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Quality of Care and Patient Outcomes in Critical Access Hospitals

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Abstract

Context—Critical Access Hospitals (CAHs) play a crucial role in the nation's rural safety net. Current policy efforts have focused primarily on helping these small, isolated hospitals remain financially viable to ensure access for Americans living in rural areas. However, we know little about the quality of care they provide, or the outcomes their patients achieve.

Objective—To examine the quality of care and patient outcomes at CAHs, and to understand why patterns of care might differ for CAHs versus non-CAHs.

Design—Retrospective analysis of national data from Medicare and other sources.

Setting—U.S. hospitals.

Patients—Medicare fee-for-service beneficiaries with acute myocardial infarction (AMI), congestive heart failure (CHF), and pneumonia, discharged in 2008–2009.

Main Outcome Measures—Clinical capabilities, performance on processes of care, and 30-day mortality rates.

Results—Compared to other hospitals, CAHs were less likely to have intensive care units (30.0% versus 74.4%, p<0.001), cardiac catheterization capabilities (0.5% versus 47.7%, p<0.001), and at least basic electronic health records (4.6% versus 9.9%, p<0.001). CAHs had lower performance on process measures than non-CAHs for all three conditions examined (Hospital Quality Alliance summary score for AMI 91.0% versus 97.8%, for CHF, 80.6% versus 93.5%, and for pneumonia 89.3% versus 93.7%, p<0.001 for each). Patients admitted to a CAH had higher 30-day mortality rates for each condition than those admitted to non-CAHs (for AMI, 23.5% versus 16.2%, Odds Ratio (OR) 1.70 (95% confidence interval 1.61, 1.80), p<0.001; for CHF, 13.4% versus 10.9%, OR 1.28 (1.23, 1.32), p<0.001; and for pneumonia 14.1% versus 12.1%, OR 1.20 (1.16, 1.24) p<0.001).

Conclusions—Care in CAHs, compared with non-CAHs, is associated with worse processes of care and higher mortality rates.

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Introduction

Critical Access Hospitals (CAHs) play an important and unique role in the nation's healthcare system, caring for Americans who live in rural areas and might otherwise have no accessible inpatient provider. This hospital designation, created by the Medicare Rural Hospital Flexibility Program of the 1997 Balanced Budget Act, resulted from a federal effort to increase resources for small, geographically isolated hospitals, many of which were struggling financially. The bill defined CAHs as hospitals with no more than 25 acute care beds, located more than 35 miles from the nearest hospital; hospitals that converted to CAH status became eligible for cost-based reimbursement rather than diagnosis-related group (DRG)-based reimbursement.[1] As a result, margins improved and closures among these small rural hospitals fell dramatically;[2, 3] over a quarter of the acute care hospitals in this country now have the CAH designation.

The CAH designation was created with the goal of ensuring "proximate access" to basic inpatient and emergency care close to home for the approximately 20% of the U.S. population that still lives in rural communities.[4] The program has been highly successful in protecting access to inpatient care for rural communities, while providing care that receives high scores on patient satisfaction.[5] However, despite broad policy interest in helping CAHs provide access to inpatient care, we have little information about the quality of care they provide: these hospitals are exempt from reporting to both the Joint Commission performance measure program[6] and the Hospital Quality Alliance (HQA) national public reporting program.[7] We are unaware of recent national data comparing outcomes at these hospitals to a national sample. CAHs have less access to capital and fewer health care providers in their communities, including fewer specialists.[8] Therefore, these hospitals may face equal or greater challenges in delivering high quality care[9] compared with other vulnerable hospitals, such as Safety Net providers, that have been more extensively studied.[10] Understanding whether the Critical Access designation has been helpful in not just improving access, but also in ensuring high quality care, is a key element in evaluating federal efforts to ensure an effective rural health system.

Therefore, we sought to examine CAHs' clinical and personnel resources, the quality of care they deliver, and their patients' outcomes. We focused on three common conditions: congestive heart failure (CHF), acute myocardial infarction (AMI), and pneumonia. We also sought to identify what factors, such as clinical capabilities, size, patient volume, or other related issues, might explain any differences in outcomes of care.

Methods

Data

Hospitals—We used the Medicare Provider Analysis and Review file (MedPAR) to identify non-federal hospitals providing acute care services to Medicare beneficiaries in the 50 U.S. states or District of Columbia. We used the 2009 American Hospital Association (AHA) survey to obtain data on hospital characteristics including critical access designation, size, ownership, teaching status, and region. We linked these data with the 2009 Area Resource File (ARF), which contains county-level data on median household income and poverty rate. While the original legislation specified that only isolated rural hospitals qualified for CAH status, states subsequently granted exemptions for this rule, allowing some hospitals in suburban or even urban settings to be eligible. Therefore, we linked the Rural Urban Commuting Area (RUCA) codes, which detail population density and urbanization at a granular level to examine the degree to which rurality affected our findings.[11]

Patients—We defined our study population as Medicare Fee-for-Service beneficiaries admitted to the hospitals in our sample in 2008 or 2009 with a primary discharge diagnosis of AMI, CHF, or pneumonia (International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9) codes for CHF 398.91, 404.x1, 404.x3, 428.0 to 428.9, for AMI 410.xx, excluding 410.x2, and for pneumonia 480 to 486). Patient race was categorized based on self-report, as reported to Medicare. We followed the Center for Medicare and Medicaid Services (CMS) approach for classifying "index admissions",[12] allowing patients to be included in the sample more than once. All patients were assigned to the admitting hospital regardless of whether they were transferred. Our final patient population included 2,351,701 admissions across these three conditions.

Outcomes

We used the AHA survey to quantify resources that have been associated with better care,[14, 15] including the presence of an intensive care unit, the ability to perform cardiac catheterization or surgery, and nurse staffing levels. Nurse staffing was estimated by calculating the number of full-time equivalent nurses on staff per 1000 patient-days.[16, 17] We used the ARF to estimate the total physician and subspecialist supply for the county in which each hospital was located. Each hospital's HIT resources were determined from the AHA HIT survey, which was distributed to every acute-care hospital in the U.S. in 2009. The survey asked responding hospitals to report the degree of adoption of specific electronic health record (EHR) functions and achieved a response rate of 63%.[18]

We used Hospital Quality Alliance (HQA) data to obtain hospitals' performance on process measures for AMI, CHF, and pneumonia during 2009; because of sample size cutoffs and reporting exemptions, these measures were available for only a subset of the hospitals in our sample. We calculated an overall performance score for each hospital for each condition[19] (see eTable 1 for list of measures). We used Medicare data to calculate mortality within 30 days of admission. Each patient's likelihood of death was adjusted for age, sex, race, and medical comorbidities using the CMS Hierarchical Condition Category (HCC) mortality models,[20] which were developed by CMS and have been demonstrated in recent studies to have a superior c-statistic and predictive accuracy than the Charlson and Elixhauser methods.[21]

Analysis

We compared summary statistics for hospital characteristics, demographics, and patient comorbidities between CAHs and non-CAHs using chi-square tests and t-tests or Wilcoxon tests as appropriate. We used chi-square tests to compare the presence of each clinical resource and functionality between CAHs and non-CAHs. We analyzed performance on the HQA metrics, weighting each hospital's performance by its number of patients with that diagnosis. We then created weighted hospital-level linear regression models for risk-adjusted 30-day mortality rates.

We subsequently built multivariable regression models. We first adjusted for factors that are outside the control of the hospitals and policy makers, including region, hospital ownership, and median county income. We next added variables to the model that we postulated might be in the explanatory pathway between CAH status and outcomes, and might be amenable to change by either hospitals or policy makers. We did this in a stepwise fashion, first adding measures of clinical personnel, followed by clinical resources and system membership, the presence of an EHR, and annual condition-specific case volume. Finally, we examined models adjusting for rurality using the RUCA codes (divided into urban, large town, small town, and rural categories). While rurality is highly collinear with being a CAH, it may also

be correlated with other, unmeasured (or inadequately measured) factors including travel time and quality of clinical personnel and resources.

Because CAHs transfer more patients than non-CAHs, we examined, in sensitivity analyses, differences in mortality rates after excluding all transfers. To better understand whether differences in outcomes between CAHs and other hospitals were driven primarily by size and rural status, or whether these differences might be driven by other factors such as CAHs' exemption from reporting or payment mechanisms, we conducted additional sensitivity analyses, restricting our sample to small, rural hospitals. Finally, we used established methods[3, 4] to model the degree of association between an unmeasured confounder and both our primary predictor (CAH status) and our outcome (mortality) that would have had to be present in order to eliminate our findings.

To account for multiple comparisons, we considered a two-sided p-value of less than 0.008 to be significant. Analyses were performed using SAS version 9.2 (Cary, NC).

Results

Hospital characteristics and resources

Of the 4,738 hospitals providing acute care to Medicare beneficiaries in 2008–2009, 1,268 (27%) were designated as CAHs. The median number of operational beds in a CAH was 18 (interquartile range (IQR) 14, 23), compared with 82 (IQR 41, 154) for non-CAHs (Table 1). CAHs were more likely to be publicly owned, and less likely to be a teaching hospital, located in an urban area or large town, or part of a hospital system. Nearly half of the CAHs were located in the Midwest. In general, CAHs were located in counties with a lower median income than non-CAHs and served a higher proportion of Medicare patients but a lower proportion of Medicaid patients.

Patient characteristics

We identified 2,351,701 index admissions for CHF, AMI, or pneumonia during our study period, of which 149,989 were to CAHs. Patients admitted to CAHs tended to be older, and had a higher incidence of diabetes and depression, but a lower incidence of hypertension, renal failure, and chronic lung disease (Table 2). Patients admitted to CAHs were more likely to be transferred to another acute care hospital than those admitted to non-CAHs (AMI 29.7% versus 9.5%, CHF 7.4% versus 2.5%, pneumonia 5.6% versus 1.5%, $p<0.001$ for each), and had significantly shorter lengths of stay for all three conditions. Patients admitted to CAHs were less likely to be transferred to a hospice at the time of discharge than patients admitted to non-CAHs.

Clinical Resources

CAHs had fewer clinical resources than other hospitals: they were less likely to have intensive care units, cardiac catheterization capability, or the ability to perform surgeries (Table 3). CAHs had comparable nurse-staffing levels to non-CAHs, but were located in counties with fewer specialists, with a seven-fold difference in the supply of cardiologists and pulmonologists per 100,000 population.

CAHs were less likely to have the key functions that comprise an EHR. Overall, just 4.6% of CAHs had at least a basic EHR[18] compared with 9.9% of non-CAHs. Each EHR component, including clinical documentation, results viewing, computerized physician order entry, and decision support was present less often at CAHs; we found no difference in adoption of telemedicine (Table 4). CAHs were also less likely to be exchanging clinical data electronically with other hospitals or with outpatient practices.

Processes of Care

For all three conditions, CAHs had lower performance on HQA measures than non-CAHs among reporting hospitals (Figure 1). For patients admitted with AMI, CAHs provided care that was concordant with HQA process measures 91.0% of the time compared to 97.8% for non-CAHs (difference of 6.8%, p<0.001). The difference was larger for CHF (12.9%) and smaller but still significant for pneumonia (4.4%). For 14 of the 17 individual measures, CAHs performed worse than non-CAHs (eTable 2). These differences persisted after adjusting for case mix and hospital characteristics (eTable 3)

Clinical Outcomes

Patients admitted to CAHs had higher 30-day risk-adjusted mortality rates for all three conditions than patients admitted to non-CAHs (Table 5). Patients admitted to a CAH had 7.3% higher absolute 30-day mortality rates for AMI (23.5% versus 16.2%, Odds Ratio (OR) 1.70, 95% confidence interval (CI) 1.61, 1.80, p<0.001); 2.5% higher mortality rates for CHF (13.4% versus 10.9%, OR 1.28, 95% CI 1.23 to 1.32, p<0.001); and 2% higher mortality rates for pneumonia (14.1% versus 12.1%, OR 1.20, 95% CI1.16 to 1.24, p<0.001) than those admitted elsewhere. When we limited our analyses to non-transferred patients, our results were similar (eTable 4).

We next built models that serially adjusted for variables that might be in the explanatory pathway to identify potentially actionable differences between CAHs and non-CAHs that contribute to outcomes. We found that differences in clinical personnel and resources into the model slightly attenuated the findings (Table 5); even after fully adjusting for all variables, including rurality, differences in mortality between CAHs and non-CAHs persisted for AMI (OR 1.18, 95% CI 1.09 to1.28, p<0.001) and for CHF (OR 1.15, 95% CI 1.00 to 1.31, p=0.04), but not pneumonia (OR 0.92, 95% CI 0.87 to 0.97, p=0.003).

When we limited our analyses to small, rural hospitals (81% of the CAHs and 11% of the non-CAHs), we found differences in resources (eTable 5a/b), quality of care, and outcomes between those with versus without the CAH designation. Although there were no significant differences in measured quality for AMI (HQA summary score 89.7 versus 90.3, p=0.59), CAHs had higher mortality than non-CAHs for this condition (OR 1.14 (1.05, 1.24), p=0.003). CAHs had lower performance on quality measures and higher mortality for CHF (HQA summary score 78.7 versus 84.8, p<0.001; OR for mortality 1.09 (1.03, 1.16), p=0.003), and lower performance on quality measures but identical mortality for pneumonia (HQA summary score 88.7 versus 91.1, p<0.001; OR for mortality 1.05 (0.99, 1.11), p=0.11, Table 6).

In our sensitivity analysis, we found that unmeasured confounding was unlikely to explain our findings. For AMI, for example, if an unmeasured confounder tripled mortality risk (a much stronger predictor of mortality than any of our current comorbidities) and was three times more common in CAH patients than non-CAH patients, the odds ratio for mortality associated with receiving care at a CAH would decrease to 1.44, still statistically significant and clinically meaningful.

Discussion

Despite more than a decade of concerted policy efforts to improve rural healthcare, our findings suggest that substantial challenges remain. While CAHs provide much needed access to care for many of the nation’s rural citizens, we found that these hospitals, with their fewer clinical and technological resources, less often provided care consistent with standard quality metrics and generally had worse outcomes than non-CAHs. The absolute differences in outcomes were even larger than those reported in the initial work on this topic

by Keeler et al., who demonstrated an excess all-cause mortality of 1.4% in rural hospitals using data from the 1980s,[22] and comparable to differences noted by the Medicare Payment Advisory Committee (MedPAC) using data from 2003.[2] These findings suggest that efforts to date have been insufficient in improving the quality of inpatient care in rural communities – and indicate a need for greater policy attention to the challenges these providers face.

The CAH designation, created with the goal of preserving access to care for Americans living in rural areas, directed financial resources to vulnerable rural hospitals at a time when many were closing due to financial insolvency. A number of regulations intended to promote quality were included in the legislation, including a formal requirement for credentialing and a state-run evaluations of quality. In return, designation as a CAH provided hospitals with financial security through cost-based reimbursement, which led to a significant improvement in these hospitals' financial stability and allowed them to remain open, preserving access[9, 24, 25] while maintaining patient satisfaction scores equal to or greater than non-CAHs.[5] However, our findings suggest that these efforts have been inadequate in ensuring high quality care.

CAHs had significantly poorer performance on process measures, which may be due to fewer resources to devote to quality improvement. Because CAHs are not required to report HQA data,[7] the CAHs that reported (which ranged from 39% of CAHs for AMI to 71% of CAHs for pneumonia) probably represent a higher-performing subset of CAHs than those choosing not to, likely understating the true differences in care. Further, CAHs have typically been exempt from pay-for-performance programs in the past, and will likely be excluded from national value-based purchasing efforts at least in the near-term.[26–28] Engaging in the process of collecting and reporting data is an important step towards developing an internal quality improvement strategy;[29] indeed, the Institute of Medicine has recommended that all CAHs participate in the HQA program for this reason.[30]

We found that personnel and clinical resources explained some of the mortality differences between CAHs and other hospitals. Assuring adequate personnel and resources is challenging for CAHs[9, 25] given their difficulties in recruiting health care providers.[25] Shorter lengths of stay, poor care transitions, or inadequate outpatient and home-based care[31–33] may also contribute to poorer outcomes. Policy efforts to bring needed providers to underserved areas to ensure that CAHs have key clinical resources may be helpful. Given prior evidence that being a member of a hospital system may be related to improved clinical outcomes,[34, 35] promoting partnerships with healthcare systems might be a useful strategy to help CAHs. Such partnerships could include onsite rotations by clinicians with specialty training, increased use of telemedicine, or formal referral and transfer agreements; arrangements that allow patients to remain close to home while still facilitating access to specialty care are likely to be particularly well-received by patients. One approach might be to provide financial incentives for tertiary care hospitals to partner with CAHs, potentially tying incentives to the CAH's performance on quality metrics.

Although we did not find that the presence of an EHR explained a significant amount of the difference in clinical outcomes between CAHs and non-CAHs, this area warrants extra attention. The use of technology, particularly telemedicine and clinical data exchange, has important applications in underserved areas.[36–39] CAHs lack financial capital and access to the personnel needed to install and effectively maintain these systems.[40, 41] The federal effort to promote EHR adoption among CAHs has focused on technical assistance by the Regional Extension Centers (RECs).[42] However, some RECs have elected not to work with CAHs and others are charging fees that may be unaffordable for CAHs. Policy makers may need to consider additional strategies to avoid exacerbating an already emerging digital divide.[18]

Adding rurality to our models seemed to explain some of the mortality differences we saw, and when we compared small, rural CAHs to small, rural non-CAHs, the excess mortality at CAHs was smaller. Our findings suggest that a substantial proportion of the barriers faced by CAHs are due to their size and their rural location, even after accounting for other factors such as clinical resources and personnel. Rurality is likely associated with other unmeasured factors such as travel distances to primary care or hospital, that impact outcomes; better understanding what factors are closely correlated with rurality that help explain these gaps in outcomes would be helpful in formulating effective interventions to help CAHs.

Despite the significant policy attention directed towards these vulnerable hospitals, there has been little empirical work on quality of care in a national sample of CAHs. Lutfiyya and colleagues examined performance on HQA process measures in 2004, the first year for which these data were available, and found that that CAHs had lower performance than non-CAHs.[43] More recent comparisons have shown mixed results; some have found that rural hospitals provide lower quality care,[44, 45] while others have failed to find a difference,[46] although the study that found no difference examined self-selected hospitals engaged in national quality improvement programs.[46] Using 2003 data, MedPAC found that, compared to other rural hospitals, CAHs had higher risk-adjusted mortality rates for CHF, AMI, pneumonia, stroke, and gastrointestinal hemorrhage; our findings extend the MedPAC work by focusing on a contemporary sample and a comparison group of non-rural hospitals, and by assessing care across a wide range of metrics while accounting for hospital characteristics and resources.[2]

Our study has limitations. We used administrative data, which fail to capture important clinical and patient characteristics (such as educational attainment) that likely affect outcomes. Based on our sensitivity analysis, however, we believe it is unlikely that any unmeasured confounder could be strong enough to fully account for the difference between CAH and non-CAH outcomes. We lacked data on the experience or qualifications of the clinicians caring for patients at CAHs, which could have potentially explained some of our findings. We were also unable to assess the role of patient choice in patterns of care; patients may have declined transfer for more advanced care due to personal preference even if clinicians recommended that a transfer occur. We could not examine outpatient care, and thus were unable to assess to what extent these differences might affect our findings. Because we relied on Medicare fee-for-service data for outcomes, we could not assess whether the patterns observed are also true for Medicare Advantage patients or for younger patients. Finally, mortality may be a crude measure of hospital quality, and therefore, we attempted to incorporate both structural and process measures to paint a more comprehensive view of care at CAHs.

Conclusions

Critical Access Hospitals play an essential role in ensuring access to health care for Americans living in rural areas. However, these institutions face many challenges, remain under-resourced both in terms of clinical and technological capabilities, perform worse on process measures, and have higher mortality rates than non-CAHs. More than a decade after major federal and state efforts to save America's rural hospitals, these findings should be seen as a call to focus on helping these providers improve their care so that all Americans have access to high quality inpatient care regardless of where they live.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Dr. Joynt had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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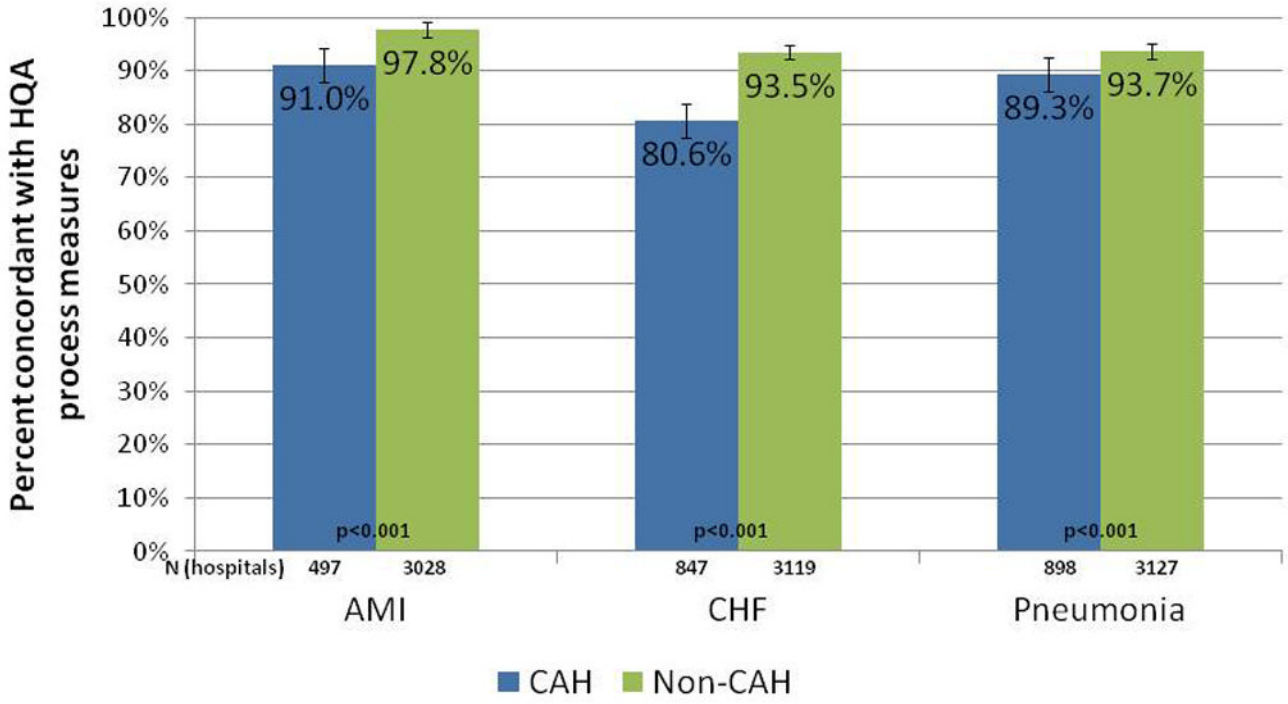

Figure 1.
Hospital Quality Alliance summary scores, mean percent concordant
AMI=acute myocardial infarction; CHF=congestive heart failure; CAH=Critical Access Hospital; HQA=Hospital Quality Alliance.

Table 1

Comparison of hospital characteristics between CAHs and non-CAHs

Hospital Characteristics		Critical Access Hospitals N=1268	Non-Critical Access Hospitals N=3470
Medical/surgical hospital bed capacity, median (IQR)		18 (14, 23)	82 (41, 154)
Ownership	Public	559 (44.1%)	571 (16.5%)
	For-profit	50 (3.9%)	781 (22.5%)
	Non-profit	659 (52.0%)	2118 (61.0%)
Major teaching hospital		0 (0%)	285 (8.2%)
Rural/urban category (RUCA)	Urban	59 (4.7%)	2287 (66.0%)
	Large town	120 (9.5%)	698 (20.2%)
	Small town	628 (49.5%)	379 (10.8%)
	Rural	461 (36.4%)	106 (3.1%)
Region	Northeast	65 (5.1%)	548 (15.8%)
	Midwest	621 (49.0%)	778 (22.4%)
	South	332 (26.2%)	1495 (43.1%)
	West	250 (19.7%)	649 (18.7%)
County income, median (IQR)		$29,041 (25,795, 32,723)	$34,619 (28,841, 41,626)
Percent county poverty, median, (IQR)†		13.5% (10.8, 17.2)	14.3% (10.6, 17.1)
Proportion Medicare patients, median (IQR)		56.8% (50.6, 67.3)	45.3% (40.0, 52.2)
Proportion Medicaid patients, median (IQR)		11.2% (6.3, 16.1)	16.6% (11.2, 21.3)
Volume of Medicare patients, median (IQR)*	AMI	7 (3, 12)	84 (29, 203)
	CHF	35 (19, 58)	206 (102, 391)
	Pneumonia	60 (34, 94)	193 (111, 312)

AMI = acute myocardial infarction; CHF = congestive heart failure; IQR = Interquartile Range; RUCA=Rural Urban Commuting Area (Urban = 50,000 or more, Large town = 10,000–49,999, Small town = 2,500–9,999, Rural = <2,500)

*Over the 23 month study period.

†p-value >0.05. Otherwise p-value for all comparisons <0.001.

Table 2

Comparison of patient characteristics between CAHs and non-CAHs

Patient characteristics		Acute myocardial infarction		Congestive heart failure		Pneumonia	
		CAH N=10,703	**Non-CAH N=469,695**	**CAH N=52,927**	**Non-CAH N=958,790**	**CAH N=86,359**	**Non-CAH N=773,227**
Age (median, IQR)		84 (77, 89)	78 (72, 85)	83 (76, 88)	81 (74, 87)	81 (74, 87)	80 (73, 86)
Female sex		58.1%	49.2%	58.7%	54.9%	54.6%	54.6% **
Race	White	95.7%	87.8%	93.6%	83.8%	95.0%	87.6%
	Black	2.5%	7.6%	4.2%	11.7%	2.5%	7.5%
	Hispanic	0.4%	1.6%	0.5%	1.9%	0.5%	1.9%
	Other/Unknown	1.4%	3.0%	1.7%	2.6%	2.0%	3.0%
Hypertension		52.9%	57.7%	51.3%	57.4%	48.6%	55.0%
Diabetes		30.1%	23.7%	34.8%	31.3%	24.6%	23.7%
Chronic pulmonary disease		21.6%	18.6%	31.9%	30.9%	43.5%	44.8%
Chronic kidney disease		16.0%	16.9% *	20.6%	28.8%	9.5%	14.1%
Peripheral vascular disease		6.6%	8.9%	5.9%	7.1%	4.5%	5.1%
Depression		4.9%	3.1%	5.8%	3.9%	7.6%	6.7%
Length of stay (mean, SD)		3.0 (1.2)	4.9 (2.6)	3.6 (0.7)	5.2 (3.8)	4.1 (0.8)	5.9 (2.4)
Discharged to hospice		2.8%	3.7%	1.2%	3.2%	1.0%	3.0%

* p=0.01,

** p>0.05.

Groups may not sum to 100% due to rounding. P value <0.001 for each comparison except where indicated. Patients assigned to the admitting hospital for purposes of categorization.

Table 3

Comparison of clinical resources between CAHs and non-CAHs

Clinical Resources	Critical Access Hospitals (N=1268)	Non-Critical-Access Hospitals (N=3470)	P value
Member of hospital system	374 (29.5%)	1653 (47.6%)	<0.001
Medical intensive care unit	380 (30.0%)	2581 (74.4%)	<0.001
Cardiac intensive care unit *	120 (11.1%)	1301 (44.0%)	<0.001
Cardiac catheterization	6 (0.5%)	1654 (47.7%)	<0.001
PET scanner *	26 (2.4%)	632 (21.4%)	<0.001
Surgical capability	1104 (87.1%)	3386 (97.6%)	<0.001
Nurse-to-census ratio, median (IQR)	6.9 (2.6, 11.2)	6.4 (4.9, 8.2)	0.35
Total physicians per 100,000 (mean, SD) †	92.6 (94.6)	256.0 (210.3)	<0.001
Generalists per 100,000 (mean, SD) †	50.0 (36.1)	52.2 (29.0)	<0.001
Cardiologists per 100,000 (mean, SD) †	1.0 (3.3)	7.0 (7.2)	<0.001
Pulmonologists per 100,000 (mean, SD) †	0.4 (1.4)	3.3 (3.3)	<0.001

*=of 4033 hospitals reporting these measures.

†=reported at the county level; means reported because medians were zero for CAHs and therefore less interpretable.

PET = positron emission tomography.

Table 4

Comparison of Health Information Technology resources between CAHs and non-CAHs*

Health Information Technology component		Critical Access Hospitals N=1241	Non-Critical-Access Hospitals N=3208	P value
Overall EHR adoption	Comprehensive	17 (1.4%)	100 (3.1%)	<0.001
	Basic	63 (5.1%)	345 (10.8%)	
	None	1160 (93.5%)	2763 (86.1%)	
Clinical Documentation				
Medication lists		575 (46.3%)	2373 (74.0%)	<0.001
Physician notes		299 (24.1%)	1162 (36.2%)	<0.001
Problem lists		399 (32.2%)	1642 (51.2%)	<0.001
Results Viewing				
Laboratory results		816 (65.8%)	2928 (91.3%)	<0.001
Radiologic reports		857 (69.1%)	2941 (91.7%)	<0.001
Computerized Physician Order Entry				
Medications		240 (19.3%)	1077 (33.6%)	<0.001
Decision Support Tools				
Clinical guidelines		236 (19.0%)	1185 (36.9%)	<0.001
Clinical reminders		277 (22.3%)	1397 (43.6%)	<0.001
Drug-drug interaction alerts		538 (43.4%)	2245 (70.0%)	<0.001
Telemedicine				
Any telemedicine		441 (35.5%)	1143 (35.6%)	0.95
Health Information Exchange				
Any exchange with another hospital		618 (49.8%)	1935 (60.3%)	<0.001
Any exchange with a physician practice		326 (26.3%)	1522 (47.4%)	<0.001

* Based on responses from the hospitals that returned the HIT survey; all results are weighted for nonresponse bias to produce a representative sample.

Percentages indicate the proportion of hospitals responding that the function is active in at least one unit of the hospital.

CAH=Critical Access Hospital; EHR=Electronic Health Record.

Table 5

Risk-adjusted 30-day mortality rates among Critical Access and non-Critical Access hospitals for common medical conditions.

	AMI			CHF			Pneumonia		
Model specifications	**CAH**	**Non-CAH**	**Odds Ratio**	**CAH**	**Non-CAH**	**Odds Ratio**	**CAH**	**Non-CAH**	**Odds Ratio**
Raw mortality rates	25.2%	15.2%		13.8%	10.6%		13.0%	11.9%	
Adjusted for age, sex, race, and medical comorbidities	**23.5%**	**16.2%**	**1.70 (1.61, 1.80)**	**13.4%**	**10.9%**	**1.28 (1.23, 1.32)**	**14.1%**	**12.1%**	**1.20 (1.16, 1.24)**
Add use of hospice services	24.6%	16.3%	1.86 (1.75, 1.98)	14.6%	11.0%	1.44 (1.39, 1.49)	15.0%	12.2%	1.32 (1.28, 1.36)
Add ownership, region, income	22.1%	16.1%	1.61 (1.51, 1.71)	13.1%	11.0%	1.25 (1.21, 1.30)	13.6%	12.3%	1.14 (1.07, 1.22)
Add clinical personnel	23.2%	16.0%	1.75 (1.64, 1.86)	15.5%	10.6%	1.65 (1.46, 1.86)	13.7%	12.1%	1.17 (1.09, 1.26)
Add clinical resources, system	20.0%	16.1%	1.39 (1.30, 1.49)	14.1%	10.6%	1.44 (1.27, 1.63)	13.4%	12.2%	1.14 (1.09, 1.19)
Add EHR	20.0%	16.1%	1.39 (1.29, 1.49)	14.1%	10.6%	1.44 (1.27, 1.63)	13.4%	12.2%	1.13 (1.05, 1.22)
Add condition-specific volume	19.5%	15.7%	1.38 (1.28, 1.48)	12.6%	10.6%	1.25 (1.11, 1.41)	11.5%	12.3%	0.91 * (0.85, 0.99)
Add rural-urban code (RUCA)	17.7%	15.8%	1.18 (1.09, 1.28)	11.9%	10.6%	1.15 * (1.00, 1.31)	11.5%	12.3%	0.92 * (0.87, 0.97)

*: $p<0.05$;

$p<0.001$ for all other comparisons.

AMI=acute myocardial infarction; CHF=congestive heart failure; CAH=Critical Access Hospital; EHR=electronic health record; RUCA=rural-urban commuting area.

Table 6

Quality of care and 30-day mortality, including only small, rural hospitals

	AMI			CHF			Pneumonia		
	CAH	**Non-CAH**	**Odds Ratio**	**CAH**	**Non-CAH**	**Odds Ratio**	**CAH**	**Non-CAH**	**Odds Ratio**
Number of patients	7,809	8,200	n/a	40,044	35,594	n/a	66,605	46,270	n/a
Number of hospitals	908	357	n/a	1007	369	n/a	1018	369	n/a
Quality of care:									
Number of hospitals reporting	359	300	n/a	643	345	n/a	684	347	n/a
Condition-specific HQA summary score (mean)	89.7	90.3*	n/a	78.7	84.8†	n/a	88.7	91.1†	n/a
30-day mortality:									
Raw mortality rates	26.5%	22.9%		13.8%	11.9%		13.0%	12.3%	
Adjusted for age, sex, race, and medical comorbidities	26.1%	23.9%	1.14† (1.05, 1.24)	13.4%	12.5%	1.09† (1.03, 1.16)	13.0%	12.5%	1.05* (0.99, 1.11)

Small rural hospitals were classified as those with fewer than 100 beds, located in RUCA rural or RUCA small town areas.

*: p>0.05;

†p ≤0.003.

AMI=acute myocardial infarction; CHF=congestive heart failure; CAH=Critical Access Hospital; HQA=Hospital Quality Alliance.

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