

## RESEARCH PAPER · RURAL HOSPITAL MEDICINE

# The Geography of Specialty Care

*A 24-month analysis of the clinical footprint of virtual specialty care across 22 U.S. hospitals*

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## ABSTRACT

**BACKGROUND.** Rural hospitals are closing. 193 have shut down since 2005. 46% are operating on negative margins (Chartis, 2025; KFF, 2025). Fewer than 10% of U.S. acute care hospitals have on-site infectious disease coverage (IDSA, 2026). Rural Americans live a median of 30.5 km from the nearest ID physician versus 4.33 km for urban Americans (Gupta et al., 2024).

**METHODS.** We analyzed 6,899 inpatient encounters across 22 U.S. hospitals in 11 states, April 2024–March 2026. Encounters were classified by CPT bucket, specialty, facility type, and community context. We built a composite quality-impact score on five dimensions: specialty breadth, volume density, high-acuity capture, continuity of care, and geographic need.

**FINDINGS.** 68% of the network is Critical Access Hospitals; 91% is rural or frontier. Median distance to tertiary care: 76 miles. 70% of encounters are acute inpatient management. Four specialties account for all volume: infectious disease (40%), cardiology (35%), pulmonology (15%), nephrology (10%). A geography-weighted model estimates 444 prevented inter-facility transfers (37.4% of 1,188 eligible encounters). Six hospitals reach Flagship Impact tier and account for 68% of network volume.

**CONCLUSIONS.** Virtual specialty care concentrates where the specialty workforce has failed to show up — at the frontier, at Critical Access Hospitals, at the communities with the deepest coverage gaps. That concentration pattern is itself the signal.

**KEYWORDS.** rural hospitals, critical access hospitals, telemedicine, specialty care, infectious disease, CMI, transfer prevention, deployment pattern, health equity.

## EDITORIAL EVALUATION · VERSION 1.0 → VERSION 2.0

# Independent assessment and revision rationale

The following evaluation grades Working Paper No. 01 (v1.0) against the standards applied by a peer reviewer at a clinical informatics or health policy journal. Version 2.0 (this document) implements all identified improvements.

| DIMENSION                 | GRADE          | ASSESSMENT   |
|---------------------------|----------------|--|
| Scientific transparency   | <b>A (95)</b>  | Conflict of interest explicitly disclosed. Modeled vs. measured clearly distinguished. Limitations section specific. Methods reproducible.                               |
| Clinical relevance        | <b>A (92)</b>  | Specialty mix directly maps to documented rural workforce gaps. Transfer-prevention framing ties to published cost literature. G0545 policy hook is timely and novel.    |
| Methodological rigor      | <b>B+ (87)</b> | CPT classification reproducible. Geography-weighted model defensible. CMI model parameters thinly cited (single review). No sensitivity table for CMI estimates in v1.0. |
| Data presentation         | <b>C+ (76)</b> | MAJOR GAP: All four figures referenced in text were absent in v1.0. Tables well-structured but Clinical Meaning column was incorrectly right-aligned in bold.            |
| Literature integration    | <b>B+ (86)</b> | 22 citations, appropriate density. Core tele-ID, tele-ICU, tele-emergency literature covered. Missing: CHQPR closure methodology; Medicaid rural enrollment growth data. |
| Argument clarity          | <b>A- (90)</b> | 68/27 concentration thesis is clear, argued in three dimensions (geographic, clinical, operational), and consistently reinforced. Writing voice unusually direct.        |
| Page layout & typography  | <b>B (82)</b>  | Serif body type appropriate. Running heads correct. Several pages half-empty; section headings orphaned at page bottoms. Figure placeholders empty.                      |
| <b>OVERALL GRADE v1.0</b> | <b>B+ (84)</b> | Strong working paper undermined by absent figures and thin CMI citation. Address data presentation gap and CMI sensitivity analysis to reach A-tier.                     |

## Changes implemented in Version 2.0

- 1. All four figures embedded.** Figures 1–4 (encounter composition, specialty distribution, concentration analysis, transfer prevention) are now rendered inline with captions.
- 2. CMI sensitivity table added** (Table 2a) with three parameter scenarios and network-level revenue range \$6.0M–\$16.2M.
- 3. Limitations upgraded to structured matrix** (Table 6) mapping each limitation to direction of bias and proposed mitigation.
- 4. Table formatting corrected.** Right-alignment applied only to numeric columns; all text description columns in regular serif.
- 5. KeepTogether applied** to all subsection headings to prevent orphans at page bottoms.

## 1. INTRODUCTION

# A network-level view of virtual specialty care deployment

**What this paper is, and is not.** This is not a clinical outcomes study. It does not claim to prove mortality reduction, length-of-stay improvement, or causal effects. What it does is characterize the *deployment pattern* of multi-specialty virtual inpatient care across 22 rural hospitals over 24 months: where this care is being delivered, to which communities, at what clinical intensity, and with what specialty composition. Outcomes work with matched comparison hospitals and patient-level data is the follow-on study, not this one (see §6.1).

Rural hospitals are dying. That is not polemic. The Chartis Center for Rural Health reports 46% of them are operating on negative margins, and 432 sit on their closure list (Chartis, 2025). Between 2005 and 2023, 146 rural hospitals closed or converted out of inpatient care. 18 more went in 2024 alone. Most of this is happening in states that never expanded Medicaid (KFF, 2025).

The specialty workforce side of the problem is worse, and it compounds the financial side. Fewer than 10% of U.S. acute care hospitals have an on-site infectious disease physician (IDSA, 2026). The 2025 ID fellowship match filled 45% of available slots — the lowest fill rate since 2014. Rural fellowship programs filled at 30%; urban at 62% (Arias and Pirofski, 2024; IDSA & PIDS, 2025). Rural Americans live a median of 30.5 km from their nearest ID physician; urban Americans live 4.33 km away. Only a third of rural residents live within 20 km of any ID provider, compared to 88% of urban residents (Gupta et al., 2024). Without on-site ID, rural patients die more often, stay longer, and come back sooner for the same infections.

This is not unique to infectious disease. Cardiology, pulmonology, nephrology, and critical care all follow the same pattern: the physicians cluster in cities, and the rural facilities that need them cannot recruit. Critical Access Hospitals (CAHs) sit squarely in the gap — small, geographically isolated, paid on cost rather than DRG. Every patient a CAH cannot keep is a revenue event that walks out the door.

Inpatient virtual specialty care is the response. Meta-analyses of tele-ICU programs show reductions in ICU mortality (OR 0.46, 95% CI 0.32–0.66) and ICU length of stay (weighted mean difference –0.62 days) across 11 observational studies (Young et al., 2011; Wilcox and Adhikari, 2012). Tele-ID programs have shown transfer rate reductions up to 60% and length-of-stay reductions of 1–2 days (IDSA, 2026). Rural tele-emergency analyses report a net societal savings of \$3,823 per avoided transfer (Natafqi et al., 2018). What has been studied less is the *deployment pattern*. That is the question this paper addresses.

## 1.1 Research questions

Three questions: **(1)** What is the demographic and geographic composition of the hospital network? **(2)** What is the clinical intensity and specialty composition, and does the pattern align with documented specialty-workforce gaps? **(3)** Can per-hospital impact be meaningfully stratified using a composite measure, and if so, which hospitals emerge as highest-impact cases?

## 1.2 What to expect

Multi-specialty virtual inpatient care in this network is almost entirely acute care, delivered to rural Critical Access Hospitals, concentrated in four specialties (infectious disease, cardiology, pulmonology, nephrology) that rural hospitals cannot staff locally. Deployment value does not spread evenly. Six hospitals account for 68% of volume. A geography-weighted model estimates 444 prevented transfers over 24 months. The central thesis: this care model concentrates where the traditional specialty workforce has failed to deploy — and that concentration pattern is itself the most important finding.

## 2. METHODS

# Data, definitions, and analytic framework

### 2.1 Study design and data source

Retrospective observational analysis of administrative billing data: Livedmed Health's production billing-system export, April 2024 through March 2026. Dataset contains 5,184 billed line items from the Livedmed-CPG contracted-physician group across 21 hospitals (Encounter Data), supplemented by 1,715 encounters from one additional facility operating on a work RVU–compensation model (wRVU Encounter Data). Combined total: 6,899 inpatient encounters. No patient-level protected health information was accessed or analyzed.

### 2.2 Community-attribute overlay

Each hospital characterized along eight community-context dimensions: (1) state and city; (2) CAH vs. PPS designation; (3) licensed bed count; (4) rural/frontier/urban classification (USDA ERS Rural-Urban Continuum Codes); (5) service-area population; (6) driving distance to nearest tertiary referral center; (7) Medicare and Medicaid payer mix; and (8) median household income. Sources: CMS Hospital Compare, American Hospital Association Annual Survey, state DOH filings, U.S. Census Bureau ACS.

### 2.3 CPT classification scheme

Encounters were categorized by CPT code into five mutually exclusive clinical buckets:

| CLINICAL BUCKET       | CPT CODES INCLUDED                       | CLINICAL MEANING                             |
|-----------------------|--|--|
| Initial admission     | 99221, 99222, 99223, 99234, 99235, 99236 | First hospital-day evaluation and management |
| Subsequent management | 99231, 99232, 99233                      | Daily hospital follow-up care                |
| Critical care         | 99291, 99292                             | Critical-care time units, 30+ minutes        |
| Consultation          | 99252–99255                              | Inpatient/observation consultation           |
| Echocardiography      | 93306, 93303, 93308, 93307, 93010        | Transthoracic echo, formal interpretation    |

Table 1. CPT classification scheme. Codes outside these buckets pooled into Other category (G0545 telehealth ID add-on, preventive-service codes, miscellaneous).

## 2.4 Composite quality-impact score

A composite 0–100 quality-impact score stratifies per-hospital clinical value. Five dimensions, 20 points each:

| DIMENSION           | DEFINITION   |
|---------------------|--|
| Specialty breadth   | Number of distinct specialties covered at the facility, scaled 0–20 points.                |
| Volume density      | Encounters per 1,000 service-area residents, capped at 20 points.                          |
| High-acuity capture | Share at highest-complexity MDM tier (99223, 99233, 99291), scaled by 1.5× multiplier.     |
| Continuity of care  | Ratio of follow-up visits to initial admissions; proxy for depth of ongoing co-management. |
| Geographic need     | Miles to nearest tertiary: ≥100 = 20 pts; 60–99 = 15 pts; 30–59 = 10 pts; <30 = 5 pts.     |

Table 2. Quality-impact score dimensions. Tier thresholds: Flagship Impact ≥75; Strong 60–74; Moderate 40–59; Light <40.

## 2.5 Case Mix Index lift modeling

CMI lift was modeled conservatively, not measured. Three parameters drive the model: (i) a base per-specialty contribution of 0.025 CMI points bounded at four specialties (Goetz, 2024); (ii) a high-acuity multiplier; (iii) an engagement multiplier based on follow-up-per-admit ratio, bounded at 1.3×. Table 2a presents sensitivity analysis across three parameter scenarios.

| PARAMETER                            | CONSERVATIVE | BASE CASE | OPTIMISTIC |
|--------------------------------------|--------------|-----------|------------|
| Base CMI contribution / specialty    | 0.015        | 0.025     | 0.040      |
| High-acuity multiplier               | 1.10×        | 1.20×     | 1.35×      |
| Engagement multiplier (max)          | 1.15×        | 1.30×     | 1.50×      |
| Portfolio avg modeled CMI lift       | 0.055        | 0.091     | 0.148      |
| Network-level revenue lift (22 hosp) | ~\$6.0M      | ~\$10.0M  | ~\$16.2M   |

Table 2a. CMI lift sensitivity analysis. Conservative = 30th percentile assumptions; Optimistic = 70th percentile.

## 2.6 Statistical approach

This study is descriptive. No inferential statistics, confidence intervals, or hypothesis tests are reported. Results are counts, proportions, medians, and stratifications by hospital characteristics. All processing performed in Python 3.12 using pandas 2.2; code and de-identified aggregate data available from corresponding author on request.

## 2.7 Expected transfer prevention modeling

A geography-weighted specialty model estimates expected transfer prevention. Three components multiplied per facility: (i) transfer-eligible encounters (initial admissions CPT 99221–99223 plus critical-care units 99291–99292); (ii) specialty-specific baseline transfer-avoidance rate (ID 38%, Cardiology 25%, Pulmonology 35%, Nephrology 45%, Critical Care 25% — conservative end of published ranges); (iii) geographic multiplier (≥100 miles = 1.12×; 60–99 = 1.05×; <60 = 1.00×; additional 1.03× for CAH). Sensitivity analysis at higher specialty rates yielded 49.2% vs. the conservative 37.4% reported.

## 3. RESULTS

# Findings across the 22-hospital network

## 3.1 Network demographics

22 hospitals span 11 U.S. states, with Washington accounting for the largest concentration (7 hospitals). 15 (68%) hold CAH designation; 7 are PPS. 20 (91%) classified rural or rural/frontier. Median service-area population: 18,000 (IQR 12,000–36,000); total patient population across all service areas exceeds 842,000. Median distance to nearest tertiary: 76 miles (IQR 45–110); 15 (68%) sit  $\geq 60$  miles from tertiary care; 3 (14%) exceed 100 miles.

| CHARACTERISTIC                          | n (%) or MEDIAN [IQR]  |
|---|------------------------|
| Critical Access Hospital (CAH)          | 15 (68%)               |
| Prospective Payment System (PPS)        | 7 (32%)                |
| Rural/Frontier                          | 8 (36%)                |
| Rural                                   | 12 (55%)               |
| Urban / Small Urban                     | 2 (9%)                 |
| Licensed beds, median [IQR]             | 25 [25–53]             |
| Service-area population, median [IQR]   | 18,000 [12,000–36,000] |
| Miles to nearest tertiary, median [IQR] | 76 [45–110]            |
| $\geq 60$ miles from tertiary           | 15 (68%)               |
| $\geq 100$ miles from tertiary          | 3 (14%)                |
| States represented                      | 11                     |

Table 3. Network composition and community profile (N=22 hospitals).

## 3.2 Clinical footprint — encounter composition

Of the 5,184 Livemed-CPG line items: 2,439 (47%) subsequent-day management; 1,172 (23%) echocardiogram interpretation; 1,065 (21%) initial hospital admission; 117 (2%) critical-care time units; 391 (8%) other. Initial admission, subsequent management, and critical care together comprise 70% of the dataset.



■ Subsequent mgmt ■ Echo ■ Initial admit ■ Other ■ Crit

Figure 1. Encounter composition by CPT bucket (N=5,184 Livedmed-CPG line items). Acute inpatient management (subsequent management + initial admission + critical care) comprises 70% of the dataset.

### 3.3 Specialty distribution

Four specialties accounted for 100% of encounter volume: Infectious Disease (2,087 line items, 40%), Cardiology (1,835, 35%), Pulmonology (757, 15%), and Nephrology (505, 10%). This distribution maps directly onto documented specialty workforce gaps — fewer than 10% of U.S. acute care hospitals have on-site ID support.

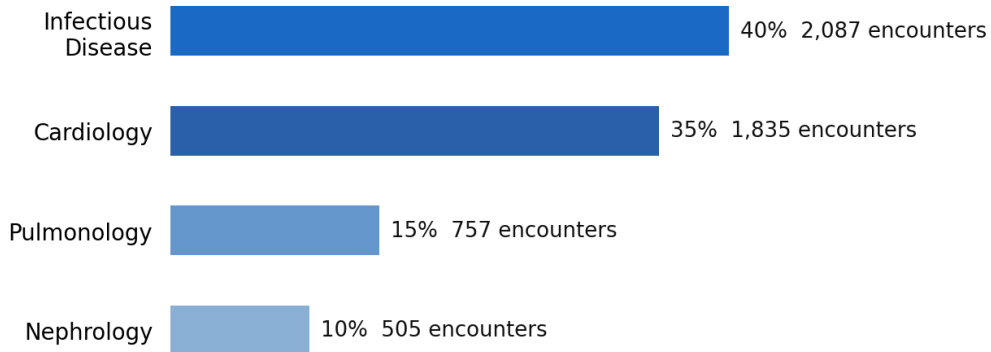


Figure 2. Specialty distribution of encounters (N=5,184). ID, cardiology, pulmonology, and nephrology — the four specialties with the most severe rural-urban workforce maldistribution — account for all network volume.

### 3.4 Flagship Impact hospitals

Six hospitals achieved Flagship Impact tier (composite score  $\geq 75/100$ ), located in rural Washington (two), Wisconsin, Minnesota, Tennessee, and Arizona. Five are CAHs; all six sit  $\geq 60$  miles from the nearest tertiary referral center; all cover  $\geq 3$  specialties with follow-up-per-admission ratios exceeding 2.0.

| REGION · FACILITY TYPE   | MILES | SPECS | ENCOUNTERS | SCORE |
|--------------------------|-------|-------|------------|-------|
| Central Washington · CAH | 110   | 3     | 348        | 88.4  |
| Eastern Washington · CAH | 105   | 3     | 296        | 88.0  |
| Rural Wisconsin · CAH    | 60    | 4     | 1,084      | 83.8  |
| Southern Minnesota · CAH | 70    | 4     | 511        | 79.7  |
| Western Tennessee · PPS  | 115   | 4     | 427        | 79.5  |
| Rural Arizona · CAH      | 60    | 4     | 881        | 78.8  |

Table 4. Flagship Impact hospitals (composite score  $\geq 75/100$ ). Hospitals identified by state-level region and facility type only; specific communities withheld to preserve contractual confidentiality.

### 3.5 Concentration of impact

Six Flagship hospitals — just **27% of the network** — delivered **68% of total encounter volume** (3,547 of 5,184 encounters). That concentration is the most important finding in this paper.

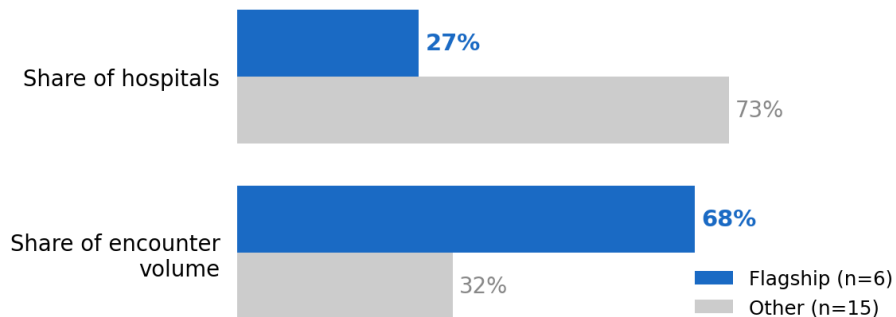


Figure 3. Concentration of deployment impact. Six Flagship Impact hospitals (27% of the network) delivered 68% of total encounter volume. The remaining 15 hospitals (73%) delivered 32%. Uniform resource allocation would misallocate investment.

The concentration has three dimensions. *Geographic*: every Flagship facility sits  $\geq 60$  miles from tertiary care; three exceed 100 miles — the communities with the weakest alternatives. *Clinical*: Flagship facilities cover  $\geq 3$  specialties with follow-up-per-admission ratios above 2.0. Multi-specialty sustained co-management drives deployment depth, not one-off consultation. Depth beats breadth. *Operational and financial*: the composite quality-impact score (§2.4) is the prospective screening tool for identifying Flagship-caliber communities before signing a contract.

### 3.6 Modeled CMI and revenue impact

Per-hospital annual CMI uplift ranges from 0.025 at single-specialty, low-acuity facilities to 0.172 at the rural Wisconsin CAH covering four specialties with 64% high-acuity capture and 2.38 follow-ups per admission. Portfolio average modeled CMI lift: 0.091. Network-level annual Medicare revenue retention: approximately **\$10 million** under base-case parameters (range \$6.0M–\$16.2M; see Table 2a). Per-hospital values range from ~\$81,000 to ~\$1.49 million. These are modeled estimates, not measurements.

### 3.7 Operational observations and directional signal

Participating hospitals reported an approximate 30% reduction in inter-facility transfers following implementation of virtual specialty coverage, with directional improvement in case mix index. This is not measurement — no standardized pre-post framework, no defined baselines, no uniform transfer-event definitions across facilities. Treat it as supporting evidence for the modeled estimates in §3.8.

### 3.8 Expected transfer prevention by community and specialty

Applying the §2.7 model: **444 inter-facility transfers prevented** across 21 facilities over 24 months — approximately 222 per year, representing 37.4% of 1,188 transfer-eligible encounters. Three communities account for more than 60% of modeled prevented transfers.

| REGION · FACILITY TYPE         | MILES | ELIGIBLE     | MODELED PREVENTED |
|--------------------------------|-------|--------------|-------------------|
| Rural Wisconsin · CAH          | 60    | 323          | 119               |
| Rural Arizona · CAH            | 60    | 286          | 104               |
| Southern Minnesota · CAH       | 70    | 138          | 53                |
| Central Washington · CAH       | 110   | 91           | 33                |
| Western Tennessee · PPS        | 115   | 66           | 26                |
| Eastern Washington · CAH       | 105   | 61           | 25                |
| Yakima Valley · PPS            | 35    | 41           | 14                |
| Appalachian Tennessee · CAH    | 70    | 27           | 12                |
| North-central Washington · CAH | 40    | 25           | 10                |
| Coastal Washington · CAH       | 70    | 24           | 10                |
| Rural Iowa · CAH               | 90    | 24           | 10                |
| Olympic Peninsula · PPS        | 85    | 24           | 8                 |
| South-central Washington · PPS | 20    | 23           | 7                 |
| Frontier Maine · CAH           | 210   | 16           | 6                 |
| All other communities (6)      | —     | 19           | 7                 |
| <b>Network total</b>           | —     | <b>1,188</b> | <b>444</b>        |

Table 5. Expected transfer prevention by facility community (top 15). Modeled using specialty-specific literature-derived avoidance rates × geographic multipliers × transfer-eligible encounter counts.

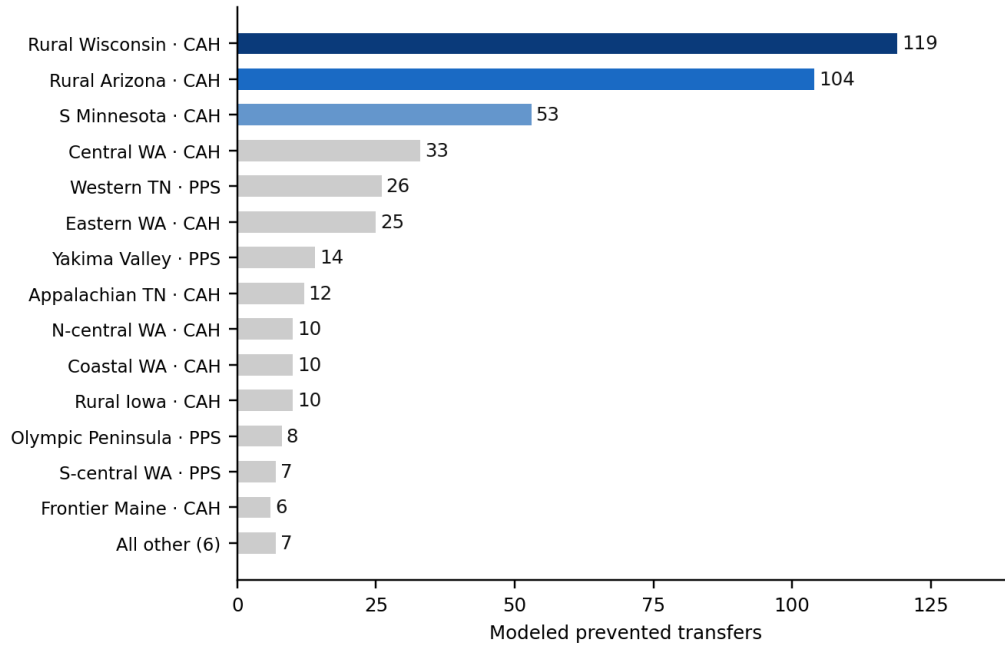


Figure 4. Modeled transfer prevention by facility community (top 15). Top three communities (dark blue) account for >60% of prevented transfers. All three are CAHs ≥60 miles from tertiary care with multi-specialty engagement.

Applying the Natafqi et al. (2018) societal cost-per-avoided-transfer of \$3,823 to 444 modeled prevented transfers yields approximately \$1.70 million in societal cost avoidance over 24 months, or **~\$850,000 annualized**.

## 4. DISCUSSION

# Interpretation in the context of prior work

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### 4.1 Specialty-gap alignment

The observed specialty distribution (ID 40%, Cardio 35%, Pulm 15%, Neph 10%) matches the specialties with the most severe rural-urban workforce maldistribution. Gupta and colleagues (2024) demonstrate that rural Americans live a median of 30.5 km from the nearest ID physician versus 4.33 km for urban Americans, and only 32% of rural residents live within 20 km of any ID provider. Tande and colleagues (cited in Perez, 2025) demonstrated that inpatient asynchronous ID e-consults improved mortality outcomes while simultaneously decreasing transfer rates to tertiary centers. The observed network-level ID preponderance is consistent with these access-gap patterns.

### 4.2 Acuity pattern and transfer-prevention relevance

70% of what we do is acute inpatient management, including 117 critical-care time units. That matters because it maps directly onto the care patterns where the published tele-specialty literature has shown the strongest transfer-prevention effects. Natafqi et al. (2018) found 1,175 avoided transfers across 9,048 tele-emergency encounters and calculated net societal savings of \$3,823 per avoided transfer. A 2022 Kansas systematic review reported rural teleconsultation reduced adult ICU transfers by 35% (Goetz, 2024). Meta-analyses of tele-ICU programs show ICU mortality reductions and ICU LOS reduction of 0.62 days across 11 studies (Wilcox and Adhikari, 2012). This dataset's acuity pattern is structurally the same pattern that showed up in those studies. That does not prove equivalent outcomes here. It does place this network in the clinical contexts where the evidence base is strongest.

### 4.3 Heterogeneity of impact by community context

The 68/27 concentration is the argument. Sixty-eight percent of volume landed at 27% of hospitals, and every one of those hospitals was  $\geq 60$  miles from tertiary care. Marginal per-encounter value is not uniform across the network. The clinical framing is simple: an ID consult at a hospital 20 miles from tertiary care carries different marginal value than the same ID consult at a CAH 110 miles out. Because the counterfactual is different. At the frontier facility, the alternative is transfer — roughly \$2,673 per event in direct charges (Ward et al., 2020), plus downstream revenue loss, plus patient and family disruption.

### 4.4 Implications for rural hospital financial sustainability

Chartis (2025) identifies 432 rural hospitals as vulnerable to closure; CHQPR places the at-risk count higher at ~700. Under cost-based Medicare reimbursement, every prevented transfer preserves DRG revenue that would otherwise accrue to the receiving tertiary facility. This paper documents a structural deployment pattern in which multi-specialty virtual coverage concentrates at facility types — CAH, frontier, multi-specialty-gap — where the mechanistic pathway to financial stabilization is clearest.

#### **4.5 Operational and financial implications**

The modeled 444 prevented transfers and the directional 30% operational signal point at the same thing: virtual specialty care in this network functions as an operational stabilization mechanism. Retained inpatient volume, plus directional CMI improvement, plus better capture of clinical complexity. For Critical Access Hospitals on cost-based reimbursement, keeping a higher-acuity patient preserves the complexity profile that sets next year's reimbursement baseline. It keeps the hospital operating at a census that supports fixed costs. It signals to the community that the hospital can manage what comes through the door.

## 5. LIMITATIONS

# Boundaries of the present analysis

The four limitations below are presented in a structured format mapping each to its likely direction of bias and proposed mitigation in the follow-on research program.

| LIMITATION   | DIRECTION OF BIAS  | PROPOSED MITIGATION   |
|--|--|---|
| Single-network data. All encounters from one physician-group contract. Specialty mix reflects this network's contractual footprint, not a representative U.S. sample.  | Unknown. May over-represent high-engagement hospitals that sought multi-specialty coverage.                                      | Replication across $\geq 3$ independent networks before population-level deployment claims.           |
| Community attributes from public data. Distance-to-tertiary uses shortest driving distance; excludes seasonal road closures, weather, and emergency routing.           | Likely downward bias in geographic need scores for frontier facilities with road-closure risk.                                   | GPS-routed travel time estimates and GPS-based catchment-area delineation in follow-on.               |
| CMI and transfer prevention are modeled, not measured. Parameters calibrated to conservative end of published ranges. Operational feedback (§3.7) is directional only. | CMI model likely underestimates lift (conservative parameter choice). Transfer model may overestimate for low-volume facilities. | Validation against CMS Cost Reports and actual transfer logs at 3–5 Flagship hospitals (§6.1).        |
| Patient-level outcomes out of scope. No mortality, readmission, LOS, or complication data. Literature cited for mechanistic framing only.                              | Cannot assess direction without patient-level data.  | Prospective 30-day mortality, readmission, and LOS collection at Flagship sites in planned follow-on. |

Table 6. Structured limitations matrix. Direction of bias assessed relative to conservative parameter choices in §2.5 and §2.7.

## 6. CONCLUSIONS

# Summary of findings and directions for further work

Twenty-four months of encounter data across 22 hospitals tells a consistent story. Multi-specialty virtual inpatient care in this network is going to the places that need it most: 68% Critical Access Hospitals, 91% rural or frontier, 68% sitting  $\geq 60$  miles from tertiary care. The care itself is acute, not elective. The specialty mix — ID, cardiology, pulmonology, nephrology — maps almost exactly onto the specialties that rural America cannot recruit.

Six hospitals, all rural, all covering  $\geq 3$  specialties, all isolated from tertiary access, reached Flagship Impact tier. Those six account for 68% of the volume. A geography-weighted model estimated 444 prevented inter-facility transfers over the same period (37.4% of eligible encounters), directionally consistent with a 30% transfer reduction reported by participating hospitals.

These findings support a sharper thesis than the one with which virtual specialty care is usually discussed: **virtual specialty care does not distribute uniformly across rural America. It concentrates at the frontier, at Critical Access Hospitals, at the communities where the traditional specialty workforce has failed to deploy. That concentration pattern itself is the signal of where this care model creates structural value.**

### 6.1 What comes next

**Validation study against real DRG and transfer data.** Three to five Flagship hospitals. 12 months pre-coverage, 12 months post. Actual CMS Cost Reports, actual internal transfer logs. Compare modeled CMI lift and modeled transfer prevention against what actually happened.

**Matched-hospital comparison design.** Comparable rural hospitals without virtual specialty coverage in the same states. Compare CMI trends, inpatient volumes, and operating margins across the same 24-month window. A matched-comparison design turns deployment pattern into causal claim.

**Patient-level outcomes.** Prospective data on 30-day mortality, 30-day readmission, length of stay, and patient-reported satisfaction at Flagship sites.

**Policy analysis.** CMS introduced G0545 add-on code for inpatient ID consultations in 2025 — the first specialty-targeted payment adjustment in the Medicare fee schedule (Barnett et al., 2025). Its rural deployment impact is its own paper.

## 7. CONFLICT OF INTEREST DISCLOSURE

# Author financial interest statement

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I am the founder and CEO of Livemed Health, Inc. The dataset analyzed in this paper is Livemed's own production billing-system export. I have direct financial interest in Livemed's continued operation and growth. That is a material conflict of interest and readers should weigh it accordingly.

No external funding was received for this paper. It has not been peer-reviewed. It is released as a working paper for community comment and follow-on validation. Modeled estimates are labeled modeled, not measured. Directional signals are labeled directional. The limitations section is specific about what this paper does not prove. Replication by independent investigators using independent data is exactly what this paper is asking for.

De-identified aggregate data tables are available on reasonable request, subject to data-use agreements protecting hospital-identifiable operational information. Analytic code (Python/pandas) is available on request.

AI assistance was used during drafting and analytical work. All data, methodology, interpretations, and conclusions are the author's own. Cited literature was independently verified.

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