Social Network Analysis and Physician Practice Patterns

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CERCIT Conference
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The University of Texas Medical Branch
Galveston, TX
OBJECTIVES

• Review an article that examines the effect of physician social networks on variations in prostate cancer care

• Present our ideas for using similar methodology to examine the effect of physician social networks on variation in receipt of minimally invasive breast biopsy in women with breast cancer in Texas
INTRODUCTION

• MIBB endorsed as the “gold standard” diagnostic modality for obtaining tissue diagnosis
  – American Society of Breast Surgeons
  – American College of Radiology
  – National Comprehensive Cancer Network (NCCN)

• Target rates set at >90% MIBB
• Described trends in the use of MIBB in Texas from 2001-2008

• Examine geographic, racial/ethnic, and socioeconomic variation
  – In overall use
  – Adoption of MIBB over time
COHORT SELECTION

- 100% Texas Medicare claims

All breast biopsies (TX), 2001-2008
N=124,652

Age 66 and older
N=101,541 biopsies

Female
N=98,953 biopsies

Part A/B without HMO 12 mo before and after biopsy
N=92,062 biopsies

Unique breast masses (Episodes)
N=75,518

Unique patients
N=67,582

*Done for a diagnosis of breast mass, benign or malignant (174.0-174.9, 217, 233.0, 238.3, 239.3, 610.0-610.9, 611.0611.9)
<table>
<thead>
<tr>
<th>CPT code</th>
<th>Total N = 75,518 Unique Breast Masses</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIBB</td>
<td>N=49,653</td>
</tr>
<tr>
<td></td>
<td>65.8% of first biopsies</td>
</tr>
<tr>
<td>Open</td>
<td>N=25,865</td>
</tr>
<tr>
<td></td>
<td>34.2% of first biopsies</td>
</tr>
</tbody>
</table>
# INITIAL BIOPSY: MIBB vs. OPEN

<table>
<thead>
<tr>
<th>CPT code</th>
<th>Procedure</th>
<th>% within Modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td></td>
<td>N=25,865 34.2% of first biopsies</td>
</tr>
<tr>
<td>19101</td>
<td>Breast biopsy; open, incisional</td>
<td>9.1%</td>
</tr>
<tr>
<td>19120</td>
<td>Excision of cyst, fibroadenoma, or other benign or malignant tumor, aberrant breast tissue, duct lesion, nipple or areolar lesion, open, one or more lesions</td>
<td>44.1%</td>
</tr>
<tr>
<td>19125</td>
<td>Excision of breast lesion identified by preoperative placement of radiological marker, open; single lesion</td>
<td>46.8%</td>
</tr>
</tbody>
</table>
TIME TREND IN THE USE OF MIBB

Consensus conferences sponsored by the University of Southern California and supported by an educational grant from Ethicon Endo-Surgery, Inc.
P<0.0001 for trend for all
GEOGRAPHIC VARIATION IN MIBB USE AND HISPANIC POPULATION DENSITY

MIBB Use% and % Population Hispanic

Map A shows MIBB Use% with color codes for different percentage ranges: 
- Light blue for ≤40%
- Lighter blue for 40-55%
- Medium blue for 55-70%
- Dark blue for >70%

Map B shows % Population Hispanic with color codes for different percentage ranges: 
- Light purple for >50%
- Medium purple for 25-50%
- Lighter purple for 16.3-24.9%
- Medium blue for 5.0-16.2%
- Light blue for <5%

Highlighted cities include: El Paso, McAllen, Brownsville, Harlingen, Midland, Lubbock, Austin, San Antonio, and others.
TIME TRENDS IN MIBB USE BY HSA

A 2001-2004

B 2005-2008

El Paso

McAllen

Harlingen

0.5% >90% MIBB

4.8% >90% MIBB

≤40%

40-55%

55-70%

>70%
Hypothesized that some of the geographic variation could be explained by physician practice – an “organizational access issue”

Used multilevel models to examine surgeon and facility variation in the use of MIBB in Texas
COHORT SELECTION

Unique breast masses
N=75,518

First breast mass
N=67,582

Breast cancer diagnosis and breast cancer operation
N=28,545

Excluded patients with missing surgeon or facility data
N=5,834

FINAL COHORT
N=22,711
### TABLE 3. Hierarchical Multilevel Models: Percentage of Variance in MIBB Use Attributable to Patient, Surgeon, and Facility Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>% Variance in MIBB Use, Adjusted for Patient Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2-level model (patient, facility)</strong> Model 1</td>
<td></td>
</tr>
<tr>
<td>No. patients</td>
<td>22,331</td>
</tr>
<tr>
<td>No. facilities</td>
<td>295</td>
</tr>
<tr>
<td>Residual ICC (% variance)—facility*†</td>
<td>33.6%</td>
</tr>
<tr>
<td><strong>2-level model (patient, facility)</strong> Model 2</td>
<td></td>
</tr>
<tr>
<td>No. patients</td>
<td>17,716</td>
</tr>
<tr>
<td>No. facilities</td>
<td>249</td>
</tr>
<tr>
<td>Residual ICC (% variance)—facility*†</td>
<td>35.8%</td>
</tr>
<tr>
<td><strong>3-level model (patient, surgeon, facility)</strong> Model 3</td>
<td></td>
</tr>
<tr>
<td>No. patients</td>
<td>17,076</td>
</tr>
<tr>
<td>No. surgeons</td>
<td>792</td>
</tr>
<tr>
<td>No. facilities</td>
<td>229</td>
</tr>
<tr>
<td>Residual ICC (% variance)—surgeon*†</td>
<td>15.4%</td>
</tr>
<tr>
<td>Residual ICC (% variance)—facility*†</td>
<td>28.7%</td>
</tr>
</tbody>
</table>
FACILITY VARIATION: 3-LEVEL MODEL
SURGEON VARIATION: 3-LEVEL MODEL
FACTORS ASSOCIATED WITH DECREASED MIBB USE

• Surgeon factors
  – More years in practice
  – Lower breast cancer case volume

• Facility factors
  – Smaller facility size
  – Low facility volume
HYPOTHESIS

- Unexplained variation in treatment may result from distinct physician practice styles
- May be specific to the regional healthcare environment
- Provider relationships may be a key determinant of these practice styles
Physician Social Networks and Variation in Prostate Cancer Treatment in Three Cities

Craig Evan Pollack, Gary Weissman, Justin Bekelman, Kaijun Liao, and Katrina Armstrong
METHODS

- Follow-up through 2006
- Three cities (de-identified)
- Identified the physicians who cared for prostate cancer patients
- Created physician networks based on shared patients
- N=5,353 men with non-metastatic prostate cancer
NETWORK CREATION

- Diagnosing urologist
  - Billed for a claim on the date of diagnosis
  - If no claim, the urologist who saw the patient closest to the date of diagnosis in prior 3 months
  - If none in the 3 months prior, then 3 months after
  - Able to assign diagnosing urologist in 94% of patients
NETWORK CREATION

• Majority urologist
  – Urologist who billed for the most claims in the 9 months after diagnosis
  – Able to assign majority urologist in 94% of patients

• PCP
  – Internal medicine, family practice, general practitioner with greatest number of claims in the 12 months prior to diagnosis
  – 75% identification rate
NETWORK CREATION

• Plurality provider
  – The physician in any specialty who billed the greatest number of claims in the 12 months prior to diagnosis
  – 95% identification rate
  – 53% of cases it was the PCP
  – 11% it was the diagnosing urologist
NETWORK CREATION

- Radiation oncologist
  - Patients who underwent external beam radiation therapy and brachytherapy
  - Provider who billed for simulation and planning
  - 99% identification rate for EBRT
  - 93% for brachytherapy
SUBGROUP DEFINITION

• Subgroups define physicians who are closely connected

• Girvan-Newman algorithm – iterative approach that successively removes edges connecting disparate subgroups

• Modularity used to determine the optimal number of subgroups
  – Measures the observed fraction of edges based on the community structure minus the fraction that would occur in a random network
METHODS

• Determine patient characteristics and network structure in each city

• Used multivariable logistic regression modeling to determine the effect of subgroup on the odds of receiving prostatectomy

• Controlled for:
  – Clinical characteristics (Gleason score, stage, PSA, comorbidity, age)
  – Sociodemographic factors

• GEE to adjust for clustering within urologists
<table>
<thead>
<tr>
<th>Feature</th>
<th>City A</th>
<th>City B</th>
<th>City C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of unique diagnosing urologists</td>
<td>271</td>
<td>128</td>
<td>111</td>
</tr>
<tr>
<td>Average degree of urologists (range)†</td>
<td>11 (0–82)</td>
<td>10 (0–62)</td>
<td>12 (1–64)</td>
</tr>
<tr>
<td>Number of subgroups in main component‡</td>
<td>36</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Number of large subgroups (≥ 50 patients)</td>
<td>14</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Percent of patients in the large subgroups</td>
<td>82.8%</td>
<td>77.6%</td>
<td>88.4%</td>
</tr>
<tr>
<td>Percent of diagnosing urologists in the large subgroups</td>
<td>67.5%</td>
<td>66.4%</td>
<td>74.8%</td>
</tr>
<tr>
<td>Average number of patients per large subgroup (range)</td>
<td>143 (54–472)</td>
<td>103 (56–195)</td>
<td>115 (54–191)</td>
</tr>
<tr>
<td>Average number of diagnosing urologists per large subgroup (range)</td>
<td>13.1 (4–39)</td>
<td>10.6 (5–21)</td>
<td>10.4 (8–14)</td>
</tr>
</tbody>
</table>
Figure 1: In City C, Doctors Are Represented by Circles (Nodes) and Patients by Lines (Edges). Larger Sized Shapes Are Used to Denote Diagnosing Urologists. Different Shades (Colors) and Shapes Are Used for Different Subgroups, with Light Squares (Red in Color Figure) Indicating Subgroups with <50 Patients. The Location on the Map Is Determined by Social Distance Using the Fruchterman–Reingold Layout.
MULTIVARIABLE MODEL

Prostatectomy rates: 25.3% in City A, 8.6% in City B, 13.8% in City C

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 1</th>
<th>Model 2</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>0.78 (0.29–2.06)</td>
<td>1.06 (0.34–3.25)</td>
<td>1.03 (0.45–2.33)</td>
<td>1.07 (0.50–2.29)</td>
<td>0.74 (0.28–1.94)</td>
<td>0.36 (0.13–1.00)</td>
<td>0.23 (0.08–0.66)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.57 (0.25–1.33)</td>
<td>0.66 (0.29–1.48)</td>
<td>1.42 (0.45–4.46)</td>
<td>1.28 (0.36–4.60)</td>
<td>0.38 (0.15–0.97)</td>
<td>0.23 (0.08–0.66)</td>
<td>0.23 (0.08–0.66)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.45 (0.22–0.92)</td>
<td>0.47 (0.23–0.96)</td>
<td>0.62 (0.28–1.36)</td>
<td>0.83 (0.37–1.85)</td>
<td>0.68 (0.26–1.80)</td>
<td>0.62 (0.24–1.62)</td>
<td>0.62 (0.24–1.62)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1.14 (0.54–2.41)</td>
<td>0.98 (0.45–2.09)</td>
<td>0.51 (0.21–1.24)</td>
<td>0.31 (0.10–0.93)</td>
<td>0.35 (0.18–0.71)</td>
<td>0.18 (0.08–0.39)</td>
<td>0.18 (0.08–0.39)</td>
<td></td>
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<tr>
<td>5</td>
<td>0.43 (0.14–1.27)</td>
<td>0.45 (0.13–1.49)</td>
<td>0.58 (0.18–1.88)</td>
<td>0.71 (0.22–2.33)</td>
<td>0.38 (0.12–1.19)</td>
<td>0.19 (0.06–0.67)</td>
<td>0.19 (0.06–0.67)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.35 (0.14–0.88)</td>
<td>0.61 (0.24–1.53)</td>
<td>0.43 (0.13–1.38)</td>
<td>0.52 (0.19–1.43)</td>
<td>0.26 (0.11–0.63)</td>
<td>0.27 (0.11–0.68)</td>
<td>0.27 (0.11–0.68)</td>
<td></td>
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<tr>
<td>7</td>
<td>0.41 (0.17–0.98)</td>
<td>0.47 (0.20–1.13)</td>
<td>0.14 (0.04–0.49)</td>
<td>0.25 (0.07–0.88)</td>
<td>0.24 (0.09–0.66)</td>
<td>0.23 (0.08–0.69)</td>
<td>0.23 (0.08–0.69)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.41 (0.16–1.02)</td>
<td>0.38 (0.14–1.01)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.27 (0.12–0.61)</td>
<td>0.30 (0.13–0.66)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>10</td>
<td>0.64 (0.25–1.61)</td>
<td>0.95 (0.35–2.62)</td>
<td></td>
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<tr>
<td>11</td>
<td>0.40 (0.16–0.99)</td>
<td>0.67 (0.26–1.70)</td>
<td></td>
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<tr>
<td>12</td>
<td>0.16 (0.07–0.38)</td>
<td>0.17 (0.07–0.40)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>0.23 (0.10–0.57)</td>
<td>0.28 (0.13–0.62)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.38 (0.17–0.84)</td>
<td>0.49 (0.22–1.08)</td>
<td>1.19 (0.50–2.86)</td>
<td>2.24 (0.93–5.39)</td>
<td>0.62 (0.26–1.45)</td>
<td>0.37 (0.15–0.90)</td>
<td></td>
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</tr>
</tbody>
</table>
CAN WE DO THE SAME IN THE BREAST DATA?

• 100% Texas Medicare data
• All patients:
  – Minimally invasive or open breast biopsy
  – Breast cancer diagnosis and breast cancer operation
  – 2010 and 2001 (before and after the guidelines)
CITIES/GEOGRAPHIC REGIONS

• Houston/Galveston
• Dallas/Fort Worth
• San Antonio
• McAllen
• El Paso
• Others?
• How do we define the region?
CAN WE DO THE SAME IN THE BREAST DATA?

• 100% Texas Medicare data

• All patients:
  – Minimally invasive or open breast biopsy
  – Breast cancer diagnosis and breast cancer operation
  – 2010 and 2001 (before and after the guidelines)
NETWORK CREATION

• Breast Cancer Surgeon
  – Surgeon who billed the claim for the definitive breast cancer operation (from UPIN ass

• Biopsying Physician
  – Physician who billed the claim for the breast biopsy
  – Might be surgeon, radiologist, other
NETWORK CREATION

• Medical Oncologist
  – In patients who received chemotherapy only
  – Medical oncologist with the most claims in the 12 months after cancer diagnosis

• Radiation Oncologist
  – In patients who received EBRT or brachytherapy
  – Provider who billed for simulation and planning
NETWORK CREATION

• PCP
  – Internal medicine, family practice, geriatrician, general practitioner with greatest number of claims in the 12 months prior to diagnosis
  – In the past, we defined PCP as two or more visits

• Plurality provider
  – The physician in any specialty who billed the greatest number of claims in the 12 months prior to diagnosis

• Radiologist Reading Mammogram?