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Specialty and Physician Referral Network

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Short Abstract

Examining the referral relationship between specialties and physicians may help improving the healthcare workflows in many ways. Studying referrals at a larger scale reveals not only the patterns but also the anomalies that help to identify specific conditions that may also require further investigations. This explanatory study examines the referral patterns among specialties and physicians using social network analysis and provides visualizations of the findings to facilitate the network perception.

INTRODUCTION

What is Medicare? Medicare is a health insurance program offered by U.S. federal government to its citizens who are older than 65 and also covers certain disabled people.

What are enrollment numbers? In 2012, more than 61 million citizens benefitted from Medicare program (Part A and/or B; see dictionary for coverage information). 91.73% of beneficiaries who are enrolled in Part A (Hospital Insurance) are also enrolled in Part B (Supplementary Medical Insurance) [1].

What is *specialty referral network*? A physician might refer a beneficiary to another physician to perform a procedure for Part B services. Such referrals are the subjects of this study. Instead of studying referral metrics individually, weighted directed graphs of specialties are generated. Medicare provider/supplier specialty descriptions are available in [2]. We group the physicians having the same specialty to a single vertex and aggregate the edges (i.e. referrals) between the physicians by their specialties.

RESULTS & DISCUSSION

Generated networks reveal many interesting information. Visualizations are created to convey the findings more effectively to subject matter experts. There is still some information difficult to read directly from the graphs. Here we briefly list some of them:

- **Average degree** is the average number of vertices directly connected, i.e. total number of different specialties one node being referred (**in-degree**) or referring (**out-degree**). Although no patient is referred to Geriatric medicine from other specialties (zero in-degree), Geriatricians refer their patients to 18 different specialties unlike the other two zero in-degree vertices: oral surgery & preventive medicine have only two out-degrees.

- **Average weighted degree** is similar to average degree; yet, instead of counting number of different specialties, number of referrals between the specialties is calculated. Clinical laboratory has the highest weighted in-degree while internal medicine is the most referring specialty.

- **Average graph distance** is the average of geodesic distances (shortest paths) between all pair of vertices and **network diameter** is the longest (directed) distance between any pairs, which is four in our sample network.

- **Closeness centrality** of a vertex can be regarded as inverse of sum of distances to all other vertices, and it is observed that allergy, interventional radiology, obstetrics and gynecologist have the least closeness centrality and they are the only vertices whose **eccentricity** (greatest geodesic distance) is also four.

- A network exhibits **small-world characteristics** if it has short average graph distance and large clustering coefficient. Specialty referral network conforms to small-world phenomenon as some specialties are more related to each other.

RELATED WORK

Many studies discussed relationships of referral rates to several factors ([3][4][5] to list a few) however none of these studies attempted to generate a network and examined social network properties.

Shea et al. studied Medicare physician referral patterns to identify correlates for the years 1992 and 1993 [3] and reported that self-referral rate is 70%, 60-85% of all beneficiaries had at least one referral. They also found strong predictors of referrals to be patient health, insurance coverage and income.

Lee et al. [6] applied social network analysis to patient sharing among hospitals in a county and observed that hospitals are highly and heterogeneously interconnected.

References

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METHODOLOGY

For specialty network analysis, we first extract vertex, edge and edge weight information from national claims history (NCH) dataset as such triples: *(referring specialty, performing specialty, total count of distinct referrals)* Then network analysis on these triples performed. In this poster we examine and visualize the referral network of physician specialties of beneficiaries residing in Clark County, Nevada. We analyze the social network measures of referral networks and visualize them using PostgreSQL [7] and Gephi [8] software.

First, we focus on the network metrics, as it is the distinctive aspect of this study. A modularity based community detection algorithm applied using edge weights and communities in the network detected. Findings are discussed in the results section. To visualize this specialty referral network we use a linear-attraction linear-repulsion model, Force Atlas 2 layout [9].

Second, we focus on the interpretability and extent of information conveyed in a diagram. In the expense of readability, vertices and edges below a certain threshold are filtered. In this diagram, curved edges in clock-wise shows the direction of referral, size of the vertices indicates number of distinct specialties they are referring to, widths of the edges are proportional to patient traffic load, color of the nodes denote the total patients they have been referred to.

Definitions

Carrier claim referring ID: ID of physician who referred beneficiary to physician that performed the Part B services.
Carrier line performing ID: Unique identifier of physician performing the procedure.
Line provider tax ID identifies whom payment is made for the line item service on the non-institutional claim.
Part A services covers hospital care, skilled nursing facility care, nursing home care, hospice and home health services.
Part B services covers medically necessary services as well as preventive care such as clinical research, ambulance services, durable medical equipment, mental health care, getting a second opinion before surgery, limited outpatient prescription drugs.