Leveraging linked secondary data and simulation modeling to inform local colorectal cancer (CRC) screening program implementation

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The opportunity
The players
The approach
  – Define target areas/regions for intervention
  – Select and adapt interventions
  – Quantify the expected impact of interventions for specific areas/regions
  – Implement intervention, measure outcomes
Where Can Colorectal Cancer Screening Interventions Have the Most Impact?

Rebecca L. Siegel, Liora Sahar, Anthony Robbins, and Ahmedin Jemal

Abstract

Background: Although colorectal cancer death rates in the United States have declined by half since 1970, large geographic disparities persist. Spatial identification of high-risk areas can facilitate targeted screening interventions to close this gap.

Methods: We used the Getis-Ord Gi* statistic within ArcGIS to identify contemporary colorectal cancer "hotspots" (spatial clusters of counties with high rates) based on county-level mortality data from the national vital statistics system. Hotspots were compared with the remaining aggregated counties (non-hotspot United States) by plotting trends from 1970 to 2011 and calculating rate ratios (RR). Trends were quantified using joinpoint regression.

Results: Spatial mapping identified three distinct hotspots in the contemporary United States where colorectal cancer death rates were elevated. The highest rates were in the largest hotspot, which encompassed 94 counties in the Lower Mississippi Delta (Arkansas (17), Illinois (16), Kentucky (13), Louisiana (6), Mississippi (27), Missouri (15), and Tennessee (10)). During 2009 to 2011, rates here were 40% higher than the non-hotspot United States [RR, 1.40; 95% confidence interval (CI), 1.34–1.46], despite being 10% lower during 1970 to 1972 (RR, 0.82; 95% CI, 0.78–0.86). The elevated risk was similar in blacks and whites. Notably, rates among black men in the Delta increased steadily by 3.5% per year from 1970 to 1990, and have since remained unchanged. Rates in hotspots in west central Appalachia and eastern Virginia/North Carolina were 10% and 9% higher, respectively, than the non-hotspot United States during 2009 to 2011.

Conclusions: Advanced spatial analysis revealed large pockets of the United States with excessive colorectal cancer death rates.

Impact: These well-defined areas warrant prioritized screening interventions. Cancer Epidemiol Biomarkers Prev; 24(6): 1151–6. ©2015 AACR.

The 3 hot spots in the U.S. with the highest colon cancer death rates

Although the risk of death from colorectal cancer in the United States has dropped dramatically in recent decades, there are three "hot spots" in Appalachia and the rural South where death rates are "unnecessarily high," researchers said. By Lena H. Sun July 8, 2015

Hotspots for colorectal cancer

- Three clusters of counties with significantly high death rates, 2000-2009.
THE OPPORTUNITY: WHY CRC, WHY NOW?

- We know how to reduce CRC morbidity and mortality
- Yet, we are terrible at implementing what we know works

CDC Trends in CRC screening, 2010
THE OPPORTUNITY: WHY CRC, WHY NOW?

- Colorectal cancer (CRC) screening via colonoscopy or fecal testing (FOBT/FIT) is effective and saves lives.
- CRC screening is underused in both the U.S. (66% up to date) and N.C. (70% up to date)
- CRC screening is especially low among rural (& low income, uninsured, and minority) populations
- Decision makers need to know the most effective and efficient approach to close the gap in specific settings
  - Impact and efficiency of CRC screening interventions vary depending on local context
- How can healthcare systems be optimized to ensure that age-eligible people receive CRC screening at the lowest cost?
THE OPPORTUNITY: EMERGING TRENDS

• **Dissemination and implementation science research**
  • “bridges the gap between clinical research, everyday practice, and public health by building a knowledge base about how health information, interventions, and new clinical practices, guidelines and policies are transmitted and translated for public health and health care service use in specific settings” (NIH PAR-16-237)

• **Systems science and simulation modeling**
  • “applies approaches such as system dynamic modeling, agent-based modeling, social network analysis, discrete event analysis, and Markov modeling to better understand complex and dynamic behavioral and social sciences processes and problems relevant to health” (NIH PAR-15-04)

• **Behavioral economics**
  • “seeks to identify individual influences on the effectiveness of population-level strategies that target behaviors, shape the development of new strategies, and communicate strategies most effectively” (NIH PAR-16-257)
THE PLAYERS: CPCRN

- A national effort funded by CDC and NCI to advance the science and practice of dissemination and implementation in cancer prevention and control
PIs

Sue Flocke, Ph.D.
Jackie Shannon, Ph.D.
Kerri Winters-Stone, Ph.D.
Sue Curry, Ph.D.
Karen Glanz, Ph.D.
Robin Vanderpool, DrPH
Jennifer Leeman, DrPH
Stephanie Wheeler, Ph.D.
Daniela Friedman, Ph.D.
Peggy Hannon, Ph.D.
Cancer Prevention and Control Research Network Logic Model

**Inputs**
- CPCRN Organizational Structure
- Infrastructure Support
- Member-Center Capacity
- Coordinating Center Capacity
- Affiliate Members
- CDC/NCI
- The Guide to Community Preventive Services
- RTIPs
- Cancer Control PLANET
- National and Regional Health Priorities
- National and Regional Health Disparities Data

**Activities**
- Organizing
  - A. Develop and Facilitate Network Infrastructure Workgroups, Steering Committee, and Network Meetings; Policies and Procedures
  - B. Engage and Collaborate with Outside Experts as Necessary
- Network
  - A. Develop Network Vision and Priorities for Research
  - B. Create a Plan for Disseminating EBAs into Practice
  - C. Create a Process to Promote the Visibility of CPCRN, its Members, and Products
  - D. Create Strong Processes for Collaboration
  - Build Capacity with Partners about Evidence-Based Approaches to Cancer Prevention and Control
  - Use Promising Dissemination Strategies to Address Research Priority Areas and Specific Audiences
  - Conduct Program Evaluation, and Intervention, Replication, and Dissemination Research; Seek Funding; Submit Grant Applications and Manuscripts

**Outcomes**
- Network
  - D1. Increase the Identification, Delivery, Maintenance, and Evaluation of EBAs by Partners
  - D2. Increased Funding, Presentations, and Publications
  - D3. Research Findings Related to Evidence-Based Recommendations
  - D4. Reports, Plans, Policies Generated with State and National Level Cancer Programs

- Proximal
  - E1. National, State, Community, and Local Organizations Adopt Evidence-Based Approaches to Cancer Prevention and Control

- Distal
  - F1. Improved Cancer Related Health Behaviors:
    - Reduced Consumption of Tobacco Products
    - Increased Sun Safety
    - Improved Dietary Behavior
    - Increased Physical Activity
    - Enhanced Cancer Survivorship and Quality of Life
  - F2. Reduced Cancer Disparities, Morbidity, and Mortality
  - F3. Increased Informed Decision Making for Cancer Screening and Increased Use of Effective Cancer Screening Tests
Unique linkages:
Cancer registry, multi-payer claims data (Medicare, Medicaid, NC private), SSI death index, BRFSS, other data

Health Care Claims:
5.5m cases since 2003

NC Cancer Registry:
100% since 2003
320,000 cases

Cases linked to claims:
80% of NC cancers
255,000

Key collaborators
Anne Marie Meyer
May Kuo
Justin Trogdon
Stephanie Wheeler

Funding
HHSA290-2005-0040
DP09-0010303SUPP11
1-U48-DP0005017-01

University Cancer Research Fund

Key pubs (>40!)
Meyer et al, NCMJ 2012
Wheeler et al, Health Place 2014
Lich et al, PCD, 2017
Wheeler et al, Preventive Med Reports, 2016
Unique linkages:
Oregon All Payer All Claims database (Medicare, Medicaid, private insurers), other data

Health Care Claims:
From 2007 for Medicare and Medicaid; 2010 for private)

THE PLAYERS: THE OHSU CENTER FOR HEALTH SYSTEMS EFFECTIVENESS

Key collaborators
John McConnell
Melinda Davis
Stephanie Renfro

Shared resources
3 Health economists
5 Statisticians
3 Research assistants
1 program coordinator

Funding
1-U48-DP005017-01

Key pubs (>52)
McConnell et al, Health Affairs, 2017
Davis et al, J of Rural Health, 2016
Charlesworth et al, JAMA IM, 2016
THE PLAYERS: THE CAROLINA CANCER SCREENING INITIATIVE

Key collaborators
Alison Brenner
Leah Frerichs
May Kuo
Jennifer Leeman
Kristen Hassmiller Lich
Anne Marie Meyer
Dan Reuland
Catherine Rohweder
Stephanie Wheeler

Shared resources
ICISS

Funding
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ACS RSG
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Key publications
Lich et al, 2017, *PCD*
Frerichs et al, 2016, *AJPH*
Brenner et al, 2014, *JGIM*
Wheeler et al, 2016, *Preventive Medicine Reports*
The 3 hot spots in the U.S. with the highest colon cancer death rates

Although the risk of death from colorectal cancer in the United States has dropped dramatically in recent decades, there are three "hot spots" in Appalachia and the rural South where death rates are "unnecessarily high," researchers said.

By Lena H. Sun  July 8, 2015
<table>
<thead>
<tr>
<th>Level</th>
<th>Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy</td>
<td>Payment model reforms (e.g., Medicaid and private insurance expansion) Access to care for uninsured (e.g., CDC-funded CRC control program)</td>
</tr>
<tr>
<td>System</td>
<td>Care coordination (e.g., through medical homes, ACOs) Improving health IT infrastructure</td>
</tr>
<tr>
<td></td>
<td>• Population identification</td>
</tr>
<tr>
<td></td>
<td>• Visit-based reminders</td>
</tr>
<tr>
<td></td>
<td>• Tracking systems/registries</td>
</tr>
<tr>
<td>Provider</td>
<td>Provider outreach, education Quality reporting and incentives to meet screening goals</td>
</tr>
<tr>
<td>Patient/Person</td>
<td>Decision aids delivered at visit Patient navigation support Community outreach, education, media campaigns Client reminders Mailed FIT kits</td>
</tr>
</tbody>
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## Example Interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Effect Size</th>
<th>Base ($)</th>
<th>Cost Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicaid Mailed Reminder</td>
<td>5% age point increase in ( p(\text{screen}) )</td>
<td>$10,000</td>
<td>Develop registry &amp; content (one-time)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Programming time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Materials (postage, paper, ink)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mail reminders</td>
</tr>
<tr>
<td>Endoscopy Expansion</td>
<td>Individually-specific predicted ( p(\text{screen}) ) based upon claims-based statistical models</td>
<td>$500,000 / facility</td>
<td>Financial incentive to locate facility in 6 underserved areas</td>
</tr>
<tr>
<td>Targeted Mass Media</td>
<td>Will reach 80% of blacks, 2% age point increase in ( p(\text{screen}) )</td>
<td>$368,000 / year</td>
<td>Content development (one-time)</td>
</tr>
<tr>
<td></td>
<td>Will reach 40% of non-blacks, 1% age point increase in ( p(\text{screen}) )</td>
<td>$332,000 / year</td>
<td>Advertising for one month</td>
</tr>
<tr>
<td>Voucher for uninsured</td>
<td>500 uninsured individuals turning 50 will receive colonoscopies</td>
<td>$750 / person</td>
<td>Voucher for colonoscopy</td>
</tr>
</tbody>
</table>
HOW WE UNDERSTAND ESTIMATED IMPACT AND COST OF POTENTIAL INTERVENTIONS

Underlying Population

- **Census data**
  - 2005-2010 American Community Survey/Public Use Microdata Sample
  - Project from sample to population

- **Synthetic population**
  - Realistic population of all individuals who will be eligible for CRC screening over the 10-year policy window

Screening Patterns

- **Claims data**
  - Medicare, Medicaid, Blue Cross Blue Shield and linked community data such as the Area Resource File
  - Statistical model development and testing

- **Statistical models**
  - Logistic regression models predicting individuals’ preferred screening modality and likelihood of compliance

Disease Progression

- **RTI Model**
  - Natural history of adenomas and cancer

Cancer Outcomes

- **Cancer Registry**
  - Population-based data on incident CRC cases (counts, patient demographics, stage at diagnosis)
  - Calibration of CRC natural history parameters
  - Parameter estimates

- **Intervention scenarios**
  - Approaches for improving population-level screening compliance

Intervention Effects

- **Literature Review**
  - Evidence on interventions to increase CRC screening, existing CRC simulation models, and cost studies
  - Interventions to consider, intervention effects and costs

NC-CRC Simulation Model

- Geo-spatially explicit, population-based, individual-level discrete-event simulation model of the natural history of CRC progression and screening behaviors
WHAT HAVE WE LEARNED FROM NC DATA?

Endoscopy proximity does not predict CRC screening in publicly insured populations.

But sending reminders to Medicaid enrollees has the potential to greatly increase screening, at low cost.
WHAT ELSE CAN WE LEARN?

- What would be required in a statewide CRC screening program to achieve CRC screening coverage targets set by Healthy People 2020 (70.5%) and the National Colorectal Cancer Roundtable (80%)
- What is the impact of Medicaid expansion on CRC outcomes? In NC? In OR?
- What are our results sensitive to?
IMPACT

• Outcomes/Products
  – Increased CRC screening
  – Simulation models for public use
  – Evidence to inform value and support better decision making
  – Publications, policy briefs, white papers, presentations, etc.

• Dissemination/Implementation
  – National level: CDC, NCI, Moonshot, National CRC Roundtable
  – Provider or State level: Medicaid, CCNC, DPH, NC Roundtable
Regional variation in colorectal cancer testing and geographic availability of care in a publicly insured population


Translating Cancer Surveillance Data Into Effective Public Health Interventions

Stephanie B. Wheeler, PhD, MPH; Ethan Basch, MD, MSc

In this issue of JAMA, Mokdad and colleagues report that cancer mortality has markedly decreased in the United States over the past 30 years. Based on data from the National...
• **CDC SIP 11-041** “Behavioral economics of colorectal cancer screening in underserved populations” (Co-PIs: Pignone and Wheeler)

• **CDC and NCI SIP 14-011** “Cancer Prevention and Control Research Network (CPCRN)” (PI: Wheeler)

• **AHRQ 1-K-12 HS019468-01** Mentored Clinical Scientists Comparative Effectiveness Development Award (PI: Weinberger; Scholar: Wheeler)

• **NIH K05 CA129166** Established Investigator Award in Cancer Prevention and Control: Improving Cancer-Related Patient Decision Making (PI: Pignone)

• **NC Translational and Clinical Sciences Institute** Pilot Grant “Using systems science methods to improve colorectal cancer screening in North Carolina” (PI: Lich)

• **CMMI-1150732 CAREER**: Incorporating Patient Heterogeneity and Choice into Predictive Models of Health and Economic Outcomes”. National Science Foundation (PI: Mayorga)

• **University of North Carolina at Chapel Hill Cancer Research Fund**

• **Integrated Cancer Information and Surveillance System**  

THANK YOU!