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Expansion Of Telestroke Services Improves Quality Of Care Provided In Super Rural Areas

ABSTRACT **Telestroke is a telemedicine intervention that facilitates communication between stroke centers and lower-resourced facilities to optimize acute stroke management. Using administrative claims data, we assessed trends in telestroke use among fee-for-service Medicare beneficiaries with acute ischemic stroke and the association between providing telestroke services and intravenous tissue plasminogen activator (IV tPA) and mechanical thrombectomy use, mortality, and medical expenditures, by urban versus rural county of residence in the period 2008–15. The proportion of ischemic stroke cases receiving telestroke increased from 0.4 to 3.8 per 1,000 cases, with usage highest among younger, male, non-Hispanic white, and patients in rural or super rural areas (super rural is the bottom quartile of rural areas. Compared with patients receiving usual care, those receiving telestroke had greater IV tPA and mechanical thrombectomy use regardless of county type, while those in super rural counties had lower thirty-day all-cause mortality. Despite increased telestroke use, rural patients remained less likely than urban patients to receive IV tPA. The findings suggest that telestroke service expansion efforts have increased, especially in rural and super rural counties, and have improved outcomes.**

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In the United States, stroke is a leading cause of long-term disability, resulting in a substantial burden to the health care system.[1] Stroke mortality is also one of the major causes of death that has contributed to the widening urban-rural gap in life expectancy during the past several decades.[2] Telestroke is a well-developed telemedicine technology that uses two-way videoconferencing to facilitate communications between specialists in stroke centers (hub hospitals) and physicians and their patients in lower-resourced health care facilities (spoke hospitals), including hospitals in rural regions.[3,4] It can include guiding the safe and effective use of thrombolysis for patients with acute ischemic stroke, the most common type of stroke (accounting for 87 percent of strokes).[5,6] The Creating High-Quality Results and Outcomes Necessary to Improve Chronic (CHRONIC) Care Act of 2017, which included the Furthering Access to Stroke Telemedicine (FAST) Act, will remove rural limits and expand Medicare coverage for hospitals to provide telestroke services starting in 2021, potentially extending telehealth services to more patients with stroke.[7]

In two policy statements, the American Heart Association recommended telestroke as a low-cost and effective tool to improve access to critical stroke care and quality of care within underserved regions.[7,8] Non–randomized controlled studies—with relatively small sample sizes and covering limited geographical areas—found that telestroke care increased the use of intravenous tissue plasminogen activator (IV tPA), and coverage by telestroke networks may reduce in-

hospital mortality in nonmetropolitan areas.[9,10] Although most telestroke networks have been established in rural regions, some studies report that telestroke care may improve quality of care in urban settings as well.[11] Economic evaluations of telestroke networks from the health care system perspective found that telestroke networks were associated with cost reduction in the network but could impose higher costs on the hub hospital.[12]

Despite a growing number of telestroke networks being established in the United States, there is limited evidence about the current use of telestroke services and telestroke's overall impact on access to care, quality of care, and spending for patients with acute ischemic stroke.[4,13] In this article we describe the trend in recent use of telestroke services among fee-for-service Medicare beneficiaries at the national level and assess the association between provision of telestroke services and use of IV tPA and mechanical thrombectomy, mortality, and total medical expenditures, stratified by the rural or urban designation of patients' county of residence. Our aim is to provide evidence to further inform the implementation of telestroke to improve acute stroke care outcomes.[4,8]

Study Data And Methods

DATA We used administrative claims data from the 100 percent Research Identifiable Files of the Centers for Medicare and Medicaid Services (CMS) for the period January 1, 2008–September 30, 2015, for fee-for-service Medicare beneficiaries. While CMS began reimbursing for telestroke services in 2007, fewer than eleven cases were reimbursed that year. Therefore, we used claims generated in 2008 and later. Claims occurring in October 2015 and later were not used because of the transition from the *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM), to the *International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, Clinical Modification (ICD-10-CM), coding system that occurred October 1, 2015, since this transition is expected to have a direct impact on the reporting of diagnoses and medical services.

SAMPLE SELECTION We extracted all inpatient claims with a principal diagnosis of acute ischemic stroke (ICD-9-CM codes 433.x1, 434.x1, and 436).[14] For each patient, we set the admission date of the first claim as the index date. We selected all inpatient claims with admission dates within seven days after the index date and all patients' ischemic stroke outpatient claims in the emergency department (revenue code 045x, 0981) between three days before and one day after their index date. We also extracted each patient's earliest ischemic stroke diagnosis date in Medicare inpatient and outpatient claims in the period January 2001–September 2015. We excluded patients who were age sixty-four or younger at admission, were enrolled in managed care programs, had missing information on age or residence, or had a diagnosis of ischemic stroke in the period January 2001 to three days before their index date. The process of sample selection is illustrated in online appendix exhibit A1.[15]

We examined all inpatient and outpatient claims for the selected patients and identified those who received telestroke services by using Healthcare Common Procedure Coding System (HCPCS) codes 9920x, 9921x, 9922x, 9923x, 9924x, 9925x, 9928x, 9929x, G0406–G0408, and G0425–G0427 and HCPCS modifier codes GT and GQ.[16] We selected all telestroke claims for the period between three days before and one day after the index date. As a comparison group, we selected four usual care (nontelehealth) ischemic stroke patients for each telestroke user using propensity score matching to address potential confounding and selection bias.[17] All patients were stratified by the rurality of their residence using the CMS ZIP code to carrier locality file into urban, rural, and super rural designations. An urban area is defined as a Metropolitan Statistical Area. ZIP code areas outside of urban areas are ranked by population density. The bottom quartile of these areas is defined as super rural, and the top three quartiles are considered rural.[18] Propensity scores for receiving telestroke care were calculated for each stratum using age group, sex, race/ethnicity, Charlson Comorbidity Index, Medicaid dual eligibility, admission season, and admission year in the logistic regression models. The characteristics of the matched samples are shown in appendix exhibits A2–A4.[15]

STATISTICAL ANALYSES We describe patient characteristics and outcome measures by rurality of residence. We used generalized linear models to estimate the differences in quality of care and spending between the patients who were treated via telestroke care and matched controls who received usual care. We used the following quality-of-care indicators: use of IV tPA (ICD-9-CM procedure code: 991.0, V45.88; HCPCS codes: 37195, 37201, 92975, J0350, and J2993), use of mechanical thrombectomy (ICD-9-CM procedure code: 39.74; HCPCS codes: 37184, 37185, and 37186), in-hospital mortality, thirty-day all-cause mortality, length-of-stay in hospital, and total expenditures per event. The latter included all patients' deductibles and copayments and Medicare payments, adjusted to 2015 US dollar values using the Consumer Price

Index from the Department of Labor.[19] We assumed a binomial distribution for dichotomous outcomes, and we provided estimates for the marginal difference (percentage change), negative binomial distribution for the outcome length-of-stay, and gamma distribution for the outcome total expenditures.

We used SAS, version 9.3, for all analyses.

We performed sensitivity analyses by developing generalized linear models using all of the available data (matched and unmatched) to provide estimates for the above measures, adjusting for age, sex, race/ethnicity, Medicaid eligibility, season of admission, Charlson Comorbidity Index, and admission year. Furthermore, we assessed for trends, using unadjusted regression models, in clinical service use and health outcomes across two-year cycles during the period 2008–15, stratified by telestroke service use status.

LIMITATIONS Our study had several limitations. First, although we applied propensity score matching to match patient characteristics between the telestroke and usual care groups, we could not rule out the possibility that selection bias resulting from the effects of not including unmeasured variables could have led to the observed differences between the two groups. For example, we could match the groups only on the Charlson Comorbidity Index, which indicates the number of comorbidities a patient has; we were unable to control for stroke severity, which is positively associated with mortality.[20] However, we conducted a robust test that used CMS's 2015 Hierarchical Condition Category variable instead of the Charlson Comorbidity Index to adjust for patients' comorbidity status and serve as a proxy for overall health. The results were largely unchanged (data not shown).

Second, we examined quality of care and spending only among fee-for-service Medicare beneficiaries ages sixty-five and older. Therefore, the findings might not be generalizable to patients with other insurance plans, such as Medicare managed care plans or private insurance plans.

Third, we did not adjust for hospital-level characteristics such as hospital bed size and urban versus rural location because some hospitals did not have sufficient numbers of patients who received telestroke care. The small sample size prevented us from using the multilevel modeling approach.

Fourth, during our study period only a small proportion of ischemic stroke patients received telestroke care, while the vast majority received care in primary or comprehensive stroke centers. With the removal of requirements for service regions under the FAST Act and the expansion of telestroke networks in both rural and urban regions,[7] the impact of telestroke on access to stroke care, IV tPA use, and spending will likely change as additional facilities are included within stroke networks. The low numbers of telestroke cases identified could also be due to misclassification bias in the billing information we used to identify telestroke use. We assumed that misclassification was nondifferential or random across the telestroke and nontelestroke populations and thus would potentially lead to an underestimation of the effect. However, if the highest-functioning telestroke programs had the most accurate billing information, there is a possibility that we overstated the benefits of telestroke coverage. A medical chart review–based study would be necessary to verify actual telestroke use.

Finally, we assessed health care spending only during the acute event and did not report potential cost savings achieved through reductions in morbidity associated with receiving telestroke care. Furthermore, we measured quality of care by using IV tPA and thrombectomy use as proxies. We had no information about other potential quality measures such as "door-to-needle" time or complications related to IV tPA use. Thus, we could not comprehensively assess the quality of stroke care provided.

Study Results

For the period January 1, 2008–September 30, 2015, we identified 1,002,045 incident ischemic stroke hospitalizations among fee-for-service Medicare patients, 1,663 of whom received telestroke services (exhibit 1). The number of telestroke cases increased each year nationwide, from 55 in 2008 to 364 in 2015 (January–September) (data not shown). The proportion of ischemic stroke cases where telestroke services were provided increased from 0.4 to 3.8 per 1,000 (exhibit 2) (overall, 1.7 per 1,000 during 2008–15), and the proportions were highest among younger, male, non-Hispanic white, and rural or super rural patients (exhibit 1). The use of telestroke services increased most rapidly among rural residents, from 0.6 to 8.6 per 1,000 ischemic stroke cases, while increasing from 1.0 to 6.1 among super rural residents and from 0.3 to 2.3 among urban residents (exhibit 2). Among both urban and super rural patients, more male patients received telestroke care than female patients during 2008–15 (1.3 versus 1.1 per 1,000 and 3.4 versus 2.8 per 1,000, respectively) (exhibit 1). Patients dually eligible for Medicare and Medicaid had a lower proportion of telestroke care use than Medicare-only patients residing in rural (2.5 versus 2.9 per

EXHIBIT 1

Characteristics of fee-for-service Medicare patients with acute ischemic stroke who received telestroke care, per 1,000 patients, by rurality of residence, January 2008–September 2015

Characteristic	All	Urban	Rural	Super rural
Total	1.7	1.2	2.8	3.1
AGE (YEARS)				
65–74	1.9	1.3	3.4	3.9
75–84	1.7	1.3	2.7	2.8
85 and older	1.3	1.0	2.3	2.4
SEX				
Male	1.7	1.3	2.8	3.4
Female	1.6	1.1	2.9	2.8
RACE/ETHNICITY				
Non-Hispanic white	1.7	1.3	2.7	3.2
Other[a]	1.3	0.8	4.3	2.2
HEALTH INSURANCE				
Medicare only	1.7	1.2	2.9	3.2
Medicare and Medicaid	1.6	1.2	2.5	2.4
SEASON OF ADMISSION				
Spring	1.7	1.2	3.0	3.0
Summer	1.8	1.3	3.0	3.6
Fall	1.7	1.2	2.7	3.3
Winter	1.5	1.1	2.6	2.4
CHARLSON COMORBIDITY INDEX				
0	1.4	0.9	2.3	3.1
1–2	1.8	1.3	3.1	3.3
3–4	1.8	1.4	2.9	2.9
5 or more	1.5	1.1	2.8	2.8

SOURCE Authors' analysis of fee-for-service Medicare claims data for the period January 1, 2008–September 30, 2015. **NOTES** There were 1,002,045 patients (1,663 received telestroke care), of whom 730,865 (879 with telestroke care) lived in urban areas, 201,803 (572) lived in rural areas, and 69,377 (212) lived in super rural areas. An urban area is a Metropolitan Statistical Area. ZIP code areas outside of urban areas were ranked by population density. The bottom quartile of these ZIP code areas was defined as super rural, and the top three quartiles were defined as rural. [a]Because some racial/ethnic groups contained observations fewer than the report limit of the Centers for Medicare and Medicaid Services ($n \geq 11$), Hispanic, non-Hispanic black, and non-Hispanic other patients were combined into a single group.

1,000) and super rural counties (2.4 versus 3.2 per 1,000), but its use was similar among both groups of patients living in urban counties (1.2 per 1,000). Patients overall had a higher telestroke use rate during the summer than in the winter (1.8 versus 1.5 per 1,000).

The five states with the highest proportion of rural patients who used telestroke services were Arizona (47.8 per 1,000), South Carolina (36.7), Louisiana (13.9), Oregon (10.4), and Oklahoma (8.8). For super rural residents the states were California (15.5), Utah (13.1), Oregon (12.0), Arizona (10.9), and Louisiana (10.0), and for urban residents were South Carolina (18.1), Louisiana (12.0), Maine (6.7), Oregon (6.3), and California (2.3) (appendix exhibit A5).[15]

Compared with patients who received usual stroke care, patients who received telestroke services had a higher percentage of IV tPA use (16.6 percent versus 6.2 percent) and mechanical thrombectomy (3.7 percent versus 1.1 percent) (exhibit 3). Compared to patients who received usual care, IV tPA use was higher among patients who received telestroke services in urban areas (23.7 percent versus 7.0 percent) as well as rural (8.9 percent versus 4.0 percent) and super rural areas (8.0 percent versus 3.3 percent). Using the propensity score matched sample, we estimated that overall, receiving telestroke services increased IV tPA use by 10.1 percent (95% confidence interval: 8.3, 12.0) (exhibit 4). The increases were 15.9 percent (95% CI: 13.0, 18.8) among urban patients, 3.2 percent (95% CI: 0.8, 5.5) among rural patients, and 3.6 percent (95% CI: −0.4, 7.6) among super rural patients (exhibit 4).

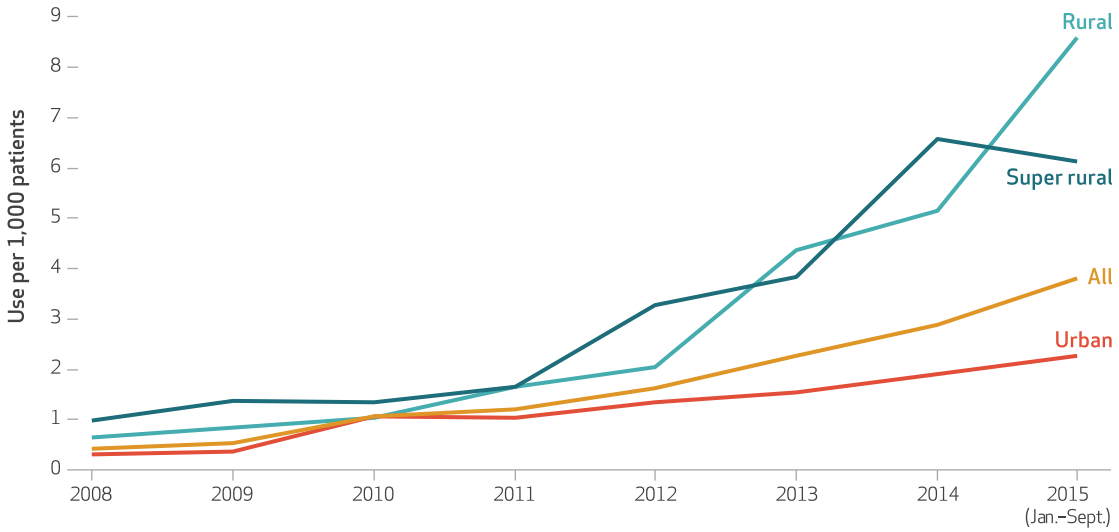
The average length-of-stay in hospitals was similar for patients with and those without telestroke care. Mean total medical expenditures were $10,735 for patients with usual care and $13,550 for those with telestroke care (exhibit 3). In the matched sample, we found that expenditures for telestroke care per inpatient were $3,003 higher (95% CI: 2,415, 3,590), compared to those who received usual care, and the cost increase was higher among super rural patients ($4,102; 95% CI: 2,839, 5,365) and rural patients ($3,844; 95% CI: 2,712, 4,976) than among urban patients ($2,245; 95% CI: 1,466, 3,024) (exhibit 4).

Overall, patients who received telestroke care had higher in-hospital mortality (6.3 percent versus 5.4 percent) and thirty-day all-cause mortality (14.7 percent versus 13.8 percent) than patients with usual care (exhibit 3). However, increased mortality was only significantly different between the two groups among urban patients: Matched-sample analyses showed an increase of 2.9 percent (95% CI: 1.2, 4.6) in in-hospital mortality and an increase of 3.9 percent (95% CI: 1.5, 6.4) in thirty-day all-cause mortality. Compared to usual care patients, patients with telestroke care had significantly lower thirty-day all-cause mortality in super rural counties, with a decrease of 4.5 percent (95% CI: −8.0, −1.0). No difference was identified between the two groups among rural patients (exhibit 4).

Adjusted analyses in the unmatched data revealed similar results (appendix exhibit A6).[15] Unadjusted assessment of trends in the proportion of patients receiving the clinical services of interest and having the specified health outcomes during 2008–15 revealed significant increases ($p < 0.05$) in IV tPA use among patients receiving usual stroke care, increases in mechanical thrombectomy among patients receiving telestroke or usual care, decreases in in-hospital

EXHIBIT 2

Use of telestroke care per 1,000 fee-for-service Medicare patients with acute ischemic stroke, by rurality of residence, January 2008–September 2015



SOURCE Authors' analysis of fee-for-service Medicare claims data for the period January 1, 2008–September 30, 2015. **NOTE** Urban, rural, and super rural areas are explained in the notes to exhibit 1.

mortality among patients receiving usual care, and decreases in thirty-day all-cause mortality among patients receiving telestroke or usual care (appendix exhibit A7).[15]

Discussion

Only about 55 percent of Americans have access to primary stroke centers within a sixty-minute drive time, and only half of all hospitals with fewer than 100 beds have a neurologist on staff.[21] This lack of access to timely and appropriate care supported the launch of the telestroke program

EXHIBIT 3

Type of care, clinical outcomes, and medical expenditures among fee-for-service Medicare patients with acute ischemic stroke, by rurality of residence, January 2008–September 2015

	All		Urban		Rural		Super rural	
Clinical outcomes and medical expenditures	**Usual care (*N* = 1,000,382)**	**Telestroke care (*N* = 1,663)**	**Usual care (*n* = 729,986)**	**Telestroke care (*n* = 879)**	**Usual care (*n* = 201,231)**	**Telestroke care (*n* = 572)**	**Usual care (*n* = 69,165)**	**Telestroke care (*n* = 212)**
IV tPA use	6.2%	16.6%	7.0%	23.7%	4.0%	8.9%	3.3%	8.0%
Mechanical thrombectomy	1.1%	3.7%	1.2%	3.4%	0.8%	3.8%	0.6%	4.7%
Mean length-of-stay (days)	6.1	6.0	6.2	6.0	5.7	6.2	5.5	5.2
Mean total medical expenditures per event	$10,735	$13,550	$11,090	$13,089	$9,721	$13,868	$10,020	$14,596
In-hospital mortality	5.4%	6.3%	5.1%	6.9%	6.0%	5.2%	6.4%	6.1%
30-day all-cause mortality	13.8%	14.7%	13.4%	15.8%	14.8%	14.5%	16.0%	10.8%

SOURCE Authors' analysis of fee-for-service Medicare claims data for the period January 1, 2008–September 30, 2015. **NOTES** Results are unadjusted. Urban, rural, and super rural areas are explained in the notes to exhibit 1. Expenditures are in 2015 dollars. IV tPA is intravenous tissue plasminogen activator.

EXHIBIT 4

Estimated differences in clinical outcomes and medical expenditures between fee-for-service Medicare patients with acute ischemic stroke who received telestroke care and those who received usual care, by rurality of residence, January 2008–September 2015

Clinical outcomes and medical expenditures	All	Urban	Rural	Super rural
IV tPA use	10.1%****	15.9%****	3.2%***	3.6%
Mechanical thrombectomy	2.6%****	2.0%****	2.7%***	4.0%***
Mean length-of-stay (days)	0.2	0.1	0.6**	−0.3
Mean total medical expenditures per event	$3,003****	$2,245****	$3,844****	$4,102****
In-hospital mortality	1.3%**	2.9%***	−0.6%	0.4%
30-day all-cause mortality	1.5%	3.9%***	0.0%	−4.5%**

SOURCE Authors' analysis of fee-for-service Medicare claims data for the period January 1, 2008–September 30, 2015. **NOTES** Urban, rural, and super rural areas are explained in the notes to exhibit 1. The differences were calculated using the following covariates: age, sex, race/ethnicity, Medicaid eligibility, season of admission, Charlson Comorbidity Index, and admission year. Expenditures are in 2015 dollars. IV tPA is intravenous tissue plasminogen activator. An expanded version of this exhibit, including 95% confidence intervals and results from the unmatched sample, is in appendix exhibit A6 (see note 15 in text). **$p < 0.05$ ***$p < 0.01$ ****$p < 0.001$

and the subsequent creation of telestroke networks throughout the country.[13,22] Our findings demonstrate that efforts to improve the infrastructure for remote stroke management supported the increased use of telestroke services among patients with incident ischemic stroke during 2008–15, especially in certain US states and, as intended, among patients residing in rural and super rural counties. In addition, despite Medicare policies that authorize reimbursement for telestroke care only when it is received in designated rural Health Professional Shortage Areas or in counties not included in Metropolitan Statistical Areas,[23] we found that telestroke use also increased during this period among Medicare beneficiaries residing in urban areas.

Furthermore, our findings suggest that telestroke use is associated with increased use of mechanical thrombectomy and IV tPA—two important indicators for reducing mortality and disability resulting from acute ischemic stroke.[24,25] Provision of telestroke services was associated with an overall 2.6 percent increase in mechanical thrombectomy among acute stroke patients, compared with those receiving usual stroke care (exhibit 4). However, its use increased during the period among both telestroke and usual care patients, and based on recent additional evidence demonstrating its effectiveness,[25] its use will likely continue to increase among both groups.

In addition, while other studies have reported that only 3.4–5.2 percent of patients with an ischemic stroke received tPA therapy,[26] our study found that tPA was provided to 6.2 percent (one in sixteen patients) of those who received usual care and 16.6 percent (one in six patients) of those who received telestroke care (exhibit 3). This finding was consistent with results of studies conducted at the regional level. For example, a recent analysis of telestroke care at the Medical University of South Carolina reported that among 7,694 patients who had a telestroke consultation, 49.2 percent were diagnosed with acute ischemic stroke, of whom 1,324 (34.8 percent) received IV tPA and 56 (1.5 percent) received mechanical thrombectomy.[27] Another study conducted at Thomas Jefferson University Hospital found that among 1,643 patients who had a telestroke consultation, 97 percent of those deemed eligible for IV tPA use received the intervention—for an overall use rate of 14 percent among those receiving telestroke services.[28]

However, despite the improvements in tPA use associated with expanded telestroke care—our study demonstrates that telestroke use is associated with a 10.1 percent increase in tPA use—geographic disparities in tPA use persist.[29] Our results show that even with increased telestroke network coverage, rural patients remained less likely than urban patients to receive tPA. This could be attributed to the lower capacity of rural hospitals to treat stroke patients, in part because of shortages of neurological experts and underdeveloped systems of care to manage stroke.[13] For example, a previous study found that one-fourth of rural hospitals in the Pacific Northwest region lacked tPA stroke protocols.[30] In addition, the volume of stroke patients seen in rural emergency departments is far smaller than that in larger, urban hospitals. As a result, even with the availability of telestroke services, there may be challenges to recognizing and efficiently responding to the rare stroke patients who present in need of emergent care in rural areas. Furthermore, studies have documented transportation as a barrier to timely stroke care access

in rural areas, and patients who present later to a rural hospital might not be eligible for tPA use.[21]

Although telestroke use was associated with increased use of thrombolytic therapy, provision of telestroke services was not associated with a reduction in patients' average hospital length-of-stay or medical expenditures, and findings related to improvement in in-hospital and thirty-day all-cause mortality were mixed. The average medical expenditures per inpatient for telestroke care were $3,003 more than those for usual care. It is likely that telestroke services increased the necessary use of tPA and mechanical thrombectomy, which in turn increased medical expenditures related to the procedures used and additional monitoring required. Previous research estimated that the average inpatient costs for a patient who received IV tPA were $31,369, compared to $19,563 without use of tPA.[31] A recent study that assessed a direct-to-consumer telehealth program also found that telehealth did not reduce spending.[32] From a cost-effectiveness perspective, however, telestroke care did not substantially increase medical expenditures among patients residing in super rural counties to achieve desirable health outcomes, as a $4,102 increase in spending per hospitalization that used telestroke care could reduce thirty-day all-cause mortality by 4.5 percent. This finding suggests that continued expansion of telestroke coverage may reduce thirty-day all-cause mortality, at least among super rural patients, and potentially mitigate rural-urban disparities in stroke outcomes.

One unexpected finding was that use of telestroke care was associated with increased thirty-day all-cause mortality among patients with incident ischemic stroke who lived in urban areas. This finding warrants additional study, as it may be due to factors we were unable to adequately control for in our analyses such as stroke severity, rather than a result of the care provided. Patients who live in urban areas tend to have greater access to high-level stroke care, compared to those living in rural and super rural areas.[6] In small and rural hospitals, telestroke consults are initiated across the spectrum of stroke severity for the purpose of initiating transfer to the telestroke hub. Conversely, in more urban spoke hospitals, it is likely that mild strokes are admitted locally without a telestroke consultation and telestroke services are provided only to patients with significant deficits and to candidates for thrombolysis or thrombectomy. Because we were able to control only for patients' comorbidities and not their stroke severity using Medicare claims data, it is possible that patients who had urban residences and received telestroke consultation also tended to have more severe strokes that increased in-hospital and thirty-day mortality.

Population Health Implications

While telestroke use has increased, it appears that there are likely additional opportunities for even greater use. This study suggests that by improving access to these services, the provision of important thrombolytic therapy can be increased and, at least among patients residing in super rural counties, health outcomes—including thirty-day all-cause mortality—can be improved. Continued barriers to and successful strategies for implementing telestroke services need to be assessed as telestroke use increases, to overcome the variation across states and help address disparities in stroke-related care and health outcomes.[33] Furthermore, additional studies need to be conducted to inform how best to structure telestroke networks to support improved outcomes for patients, appropriately reimburse both the spoke and hub hospitals for the services they provide, and ensure that appropriate postacute care is provided to patients to maximize their recovery regardless of the location of their residence.

Conclusion

This study demonstrates that in the period 2008–15, use of telestroke services increased among fee-for-service Medicare patients who had an incident ischemic stroke. The greatest increase in its use occurred among patients residing in rural and super rural regions. In addition, we found that use of telestroke services was associated with increased use of thrombolytic therapy, an evidence-based intervention for which use has been suboptimal. With the rising prevalence of cardiovascular disease in the United States, the numbers of ischemic stroke cases are anticipated to steadily increase. While efforts to expand telestroke services have resulted in increased utilization, additional support could further extend telestroke use in rural America. The continued use and optimization of telestroke services could help address persistent disparities in stroke-related outcomes in the United States. ■

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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