

Evidence-Based Therapies and Mortality in Patients Hospitalized in December with Acute Myocardial Infarction

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Background: Previous studies suggest that patients hospitalized with acute myocardial infarction (MI) in December have poor outcomes, and some studies have hypothesized that the cause may be the infrequent use of evidence-based therapies during the December holiday season.

Objective: To compare the care and outcomes of patients with acute MI hospitalized in December and patients hospitalized during other months.

Design: Retrospective analysis of data from the Cooperative Cardiovascular Project.

Setting: Nonfederal, acute care hospitals in the United States.

Patients: 127 959 Medicare beneficiaries hospitalized between January 1994 and February 1996 with confirmed acute MI.

Measurements: Use of aspirin, β -blockers, and reperfusion therapy (thrombolytic therapy or percutaneous coronary intervention), and 30-day mortality.

Results: When the authors controlled for patient, hospital, and physician characteristics, the use of evidence-based therapies was not significantly lower but 30-day mortality was higher (21.7% vs. 20.1%; adjusted odds ratio, 1.07 [95% CI, 1.02 to 1.12]) among patients hospitalized in December.

Limitations: This was a nonrandomized, observational study. Unmeasured characteristics may have contributed to outcome differences.

Conclusions: Thirty-day mortality rates were higher for Medicare patients hospitalized with acute MI in December than in other months, although the use of evidence-based therapies was not significantly lower.

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The incidence of acute myocardial infarction (MI) in the United States is higher during the winter months (1), and patients hospitalized with acute MI in the winter, particularly during the December holiday season, have higher mortality (2). The cause of this increase in mortality is not understood. In addition, a recent study documented an increase in daily mortality (after adjustment for trends and seasonal factors) for patients with cardiac and noncardiac diseases who were hospitalized during the Christmas and New Year's holiday season (3). To our knowledge, there has been no analysis of the level of care provided to patients hospitalized during the winter holidays and its relationship to mortality. Therefore, we examined the use of evidence-based therapies and 30-day mortality rates in patients hospitalized in December with acute MI.

METHODS

Source of Data

Data were from the Cooperative Cardiovascular Project, a program of the Centers for Medicare & Medicaid Services to improve quality of care for Medicare beneficiaries hospitalized with acute MI. The data set contains records for patients discharged between January 1994 and February 1996 from nonfederal, acute care hospitals in the United States with a primary diagnosis of acute MI (International Classification of Diseases, Ninth Revision, Clinical Modification code 410). Prespecified demographic, clinical, and treatment variables were abstracted from hospital discharge records. Charts were reabstracted randomly

to confirm the validity of the database, resulting in overall variable agreement of 95% (4).

Quality indicators for processes of care for acute MI were developed by the Centers for Medicare & Medicaid Services as reported by Marciniak and associates (4). These indicators include use of aspirin, β -blockers, and reperfusion therapy (that is, thrombolytic treatment or primary percutaneous coronary intervention). The indicators have been validated and incorporated into national guidelines of care (5, 6).

The institutional review board of Duke University Medical Center approved this study.

Study Sample

We limited our analysis to patients 65 years of age and older with a confirmed diagnosis of MI. Myocardial infarction was defined as elevation of creatine kinase-MB level greater than 5%, elevation of lactate dehydrogenase levels with isoenzyme reversal, or 2 of the following: chest pain in the previous 48 hours, 2-fold elevation in creatine kinase

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Context

In the United States, the outcomes of patients who have myocardial infarctions (MIs) in December are worse than the outcomes during other months. Some attribute this result to less use of evidence-based therapies during the holiday season.

Contribution

From January 1994 through February 1996, Medicare beneficiaries hospitalized with acute MI in December received evidence-based therapies at the same rate as patients hospitalized in other months but had slightly higher 30-day mortality rates (21.7% vs. 20.1%; $P < 0.001$).

Implications

Worse outcomes in patients with MI during December are not attributable to less frequent use of evidence-based therapies.

—The Editors

level, or electrocardiographic changes (ST-segment elevation or new Q waves) (4). For patients with multiple admissions for MI or readmissions during the study period, only data from the first admission were used. We also excluded patients with invalid ZIP codes, patients hospitalized outside the 50 states or the District of Columbia, patients transferred to another acute care facility, and patients in hospitals with fewer than 10 admissions during any calendar year. The 4 states that participated in the original Cooperative Cardiovascular Project quality improvement project were excluded from the analysis.

Statistical Analysis

We defined the month of December as the period of interest and compared the care and outcomes of patients hospitalized in December with the care and outcomes of patients hospitalized during the remainder of the year. To test for differences between patients hospitalized in December and those hospitalized during other months, we developed bivariate regression models using generalized estimating equations to account for the clustered structure of the sample (that is, patients clustered within hospitals). To test for differences in Killip class at admission, we used the Wilcoxon rank-sum test. We developed multivariable logistic regression models using generalized estimating equations to examine associations between admission during December and both the use of evidence-based therapies and 30-day mortality. We controlled for demographic characteristics, socioeconomic status, clinical characteristics, “ideal” patient status (that is, no documented contradictions to each of the evidence-based therapies), hospital characteristics, and physician characteristics, and accounted for the clustering of patients within hospitals (7, 8). To control confounding by center, we divided the time-of-year

variable into within-center and among-center components (9). A binary variable indicating hospitalization during December measured the within-center component, and a variable measuring the proportion of all patients hospitalized in December for each center represented the among-center component. For the logistical regression model examining 30-day mortality, we also controlled for the use of evidence-based therapies at admission. We also developed a multivariable logistic regression model using generalized estimating equations to examine the association between admission during the month of December and 30-day mortality, controlling for demographic characteristics, socioeconomic status, clinical characteristics, “ideal” patient status (that is, no documented contradictions to each of the evidence-based therapies), hospital characteristics, and physician characteristics, and accounting for the clustered structure of the sample (7, 8). In addition, we controlled for confounding by center (9) and the use of evidence-based therapies at admission. We report adjusted and unadjusted use of evidence-based therapies and 30-day mortality.

Role of the Funding Source

No funding was received for this study.

RESULTS

The study involved 127 959 Medicare beneficiaries. **Table 1** gives baseline characteristics of patients hospitalized in December and patients hospitalized during the rest of the year. Although patients hospitalized in December were older, the 2 groups were similar in sex, socioeconomic status, history of hypertension, systolic blood pressure at admission, and rates of anterior infarctions. **Table 1** also shows hospital and physician characteristics. Patients hospitalized in December were as likely as other patients to be cared for by board-certified physicians, were more likely to be cared for by an internist, and were more likely to be admitted to a teaching hospital. However, patients hospitalized in December were less likely than other patients to be admitted to a hospital with cardiac catheterization facilities or to be cared for by a cardiologist.

Table 2 compares the use of evidence-based therapies among patients hospitalized in December and patients hospitalized during the rest of the year. Patients hospitalized in December were less likely than other patients to receive aspirin at admission (77.5% vs. 78.9%; $P < 0.001$) and to have primary percutaneous coronary intervention (14.2% vs. 16.1%; $P < 0.001$). When we controlled for patient, physician, and hospital characteristics, patient clustering within hospitals, and confounding by center, the use of evidence-based therapy was not statistically significantly different for patients hospitalized in December as compared with those hospitalized during the rest of the year. Finally, unadjusted 30-day mortality was higher in patients hospitalized in December than in other patients (21.7% vs. 20.1%; $P < 0.001$). After adjustment for patient, hospital, and physician characteristics, patient clustering within hos-

Table 1. Patient, Hospital, and Physician Characteristics

Characteristic	December Admissions (n = 14 492)	Other Admissions (n = 113 467)	P Value
Patient			
Mean age (SD), y	77.1 (7.5)	76.8 (7.4)	<0.001
Women, n (%)	7198 (49.7)	55 991 (49.3)	0.464
Median Killip class at admission (interquartile range)	2 (1–3)	2 (1–3)	<0.001*
Low socioeconomic status†, n (%)	1373 (9.6)	10 870 (9.8)	0.666
Anterior myocardial infarction, n (%)	6753 (46.5)	53 672 (47.3)	0.060
Systolic blood pressure < 100 mm Hg at admission, n (%)	1178 (8.1)	9027 (8.0)	0.469
Diabetes mellitus, n (%)	4537 (31.3)	34 847 (30.7)	0.143
Hypertension, n (%)	9038 (62.4)	70 363 (62.0)	0.409
Current smoking, n (%)	2095 (14.5)	16 760 (14.8)	0.314
Hospital, n (%)			
Teaching hospital	6016 (41.5)	46 001 (40.5)	0.025
Cardiac catheterization laboratory	9429 (65.1)	77 991 (68.7)	<0.001
Physician			
Mean age (SD), y	46.0 (9.1)	46.0 (8.9)	0.783
Mean years since medical school graduation (SD)	19.5 (9.3)	19.4 (9.0)	0.524
Family practitioner, n (%)	1815 (12.5)	14 106 (12.4)	0.751
Internist, n (%)	4950 (34.2)	37 705 (33.2)	0.030
Cardiologist, n (%)	5808 (40.1)	46 857 (41.3)	0.010
Board-certified, n (%)	12 028 (83.0)	94 279 (83.1)	0.78

* P value calculated by using the Wilcoxon rank-sum test.

† Indicates percentage of patients living in an area (by ZIP code) with median income less than 200% of poverty level.

pitals, and confounding by center, 30-day mortality remained statistically significantly higher in patients hospitalized in December than in patients hospitalized during the rest of the year (Table 3).

DISCUSSION

Patients hospitalized in December with acute MI had higher 30-day mortality, even after adjustment for patient, physician, and hospital characteristics; for clustering of patients within hospitals; for confounding by hospital; and for the use of evidence-based therapies. A previous study reported increased rates of MI and mortality during winter months (1). This relationship was independent of geographic region, suggesting that the increase in the incidence of MI could not be explained by climate-related factors alone. Another study has raised the possibility that the increase in winter mortality rates is related to the December holiday season. Kloner and colleagues (2) found

that cardiovascular deaths in Los Angeles County, California, peaked during the November and December holidays. They suggested that this increase in mortality may have been related to emotional stresses or behavioral changes associated with the holidays. However, because they lacked descriptors of patient care and illness severity, they could not further examine the cause of the increase in mortality (2).

To our knowledge, no previous study has examined the use of evidence-based therapies as a potential mechanism for mortality differences during December, a month of decreased staffing at most hospitals (10). However, several studies have found associations between the level of hospital staffing and patient outcomes (11–14). Bell and Redelmeier (11) found that patients with various medical conditions were more likely to die in the hospital if they had been admitted on a weekend rather than on a weekday. They attributed some of this increase in mortality to decreased hospital staffing on weekends. It is noteworthy

Table 2. Use of Evidence-Based Therapy according to Month of Admission

Therapy	Use of Evidence-Based Therapy, n (%)			Adjusted Odds Ratio* (95% CI)	P Value
	December Admissions (n = 14 492)	Other Admissions (n = 113 467)	P Value		
Aspirin during admission	11 195 (77.5)	89 200 (78.9)	<0.001	0.97 (0.93–1.02)	0.21
Aspirin at discharge	7900 (69.4)	63 322 (69.9)	0.249	1.01 (0.96–1.06)	0.65
β-Blocker during admission	6459 (44.7)	51 465 (45.5)	0.073	0.98 (0.94–1.02)	0.32
β-Blocker at discharge	4410 (30.4)	35 182 (31.0)	0.158	0.98 (0.94–1.03)	0.46
Smoking cessation counseling	861 (5.9)	7159 (6.3)	0.085	1.03 (0.95–1.12)	0.45
Reperfusion at admission	2513 (17.3)	20 232 (17.8)	0.146	1.03 (0.98–1.09)	0.22
Thrombolytic therapy	1987 (13.8)	15 577 (13.8)	0.957	1.04 (0.98–1.10)	0.25
Percutaneous coronary intervention	2064 (14.2)	18 282 (16.1)	<0.001	0.99 (0.93–1.05)	0.71

* Adjusted odds ratios for within-center effects are reported.

Table 3. Thirty-Day Mortality according to Month of Admission

Model	Mortality Rate, %		Odds Ratio (95% CI)*	P Value
	December Admissions (n = 3142)	Other Admissions (n = 22 771)		
Unadjusted	21.7	20.1	1.09 (1.04–1.13)	<0.001
Adjusted for patient characteristics	–	–	1.08 (1.02–1.13)	0.003
Adjusted for patient and hospital characteristics	–	–	1.07 (1.02–1.13)	0.004
Adjusted for patient, hospital, and physician characteristics	–	–	1.07 (1.02–1.12)	0.046
Adjusted for patient, hospital, and physician characteristics and use of evidence-based therapies at admission	–	–	1.06 (1.01–1.12)	0.018

* Adjusted odds ratios for within-center effects are reported.

that although rates of primary coronary intervention and use of evidence-based therapy were lower during December, there was no statistically significant difference in the use of proven medical or percutaneous therapies.

A previous study found that MIs tend to be larger in winter months (15). Although our data set did not contain information about the size of the infarctions, patients who were hospitalized in December were older than other patients and thus at higher risk for in-hospital death. High-risk patients may be more likely to postpone seeking medical care during holiday periods (16, 17). In this analysis, however, the mortality finding persisted after adjustment for patient risk.

Fewer patients hospitalized in December were cared for by cardiologists or were admitted to hospitals with cardiac catheterization laboratories. One study suggested that patients with acute MI who are cared for by a cardiologist have lower mortality rates and are more likely to receive evidence-based therapies, including coronary intervention (18). However, this finding does not explain the difference in mortality rates, which remained after controlling for physician and hospital characteristics.

The overall mortality rate in our study was approximately 20%. Although this may seem high, it reflects the age of the Medicare population. This mortality rate has been described in a previous study from the Cooperative Cardiovascular Project and is in keeping with national rates during the period of the project (18). A limitation of observational analyses is that unmeasured characteristics may contribute to differences in treatment and outcomes during the period of interest; our ability to control for such patient characteristics was limited to data collected in the Cooperative Cardiovascular Project. Also, the data are from 1994 to 1996; cardiac care has changed somewhat in the intervening years. However, current approaches to care of patients with acute MI were largely established in randomized trials done before 1995. More recent changes in cardiac care have mainly involved additional anticoagulants and drug-eluting stents. These therapies have relatively limited roles in acute ST-segment–elevation MI and have not been found to affect mortality, the main outcome of the current study. In addition, the overall rate of reperfusion for acute MI increased only 1.2% from 1995 through

1999 (19). Finally, observational findings can describe only associations and not causality.

In conclusion, we found that the 30-day mortality of patients hospitalized with acute MI in December was higher than in other months, even after adjusting for patient, physician, and hospital characteristics and use of evidence-based therapies. Our findings highlight the need for further research into the mechanism of increased mortality in patients hospitalized in December while ensuring continued emphasis on standardized care during holiday seasons for patients with acute MI.

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