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Examining Rural Hospital Bypass for Inpatient Services

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INTRODUCTION

Rural hospitals are the anchor for health care delivery in most rural communities and provide access to essential health care services for the approximately 4 million Medicare beneficiaries who live in rural America. Rural hospitals also contribute to their local economies, often serving as significant economic engines and major employers [1]. The presence of a hospital in a rural community has direct and indirect effects on the local economy—on average, critical access hospitals (CAHs) employ 127 employees and pay $6 million in wages, salaries, and benefits, and also generate an additional 43 jobs and $1.1 million in secondary wages, salaries, and benefits. Health care often accounts for 10 to 15 percent of jobs in a rural community [2].

Rural hospitals also face challenges. Many rural hospitals inherently experience lower patient volumes than urban hospitals due to population density and geography. Low patient volumes contribute to the financial vulnerability of rural hospitals [3]. While rural residents may receive inpatient care in their local community, some rural residents receive inpatient services at hospitals that are not their nearest rural hospital (*rural hospital bypass*). When patients bypass their local rural hospital for the same services that are available locally, it can further threaten the sustainability of their local rural hospital [4].

A limited number of rural hospital bypass studies have been published in the last 25 years. Most rural hospital bypass studies using quantitative data (i.e., claims data) were limited to a few select states and found bypass rates that ranged from 25 percent to 50 percent [5] [6] [7]. Qualitative studies of rural patients showed an even greater bypass rate that ranged from 16 percent to 70 percent [8].

Previous studies have explored patient and hospital market characteristics associated with rural hospital bypass. For complex procedures, such as thoracic surgery, rural hospital bypass is to be expected because those services are not likely to be offered at a patient's local rural hospital. Rural patients often cite limited services and lack of specialty care as reasons for bypassing their local rural hospital [9]. Recognizing the services offered in rural hospitals, some studies controlled for the types of services for which patients are accessing care locally and outside of their home community. Across inpatient and outpatient admissions, patients are more likely to access care nearby for emergency and urgent care than for elective or scheduled care [5] [8]. One recent study found that smaller hospitals (i.e., hospitals with fewer beds), less profitable hospitals, and those closer to larger hospitals were associated with higher bypass [9].

Several studies identified patient characteristics associated with higher rates of rural hospital bypass. For example, a study conducted in a few selected states found that younger patients, males, and racial/ethnic minorities were more likely to bypass their local rural hospital [7]. Other studies found that privately insured patients were more likely to bypass their local rural hospital, compared to Medicare and uninsured patients. Medically complex and higher-risk patients are also more likely to bypass their local hospital [5] [6].

Rural patients may choose not to seek care at their nearest rural hospital for many reasons. Patient perception of the local hospital, including the perception of quality and reputation of local services and providers, may affect a patient's choice to seek care locally [9]. Satisfaction with the local hospital is also associated with rural hospital bypass [9]. While patients may not favor a local rural hospital due to limited services or specialty care, increasing the number of

services and technologies offered by rural hospitals has only a small effect on patient decision-making [10].

Purpose of the study

The purpose of the study is to explore the drivers of rural hospital bypass for inpatient services. The study was guided by the following research questions:

1. What demographic characteristics are associated with rural hospital bypass?
2. Why did patients receive inpatient care at a hospital that is not their nearest rural hospital?
3. How does the local supply of primary care and specialty care services affect rural hospital bypass?
4. How do insurance networks or cost affect decisions to use rural hospitals?

DATA SOURCES AND METHODS

We conducted a national mixed methods study using quantitative methods and Medicare fee-for-service (FFS) claims combined with a qualitative case study approach. Quantitative analyses were completed prior to qualitative data collection to inform case study selection. A detailed description of the study methodology is included in Appendix B.

Quantitative Data and Analysis

The quantitative study was designed as a retrospective cohort study. The Medicare acute care hospital inpatient claims and enrollment files for calendar year (CY) 2018 were the primary data used for the analysis. Only rural fee-for-service (FFS) Medicare beneficiaries who had coverage for all 12 months during CY 2018 and had at least one inpatient stay were included in the 50-state analysis. Medicare Advantage and beneficiaries with end-stage renal disease (ESRD) were excluded from the analysis.

The 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims were merged with the Medicare Master Beneficiary Summary File to provide demographic characteristics and other information such as patients' hierarchical condition category (HCC) scores and dual eligible status (i.e., individuals who receive both Medicare and Medicaid benefits). Other hospital and market characteristics data were merged with the inpatient claims, including Rural-Urban Commuting Area (RUCA) codes from the United States Department of Agriculture's Economic Research Service, the Rural Hospital List from the University of North Carolina at Chapel Hill Cecil G. Sheps Center for Health Services Research (Sheps Center), a list of Tribal hospitals generated by the Indian Health Service (2019), the CMS Provider of Services file, the Area Health Resource File (HRSA), American Hospital Association (AHA) Annual Survey, County Health Rankings, Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) data from Hospital Compare, and the CMS geographic variation public use file.

Defining Rural Hospitals

All general acute care hospitals located in rural ZIP codes, including critical access hospitals (CAHs) and rural Prospective Payment System (PPS) hospitals,[i] were included in the analysis. The hospitals were categorized as rural or urban facilities based on the RUCA code for the hospital's ZIP code (rural includes RUCA codes ≥ 4 and urban includes RUCA codes < 4). RUCA codes, which are based off of the Office of Management and Budget metropolitan statistical area and micropolitan statistical area definitions, were used to define rural and urban. Hospitals that did not provide general medical services (i.e., psychiatric hospitals, long-term care hospitals, and specialty hospitals) were not included in the analysis.

Defining Rural Hospital Markets (Hospital Service Areas)

For this analysis, hospital service areas (HSAs) are defined by the ZIP codes that a rural hospital serves. The goals of this analysis required construction of an HSA for every hospital located in a rural ZIP code treating Medicare FFS inpatients and assignment of beneficiaries to one HSA. Each HSA was defined by ranking the ZIP codes for Medicare beneficiaries by Medicare inpatient volume of the hospital and identifying those ZIP codes that accounted for 80 percent of Medicare inpatient volume [11] [12]. Patients who received services at the rural hospital and reside in one of the ZIP codes that did not comprise the top 80 percent of inpatient stays were not considered to be part of an HSA. If the 80 percent threshold only captures one beneficiary ZIP code, the HSA for the hospital contains only one residential ZIP code.

There were instances in which ZIP codes, and the rural Medicare beneficiaries who live in those ZIP codes, were assigned to multiple HSAs. For beneficiaries with multiple HSA assignments, we identified the type of markets in which they reside by calculating the distance between each beneficiary's ZIP code centroid (the point marking the center of the ZIP code) and the ZIP code centroid for each hospital used by the patient. [ii] We then used this calculation to determine the HSA that is the closest to beneficiary's residence and estimate whether any other HSAs including that ZIP code were less than or greater than 30 miles away [13] [14]. This distinction between HSA markets was used (as described below) to avoid assigning a hospital stay as bypass if the hospital stay was actually at a reasonably close hospital other than at the nearest hospital.

Defining Rural Hospital Bypass

We identified the inpatient stays for rural Medicare FFS beneficiaries and determined the facilities where the beneficiaries received inpatient hospital services. The closest hospital that rural Medicare beneficiaries are attributed to is considered the "home" hospital. Each inpatient stay was assigned to one of three HSA markets:

- **In-Market Inpatient Stays:** Inpatient stays at rural hospitals that are either the home hospital, or are ≤ 30 miles away. In-Market Inpatient Stays were not considered to be rural hospital bypasses.
- **Rural to Other Rural Bypass:** Inpatient stays at distant rural hospitals >30 miles away

[i] Rural Prospective Payment System (PPS) hospitals include all general, acute care hospitals located in rural ZIP codes (RUCA ≥4) that receive reimbursement for inpatient services under the inpatient prospective payment system (IPPS).

[ii] A centroid is a point (usually on a map) that defines the center (in this case, of the zip code). The centroid (point) is represented by longitude and latitude coordinates. In this study, the ZIP code centroid is used to approximate the Euclidean (or straight line) distance between two ZIP codes.

- **Rural to Urban Bypass:** Inpatient stays at distant urban hospitals

Recognizing that some rural hospital bypass was due to the availability of services, we characterized bypasses as "*unavoidable*" – an inpatient stay at a distant hospital for a service not available at the home hospital - or "*avoidable*" – an inpatient stay at a distant hospital for a service that is also available at the home hospital. We limited the inpatient stays to the most common 50 diagnostic related groups (DRGs), out of the 765 DRGs provided by rural hospitals in CY 2018 (Appendix A, Table A.1) and determined the availability of services in each HSA. In Appendix A, Figure A.1 provides a diagrammatic presentation of the study design and selection process.

Variables and Outcomes

Variables in the study included those at the inpatient hospital stay level, beneficiary level, hospital level, and community level. In addition to DRG, we included elective inpatient stays as a binary indicator. For beneficiary level factors, Medicare beneficiaries were categorized by sex and age categories. The RTI race code was used to identify race/ethnicity (non-Hispanic White, Black, Hispanic, Asian/Pacific Islander, and American Indian/Alaska Native). We also included dual eligible status and the beneficiary's 2018 health risk score based on the HCC risk-adjustment models as a proxy estimate of patient's severity of illness.

We accounted for the following hospital level variables for home hospitals: number of beds; hospital ownership type (i.e., private vs. public); HCAHPS measures of overall hospital rating and hospital recommendation; and presence of a cancer program approved by American College of Surgeons. Three additional variables were derived using Medicare claim and enrollment data: hospital telehealth service flag, Medicare Advantage penetration, and percentage of dual eligible Medicare beneficiaries by HSA. The telehealth services flag was defined for those hospitals that delivered at least one telehealth office visit or consultation service to a Medicare patient during an inpatient stay.

The following HSA and community level indicators were included:

- Health insurance coverage: percentage of households comprised of individuals who are 18-64 years of age without health insurance by county, 2017
- Medicare market: Medicare Advantage penetration and percentage of dual eligible Medicare beneficiaries by HSA, 2018
- Physicians per capita: primary care physicians (i.e., MDs and DOs) and specialists per 1,000 population by county, 2017
- Education: percentage of residents with high school and higher education diploma(s) by county, 2017
- Population wealth: median household income by county, 2017
- Social cohesion: Number of membership associations per 10,000 population by county, 2017[iii]

[iii] The number of membership associations was used as a proxy for social connectedness. Additional information is available through County Health Rankings at https://www.countyhealthrankings.org/explore-health-rankings/measures-data-sources/county-health-rankings-model/health-factors/social-and-economic-factors/family-social-support/social-associations.

- Average HCC score for Medicare population who reside in the county, 2017
- Geography: rural-urban commuting area codes (RUCA); Census region: Northeast, South, West, Midwest
- State policy: Medicaid expansion state [15]

The primary outcome in the analysis was whether the inpatient stay was an avoidable bypass. At the inpatient stay level, the avoidable rural hospital bypass rate was the percentage calculated from the total number of avoidable bypasses divided by total number of hospital inpatient stays for the Medicare beneficiaries who reside in the HSA, excluding unavoidable bypasses. At the beneficiary level, the beneficiary was flagged as having an avoidable bypass if at least one of his/her inpatient stays during CY 2018 was an avoidable bypass.

Statistical Analysis

We developed statistical models to assess the impact of community, hospital, patient, and stay level characteristics on avoidable hospital bypass. The exploratory data analysis before model testing was conducted to:

1. Describe rural hospital bypass among Medicare FFS beneficiaries for inpatient care;
2. Identify factors influencing avoidable rural hospital bypass for inpatient services; and
3. Quantify the relationship between avoidable bypass and patient demographics.

The results of the exploratory data analysis are expressed as frequencies and percentages for patient and hospital characteristics by home hospital type—rural PPS hospitals and CAHs. This study compared quality measures of the home and distant hospitals for beneficiaries who bypassed the home facility. Multiple linear regression models were used to identify factors associated with avoidable bypass; separate estimates were obtained for home PPS and CAHs. Linear regression is based on some important assumptions, which we addressed during the analysis process. [16] Statistical significance was set at the $p< 0.05$. Regression coefficients and standard errors are included in Appendix A.

Qualitative Data Collection and Analysis

Results of the quantitative analysis were used to inform the collection of qualitative data from key stakeholders. Due to the COVID-19 public health emergency (PHE), we conducted virtual listening sessions with state-level representatives in four states. The four states chosen for case studies—Georgia, Kansas, Michigan, and Montana—were selected to represent geographic and market diversity, including Census region, rural/frontier population and areas, Medicaid expansion/non-expansion, and market factors.

We invited stakeholders from each state, including representatives from:

- CMS Regional Office Rural Health Coordinators;
- State Health Insurance Assistance Programs (SHIPs);
- State Offices of Rural Health and State Flex Directors;
- State Hospital Associations; and
- State Rural Health Associations.

As these were listening sessions and open to those who wanted to participate, we welcomed participants to invite colleagues and other stakeholders within their state who might have input on the topic of rural hospital bypass. As a result, representatives from rural hospitals, community health centers, and rural health clinics also participated in some state listening sessions.

In advance of the listening sessions, participants were sent a spreadsheet that included their state's median rural hospital avoidable bypass rate and a list of all the state's rural hospitals that were classified as having a lower or higher bypass rate based on the state median. Five listening sessions were completed in July and August 2020, with one listening session per selected state and one with representatives from SHIPs. Each listening session was 60 to 90 minutes in length. The listening session discussion guide included questions about drivers of home hospital use and drivers of home hospital bypass.

QUANTITATIVE FINDINGS

Overall, about one in five Medicare beneficiaries (20 percent) resided in a rural area. Of the 12.2 million rural Medicare beneficiaries, the majority were White (89 percent) and enrolled in FFS Medicare (75 percent in CAH HSAs; 70 percent in rural PPS HSAs). By comparison, about 59 percent of urban Medicare beneficiaries were enrolled in FFS Medicare.

This study included 1,002,373 inpatient stays for 749,053 rural Medicare FFS beneficiaries assigned to 2,051 HSAs. Slightly over half of the rural hospitals (57 percent) were CAHs, and the balance were rural PPS hospitals (43 percent). The majority of rural PPS hospitals (70 percent) have 26-100 beds, and two-thirds are located in micropolitan areas, the most densely populated rural areas (RUCA 4-6) with populations between 10,000 and 49,999. In contrast, half of the CAHs (50 percent) are located in rural noncore areas, the most sparsely populated rural areas (RUCA 10) with populations less than 10,000. Generally, rural PPS hospitals are concentrated in the eastern region of the U.S., whereas CAHs are concentrated in the central and western regions (Appendix A, Figure A.2).

Of rural Medicare FFS beneficiaries who had at least one inpatient stay in CY 2018 the average inpatient stays per patient was 1.5. Almost one-fourth of rural Medicare beneficiaries (23 percent) had two or more inpatient stays in CY 2018. Although one-fifth of the rural Medicare FFS population are dual eligible Medicare beneficiaries (20 percent), they accounted for almost one-third of all rural Medicare beneficiary inpatient stays (31 percent).

The following sections describe beneficiary demographic characteristics, and market and hospital factors related to avoidable rural hospital bypass.

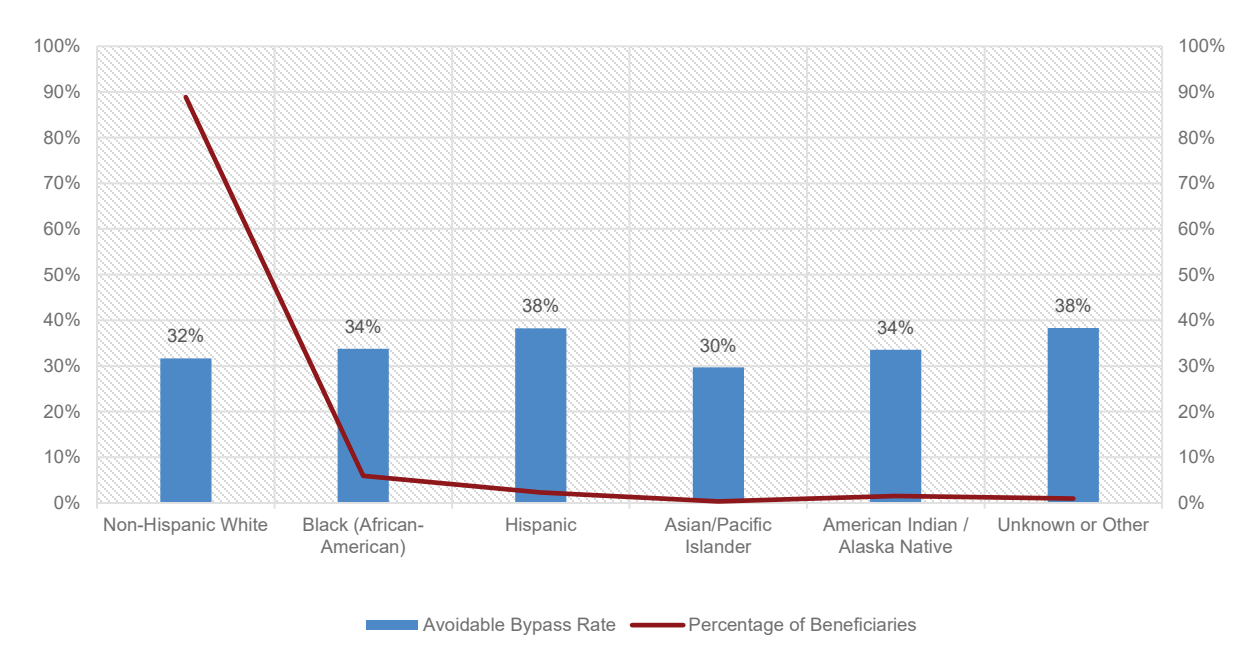
Beneficiary Demographic Characteristics

Two-thirds of Medicare FFS beneficiaries (68 percent) had one in-market inpatient stay or all in-market stays (i.e., inpatient stays at home hospital), while one-third of beneficiaries (32 percent) had at least one avoidable bypass in CY 2018 (i.e., inpatient stay at distant hospital).

Among all age groups, rural Medicare beneficiaries who were 85 years and over had the lowest avoidable bypass (23 percent for rural PPS hospitals; 24 percent for CAHs), while rural Medicare beneficiaries in the age 65 to 74 years group had the highest avoidable bypass (37 percent for rural PPS hospitals; 36 percent for CAHs).

Hispanic, Black, and American Indian/Alaska Native rural Medicare beneficiaries have slightly higher avoidable bypass rates compared with the white population (Figure 1). Asian/Pacific Islander and American Indian/Alaska Native beneficiaries are grouped into a single category in the beneficiary-level regression analysis due to small numbers. Beneficiary demographic characteristics are included in Appendix A, Table A.5.

Figure 1. Avoidable Rural Hospital Bypass by Medicare FFS Beneficiary Race and Ethnicity



NOTE: Avoidable bypass rate is the percentage of rural Medicare beneficiaries with at least one inpatient stay at a distant hospital even though those services were available at their home hospital. Percentage of beneficiaries is the percentage of rural Medicare beneficiaries included in the analysis by RTI race code.

Source: Estimates were produced using 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims and Medicare enrollment data.

Market and Hospital Factors

The average distance from a rural Medicare beneficiary's residence to a distant hospital was about 55 miles to urban hospitals and 57 miles to other rural hospitals. About 85 percent of avoidable bypasses were to distant hospitals in metropolitan areas (RUCA 1), while almost 10 percent of avoidable bypasses were to distant hospitals in micropolitan areas (RUCA 4-6).

HCAHPS Overall Quality Star Rating[iv] of Hospital scores were examined to determine if there were differences between the quality of the home rural PPS hospitals[v] and the distant hospitals where rural Medicare beneficiaries received care. Regardless of the home hospital HCAHPS overall star rating, rural Medicare beneficiaries who bypassed rural PPS hospitals most often chose hospitals with an HCAHPS overall rating of three or greater (Table 1). Eighty-eight percent of rural Medicare beneficiaries who resided in lower quality star rating (1, 2) home HSAs (≥3) and bypassed their home hospital chose hospitals with higher quality star ratings

[iv] For additional information, see Technical Notes for HCAHPS Star Ratings at https://hcahpsonline.org/globalassets/hcahps/star-ratings/tech-notes/2017-10_star-ratings_tech-notes.pdf.

[v] CAHs were excluded because almost half of the CAHs (47 percent) are missing HCAHPS overall rating.

while only 6 percent of rural Medicare beneficiaries who resided in higher quality star rating home HSAs (≥3) and bypassed their home hospital chose hospitals with lower quality star ratings (1, 2) ($p<0.001$).

Table 1. Home Hospital Rating (Rural PPS Hospitals) versus Distant Hospital HCAHPS Overall Quality Star Rating

Home Hospital Star Rating (Rural PPS Only)	Distant Hospital Star Rating: 1	Distant Hospital Star Rating: 2	Distant Hospital Star Rating: 3	Distant Hospital Star Rating: 4	Distant Hospital Star Rating: 5
1	0%	24%	46%	26%	3%
2	0%	10%	44%	39%	5%
3	0%	6%	50%	36%	6%
4	0%	5%	48%	39%	7%
5	0%	11%	47%	31%	9%
N/A	0%	9%	42%	44%	3%

NOTE: Percentages of all inpatient claims for avoidable bypass of a rural PPS hospital by home HSA rating. About 1 percent of inpatient stays were excluded due to missing HCAHPS overall rating. CAHs were excluded because almost half of the CAHs (47 percent) have missing HCAHPS overall rating scores.

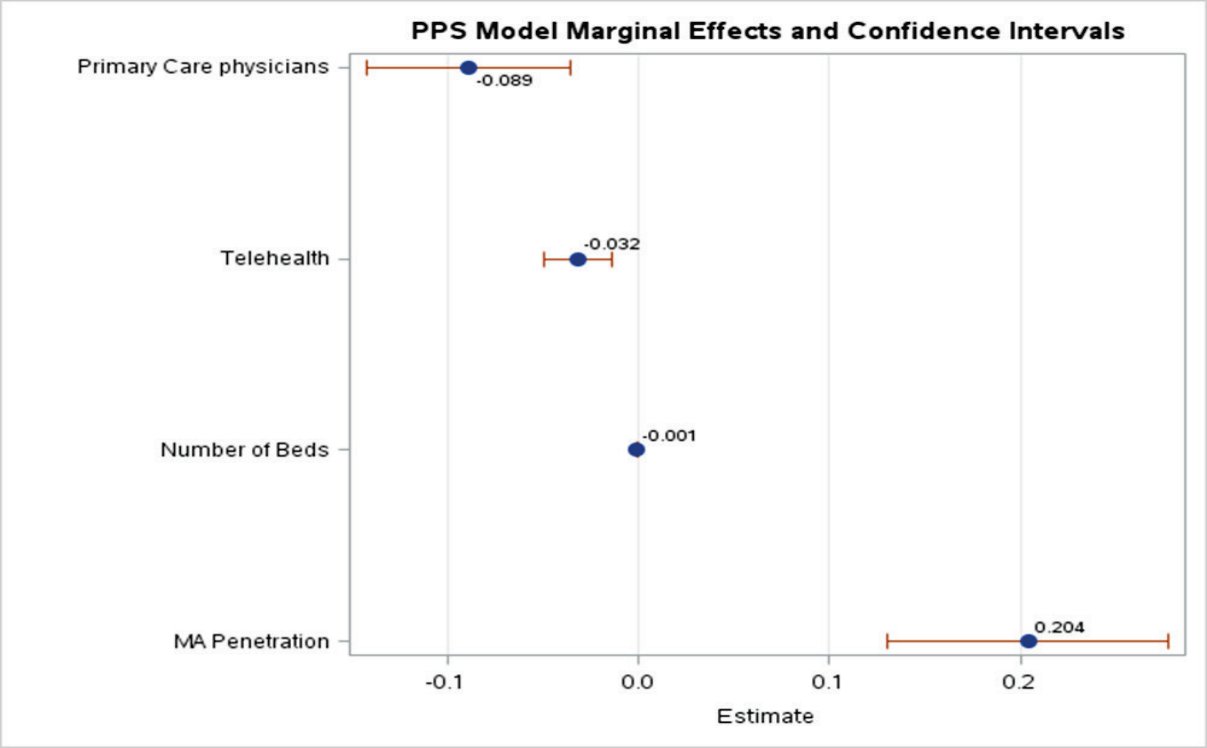
Source: Estimates were produced using 2017 HCAHPS Overall Quality Star Rating from Hospital Compare. https://data.medicare.gov/Hospital-Compare/Patient-survey-HCAHPS-Hospital/dgck-syfz

Multiple linear regression results are included in Appendix A, Table A.6a for home PPS hospitals and Table A.7a for home CAHs. The regression coefficients represent the marginal effect of changing one variable while holding all the other variables constant. The most important variables associated with avoidable rural hospital bypasses are included in Figure 2 for rural PPS hospitals and Figure 3 for CAHs.

Rural hospitals where inpatient telehealth consultation services were available had significantly lower avoidable bypass. Rural PPS hospitals that used telehealth services had an average bypass rate of 26 percent compared to 33 percent for facilities that did not use telehealth services ($p<0.005$). The avoidable bypass rate is negatively associated with the supply of primary care physicians ($p<0.005$); hospital markets with a greater supply of primary care physicians had lower avoidable bypass. Bypasses are directly associated with the MA penetration rate ($p<0.005$); hospital markets with a greater percentage of Medicare beneficiaries with MA had higher avoidable bypass.

The regression analysis also suggests that PPS hospitals in counties with more hospital beds per capita have lower bypass rates ($P<0.0001$). PPS hospitals in Medicaid expansion states, those hospitals with an approved cancer program, and hospitals located in counties with higher median incomes had lower avoidable bypass ($p=0.003$, <0.001, <0.001 respectively) (See Appendix X Table X). In contrast, those PPS hospitals with lower patient recommendation scores (HCAHPS measure of willingness to recommend hospital) tended to have higher bypass rates ($P=0.0095$).

Figure 2. Home Hospital Bypass Factors for Rural PPS Hospitals

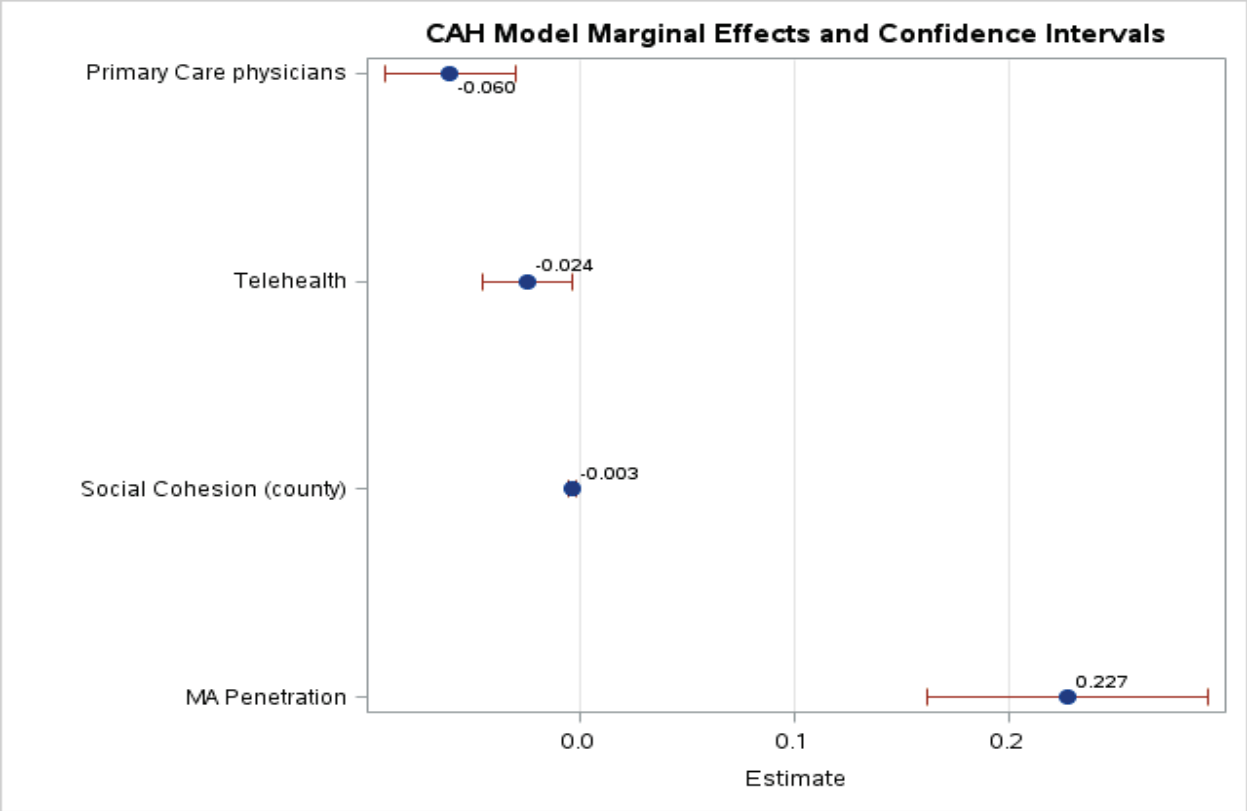


NOTE: This chart is a graphical representation of results included in Appendix A, Table A.6a. The points are the coefficient (marginal effect) estimates for the factors on the y-axis; a factor greater than zero implies that higher hospital bypass rate is positively related to higher factor values; a factor less than zero implies the negative relationship between hospital bypass and factors. With all other independent variables held constant, a one unit increase in primary care physicians per 1,000 county population is associated with an 8 percent decrease in the avoidable hospital bypass rate for rural PPS hospitals. Compared to hospitals that did not use telehealth services, bypass rates of hospitals that used telehealth services are 3 percent lower for rural PPS hospitals. When the MA penetration rate increases by 1 percent, bypass rates for rural PPS hospitals increase by 0.2 percent. There is a 0.1 percent decrease in the avoidable bypass rate for rural PPS hospitals for every one unit increase in the number of beds.

Source: Estimates were produced using 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims, Area Health Resource File (HRSA), Provider of Services file, and County Health Rankings.

Similar to rural PPS hospitals, avoidable bypass for CAHs that provided inpatient telehealth services was 28 percent compared to 33 percent for those that did not provide telehealth services ($p=0.03$). The avoidable bypass rate is negatively associated with the supply of primary care physicians ($p<0.005$), i.e, hospital markets with a greater supply of primary care physicians had lower avoidable bypass. Bypasses are directly associated with the MA penetration rate ($p<0.005$); hospital markets with a greater percentage of Medicare beneficiaries with MA had higher avoidable bypass. CAHs that were located in the Midwest and northeast regions, and CAHs in counties with stronger social cohesion had lower avoidable bypass rates ($P=0.003$, $=0.001$, <0.0001, respectively). A hospital's avoidable bypass rate does not appear to be associated with hospital ownership (private vs. non-private), education level in the county at-large, the share of dual eligible beneficiaries among Medicare enrollees, and the 18-64 age population without health insurance.

Figure 3. Home Hospital Bypass Factors for CAHs



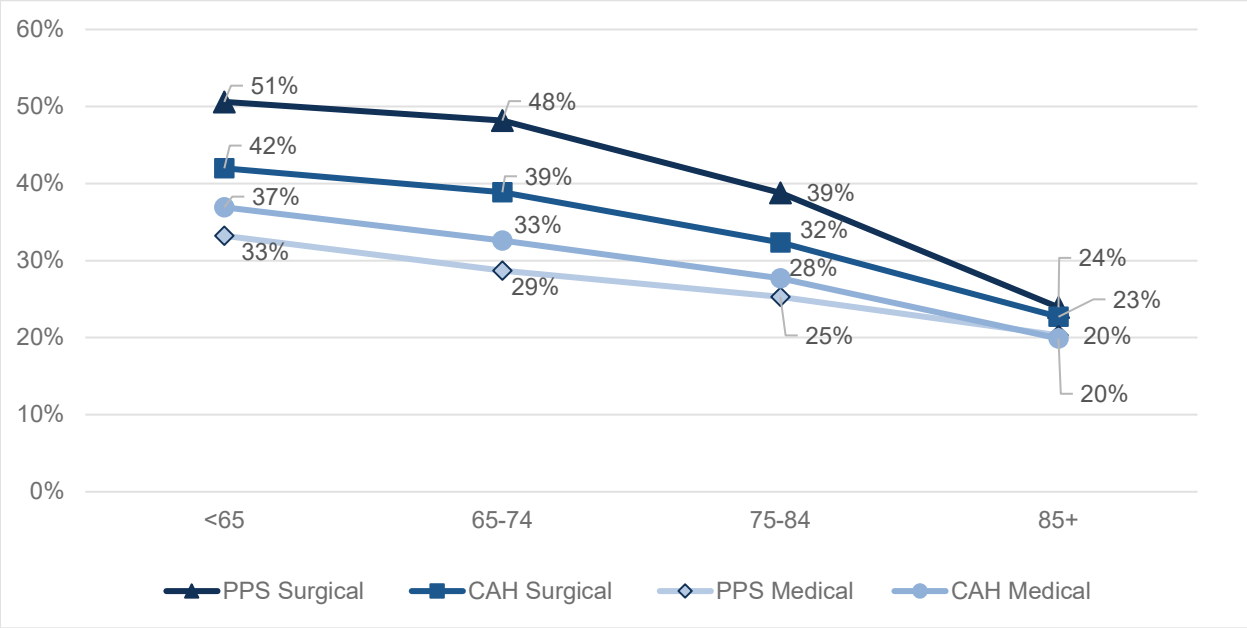
NOTE: This chart is a graphical representation of results included in Appendix A, Table A.7a. The points are the coefficient (marginal effects) estimate for the factors on the y-axis; a factor greater than zero implies that higher hospital bypass rate is positively related to higher factor values; a factor less than zero implies the negative relationship between hospital bypass and factors. With all other independent variables held constant, a one unit increase in primary care physicians per 1,000 county population is associated with a 6 percent decrease in the avoidable hospital bypass rate for CAHs. Compared to hospitals that did not use telehealth services, bypass rates of hospitals that used telehealth services are 2 percent lower for CAHs. When the MA penetration rate increases by 1 percent, bypass rates for CAHs increase by 0.2 percent. With every one unit increase in social cohesion per 10,000 county population, there is a 0.3 percent decrease in the avoidable bypass rate for CAHs.

Source: Estimates were produced using Medicare Provider Analysis and Review files (MedPAR) inpatient claims, Area Health Resource File (HRSA), Provider of Services file, and County Health Rankings.

Hierarchical Analysis for Beneficiaries: Demographic Characteristics Associated with Avoidable Bypass

Four models were used to examine patients' inpatient stays based on the following categories: PPS surgical DRGs; CAH surgical DRGs; PPS medical DRGs; and CAH medical DRGs.[vi] (A full table of results are shown in Appendix A, Tables A.8a and A.8b.) The odds of bypassing a patient's home hospital was significantly lower among rural Medicare beneficiaries who were older or dual eligible ($p<0.0001$) across all four models; however, the difference between beneficiaries age <65 years and 65-74 years is not statistically significant ($p>0.05$) in surgical DRG models (Figure 3 and Table 2).

Figure 4. Adjusted Hospital Bypass Rate by Age Category



NOTE: The points are the estimated hospital bypass rates for age groups that are adjusted of other factors in the four DRG models. DRG is the Diagnostic Related Group that is used to classify the type of hospitalization. There are two clinical types of DRG. A medical DRG is one where no operating room (OR) procedure is performed. When an OR procedure is performed, a surgical DRG is assigned.

Source: Estimates were produced using 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims and Medicare enrollment data.

[vi] Among the top 50 DRGs, there are six surgical DRGs and 44 medical DRGs. The observed the bypass for surgical DRGs is higher than for medical DRGs (45 percent versus 27 percent). Therefore, four separate models were developed for beneficiaries with surgical DRGs in PPS and CAH home hospitals and beneficiaries with medical DRGs in PPS and CAH home hospitals. The four patient-level null models suggested that there was significant variation in the odds of bypassing across the HSAs ($p<0.001$), which indicates the hierarchical logistic regression model is an appropriate model for this analysis.

Table 2. Adjusted Hospital Bypass Rate by Dual Eligible Status

	Dual Eligible	Surgical DRGs: Bypass Rate	Surgical DRGs: Lower 95% CI	Surgical DRGs: Upper 95% CI	Medical DRGs: Bypass rate	Medical DRGs: Lower 95% CI	Medical DRGs: Upper 95% CI
PPS	No	48%	46%	50%	30%	29%	32%
	Yes	32%	30%	35%	23%	22%	24%
CAH	No	40%	37%	44%	33%	32%	34%
	Yes	27%	23%	31%	25%	23%	26%

NOTE: The estimated hospital bypass rates for Medicare and Medicaid dual eligible status are adjusted of other factors in the four DRG models. DRG is the Diagnostic Related Group that is used to classify the type of hospitalization. There are two clinical types of DRG. A medical DRG is one where no operating room (OR) procedure is performed. When an OR procedure is performed, a surgical DRG is assigned

Source: Estimates were produced using 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims and Medicare enrollment data.

Sex and race/ethnicity were not found significantly associated with bypass rate (P>0.05) in both surgical DRG models.

The majority of the 138,721 surgical inpatient admissions (70 percent) were classified as elective surgical stays; slightly over half of these stays (53 percent) were avoidable bypass. Less than one-third of non-elective surgical stays (29 percent) were avoidable bypass (p<0.0001); no differences were found between PPS hospitals and CAHs.

For medical DRG models, males were 16 percent more likely to bypass their home hospitals than females (PPS model: OR 1.16, 95% CI 1.12-1.20, p<.0001; CAH model: OR 1.17, 95% CI 1.10-1.23, p<.0001). In assessing patient health risks, with a one-unit increase in the HCC score, we expect to see an increase in the odds of bypassing by about 9 percent for CAHs and 8 percent for rural PPS hospitals (p<0.001). Black and Hispanic beneficiaries in CAH HSAs were more likely than other rural beneficiaries to bypass their home hospitals to seek care for medical DRG inpatient stays (p<0.0001).

Overall, there was no difference in avoidable bypass based on whether the admission source was elective or emergent/urgent in CAH HSAs; however, patients were 80 percent more likely to bypass their home PPS hospitals when the admission was emergent or urgent. (OR: 0.19, CI: 0.15-0.24, p<0.0001).[vii]

Listening Session Observations[viii]

Listening session participants discussed their perceptions of the drivers influencing patient decisions to receive care in their home community or seek care outside of their home community. The most frequently cited reasons for using local services were convenience or

[vii] Admission types are nested within patients that are located within the home hospital. The covariance structure test indicates the patient effect was not significant for both rural PPS hospitals and CAHs (p>0.05). Therefore, we developed a two level logistic regression model with inpatient stays clustered within HSA.

[viii] The observations summarized below reflect only the perceptions of listening session participants and what was discussed during these sessions.

limited transportation options, perceptions of quality of care, and provider relationships. Across listening sessions, participants noted that it was their perception that when patients receive care in a larger community, it is unlikely that they will come back to receive care locally in the future. The most frequently cited drivers of hospital bypass were access to care, perceptions of quality and trust, cost/insurance, and personal preferences.

Access to Care

Listening session participants noted that patients may choose to seek care locally for more common illnesses or urgent care needs, but may be more willing to travel to a distant hospital for services they consider to be complex. A few participants noted that physician turnover or gaps in local health care services have led patients to seek care outside of their community. Even with visiting specialists and telehealth, some participants noted that rural hospitals may not be able to provide a health care service at the time it is needed. Once those patients are established with another physician at a distant hospital, the likelihood increases that they will not seek care in their rural community for that service line in the future. A few participants noted that rural hospitals serve small populations and may only treat five to 10 instances of a condition in a year; suggesting that many rural hospitals have stopped delivering babies due to difficulty in maintaining staff skills with low volumes. One participant commented that overall inpatient days are declining nationally, creating greater challenges to maintain access to hospital services in rural communities.

The role of telehealth in access to care was also a big point of discussion. A few participants noted that telehealth used in emergency rooms has increased the community's faith in the skills and abilities of the local rural hospital, particularly in those facilities staffed by advanced practice clinicians. One participant commented on the benefit of telehealth for specialty care, including care that may not be available in the entire state. The use of telehealth may be beneficial to those who lack reliable transportation and reduces travel time for both the patient and the provider. While COVID-19 has expanded the use of telehealth, a few participants noted that some rural communities still lack broadband or other wireless telecommunication causing difficulties for either the provider or patient to access telehealth services. CMS telehealth flexibilities allowed during the COVID-19 PHE has expanded the use of telehealth, and a few participants noted the recent change, allowing Federally Qualified Health Centers and Rural Health Clinics to serve as originating sites, has increased the provision of telehealth.

Participants from all states noted that limited transportation options, particularly for elderly residents and residents with low incomes (e.g., Medicare and Medicaid patients), contribute to the convenience of receiving care in a patient's local area. Transportation challenges are exacerbated when distances to other facilities are great, such as in frontier areas. For both the patient and family members or friends, transportation is a concern for supporting the patient during an inpatient stay.

A few participants commented on the role of emergency medical services (EMS) in exacerbating rural hospital bypass. When a patient is located between multiple hospitals, EMS drivers may choose where they want to take a patient. One participant commented that EMS might choose to bypass the local hospital, without input from the patient or their family member. In response, another participant correctly noted that emergency transportation coverage by Medicare requires that EMS take a patient to the nearest hospital. Finally, another participant relayed stories of patients or their family members instructing EMS to avoid a particular hospital. In two states,

participants noted limited EMS capacity in rural areas, resulting in longer waits for transfers to higher levels of care, such as a tertiary hospital.

Perceptions of Quality and Trust in Providers

Patient perceptions of quality and trust in local services based on previous experiences, word-of-mouth endorsements, or reputation were noted by listening session participants as a common driver in the health care decision-making process. Listening session participants noted that rural communities tend to be socially connected and that patient experiences—both good and bad—spread quickly throughout the community and can have lasting influence on where patients choose to seek care. A few participants noted that hospitals with known financial challenges appear to be less stable and, as a result, appear to have lower quality. One participant noted that aging facilities affected perceptions of the quality of care offered. Often, patients want to receive care in a larger, newer facility located in an urban area. One participant noted that retirement destinations located in rural areas within their state attract reputable physicians who move to those rural communities to retire. A few participants noted that patients have privacy concerns with receiving treatment from neighbors who are also their health care providers. One participant noted that if patients were able to experience the level of care provided in rural settings, including faster and friendlier care, they would choose to seek care at their local rural hospital. When asked about HCAHPS scores, all participants indicated that patients are likely not aware of Hospital Compare and do not use HCAHPS to determine where to seek care. One participant commented that family members might be more likely to assess hospital quality when choosing a hospital for an elderly patient.

Listening session participants commented that existing provider relationships and provider referrals affect where patients receive care. A few participants noted that patients might have long-standing relationships with providers who have seen multiple generations of families. The concept of "loyalty" was noted by a few participants, including when a physician is recruited to a neighboring community. One participant commented that if a patient seeks local primary care services, they are more likely to be admitted to their rural hospital. Another participant commented that a rural hospital relying on travelling providers results in a perceived lack of continuity of care. Many participants noted that patients would not push back if their primary care provider referred them to a hospital in another community. Some participants commented that patients, who have established relationships with specialty providers in another community, would want to receive their inpatient care where those providers are located. One participant commented that providers located in larger communities may not have accurate information about the services available in the rural community and do not send their patients to rural facilities for local care.

A few participants commented on the role of health system affiliations. For example, specialty providers may be affiliated with larger health systems, and those providers will admit patients to the affiliated hospital. The purchase of a small rural hospital by a larger system drove patients to receive inpatient care at the larger hospital. One participant also noted the influence of accountable care organizations (ACOs) and bundled payments, commenting that they have seen those relationships affect referral patterns. Bundled payments tend to align incentives for providers, allowing them to work closely together and were particularly influential for deciding where to refer patients for care in certain post-acute care settings (e.g., CAH swing bed versus other facility).

Most participants spoke about the limited role of health care marketing in rural communities. A few participants did not believe marketing heavily influenced patients; one participant noted that most Medicare patients have already formed opinions on local facilities. While one participant mentioned the capacity of larger, urban facilities to produce sleek marketing, other participants noted that marketing is often a "real challenge" for rural facilities due to budgetary constraints and a lack of local media outlets, such as TV and radio stations. All participants concurred that the primary method for sharing information about health care facilities in rural communities was word-of-mouth from community members. However, one participant acknowledged that relying on word-of-mouth experiences may result in the spread of inaccurate information, especially when spread through social media platforms. One participant noted that the SORH, state hospital association, and Flex Program provide rural hospitals with information describing the value of the hospital to the community and why the hospital is an essential business, particularly in counties where the hospital is the largest employer. The information is intended for use by hospitals to demonstrate to the community that they need to support the hospital like other local businesses to maintain those services.

Out-of-Pocket Costs and Insurance Coverage

Some participants mentioned that out-of-pocket costs and insurance coverage affect where patients seek care. A few participants noted that they believe rural hospitals serve a large proportion of Medicare and Medicaid patients, who may have fewer options and limited transportation. One participant commented that some rural providers offer concierge services[ix] and do not accept Medicare or Medicaid. Some participants commented that insurance networks affect where patients receive care and noted that Medicare Advantage plans may not cover services provided at rural hospitals. One participant noted that Tribal members might choose an Indian Health Service (IHS) hospital because of costs. A few participants commented that patients shop for certain types of services, such as elective procedures and MRIs. Others stated that sometimes care is more expensive in the rural hospital, particularly CAHs, and may influence bypass behavior. A few participants mentioned that some patients make decisions based on transportation costs, including emergency transportation costs.

Personal Preferences

Personal preferences also play a role in rural hospital bypass behavior. These preferences include proximity to family members, commuting behaviors, and other personal circumstances. Family support is a key factor in patient decision-making. A few participants commented that patients might seek care locally to stay closer to family members, while other participants commented that patients might seek care in distant communities where children or other family members live. One participant commented that rural patients might leave their home communities to seek care at hospitals where a family member works. Another participant noted that Tribal members might prefer to receive culturally competent care at IHS facilities. One participant commented that family members might also influence where EMS takes a patient. Participants from one state commented that there is a large snowbird population, who have second homes in other states (e.g., Arizona). Those patients may choose to receive care while living in another state. One participant also noted that patients with higher incomes might choose to seek care at top-rated

[ix] Concierge care is a primary care model for which patients pay a membership fee for a set of health care services, including Medicare-covered services, and other amenities, such as same-day appointments. More information is available at https://www.medicare.gov/coverage/concierge-care.

tertiary care centers. A few participants commented that where patients seek care might be aligned with where they travel for shopping or work. An additional comment was that COVID-19 may have led to fewer bypasses as patients view the risk of going to a small hospital to be less than that at a larger hospital.

Participants also commented on a number of general concerns related to providing care in a rural community. Many participants noted workforce recruitment and retention challenges, particularly as many rural providers retire. Some stated that workforce pipeline programs and loan forgiveness might help attract new providers to rural communities. In some rural communities, COVID-19 has led to greater recruitment activity as providers are looking for opportunities to move away from urban centers. One participant commented on alternative models for rural hospitals, including an option without inpatient beds that maintains access to 24/7 emergency care.

LIMITATIONS

This study has a few limitations to consider. First, the quantitative analysis is limited to inpatient acute hospital care for rural FFS Medicare beneficiaries in CY 2018 and represents only a portion of the patients served and services provided by rural hospitals in their communities. Additionally, Medicare FFS claims data has limitations in terms of understanding clinical severity and patient conditions, despite patients having similar diagnoses or DRGs. While patients with higher degrees of clinical complexity or severity may be appropriately referred to a higher-level facility outside of their home HSA, these referrals are classified as a bypass in this analysis, potentially overestimating the avoidable rural hospital bypass rate. It was also not possible to capture in the models the influence of patients' and families' perceptions of rural hospitals and providers, community good will, and the interplay of patient/family and provider decision-making.

The qualitative data collection plan, to capture rural community members' perspectives on hospital utilization, shifted due to the evolving COVID-19 PHE. The in-person listening sessions with rural Medicare beneficiaries, rural community leaders, and rural hospital administrators and clinicians were cancelled when COVID-19 cases increased in rural communities. Instead, virtual listening sessions were held with state and regional stakeholders who provided insights regarding their observations and/or experiences with rural hospital utilization. Although these stakeholders were very knowledgeable about the rural hospitals and communities in their state or region, some participants had not resided in rural communities nor had direct experiences accessing rural health care. It should also be noted that listening session observations represent the perspectives of 24 participants who bring perspectives that are specific to their roles, locations, and previous experiences.

CONCLUSION AND NEXT STEPS

This study creates the first national analysis of avoidable rural hospital bypass for Medicare beneficiaries, expanding upon on previous rural hospital bypass studies based on a limited number of states. We developed a methodology to define hospital service areas (HSAs) that are targeted and suitable for rural Medicare populations; explored drivers of rural hospital bypass based on hospital and market characteristics; and identified factors associated with likelihood of patients' bypassing their home hospitals.

As expected, rural hospital characteristics associated with a higher likelihood of retaining Medicare FFS beneficiaries include high quality ratings, high number of primary care physicians in the HSA, large number of beds, and offering telehealth and advanced care. Patient characteristics associated with a lower likelihood of bypassing their local rural hospital include older Medicare FFS beneficiaries, females, and dually eligible beneficiaries. Travel to a distant hospital may be more difficult for these rural Medicare beneficiaries given limited transportation options in many rural communities. Qualitative findings confirmed the challenges that many older rural Medicare beneficiaries have in either accessing care outside of their home community due to limited transportation options, or the concern of placing a burden on their family or caregiver to provide transportation.

On average, rural residents travel at least an hour (approximately 60 miles) when seeking care at distant hospitals. A number of factors contribute to the hospital bypass decision-making process, including, patient and family perceptions and provider trust, provider referrals, and EMS drop-off decisions. Patient choice plays an important role in bypassing home hospitals for surgical admissions, particularly because these admissions are not urgent or emergent. When stakeholders were asked if publicly available hospital quality data were used to inform patients' hospital bypass decisions, participants indicated that hospital quality information is most often based on word-of mouth, not existing hospital quality data sources like HCAHPS. Stakeholders may consider how to construct more rural-relevant quality measures that provide useful information for rural providers to improve their quality and community perception. In addition, stakeholders observed that learning and action networks (LANs) may support rural providers in better understanding what important health care services, such as telehealth services, are valued by the community that will lead to an increase in utilization of local health care services.

Access to local primary care providers also plays an important role in rural Medicare beneficiaries choosing to use their home hospital. Rural hospitals with the lowest bypass rates had the greatest number of primary care providers per population. Listening session participants noted the importance of the relationship between primary care providers and rural Medicare beneficiaries, particularly the loyalty that patients feel for their providers. These relationships often extend beyond the rural Medicare beneficiary to other members of the family, which contributes to rural Medicare beneficiaries choosing their home hospitals – there is a strong, long-lasting trust in the local health care system. In addition, rural communities with a large number of primary care providers often have greater access to specialty care providers, which increases the likelihood that rural Medicare beneficiaries seek inpatient hospital care locally.

Even though Medicare Advantage (MA) has rapidly expanded in urban areas during the last decade, MA penetration is still low in rural areas. In rural areas where MA penetration is highest, there is also a higher bypass rate among Medicare FFS beneficiaries. Based on stakeholders' observations, some MA plans do not contract with rural hospitals,[x] which affect overall revenue and may reduce the financial viability of providing some services locally. Likewise, some stakeholders observed that out-of-pocket costs may be higher at rural hospitals, particularly for diagnostic and laboratory services at CAHs, resulting in rural Medicare beneficiaries shifting their inpatient hospital care to a distant location where they receive other health care services for less cost.

[x] Under §422.116, an MA plan must demonstrate it has an adequate contracted provider network sufficient to provide access to covered services.

As health care systems continue to evolve, information on access to health care services, especially inpatient hospital care, for rural Medicare beneficiaries is essential. Medicare plays a vital role in sustaining access to essential health care services in many rural communities. Rural hospitals play a pivotal role in supporting the health and economic stability of the rural communities they serve.

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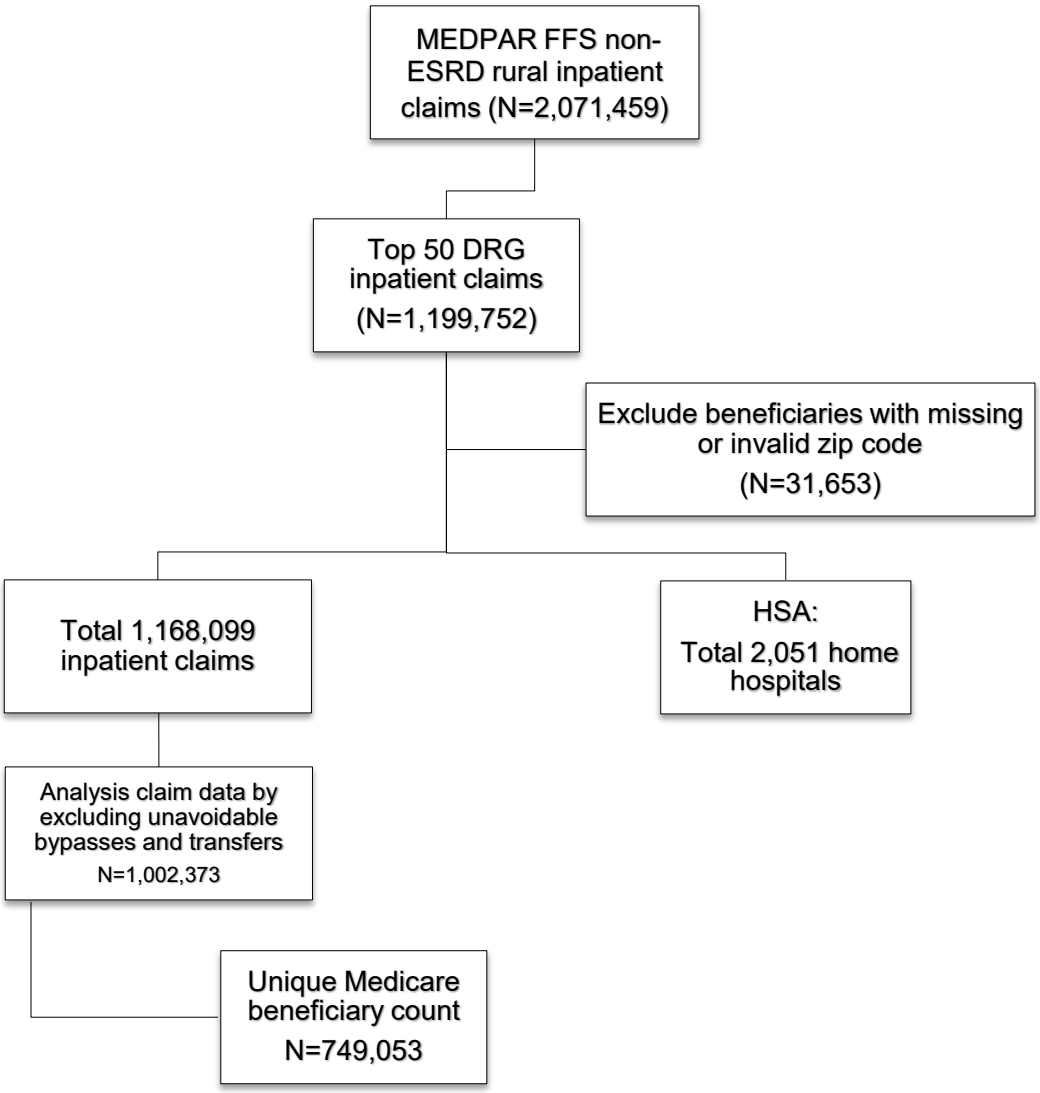
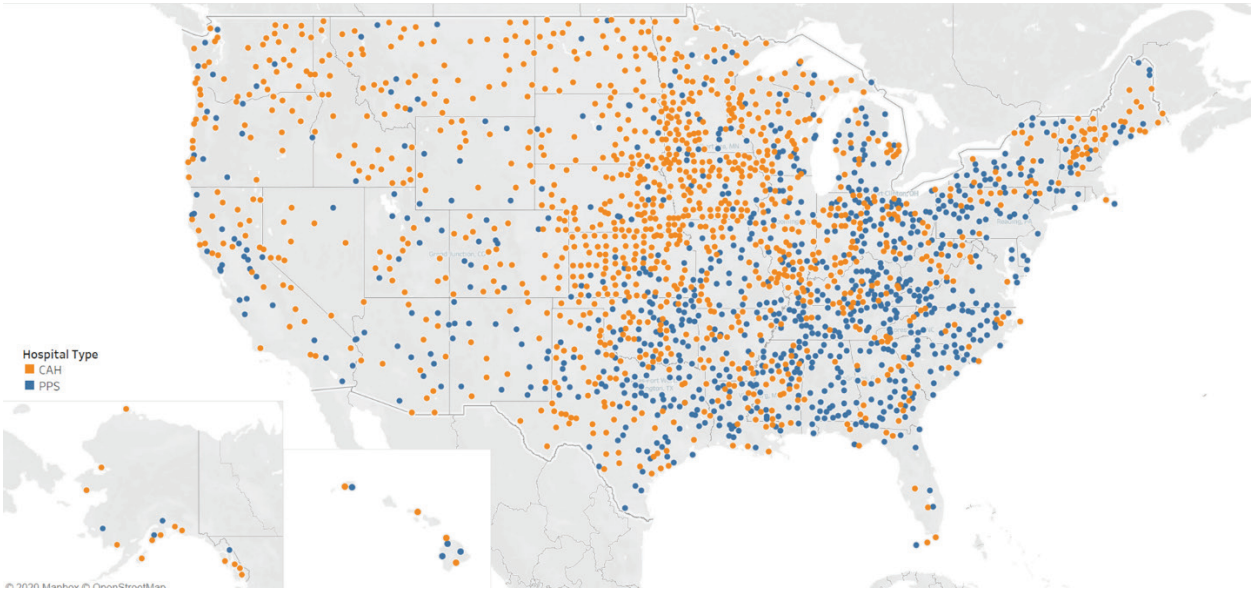
APPENDIX A: SUPPORTING TABLES AND FIGURES

Figure A.1. Study Design and Patient Selection



NOTE: A total of 1,002,373 acute hospital inpatient stays were identified and included; a total 15,781 out of 37,856 residential ZIP codes were assigned to rural HSAs; a total 2,051 out of 4,282 home HSAs classified as rural.
Source: Estimates were produced using 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims.

Figure A.2. Geographic Distribution of Rural home Hospitals by Hospital Type



NOTE: Total of 1,168 CAHs (orange) and 883 rural PPS hospitals (blue) are included.
Source: Hospitals were identified using the U.S. Hospital List from the NC Rural Health Research Program, available at https://www.shepscenter.unc.edu/programs-projects/rural-health/data/.

Table A.1. Top 50 DRGs Included in the Analysis

DRG Number	DRG Description	Number of HSAs	Total Number of Inpatient Claims
064	Intracranial Hemorrhage or Cerebral Infarction with MCC	1,872	16,656
065	Intracranial Hemorrhage or Cerebral Infarction with CC or Tissue Plasminogen Activator (TPA) in 24 Hours	1,945	24,601
281	Acute Myocardial Infarction Discharged Alive with CC	1,796	12,791
280	Acute Myocardial Infarction Discharged Alive with MCC	1,827	19,178
377	Gastrointestinal (GI) Hemorrhage with MCC	1,768	10,611
853*	Infectious and Parasitic Diseases with Operating Room (OR) Procedure with MCC	1,892	16,055
552	Back Problems without MCC	1,852	10,455
330*	Major Small and Large Bowel Procedures with CC	1,847	12,750
378	Gastrointestinal (GI) Hemorrhage with CC	1,951	28,647
208	Respiratory System Diagnosis with Ventilator Support ≤ 96 Hours	1,752	12,330
066	Intracranial Hemorrhage or Cerebral Infarction without CC/MCC	1,738	8,750
470*	Major Hip and Knee Joint Replacement or Reattachment of Lower Extremity without MCC	2,040	104,847
682	Renal Failure with MCC	1,851	19,609
885	Psychoses	1,518	12,329
309	Cardiac Arrhythmia and Conduction Disorders with CC	1,913	21,064
069	Transient Ischemia without Thrombolytic	1,670	8,767
483*	Major Joint/Limb Reattachment Procedure of Upper Extremities	1,901	16,379
310	Cardiac Arrhythmia and Conduction Disorders without CC/MCC	1,874	15,866

DRG Number	DRG Description	Number of HSAs	Total Number of Inpatient Claims
313	Chest Pain	1,641	8,733
308	Cardiac Arrhythmia and Conduction Disorders with MCC	1,836	15,009
871	Septicemia or Severe Sepsis without Mechanical Ventilation (MV) >96 Hours with MCC	2,034	123,042
683	Renal Failure with CC	1,926	28,212
291	Heart Failure and Shock with MCC or Peripheral Extracorporeal Membrane Oxygenation (ECMO)	2,015	71,026
698	Other Kidney and Urinary Tract Diagnoses with MCC	1,609	10,175
312	Syncope and Collapse	1,765	11,758
177	Respiratory Infections and Inflammations with MCC	1,777	15,433
389	Gastrointestinal (GI) Obstruction With CC	1,829	11,929
640	Miscellaneous Disorders of Nutrition Metabolism Fluids and Electrolytes with MCC	1,712	9,165
392	Esophagitis Gastroenteritis and Miscellaneous Digestive Disorders without MCC	1,992	33,025
481*	Hip and Femur Procedures except Major Joint with CC	1,935	18,049
812	Red Blood Cell Disorders without MCC	1,775	11,821
390	Gastrointestinal (GI) Obstruction without CC/MCC	1,744	8,247
872	Septicemia or Severe Sepsis without Mechanical Ventilation (M) >96 Hours without MCC	1,976	36,569
292	Heart Failure and Shock With CC	1,974	24,106
189	Pulmonary Edema and Respiratory Failure	1,936	35,614
638	Diabetes with CC	1,742	11,434
178	Respiratory Infections and Inflammations with CC	1,653	8,031
193	Simple Pneumonia and Pleurisy with MCC	1,991	37,542
689	Kidney and Urinary Tract Infections with MCC	1,801	16,296
948	Signs and Symptoms without MCC	1,829	9,794
603	Cellulitis without MCC	1,980	24,572
641	Miscellaneous Disorders of Nutrition Metabolism Fluids and Electrolytes without MCC	1,984	24,078
293	Heart Failure and Shock without CC/MCC	1,836	11,010
690	Kidney and Urinary Tract Infections without MCC	2,006	35,279
190	Chronic Obstructive Pulmonary Disease with MCC	1,954	37,743
191	Chronic Obstructive Pulmonary Disease with CC	1,879	19,750
194	Simple Pneumonia and Pleurisy with CC	2,015	40,078
192	Chronic Obstructive Pulmonary Disease without CC/MCC	1,857	12,249
195	Simple Pneumonia and Pleurisy without CC/MCC	1,951	14,796
247*	Percutaneous Cardiovascular Procedures with Drug-Eluting Stent without MCC	1,946	21,849

NOTE: DRG is the Diagnostic Related Group that is used to classify the type of hospitalization. DRG is the Diagnostic Related Group that is used to classify the type of hospitalization. There are two clinical types of DRG. A medical DRG is one where no operating room (OR) procedure is performed. When an OR procedure is performed, a surgical DRG is assigned. CC is complication or comorbidity. MCC is major complication or comorbidity.

* =Surgical DRGs

Source: Estimates were produced using 2018 MedPAR inpatient claims.

Table A.2. Home Hospital Characteristics, 2018

	Rural PPS Hospital: N	Rural PPS Hospital: %	CAH: N	CAH: %
Number of Beds				
≤ 25	46	5%	1,168	100%
26 to 50	306	35%		
51 to 100	308	35%		
101 to 200	179	20%		
201+	44	5%		
RUCA Code				
Micropolitan (4,5,6)	571	65%	166	14%
Small town (7,8,9)	254	7%	581	36%
Noncore (10)	58	29%	421	50%
Other Characteristics				
IHS hospitals	19		7	
Closed hospitals as of January 2020	14		7	

NOTE: Total 2,051 home hospitals are included. Rural-Urban Commuting Areas (RUCA) Code is defined by the U.S. Department of Agriculture Economic Research Service.

Source: Estimates were produced using 2018 MedPAR inpatient claims, 2018hospital list from the Sheps Center, and 2018 Provider of Services file.

Table A.3. Home Hospital Market Characteristics, 2018

	Rural PPS Hospital: N	Rural PPS Hospital: %	CAH: N	CAH: %	Urban Hospital: N	Urban Hospital: %
Total Medicare Population	8,596,908		3,646,533		50,158,191	
FFS	5,999,264	70%	2,722,519	75%	29,613,965	59%
Dual Eligible	1,238,290	21%	515,849	19%	5,006,231	17%

NOTE: Medicare population were classified into Rural (PPS and CAH) and Urban markets based on Medicare beneficiary's residential zip codes that crosswalked with RUCA codes.

Source: Estimates were produced using 2018 MedPAR inpatient claims and Medicare enrollment data.

Table A.4. Inpatient Stays by Home Hospital Type, 2018

Rural Home Hospital Characteristics	All 765 DRG Inpatient FFS Claims: Number of Stays	All 765 DRG Inpatient FFS Claims: Number of Benes	Top 50 DRGs: Number of Stays	Top 50 DRGs: Number of Beneficiaries	Top 50 DRGs: In-market Stays	Top 50 DRGs: Avoidable Stays	Top 50 DRGs: Percent In-market Stays
All Rural Hospitals	2,071,459	1,336,799	1,199,752	867,228	711,782	290,591	59%
Rural PPS Hospitals	1,460,043	936,011	849,163	609,546	531,526	207,465	63%
CAH	606,616	398,991	350,589	258,506	180,256	83,126	51%

NOTE: Rural home hospital markets were classified into Rural (PPS and CAH) markets based on Medicare beneficiary's residential zip codes that crosswalked with RUCA codes. Total 2,051 home hospital HSAs were identified. Avoidable stays are the inpatients hospital admissions for which rural Medicare beneficiaries received acute care at a distant hospital even those those services were avaiable in home hospital. Percent In-market stays is the percentage of inpatient stays for which rural Medicare beneficiaries received acute care at home hospital HSA.

Source: Estimates were produced using 2018 MedPAR inpatient claims.

Table A.5. Rural Hospital Bypass by Medicare Beneficiary Characteristics, 2018

	Rural PPS Hospital: In-market Stays	Rural PPS Hospital: Avoidable Bypass	Rural PPS Hospital: % of Bypass	CAH: In-market Stays	CAH: Avoidable Bypass	CAH: % of Bypass
Sex						
Male	160,935	78,794	33%	56,923	33,405	37%
Female	214,278	91,363	30%	76,797	36,558	32%
Age Group						
<65	52,796	26,559	33%	14,355	9,298	39%
65-74	112,250	63,213	36%	37,330	25,369	40%
75-84	117,740	52,450	31%	43,180	22,857	35%
85+	92,427	27,935	23%	38,855	12,439	24%
RTI Race Code						
Non-Hispanic White	330,635	147,796	31%	124,018	63,137	34%
Black (African-American)	26,091	12,548	32%	3,253	2,417	43%
Hispanic	7,977	4,581	36%	2,830	2,121	43%
Asian/Pacific Islander	1,497	572	28%	316	193	38%
American Indian / Alaska Native	5,646	2,703	32%	2,083	1,202	37%
Unknown or Other	3,367	1,957	37%	1,220	893	42%
Dual Eligible: No	251,108	125,658	33%	92,326	52,118	36%
Dual Eligible: Yes	124,105	44,499	26%	41,394	17,845	30%
Beneficiaries with at least 3 chronic conditions	343,047	151,480	31%	122,174	61,903	34%
Average HCC score	1.83 (1.45)	1.81(1.57)		1.72 (1.33)	1.80 (1.55)	

NOTE: The total rural Medicare beneficiaries with non-missing inpatient stays data for the 50 most common DRGs is 749,053. In-market stays is the inpatient stays for which rural Medicare beneficiaries received acute care at home hospital HSA. Avoidable bypass is the number of inpatient stays for which rural Medicare beneficiaries received acute care at a distant hospital even though those services were available at home hospital.

Source: Estimates were produced using 2018 MedPAR inpatient claims and Medicare enrollment data.

Table A.6a. Linear Regression Model for Rural PPS Hospital Avoidable Bypass

	Coefficient	Standard Error	t Value	Pr > |t|	Statistical Significance
Intercept	0.514	0.130	3.96	<.0001	
Hospital Level					
Percentage of MA beneficiaries, HSA	0.204	0.037	5.46	<.0001	***
Bed count	-0.001	0.000	-4.26	<.0001	***
Bed count squared	<0.001	<0.001	2	0.05	
Cancer program approved by American College of Surgeons (1=yes, 0=no)	-0.045	0.013	-3.59	<.001	***
Telehealth office visits or consultation (1=yes, 0=no)	-0.032	0.009	-3.46	<.001	***
HCAHPS: % definitely recommend the hospital	-0.001	0.001	-2.6	<.01	**
Percentage of dual eligible beneficiaries, HSA	-0.167	0.088	-1.9	0.06	
Hospital Ownership: Private	-0.003	0.009	-0.3	0.76	
State/Region Indicator					
State Medicaid Expansion (1= not adopted, 0=yes)	0.039	0.013	2.99	0.003	***
Census Region: Mid-West (1=yes, 0=no)	-0.040	0.019	-2.09	0.04	*
Census Region: South (1=yes, 0=no)	0.033	0.019	1.75	0.08	
Census Region: Northeast (1=yes, 0=no)	-0.016	0.022	-0.76	0.45	
RUCA code 10	-0.024	0.019	-1.27	0.21	
RUCA code 4	0.009	0.011	0.8	0.42	
County Market Characteristics					
County Primary Care Physicians, MD+DO per 1,000 population, 2017	-0.089	0.027	-3.26	0.001	***
County median household income per 1,000 population, 2017	0.002	0.001	3.73	<.001	***
Percentage of residents with high school and higher education diploma, ZIP code	-0.002	0.001	-1.72	0.09	
Percentage age 18-64 years without health insurance, county, 2017	-0.002	0.001	-1.72	0.09	
County social cohesion per 10,000 population	-0.002	0.001	-1.61	0.11	
County average HCC score	0.102	0.073	1.4	0.16	
County specialists per 1,000 population, 2017	-0.011	0.013	-0.85	0.40	

NOTE: The model dependent variable is hospital-level avoidable bypass percentage. Rural PPS hospital model included 852 hospitals, 29 Rural hospitals that have no HCHAPS and 2 hospitals with less than 20 inpatient stays are excluded from modeling. The model R^2 is 0.33. States that had not adopted Medicaid expansion as of January 1, 2018 include AL, FL, GA, KS, MS, MO, NC, OK, SC, SD, TN, TX, WI, WY, VA, NE, UT, ID (https://www.kff.org/medicaid/issue-brief/status-of-state-medicaid-expansion-decisions-interactive-map/).

* = statistical significance at $p < 0.005$, $p < 0.01$, and $p < 0.05$, respectively.

Source: Estimates were produced using 2018 MedPAR inpatient claims, 2018 Area Health Resource File (HRSA), 2018 Provider of Services file, and 2018 County Health Rankings.

Table A.6b. Variable Profiling for Rural PPS Hospitals

Variable	Mean	Std. error	Min	1st Percentile	25th Percentile	Median	75th Percentile	99th Percentile	Max
Avoidable bypass	0.30	0.15	0	0.05	0.19	0.29	0.40	0.72	0.78
Census Region: Northeast	0.10	0.30	0	0	0	0	0	1	1
Census Region: South	0.51	0.50	0	0	0	1	1	1	1
Census Region: Mid-West	0.27	0.44	0	0	0	0	1	1	1
State Medicaid Expansion not adopted	0.51	0.50	0	0	0	1	1	1	1
RUCA code 4	0.64	0.48	0	0	0	1	1	1	1
RUCA code 10	0.06	0.24	0	0	0	0	0	1	1
County average HCC score	0.98	0.09	0.61	0.76	0.93	0.98	1.03	1.2	1.42
Percentage of resident with high school and higher education diploma, ZIP code	85.20	6.72	46.4	67.1	81.25	86	90.1	96.7	100
County Primary Care Physicians, MD+DO per 1,000 population, 2017	0.58	0.26	0	0.18	0.40	0.52	0.70	1.45	2.06
County specialists per 1,000 population, 2017	0.66	0.57	0	0	0.33	0.53	0.84	2.62	8.04
County median household income, 2017	44,653	10,985	14,914	25,122	37,373	43,257	49,721	80,110	110,190
Percentage ages 18-64 years without health insurance, county, 2017	13.72	6.24	3.4	5.2	8.3	12.85	18.05	30.2	39.6
County social cohesion	12.00	3.94	0	2.93	9.46	11.77	14.54	21.84	29.20
Percentage of MA beneficiaries, HSA	0.25	0.13	0.001	0.02	0.16	0.25	0.33	0.58	0.65
Percentage of dual eligible beneficiaries, HSA	0.22	0.08	0.03	0.07	0.16	0.20	0.26	0.50	0.63
Hospital Ownership: Private	0.57	0.50	0	0	0	1	1	1	1
Telehealth services	0.39	0.49	0	0	0	0	1	1	1
Bed count	85.05	60.34	4	19	47	67	102	286	566
HCAHPS: % definitely recommend the hospital	67.74	8.60	31	45	62	68	74	87	93

NOTE: Table shows the mean, standard errors and percentiles of the variables in linear regression model for Rural PPS hospital.

Source: Estimates were produced using 2018 MedPAR inpatient claims, 2018 Area Health Resource File (HRSA), 2018 Provider of Services file, and 2018 County Health Rankings.

Table A.7a. Linear Regression Model for CAH Avoidable Bypass

	Coefficient	Standard Error	t Value	Pr > |t|	Statistical Significance
Intercept	0.261	0.114	2.28	0.02	
Hospital Level					
Percentage of MA beneficiaries, HSA	0.227	0.033	6.84	<.0001	***
Telehealth office visits or consultation (1=yes, 0=no)	-0.024	0.011	-2.24	0.03	*
Percentage of dual eligible beneficiaries, HSA	-0.122	0.089	-1.37	0.17	
State/Region Indicator					
State Medicaid Expansion (1=no, 0=yes)	0.005	0.012	0.37	0.71	
Census Region: Mid-West (1=yes, 0=no)	-0.049	0.016	-3.04	0.003	**
Census Region: South (1=yes, 0=no)	0.000	0.018	0	0.996	
Census Region: Northeast (1=yes, 0=no)	-0.076	0.023	-3.27	0.001	**
RUCA code 10	-0.021	0.010	-2.13	0.03	*
RUCA code 4	0.004	0.015	0.28	0.78	
County Market Characteristics					
County Primary Care Physicians, MD+DO per 1,000 population, 2017	-0.060	0.016	-3.87	<.0001	***
County social cohesion per 10,000 population	-0.003	0.001	-4.47	<.0001	***
County average HCC score	0.178	0.069	2.58	0.01	*
County median household income per 1,000 population, 2017	0.001	0.001	1.1	0.27	

NOTE: The model dependent variable is hospital-level avoidable bypass percentage. CAH model included 1,157 hospitals, 11 CAHs with less than 20 inpatient stays are excluded from modeling. The model R2 is 0.18. States that had not adopted Medicaid expansion as of January 1, 2018 include AL, FL, GA, KS, MS, MO, NC, OK, SC, SD, TN, TX, WI, WY, VA, NE, UT, ID (https://www.kff.org/medicaid/issue-brief/status-of-state-medicaid-expansion-decisions-interactive-map/).

* = statistical significance at $p < 0.005$, $p < 0.01$, and $p < 0.05$, respectively.

Source: Estimates were produced using 2018 MedPAR inpatient claims, 2018 Area Health Resource File (HRSA), 2018 Provider of Services file, and 2018 County Health Rankings.

Table A.7b. Variable Profiling for CAHs

Variable	Mean	Std. error	Min	1st Percentile	25th Percentile	Median	75th Percentile	99th Percentile	Max
Avoidable bypass	0.31	0.16	0	0.03	0.19	0.29	0.41	0.75	0.98
Census Region: Northeast	0.06	0.23	0	0	0	0	0	1	1
Census Region: South	0.23	0.42	0	0	0	0	0	1	1
Census Region: Mid-West	0.49	0.50	0	0	0	0	1	1	1
State Medicaid Expansion not adopted	0.43	0.50	0	0	0	0	1	1	1
County average HCC score	0.91	0.09	0.64	0.70	0.85	0.91	0.96	1.14	1.28
Percentage of residents with high school and higher education diploma, ZIP code	87.07	6.73	53.60	65.00	84.10	88.70	91.90	96.70	99.00
County Primary Care Physicians, MD+DO per 1,000 population, 2017	0.56	0.35	0.00	0.00	0.33	0.50	0.71	1.64	4.31
County specialists per 1,000 population, 2017	0.32	0.60	0.00	0.00	0.05	0.18	0.40	2.12	8.04
County median household income, 2017	47,628	10,189	18,846	25,453	40,995	47,340	53,098	79,611	93,940
Percentage of MA beneficiaries, 2017	0.19	0.15	0.00	0.00	0.06	0.16	0.28	0.61	0.67
Percentage of dual eligible beneficiaries, HSA	0.18	0.08	0.03	0.06	0.13	0.16	0.21	0.42	0.60
Percentage ages 18-64 years without health insurance, 2017	13.11	6.10	3.80	5.00	8.40	11.50	16.30	30.00	38.40
County social cohesion	14.03	6.85	0.00	0.00	9.59	13.20	17.42	34.93	52.31
RUCA code 4	0.11	0.31	0	0	0	0	0	1	1
RUCA code 10	0.36	0.48	0	0	0	0	1	1	1
Telehealth services	0.21	0.41	0	0	0	0	0	1	1

NOTE: Table shows the mean, standard errors and percentiles of the variables in linear regression model for CAH.

Source: Estimates were produced using 2018 MedPAR inpatient claims, 2018 Area Health Resource File (HRSA), 2018 Provider of Services file, and 2018 County Health Rankings.

Table A.8a. Hierarchical Logistic Regression Model (HLRM) for Patient and Inpatient Stays for Surgical DRGs in Rural Hospitals (PPS and CAH)

Characteristics	Rural PPS Hospital: OR	Rural PPS Hospital: 95% CI	Rural PPS Hospital: Statistical Significance*	CAH: OR	CAH: 95% CI	CAH: Statistical Significance
Sex: ref - Female						
Male	1.037	0.979-1.098		1.073	0.961-1.198	
Age Category: ref - 65-74						
<65	1.102	0.996-1.219		1.138	0.909-1.425	
75-84	0.682	0.64-0.728	***	0.753	0.666-0.851	***
85+	0.339	0.307-0.373	***	0.462	0.384-0.557	***
Race: Black ref - No						
Yes	0.943	0.812-1.094		0.686	0.378-1.246	
Race: Hispanic ref - No						
Yes	1.028	0.833-1.269		0.843	0.549-1.295	
Race: Asian/Pacific Islander, and American Indian/Alaska Native ref - No						
Yes	1.073	0.836-1.376		1.533	0.925-2.542	
Dual Eligible status: ref - No						
Yes	0.528	0.485-0.574	***	0.551	0.462-0.658	***
HCC score	1	0.974-1.027		1.124	1.061-1.191	***
Stay level PPS and CAH combined						
Elective =1 (ref=0)	3.519	3.264-3.794	***			
Measure of variation	Intercept Variance Estimates (SE)	ICC		Intercept Variance Estimates (SE)	ICC	
Hospital level	0.98 (0.08)	22.9%	***	2.61 (0.24)	44.3%	***
Deviance from Null Model	903.66			129.39		

NOTE: The surgical HLRM Models were developed by ~30% of randomly selected sample and validated by cross-validation. The model sample size for rural PPS is 25,540 and for CAH is 8,091 respectively. Odds Ratio (OR) represents the odds that a bypass occurred at the characteristics category, compared to the odds of bypass occuring in the reference category. The intraclass correlation coeeficient (ICC) indicates the proportion of the total variance of bypass that is due to hospital is 23% in PPS model and 44% in CAH model. Deviance from null model is calculated as -2 Log Likelihood(LL) of Null model - -2LL of full model. Positive deviance implies better fit.

* = statistical significance at $p < 0.005$.

Source: Estimates were produced using 2018 MedPAR inpatient claims and Medicare enrollment data.

Table A.8b. Hierarchical Logistic Regression Model (HLRM) for Patient and Inpatient Stays for Medical DRGs in Rural Hospitals (PPS and CAH)

Characteristics	Rural PPS Hospital: OR	Rural PPS Hospital: 95% CI	Rural PPS Hospital: Statistical Significance*	CAH: OR	CAH: 95% CI	CAH: Statistical Significance*
Sex: ref - Female						
Male	1.159	1.117-1.202	***	1.165	1.102-1.23	***
Age Category: ref - 65-74						
<65	1.229	1.161-1.301	***	1.317	1.199-1.446	***
75-84	0.855	0.817-0.895	***	0.817	0.763-0.875	***
85+	0.626	0.595-0.659	***	0.497	0.461-0.536	***
Race: Black ref - No						
Yes	0.954	0.887-1.027		1.465	1.236-1.736	***
Race: Hispanic ref - No						
Yes	1.068	0.969-1.261		1.434	1.202-1.712	***
Race: Asian/Pacific Islander, and American Indian/Alaska Native ref - No						
Yes	1.068	0.922-1.237		1.209	0.995-1.469	
Dual Eligible status: ref - No						
Yes	0.683	0.654-0.713	***	0.671	0.628-0.717	***
HCC score	1.077	1.064-1.089	***	1.087	1.067-1.108	***
Stay level						
Elective =1 (ref=0)	0.972	0.83-1.138		0.193	0.152-0.244	***
Measure of variation	Estimates (SE)	ICC		Estimates (SE)	ICC	
Hospital level	0.69 (0.04)	17.3%	***	0.68 (0.04)	17.1%	***
Deviance from Null Model	977.92			697.74		

NOTE:

The Medical HLRM Models were developed by ~30% of randomly selected sample and validated by cross-validation. The model sample size for rural PPS is 69,106 and for CAH is 29,148 respectively. Odds Ratio (OR) represents the odds that a bypass occurred at the characteristics category, compared to the odds of bypass occurring in the reference category. The intraclass correlation coeeficient (ICC) indicates the proportion of the total variance of bypass that is due to hospital is 17% in both PPS model and CAH model. Deviance from null model is calculated as -2 Log Likelihood(LL) of Null model - -2LL of full model. Positive deviance implies better fit.

* = statistical significance at $p < 0.005$.

Source: Estimates were produced using 2018 MedPAR inpatient claims and Medicare enrollment data.

APPENDIX B: DETAILED METHODOLOGY

We conducted a national mixed methods study using quantitative methods and Medicare fee-for-service (FFS) claims combined with a qualitative case study approach. Quantitative analyses were completed prior to qualitative data collection to inform case study selection.

Quantitative Data and Analysis

The quantitative study was designed as a retrospective cohort study. The Medicare acute care hospital inpatient claims and enrollment files for calendar year (CY) 2018 were the primary data used for the analysis. Only rural fee-for-service (FFS) Medicare beneficiaries who had coverage for all 12 months during CY 2018 and had at least one inpatient stay were included in the 50-state analysis. Medicare Advantage and beneficiaries with end-stage renal disease (ESRD) were excluded from the analysis.

The 2018 Medicare Provider Analysis and Review files (MedPAR) inpatient claims were merged with the Medicare Master Beneficiary Summary File to provide demographic characteristics and other information such as patients' hierarchical condition category (HCC) scores and dual eligible status (i.e., individuals who receive both Medicare and Medicaid benefits). Other hospital and market characteristics data were merged with the inpatient claims, including Rural-Urban Commuting Area (RUCA) codes from the United States Department of Agriculture's Economic Research Service, the Rural Hospital List from the University of North Carolina at Chapel Hill Cecil G. Sheps Center for Health Services Research (Sheps Center), a list of Tribal hospitals generated by the Indian Health Service (2019), the CMS Provider of Services file, the Area Health Resource File (HRSA), American Hospital Association (AHA) Annual Survey, County Health Ranking, Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) data from Hospital Compare, and the CMS geographic variation public use file. Variables of interest from these datasets provided information on hospital and neighborhood characteristics, such as hospital type (e.g., CAH or prospective payment system [PPS] status), number of beds, hospital ownership, income per capita, Medicaid concentration, Medicaid program indicators, physicians per capita, and "ruralness" or degree of rurality.

Defining Rural Hospitals

All acute care hospitals that located in rural ZIP codes, including critical access hospitals (CAHs) and hospitals paid under Medicare's prospective payment systems (PPS), were included in the analysis. RUCA codes, which are based on the Office of Management and Budget metropolitan statistical area and micropolitan statistical area definitions, were used to define rural and urban. The hospitals were categorized as rural or urban facilities based on the RUCA code for the hospital's ZIP code (rural includes RUCA codes ≥ 4 and urban includes RUCA codes < 4). Hospitals that did not provide general medical services (i.e., psychiatric hospitals, long-term care hospitals, and specialty hospitals) were not included in the analysis.

Defining Rural Hospital Markets (Hospital Service Areas)

For this analysis, hospital service areas (HSAs) are defined by the ZIP codes that a rural hospital serves. The goals of this analysis required construction of an HSA for every hospital located in a

rural ZIP code treating Medicare FFS inpatients and assignment of beneficiaries to one HSA.[xi] Each HSA was defined by ranking the ZIP codes for Medicare beneficiaries by Medicare inpatient volume of the hospital and identifying those ZIP codes that accounted for 80 percent of Medicare inpatient volume [11] [12]. Patients who received services at the rural hospital and reside in one of the ZIP codes that did not comprise the top 80 percent of inpatient stays were not considered to be part of an HSA. If the 80 percent threshold only captures one beneficiary ZIP code, the HSA for the hospital contains only one residential ZIP code.

This approach to constructing HSAs allowed for some overlap in ZIP codes. There were instances in which ZIP codes, and the rural Medicare beneficiaries who live in those ZIP codes, were assigned to multiple HSAs. A maximum of seven rural HSAs for certain beneficiaries was identified using this assignment method. For beneficiaries with multiple HSA assignments, we identified the type of markets in which they reside by calculating the distance between each beneficiary's ZIP code centroid (the point marking the center of the ZIP code) and the ZIP code centroid for each hospital used by the patient. [xii] We then used this calculation to determine the HSA that is the closest to beneficiary's residence and estimate whether any other HSAs including that ZIP code were less than or greater than 30 miles away [13] [14]. This distinction between HSA markets was used (as described below) to avoid assigning a hospital stay as bypass if the hospital stay was actually at a reasonably close hospital other than at the nearest hospital.

Defining Rural Hospital Bypass

We identified the inpatient stays for rural Medicare FFS beneficiaries and determined the facilities where the beneficiaries received inpatient hospital services. The closest hospital that rural Medicare beneficiaries are attributed to is considered the "home" hospital. Each inpatient stay was assigned to one of three HSA markets:

- In-Market Inpatient Stays: Inpatient stays at rural hospitals that are either the home hospital, or are ≤ 30 miles away. In-Market Inpatient Stays were not considered to be rural hospital bypasses.
- Rural to Other Rural Bypass: Inpatient stays at distant rural hospitals >30 miles away
- Rural to Urban Bypass: Inpatient stays at distant urban hospitals

Recognizing that some rural hospital bypass was due to the availability of services, we characterized bypasses as "*unavoidable*" – an inpatient stay at a distant hospital for a service not available at the home hospital - or "*avoidable*" – an inpatient stay at a distant hospital for a service that is also available at the home hospital. To determine the availability of services in each HSA, we compiled a list of diagnostic related groups (DRGs) from the most common 50 DRGs (Appendix A, Table A.1) for each hospital. If the beneficiary's DRG code on the claim appeared in the list of DRGs for that beneficiary's home hospital, we classified this particular discharge as an "avoidable" bypass, as the DRG could be provided at the beneficiary's home

[xi] We determined that the HSAs developed by the Dartmouth Atlas were not appropriate for this analysis, because they were generally constructed for urban areas. The Dartmouth Atlas creates HSAs by assigning ZIP codes to the hospital area where the greatest proportion of their Medicare residents were hospitalized, allowing for only one hospital service area per ZIP code and for more than one hospital to comprise a single HSA.

[xii] A centroid is a point (usually on a map) that defines the center (in this case, of the zip code). The centroid (point) is represented by longitude and latitude coordinates. In this study, the ZIP code centroid is used to approximate the Euclidean (or straight line) distance between two ZIP codes.

hospital. If the beneficiary's DRG code did not appear in the list of DRGs for that beneficiary's home hospital, we classified this discharge as an "unavoidable" bypass, as the DRG could not be provided at the beneficiary's home hospital. We limited the inpatient stays to the most common 50 diagnostic related groups (DRGs), out of the 765 DRGs provided by rural hospitals in CY 2018 (Appendix A, Table A.1) and determined the availability of services in each HSA. Both unavoidable bypass and all inpatient stays that were admitted as a transfer from other hospitals, skilled nursing facilities (SNFs), hospices and Ambulatory Surgical Centers (ASCs) were excluded. Appendix A, Figure A.1 provides a diagrammatic presentation of the study design and selection process.

Variables and Outcomes

Variables included those at the stay level, beneficiary level, hospital level, and community level. In addition to DRG, we included elective inpatient stays[xiii] as a binary indicator. For patient level factors, Medicare beneficiaries were categorized by sex and age categories (i.e., <65 years, 65–74 years, 75–84 years, and ≥ 85 years). The RTI race code[xiv] was used to identify race/ethnicity (non-Hispanic white, black, Hispanic, Asian/Pacific Islander, and American Indian/Alaska Native). We also included dual eligible status and the beneficiary's 2018 health risk score based on the HCC risk-adjustment models as a proxy estimate of patient's severity of illness.

We accounted for the following hospital level variables for home hospitals: number of beds; hospital ownership types (private vs. public); HCAHPS measures of overall hospital rating and hospital recommendation; and presence of a cancer program approved by American College of Surgeons. Three additional variables were derived using Medicare claim and enrollment data: hospital telehealth service flag, Medicare Advantage penetration, and percentage of dual eligible Medicare beneficiaries by HSA. A telehealth services flag was defined for each hospital based on whether at least one telehealth office visit or consultation service was billed during the patient's inpatient stay.[xv]

Random forest classification regression and clustering analysis were applied to reduce community level variables [17]. The following HSA and community level indicators were included:

- Health insurance coverage: percentage of households comprised of individuals who are 18-64 years of age without health insurance by county, 2017
- Medicare market: Medicare Advantage penetration and percentage of dual eligible Medicare beneficiaries by HSA, 2018

[xiii] Admission source as defined in the Chronic Conditions Data Warehouse available at https://www2.ccwdata.org/web/guest/data-dictionaries.

[xiv] RTI race code as defined in the Chronic Conditions Data Warehouse available at https://www2.ccwdata.org/web/guest/data-dictionaries.

[xv] Telehealth professional claims were identified as physician or practitioner services furnished to beneficiaries in hospitals through a telecommunications system.Telehealth services were identified using place of service code=02 and HCPCS code G0425–G0427, G0406–G0408, 99231–99233, G0508, G0509 with identifier 95 or GT, as described in the Telehealth Services MLN Booklet available at.https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/TelehealthSrvcsfctsht.pdf.

- Physicians per capita: primary care physicians (i.e., MDs and DOs) and specialists per 1,000 population by county, 2017
- Education: percentage of residents with high school and higher education diploma(s) by county, 2017
- Population wealth: median household income by county, 2017
- Social cohesion: Number of membership associations per 10,000 population by county, 2017[xvi]
- Average HCC score for Medicare population who reside in the county, 2017
- Geography: rural-urban commuting area codes (RUCA); Census region: North-east, South, West, Midwest
- State policy: Medicaid expansion state [15]

The primary outcome in the analysis was whether the inpatient stay was an avoidable bypass (coded as "1"). At the beneficiary level, the beneficiary was flagged as having an avoidable bypass if at least one of his/her inpatient stays during CY 2018 was an avoidable bypass. At the inpatient stay level, when aggregating the inpatient stays within a home hospital, the home hospital avoidable bypass rate was calculated as the percentage of the total number of avoidable bypasses divided by total number of hospital inpatient stays from the Medicare beneficiaries who reside in the HSA excluding unavoidable bypasses.

Statistical Analysis

We developed statistical models to assess the impact of community, hospital, patient, and stay level characteristics on avoidable hospital bypass. The exploratory data analysis before model testing was conducted to:

1. Describe rural hospital bypass among Medicare FFS beneficiaries for inpatient care;
2. Identify factors influencing avoidable rural hospital bypass for inpatient services; and
3. Quantify the relationship between avoidable bypass and patient demographics.

The results of the exploratory data analysis are expressed as frequencies and percentages for patient and hospital characteristics by home hospital type—rural PPS hospitals and CAHs. This study compared quality measures of the home and distant hospitals for beneficiaries who bypassed the home facility. Multiple linear regression models were used to identify factors associated with avoidable bypass; separate estimates were obtained for home PPS and CAHs. Linear regression is based on some important assumptions, which we addressed during the analysis process [16]. The residual errors were examined to ensure it was normally distributed, and collinearity among independent variables were diagnosed to assess the stability and variance of the regression estimates. Significance tests were two-tailed and statistical significance was set at the $p< 0.05$. Regression coefficients and standard errors are included in Appendix Tables.

Beneficiaries who live within an HSA are likely to be more similar than randomly selected beneficiaries (within HSA beneficiaries are "naturally clustering"). Hence, a multilevel design

[xvi] The number of membership associations was used as a proxy for social connectedness. Additional information is available through County Health Rankings at https://www.countyhealthrankings.org/explore-health-rankings/measures-data-sources/county-health-rankings-model/health-factors/social-and-economic-factors/family-social-support/social-associations.

was considered suitable for the analysis of data with hierarchical structures to account for variability within and between HSAs and beneficiaries. Hierarchical generalized logistic regression models (HGLMs) [18] with random intercepts were estimated to assess how patient demographic, socio-economic status (dual eligible), and admission elective choices affected home hospital bypass. In hierarchical models, levels are counted from the bottom up. The highest level in our data is the HSA. Patients are nested within HSA. The outcome variable, avoidable bypass, is measured for patients (at level 1) residing in an HSA (at level 2). The probability of bypassing home hospitals was related to a set of patient characteristics and a random HSA effect. Two models were constructed to judge the goodness-of-fit of the model. The first model (null model) did not contain any exposure variables. This model was fitted to decompose the total variance that existed between HSAs. The second full model expanded the null model to include all fixed effects (patient characteristics). We conducted deviance test to assess model fit by examining differences in the -2 log likelihood (-2LL) between null and full model [19]. The Inter-class Correlation coefficient (ICC) [20] was computed to measure the proportion of variability in the chance of bypassing that lies between HSAs, which provides information regarding to the importance and effect of the cluster (HSA).

To account for the possibility of type I error (false positives) as the modeling samples are large, we adopted a stricter threshold for statistical significance of $p<0.005$ [21] [22]. The results of fixed effects are shown as odds ratios with their 95% confidence intervals (CIs) in Appendix A, Tables A.8a and A.8b.

Qualitative Data Collection and Analysis

Results of the quantitative analysis were used to inform the collection of qualitative data from key stakeholders. The initial study design included in-depth qualitative data collection through site visits to four rural HSAs located in two states in April and May 2020. Given that health systems were responding to the COVID-19 public health emergency (PHE) beginning in March 2020, qualitative data collection was delayed until June 2020. Beginning in June 2020, we contacted State Offices of Rural Health (SORH) and rural hospital leaders in Georgia and Michigan to assess feasibility of conducting virtual listening sessions with community stakeholders. As COVID-19 cases in those states continued to grow, virtual listening sessions did not appear to be a viable option. As a result, we changed the study design to focus on state-level representatives to share their experiences and perspectives from their stakeholders.

The alternative study design involved virtual listening sessions with state-level representatives in four states. The four states chosen for case studies—Georgia, Kansas, Michigan, and Montana—were selected to represent geographic and market diversity, including Census region, rural/frontier population and areas, Medicaid expansion/non-expansion, and market factors.

We invited stakeholders from each state, including representatives from:

- CMS Regional Office Rural Health Coordinators;
- State Health Insurance Assistance Programs (SHIPs);
- State Offices of Rural Health and State Flex Directors;
- State Hospital Associations; and
- State Rural Health Associations.

As these were listening sessions and open to those who wanted to participate, we welcomed participants to invite colleagues and other stakeholders within their state who might have input on the topic of rural hospital bypass. As a result, representatives from rural hospitals, community health centers, and rural health clinics also participated in some state listening sessions (Table B.1).

Table B.1. Interview Participants by Type

Organization	Number of Participants
Health Care Facility	8
State Health Insurance Assistance Program (SHIP)	6
State Office of Rural Health	6
Hospital Association	2
Federal Government	1
University	1
Total	24

In advance of the listening sessions, participants were sent a spreadsheet that included their state's median rural hospital avoidable bypass rate and a list of all the state's rural hospitals that were classified as having a lower or higher bypass rate based on the state median. Five listening sessions were completed in July and August 2020, with one listening session per selected state and one with representatives from SHIPs. Each listening session was 60 to 90 minutes in length. The listening session discussion guide included questions about drivers of home hospital use and drivers of home hospital bypass. Listening session transcripts were coded in NVivo 12 (QSR International, 2018).