Geographic Patterns of Radiology Referrals in the US
Authors & Disclosures

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Background

• Driven by Medicare, value-based care transformation is spurring widespread care redesign and reorganization

• This trend will have an unique effect on radiology services, which can be provided by geographically separated referring and radiology providers

• In turn, radiology referral patterns among Medicare beneficiaries are likely to change going forward

• However, little is known about current national geographic patterns in radiology referrals
Methods - Sample

- Combined publicly available data from (1) the 2015 30-day Medicare Referral dataset and (2) the Medicare National Plan and Provider Enumeration System.

- Identified referring non-radiology providers and receiving radiology providers using taxonomy codes from the National Uniform Claim Committee.

- After data cleaning, our sample consisted of 3,925,366 shared relationships representing referrals originating in the 50 states and District of Columbia between non-radiology referrers and diagnostic radiology providers.
Methods

Descriptive Analysis Measures
1. Per-state referral volume
2. Proportion of referrals originating in and received in the same state (“in-state referrals”)
3. Correlation between state referral volume and in-state referrals
4. Proportion of referrals originating and received in the same geographic region as defined by the US Census Bureau

Network Analysis Measures
Generated two novel network-based measures:
1. State-level mean number of referrer relationships
2. State-level mean referral density index (RDI)
Method – Network Analysis

Number of Referrer Relationships
• Describes the degree to which radiology providers are connected via referral relationships to non-radiology providers

Example
If radiology provider A from state 1 receives a total of 10 referrals – 6 from state 1 and 4 from state 2 - it has 6 in-state referrer relationships
Methods – Network Analysis

Referral density index (RDI)
• Calculated by squaring the share of referrals from each referring provider and summing across all referrers
• Values range 0 to 1, with higher values representing a pattern more concentrated among specific referrers

Example
Assume a radiology provider receives 50 referrals from 2 referrers
• If 47 referrals come from 1st referrer, and 3 from the 2nd: RDI = (47/50)^2 + (3/50)^2 = 0.89
• If referrals are received evenly between the 2 referrers, RDI = (25/50)^2 + (25/50)^2 = 0.50
Results

- Proportion of in-state referrals ranged from 9.2% (DC) to 87.4% (AL)
- Correlation between state referral volume and proportion of in-state referrals was low (0.18)
- Proportion of in-region referrals ranged from 83.7% (Northeast) to 89.2% (Midwest)

Proportion of in-state radiology referrals for Medicare beneficiaries (2015)
*Does not include District of Columbia (9.2%)
Results

• State-level mean number of referrer relationships ranged from 7.0 (UT) to 25.0 (CA)

• Approximately half of the states (25 of 51) had a mean number of referrers relationships of 15 or greater
Results

• State-level mean RDI ranged from 0.05 (KS) to 0.25 (HI)

• Most states (39 of 51) had mean RDI between 0.05 and 0.124

• On average, referral volume tends to be evenly distributed across referrers
Discussion

• There is significant state-level variation in patterns of radiology referrals, but far less region-level variation.

• Novel network-based measures can be used to quantify referral relationships.

• Future work should (1) identify the complex factors underlying referral patterns, (2) evaluate patterns in non-Medicare fee-for-service populations, and (3) adopt network-based measures to quantify changes in referral patterns amid value-based care transformation.