Impact of physician community structure on healthcare outcomes

Dr Shahadat Uddin
Complex Systems Research Group
Faculty of Engineering & IT
The University of Sydney, Australia

Professor Margaret Kelaher
Melbourne University
Dr Mahendra Piraveenan
The University of Sydney
Physician community and Healthcare outcomes

**Agenda**

- Establishing the research context: the use of electronic health data (EHD)
- Social network and community detection
- Capturing physician collaboration network (PCN) from EHD
- Exploring impact of physician community on healthcare outcome
- Conclusion and future research direction
Research context and Electronic health data

- With the advent of modern technology, the volume of electronic health data (EHD) has been increasing exponentially over the time.
- Although EHD are mainly maintained for billing and administrative purposes, this type of dataset has already shown wide acceptability to the present healthcare research community.
- This has been reflected in the volume of recent research outcome based on EHD.

In this study, we will show another usage of EHD for research investigation. In particular, we will:

- Show how to capture physician collaboration network (PCN) from EDA
- From this PCN, we will show how to extract physician communities
- Finally, explore how physician communities affect patients' healthcare outcome (readmission and cost)
Physician community and Healthcare outcomes

Network terminology

(a) Network, Node and Link

(b) Community Structure
Physician community and Healthcare outcomes

Extracting Physician Collaboration Network from EHD

- EHD contains mainly three different types of claim data: ancillary, medical and hospital
- This study used the medical claims since this type of claim data contain information of ‘all physicians who visit a patient during her hospitalisation period’
Physician community and Healthcare outcomes

Research Dataset

- Electronic health data from private health insurance organisations
- Data from 85 hospitals (2005 to 2009) – only for 2352 hip replacement patients
- Consider ‘medical’ claim (in total 24,559) to extract the information of physician visits to patients. This information has been used to extract physician collaboration networks
- Before giving permission to use this dataset for research analysis purpose, this dataset was de-identified for privacy reasons by following a standard encryption algorithm
- Two outcome variables: hospitalisation cost and readmission rate
- Three structural measures of physician communities are used as independent variables

Underlying process represented by claim dataset

- A hospital admission of a patient generates many physician claims submitted to the health insurance provider.
- These claims render details of services that had been provided by physicians during their visits to hospitalised patients.
# Physician community and Healthcare outcomes

## Research Dataset: basic statistics

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Range</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communities per physician collaboration network</td>
<td>4.25</td>
<td>[2 – 7]</td>
<td>1.24</td>
</tr>
<tr>
<td>Average number of physician per community</td>
<td>13.42</td>
<td>[3.2 – 37.8]</td>
<td>6.96</td>
</tr>
<tr>
<td>Ratio of the number of physicians and patients</td>
<td>3.17</td>
<td>[0.74 – 6.79]</td>
<td>1.44</td>
</tr>
<tr>
<td>Readmission rate (%)</td>
<td>11.64</td>
<td>[0 – 67]</td>
<td>12.79</td>
</tr>
<tr>
<td>Hospitalisation cost ($AUD)</td>
<td>$24,009</td>
<td>[$13,926 - 622,193]</td>
<td>9596</td>
</tr>
</tbody>
</table>

**Table 1:** Descriptive statistics about physician collaboration networks
Physician community and Healthcare outcomes

Extracting Physician communities from physician collaboration network (PCN)

- Use NodeXL tool for network analysis

![Physician-patient link](a)
![Corresponding PCN](b)
![Communities in PCN](c)
**Physician community and Healthcare outcomes**

Exploring the impact of physician community structure on healthcare outcome

<table>
<thead>
<tr>
<th>Model</th>
<th>Dependent Variable</th>
<th>$R^2$ Value</th>
<th>Intercept</th>
<th>Independent Variable</th>
<th>Coefficient</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Readmission rate</td>
<td>0.127</td>
<td>31.12</td>
<td>Number of community</td>
<td>-3.29</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>Readmission rate</td>
<td>0.077</td>
<td>8.81</td>
<td>Physician per community</td>
<td>0.41</td>
<td>0.04</td>
</tr>
<tr>
<td>3</td>
<td>Hospitalisation cost</td>
<td>0.323</td>
<td>19172.36</td>
<td>Ratio of physician and patient</td>
<td>1525.17</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 2: Linear regression models for checking relations between independent and dependent variables
Physician community and Healthcare outcomes

Discussion of the findings

*Higher number of communities in PCN will make readmission rate of patients low*

- Physicians of the same community are more connected among themselves
- Facilitate
- Efficient and effective exchange of healthcare knowledge
- Lead to
- Low readmission rate
Higher ratio of physician and patient in a PCN will make hospitalisation cost higher.
Physician community and Healthcare outcomes

Discussion of the findings (contd…)

Higher number of physicians per community will make readmission rate of patients high

- Higher #. physicians per community 
  Lead to 
  More connections or information sharing among physicians 

  Effect 1 
  Physicians need time to maintain relations 
  Make 
  Higher readmission rate 

  Effect 2 
  Suffer from information overload 
  Make 
  Redundant information 
  Repetitive information
In summary, this study demonstrated that structural characteristics of physician collaboration networks have significant impact on hospitalisation cost and readmission rate.

This study provides some opportunities for future research.

- Unobserved moderating factors (e.g. patient age and comorbidity score)
- Other dependent variables (e.g. patient satisfaction and hospital infection rate)
- Physician communities other than for hip replacement patients
Thank you! for you patience....