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RESEARCH LETTER

# Improving Population Access to Stroke Expertise Via Telestroke: Hospitals to Target and the Potential Clinical Benefit

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Reperfusion with thrombolysis or endovascular thrombectomy leads to improved outcomes in patients with ischemic stroke (IS).[1] For patients presenting to hospitals without onsite stroke expertise, telestroke is associated with increased reperfusion and decreased mortality.[2] The largest benefits are observed in hospitals with lower stroke volumes,[2] however, they are least likely to have telestroke.[3]

We outline a strategy to identify US hospitals without acute stroke expertise where telestroke implementation might improve stroke care, and estimate improvements in both number of patients receiving reperfusion treatment (thrombolysis or thrombectomy) and lives saved.

We identified from all short-term acute-care and critical access hospitals with at least one acute IS hospitalization in Medicare fee-for-service data in 2018. We then excluded hospitals with, or located within 20 miles of another hospital with, telestroke, stroke center status, major academic teaching status, or thrombectomy capability. We characterized hospitals by rurality, critical access status, ownership, region, and bed count using 2019 Medicare Provider of Service data.

Among candidate hospitals, we measured IS volume from the Medicare fee-for-service program in 2018. We used previously derived risk ratios[2] to quantify an estimated marginal benefit of telestroke introduction. For each hospital, we estimated the hypothetical number of *additional* patients receiving reperfusion treatment and *additional* lives saved with telestroke introduction by multiplying its annual stroke volume with the appropriate risk ratio.

Hospitals were sorted in descending order by the estimated number of additional reperfused patients per year with telestroke introduction. We then categorized hospitals into quartiles based on marginal benefit to reperfusion. We used Chi-squared, Kruskal-Wallis, and one-way ANOVA tests to compare hospital characteristics across quartiles. The study was approved by the Harvard Medical School Institutional Review Board. Because of the sensitive nature of the data, requests for data access from qualified researchers trained in human subjects confidentiality protocols may be sent to the corresponding author.

Among 4657 US hospitals providing stroke care in 2018, 1057 (22.7%) had limited stroke capabilities themselves and within a 20-mile radius. Of these 1057, most were rural (83.1%), critical access hospitals (64.6%), had a low bed count (median 25, interquartile range [IQR] 25–50), and low annual stroke volume (median 6 patients, IQR 3–13). Together these hospitals provided initial care for 7.4% of Medicare fee-for-service patients with IS.

Among hospitals in the highest quartile, the average expected marginal benefit to reperfusion and

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**Table. Hospital Characteristics by Quartile of Marginal Benefit to Reperfusion***

| | 1st quartile (n = 263) | 2nd quartile (n = 262) | 3rd & 4th quartiles (n = 532) | *P* value |
|---|---|---|---|---|
| Rural location, n (%) | 221 (84.0) | 219 (83.6) | 438 (82.3) | 0.81† |
| Critical access hospital, n (%) | 78 (29.7) | 169 (64.5) | 436 (82.0) | <0.001† |
| Government ownership, n (%) | 85 (32.3) | 100 (38.2) | 270 (50.8) | <0.001† |
| Region, n (%) | | | | 0.001† |
| Northeast | 30 (11.4) | 20 (7.6) | 12 (2.3) | |
| Midwest | 88 (33.5) | 109 (41.6) | 250 (47.0) | |
| South | 114 (43.3) | 89 (34.0) | 187 (35.2) | |
| West | 31 (11.8) | 44 (16.8) | 83 (15.6) | |
| Bed count, median (IQR) | 65 (25–119) | 25 (25–58) | 25 (20–25) | <0.001‡ |
| Annual stroke volume, median (IQR) | 20 (16–28) | 9 (8–11) | 3 (2–5) | <0.001‡ |
| Marginal benefit to reperfusion, averaged across hospitals | 0.34 | 0.16 | 0.06 | <0.001§ |
| Marginal benefit to 30-d mortality, averaged across hospitals | 0.21 | 0.08 | 0.03 | <0.001§ |

*Marginal benefits to reperfusion and 30-day mortality defined by estimated numbers of additional patients reperfused and additional lives saved, respectfully, per hospital per year with telestroke introduction. IQR indicates interquartile range.

†*P* value based on Chi-squared test.

‡*P* value based on Kruskal-Wallis test.

§*P* value based on one-way ANOVA test.

mortality with telestroke introduction were 0.34 and 0.21 patients in Medicare fee-for-service per year respectively (Table). Thus, for a given hospital in this quartile it would take 2.9 years on average for an additional reperfusion (1/0.34) and 4.8 years on average to save an additional life (1/0.21) after telestroke inititation.

We estimate that introducing telestroke to all 1057 hospitals would lead to an additional 164 reperfused patients and 90 lives saved annually across the US. The quartile of hospitals with the highest marginal benefit account for just over half the total benefit (90 [54.9%] additional reperfusions and 55 [55.5%] additional lives). These hospitals were more likely to be higher in bed count, not government-owned, and located in the Northeast or South (Table).

Roughly a quarter of US hospitals treating patients with stroke may lack readily available stroke expertise. Most are small, in rural communities, and care for relatively few stroke cases—typically fewer than 20 per year and only ≈7% of stroke cases nationally.

The total marginal benefits achieved by introducing telestroke to all 1057 candidate hospitals was relatively low, highlighting common challenges in rural health care.[4] Despite important benefits to the patients impacted, and the existence of technology to mitigate rural-urban inequities in stroke care, the introduction of an intervention ultimately benefits a relatively small number. From a societal perspective, addressing inequities in access for populations at smaller, lower-volume hospitals may require increased resources to these sites despite lower financial return on investment. Prior research has highlighted that telemedicine adoption at small rural hospitals is lower than at larger urban hospitals.[5] Payers and policymakers may need new policies to incentivize engagement of smaller hospitals, and our outlined strategy helps to identify the hospitals that most benefit.

This study has limitations. First, solutions in stroke systems of care will vary by regional characteristics. Second, we used a simple convenience threshold of a 20-mile-radius to identify hospitals remote from sites with stroke expertise. Also, the risk ratios were drawn from previous work[2]; alternative approaches to quantifying benefit could lead to different results. Finally, our models were based on Medicare fee-for-service patients and do not include the roughly 1/3 of stroke patients under age 65, or patients with Medicare Advantage, thus our estimates of benefit may be an underestimate.

We characterize roughly 1000 US hospitals that would benefit most from new telestroke capacity and estimate the number of patients more likely to receive reperfusion and lives saved. Further consideration of strategies to help these hospitals adopt telestroke care is merited.

## ARTICLE INFORMATION

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