Working Paper

June 2002 #72

Quality of Care for Acute Myocardial Infarction in Rural and Urban U.S. Hospitals

by

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About the Center

The WWAMI Rural Health Research Center (RHRC) is one of six centers supported by the Federal Office of Rural Health Policy (FORHP), a component of the Health Resources and Services Administration (HRSA) of the Public Health Service. The major focus of the WWAMI RHRC is to perform policy-oriented research on issues related to rural health care. Specific interests of the Center include the training and supply of rural health care providers and the content and outcomes of the care they provide; the availability and quality of care for rural women and children, including obstetric and perinatal care; and access to high-quality care for vulnerable and minority rural populations.

The WWAMI Rural Health Research Center is based in the Department of Family Medicine at the University of Washington School of Medicine, and has close working relationships with the WWAMI Center for Health Workforce Studies, Programs for Healthy Communities (PHC), and the other health science schools at the University, as well as with other major universities in the five WWAMI states: Washington, Wyoming, Alaska, Montana, and Idaho. The University of Washington has over 25 years of experience as part of a decentralized educational research and service consortium involving the WWAMI states, and the activities of the Rural Health Research Center are particularly focused on the needs and challenges in these states. The WWAMI RHRC also works closely with the associated Area Health Education Centers.

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The WWAMI Rural Health Research Center is supported by the Federal Office of Rural Health Policy, Health Resources and Services Administration, Public Health Service (grant #1UICRH00035-01, $500,000, 100%).

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June 2002

The authors would like to thank Christine Rubadue for her review of this manuscript. This WWAMI Rural Health Research Center study was performed with funding from the Federal Office of Rural Health Policy of the Health Resources and Services Administration, U.S. Department of Health and Human Services.

ABSTRACT

Context: Acute myocardial infarction (AMI) is an important condition cared for in rural hospitals. Most recommended interventions require no sophisticated technology and should be available in rural and urban hospitals.

Objective: To examine the quality of AMI care in rural hospitals.

Design: Cohort study using data from the 1994 and 1995 Centers for Medicare & Medicaid Services' Cooperative Cardiovascular Project (CCP) and the 1995 American Hospital Association's Annual Survey of Hospitals.

Setting: The 4,085 U.S. acute-care hospitals caring for patients with AMI.

Patients or Other Participants: 135,759 Medicare beneficiaries ages 65 and older directly admitted to four types of acute-care hospitals—remote small rural, small rural, large rural, and urban—for a confirmed AMI between February 1994 and July 1995.

Main Outcome Measures: Recommended treatments from American Heart Association and American College of Cardiology guidelines: use of aspirin, reperfusion, heparin, and intravenous nitroglycerin during hospitalization; use of beta-blockers, aspirin and angiotensin-converting-enzyme inhibitors at discharge; avoidance of calcium channel blockers at discharge; thirty-day mortality.

Results: Substantial proportions of Medicare beneficiaries in both urban and rural hospitals did not receive the recommended AMI treatments. Medicare patients treated in rural hospitals were less likely than urban hospitals' patients to receive aspirin either during hospitalization or at discharge, intravenous nitroglycerin, heparin, and either thrombolytics or percutaneous transluminal coronary angioplasty. Only one treatment—ACE inhibitors at discharge—was used more for patients in rural hospitals compared to patients in urban hospitals. Medicare patients in rural hospitals had significantly higher adjusted 30-day post-AMI death rates from all causes than those in urban hospitals (odds ratio for large rural 1.14 [1.10-1.18], for small rural 1.24 [1.20-1.29], for remote small rural 1.32 [1.23-1.41]).

Conclusions: Efforts are needed to help hospital medical staffs, especially those in rural areas, develop systems to assure that patients receive recommended AMI treatments.

BACKGROUND

Acute myocardial infarction (AMI) is one of the leading causes of death in the United States and a common cause for admission to U.S. hospitals.[1-3] In 2001, an estimated 880,000 individuals were hospitalized for AMI.[2] AMI is an acute condition that requires immediate care in a hospital setting to minimize morbidity and mortality. Several AMI treatments must be administered promptly to provide maximum benefit (e.g., thrombolytics). It is an especially important condition in the rural hospital setting, as transport of AMI patients to urban settings could result in delays in care. AMI treatment has been studied extensively, and clear management guidelines have been developed and published.[4,5]

Some of the most effective and immediate treatments of acute myocardial infarction, such as aspirin, thrombolytic therapy, and beta-blockers, require at most only basic intravenous access, rather than sophisticated technology. As such, these treatments should be equally accessible in rural as well as urban hospitals and can represent the quality of care provided to AMI patients in these settings. This study used the national Cooperative Cardiovascular Project (CCP) database, with its detailed clinical information abstracted from medical charts, to examine the quality of care provided to Medicare-insured AMI patients in hospitals with differing degrees of remoteness and to compare the quality of care in hospitals in three different types of rural areas to that of urban hospitals.

METHODS

Data Sources

The data for this retrospective cohort study come from two sources: the Cooperative Cardiovascular Project (CCP) and the 1995 American Hospital Association's Annual Survey of Hospitals Database (AHA Database). The Cooperative Cardiovascular Project has been described elsewhere.[6,7] Briefly, all hospital claims from February 1, 1994, through July 31, 1995, with a principal discharge diagnosis of a primary episode of AMI were identified from Medicare's National Claims History File. From these admissions, acute care hospitals submitted the medical charts for all AMI discharges during eight consecutive months of this time period for abstraction. Five states were not available for this analysis: Alabama, Connecticut, Iowa, Minnesota, and Wisconsin.[8] Sociodemographic and clinical characteristics of the patients were collected from the medical records. Dates of death were extracted from the Medicare Enrollment Database. The AHA surveys all U.S. hospitals annually to obtain information on their organizational structure, facilities and services, bed size and utilization, personnel, and finances. The AHA data were used only to describe the characteristics of the hospitals in this study.

Study Population

There were 222,612 admissions for AMI in the 45 U.S. states in the database. We excluded patients (1) under the age of 65 (16,756); (2) without an 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 (29,267); and (3) with an AMI in the hospital rather than prior to admission (22,002). Patients transferred from another hospital for their AMI or with unknown admission status were excluded from the primary study analyses (43,699). These exclusions resulted in 138,767 admissions for AMI in the study.

There were 4,254 hospitals caring for the original 222,612 AMI admissions in our database. Of these hospitals, 71 caring for 2,115 AMI admissions could not be linked to the AHA Database and were excluded. We also excluded the 46 nongeneral, noncommunity hospitals that would not routinely admit AMI patients. The 52 hospitals that did not care for any patients in our study sample were excluded de facto, leaving 4,085 study hospitals.

Our final study population included 135,759 direct admissions for AMI to one of 4,085 hospitals.

Study Variables

We used hospital ZIP code from the CCP database to link to its Rural Urban Commuting Area (RUCA), which defines each hospital's urban-rural status.[9] RUCAs use Census Bureau information on urbanized areas and urban places in combination with work commuting information to differentiate places based on their city/town size and functional relationships to larger cities and towns. Currently, the federal government uses the RUCAs to determine eligibility for funding for several rural-based programs. The 30 RUCA designations were aggregated into four categories to represent hospitals in or strongly associated with urban and three types of rural locations—large rural (i.e., in or associated with a large town of 10,000 to 50,000), small rural (town of 2,500 to less than 10,000), and remote small rural (town of less than 2,500).

Available characteristics of those admitted included sociodemographic descriptors (age, sex, race), a full range of clinical conditions simultaneous with or prior to the AMI (e.g., previous MI, congestive heart failure, incontinence, terminal illness, cigarette use, diabetes, hypertension, cerebrovascular accident, chronic obstructive pulmonary disease, dementia), prior interventions related to coronary heart disease (e.g., coronary artery bypass grafting, percutaneous transluminal coronary angioplasty), the Acute Physiology and Chronic Health Evaluation (APACHE II) score[10] to describe severity of disease, and other factors that might affect treatment choice or severity of illness (e.g., do-not-resuscitate status, admission from a skilled nursing facility or intermediate care facility, chest pain greater than six hours, intubation requirement for the AMI). The AHA database (see Table 1) provided information on hospital organization, size, staffing, and availability of technology such as cardiac catheterization, angioplasty, and open-heart surgery. The CCP database supplied information on performance of cardiovascular procedures and volume of AMI patients, as well as whether the patient remained in his or her admitting hospital or was transferred to another hospital for care.

Quality of care indicators included those defined by the CCP from American Heart Association and American College of Cardiology guidelines: use of thrombolytic agents or reperfusion with percutaneous transluminal coronary angioplasty (PTCA), heparin, intravenous (IV) nitroglycerin for persistent chest pain, and aspirin during hospitalization; use of beta-blockers, aspirin, and angiotensin-converting-enzyme (ACE) inhibitors at discharge; and avoidance of calcium-channel blockers at discharge.[6,11] The CCP database allowed identification of ideally eligible treatment candidates for each of the interventions, making it a particularly powerful data source to examine quality of AMI care. Ideally eligible treatment candidates had no documented contraindications to the intervention being studied. For example, ideal candidates for aspirin could not have evidence of bleeding, treatment with warfarin on admission, history of peptic ulcer disease, or allergy to aspirin. These criteria were developed as part of the CCP's pilot project and are listed in detail elsewhere.[6] Only those patients designated as ideally eligible treatment candidates were included in the quality indicator analyses. The use of heparinization during hospitalization was examined in the subgroup of patients that had not received treatments requiring heparin therapy (thrombolysis, percutaneous transluminal coronary angioplasty [PTCA], coronary artery bypass grafting [CABG]). Mortality within 30 days of the AMI admission was included as another study outcome.

Statistical Analysis

Differences in the patient populations and facility characteristics between hospitals in the four different geographic locations were analyzed using chi-square tests, ANOVA, and Student's t-tests, as appropriate. Means and standard deviations (SDs) are reported for continuous variables. Because of notable differences in rates of admissions transferred from their admitting hospital between the four hospital types, we compared the characteristics of admissions who remained in their admitting hospital with those who were transferred. We tested for differences in the crude rates of our quality indicators and mortality between the admissions in the three types of rural hospitals and urban hospitals using an overall chi-square test. Differences in quality indicators and mortality between admissions transferred from their admitting hospital and those remaining were analyzed using chi-square tests.

We used a Cox proportional hazards model with constant survival time, using the Breslow method for ties, to estimate the adjusted relative risks of our study outcomes for patients admitted to the three types of rural hospitals compared to urban hospitals. Logistic models often are used to analyze data with a dichotomous outcome; however, when the outcome is highly prevalent, the odds ratio tends to overestimate the relative risk.[12] Cox's proportional hazard model with constant survival time has been suggested[13] as an alternative that better estimates the relative risk but gives slightly wider (more conservative) confidence intervals.[14] Models containing all patient characteristics variables listed in Table 2 was fit. We controlled for potential clustering of similar patients within hospitals using robust standard errors. All analyses were conducted using Stata V7.0 software.[15] Relative risks are reported with their 95 percent confidence intervals.

RESULTS

Characteristics of Study Hospitals

Of the 4,085 study hospitals, 53 percent were in urban areas, 15 percent in large rural areas, 22 percent in small rural areas, and 10 percent in remote small rural areas. The urban hospitals cared for the greatest number of AMI admissions—75 percent—while the large rural cared for 14 percent, small rural 9 percent, and remote small rural 2 percent of all Medicare AMI admissions in this study. Over 40 percent of small and remote rural hospitals, but only about a quarter of urban and large rural hospitals, were government operated (Table 1). The more rural the hospital, the smaller the bed size. Over 90 percent of urban and large rural hospitals were accredited by the JCAHO; small rural and remote hospitals had much lower accreditation rates (61% and 33% respectively). Not unexpectedly, urban hospitals had the highest rates of on-site medical student and graduate medical training programs, on-site coronary care units, and the ability to perform angioplasty, coronary catheterization, and cardiac surgery.

Characteristics of AMI Admissions in Study Hospitals

The mean age of the AMI admissions overall was 76.6 (Table 2). The vast majority of all admissions were of white patients (91.2%), with higher proportions of white admissions in rural compared to urban hospitals. Substantial proportions of AMI admissions had comorbid conditions. Hypertension rates between the admissions in urban and rural hospitals were quite different, with rural hospitals having lower hypertension rates among their AMI admissions than urban hospitals. AMI admissions in urban hospitals were more likely to have had prior PTCA and CABG than AMI admissions in rural hospitals. AMI admissions in rural hospitals were less likely to be intubated and more likely to have come from a skilled nursing facility (SNF) or intermediate care facility (ICF) than AMI admissions in urban hospitals.

AMI admissions from rural hospitals were more likely than those from urban hospitals to be transferred to another hospital. Of those direct admissions for AMI, 40.0 percent of remote rural, 33.5 percent of small rural, 30.5 percent of large rural, and 16.0 percent of urban admissions were transferred to another hospital. Admissions transferred from their admitting hospital were more likely to be younger, male, and white and to have fewer comorbid conditions and lower APACHE II scores than those who stayed in their admitting hospital (Table 2). The "do not resuscitate" rate for AMI admissions staying in their admitting hospital was markedly higher (21.8%) compared to their transferred counterparts (2.7%). AMI admissions who were transferred were less likely to have been admitted from a SNF or ICF and to be intubated, and were more likely to have had chest pain with their AMI.

Quality of AMI Care

Substantial proportions of ideally eligible admissions in both urban and rural hospitals did not receive the recommended AMI treatments (Table 3). About 45 percent of all admissions did not receive aspirin within the first 24 hours, 54 percent did not receive thrombolytics within 60 minutes, 32 percent did not receive intravenous nitroglycerin for persistent chest pain, and 40 percent of admissions who did not otherwise receive an intervention requiring heparin (PTCA, CABG, thrombolysis) did not receive heparin.

Admissions in rural hospitals were less likely than admissions in urban hospitals to receive aspirin, heparin, IV nitroglycerin, and to be reperfused. In general, the smaller and more remote the area of the rural hospital, the less likely admissions were to receive the treatments. For example, 55.9 percent of admissions in urban hospitals received aspirin in the first 24 hours, 55.8 percent of admissions in large rural hospitals, 51.4 percent of admissions in small rural hospitals, and 47.8 percent of admissions in remote small hospitals. A similar trend was seen for use of reperfusion, heparin, IV nitroglycerin, and prescription of aspirin at any time during the hospitalization and at discharge, with admissions in urban hospitals most likely to receive these therapies and admissions in rural hospitals decreasingly likely to receive them based on smaller and more remote locations. While on average admissions in rural hospitals were less likely to receive several of the recommended treatments, similar proportions of rural and urban hospitals had nearly complete adherence to the recommendations. For example, the proportion of hospitals with over 95 percent of their patients receiving aspirin during the hospitalization was 25 percent in remote rural areas, 24 percent in small rural areas, 23 percent in large rural areas, and 24 percent in urban areas.

Use of beta-blockers and avoidance of calcium-channel blockers at discharge did not differ significantly between admissions in rural and urban hospitals. One intervention, prescription of an ACE inhibitor, was higher for discharges from the large and remote small rural hospitals than discharges from urban and small rural hospitals.

Nearly all of the findings from the analysis of crude rates were upheld after adjustment for control variables. Admissions in each of the three rural hospital types were less likely than admissions in urban hospitals to receive heparin, intravenous nitroglycerin, aspirin at any time during their hospitalization, or early reperfusion. Admissions in both small rural and remote small rural hospitals were less likely than urban hospitals to undergo reperfusion at any time, or to receive aspirin in the first 24 hours or at discharge. Admissions in large rural hospitals were more likely to receive ACE inhibitors at discharge.

An incidental, but notable, study finding was that differences in AMI treatment between admissions who were transferred to another hospital and those remaining in their admitting hospital often were more dramatic than differences between admissions in rural and urban hospitals (Table 3). Those transferred consistently were more likely to receive recommended treatments than admissions who remained in their admitting hospital. For example, analysis of crude rates demonstrated that 53.2 percent of admissions remaining in their admitting hospital received aspirin in the first 24 hours, while 62.7 percent of admissions who were transferred to another hospital received this treatment ($p = 0.000$). However, controlling for transfer status in the analyses examining rural/urban differences in use of recommended AMI treatments did not change the findings that admissions in rural hospitals were less likely to receive several interventions (not shown).

Mortality

Rates of death within 30 days of an AMI admission increased with the rurality of the hospital (Table 3). AMI admissions in the remote small rural town hospitals had the highest death rates (21.6%); AMI admissions in urban hospitals had the lowest death rates (18.7%). Admissions who were transferred to another hospital had much lower death rates (8.8%) than those who stayed in their admitting hospitals (21.6%). This was true in urban as well as rural hospitals (not shown). The differences in mortality between rural and urban hospitals as well as the differences between transferred and nontransferred admissions persisted after adjustment for the characteristics of those admitted (Table 4). The adjusted risk of death within 30 days for remote small rural hospitals was 1.32 (1.24,1.42), for small rural hospitals 1.25 (1.20,1.30), and for large rural hospitals 1.14 (1.10,1.18) compared to urban hospitals.

DISCUSSION

After controlling for a variety of patient characteristics, Medicare beneficiaries hospitalized for AMI in rural hospitals were less likely than those hospitalized in urban hospitals to receive several recommended interventions: aspirin, reperfusion, intravenous nitroglycerin for persistent chest pain, and heparin. Thirty-day mortality followed the same pattern, with admissions in rural hospitals having significantly higher death rates than admissions in urban hospitals. Beta-blockers and avoidance of calcium-channel blockers at discharge were not used at different rates between admissions in urban and rural hospitals. Only one treatment—ACE inhibitors at discharge—was used more for admissions in large rural hospitals than in urban hospitals. This finding was not consistent across all other types of rural hospital, however.

These findings parallel those of other smaller studies. Keeler et al. examined the care provided by 297 hospitals in five states in the 1980s and found both a lower quality of care and higher mortality rates for AMI in rural hospitals.[16] Sheikh and Bullock used a subset of the CCP database for Kansas only and found that patients in rural hospitals were less likely to receive aspirin both during their hospital stay and at discharge, as well as less likely to receive heparin and intravenous nitroglycerin during their hospitalization compared to patients in urban hospitals in

Kansas.[17] Our study has confirmed the findings of this prior work using a much larger national database. In addition, we have aggregated rural hospitals into three levels of remoteness and town population and found that for several outcomes, AMI admissions to all types of rural hospital were less likely to receive several of the recommended interventions.

Several studies using the CCP database have found an association between hospital characteristics, such as hospital volume, bed size, and teaching status, and the quality of care.[8,18-20] These findings are consistent with the results of this study, as rural hospitals, especially in small and remote small rural areas, have fewer beds and lower patient volumes. Larger hospitals may have a more substantial infrastructure with clinical and administrative protocols for managing AMI. Their higher patient volumes provide them with more experience in treating AMI. In addition, they may have the resources to develop more extensive quality assurance and continuing education programs that both review cases and help educate practitioners.

This study identified transfer from admitting hospital as a factor strongly associated with quality of care. Transfers were more likely to be younger, less ill, male, and white than nontransferred admissions. Transfers also were more likely to receive recommended treatments. This closely matches the findings of a smaller study of patients transferred for AMI in Michigan.[21] It is possible that patients were transferred from their admitting hospital to receive technologies unavailable in their admitting hospital, such as PTCA, CABG, or cardiac catheterization. While physicians may have customized their treatments and transfer decisions based on patient preference or contraindications not identified in this study, physicians in all types of hospitals were making treatment choices based on criteria other than those in published guidelines and missing opportunities to provide recommended AMI treatments.

AMI admissions cared for in rural hospitals had significantly higher mortality rates compared to their urban counterparts, even after controlling for patient comorbidity. This finding is consistent with those of other studies, which found higher mortality for AMI in rural hospitals.[16,22] Mortality is complex, however, and is affected by factors unmeasured in this study, such as patient preferences and ability to safely transfer patients from their treating hospital. Therefore, these results should be viewed with care.

Our study has several limitations. First, we were unable to control for factors not available from the medical record, such as patient and physician preferences, physician and hospital volume of AMI cases, and unmeasured patient comorbidities. Second, abstraction errors were possible, although validation studies of the CCP data have found a high level of data reliability.[11] Third, data from several states with substantial rural populations (e.g., Iowa, Minnesota) were not available in our database. If these states' rural hospitals differed substantially in the study's quality of care indicators, our study results would not be representative of the nation. Last, this study's data were collected in the mid-1990s, so they may not represent current care. The American Heart Association and the American College of Cardiology reissued their "Guidelines for the Management of Patients with Acute Myocardial Infarction" in 1996,[5] which may have had an impact on the quality of AMI care since that time. Other changes since the study data were collected, such as the reduction of rural hospital profit margins,[23] may also have affected quality of AMI care by making it more difficult for small hospitals to maintain or expand their quality assurance programs. However, other factors such as the new Critical Access Hospital (CAH) Program have been implemented since the time of this study, with over 500 of the smallest and most remote rural hospitals participating. One CAH objective is to improve quality of care, and there are preliminary indications that the program has had a positive influence.[24]

Our results have several implications. The task of improving AMI quality in rural hospitals is possible, as indicated by the over 20 percent of rural hospitals of all types with nearly complete adherence to the aspirin treatment guideline. In addition, several of the AMI interventions with the greatest effect on outcomes (e.g., beta-blockers, ACE inhibitors) were not used significantly less in rural hospitals compared to urban hospitals.[5] However, our results also indicate that much work still needs to be done. One important policy issue emanating from this study is to determine the remedial actions necessary for lower quality rural hospitals. While regionalizing care to larger, more specialized hospitals is used as a strategy for some conditions, the need for immediate intervention and a high incidence rate precludes this as a practical strategy for AMI. Some have suggested mandating that Medicare's Quality Improvement Organizations (QIOs, formerly known as Peer Review Organizations) include rural populations in their quality activities and that a third of rural hospitals be surveyed to certify Medicare compliance as a condition of participation.[23] However, rural hospitals have well-documented and unique issues related to quality improvement activities (e.g., small sample size, provider shortages, patient-choice issues, and limited finances),[25,26] and these issues will need to be confronted in any systematic effort to improve AMI care.

Our study highlights the need to assess a broad range of outcome variables when determining the quality of care in rural areas. For instance, the Medicare Payment Advisory Commission (MedPAC), the commission charged with reporting to Congress on Medicare policy issues, recently published its first report focusing on Medicare services in rural areas. This analysis used Medicare administrative data to examine quality of care across a broad spectrum of conditions. There were two quality measures examined for AMI: a visit within four weeks following discharge of patients hospitalized for MI (based on 1,093 patients) and a cholesterol test once every six months for patients hospitalized for MI who have hypercholesterolemia (based on 604 patients).[27] This report concluded, "Quality of care, as measured by the use of recommended services, is roughly comparable among rural counties of varying proximity to metropolitan areas, as well as between rural and metropolitan areas."[23(p.xvi)]

The current study's finding of poorer adherence to several recommended guidelines for AMI care and higher mortality in rural hospitals is at odds with MedPAC's conclusions. Clearly, there are significant differences in the methodologies used by these two studies. However, the current study's ability to use more detailed data abstracted from the medical records allows a clinically and geographically more refined analysis and suggests that similar and more detailed studies are needed for this and other conditions before concluding that care in rural and urban settings is truly comparable.

Beyond differences in AMI care between rural and urban hospitals, this study has found that all hospitals, both rural and urban, were not meeting many of the recommended treatment guidelines for AMI care. These AMI treatments were being applied preferentially to admissions who were transferred out of their admitting hospitals, suggesting that physicians were making decisions regarding qualifications for treatment that were based on criteria other than those in the published literature. Since these easy-to-administer treatments are amenable to change,[28] and can be implemented by protocol, and because proximity to care is important for AMI patients, efforts are needed to help both rural and urban hospitals develop systems to assure patients receive recommended AMI treatments. While implementing such change can be more challenging in rural hospitals because of their smaller size and more limited resources,[29] it is essential so that they can provide the highest quality care for this common medical condition.

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Table 1: Hospital Characteristics by Geographic Location

	Urban* (n = 2,165)	Large Rural* (n = 619)	Small Rural* (n = 893)	Remote Small Rural* (n = 408)	Total (n = 4,085)
Organizational structure (%):					
Not for profit	68.3	61.6	48.5	49.5	61.1
For profit	18.9	13.1	8.3	5.9	14.4
Local/state/federal government	21.7	25.4	43.2	44.6	24.5
Bed size (%):					
< 50	5.2	13.3	56.2	83.3	25.4
50-99	11.8	32.6	32.9	13.5	19.8
100-199	30.3	41.8	9.6	2.7	24.8
200-299	22.7	9.5	1.0	0.5	13.8
300+	30.0	2.8	0.2	0.00	16.4
Inpatient days (median)	44,550	17,752	6,585	3,673	20,334
Admissions (median)	8,256	3,816	1,426	668	4,084
FTE nurses (median)	215	100	36	18	107
Average daily census (median)	122.1	48.6	18.0	10.1	55.7
Presence of medical/surgical intensive care unit (%)	80.7	78.8	51.6	32.1	69.2
Presence of cardiac intensive care unit (%)	44.8	25.4	14.0	14.7	32.2
Capacity for angioplasty (%)	38.7	11.2	1.7	0.0	22.6
Presence of catheterization lab (%)	53.9	27.8	4.5	1.7	33.9

	Urban* (n = 2,165)	Large Rural* (n = 619)	Small Rural* (n = 893)	Remote Small Rural* (n = 408)	Total (n = 4,085)
Capacity for open-heart surgery (%)	33.4	5.8	0.7	0.0	18.8
Accredited by the Joint Commission on Accreditation of Health Care Organizations (%)	93.5	92.9	61.4	33.1	80.3
Residency training approved by the Accreditation Council for Graduate Medical Education (%)	32.8	5.7	1.1	0.5	18.6
Medical school affiliation reported to the American Medical Association (%)	33.3	8.6	1.9	3.9	19.7
Member of the Council of Teaching Hospitals of the Association of American Medical Colleges (AAMC) (%)	11.2	0.3	0.1	0.3	94.0

* Rural Urban Commuting Area (RUCA) codes used to designate urban and rural areas are as follows: Urban (1.0, 1.1, 2.0, 2.1, 2.2, 3.0, 4.1, 5.1, 7.1, 8.1, 10.1); Large Rural (4.0, 5.0, 6.0); Small Rural (7.0, 7.2, 7.3, 7.4, 8.0, 8.2, 8.3, 8.4, 9.0, 9.1, 9.2); Remote Small Rural (10.0, 10.2, 10.3, 10.4, 10.5).

Table 2: Characteristics of AMI Admissions by Geographic Location of Admitting Hospital

Admission Characteristics	Urban (n = 102,289)	Large Rural (n = 28,516)	Small Rural (n = 11,862)	Remote Small Rural (n = 2,092)	p Value*	All Admissions† (n = 135,759)	Admissions Remaining in Admitting Hospital (n = 108,815)	Admissions Transferred from Admitting Hospital** (n = 26,944)
Age (SD)	76.5 (7.4)	76.4 (7.3)	76.9 (7.5)	77.4 (7.6)	≤ 0.001	76.6 (7.4)	77.4 (7.5)	73.3 (5.7)
Female (%)	48.9	49.0	50.1	49.3	0.117	49.1	50.6	42.6
White (%)	90.2	93.8	93.9	95.8	≤ 0.001	91.2	90.6	93.3
Diabetes (%)	30.9	31.2	31.1	30.4	0.732	30.9	31.4	29.1
Hypertension (%)	62.7	60.1	58.4	54.8	≤ 0.001	61.8	62.1	60.5
Congestive heart failure (%)	22.0	21.9	23.7	23.8	≤ 0.001	22.1	24.7	12.0
Cerebrovascular accident (%)	13.9	14.2	14.2	14.2	0.646	14.0	15.2	9.2
Previous MI (%)	31.3	31.5	30.0	30.7	0.023	31.2	32.1	27.6
Chronic obstructive pulmonary disease (%)	19.9	21.6	22.6	22.8	≤ 0.001	20.5	21.1	17.8
Prior PTCA (%)	7.3	5.6	4.5	4.7	≤ 0.001	6.8	6.5	7.8
Prior CABG (%)	12.8	11.7	10.0	10.8	≤ 0.001	12.4	12.6	11.6
Smoking (%)	14.6	15.2	14.4	12.8	0.002	14.6	14.0	17.2
Terminal illness (%)	0.4	0.4	0.4	0.5	0.793	0.4	0.4	0.2
Incontinent (%)	7.3	7.5	8.5	9.0	≤ 0.001	7.5	8.6	3.0
Dementia (%)	6.2	5.8	6.7	6.8	0.010	6.2	7.4	1.2
Admitted from SNF or ICF (%)	5.3	5.9	7.2	7.3	≤ 0.001	5.6	6.8	0.7
Metastatic cancer (%)	2.0	1.7	1.5	1.7	≤ 0.001	1.9	2.1	1.0

Admission Characteristics	Urban (n = 102,289)	Large Rural (n = 28,516)	Small Rural (n = 11,862)	Remote Small Rural (n = 2,092)	p Value*	All Admissions† (n = 135,759)	Admissions Remaining in Admitting Hospital (n = 108,815)	Admissions Transferred from Admitting Hospital** (n = 26,944)
APACHE II (SD) (%)	10.1 (4.5)	10.2 (4.5)	10.3 (4.5)	10.1 (4.3)	≤ 0.001	10.1 (4.5)	10.4 (4.5)	8.9 (3.4)
Intubation (%)	13.1	9.0	7.7	7.2	≤ 0.001	12.0	13.7	5.1
Limitation of resuscitation (e.g., DNR) (%)	17.8	18.4	18.7	18.9	0.029	18.0	21.8	2.7
Chest pain > 6 hours (%)	24.2	24.6	25.0	25.2	≤ 0.001	24.3	24.2	24.7

* p value for chi-square or t-test between patients in hospitals in different rural and urban areas.

** p value for chi-square or t-test between patients remaining in their admitting hospital versus patients transferred from their admitting hospital. All ≤ 0.001 except chest pain > 6 hours, in which p = 0.12.

† Missing values: age 42, sex 40, race 2,363, incontinence 3,061, chest pain duration 11,506.

Table 3: Rates of AMI Treatment Use and 30-Day Mortality by Hospital Geographic Location

	Urban (%)	Large Rural (%)	Small Rural (%)	Remote Small Rural (%)	p Value*	All Admissions (%)	Admissions Remaining in Admitting Hospital (%)	Admissions Transferred from Admitting Hospital (%)	p Value**
Interventions During Hospitalization:									
ASA during first 24 hours	55.9	55.8	51.4	47.8	≤ 0.001	55.3	53.2	62.7	≤ 0.001
ASA during hospitalization	86.5	84.4	80.9	77.5	≤ 0.001	85.5	84.7	88.2	≤ 0.001
Early reperfusion†	47.9	42.9	38.3	33.5	≤ 0.001	46.0	45.4	47.2	0.06
Reperfusion at any time	67.6	68.1	64.7	58.0	0.002	67.2	64.9	71.9	≤ 0.001
Heparin-PTCA/CABG/ thrombolytics not given	62.2	57.5	53.5	49.8	≤ 0.001	60.3	55.6	77.4	≤ 0.001
IV nitroglycerin	70.4	65.1	59.0	51.3	0.001	68.1	66.0	74.2	≤ 0.001
Interventions at Discharge:									
ASA at discharge	76.4	74.4	71.1	67.7	≤ 0.001	75.6	NA	NA	NA
ACE inhibitor at discharge	59.4	63.1	56.9	64.0	0.021	59.7	NA	NA	NA
Beta-blocker at discharge	51.8	49.6	47.2	55.4	0.160	51.4	NA	NA	NA
Avoid calcium channel blockers at discharge	83.6	84.7	86.2	89.7	0.274	84.0	NA	NA	NA
30-day all-cause mortality	18.7	19.4	20.9	21.6	≤ 0.001	19.0	21.6	8.8	≤ 0.001

* p value for chi-square between hospitals in different rural and urban areas.

** p value for chi-square between patients remaining in their admitting hospital versus patients transferred from their admitting hospital.

† Thrombolytics in 60 minutes or PTCA within 12 hours.

The number of ideal candidates from which the rates were calculated differs for each measure and is listed in the following order: urban, large rural, small rural, remote small rural, admissions remaining in admitting hospital, admissions transferred to another hospital.

ASA during first 24 hours: 52,998; 9,670; 6,335; 1,662; 54,760; 15,905.
ASA during hospitalization: 53,105; 9,689; 6,351; 1,671; 54,873; 15,943.
Early reperfusion: 10,102; 1,957; 1,208; 251; 8,992; 4,526.
Reperfusion at any time: 10,399; 1,995; 1,239; 257; 9,269; 4,621.
Heparin: 54,723; 11,179; 7,736; 2,072; 59,453; 16,257.
IV nitroglycerin: 27,361; 5,446; 3,245; 903; 27,369; 9,586.
ASA at discharge: 34,382; 5,111; 3,229; 916.
ACE inhibitor at discharge: 10,386; 1,317; 620; 136.
Beta-blocker at discharge: 8,633; 936; 413; 74.
Avoidance of calcium channel blockers at discharge: 5,229; 701; 326; 78.

N for 30-day all-cause mortality: 102,289; 18,516; 11,862; 3,092; 108,815; 26,944.

Table 4: Adjusted Relative Risk of AMI Treatment Use and 30-Day Mortality by Hospital Geographic Location*

	Urban	Large Rural	Small Rural	Remote Small Rural
Interventions During Hospitalization:				
ASA During First 24 Hours	Ref	0.99 (0.97,1.02)	0.93 (0.90,0.96)	0.87 (0.82,0.93)
ASA During Hospitalization	Ref	0.97 (0.96,0.99)	0.94 (0.93,0.96)	0.91 (0.88,0.94)
Early reperfusion†	Ref	0.89 (0.84,0.95)	0.79 (0.73,0.86)	0.74 (0.62,0.88)
Reperfusion at any time	Ref	1.01 (0.98,1.04)	0.95 (0.91,0.99)	0.89 (0.80,0.99)
Heparin§	Ref	0.91 (0.88,0.94)	0.86 (0.82,0.89)	0.80 (0.73,0.87)
IV Nitroglycerin	Ref	0.93 (0.90,0.96)	0.85 (0.81,0.88)	0.75 (0.67,0.83)
Interventions at Discharge:				
ASA at discharge	Ref	0.99 (0.96,1.01)	0.95 (0.92,0.98)	0.90 (0.86,0.96)
ACE inhibitor at discharge	Ref	1.06 (1.01,1.11)	0.94 (0.87,1.02)	1.08 (0.93,1.24)
Beta-blocker at discharge	Ref	0.97 (0.89,1.05)	0.93 (0.83,1.05)	1.07 (0.83,1.38)
Avoid Ca channel blockers at discharge	Ref	1.01 (0.97,1.05)	1.03 (0.98,1.08)	1.06 (1.00,1.14)
30-Day All-Cause Mortality:	Ref	1.14 (1.10,1.18)	1.24 (1.20,1.29)	1.32 (1.23,1.41)

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* There was no change in regression results when length of chest pain and transfer status were added to the models.

† Thrombolytics in 60 minutes or PTCA within 12 hours.

§ Includes only those patients who would not have received heparin in follow-up for PTCA, CABG, or thrombolysis.

All regressions controlled for patient characteristics in Table 2.

Previous WWAMI Rural Health and Health Workforce Research Center Working Papers

The WWAMI Rural Health Research Center was established in 1988. The WWAMI Center for Health Workforce Studies was established in 1998.

1. Hart, L. Gary; Rosenblatt, Roger A.; and Amundson, Bruce A. Is There a Role for the Small Rural Hospital? January 1989.
2. Hart, L. Gary; Rosenblatt, Roger A.; and Amundson, Bruce A. Rural Hospital Utilization: Who Stays and Who Goes? March 1989.
3. Amundson, Bruce A. and Hughes, Robert D. Are Dollars Really the Issue for the Survival of Rural Health Services? June 1989.
4. Nesbitt, Thomas S.; Rosenblatt, Roger A.; Connell, Frederick A.; and Hart, L. Gary. Access to Obstetrical Care in Rural Areas: Effect on Birth Outcomes. July 1989.
5. Schleuning, Dianne; Rice, George; and Rosenblatt, Roger A. Addressing Barriers to Rural Perinatal Care: A Case Study of the Access to Maternity Care Committee in Washington State. October 1989.
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9. Hart, L. Gary; Pirani, Michael; and Rosenblatt, Roger A. Causes and Consequences of Rural Small Hospital Closures from the Perspectives of Mayors. September 1990.
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14. Larson, Eric H.; Hart, L. Gary; and Rosenblatt, Roger A. Is Rural Residence Associated with Poor Birth Outcome? June 1991.
15. Williamson, Harold A.; Rosenblatt, Roger A.; Hart, L. Gary. Physician Staffing of Small Rural Hospital Emergency Departments: Rapid Change and Escalating Cost. September 1991.
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19. Williamson, Harold; Hart, L. Gary; Pirani, Michael J.; Rosenblatt, Roger A. Rural Hospital Surgical Volume: Cutting Edge Service or Operating on the Margin? January 1993.
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