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Quality of Care for Myocardial Infarction in Rural and Urban Hospitals

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Abstract

Background—In the mid-1990s, significant gaps existed in the quality of acute myocardial infarction (AMI) care between rural and urban hospitals. Since then, overall AMI care quality has improved. This study uses more recent data to determine whether rural-urban AMI quality gaps have persisted.

Methods—Using inpatient records data for 34,776 Medicare beneficiaries with AMI from 2000–2001, unadjusted and logistic regression analysis compared receipt of 5 recommended treatments between admissions to urban, large rural, small rural, and isolated small rural hospitals as defined by Rural Urban Commuting Area codes.

Results—Substantial proportions of hospital admissions in all areas did not receive guideline-recommended treatments (eg, 17.0% to 23.6% without aspirin within 24 hours of admission, 30.8% to 46.6% without beta-blockers at arrival/discharge). Admissions to small rural and isolated small rural hospitals were least likely to receive most treatments (eg, 69.2% urban, 68.3% large rural, 59.9% small rural, 53.4% isolated small rural received discharge beta-blocker prescriptions). Adjusted analyses found no treatment differences between admissions to large rural and urban area hospitals, but admissions to small rural and isolated small rural hospitals had lower rates of discharge prescriptions such as aspirin and beta-blockers than urban hospital admissions.

Conclusions—Many simple guidelines that improve AMI outcomes are inadequately implemented, regardless of geographic location. In small rural and isolated small rural hospitals, addressing barriers to prescription of beneficial discharge medications is particularly important. The best quality improvement practices should be identified and translated to the broadest range of institutions and providers.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1 Characteristics of Ideally Eligible Weighted Admissions for Acute Myocardial Infarction by Geographic Area of Admitting Hospital and AMI Treatment Type

Table S2 Relative Risk of Receiving Acute Myocardial Infarction Treatments by Patients With Different Characteristics

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Keywords

Medicare; myocardial infarction; quality of care; rural hospitals

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Improving the quality of care for acute myocardial infarction (AMI) has garnered considerable attention for over a decade. The American College of Cardiology (ACC), the American Heart Association (AHA), the Centers for Medicare & Medicaid Services (CMS), the Joint Commission, and the Agency for Healthcare Research and Quality have collaborated since 1993 to develop objective performance measures to track the care of inpatients with AMI at the state and national levels.[1] Quality improvement interventions for AMI have been developed by the ACC (Guidelines Applied in Practice) and the AHA (Get With the Guidelines), and been applied by hospitals nationally.[2–5] These efforts are reaping benefits. Across the nation, the quality of AMI care has improved, though substantial gaps remain between actual and recommended care.[6–8]

Whether patients cared for in rural and urban hospitals are reaping similar benefits is unknown. In the mid-1990s, quality of AMI care lagged significantly in rural hospitals.[9–11] AMI admissions to rural hospitals were less likely than urban hospital admissions to receive recommended life-saving treatments such as aspirin and reperfusion. Hospital patients in small rural and isolated small rural areas were least likely to receive many of these treatments.

Rural hospitals have well-documented and unique challenges (eg, low volume, limited resources)[12] to implementing resource-intensive quality improvement programs such as those noted above. In this study, we use the most recent national data on AMI care to examine whether differences in the quality of AMI care have persisted between urban hospitals and hospitals in 3 types of rural area. Identification of remaining gaps can help organizations tailor quality improvement efforts to hospitals in smaller and more isolated rural areas.

Methods

Data Sources

This research used a database developed by the CMS to measure the quality of AMI care.[8,13] The Medicare Quality Improvement Organization systematically randomly sampled up to 750 inpatient records of Medicare patients from each state discharged from a short-term nonfederal hospital with a principal discharge diagnosis of AMI. Each state’s discharge records were sampled over a 6-month period in 2000–2001. These records underwent abstraction to gather patient demographics, measures of case severity, and elements of care during hospitalization. The abstracted data were used to determine whether admissions were eligible for and received 5 recommended clinical treatments for AMI (quality indicators). These quality indicators were based on practice guidelines published by the ACC and the AHA, and updated or expanded measures used in the Medicare Cooperative Cardiovascular Project.[14–16] Hospital ZIP code data facilitated classification of geographic location. This comprehensive database provides a rich set of clinical variables, including severity of illness measures that facilitate quality of care analyses.

Study Population

Medical records data were abstracted for 34,776 Medicare admissions meeting the sampling criteria. Because individual patients could be duplicated in these records, and we could not identify multiple admissions for the same individual, the unit of analysis is the admission rather than the patient. We excluded Medicare admissions that did not meet the following criteria at hospitalization: (1) ages 65 years and older (excluded n = 2,945); (2) AMI confirmed by a creatine kinase MB fraction above 0.05 units, a lactate dehydrogenase level more than 1.5 times the upper limit of normal with the level of lactate dehydrogenase isoenzyme 1 greater than the level of lactate dehydrogenase isoenzyme 2, or the presence of at least two of the following: chest pain, doubling of the creatine kinase level, or electrocardiographic evidence of a new myocardial infarction (excluded n = 3,567); (3) AMI prior to rather than during their hospitalization (excluded n = 847); and (4) directly admitted for AMI care rather than being transferred from another acute care hospital (excluded n = 9,484).We excluded 26 admissions to hospitals without a geographic designation. A total of 21,616 Medicare admissions met our study criteria.

Study Variables

The rural-urban status of each hospital was determined by linking Rural-Urban Commuting Area (RUCA) codes to the hospital's ZIP code, and aggregating these codes to represent hospitals in or strongly associated with urban and 3 types of rural areas—large rural (RUCAs 4.0, 5.0, 6.0), small rural (RUCAs 7.0, 7.2, 7.3, 7.4, 8.0, 8.2, 8.3, 8.4, 9.0, 9.1, 9.2), and isolated small rural (RUCAs 10.0, 10.2, 10.3, 10.4, 10.5).[17] RUCAs combine Census Bureau information on Urbanized Areas and Urban Places with work commuting information to differentiate places based on their city/town size and functional relationships to larger cities and towns.

Characteristics describing the study admissions available for analysis included sociodemographic factors (ie, age, sex, and race), prior or current comorbidities (ie, diabetes, hypertension, congestive heart failure, cerebrovascular accident, previous myocardial infarction, chronic obstructive pulmonary disease, dementia, and metastatic cancer), previous coronary artery disease interventions (ie, percutaneous transluminal coronary angioplasty [PTCA] and coronary artery bypass grafting [CABG]), severity of disease (Acute Physiology and Chronic Health Evaluation [APACHE]-II score), and factors that might influence treatment choice or severity of illness (ie, limitation of resuscitation status, terminal illness, admission from a skilled nursing or intermediate care facility, and current smoking).

The recommended treatments available in the 2000–2001 database include: (1) Receipt of aspirin within 24 hours before or after hospital arrival; (2) Receipt of beta-blocker within 24 hours after hospital arrival; (3) Aspirin prescription at discharge; (4) Angiotensin converting enzyme (ACE) inhibitor prescription at discharge for individuals with moderate or severe left ventricular systolic dysfunction; and (5) Beta-blocker prescription at discharge.

These measures first identify those who are "ideally eligible" for the treatment, then measure whether they received it. Ideal eligibility requires available data to record the measure, and absence of contraindications to the treatment.[15,16] For example, ideally eligible patients for the aspirin prescription at discharge excluded those who transferred to another acute care hospital or hospice, left against medical advice, and had medical contraindications such as an aspirin allergy or active bleeding.

Analysis

To ensure nationally representative results, we weighted each state's data on the roughly 750 AMI cases up to the expected number of AMIs based on the age and gender distribution as follows. Using available data on all AMIs nationally in 1994–1995,[9] we calculated the AMI rate for 6 age (65–74, 75–84, 85 years and older)/gender categories by state at that time. For the 5 states missing state-level data, we used the overall US AMI rate for each age/gender category. Assuming a constant AMI rate, we applied the 1994–1995 rates to the 2000–2001 census population to calculate an expected number of AMIs in each state for the 6 age/gender categories. The ratio of expected to actual numbers of AMIs generated state/age/gender-specific weights. Using this weighting strategy, the 21,616 Medicare admissions in our sample represent an estimated 159,305 admissions nationally.

We compared the characteristics of our weighted admissions by the geographic area of the treatment hospital, using chi-square and standard student *t*-tests to identify statistically significant differences. We calculated unadjusted treatment rates of weighted admissions to the hospitals in the 4 geographic areas, and unadjusted rate ratios of each treatment among weighted admissions in different rural compared to urban areas. Chi-square tests tested for statistically significant differences between unadjusted rates of different treatments between weighted admissions to rural and urban hospitals. Last, we conducted multivariate logistic regression analysis to examine the odds of receipt of different treatments among admissions to hospitals in the 3 rural areas compared to those in urban hospitals, controlling for variables that had a significant association with our study outcomes. Control variables included age (continuous), sex, race (white, non-Hispanic; non-white; missing), and dichotomous unweighted indicator variables for hypertension, previous myocardial infarction, chronic obstructive pulmonary disease, dementia, metastatic cancer, prior PTCA, prior CABG, limitation of resuscitation status, presence of a terminal illness, and admission from a skilled nursing or intermediate care facility. We used the SUDAAN software package to adjust the standard errors because of the differential probability of selection into the study sample across the states.[18] Because the study measures are relatively common, the odds ratios and their confidence intervals were converted to relative risks using published methods.[19]

Results

Individuals admitted to hospitals in all 4 geographic areas were in their late 70s, predominantly non-Hispanic Caucasian, and had a range of comorbidities (Table 1). The majority of all 4 groups had hypertension, though there were significant differences between the hospital types, with the lowest hypertension rates among admissions to hospitals in isolated small rural areas. Admissions to isolated small rural hospitals had the highest rates of chronic obstructive pulmonary disease and admission from a skilled nursing or intermediate care facility. Urban hospital admissions had high rates of prior PTCA and CABG. (Characteristics of individuals who were ideally eligible for each AMI treatment, by the admitting hospital's geographic area, are given in Table S1, available online only).

Substantial proportions of admissions to hospitals in all 4 geographic areas did not receive recommended AMI treatments for which they were "ideally eligible" (Table 2). Beta-blockers at arrival and discharge, and ACE inhibitors at discharge were not received by around a third of admissions. About a fifth of admissions did not receive aspirin within 24 hours before and after admission and at discharge.

Unadjusted rates of recommended AMI treatments differed significantly by the geographic area of the admitting hospital (Table 2). For most treatments, those admitted to hospitals in small rural and isolated small rural areas were least likely to receive recommended care. For example, among those ideally eligible, 69.2% of urban and 68.3% of large rural hospital admissions were prescribed a beta-blocker at discharge, compared to 59.9% of small rural and 53.4% of isolated small rural hospital admissions. In a notable exception, admissions to isolated small rural hospitals had the highest rate of ACE inhibitor prescription at discharge, though these findings were not statistically significant.

Logistic regression analysis demonstrated that few of these differences were statistically significant after adjustment for patient characteristics (Table 3, and Table S2, available online only). There were no differences between large rural and urban hospitals in the adjusted relative risk of receiving any of the AMI treatments. Admissions to isolated small rural hospitals were significantly less likely than admissions to urban hospitals to receive aspirin and beta-blocker prescriptions at discharge. Admissions to small rural hospitals were significantly less likely than admissions to urban hospitals to receive a beta-blocker prescription at discharge. Rural-urban differences were limited to discharge care measures; there were no significant rural-urban differences in AMI care measures provided at admission or during hospitalization.

Discussion

In the mid-1990s, several studies demonstrated clear disparities in receipt of recommended AMI treatments between rural and urban Medicare beneficiaries, with small rural and isolated small rural hospitals least likely to offer most recommended care in both adjusted and unadjusted analyses.[9–11] Also notable were deficits in receipt of the most basic recommended AMI treatments at both urban and rural hospitals. This study's reexamination of rural-urban differences in AMI care 6 years later suggests overall improvement in several quality measures. Additional good news is that admissions to large rural hospitals received virtually equivalent care to admissions to urban hospitals. However, small rural and isolated small rural hospitals were still the least likely to offer most recommended AMI treatments, though adjusted analyses demonstrated only a few disparities in prescription of recommended discharge medications between these rural and urban hospitals.

In 2000–2001, the recommended treatment used most frequently in the care of AMI admissions was aspirin, both within the first 24 hours (76.4%–83.0% depending on hospital geographic area) and on hospital discharge (64.7%–82.0%). With only about half of AMI admissions receiving early aspirin in the mid-1990s,[9] receipt rates between 76.4% and 83.0% in 2000–2001 represent an overall increase in early aspirin use of 1.5 times that of the earlier period. In the mid-1990s, small rural and isolated small rural hospital admissions were significantly less likely to receive aspirin at admission and discharge than urban admissions, while by 2000–2001, the only rural-urban disparity in aspirin use was at discharge among isolated small rural hospital admissions. This is a significant success story for the quality improvement programs working with patients, physicians, and hospitals to disseminate the guidelines for simple and effective treatments such as aspirin.

Beta-blocker prescription at hospital discharge also improved in most geographic areas over time. In the mid-1990s, about half of eligible AMI admissions received beta-blockers at discharge,[9] compared to between 59.9% and 69.2% of AMI admissions to urban, large rural, and small rural hospitals in 2000–2001. There was still room for improvement in receipt of this treatment, however, especially in isolated small rural hospitals, where there was no improvement in discharge beta-blocker prescription over time. Notably, there was no rural-urban disparity in discharge beta-blocker prescription in the mid-1990s. However, because urban hospital admissions had substantial increases in discharge beta-blocker prescription, significant rural-urban disparities in this treatment developed by 2000–2001.

Of interest, in the adjusted analyses of 2000–2001 data, the disparities between small rural and isolated small rural hospitals and urban hospitals were in discharge medication prescription. Discharge medications may reflect physician discretion to a greater degree than other treatments, which may be directed by emergency room or hospital protocols. Emergency room and hospital systems may be influenced more easily than individual physicians.

An important finding is the essentially equivalent care received in large rural and urban hospitals. One contributing factor may be the higher volume of AMI patients at large rural hospitals. The median average daily census of large rural hospitals has been reported at 49, compared to 18 for small rural hospitals and 10 for isolated small rural hospitals.[9] Studies have shown that hospitals with higher AMI patient volumes have lower mortality rates and are more likely to provide guideline-recommended care.[20,21] However, these studies have demonstrated that overall, rural hospitals had lower survival and lower likelihood of providing guideline-recommended AMI care even after controlling for AMI patient volume, suggesting that other characteristics contribute to AMI care processes and outcomes in rural hospitals.

This project is limited by the age of its data, though it has used the richest national data sources available on AMI care in rural hospitals. However, several quality improvement projects, such as the AHA's "Get With The Guidelines" program,[22] became widely available shortly before this study's data were gathered. Thus, changes in adherence to AMI care guidelines in rural and urban hospitals may not be reflected in these findings. We found 1 study using recent data to examine differences in quality between a limited set of rural critical access hospitals and urban hospitals, and its findings were consistent with this study's findings.[23]

Although our study database included a full range of clinical variables, there are data limitations. First, we could not measure the severity of the patients' comorbidities. This and other unmeasured factors, such as patient preference or functional status, could influence our study findings, though all patients in our analyses were screened as ideally eligible for these treatments, and published guidelines suggest they should be receiving this care. Second, timing of reperfusion (percutaneous transluminal coronary angioplasty, thrombolysis) was missing from many records, making it impossible to examine a reperfusion outcome. Third, the data did not include hospital characteristics such as size or volume, so we were unable to explore the relationship between hospital volume, rural-urban location, and our study outcomes. Another study limitation is that the small number of study patients in the isolated small rural hospitals could result in a lack of statistically significant findings despite clinically significant outcome differences (type II error).

Our comparison of 1995–1996 and 2000–2001 data must be interpreted with caution because of differences in AMI case ascertainment in the 2 time periods. In addition, the 2000–2001 data required weighting, while 1995–1996 data did not, and there may be some error related to our weighting scheme. The consistency of our data with other published AMI treatment rates is reassuring, however.

This study supports the need for continued monitoring of guideline adherence in caring for AMI patients. Many simple, evidence-based guidelines that can improve AMI outcomes are not adequately implemented. In small rural and isolated small rural areas, special attention should be paid to identifying and addressing barriers to underutilized, life saving AMI care such as aspirin and beta-blockers at discharge. To improve care for AMI patients, we need to explore the strategies used by institutions with the greatest improvements. If best practices in quality improvement can be identified, efforts to translate these practices to the broadest range of institutions and providers can be mounted, ensuring that individuals with AMI receive the highest quality care regardless of geographic location.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Characteristics of Admissions for Acute Myocardial Infarction by Geographic Area of Admitting Hospital

Admission Characteristics	Urban	Large Rural	Small Rural	Isolated Small Rural	*P* Value*	All Admissions†
	(n = 119,011)	(n = 23,235)	(n = 13,932)	(n = 3,127)		(n = 159,305)
Age (SE)	77.3 (0.08)	77.2 (0.15)	77.9 (0.20)	77.6 (0.40)	.02	77.3 (0.07)
Female (%)	48.8	47.6	51.7	47.2	.09	48.8
White non-Hispanic (%)	82.1	89.3	89.2	89.2	<.001	83.9
Diabetes (%)	35.2	36.5	37.9	40.0	.09	35.8
Hypertension (%)	74.4	74.8	71.8	64.6	<.001	74.0
Congestive heart failure (%)	31.9	31.9	32.7	30.8	.91	32.0
Cerebrovascular accident (%)	19.9	21.0	20.2	18.4	.56	20.0
Previous MI (%)	38.3	40.3	37.3	31.3	.01	38.3
Chronic obstructive pulmonary disease (%)	24.7	27.0	28.9	29.5	.001	25.5
Prior PTCA (%)	15.2	13.7	11.5	8.9	<.001	14.5
Prior CABG (%)	19.0	19.2	15.4	17.0	.01	18.7
Current smoking (%)	15.8	16.5	16.3	15.4	.80	15.9
Terminal illness (%)	0.2	0.1	0.1	0.1	.05	0.2
Dementia (%)	10.1	9.4	12.4	8.9	.02	10.2
Admitted from SNF or ICF (%)	8.1	8.4	11.5	11.6	<.001	8.5
Metastatic cancer (%)	1.4	1.3	0.6	2.4	.02	1.3
APACHE II (SE)	8.8 (0.04)	8.9 (0.07)	9.0 (0.08)	8.9 (0.21)	.50	8.9 (0.03)
Limitation of resuscitation (%)	20.1	22.1	24.7	24.7	<.001	20.9
Transferred to another acute care setting	16.1	35.8	42.7	43.5	<.001	21.9

SE = standard error; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; CABG = coronary artery bypass graft; SNF = skilled nursing facility; ICF = intermediate care facility; APACHE = acute physiological and chronic health evaluation. Weighted estimates are based on data from the following numbers of chart abstracts: urban 14,337; large rural 4,244; small rural 2,423; isolated small rural 612; total 21,616.

* *P* value for overall chi-square or *t*-test between admissions in hospitals in different geographic areas.

† Missing values (weighted): race 11,420; APACHE II 11,798.

Table 2

Unadjusted Rates and Rate Ratios of Acute Myocardial Infarction Treatment Use by Hospital Geographic Area

	Urban	Large Rural	Unadjusted RR Large Rural Compared to Urban	Small Rural	Unadjusted RR Small Rural Compared to Urban	Isolated Small Rural	Unadjusted RR Isolated Small Rural Compared to Urban	Overall	N§
Aspirin within 24 hours*	82.2%	83.0%	1.01*	79.8%	0.97	76.4%	0.93	82.0%	127,419
Beta-blocker at arrival	62.6%	64.1%	1.02	59.8%	0.96	54.3%	0.87*	62.5%	105,158
Aspirin at discharge	82.0%	78.0%	0.95	77.4%	0.94*	64.7%	0.79¶	80.9%	68,343
ACE inhibitor at discharge	61.2%	62.7%	1.03	62.6%	1.02	68.8%	1.12	61.5%	30,011
Beta-blocker at discharge	69.2%	68.3%	0.99	59.9%	0.87¶	53.4%	0.77¶	68.3%	86,233

RR = rate ratio; ACE inhibitor = angiotensin converting enzyme inhibitor.

* $P \leq .05$,

† $P \leq .01$,

¶ $P \leq .001$.

§ N = the total weighted number of ideally eligible admissions across the 4 geographic areas for which each quality indicator was measured.

* Aspirin within 24 hours before or after hospital arrival.

Table 3

Adjusted Relative Risk of Acute Myocardial Infarction Treatment Use by Hospital Geographic Area

Treatments	Urban	Large Rural RR (CI)	Small Rural RR (CI)	Isolated Small Rural RR (CI)	N[§]
Aspirin within 24 hours[*]	Ref 1.0	1.01 (0.99,1.03)	0.98 (0.95,1.01)	0.94 (0.87,1.00)	127,419
Beta-blocker at arrival	Ref 1.0	1.03 (0.98,1.07)	0.98 (0.92,1.03)	0.90 (0.78,1.01)	105,158
Aspirin at discharge	Ref 1.0	0.97 (0.93,1.00)	0.99 (0.94,1.02)	0.84 (0.73,0.93)	68,343
ACE inhibitor at discharge	Ref 1.0	1.05 (0.96,1.13)	1.04 (0.90,1.17)	1.16 (0.85,1.37)	30,011
Beta-blocker at discharge	Ref 1.0	1.01 (0.97,1.05)	0.92 (0.85,0.98)	0.82 (0.69,0.94)	86,233

RR = relative risk; CI = 95% con.dence interval; Ref = reference; ACE inhibitor = angiotensin converting enzyme inhibitor.

[§] N = the total weighted number of ideally eligible admissions across the 4 geographic areas for which each quality indicator was measured. Allmodels include age as a continuous variable, sex, race (white, non-Hispanic; non-white;missing), and dichotomous indicator variables for hypertension, previous myocardial infarction, chronic obstructive pulmonary disease, dementia, metastatic cancer, prior PTCA, prior CABG, limitation of resuscitation status, presence of a terminal illness, and admission from a skilled nursing facility or intermediate care facility.

[*] Aspirin within 24 hours before or after hospital arrival.