Payer Status and the Utilization of Hospital Resources in Acute Myocardial Infarction

A Report From the National Registry of Myocardial Infarction 2

John G. Canto, MD, MSPH; William J. Rogers, MD; William J. French, MD; Joel M. Gore, MD; Nisha C. Chandra, MD; Hal V. Barron, MD; for the National Registry of Myocardial Infarction 2 Investigators

Background: Prior studies have suggested that payer status may be an important determinant of medical resource utilization and outcome in acute myocardial infarction (AMI).

Methods: A national cohort of 332,221 patients with AMI enrolled from June 1994 to July 1996 were compared within 5 payer groups to ascertain the influence of payer status on hospital resource allocation for AMI in the United States.

Results: Medicare comprised the largest proportion (56%), followed by commercial insurance (25%), health maintenance organization (HMO) (10%), uninsured (6%), and Medicaid (3%). Compared with commercially insured patients, Medicare and Medicaid patients received fewer reperfusion therapies, underwent fewer invasive cardiac procedures, and had longer hospitalizations. After adjusting for differences in clinical characteristics, Medicare recipients were as likely as commercially insured patients to receive acute reperfusion therapies or any invasive cardiac procedure. Uninsured and HMO patients tended to utilize hospital resources with intermediate frequency. Medicare recipients aged 65 years or older and the HMO group had similar hospital mortality rates compared with the commercial group (odds ratio [OR], 1.07; 95% confidence interval [CI], 0.96-1.20 and OR, 0.93; 95% CI, 0.83-1.04, respectively), but Medicaid and uninsured groups had higher hospital mortality rates compared with the commercial group (OR, 1.30; 95% CI, 1.14-1.48 and OR, 1.29; 95% CI, 1.12-1.48, respectively).

Conclusion: This report suggests significant variation in payer status in the management of AMI throughout the United States, but no important differences in mortality among the 3 largest payer groups.

Arch Intern Med. 2000;160:817-823
PATIENTS AND METHODS

PATIENT POPULATION

The NRMI 2 is a multicenter, voluntary study designed to collect, analyze, and report cross-sectional data on patients admitted with confirmed AMI at participating hospitals, and has enrolled 332,221 patients from June 1994 to July 1996. Data from each enrolled patient are entered onto a 2-page case report form by trained chart abstractors and forwarded to ClinTrials Research, Inc., Lexington, Ky. Double key data entry and 87 electronic data checks are routinely performed by the data collection center to help ensure the accuracy, consistency, and completeness of the data. Inaccurate and internally inconsistent case report forms are excluded from analysis and returned to the principal hospital site for additional review and correction. Hospitals are strongly encouraged to consecutively enroll all patients with a diagnosis of AMI. Confirmation of AMI is based on having at least 1 of the following criteria: (1) a total creatine kinase (CK) or CK-MB level greater than or equal to twice the upper limits of normal; (2) electrocardiographic evidence indicative of AMI; (3) alternative enzymatic, scintigraphic, or autopsy evidence indicative of AMI; or (4) International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis code of 410.X1.

The NRMI 2 database was analyzed by primary payer status. First, the study population was divided into the following 5 payer groups: Medicare, Medicaid, HMO, uninsured, and commercial. Patients whose primary payer were the Veterans Administration or Champus (<1% of total), other (which includes charity or free care), and unknown (8% of total) were not included in this analysis. Also, at the conception of the NRMI 2 case report form, Medicare/Medicaid HMOs were not considered a separate payer category.

DEFINITION OF PRIMARY PAYER STATUS

Medicare included all state and federal Medicare-type programs for qualified individuals aged 65 years or older, and qualified persons with end-stage renal disease who required dialysis or a kidney transplant (regardless of age). Medicaid included all state and federal Medicaid-type programs for certain low-income individuals. HMO involved the following models that provided health care services for members on a prepaid basis: staff-model, group model, network model, and individual practice associations. Uninsured included patients with no health insurance and cases in which the individual was the primary payer regardless of the ability to pay. Commercial covered all indemnity (fee-for-service) carriers and preferred provider organizations.

STUDY VARIABLES

Patients from each payer group were analyzed with respect to (1) baseline and clinical presenting characteristics; (2) utilization of hospital resources, such as acute reperfusion strategies, coronary arteriography, coronary angioplasty, CABG surgery, and length of hospitalization; and (3) mortality. Acute reperfusion strategies, defined by the use of intravenous or intracoronary thrombolytic therapy, primary angioplasty, or immediate CABG, were determined in AMI patients who presented with ST segment elevation or left bundle branch block on the first electrocardiogram, within 12 hours of symptom onset, and with no contraindication to thrombolytic therapy. Invasive cardiac procedures included any coronary arteriography, coronary angioplasty (primary/immediate, rescue, and elective), and CABG surgery (immediate and elective) performed during the hospitalization.

STATISTICAL METHODS

Differences between the groups were assessed by the χ² test for percentages, analysis of variance for mean comparisons, and nonparametric test for median comparisons. Multiple logistic regression analyses were used to ascertain whether payer status was an important predictor of (1) receiving intravenous thrombolytic therapy or primary angioplasty, (2) receiving coronary arteriography and subsequent coronary revascularization, and (3) hospital mortality in the study population. In these adjusted models, payer groups were compared with the commercial (referent) group, and the odds ratio (OR) and 95% confidence interval (CI) were reported. All statistical analyses were performed with SAS 6.10 statistical package programs (SAS Institute, Cary, NC). This report was based on information processed by the central data collection center as of July 31, 1996.

RESULTS

BASELINE AND PRESENTING CHARACTERISTICS

Baseline and presenting characteristics of the patients, by payer status, are shown in Table 1. From June 1994 to July 1996, a total of 295,921 patients satisfying the study definition were enrolled in the NRMI. Medicare and commercial insurance represented four fifths of all study patients, and HMO, uninsured, and Medicaid represented the remaining one fifth of patients (9%, 6%, and 3%, respectively). Medicare recipients represented a predominantly older group (mean age, 75 years) compared with the other payer groups (mean age, 57 years) with a higher proportion of whites and women. The uninsured group was the youngest group. Medicaid had a higher proportion of women, and the uninsured had a higher proportion of men. The commercial group tended to be predominantly middle-aged, white men.

Medicare and Medicaid recipients were more likely to have a history of heart failure or AMI and a higher likelihood of diabetes mellitus and hypertension. Patients in the commercial and the uninsured groups were less likely to have a history of heart failure or AMI and a lower likelihood of diabetes mellitus and hypertension. The HMO group was more apt to be in the midrange with respect to baseline demographics, history of cardiac disease, diabetes mellitus, and hypertension compared with the other payer groups.
Compared with commercially insured patients, Medicare and Medicaid recipients were more likely to delay longer before hospital arrival, present with atypical clinical symptoms (without chest pain), and were more likely to have a worse Killip heart failure classification on initial evaluation. Once in the hospital, Medicare and Medicaid patients more frequently had congestive heart failure, cardiogenic shock, and were subsequently found to have lower ejection fractions (when measured) and higher unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality.

Table 1. Patient Baseline and Presenting Characteristics by Payer Status*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Medicare (n = 165,456)</th>
<th>Medicaid (n = 99,099)</th>
<th>HMO (n = 27,953)</th>
<th>Uninsured (n = 17,118)</th>
<th>Commercial (n = 75,485)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic profile</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean, y</td>
<td>75‡</td>
<td>58‡</td>
<td>60‡</td>
<td>53‡</td>
<td>56‡</td>
</tr>
<tr>
<td>Female, %</td>
<td>47‡</td>
<td>47‡</td>
<td>29‡</td>
<td>27‡</td>
<td>24‡</td>
</tr>
<tr>
<td>Nonwhite, %</td>
<td>11§</td>
<td>34‡</td>
<td>19‡</td>
<td>12‡</td>
<td>11‡</td>
</tr>
<tr>
<td>Medical history, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous MI</td>
<td>29‡</td>
<td>28‡</td>
<td>21†</td>
<td>17†</td>
<td>18‡</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>18‡</td>
<td>13‡</td>
<td>7†</td>
<td>4†</td>
<td>4†</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>29‡</td>
<td>34‡</td>
<td>23‡</td>
<td>18§</td>
<td>19†</td>
</tr>
<tr>
<td>Hypertension</td>
<td>54‡</td>
<td>53‡</td>
<td>47‡</td>
<td>40‡</td>
<td>43‡</td>
</tr>
<tr>
<td>Clinical presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest pain on presentation, %</td>
<td>68‡</td>
<td>78‡</td>
<td>81‡</td>
<td>86§</td>
<td>85‡</td>
</tr>
<tr>
<td>Symptom onset to hospital time, min</td>
<td>138‡</td>
<td>132‡</td>
<td>120‡</td>
<td>120†</td>
<td>114‡</td>
</tr>
<tr>
<td>Ambulance, %</td>
<td>51‡</td>
<td>49‡</td>
<td>49‡</td>
<td>47‡</td>
<td>38‡</td>
</tr>
<tr>
<td>Systolic BP, mean, mm Hg</td>
<td>143.0§</td>
<td>141.7†</td>
<td>142.1</td>
<td>141.2†</td>
<td>142.5</td>
</tr>
<tr>
<td>Pulse, mean/min</td>
<td>87.2‡</td>
<td>87.5†</td>
<td>82.3‡</td>
<td>82.9‡</td>
<td>80.8‡</td>
</tr>
<tr>
<td>Killip class I, %</td>
<td>67‡</td>
<td>75‡</td>
<td>83‡</td>
<td>84‡</td>
<td>88‡</td>
</tr>
<tr>
<td>ST segment elevation or LBBB, %</td>
<td>45‡</td>
<td>49‡</td>
<td>53‡</td>
<td>60†</td>
<td>55‡</td>
</tr>
<tr>
<td>Q wave infarction, %</td>
<td>48.1‡</td>
<td>52.1‡</td>
<td>55.5‡</td>
<td>63.4‡</td>
<td>60.3‡</td>
</tr>
<tr>
<td>Anterior infarction, %</td>
<td>27.9§</td>
<td>29.2</td>
<td>28.5</td>
<td>32.9†</td>
<td>28.7†</td>
</tr>
<tr>
<td>Clinical outcome (unadjusted), %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recurrent ischemia</td>
<td>13.7‡</td>
<td>13.8‡</td>
<td>14.5‡</td>
<td>14.8§</td>
<td>15.5‡</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>22.4‡</td>
<td>15.3†</td>
<td>11.2†</td>
<td>9.6‡</td>
<td>8.8‡</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>6.8‡</td>
<td>4.9†</td>
<td>3.9‡</td>
<td>4.4‡</td>
<td>3.2‡</td>
</tr>
<tr>
<td>Ejection fraction†</td>
<td>45.0‡</td>
<td>46.0†</td>
<td>49.0‡</td>
<td>50.0†</td>
<td>50.0</td>
</tr>
</tbody>
</table>

*HMO indicates health maintenance organization; MI, myocardial infarction; BP, blood pressure; and LBBB, left bundle branch block.
†Assessment of ejection fraction was not performed on all patients; the sample sizes for ejection fraction were available as follows: Medicare, 88,484; Medicaid, 54,959; HMO, 15,305; uninsured, 9,552; and commercial, 44,306.
‡P < .01.
§P < .05 (compared with commercial).

Compared with commercially insured patients, Medicare and Medicaid recipients were more likely to delay longer before hospital arrival, present with atypical clinical symptoms (without chest pain), and were more likely to have a worse Killip heart failure classification on initial evaluation. Once in the hospital, Medicare and Medicaid patients more frequently had congestive heart failure, cardiogenic shock, and were subsequently found to have lower ejection fractions (when measured) and higher unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality. Conversely, the commercial group was more likely to arrive earlier at the hospital, to be in Killip heart failure classification I, and to have a lower likelihood of congestive heart failure, cardiogenic shock, and unadjusted in-hospital mortality.

Invasive Cardiac Procedures

There was significant variation in the utilization of invasive cardiac procedures among the 5 payer groups. Among the entire study population, 52% received coronary angiography and this was lowest among Medicare and Medicaid recipients (42% and 52%, respectively) and highest among the commercially insured (67%). The proportion of patients who presented to hospitals with on-site catheterization facilities varied little among the payer groups (range, 83%-86%). The mean proportion of all patients...
who underwent coronary angioplasty, atherectomy, stent, or intracoronary laser therapies was 21%, and was lowest among Medicare and Medicaid recipients (15% and 20%, respectively) and highest among commercially insured patients (30%). Lastly, the mean proportion of all patients who underwent CABG surgery was 10%, and was lowest among Medicare, Medicaid, and uninsured patients (range, 9%-10%) and highest among commercially insured patients (12%).

After adjusting for the effect of age and other important baseline and presenting characteristics (listed in Table 2), Medicare and Medicaid recipients were as likely as commercially insured patients to undergo any invasive cardiac procedure (coronary angiography: OR, 1.01 [95% CI, 0.97-1.05]; catheter-based revascularization procedure: OR, 0.94 [95% CI, 0.91-0.98]; CABG surgery: OR, 1.05 [95% CI, 0.99-1.10]). Otherwise, patients in the Medicaid, HMO, and uninsured groups were least likely to receive coronary arteriography (Medicaid: OR, 0.71 [95% CI, 0.66-0.77]; HMO: OR, 0.72 [95% CI, 0.68-0.75]; uninsured: OR, 0.64 [95% CI, 0.61-0.68]), and Medicaid and uninsured patients were the least likely to receive catheter-based procedures (Medicaid: OR, 0.81 [95% CI, 0.75-0.88]; uninsured: OR, 0.86 [95% CI, 0.81-0.90];) or CABG surgery (Medicaid: OR, 0.87 [95% CI, 0.77-0.97]; uninsured: OR, 0.78 [95% CI, 0.72-0.84]).

### Length of Intensive Care Unit Care and Overall Hospitalization

The overall length of stay (data not shown) was evaluated among nontransferred-out patients who survived to hospital discharge, and this was shortest in HMO (7.0 mean days; 5.8 median days), uninsured (7.0 mean days; 5.9 median days), and commercial (7.1 mean days; 6.0 median days) patients and longest in Medicaid (8.2 mean days; 6.6 median days) and Medicare (8.8 mean days; 7.2 median days) patients.

### ADJUSTED HOSPITAL MORTALITY

To determine whether payer status was a predictor associated with hospital mortality (the dependent variable), multiple logistic regression analysis was performed to adjust for available differences in presenting characteristics among the payer groups. Variables included in the model are listed in the Figure. Each payer group was compared with the commercial group. The overall age-adjusted mortality in the Medicare group was increased (compared with the commercial group: OR, 1.29 [95% CI, 1.19-1.39]; P<.001). However, when the analysis was confined to patients 65 years or older, Medicare patients had no statistically significant difference in mortality compared with the commercial group. On the other hand, Medicaid and uninsured groups showed both higher short-term mortality compared with the commercial group (OR, 1.30 [95% CI, 1.14-1.48]; OR, 1.29 [95% CI, 1.12-1.48]; both P values <.001, respectively). Patients insured by an HMO had similar adjusted hospital mortality rates when compared with the commercial group (OR, 0.93 [95% CI, 0.83-1.04]; P = .20). The C index for the receiver operating characteristic curve of this logistic re-
gession model, a measure of the predictive accuracy of mortality in this model, was highly predictive at 0.84.

COMMENT

This descriptive report, which represents one of the largest observational series of patients with AMI collected to date, showed that Medicare and commercial (fee-for-service) patients represented four fifths of all study patients and that HMO, uninsured, and Medicaid represented the remaining one fifth. Significant payer variation in the United States was evident with respect to baseline demographics, presenting characteristics, and hospital resource utilization, including the use of acute reperfusion therapies, invasive cardiac procedures, and length of hospitalization. After adjusting for age and other important clinical characteristics, the commercial and Medicare groups tended to utilize overall hospital resources with the greatest and similar frequency, HMO and uninsured patients with intermediate frequency, and Medicaid recipients with the lowest frequency (although Medicaid patients were among those with the longest hospitalizations).

PRESENTING CHARACTERISTICS

Payer groups represented a diverse collection of patients. Medicare and Medicaid recipients generally had a much higher-risk profile at the time of clinical presentation: Medicare, by virtue of an older mean age, but also both groups tended to have a higher proportion of women, with more diabetes mellitus, hypertension, prior AMI and congestive heart failure, later presentation to the hospital, and a higher Killip heart failure classification on initial evaluation. Our observations are consistent with Miles and Parker,19 who recently reported that Medicare and Medicaid (also the uninsured) payer groups are frequently poor, with a higher proportion of women and chronic medical conditions when compared with those with private insurance. Conversely, commercially insured patients were more likely to have a lower-risk profile with a lower proportion of women, less diabetes mellitus or hypertension, less prior AMI or congestive heart failure, earlier presentation to the hospital, and a lower Killip classification on initial evaluation.

UTILIZATION OF HOSPITAL RESOURCES

Acute Reperfusion Therapies and Invasive Cardiac Procedures

Reperfusion therapies were used in 76% of appropriate patients who presented with ST segment elevation or left bundle branch block, within 12 hours of symptom onset, and no contraindication to thrombolytic therapy. Especially concerning were the significantly lower proportion of Medicaid and Medicare candidates who received acute reperfusion therapies, despite fulfilling many of the established criteria for receiving these lifesaving therapies. Even after adjusting for important baseline differences, Medicaid was associated with a lower utilization of acute reperfusion therapies. The full benefits of national health care policy initiatives that have recently focused on the prehospital (earlier hospital presentation) and hospital (door-to-drug treatment times) components in AMI treatment20 may be significantly diminished if hospitals and health care professionals withhold acute reperfusion therapies in “appropriate” AMI patients who otherwise fulfill criteria for thrombolysis and other modalities.

In the NRMI Medicare population, it appears that their demographic profile (which generally included a significantly older age group) and the presence of more coexisting illnesses, accounted for the lower use of acute reperfusion therapies and invasive cardiac procedures, and not payer status itself. After adjusting for these important factors, Medicare recipients were as likely as the commercial group to receive acute treatments, coronary arteriography, or subsequent coronary revascularization. On the other hand, after adjusting for these baseline differences, Medicaid patients, HMO patients, and the uninsured were the least likely to undergo coronary arteriography, and Medicaid recipients and the uninsured were the least likely to receive subsequent coronary revascularization compared with the commercial group.

Although speculative, these analyses by payer group raise the question whether economic considerations may have partially contributed to the degree of differences observed among payer groups. For example, the commercial group, whose physicians may have a stronger economic incentive to perform a more expensive strategy of risk stratification, were also the most likely to utilize this costly procedure. Conversely, Medicaid, HMO, and the uninsured groups, whose physicians may consider more inexpensive alternatives to initially risk stratify their patients with AMI, were also the least likely to utilize this more costly procedure when available. These findings also paralleled those observed by Sada et al,2 although their analysis represented only 10% of the NRMI population using strict inclusion criteria. Lastly, the presence of an on-site cardiac catheterization facility, which may be associated with increased utilization of invasive cardiac procedures, varied little between payer groups, and could not have explained the variation seen among payer groups.

Length of Hospital Stay

In NRMI 2, the total length of stay in the hospital varied, ranging from 7.0 to 8.8 mean days and 5.8 to 7.2 median days among the payer groups, and was highest among Medicare and Medicaid groups. Overall length of hospital stay has been one of the most important determinants of the total cost of care.21 Young and Cohen22 and Chen and Naylor23 have reported that those of advanced age, female sex, and with more chronic diseases were more likely to have increased length of stay, characteristic features frequently seen in Medicare and Medicaid recipients. Also, Every et al13 and Grines et al24 have shown that the use of early diagnostic coronary arteriography may predict a shorter hospital stay, and Medicare and Medicaid patients were least likely to undergo such procedures (unadjusted). Furthermore, both these groups tended to have more in-hospital complications, such as
heart failure and cardiogenic shock, which may have required prolonged care.

IN-HOSPITAL MORTALITY

Is the utilization of hospital resources associated with improved in-hospital survival? The NRMI 2 data show that there were no important differences in hospital-adjusted mortality among commercially insured patients, HMO patients, and conventional Medicare patients aged 65 years or older (93% of all Medicare patients) despite different degrees of hospital resource utilization. These results are also largely comparable to those found by Kreindel et al., who reported that patient insurance status was not significantly associated with short-term mortality following AMI in a metropolitan, population-based study. The outlier payer groups associated with a higher in-hospital adjusted mortality included Medicare recipients younger than 65 years (7% of all Medicare patients), Medicaid recipients, and uninsured patients. Especially concerning was the observation that the Medicaid cohort, who tended to receive less acute reperfusion therapies and less invasive cardiac procedures, also had a higher in-hospital mortality. Whether the less aggressive use of medical resources contributed to their worse survival warrants additional investigation. Although there may be differences in adjusted hospital mortality among these latter groups, we cannot rule out the possibility that unmeasured confounding variables, and not payer status or the care received while in the hospital, were responsible for such differences.

Medicare recipients younger than 65 years, who primarily represent patients with end-stage renal disease, are an extremely high-risk group associated with increased mortality. Furthermore, the uninsured have a higher proportion of patients of lower socioeconomic status who may be unemployed, undereducated, homeless, or abuse drugs; and similarly, Medicaid recipients have a higher proportion of minority women receiving welfare. In the NRMI 2, such important factors that may be associated with a worse prognosis were not collected in the case report form, and their exclusion alone may account for the higher adjusted mortality observed in Medicare recipients younger than 65 years, Medicaid recipients, and uninsured patients.

LIMITATIONS

The NRMI 2 was not a randomized sample of patients or hospitals, and therefore our results may be subject to bias and confounding by unknown and known factors not collected in the NRMI 2. Registry hospitals, which collectively represent almost one fourth of all acute care hospitals in the United States, were more likely to be larger, have a coronary care unit or emergency department, and have capabilities to perform coronary arteriography or CABG surgery than nonregistry hospitals. Also, NRMI 2 has no mechanism in place to verify or validate the potential for nonconsecutive enrollment of AMI patients. In addition, data for each patient were only collected during the hospitalization. Therefore, patients who died prior to hospital arrival were not included in this analysis. Longitudinal follow-up after hospital transfer or discharge was not available, and the impact of procedures performed after hospital discharge and those rehospitalized for postinfarct angina without myocardial necrosis were unknown.

Primary payer status was determined by chart review from trained abstractors, but proper coding of primary payer status was not directly verified or validated. Therefore, payer misclassification may be possible, especially in situations where more than one payer group existed. Also, at the conception of the NRMI 2 case report form, Medicare/Medicaid HMOs were not largely prevalent, and were not considered a separate payer category. Recent figures from the Health Care Financing Administration Internet site (http://www.hcfa.gov) report that only a minority (<10%) of all Medicare beneficiaries were enrolled in managed care plans in 1996, and Medicare HMOs in our analysis likely represent an even smaller proportion as our study predates this 1996 figure when Medicare HMOs were even less prevalent.

The utilization of acute reperfusion therapies and invasive cardiac procedures and length of stay represent surrogate economic markers, and true hospital costs or charges were not collected. Furthermore, it was unknown whether the physicians involved were aware of the payer status during the patient's hospitalization. Also, other important sociodemographic factors, which were not collected in NRMI 2, such as employment, education, and income, or choices that were available to the patient at the time of enrollment, may have influenced which insurance was ultimately obtained. In addition, patients' satisfaction with their health plan was unknown. Lastly, certain health plans may be inherently biased to select the healthier patients.

CONCLUSIONS

This comparative report of almost one third of a million AMI patients enrolled in the NRMI 2 from June 1994 to July 1996 showed that the commercial and Medicare groups tended to utilize hospital resources with the greatest frequency, HMO and uninsured patients with intermediate frequency, and Medicaid recipients with the lowest frequency. However, after adjusting for age and other important baseline characteristics, there were no important differences in hospital mortality among the 3 largest payer groups—commercially insured patients, HMO patients, and conventional Medicare patients aged 65 years or older.

Accepted for publication June 29, 1999.

This work was partially supported by grant HS08843 from the Agency for Health Care Policy and Research.

The National Registry of Myocardial Infarction 2 is supported by Genentech, Inc, South San Francisco, Calif.

A list of hospitals participating in the National Registry of Myocardial Infarction 2 can be obtained from ClinTrials Research, Inc, 220 Lexington Green Cir, Suite 200, Lexington, KY 40503.

Reprints: John G. Canto, MD, MSPH, University of Alabama Medical Center, 363 BDB, 1808 Seventh Ave S, Birmingham, AL 35294-0012.
REFERENCES

14. Ware JE, Bayliss MS, Rogers WH, Kosinski M, Tarlov AR. Differences in 4-year health outcomes for elderly and poor, chronically ill patients treated in HMO and fee-for-service systems. JAMA. 1996;276:1039-1047.