Moving from patient to physician to networks: Old and new approaches to evaluating quality and disparities in breast cancer care

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Overview

• Needle biopsy for breast cancer
  – Case
  – Literature
  – Patient predictors
  – Physician predictors

• Physician network analysis
  – What is it?
  – How might it be helpful?
  – What can we do to develop this field?
Case

60 year old woman presenting with an abnormal mammogram
Referred to a surgeon and excisional biopsy was performed that established a diagnosis of breast cancer
Needle biopsy for breast cancer

- Performed using US or Mammogram guidance
- Sensitivity > 95%
- If DCIS or ADH found, then surgical excision warranted due to possible underestimation

Stereotactically guided core-needle biopsy can be performed on most nonpalpable, mammographically suspicious abnormalities or on those highly suggestive of malignancy.
Use of Needle Biopsy in the US

FIGURE 1. Initial breast biopsy technique over time is shown. One-step surgery is defined as surgical excision of breast tissue without a claim for needle or surgical biopsy. Cochran-Armitage test for trend is significant (z test, −24.69; both P < .0001).

Friese et al, Cancer 115:716-724, 2009
Use of Needle Biopsy in the US

**State of Florida, 2003-2008**

*Figure 2* The percentage use of breast biopsy procedures in Florida by quarter (fourth quarter 2003 to third quarter 2008). *Current Procedural Terminology* code 19100 = needle biopsy (MIBB); code 19101 = incisional biopsy (open surgical biopsy); code 19102 = needle biopsy with image guidance (MIBB); code 19103 = vacuum-assisted biopsy with image guidance (MIBB); code 19125 = needle-localized biopsy (open surgical biopsy).

*About 30% of breast biopsies were surgical, “open” biopsies*

N ~ 400,000
~ 79% of breast cancers in US

Limitations:
1) Incisional biopsy included in definition of “needle biopsy”.
2) Only patients receiving care at accredited cancer centers included.
3) Patients grouped by hospital and not physician
1) Determine the true, population-based utilization of breast needle biopsy in a contemporary cohort.

2) Evaluate regional variation in use.

3) Identify patient-specific risk factors

4) Assign blame
   a) To what extent is this driven by surgeons?
   b) What surgeons are the culprits?

5) Evaluate harm
   a) Does no needle biopsy lead to more surgeries?
Our outcomes

1) Receipt of needle biopsy (either core or fine needle aspirate) within 60 days prior to the first lumpectomy (yes/no)

2) Number of breast cancer surgeries performed prior to initiation of radiation therapy (single vs multiple)
Our dataset

  - One year of lookback claims
  - Continuous follow up through 2008
Our cohort

• Application of modified Nattinger algorithm
• Include fee-for-service Medicare beneficiaries
• Treated with lumpectomy followed by radiation
• Exclude
  – Distant metastases
  – Prevalent case
  – Chemotherapy or radiation prior to surgery
  – Operating physician cannot be determined
  – Patient does not live in 50 states
• Final N=92,731
Geographic variation
Patient Factors: By Medicaid Status

Medicaid enrollment (state buy-in)

- No: 70%
- Yes: 61%

% needle biopsy
Patient Factors: By radiologist density

Radiologist Density

% needle biopsy

- ≤ 6
- 14 to 20
- 15 to 21
- >21

- 63
- 70
- 72
- 71
Physician Factors: By specialty

% needle biopsy

Physician Specialty

- Surgical Oncologist: 81
- General Surgeon: 67
- Other: 59
Physician Factors: By volume

% needle biopsy

Physician volume

- ≤5
- 6 to 10
- 11 to 20
- 21 to 30
- >30

54 64 70 73 82
Physician Factors: By graduation year

- Before 1980: 66%
- 1980-1989: 71%
- 1990-1999: 72%
- 2000+: 79%
Physician Factors: By sex

% needle biopsy

Physician sex

Male: 67
Female: 77
Physician Factors: By degree

- % needle biopsy

Physician degree:
- DO: 52
- MD: 70
Physician Factors: By training location

% needle biopsy

Physician training location

US
Not US

71
58
Partitioning Variance: Patient vs MD

- Variance attributable:
  - 45% physician level
  - 55% patient level
Multivariate model

Significant patient factors:
- Age, Race, State buy-in, Year, Comorbidity, Receipt of chemotherapy, Radiologist density, Rural setting

Significant physician factors
- Board certification, US trained, Degree, Years since graduation, Volume, Specialty, Sex
Needle biopsy and number of surgeries

![Bar chart showing the proportion of breast cancer surgeries with needle biopsy. The chart indicates that the majority of cases involve one surgery, with a smaller proportion involving two surgeries, and a minimal proportion requiring three or more surgeries.]

- Proportion, %
- Number of breast cancer surgeries
- Yes needle biopsy
Needle biopsy and number of surgeries

![Bar chart showing the proportion of breast cancer surgeries with and without needle biopsy. The x-axis represents the number of surgeries (1-5 or more), and the y-axis represents the proportion, in percentage. The chart indicates that most patients had one or two surgeries, with a significant portion having no needle biopsy.]
No Needle biopsy: **RR=2.15 (95% CI 2.13-2.17)**

Adjusted for patient and physician factors

Needle biopsy was by far the most dominant risk factor for multiple surgeries
Moving forward

• Medicare claims could be used to measure and monitor compliance with needle biopsy on a physician and hospital level

• To understand quality of cancer care, we really need to understand the relationships between different specialists providing care.
Moving forward farther
The Basics

**Figure 1. Basic Social Network Concepts**

**Basic elements of network diagrams**

The basic elements of a network are nodes and edges (also called ties or connections).

- A network between 2 types of nodes (physicians and patients)
  - Node 1: Physician
  - Edge: A
  - Node 2: Patient

- A network between a single type of node (physicians)
  - Node 1: Physician
  - Edge: 2
  - Node 2: Physician

**Two-mode (bipartite) network**

- Nodes 1, 2, 3, 4, 5, 6
- Edges connecting different nodes

**One-mode (unipartite) network**

- Nodes 1, 2, 3, 4, 5, 6
- Edges connecting different nodes

Projection of a unipartite network from a bipartite network

- Edge represents connection between physician and patient based on episode(s) of care
- Edge represents shared patient(s) between physicians
Variations in network configurations based on the number of patient-sharing connections between physicians at different hospitals

Loosely connected network

In a network in which physician connections are mostly within hospitals, the network has tight hospital clusters but loose connections between hospital clusters.

Tightly connected network

In networks with more physician connections across hospitals, the hospital clusters are closer together and the overall network becomes tighter.

In a network with many physician connections both within and across hospitals, the hospital clusters are tightly connected to each other.
Real Data

Example of a loosely connected network: Albuquerque, NM (n=1391 physicians)

Hospital affiliation
- Hospital affiliation legend

Specialty
- Primary care physician
- Medical specialist
- Surgical specialist
- Other specialist

Shared patients (≥10)
More Real Data

Example of a tightly connected network: Minneapolis/St Paul, MN (n=596 physicians)

Hospital affiliation
- Hospital affiliation
- Shared patients (≥10)

Specialty
- Primary care physician
- Medical specialist
- Surgical specialist
- Other specialist
- Shared patients (≥10)
Los Angeles County

- 4400 breast cancer patients in 2003-2007
- 5900 clinical physicians in LA county saw these patients
- 29% of patients had Medicaid
- 25% were of minority race/ethnicity

Our preliminary forays...
Our preliminary forays...

- Number physician pairs with at least 1 shared patient = 191,897.
- Number physician pairs with 1, 2, or 3 shared patients = 184,436 (96%).
- Deciles of # shared patients of the 7461 physician pairs with 4 or more shared patients:

  0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
  4   4   4   4   5   5   6   7   8  12  87
Our preliminary forays...

N=1200 physicians

Min # Patients = 5
Tightly connected clusters

A. Physician Specialty

3200 patients saw at least one of these providers
Tightly connected clusters

B. Medicaid Patients (by quartile)           C. Minority patients (by quartile)

3200 patients saw at least one of these providers
**Network metric definitions**

**Degree** quantifies the number of connections a node has.

Physician 6 has a degree of 5.

Clustering coefficient quantifies the extent to which other nodes connected to a node of interest are also connected to each other.

Physician 6, the node of interest, is connected to 5 other nodes. These nodes (physicians 1, 2, 3, 4, and 5) have 5 actual ties to each other.

**Betweenness centrality** quantifies the structural centrality of a node in the network. It is proportional to the number of times the node lies on the shortest path between 2 nodes in the network considering all the shortest paths between all node pairs.

Below is an example of a node (○) that lies on many of the shortest paths between node pairs in the network.

The network below demonstrates the variation in betweenness centrality among nodes in the network.

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The clustering coefficient of Physician 6 is 0.5 calculated by:

\[
\text{Clustering coefficient} = \frac{\text{No. of actual ties that exist between nodes connected to a node of interest}}{\text{Overall no. of ties that could exist between those connected nodes}} = \frac{5}{10} = 0.5
\]
## Network Metrics by Physician Specialty

<table>
<thead>
<tr>
<th>Specialty</th>
<th>Degree</th>
<th>$P_{\text{degree}}$</th>
<th>Clustering Coefficient</th>
<th>$P_{cc}$</th>
<th>Relative Betweenness Centrality</th>
<th>$P_{RBC}$</th>
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<tbody>
<tr>
<td>Medical Oncologist</td>
<td>5.4</td>
<td>0.03</td>
<td>0.71</td>
<td>0.32</td>
<td>0.41</td>
<td>&lt;0.001</td>
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<tr>
<td>Radiation Oncologist</td>
<td>7.0</td>
<td></td>
<td>0.67</td>
<td></td>
<td>1.40</td>
<td></td>
</tr>
<tr>
<td>Surgeon</td>
<td>5.8</td>
<td></td>
<td>0.64</td>
<td></td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>
Key questions

- What about the patients who don’t receive care from these clusters? How are they different?
- Do patients tend to stay in one cluster?
- Is care different in different clusters?
- Do more tightly connected clusters provide better care?
- Can the structure of HRR level networks explain regional variation in practice patterns?
- Can we use such analyses as a roadmap for disparity-reducing initiatives?
- Is this just a fancy way of identifying high volume providers?
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