THE IMPACT OF MISSING STAGE AT DIAGNOSIS ON RESULTS OF GEOGRAPHIC RISK OF LATE-STAGE COLORECTAL CANCER

Recinda Sherman, MPH, PhD, CTR
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Outline

- Background: Missing data, Colorectal Cancer, Colorectal Cancer Screening
- Methods: Cluster Detection, Area-based measures, Distance analysis
- Results: Cluster Detection, Area-based measures, Distance analysis
- Conclusions
  - Future directions
Cancer Registry Purpose

“These data are then used to inform a wide variety of public health decisions and provide rich information for cancer diagnosis and treatment education.”

- Guides policy and treatment decisions
  - Reduce the burden of cancer
- Error
  - Inappropriate public health response
  - Fail to protect population; waste of public funds
- Cause
  - Flawed research design, inappropriate assumptions, bias
  - Data quality in registry data
Missing data

- Random – hard to correct during collection but established methods for analysis
  - Remove cases with missing data, random allocation of missing information, interpolation based on known data

- Systematic – “easy” to correct during collection but no established method for analysis
  - Cartographic selection bias

- Leads to reduced power and possibly biased results
Background: Cancer surveillance

- System of central (state) cancer registries
- Collect incidence, type, anatomic location, extent of disease, treatment, and outcomes
  - National standards, “Gold Standard”
- Systematic analysis of cancer data
  - Identify burden and trends of cancer
  - Generate hypotheses about cancer risk and etiology
- Guides policy and treatment decisions
  - Reduce the burden of cancer
Background: Colorectal cancer

- 2nd Mortality
- 4th Invasive
- Cause?
  - Multifactorial
  - Diet, exercise, HPV
- 95% adenocarcinomas
  - Pre-cancerous polyps
Background: Screening

- Multimodal
  - FOBT, sigmoidoscopy, colonoscopy
  - 50+
- USPSTF Grade A recommendation
  - Primary and secondary prevention
- 50% general population
  - Blacks, lower
  - Hispanics, lowest
Stage of disease

- Common outcome measure: early vs late
  - Proxy for screening uptake
  - Proxy for prognosis

- Often missing/unknown
  - Lack of clinical assessment
    - Lack of connection to health services
    - Contraindicated (age, comorbidities)
    - Low survival, likely unscreened
  - Lack of collection
    - Unknown survival/screening
Aim of study

- Evaluate the impact of missing stage at diagnosis for colorectal cancer geospatial research
  - By race/ethnicity
- Three different methods of handling missing stage
  - Remove cases (most common approach)
  - Allocate based on demographics
  - Code all as late
- Three different cancer control questions
  - Where should we target a screening intervention?
  - How should we tailor the intervention based on demographics?
  - Are disparities being driving by unequal proximity to clinical care?
Methods: Florida Cancer Data System

- NPCR, Incidence based, 1981+
- 2nd largest cancer registry in US
- 115,000 incident cancer cases annually
  - 200,000 reports, 150,000 Death, 1,000,000 Discharge
- Gold Certification
- System
  - Facilities, physicians, vital statistics, hospital discharge, medical billing, pathology
- Geocoding
  - 95% street level, 3% PO Box
  - Proprietary vendor, no manual follow-up
Methods: Case selection

- Colorectal cases
  - diagnosed 1996-2010
  - 1st primary, age 50+, adenocarcinomas

- Geocoded to 2010 tract or block group
  - based on street address

- Stage at diagnosis
  - Dichotomous “early” & “late”
Methods: Cluster detection

- **First**: Detect high risk clusters of late-stage at diagnosis CRC
  - Blacks, Cubans, White Hispanics, White Non-Hispanics

- **SaTScan**
  - Spatial Scan
  - Poisson Model
    - Late-stage incidence using age-adjusted rates
  - Bernoulli Model
    - ratio of counts late:early

- Details in upcoming *Preventing Chronic Disease* method paper: *Issues in applying spatial analysis tools in public health: an example of using SaTScan to identify geographic targets for colorectal cancer screening interventions*
Methods: Area-based measures

- 2006-2010 ACS aggregated dataset
  - Tract-level measure
  - Socio-demographic characteristics
- 2010 Florida BRFSS
  - County-level measure
  - Screening uptake
- Hierarchical, logistic regression models
  - Proc glimmix
Methods: Distance analysis

- Travel distance between patient’s residence and facility that reported the case
  - Median and mean
- NAACCR Shortest Path Finder Tool
  - Road networks, TeleAtlas
## Results:

<table>
<thead>
<tr>
<th></th>
<th>Black (n=3,779)</th>
<th>Hispanic White (n=4,989)</th>
<th>Non-Hispanic White (n=28,796)</th>
</tr>
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<tbody>
<tr>
<td><strong>Total late cases</strong></td>
<td></td>
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<tr>
<td>All combined</td>
<td>2,242</td>
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<td><strong>Age</strong></td>
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<td>50-54</td>
<td>61%</td>
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</tbody>
</table>

Table 1. Distribution of late stage by method of handling unknowns, by race/ethnicity, sex, and age.
Results: Cluster detection

<table>
<thead>
<tr>
<th></th>
<th># clusters</th>
<th># cases in cluster(s)</th>
<th>range of RR</th>
<th>range of p</th>
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<td>=Exclude = Allocate</td>
<td>=Late</td>
<td>=Exclude = Allocate</td>
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<td>&lt;0.01 - 0.05</td>
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<tr>
<td>Black (P 40%)</td>
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<td>HW (B na)</td>
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<td>&lt;0.01 - 0.05</td>
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<tr>
<td>HW (P 50%)</td>
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<td>1,860</td>
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<td>&lt;0.001 - 0.05</td>
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<tr>
<td>nonHW (B 15%)</td>
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<td>2</td>
<td>4</td>
<td>4</td>
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<td>nonHW (P 25%)</td>
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<td>12</td>
<td>12</td>
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<td>1.2-5.1</td>
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</tbody>
</table>

All = allocate B = Bernoulli, P = Poisson, * maximum cluster size (scale), \(^{\text{\textsuperscript{*}}}\) RR = Relative Risk, HW = Hispanic White

Note: none of the Bernoulli analysis was statistically significant for comparison.

Table 2. Late-stage at diagnosis colorectal cancer clusters, Florida 2006-2010
Figure 1. Comparison of tract-based cluster locations by method of handling unknowns, by race/ethnicity and Model type.
Results: Area-based measures

<table>
<thead>
<tr>
<th>Non-Hispanic White: Bernoulli Method</th>
<th>Unknown=Late</th>
<th>Unknown=Exclude</th>
<th>Unknown=Allocate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tract Level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% non-white</td>
<td>1.0 &lt;.001</td>
<td>1.0 &lt;.001</td>
<td>1.0 0.04</td>
</tr>
<tr>
<td>% hispanic</td>
<td>1.0 0.03</td>
<td>1.0 0.00</td>
<td>not included</td>
</tr>
<tr>
<td>% minority</td>
<td>not included</td>
<td>not included</td>
<td>not included</td>
</tr>
<tr>
<td>% foreign born</td>
<td>1.1 &lt;.001</td>
<td>1.1 &lt;.001</td>
<td>1.0 &lt;.001</td>
</tr>
<tr>
<td>% not hs grad</td>
<td>not included</td>
<td>not included</td>
<td>not included</td>
</tr>
<tr>
<td>% no English spoken</td>
<td>0.9 0.00</td>
<td>0.9 0.00</td>
<td>0.9 0.00</td>
</tr>
<tr>
<td>% below poverty</td>
<td>1.0 0.00</td>
<td>1.0 1.0</td>
<td>1.0 0.05</td>
</tr>
<tr>
<td><strong>County Level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% ever received sigmoidoscopy/colonscopy</td>
<td>0.8 &lt;.001</td>
<td>0.8 &lt;.001</td>
<td>1.0 0.0</td>
</tr>
<tr>
<td>% received fobt last 2 years</td>
<td>not included</td>
<td>not included</td>
<td>1.1 &lt;.001</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Hispanic White: Poisson Method</th>
<th>Unknown=Late</th>
<th>Unknown=Exclude</th>
<th>Unknown=Allocate</th>
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<tbody>
<tr>
<td><strong>Tract Level</strong></td>
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</tr>
<tr>
<td>% non-white</td>
<td>not included</td>
<td>not included</td>
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<tr>
<td>% hispanic</td>
<td>not included</td>
<td>not included</td>
<td>not included</td>
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<tr>
<td>% minority</td>
<td>1.1 &lt;.001</td>
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<td>1.1 &lt;.001</td>
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<tr>
<td>% foreign born</td>
<td>1.1 &lt;.001</td>
<td>not included</td>
<td>not included</td>
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<tr>
<td>% not hs grad</td>
<td>not included</td>
<td>1.0 0.01</td>
<td>not included</td>
</tr>
<tr>
<td>% no English spoken</td>
<td>0.8 &lt;.001</td>
<td>0.9 0.04</td>
<td>0.8 &lt;.001</td>
</tr>
<tr>
<td>% below poverty</td>
<td>1.0 1.0</td>
<td>1.0 1.0</td>
<td>1.0 1.0</td>
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<tr>
<td><strong>County Level</strong></td>
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<td>% ever received sigmoidoscopy/colonscopy</td>
<td>0.8 &lt;.001</td>
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<td>0.8 &lt;.001</td>
</tr>
<tr>
<td>% received fobt last 2 years</td>
<td>not included</td>
<td>1.0 0.01</td>
<td>1.0 0.01</td>
</tr>
</tbody>
</table>

Table 3: Various white race and ethnic models for Non-Hispanic whites. The method of handling unknown cases varies.
## Results: Distance analysis

<table>
<thead>
<tr>
<th>Tract Level</th>
<th>Non-Hispanic White: Bernoulli Method</th>
<th>Unknown=Late</th>
<th>Unknown=Exclude</th>
<th>Unknown=Allocate</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>p-value</td>
<td>CI</td>
<td>OR</td>
</tr>
<tr>
<td>% non-white</td>
<td>1.0</td>
<td>&lt;.001</td>
<td>1.0, 1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>% hispanic</td>
<td>1.0</td>
<td>0.03</td>
<td>not included</td>
<td>1.0</td>
</tr>
<tr>
<td>% minority</td>
<td>1.0</td>
<td>not included</td>
<td>not included</td>
<td>1.0</td>
</tr>
<tr>
<td>% foreign born</td>
<td>1.1</td>
<td>&lt;.001</td>
<td>1.1, 1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>% not hs grad</td>
<td>not included</td>
<td>not included</td>
<td>not included</td>
<td>1.0</td>
</tr>
<tr>
<td>% no English spoken</td>
<td>0.9</td>
<td>0.00</td>
<td>0.8, 1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>% below poverty</td>
<td>1.0</td>
<td>0.00</td>
<td>1.0, 1.0</td>
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</tr>
</tbody>
</table>

<table>
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<th>County Level</th>
<th>Non-Hispanic White: Poisson Method</th>
<th>Unknown=Late</th>
<th>Unknown=Exclude</th>
<th>Unknown=Allocate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>p-value</td>
<td>CI</td>
<td>OR</td>
</tr>
<tr>
<td>% ever received sigmoidoscopy/colonscopy</td>
<td>not included</td>
<td>not included</td>
<td>not included</td>
<td>1.0</td>
</tr>
<tr>
<td>% received foBT last 2 years</td>
<td>1.0</td>
<td>0.00</td>
<td>1.0, 1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

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<tr>
<td></td>
<td>OR</td>
<td>p-value</td>
<td>CI</td>
<td>OR</td>
</tr>
<tr>
<td>% ever received sigmoidoscopy/colonscopy</td>
<td>not included</td>
<td>not included</td>
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<td>1.0</td>
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<td>% received foBT last 2 years</td>
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<td>1.0, 1.0</td>
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Table 3c. Hierarchical, area-based risk models for non-Hispanic whites, by method of handling unknowns and Model Type
Conclusions

- Currently no standard method on how to handle cases with unknown stage at diagnosis
- Most remove from analysis
  - Results from this method deviated the most from the other two
  - Reduces power due to reduce n
  - Creates geographic selection bias; can overestimate effects
- Recoding to late/allocation
  - Potential for misclassification bias; more likely to move results to null
Moving forward...

- Re-abstraction studies or links with clinical datasets
  - To determine a more precise allocation method
- Multiple imputation
  - Compare to other methods
- Results consistent among multiple methods can be interpreted with more confidence
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Dr. Kevin Henry, Department of Epidemiology, Rutgers University
Questions?

Recinda Sherman

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