 276 (72%) received it (Tables 2 and 3). Performance of this quality indicator varied across the hospitals from 66% to 77%. The use of aspirin on admission in the ideal group increased significantly over the two periods, from 66% to 82% ($p < 0.001$) (Table 3). The absolute increase at the hospitals ranged from 8% to 27%. Adjusting for baseline differences between the groups, the odds ratio (OR) increase in the use of aspirin in 1995 compared with 1993 to 1994 was 2.31 (95% confidence interval [CI] 1.32 to 4.03). Other factors that were associated with performance of this quality indicator included aspirin as a preadmission medication (OR 3.0, 95% CI 1.7 to 5.0), history of heart failure (OR 0.4, 95% CI 0.2 to 0.8), history of renal disease (OR 0.6, 95% CI 0.3 to 1.0) and preadmission use of warfarin (OR 0.2, 95% CI 0.1 to 0.4).

Heparin on hospital admission. Of the 450 patients in the sample, 369 were considered ideal candidates for intravenous heparin on admission. Of these patients, 89 (24%) received it (Table 2). Performance of this quality indicator varied across the hospitals from 10% to 43%. The use of heparin increased significantly over the two periods, from 20% to 32% ($p < 0.01$) (Table 3). The absolute change at the hospitals ranged from −5% to 29%. After baseline differences between the groups were adjusted, the OR increase in the use of heparin among the ideal patients was 2.83 (95% CI 1.64 to 4.89). Other factors that were associated with satisfactory performance of this quality indicator included tachycardia (OR 2.1, 95% CI 1.1 to

Table 1. Hospital Admission Characteristics of the Study Sample

Characteristic	Total (n = 450)	1993–1994 (n = 300)	1995 (n = 150)	p Value*
Age group (yr)				
65–74	190 (42%)	126 (42%)	64 (43%)	0.9
75–84	195 (43%)	135 (45%)	60 (40%)	0.3
≥85	65 (14%)	39 (13%)	26 (17%)	0.2
Female gender	290 (64%)	186 (62%)	104 (69%)	0.1
White race	398 (88%)	261 (87%)	137 (91%)	0.2
Cardiac risk factor				
Hx of HTN	276 (61%)	190 (63%)	86 (57%)	0.2
DM	106 (24%)	77 (26%)	29 (19%)	0.1
Current smoker	43 (10%)	33 (11%)	10 (7%)	0.1
Cardiac history				
UA	314 (70%)	233 (78%)	81 (54%)	< 0.001
MI	155 (34%)	117 (39%)	38 (25%)	0.004
CHF	79 (18%)	62 (21%)	17 (11%)	0.01
PTCA	43 (10%)	33 (11%)	10 (7%)	0.1
CABG	69 (15%)	51 (17%)	18 (12%)	0.2
Medical history				
Stroke	58 (13%)	40 (13%)	18 (12%)	0.7
PVD	61 (14%)	44 (15%)	17 (11%)	0.3
COPD	83 (18%)	61 (20%)	22 (15%)	0.1
Peptic ulcer disease	6 (1%)	6 (2%)	0	0.2
Liver disease	7 (2%)	6 (2%)	1 (0.7%)	0.3
Bleeding within 1 yr	14 (3%)	10 (3%)	4 (3%)	0.7
Dementia	17 (4%)	13 (4%)	4 (3%)	0.4
Metastatic cancer	81 (18%)	58 (19%)	23 (15%)	0.3
Terminal illness	0	0	0	—
Preadmission meds				
Aspirin	194 (43%)	131 (44%)	63 (42%)	0.7
Nitrates	213 (47%)	154 (51%)	59 (39%)	0.02
BBs	128 (28%)	85 (28%)	43 (29%)	0.9
CCBs	192 (43%)	141 (47%)	51 (34%)	0.009
Digoxin	92 (20%)	66 (22%)	26 (17%)	0.2
ACE I	89 (20%)	54 (18%)	35 (23%)	0.2
Loop diuretic	131 (29%)	93 (31%)	38 (25%)	0.2
Warfarin	36 (8%)	27 (9%)	9 (6%)	0.3
Chest pain				
Present on presentation	279 (62%)	178 (59%)	101 (67%)	0.3
Duration >6 h	112 (25%)	73 (24%)	39 (26%)	0.7
Killip class 1	321 (71%)	201 (67%)	120 (80%)	0.004
Initial vital sign				
Pulse >100 bpm	69 (15%)	50 (17%)	19 (13%)	0.3
RR >30 breaths/min	16 (4%)	16 (5%)	0	0.004
SBP <125 mm Hg†	36 (8%)	14 (5%)	22 (15%)	< 0.001
ECG obtained within 20 min	N/A	128 (43%)	N/A	—
Admission lab results				
BUN >40 mg/dl or creatinine >2.5 mg/dl	30 (7%)	25 (8%)	5 (3%)	0.04
Hct <30%	27 (6%)	23 (8%)	4 (3%)	0.03
PTT >16 s	24 (5%)	19 (6%)	5 (3%)	0.2
Shock within 24 h of admission	1 (0.2%)	1 (0.3%)	0	0.5
Intubation within 24 h of admission	0	0	0	—

*For comparison of time periods. †Highest systolic blood pressure (SBP) within 24 h. Data presented are number (%) of patients. ACE I = angiotensin-converting enzyme inhibitor; BBs = beta-blockers; bpm = beats per minute; BUN = blood urea nitrogen; CABG = coronary artery bypass graft surgery; CCBs = calcium channel blockers; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; DM = diabetes mellitus; ECG = electrocardiogram; HTN = hypertension; Hx = history; lab = laboratory; meds = medications; MI = myocardial infarction; N/A = not applicable; PTT = prothrombin time; PTCA = percutaneous transluminal coronary angiography; PVD = peripheral vascular disease; RR = respiratory rate; UA = unstable angina.

Table 2. Use of Aspirin and Heparin on Hospital Admission and Aspirin at Discharge Among Patients Without Contraindications

	Aspirin on Admission		Aspirin at Discharge		Heparin on Admission	
	No. of Pts Without Contraindications	No. (%) of Pts Treated	No. of Pts Without Contraindications	No. (%) of Pts Treated	No. of Pts Without Contraindications	No. (%) of Pts Treated
Hospital A	122	94 (77%)	113	65 (58%)	121	23 (20%)
Hospital B	129	94 (73%)	101	73 (72%)	126	13 (10%)
Hospital C	133	88 (66%)	107	71 (66%)	122	53 (43%)
Total	384	276 (72%)	321	209 (65%)	369	89 (24%)

Pts = patients.

4.1), history of bypass surgery (OR 2.5, 95% CI 1.3 to 4.9), history of angioplasty (OR 2.9, 95% CI 1.3 to 6.6), Killip class 1 or 2 (OR 2.3, 95% CI 1.3 to 3.9) and history of hypertension (OR 2.0, 95% CI 1.2 to 3.4).

Of those patients receiving heparin, 51% had a therapeutic activated partial thromboplastin time (aPTT) within 24 h. The rate across hospitals ranged from 28% to 58%. Sixteen percent had an aPTT >100 s within the first 24 h, and 5% never achieved an aPTT >46 s. In the second period there was no significant increase in the proportion of patients who achieved a therapeutic aPTT.

Aspirin at hospital discharge. Of the 321 patients considered ideal candidates for the prescription of aspirin at discharge, 209 (65%) received it (Table 2). Performance of this quality indicator varied across the hospitals from 58% to 72%. The prescribed use of aspirin at discharge slightly increased over the two periods, from 63% to 68% (p = 0.7) (Table 3). The absolute change at the hospitals ranged from −3% to 16%. After baseline differences between the groups were adjusted, the OR increase in the use of aspirin was 1.39 (95% CI 0.80 to 2.43). Other factors that were associated with performance of this quality indicator included aspirin as a preadmission medication (OR 5.2, 95% CI 2.9 to 9.5), history of chronic angina (OR 2.8, 95% CI 1.6 to 4.9), stress test (OR 2.8, 95% CI 1.6 to 5.1), history of stroke or transient ischemic attack (OR 3.3, 95% CI 1.1 to 9.8), Killip class 1 or 2 (OR 0.5, 95% CI 0.3 to 0.9) or tachypnea on presentation (OR 0.1, 95% CI 0.2 to 0.8).

After the patients who were coded with a principal discharge diagnosis of 786.50 (chest pain) were excluded, there remained 200 patients who were ideal candidates for aspirin at hospital discharge. Of this group, 139 (70%) were prescribed aspirin. The prescribed use of aspirin at discharge increased over the two periods, from 66% to 79% (p = 0.09). The absolute increase at the hospitals ranged from 4% to 20%. After adjustment of baseline differences between the groups, the OR increase in the use of aspirin was 2.10 (95% CI 0.91 to 5.01).

Clinical outcomes. The 30-day readmission rate for the first period was 18% compared with 9% in the second period (p = 0.03). The 30-day mortality rate for the first period was 2.3% compared with 1.0% in the second period (p = 0.2). After age, Killip class, diabetes mellitus and renal function were adjusted, the OR decrease in 30-day mortality from the 1993 to 1994 period to 1995 was 0.49 (95% CI 0.05 to 5.00), and the OR decrease in 30-day readmission was 0.52 (95% CI 0.27 to 0.99).

Discussion

We measured the quality of care between 1993 to 1994 and 1995 for elderly Medicare beneficiaries discharged from the hospital with a principal discharge diagnosis code consistent with unstable angina, and we found improvement in adherence to the best practices described by the AHCPR Guideline. We also found potential opportunities for improvement in the care of these patients. Our evaluation of consecutive patients admitted to three Connecticut hospitals over two periods with unstable angina revealed that 28% of appropriate patients did not receive aspirin on hospital admission, 76% did not receive heparin on admission and 35% were not prescribed aspirin at discharge.

Patients may not receive treatment which the Guideline states as optimal, either because of mere oversight or deliberate rejection of the recommendations of the expert panel. Clinical trial data supporting the use of these therapies preceded the

Table 3. Use of Aspirin and Heparin on Hospital Admission and Aspirin at Discharge Among Patients Without Contraindications by Time Period

	Aspirin on Admission			Aspirin at Discharge			Heparin on Admission		
	1993–1994	1995	p Value	1993–1994	1995	p Value	1993–1994	1995	p Value
Hospital A	74%	82%	0.3	59%	56%	0.9	21%	16%	0.6
Hospital B	69%	80%	0.2	71%	75%	0.3	5%	20%	0.008
Hospital C	57%	84%	0.002	61%	77%	0.3	34%	63%	0.003
Total	66%	82%	0.001	63%	68%	0.7	20%	32%	0.01

Data presented are percent of patients.

first study period, but some physicians may not have been aware of these studies or were not persuaded by them. In a recent study, many physicians, especially noncardiologists, were not confident about the benefit of several interventions, including aspirin, that had been demonstrated to be efficacious in clinical trials and endorsed by practice guidelines for the treatment of acute myocardial infarction (6).

The varied inclusion and exclusion criteria employed in trials of unstable angina may have raised concerns about generalizability and may have deterred some physicians from treating patients with the appropriate therapy (7–13). Unstable angina defies easy categorization and may comprise an extremely broad range of clinical conditions. Although the Guideline attempted to address this issue by creating criteria for risk stratifying a broad range of patients, the acceptance of this approach is not known.

To understand why the care of some patients may deviate from the Guideline's recommendations, we identified the factors independently associated with the decision not to treat patients with aspirin and heparin on admission and aspirin at discharge. No unifying explanation emerged from this analysis because different factors related to each of the indicators. As expected, the previous use of aspirin was predictive of its use on admission and at discharge. Patients with known coronary artery disease, as evidenced by previous revascularization, were more likely to receive heparin. Neither age nor gender was associated with performance of any of the indicators.

Adherence to the Guideline recommendations for all three indicators was higher in the second period, suggesting that the recent attention to quality improvement and the dissemination of information on unstable angina through the efforts of the AHCPR and other organizations may have had a salutary effect. The Guideline, which distilled the information available in the published medical data into several recommendations and treatment algorithms, was widely publicized. More than 500,000 copies were distributed to health care providers around the country. Between 1993 to 1994 and 1995, contemporaneous with the publication of the AHCPR Guideline, there was a marked improvement in the process of care for patients with unstable angina. This change in practice occurred even though the information on which the specific recommendations about aspirin and heparin were based had been available for several years. In particular, the use of aspirin on presentation improved dramatically. Although these data cannot prove a causal relation, they do demonstrate an improvement in the process of care during a period in which leaders in cardiology focused their attention on defining and improving the optimal care of this condition.

Despite the improvement in care, the use of heparin remained low. The explanation for this practice may involve the perception of the patient's risk. Although the Guideline places elderly patients into at least the intermediate risk category on the basis of age alone, we found that elderly patients admitted with unstable angina in actual clinical practice had fairly low risk characteristics aside from their age. Few of these patients had tachycardia, tachypnea or hypotension, and one-fifth had a normal ECG on presentation. The mortality rate for the group was only 2%. Unstable angina is commonly considered a high risk condition, but our data suggest that many of these patients may not have had a high risk ischemic syndrome.

The recognition by treating physicians of a low risk subgroup of elderly patients may explain why clinical practice occasionally deviates from the recommendations of the expert panel. The Guideline indicated that patients >65 years old and meeting criteria for the diagnosis of unstable angina merit hospital admission. However, if many older patients with criteria for unstable angina are truly at low risk, despite their age, then the Guideline would not support a decision to admit and initiate heparin therapy, but would commend outpatient management as it does for younger low risk patients. It is therefore possible that clinicians who admitted elderly patients with unstable angina according to local standards recognized many of these patients as having a low risk of adverse outcomes and, accordingly, withheld heparin.

Among the patients who did begin heparin therapy, many did not reach the target levels of anticoagulation cited by the AHCPR Guideline within 24 h of the initiation of therapy. This finding has been observed by other investigators and demonstrates that an assessment of the use of heparin needs to be supplemented by information about whether it is being given in the proper dose (14). Determining merely whether heparin was used does not truly indicate the adequacy of therapy, because even patients who satisfy the quality indicator for heparin may not be therapeutically anticoagulated. This finding also identifies an area for improvement. Hospitals need to develop better strategies to achieve therapeutic anticoagulation, such as the use of weight-based heparin dosing (15).

Finally, there was a clear association between the site of care and the use of medications. With such a small number of hospitals, the stratification of results by hospital characteristics would obviously reveal their identities and violate our confidentiality agreement. We can note, however, that marked differences occurred and may represent cultures and processes particular to each institution. Hospitals cooperated in this project to identify ways to ameliorate quality of care and are already embarking on quality improvement initiatives.

Although this study focused on process of care as a surrogate for quality of care, it also included information on outcome. The mortality rate of the patients admitted to the hospital during the first period was higher than that in the second period. With the small number of events, the study was not adequately powered to detect a significant difference. The nonsignificant difference in the mortality rate in the face of an improvement in process illustrates the difficulty of focusing solely on outcomes as a measure of quality, because each improvement in process does not translate directly into an improvement in outcome. Because many patients must be treated with an efficacious medical strategy to save even one life, a relatively small sample size may limit our ability to detect differences in mortality in a single institution or several institutions. However, for these patients, a more important out-

come may be the readmission rate within 30 days. The readmission rate of the patients admitted to the hospital during the first period was significantly higher than that in the second period, even after adjusting for baseline differences. Although this difference cannot be attributed to the change in process, it was reassuring to observe improvements in process and outcome tracking together. Nevertheless, the observed decrease in readmissions is larger than what would have been expected from the improvements in process alone.

Study limitations. This study has several limitations: 1) The information was collected by retrospective chart review and is dependent on the quality of the record-keeping. However, the medications, which constitute the most important variables, were well documented in the hospital record. 2) The identification of cases was dependent on coding of the principal discharge diagnosis. To improve the sensitivity of our case ascertainment, we included a broad range of codes and validated the diagnosis by chart review. To improve specificity, we excluded patients admitted for an elective procedure or those who did not have chest pain consistent with ischemia within 24 h of admission. 3) Our study was restricted to three hospitals, although we did include a range of facilities. 4) The sample size is another limitation. We had the power to detect moderate improvements in the process of care. Aspirin and heparin on hospital admission showed marked improvement, and the differences over time were significant. The improvement in aspirin at hospital discharge was more modest and did not reach statistical significance. This result may have been statistically significant with a larger number of patients. Also, given the relatively small number of outcome events, we could not quantify precisely the association between the improvements in process and the improvements in the clinical outcomes. A much larger sample size or a much higher event rate would have been necessary to examine this issue. Despite these limitations, this study provides a first step toward addressing the remarkable dearth of information on the actual care of elderly patients with unstable angina.

Conclusions. This study indicates the progress toward better treatment of patients with unstable angina and the challenges for the future. Improvement in adherence to the best practice is occurring, but there remain patients who do not receive care that is consistent with the practice guidelines. The reasons for the lack of adherence to the recommendations and their implications on patient outcomes need further investigation. The low event rate in this group suggests that some elderly patients with symptoms consistent with an ischemic syndrome may be stratified as low risk, thus avoiding hospital admission.

We are indebted to the many individuals from the Connecticut Peer Review Organization and the hospitals, physicians and health care professionals who participated in this project. We are also indebted to Maria Johnson for editorial assistance with the manuscript.

References

1. Braunwald E, Mark D, Jones R, et al. Unstable angina: diagnosis and management. In: Clinical Practice Guideline No. 10, AHCPR Publication No. 94-0602. Public Health Service, U.S. Department of Health and Human Services. Rockville (MD): Agency for Health Care Policy and Research and the National Heart, Lung, and Blood Institute. 1994.
2. Graves E. National hospital discharge survey: annual summary, 1991. National Center for Health Statistics. Vol. 114. Washington, DC: Public Health Service, 1993.
3. Landwehr J, Pregibon D, Shoemaker A. Graphical methods for assessing logistic regression models. J Am Statistical Assoc 1984;79:61–3.
4. Hosmer D, Lemeshow S. Applied Logistic Regression. New York: Wiley, 1989.
5. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1992;143:29–36.
6. Ayanian JZ, Hauptman PJ, Guadagnoli E, Antman EM, Pashos CL, McNeil BJ. Knowledge and practices of generalist and specialist physicians regarding drug therapy for acute myocardial infarction. N Engl J Med 1994:1136–42.
7. Telford AM, Wilson C. Trial of heparin versus atenolol in prevention of myocardial infarction in intermediate coronary syndrome. Lancet 1981;1: 1225–8.
8. Theroux P, Ouimet H, McCans J, et al. Aspirin, heparin, or both to treat acute unstable angina. N Engl J Med 1988;319:1105–11.
9. Theroux P, Waters D, Qiu S, McCans J, deGuise P, Juneau M. Aspirin vs. heparin to prevent myocardial infarction during the acute phase of unstable angina. Circulation 1993;88(Pt. 1):2045–8.
10. Lewis HD Jr, Davis JW, Archibald DG, et al. Protective effects of aspirin against acute myocardial infarction and death in men with unstable angina: results of a Veterans Administration Cooperative Study. N Engl J Med 1983;309:396–403.
11. Wallentin LC, for the Research Group on Instability in Coronary Artery Disease in Southeast Sweden. Aspirin (75 mg/day) after an episode of unstable coronary artery disease: long term effects on the risk for myocardial infarction, occurrence of severe angina and the need for revascularization. J Am Coll Cardiol 1991;18:1587–93.
12. Antiplatelet Trialists' Collaboration. Collaborative overview of randomised trials of antiplatelet therapy. I. Prevention of death, myocardial infarction, and stroke by prolonged antiplatelet therapy in various categories of patients. BMJ 1994;308:81–106.
13. The RISC Group. Risk of myocardial infarction and death during treatment with low dose aspirin and intravenous heparin in men with unstable coronary artery disease. Lancet 1990;336:827–30.
14. Fennerty AG, Thomas P, Backhouse G, Bentley P, Campbell IA, Routledge PA. Audit of control of heparin treatment. BMJ 1985;290:27–8.
15. Raschke RA, Reilly BM, Guidry JR, Fontana JR, Srinivas S. The weight-based heparin dosing nomogram compared with a "standard care" nomogram. Ann Intern Med 1993;119:874–81.