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Data-powered decision making:
One state's approach to improving colorectal cancer screening in underserved populations

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Lineberger Comprehensive Cancer Center

PRC Prevention Research Centers

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Roadmap

- The rationale
- The approach
  - Defining target areas/regions for intervention
  - Selecting and adapting interventions
  - Quantifying the expected impact of interventions for specific areas/regions
  - Implementing interventions
  - Evaluating outcomes

The rationale for CRC screening

Published OnlineFirst July 8, 2015; DOI: 10.1158/1055-9965.EPI-15-0082

Cancer Surveillance Research

Cancer Epidemiology Biomarkers & Prevention

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 (3), 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 18% 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 18% 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.

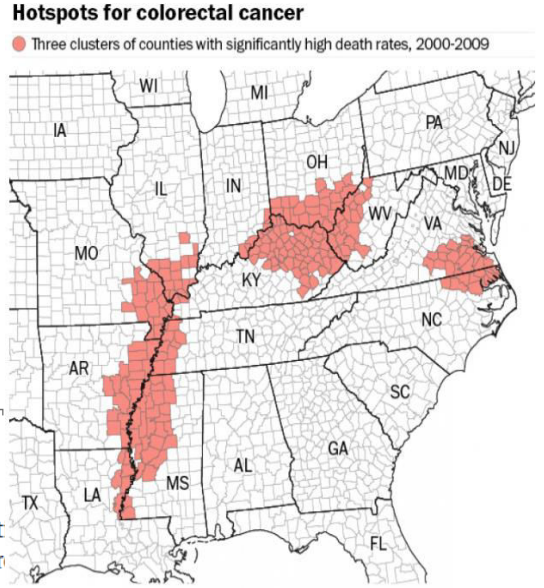
Impact: These well-defined areas warrant prioritized screening intervention. *Cancer Epidemiol Biomarkers Prev; 24(8); 1151–6.* ©2015 AACR.

Sections | The Washington Post | Sign In

To Your Health

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



Translating Cancer Surveillance Data Into Effective Public Health Interventions

JAMA®
The Journal of the American Medical Association

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

In this issue of *JAMA*, Mokdad and colleagues[1] report that cancer mortality has markedly decreased in the United States over the past 30 years. Based on data from the National

The greatest value of these data lies in their potent
support scientific and public health priority setting thr
3 key approaches.

The rationale for CRC screening

- 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 people receive CRC screening *at the lowest cost*?

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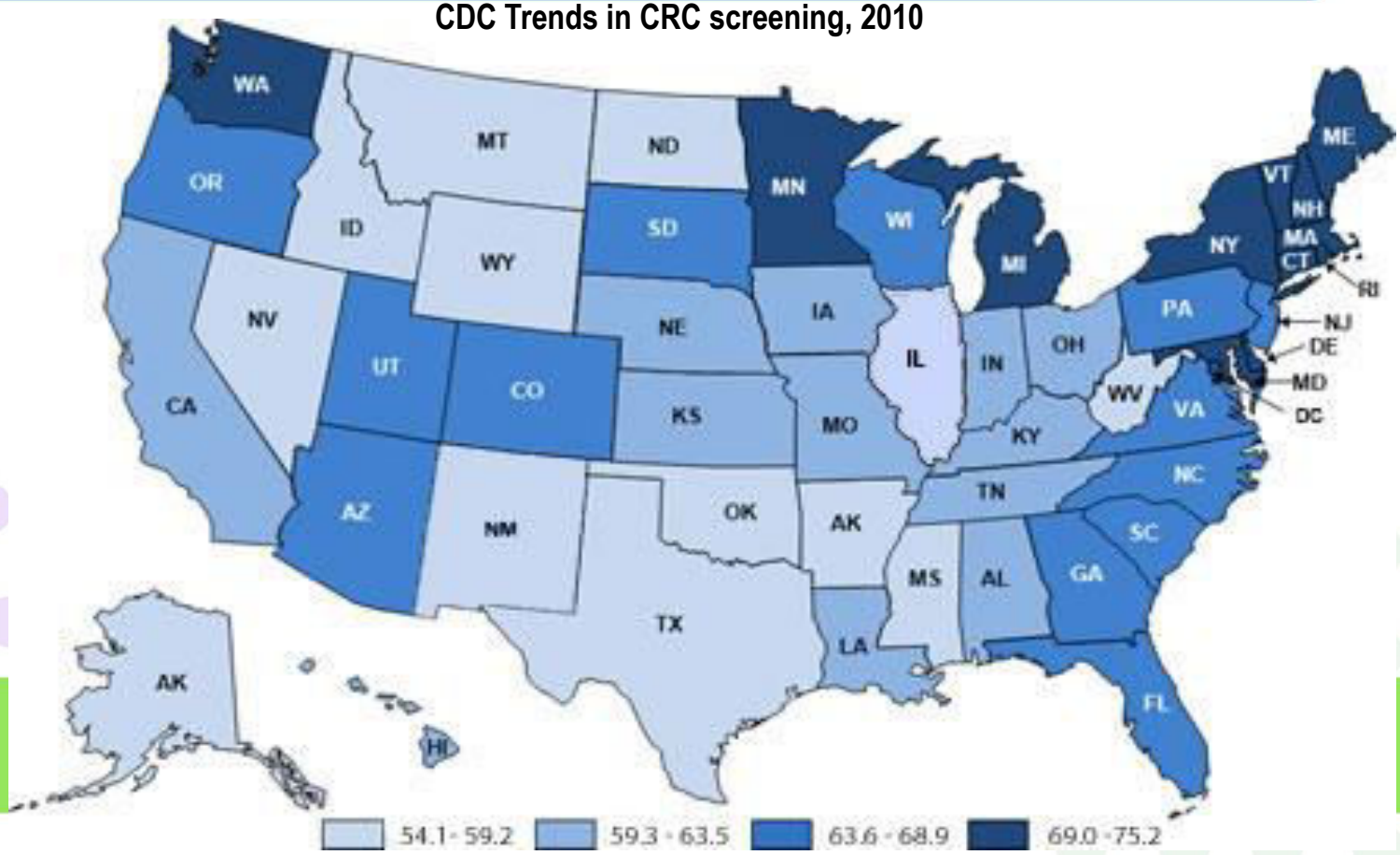
- We know how to reduce CRC morbidity and mortality
- Yet, we are terrible at implementing what we know works

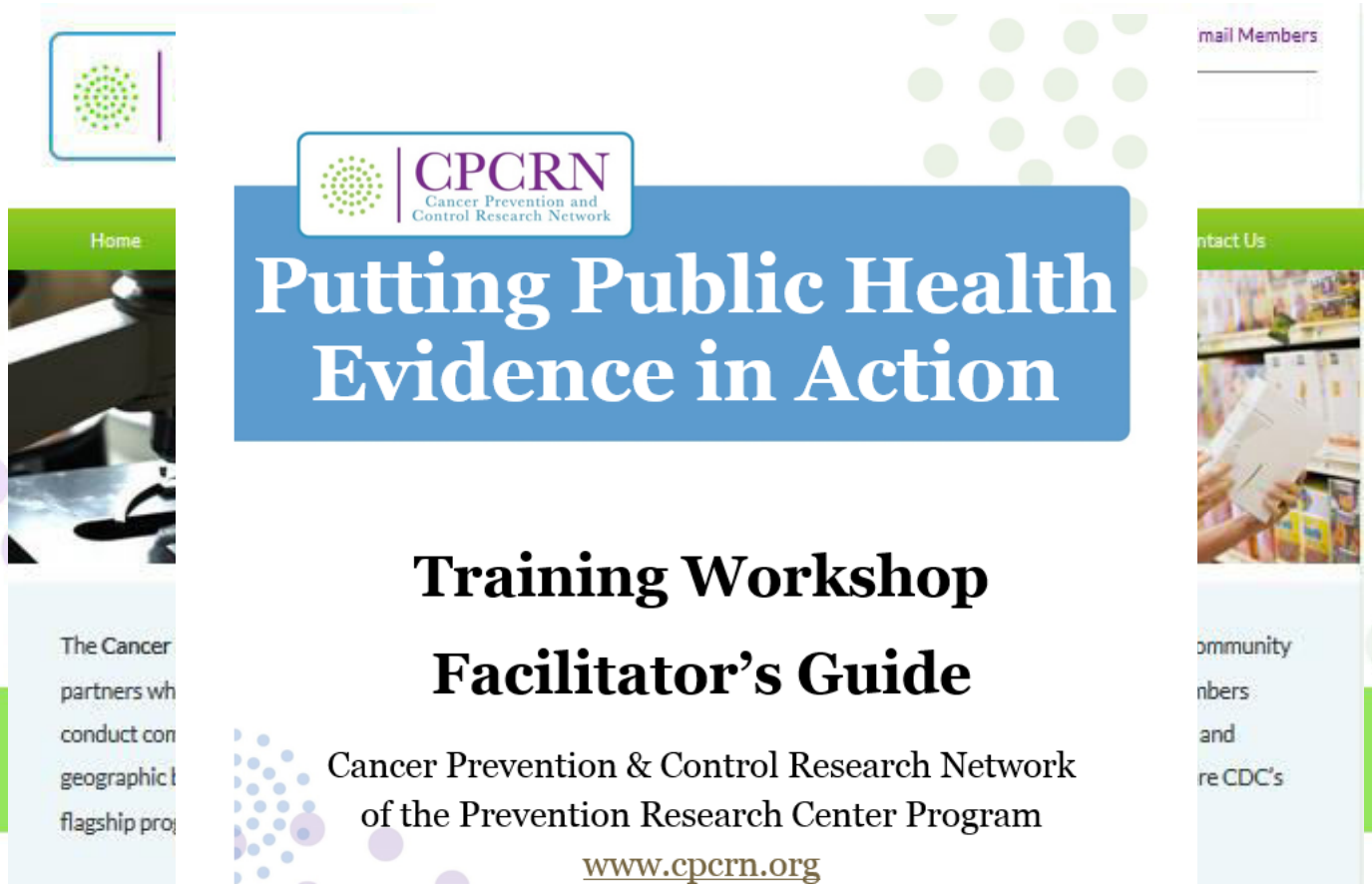
CDC Trends in CRC screening, 2010



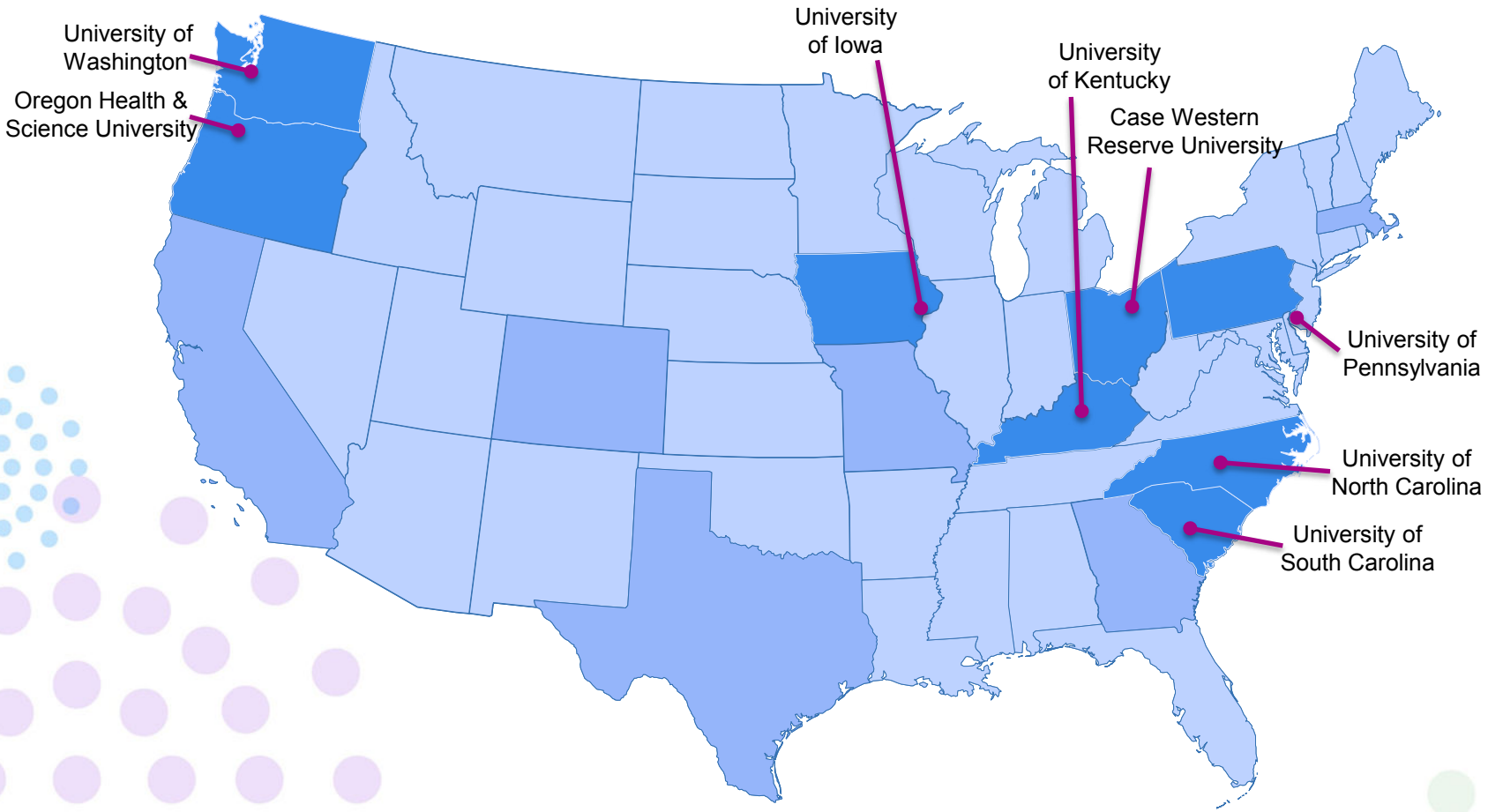
PRC
Prevention Research Centers

Cancer Prevention and Control Research Network:

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



CPCRN Network Center Map



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Evidence-Based Intervention (EBI) Modeling Impact Workgroup

Purpose:

To inform cancer screening implementation planning at practice, health system, and policy levels by integrating best available evidence into decision support models and using these models to conduct virtual comparative effectiveness research

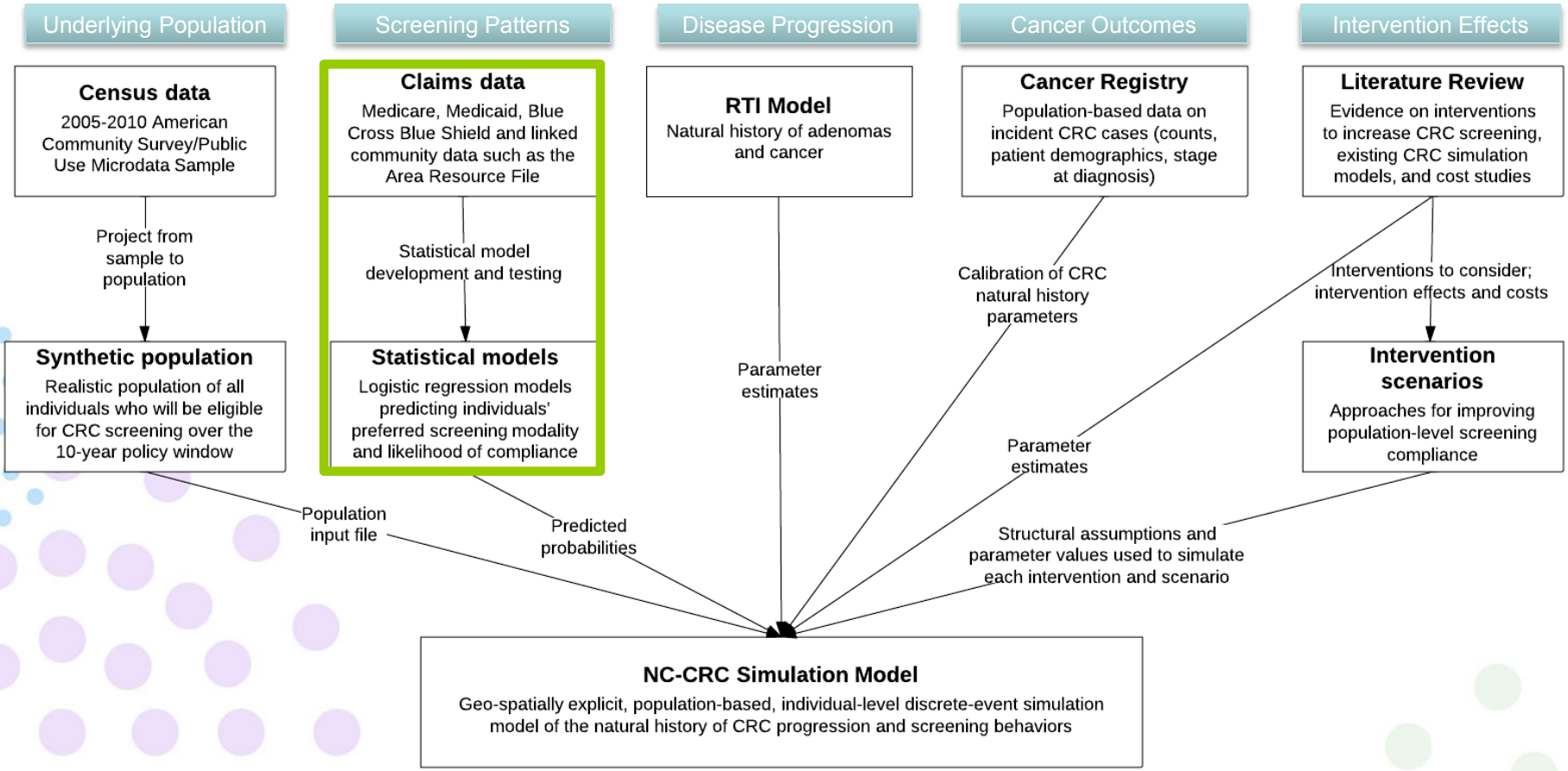
Example Works in Progress:

- Estimate statewide effect of health insurance coverage (via Medicaid expansion and health insurance exchanges) on costs and benefits of CRC screening in vulnerable populations
- Compare EBIs for improving CRC screening for Oregon's counties and regional Coordinated Care Organizations

Why simulate?

- Mathematical simulations offer a systematic method to:
  - Incorporate a range of diverse data sources into a complex "whole system" model
  - Quantify the expected uptake and health and economic impact of implementing specific EBIs
  - Forecast outcomes over a longer time period than observed in traditional epidemiologic or experimental data
  - Evaluate uncertainty
- Mathematical simulations can aid in:
  - Comparing specific EBIs to each other (selection and adaptation)
  - Evaluating implementation strategies
  - Selecting relevant implementation outcomes
  - Evaluating clinical/comparative effectiveness outcomes

Why simulate?



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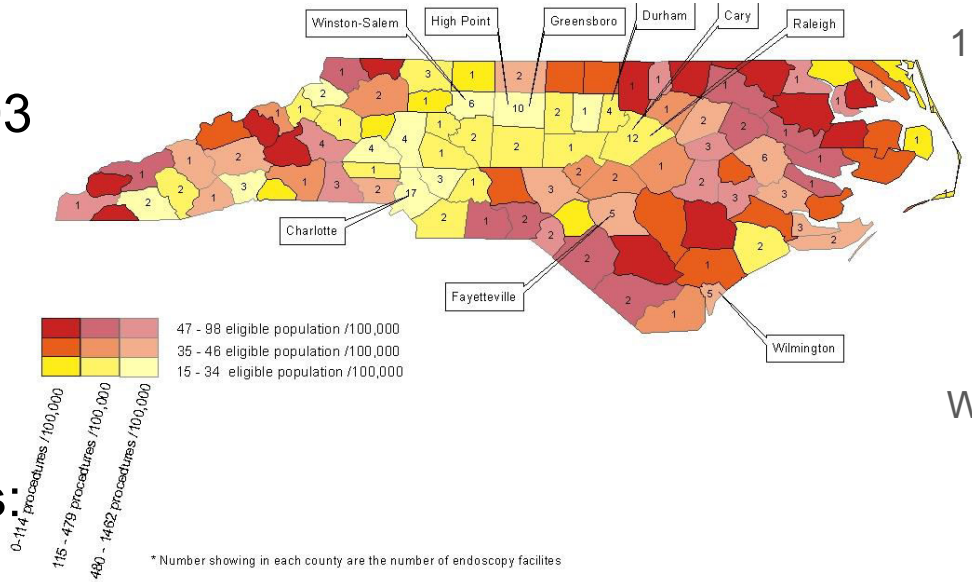
Cancer Information & Population Health Resource (CIPHR)

Unique linkages:
Cancer registry, multi-payer claims data (Medicare, Medicaid, private), SSI death index, BRFSS, other contextual data

Health Care Claims:
>6m persons since 2003

NC Cancer Registry:
100% of 2003-2013
>500,000 cases

Cases linked to claims:
80% of NC cancers
450,000



Key collaborators
May Kuo
Anne Marie Meyer
Chris Baggett

Shared resources
4 Systems developers
6 Analysts
1 program coordinator

Funding
1-U48-DP005017-01

Key pubs (>50)
Meyer et al, NCMJ, 2014
Wheeler et al, H&P, 2014
Wheeler et al, Medical Care, 2013
Wheeler et al, Prev Med Reports, 2016

CIPHR

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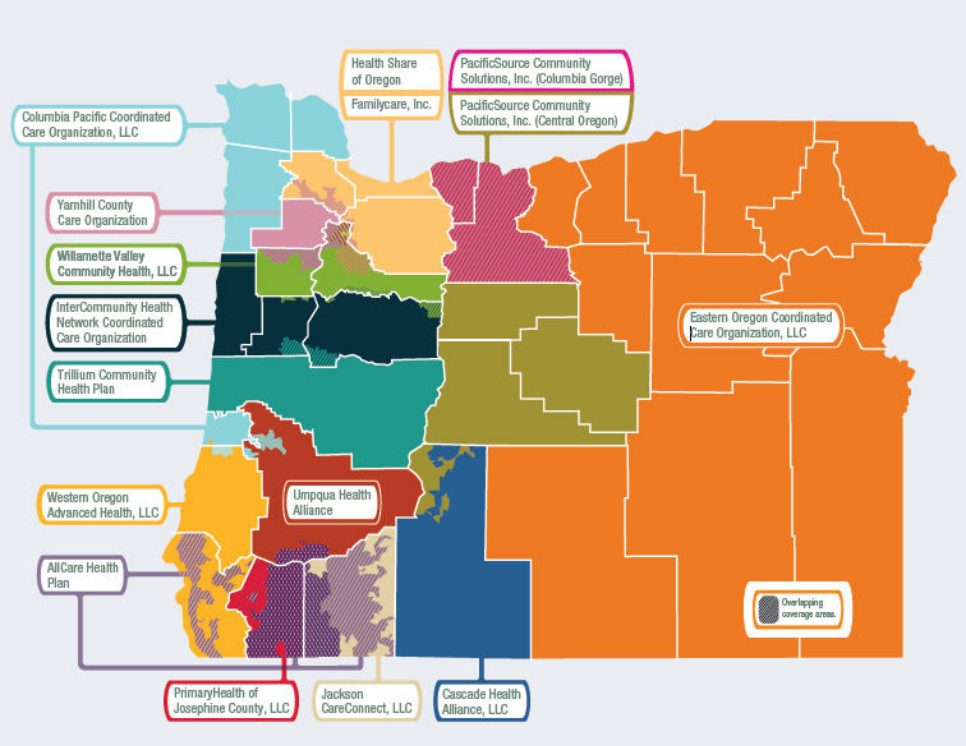
OHSU Center for Health Systems Effectiveness

Unique linkages:
Oregon All Payer All Claims database (Medicare, Medicaid, private insurers), other contextual data

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



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

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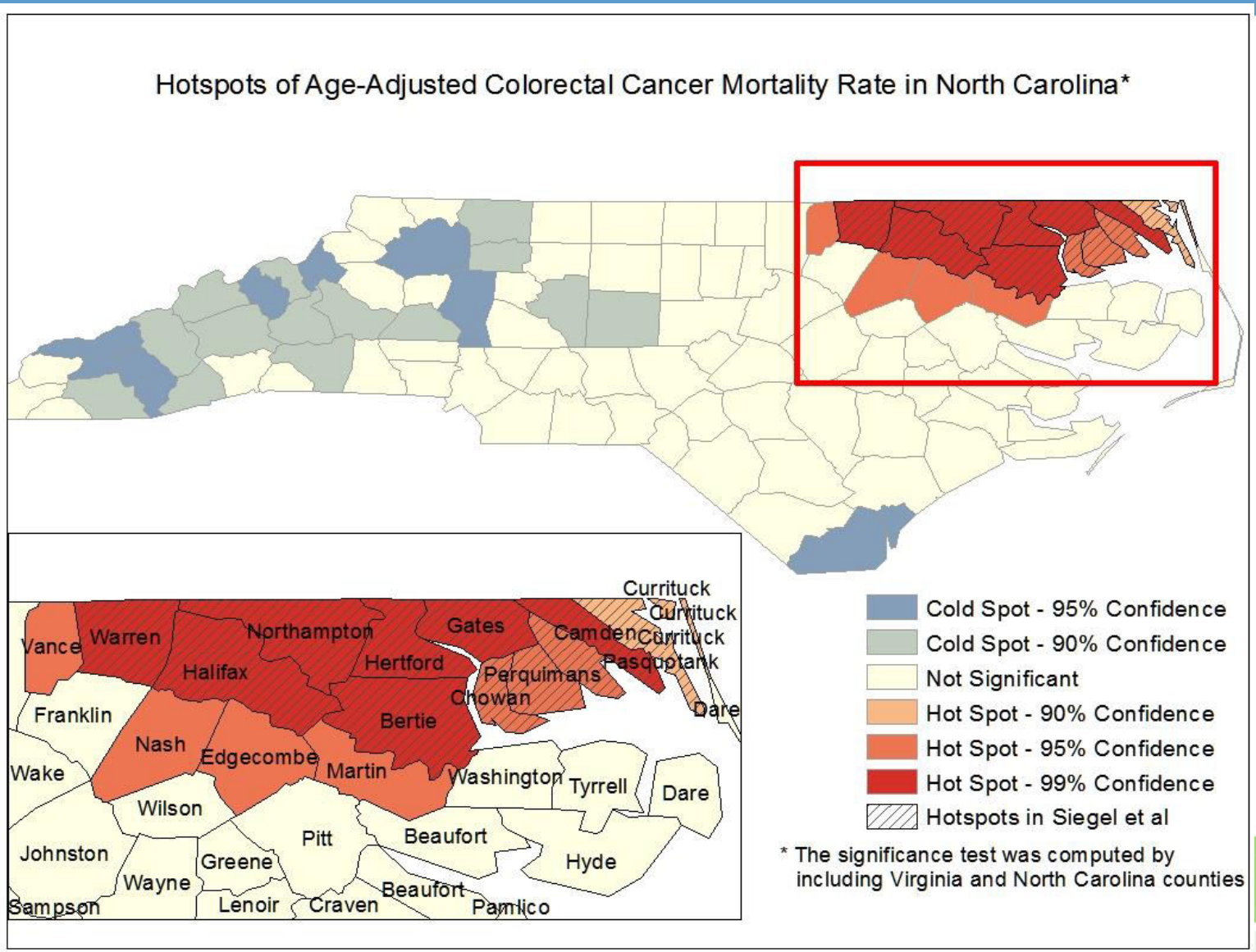
Defining target areas for intervention



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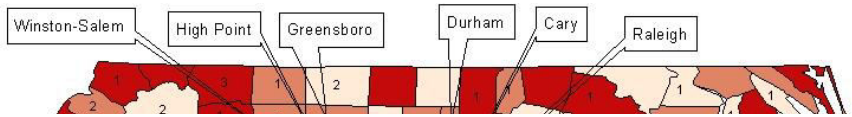
Selecting and adapting evidence based interventions for local implementation

Level	Approaches
Policy	Payment model reforms (e.g., Medicaid and private insurance expansion) Access to care for uninsured (e.g., CDC-funded CRC control program)
System	Care coordination (e.g., through medical homes, ACOs) Improving health IT infrastructure • Population identification • Visit-based reminders • Tracking systems/registries
Provider	Provider outreach, education Quality reporting and incentives to meet screening goals
Patient/Person	Decision aids delivered at visit Patient navigation support Community outreach, education, media campaigns Client reminders

Selecting and adapting evidence based interventions for local implementation

Intervention	Effect Size	Base ($)	Cost Components
Medicaid Mailed Reminder	5%age point increase in p(screen)	$10,000	Develop registry & content (one-time)
		$200 / year	Programming time
		$0.71 / reminder	Materials (postage, paper, ink)
		$3,850 / year	Mail reminders
Endoscopy Expansion	Individually-specific predicted p(screen) based upon claims-based statistical models	$500,000 / facility	Financial incentive to locate facility in 6 underserved areas
Targeted Mass Media	Will reach 80% of blacks, 2%age point increase in p(screen)	$368,000 / year	Content development (one-time)
	Will reach 40% of non-blacks, 1%age point increase in p(screen)	$332,000 / year	Advertising for one month
Voucher for uninsured	500 uninsured individuals turning 50 will receive colonoscopies	$750 / person	Voucher for colonoscopy

Quantifying the expected impact of interventions for specific areas/regions



Endoscopy proximity

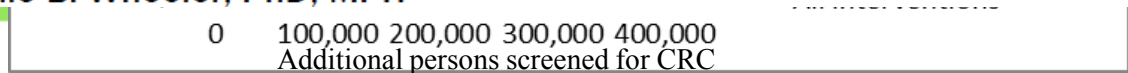
PREVENTING CHRONIC DISEASE
PUBLIC HEALTH RESEARCH, PRACTICE, AND POLICY
Volume 14, E18 FEBRUARY 2017

ORIGINAL RESEARCH

Cost-Effectiveness Analysis of Four Simulated Colorectal Cancer Screening Interventions, North Carolina

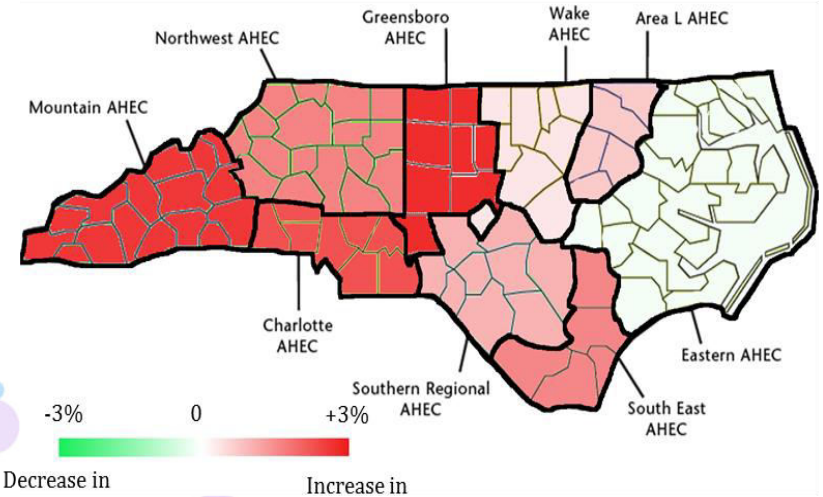
Kristen Hassmiller Lich, PhD[1]; David A. Cornejo[2]; Maria E. Mayorga, PhD[2]; Michael Pignone, MD, MPH[3,4,5,6]; Florence K.L. Tangka, PhD[7]; Lisa C. Richardson, MD, MPH[7]; Tzy-Mey Kuo, PhD, MPH[3]; Anne-Marie Meyer, PhD[3,8]; Ingrid J. Hall, PhD, MPH[7]; Judith Lee Smith, PhD[7]; Todd A. Durham, MS[1]; Steven A. Chall, MS[9]; Trisha M. Crutchfield, MHA, MSIS[4,6]; Stephanie B. Wheeler, PhD, MPH[1,3,4]

screening, at low cost.



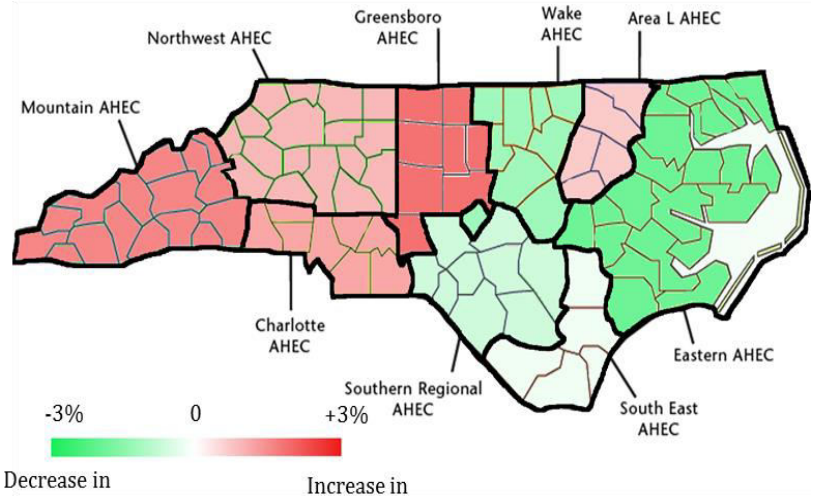
Impact of Medicaid expansion: Expected change in disparity gap between White and African American males in the percent up-to-date with colorectal cancer screening from baseline to 2023 by NC region

Control



Change in Disparity Gap from 2014 to 2023

Medicaid Expansion (High Enrollment and Compliance)



Change in Disparity Gap from 2014 to 2023

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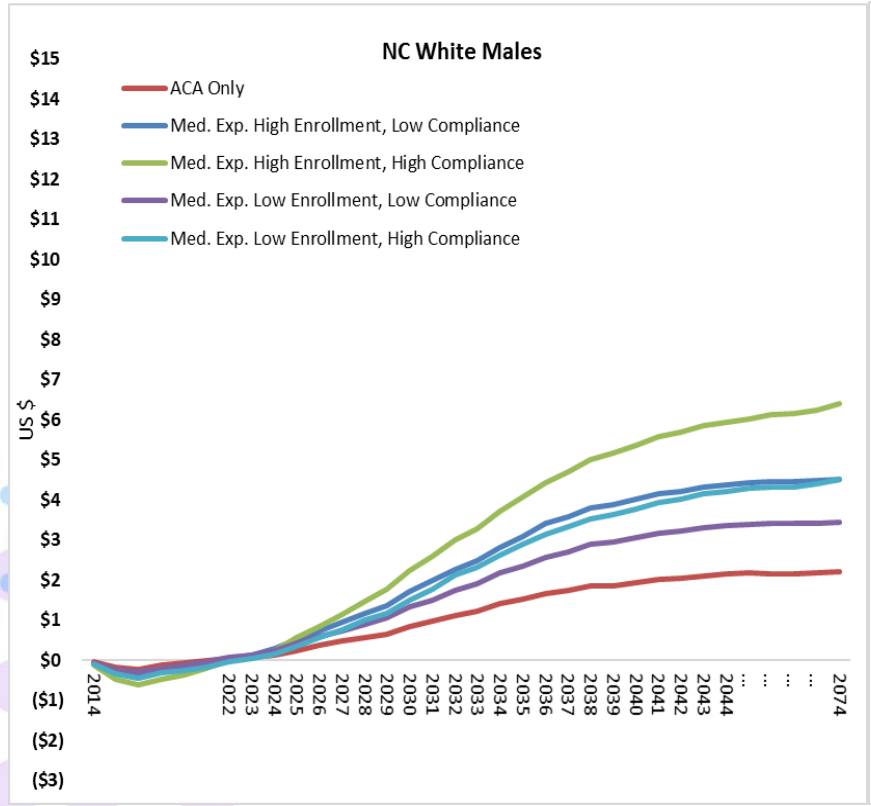
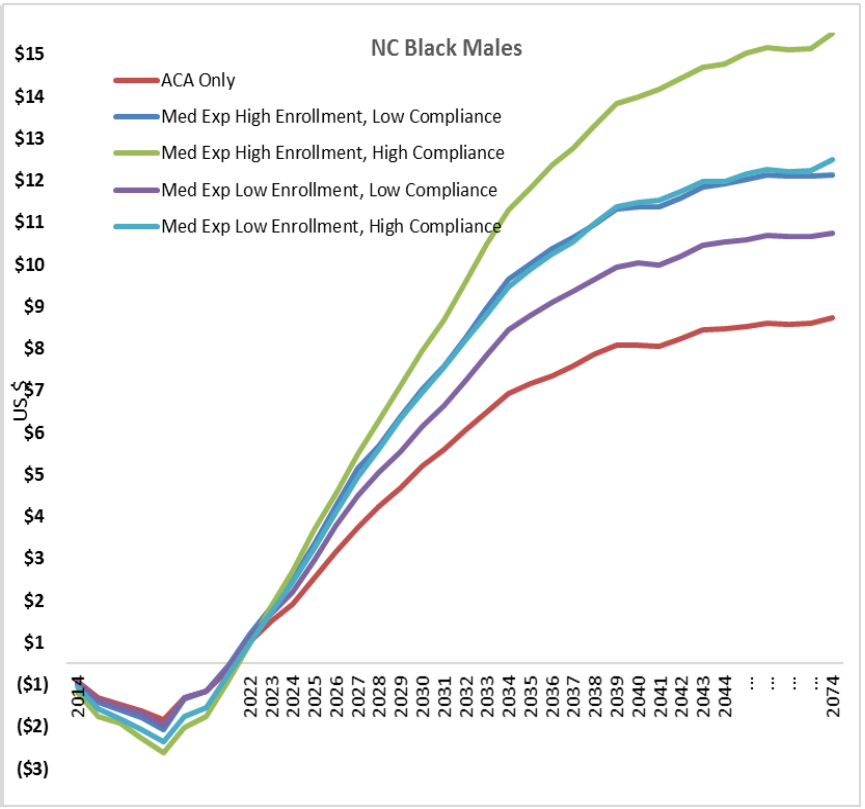
Impact of Medicaid expansion: Differences in cumulative CRC screening and treatment cost savings per person between policy scenarios





ACA and Medicaid Expansion result in substantial long-term cost savings, especially for African American males

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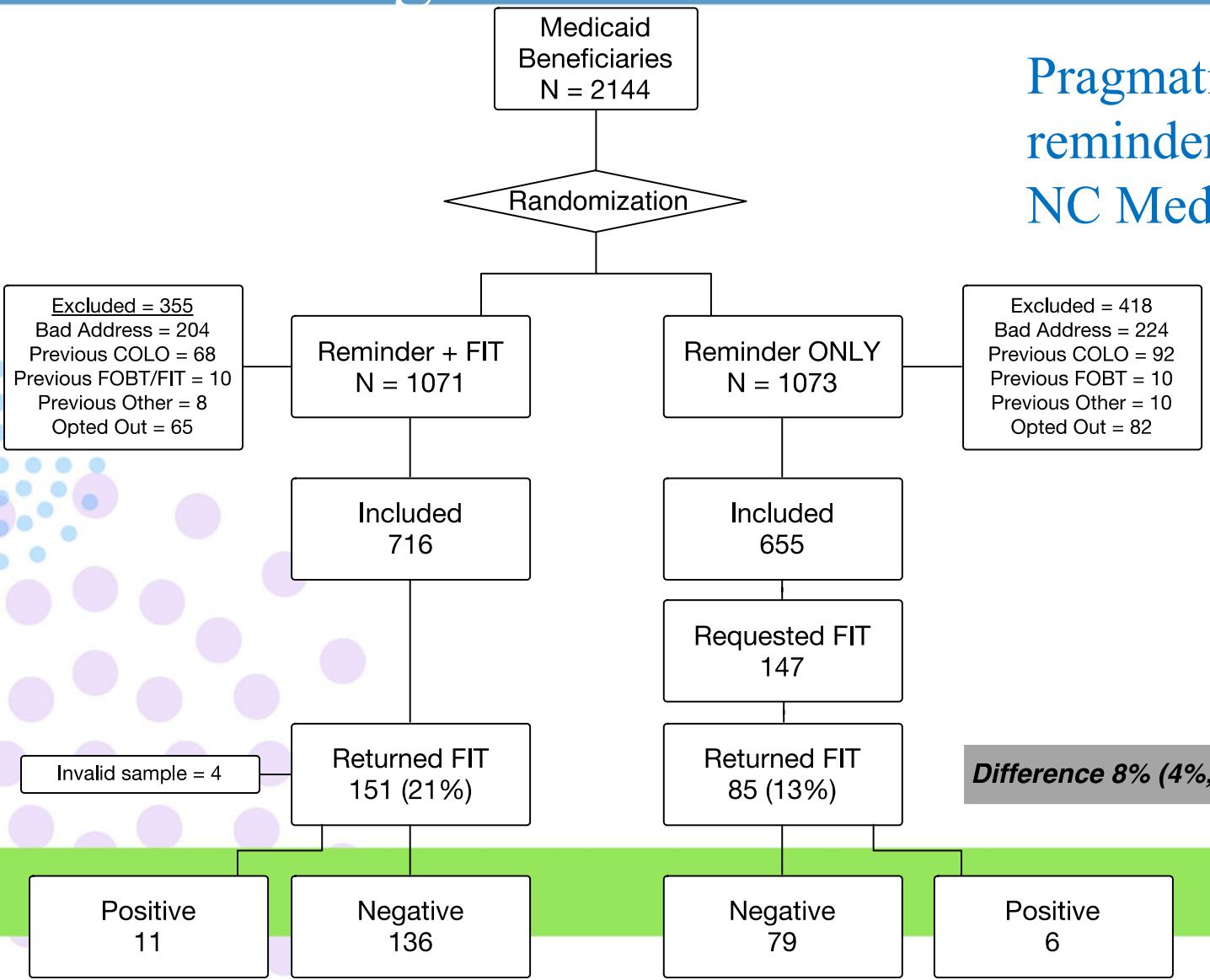
Implementing interventions and evaluating outcomes



Pragmatic trial of mailed reminders +/- FIT kits in NC Medicaid populations

Difference 8% (4%, 12%; p<0.01)

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What's next for the Modeling EBI workgroup?

- What would it take to get to 80% by 2018 in NC? In OR?
- How can we best integrate decision support modeling with implementation science for CRC screening?
  - To inform implementation of specific CRC screening EBIs in geographically distinct areas and populations:
    - Urban, publicly insured populations
    - Federally qualified health centers (FQHCs)
    - Coordinated Care Organizations (CCOs) in OR
    - Eastern NC
  - To develop best practices for using simulation in stakeholder implementation decision support

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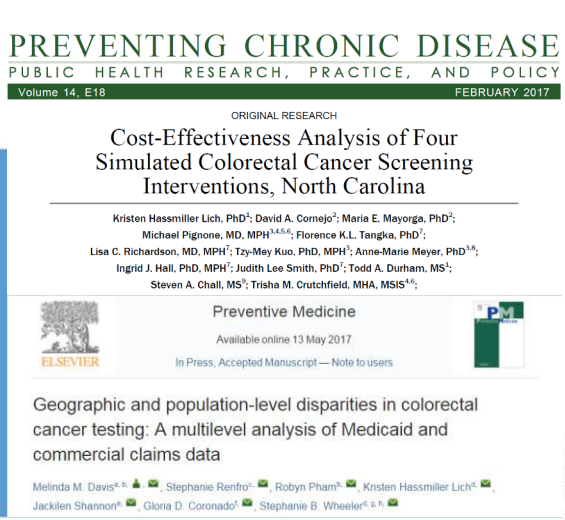
Realizing impact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Preventive Medicine
Available online 13 May 2017
In Press, Accepted Manuscript — Note to users

Geographic and population-level disparities in colorectal cancer testing: A multilevel analysis of Medicaid and commercial claims data

Melinda M. Davis[a, b], Stephanie Renfro[c], Robyn Pham[b], Kristen Hassmiller Lich[c], Jackilen Shannon[e], Gloria D. Coronado[f], Stephanie B. Wheeler[d, g, h]


Translating Cancer Surveillance Data Into Effective Public Health Interventions

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The greatest value of these data lies in their potential to support scientific and public health priority setting through

ELSEVIER
Health & Place
Volume 29, September 2014, Pages 114–123

Regional variation in colorectal cancer testing and geographic availability of care in a publicly insured population ☆

Stephanie B. Wheeler[a, b, c, d], Tzy-Mey Kuo[b], Ravi K. Goyal[b], Anne-Marie Meyer[b], Kristen Hassmiller Lich[a], Emily M. Gillen[a], Seth Tyree[b], Carmen L. Lewis[b, c, e], Trisha M. Crutchfield[c, d],


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Contents lists available at ScienceDirect
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journal homepage: http://ees.elsevier.com/pmedr

Multilevel predictors of colorectal cancer testing modality among publicly and privately insured people turning 50

Stephanie B. Wheeler [a,b,c,d,*], Tzy-Mey Kuo [b], Anne Marie Meyer [b,e], Christa E. Martens [b], Kristen M. Hassmiller Lich [a], Florence K.L. Tangka [f], Lisa C. Richardson [f], Ingrid J. Hall [f], Judith Lee Smith [f], Maria E. Mayorga [g], Paul Brown [b], Trisha M. Crutchfield [c,d], Michael P. Pignone [b,c,d,i]

- Outcomes/Products
  - Increased CRC screening
  - Evidence to inform **value**
  - 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

EIGHTYBY2018
SCREENING SAVES LIVES
Reaching 80% screened for colorectal cancer by 2018

CANCER MOONSHOT

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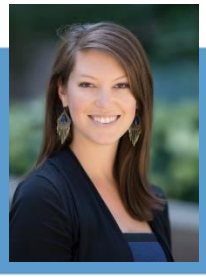
Cancer Prevention and Control Research Network

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

NATIONAL CANCER INSTITUTE

American Cancer Society

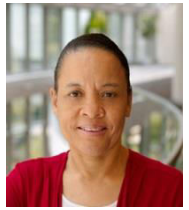
Our Team


Stephanie Wheeler, UNC


Florence Tangka, CDC


Mike Pignone, UNC


Melinda Davis, OHSU


Lisa Richardson, CDC


Kristen Hassmiller Lich, UNC

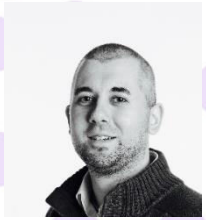

Stephanie Renfro, OHSU


Maria Mayorga, NC State


Justin Trogdon, UNC

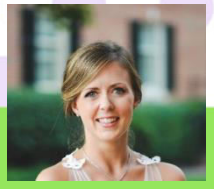

Jackie Shannon, OHSU


Siddhartha Namibar, NC State


Paul Shafer, UNC


John McConnell, OHSU


Rachel Townsley, NC State


Sarah Drier, UNC


Leah Frerichs, UNC

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Relationships, Data, and Quality Improvement Infrastructure

Critical Factors when Accountable Care Organizations and Primary Care Practices Collaborate to Increase Colorectal Cancer Screening in Medicaid Members

PRESENTED BY: Melinda M. Davis, PhD, Director of Community Engaged Research, Associate Professor – Department of Family Medicine

DATE: August 14, 2017 LOCATION: CDC National Cancer Conference, Atlanta, MD

Background

- Health system stakeholders are increasingly aligning as Accountable Care Organizations (ACOs) to support improved quality, experience, and controlled costs.

- Context:

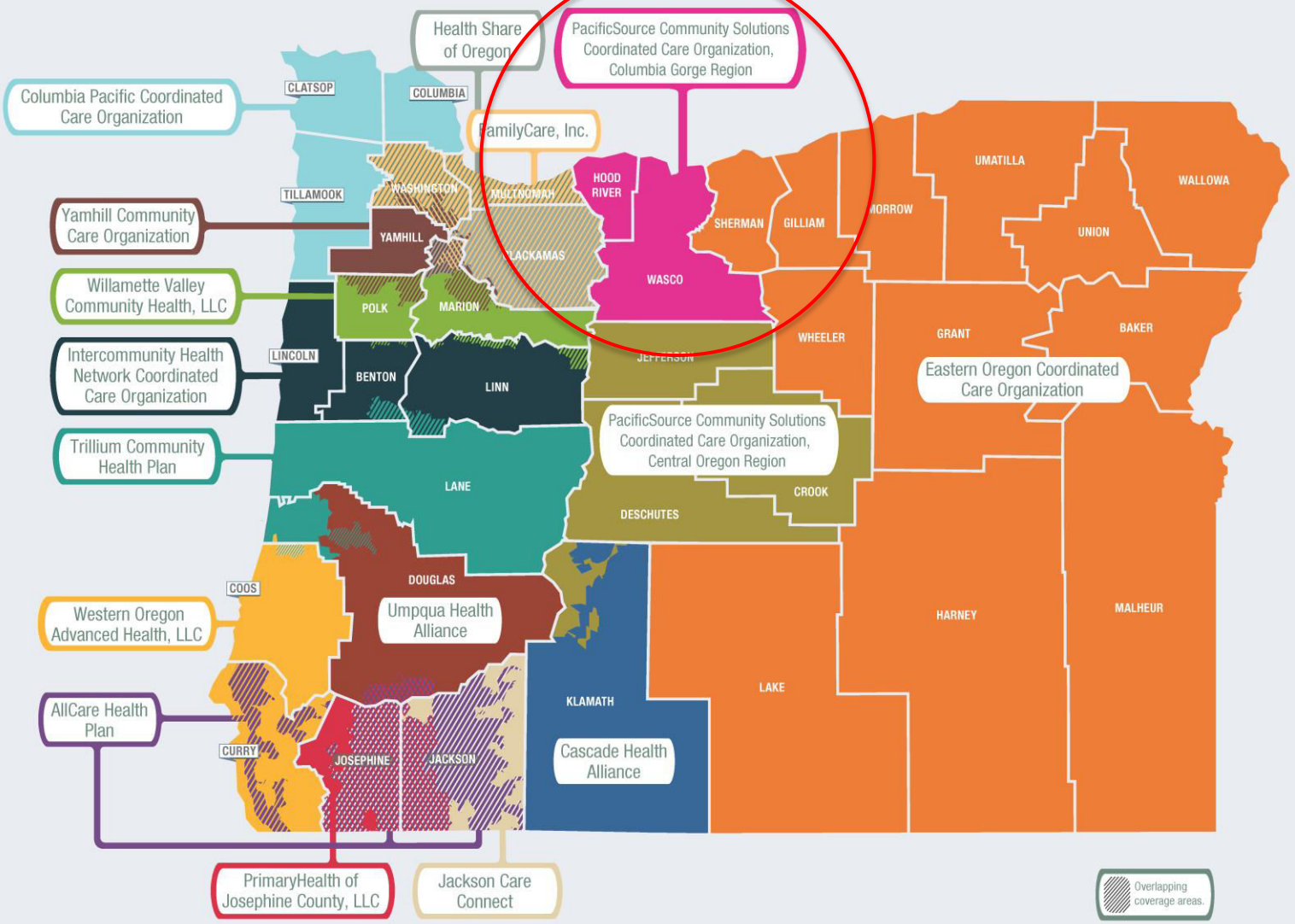
  - Oregon's Coordinated Care Organizations (CCOs, Medicaid ACOs) are the single point of accountability for health care access, quality, and outcomes of Medicaid members.

  - Colorectal cancer screening is one of 18 CCO quality incentive metrics.

- **Research Questions:** How are clinics and ACOs/CCOs working together to improve care (colorectal cancer screening)? What interventions are they implementing?

OHSU

Coordinated Care Organization Service Areas

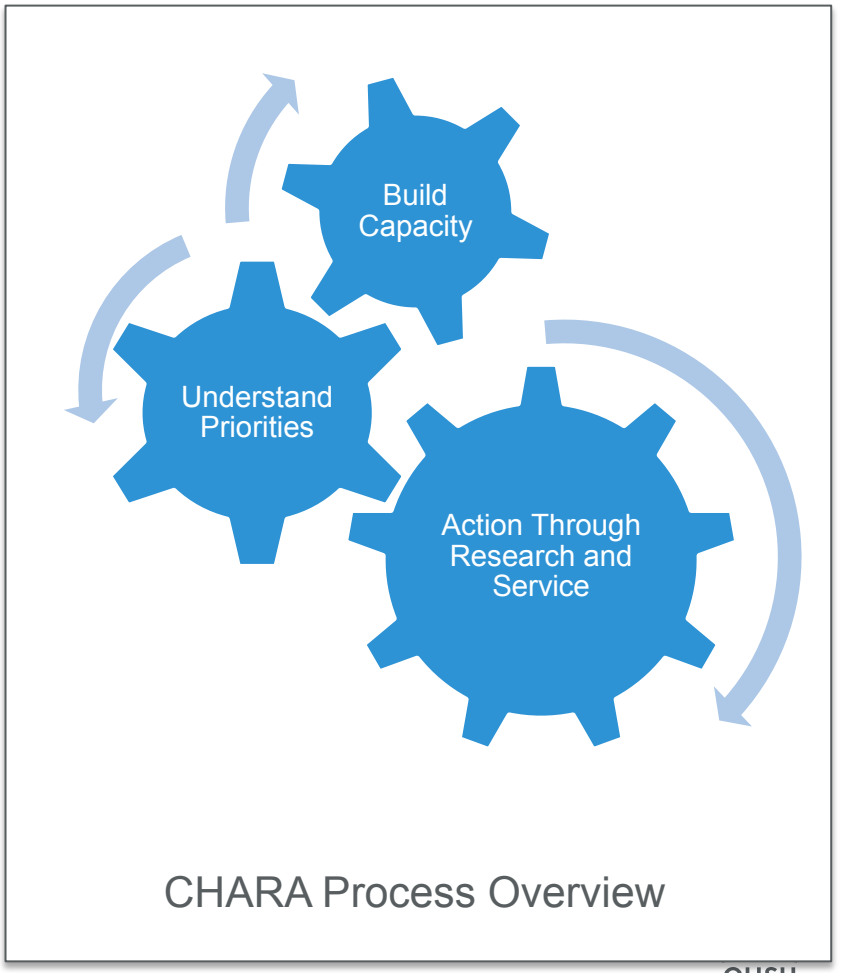


Oregon Health Authority

OHSU

Community Health Advocacy and Research Alliance (CHARA)

- Location: Columbia River Gorge (PacificSource CCO Region)
- Established with funding from the PCORI Pipeline to Proposal Award Series (2014 – 2017)
- **Goal:** Network of community members, local health leaders and researchers who can "identify, develop, and conduct health research to answer questions that matter here."



CHARA Process Overview

For more information: davismel@ohsu.edu
http://www.communityresearchalliance.org/

CRC Testing in Oregon: Multilevel Factors

Preventive Medicine
Available online 13 May 2017
In Press, Accepted Manuscript — Note to users

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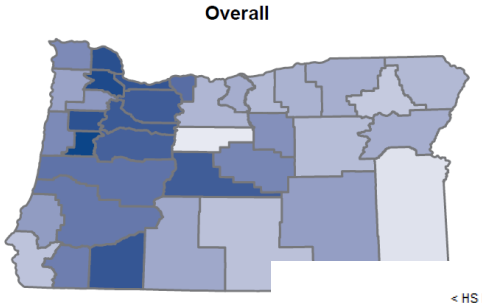
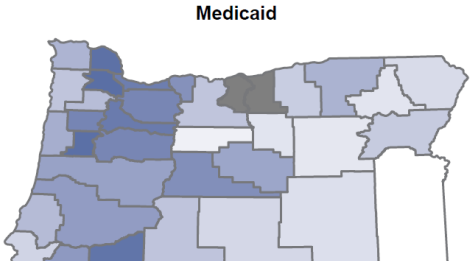
Show more

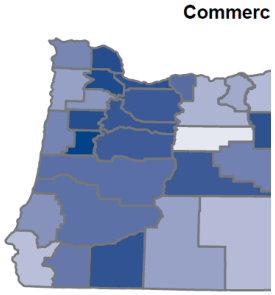
https://doi.org/10.1016/j.ypmed.2017.05.001

Highlights

- Despite insurance, 58% had not received colorectal cancer (CRC) testing.
- CRC testing varied from 22.4% to 46.8% across Oregon's 36 counties.
- Individual, community, and health system-level factors impacted CRC testing.
- Counties with higher socioeconomic deprivation displayed lower CRC testing.
- Work to increase CRC testing in targeted counties and populations is needed.







	< HS Educ	< FPL	Unemployed	Uninsured	Fam Med MDs	Specialists
Jefferson - 22.4	16.3	21	10.7	25.1	4.1	0.9
Malheur - 23.4	20.2	25.8	8.7	22	1.3	3.3
Union - 26.6	10.7	19	8.2	17.2	1.9	7
Curry - 27.6	9.2	17.9	10.6	18.7	4.5	1.8
Lake - 27.9	13.6	19.8	11.1	20.2	5.1	0
Grant - 28.5	11.2	18.8	11.8	20.7	9.6	0
Gilliam - 28.9	10.4	11.6	6.9	15.2	0	0
Wallowa - 29.0	7.7	16.6	9.9	19.5	8.8	2.9
Wasco - 29.4	16.7	17	7.1	21.9	3.5	4.3
Morrow - 30.0	21.7	15.5	7.8	20.1	2.7	0.9
Baker - 30.5	11.9	19.3	9.2	17.4	6.9	1.9
Umatilla - 30.5	17.8	17.5	8.1	21	2	2
Sherman - 30.7	9.8	14.8	7.3	16.6	0	0
Klamath - 31.4	12.8	19.9	10.7	21.6	8.3	3.3
Tillamook - 32.1	11.5	15.4	7.2	22.7	5.5	2
Harney - 32.8	10.6	18.5	12.3	21.9	8.3	0
Coos - 33.2	12.2	20.6	9.9	18.6	3.2	6.4
Yamhill - 33.8	12.8	16.9	7.4	17.4	3.3	4.7
Wheeler - 34.9	12.8	21.8	7.1	22	0	0
Clatsop - 35.7	8.2	17.1	6.8	17.5	4	3.5
Lincoln - 35.8	10.7	18.5	8.2	21.7	2.2	2.8
Crook - 36.4	14.6	18.9	12.3	18.6	3.9	0
Josephine - 37.6	11.8	22.2	10.9	19.4	3.4	3.7
Douglas - 38.6	13.2	21.3	10.8	18.2	1.9	5
Lane - 39.3	9.4	22.1	7.6	17.7	4	7.3
Hood River - 40.2	17.7	14	6.1	21.6	13.3	7.1
Linn - 42.2	11.3	17.6	9.7	16.6	4.5	2.4
Deschutes - 42.8	7	15.8	9.5	18.2	3.9	8.3
Clackamas - 43.0	7.6	9.3	6.8	13.7	2.6	8.1
Marion - 43.3	16.9	20.2	8.4	20.6	4.2	4.7
Jackson - 43.9	10.6	18.1	9.5	19.2	4.1	8.1
Multnomah - 44.1	10.5	18.3	6.9	16.7	4.5	19.4
Polk - 44.7	10.1	16.2	7.6	15.6	2.4	2.6
Columbia - 45.0	11.1	15.8	8.2	15.2	1.4	1.4
Washington - 45.9	9.3	12.1	6.3	14.1	2.6	10.4
Benton - 46.8	6	19.7	5.8	13.7	3.8	13.2

- Controlling for age, beneficiaries had greater oc testing if they were female (OR 1.04, 95% CI 1. commercially insured, or urban residents (OR 1 1.21).
- Accessing primary care (OR 2.47, 95% CI 2.37 [illegible]), but not distance to endoscopy (OR 0.98, 95% CI 0.92-1.03) was associated with testing.

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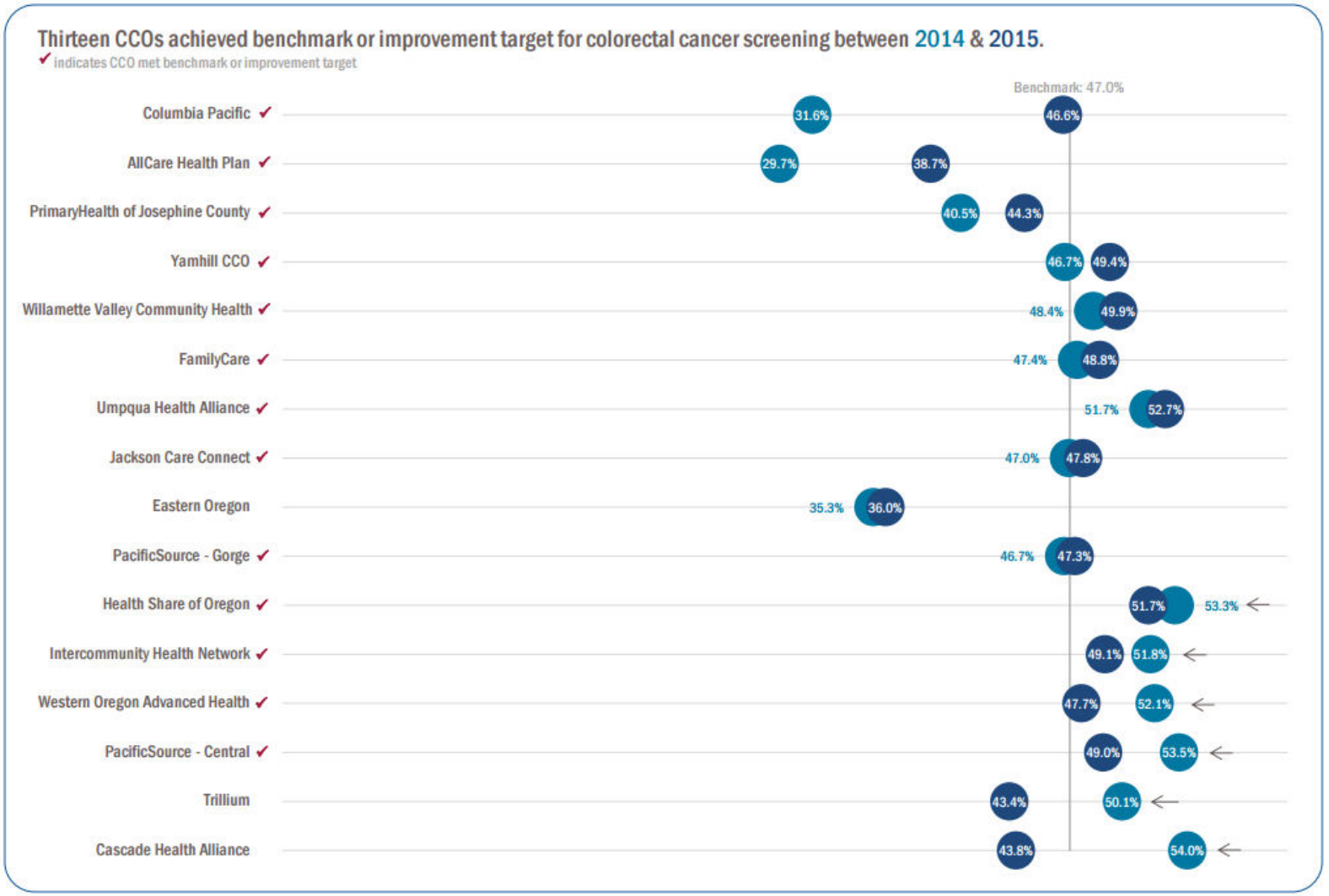
CRC Screening in Oregon's CCOs



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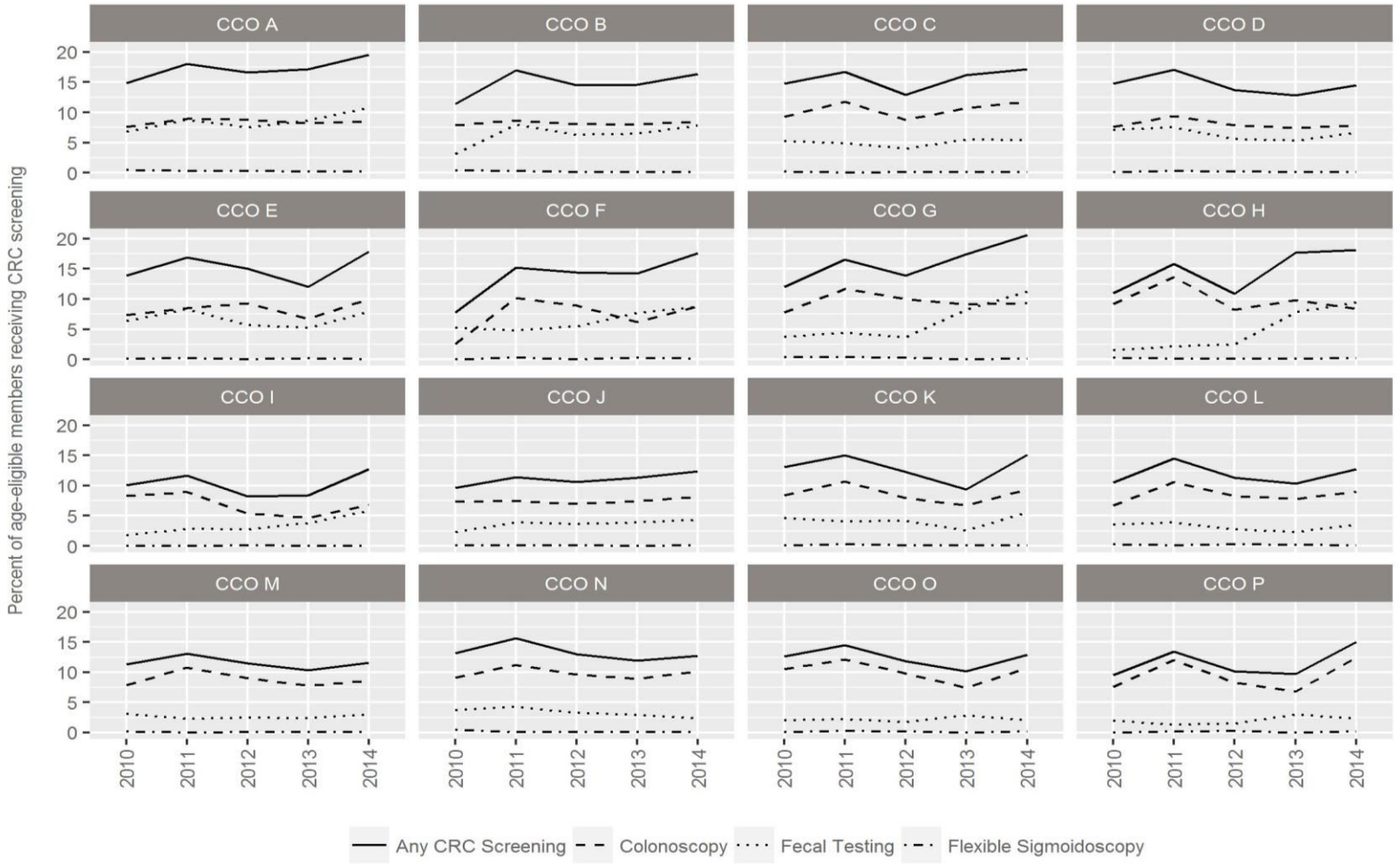
Point Prevalence of CRC Testing in Oregon CCO Medicaid Members



Results displayed where number of cases (denominator) ≥ 10.

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Methods

- Design & Setting: Observational cross case comparative study among Oregon's 16 CCOs
- Data Collection & Participant Sample:
  - CRC technical assistance consults with CCOs between June – July 2016
  - Semi-structured interviews with key stakeholders between February – August 2016
- Analysis: Fieldnotes & interview transcripts transferred to Atlas.ti and analyzed using data-driven, emergent approach

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Results - Participants

- Data gathered from 14 of 16 CCOs
  - 10 CCO consultations
  - 26 key informants: state innovator agents (n=4), CCO leadership (n=16) and primary care practice members (n=6)
- Over 30% of the informants (n=8) worked with more than 1 CCO.

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Results

- CCOs developed their strategies and infrastructure to work with clinics over time
- CCOs often started very lean: *"for over a year and a half, [the CCO] didn't lease a physical office space... They held meetings in their partners' offices." (P12)*
- CCOs implemented multicomponent interventions to improve CRC screening

CRC Intervention Strategy	Component	Evidence-based?*
Increase community demand	Client reminders	Yes
	Client incentives	Insufficient
	Small media	Yes
	Mass media	Insufficient
	One-on-one education	Yes
Interventions to increase community access	Reducing structural barriers	Yes
	Reducing client out-of-pocket costs	Insufficient
Interventions to increase provider delivery	Provider assessment & feedback	Yes
	Provider reminder & recall	Yes
	Provider incentives	Insufficient

* Based on the Guide to Community Preventive Services

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CCO Case Examples

Regional efforts have focused on implementing incentive programs for members ($20 Walmart gift card for returning a fecal test) and providers ($50-$100 when a patient completes screening). The CCO has improvement staff who leverage relationships with practices to provide education on their alternative payment method (APM) strategies, help create pop-up reminders in clinic EHRs, and provide patient gap lists. Additionally, CCO receptionists make reminder calls to patients that are due for screening.

...the CCO elected to implement a direct mail program modeled after Kaiser. CCO leadership worked with 4-5 clinics to pilot test the intervention and work out the kinks in the first year; this included learning to have clinics review member lists in advance. The program has expanded over time and recently transitioned from implementation by CCO staff to a contract with a vendor who supports material prep and distribution. The CCO also distributes money from the quality metric pool back to clinics that meet their CRC performance targets.

Results

CCOs addressed three key dimensions as they sought to improve CRC screening with regional clinics:

1) Establishing and building relationships

2) Producing and sharing data

3) Developing a process and infrastructure to support quality improvement (QI)

1) Establishing Relationships

Relationships and physical proximity were critical in building trust, buy-in, and shared decision making for improvement activities by CCO and clinic partners.

"…[CCO A] did not exist as an entity on the ground before…for us in [rural] Oregon, Portland can sometimes be a million miles away…Versus [CCO B] that has a physician led organization and the community…you knew the players from that one [from the start]." (P15)

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“I think that's the way we've been able to achieve anything [is by building and leveraging relationships]. It has to be a partnership with the clinic, because we really are a guest in their clinics, so you can't just go in there and tell them what to do.”

- CCO Staff, P9

2) Producing and Sharing Data

Multiple CCOs focused on generating and producing actionable data to inform improvement efforts

- Some CCOs routinely, and strategically, shared data with member clinics
- Others were refining their approach

Clinics varied in their interest and ability to respond to performance data

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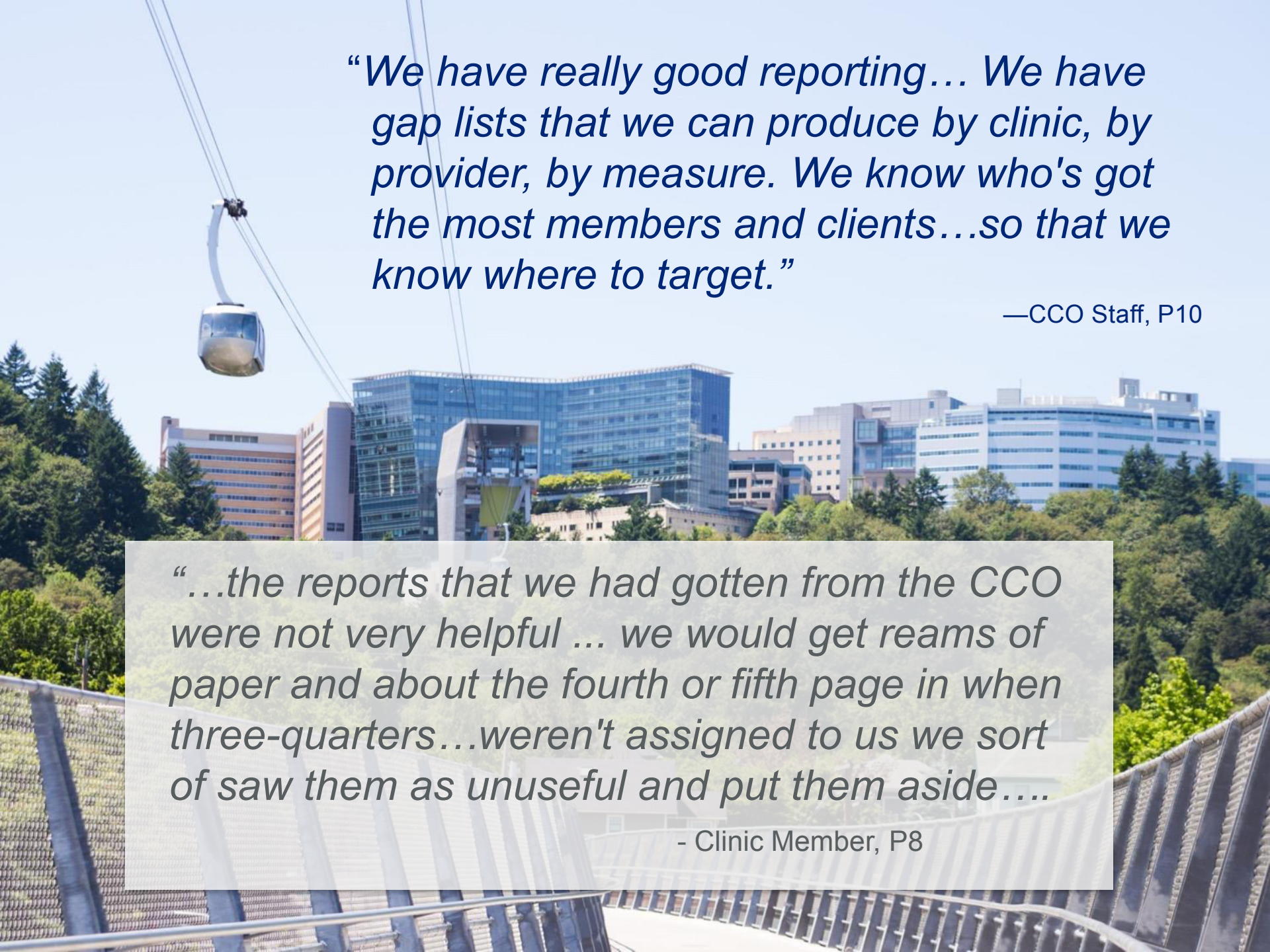

"We have really good reporting… We have gap lists that we can produce by clinic, by provider, by measure. We know who's got the most members and clients…so that we know where to target."

—CCO Staff, P10

"…the reports that we had gotten from the CCO were not very helpful ... we would get reams of paper and about the fourth or fifth page in when three-quarters…weren't assigned to us we sort of saw them as unuseful and put them aside…..

- Clinic Member, P8

3) Developing a Process and Infrastructure to Support QI

Some CCOs led regional learning collaboratives and supported improvement staff

- Clinic-based panel managers and QI leads
- CCO-level improvement staff

"[The CCO improvement staff] actually come [out here to] the clinic and say, "What do you guys need as a clinic? What can we do to help you?"…they do a lot of support for [clinic] management …for implementation of metrics… They are really there to help operationalize [what] we need to do to show that we're giving good care….They help with data collection…They're fabulous. I couldn't ask for anything more." (P11)

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Conclusions

- CCOs used multicomponent strategies to increase CRC screening
- Not all interventions had sufficient evidence, according to the Community Guide
- CCOs needed to address relationships, data, and QI infrastructure when working with clinics to increase CRC screening

→ similar steps for other quality metrics?

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Implications & Recommendations

- Health system and policy leaders must consider relationships, data, and QI infrastructure when implementing population health initiatives across diverse settings
  - Understand/assess/respond to local context
  - Allow prior history and experience to inform partnership goals
  - Set realistic improvement targets based on local capacity
- Use and equity-based participatory implementation science approach
- Monitor for unintended consequence: increasing disparities because of focus on “larger” clinics/systems

See also, Wheeler & Davis (In Press). “Taking the Bull by the Horns”: Four Principals to Align Public Health, Primary Care, and Community Efforts to Improve Rural Cancer Control. *Journal of Rural Health.*

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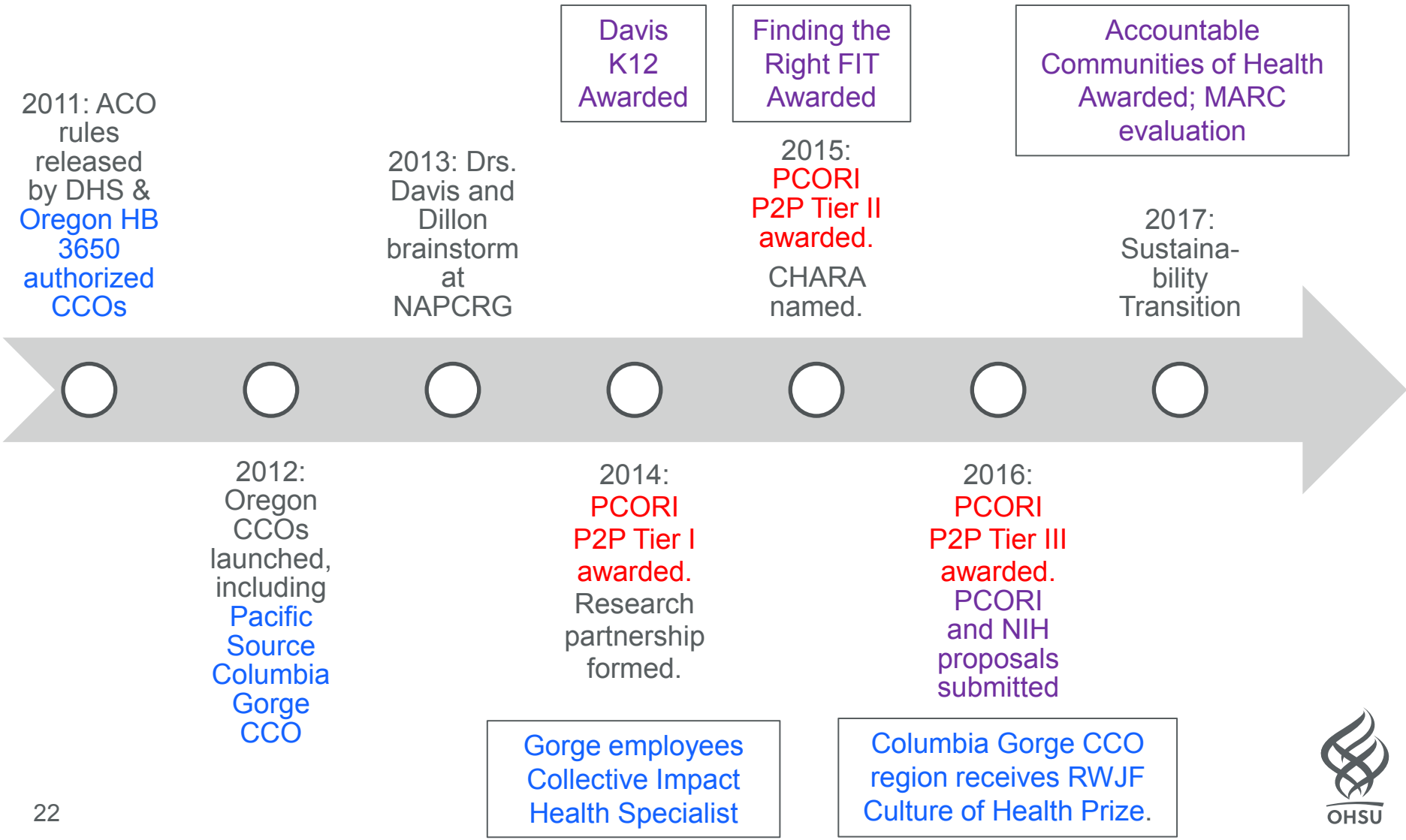
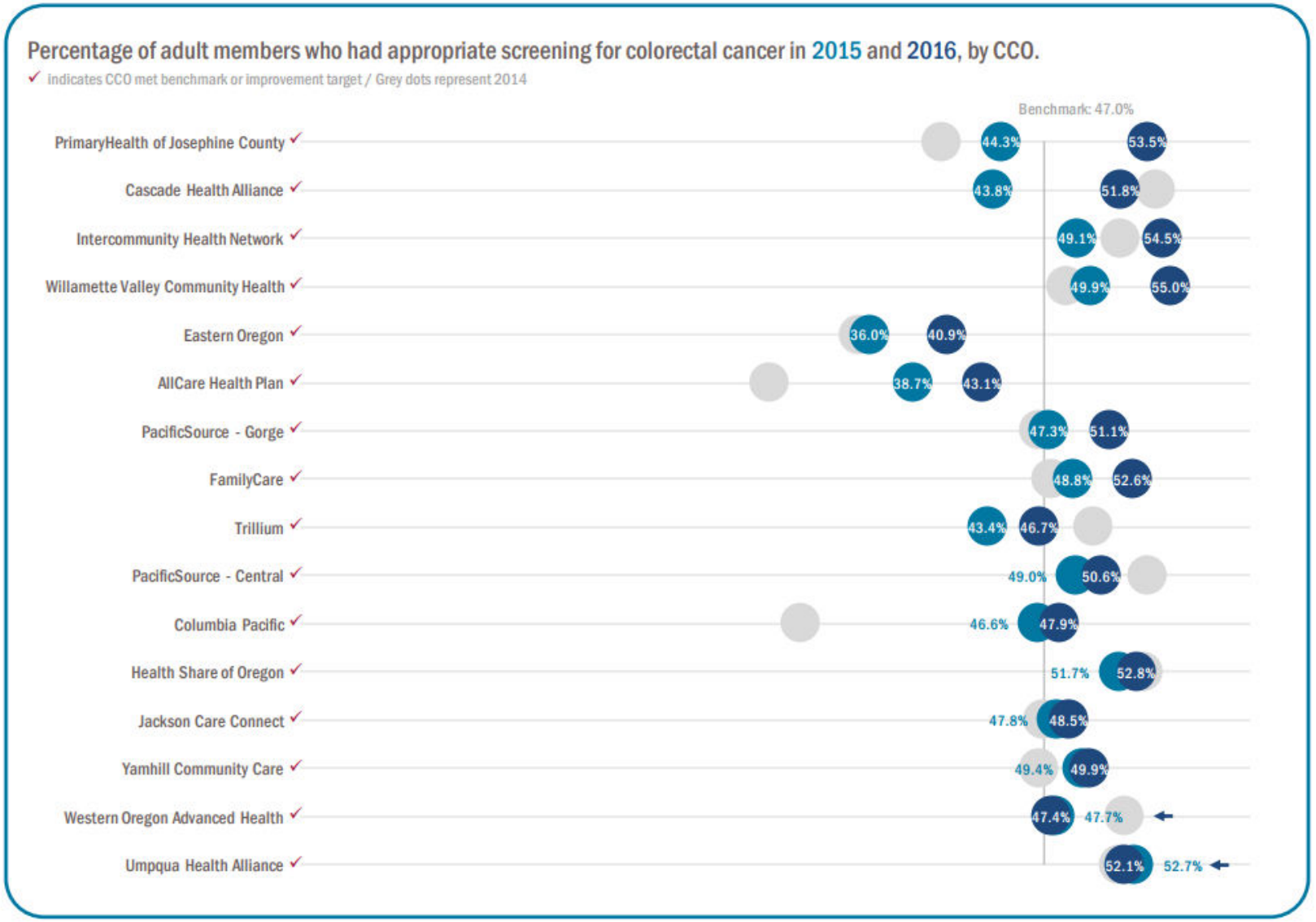
Thank You

For more information: davismel@ohsu.edu

Community Health Advocacy and Research Alliance (CHARA) Timeline



CRC Screening in Oregon's CCOs



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Technical Considerations: the past, present and future of simulation modeling of colorectal cancer

EDWARD P. FITTS DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

Siddhartha Nambiar, Rachel Townsley, Maria Mayorga
North Carolina State University

Kristen Hassmiller Lich, Stephanie Wheeler
University of North Carolina-Chapel Hill

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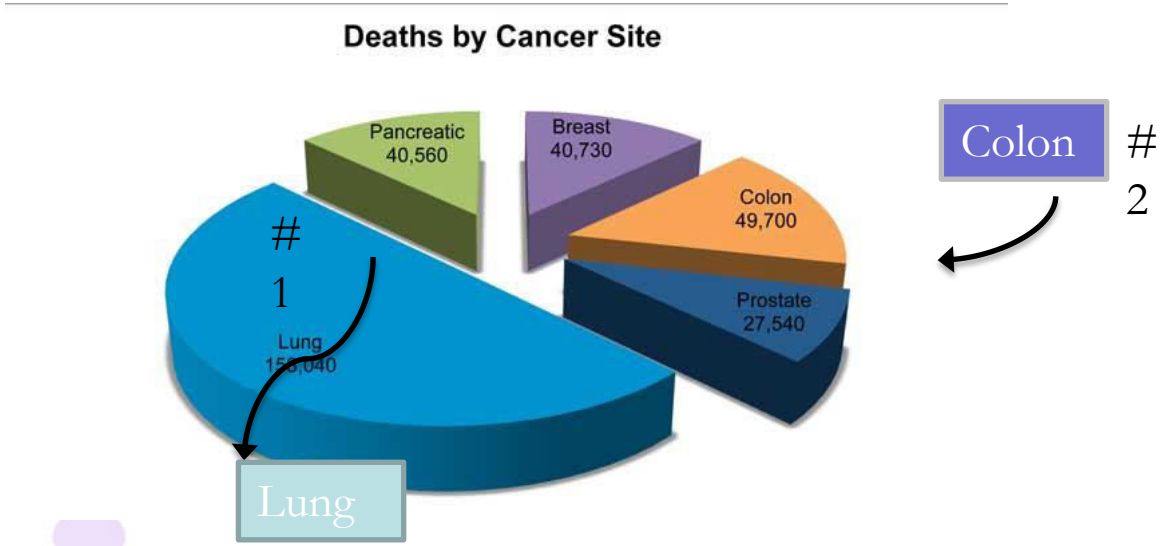
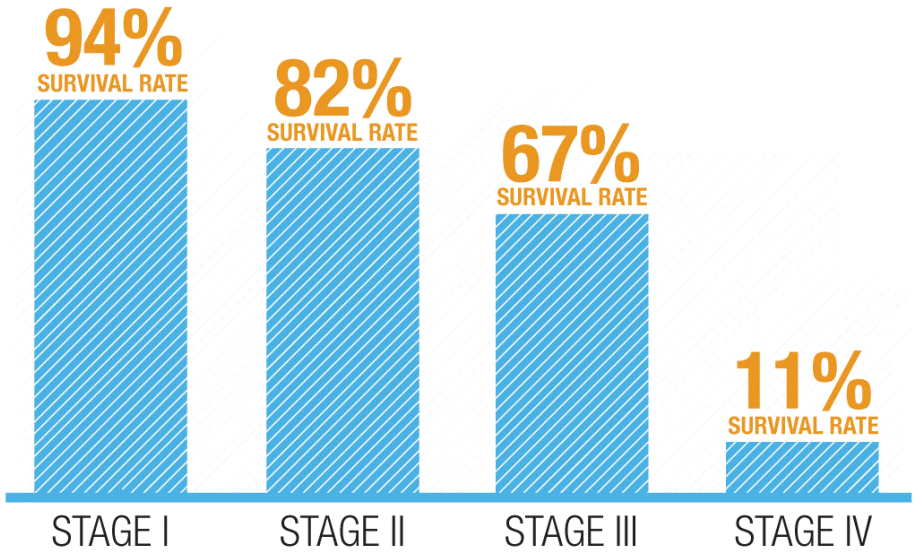
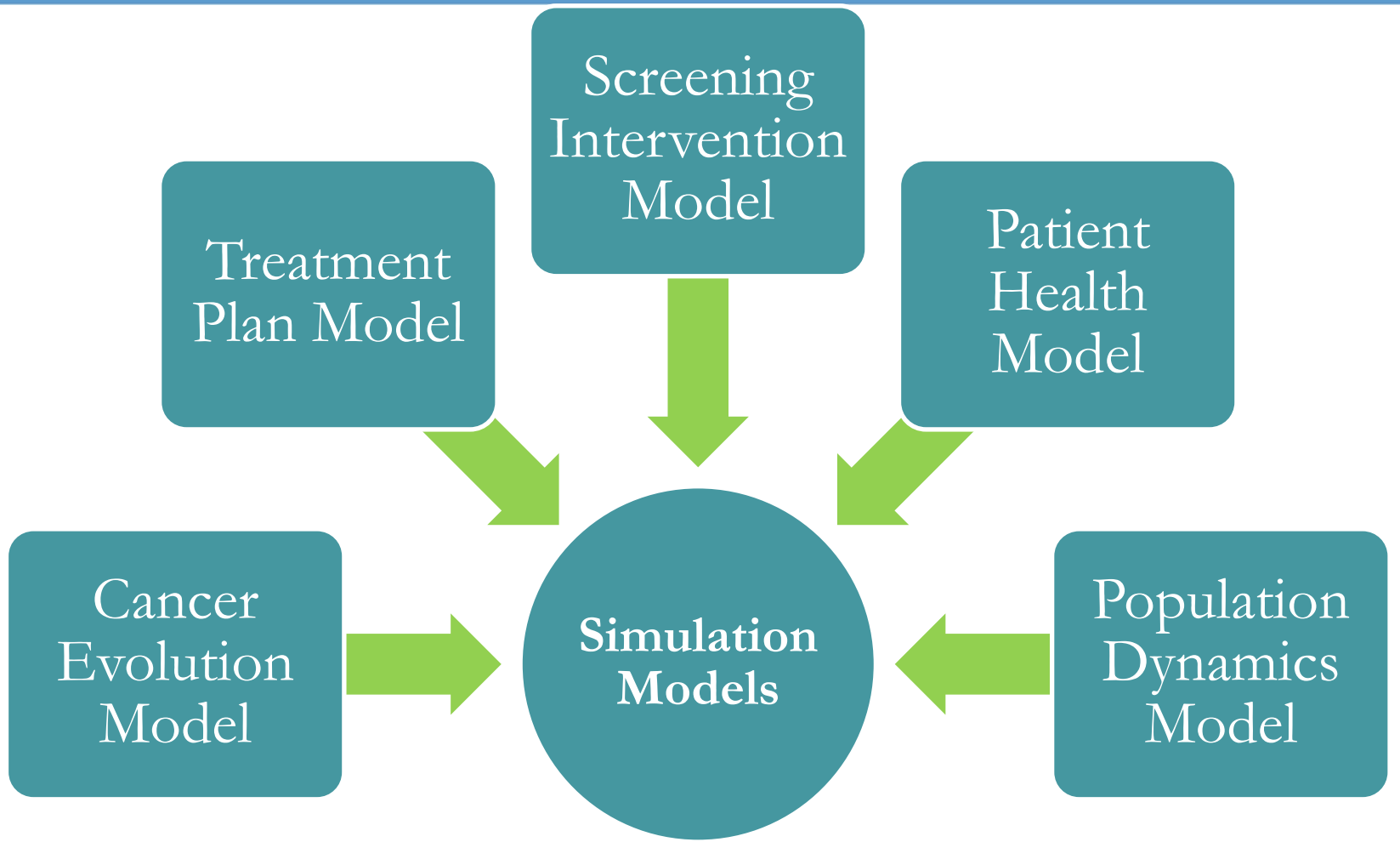
Background on Colorectal Cancer



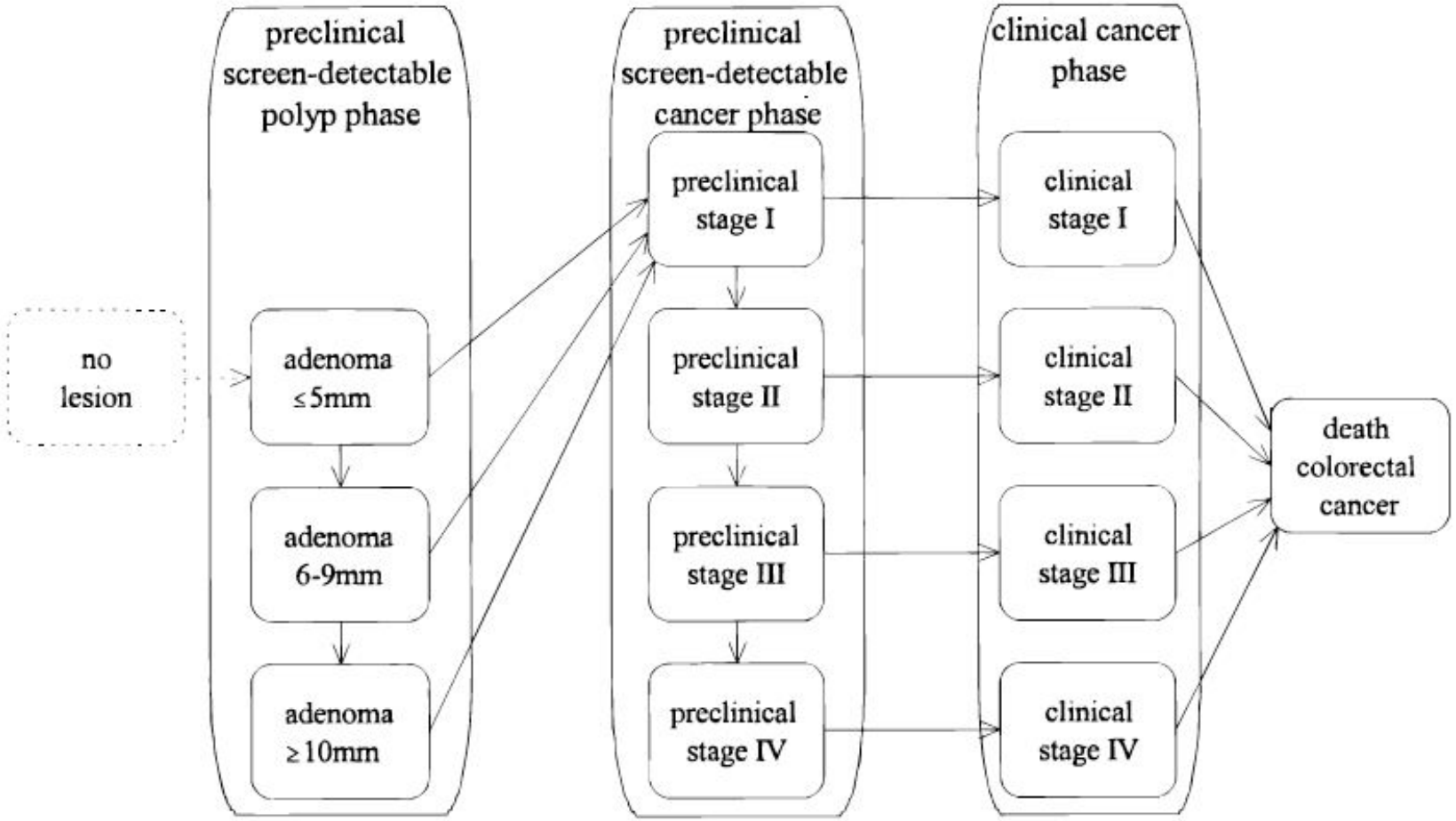


- In 2012 only about 65% of individuals were up-to-date with screening
- 27% had never screened
- Improving *screening rates* is a priority

Elements of CRC Simulation Models



Example Cancer Evolution Model



CRC Simulation Model Paradigms

Discrete Event Simulation Models

- Support for Individual Patient Simulation (IPS).
- Flexibility for patient-patient, patient-environment interaction.

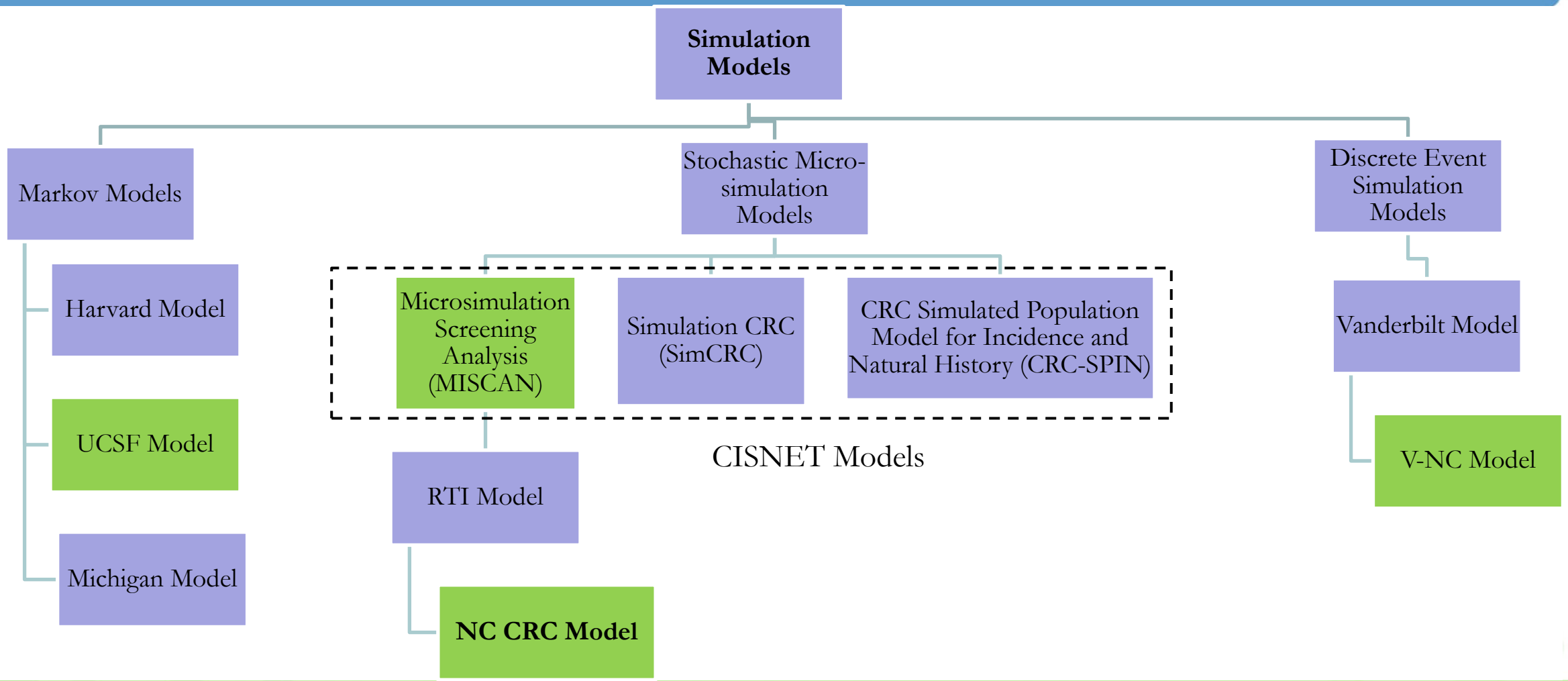
Markov Models

- Enumerate health states a person will experience during the course of the disease.
- The changes in state are described using transition diagrams very similar to flow charts.

Stochastic Microsimulation Models

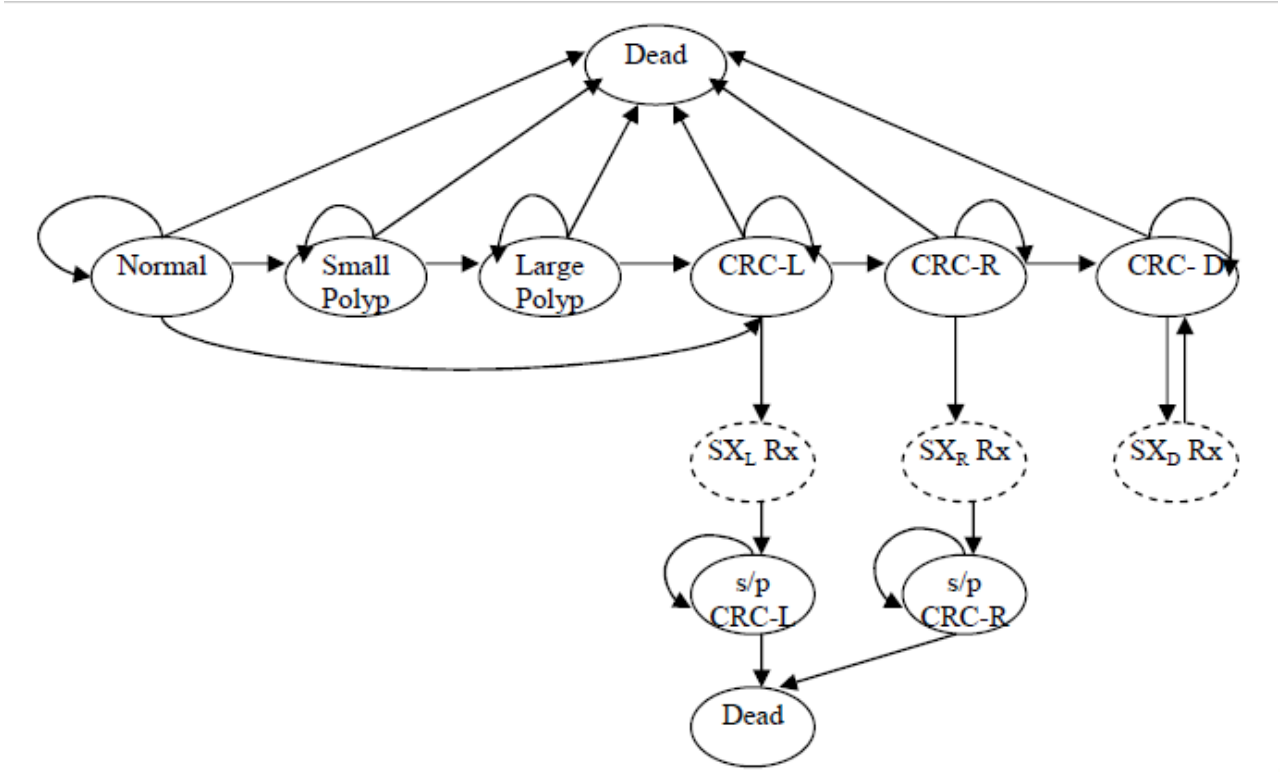
- "Stochastic" - Models simulate sequences of events by drawing from distributions of probabilities or durations.
- "Microsimulation" - persons are moved through the model one at a time.

CRC Simulation Model- Development History



Sample Markov Model Structure

- **UCSF (University of California, San Francisco) Model** - a cohort based Markov model from age 50 until death.
- Monte Carlo simulation that runs through the model 3500 times to determine approximate values for the percent of people in each state at a given time.
- Has a small probability for cancer to develop without developing from an adenoma.

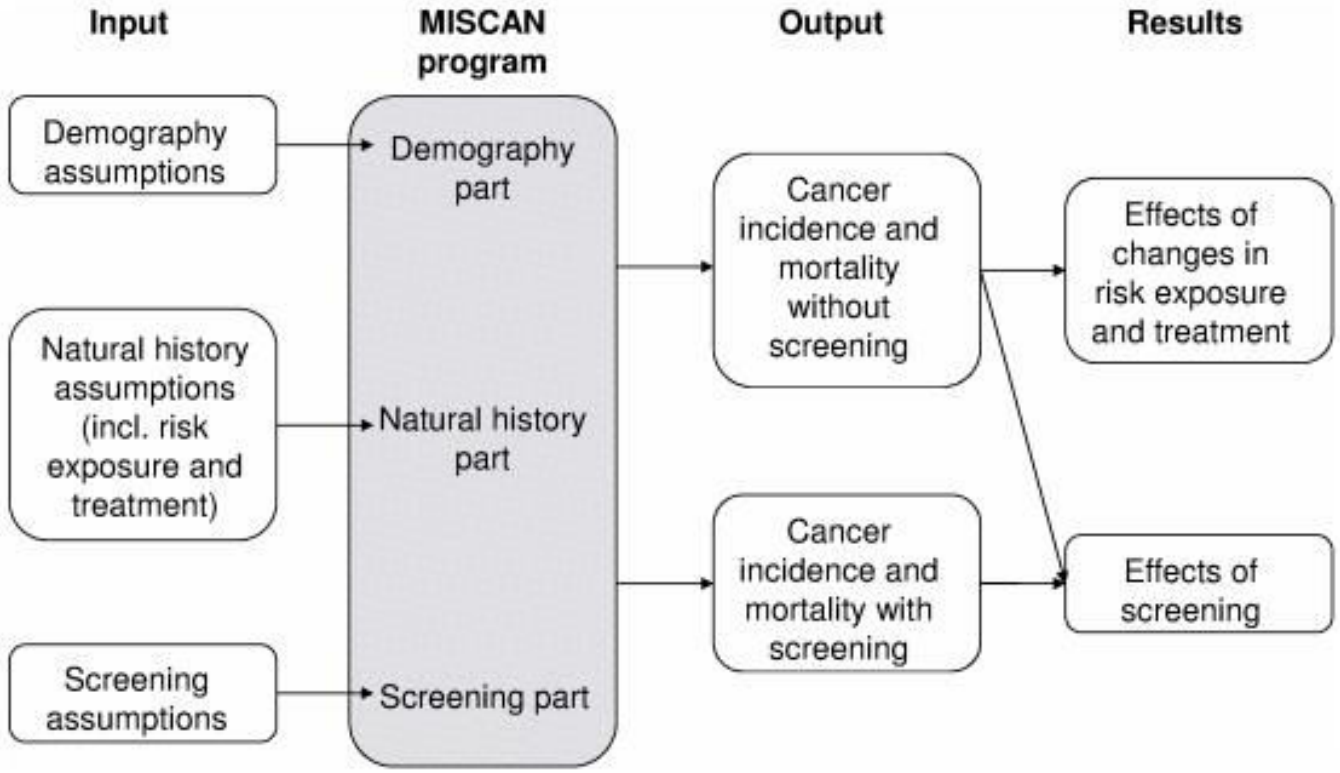


V-NC Model

- Primary Simulation Objects
  - Employs an **OOS** (Object Oriented System), driven by a model-independent database.
  - Allows for convenient modeling of causal and treatment pathways.
  - The primary object in the CRC simulation is the **person**.
  - The replication will be terminated when the person dies or when statistics collection ends.

MIcrosimulation SCreening ANalysis (MISCAN)

- MISCAN–Colon is a micro–simulation program, generating individual life histories.
- Uses the Monte Carlo method to simulate all events in the program.
- Possible events are birth and death of a person, adenoma incidence and transitions from one state of disease to another.



North Carolina Colorectal Cancer (NC-CRC) model

Outline-

- Designed to support decision making regarding population screening for colorectal cancer within the state of North Carolina.
- Simulates cancer incidence and mortality by stage, age and calendar year.
- The model can be used to test the effects of various interventions on life-years and costs by increasing an individual's probability of being screened for CRC.

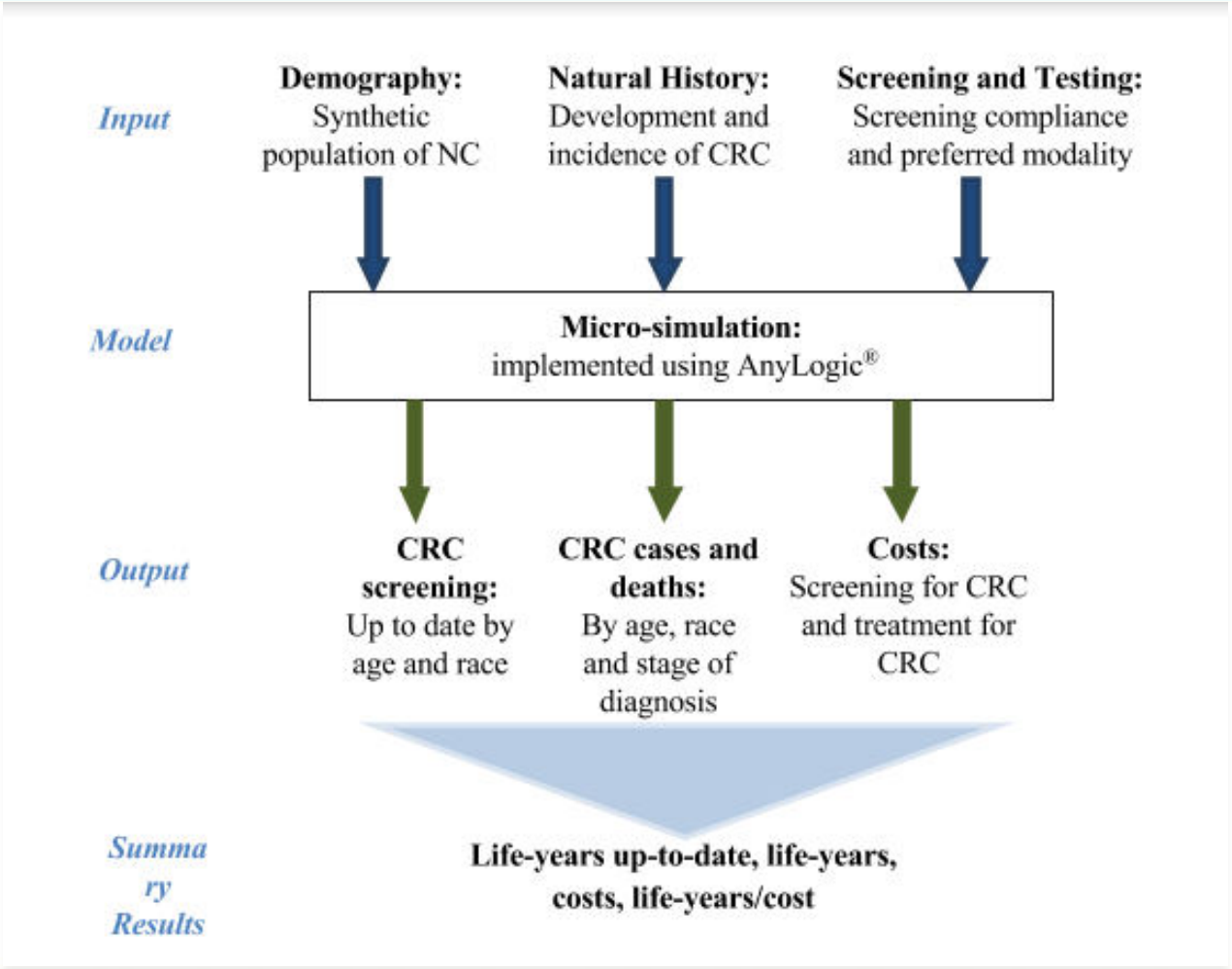
History-

- Based significantly on the MISCAN-COLON model (Loeve et al. 1999) and the work of Subramanian and colleagues. (2005)

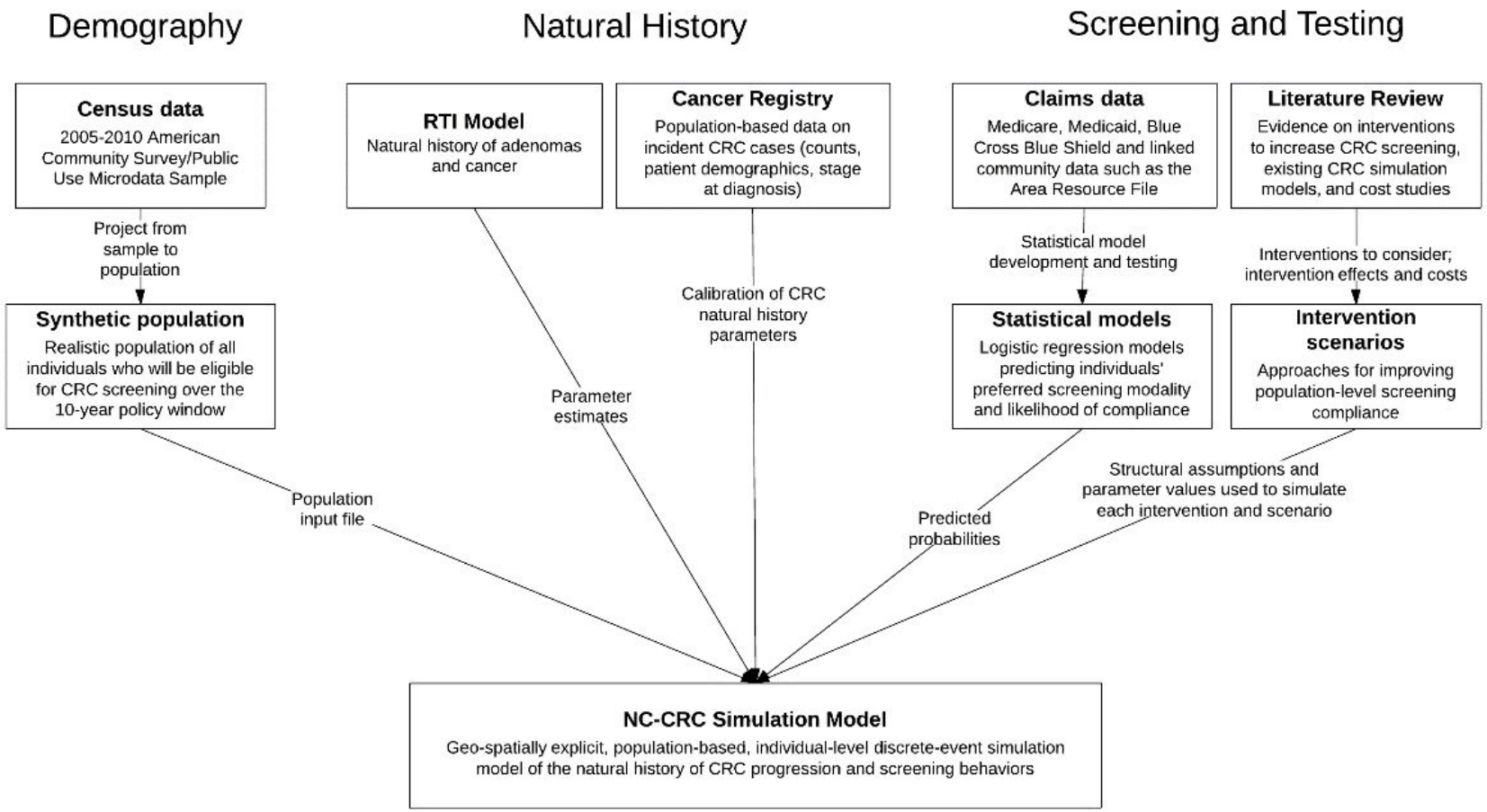
Expansion on other simulation models

- **Applying statistical models** from administrative claims data to predict the preferred screening modality of individuals and compliance with screening.
- **Calibrating natural history parameters** so that the incidence, age and stage of CRC diagnosis closely match registry data specific to the state of NC.
- **Models insurance** and allows status to change over time.
- Incorporating the effects of **population-level interventions** to increase compliance with CRC screening recommendations.

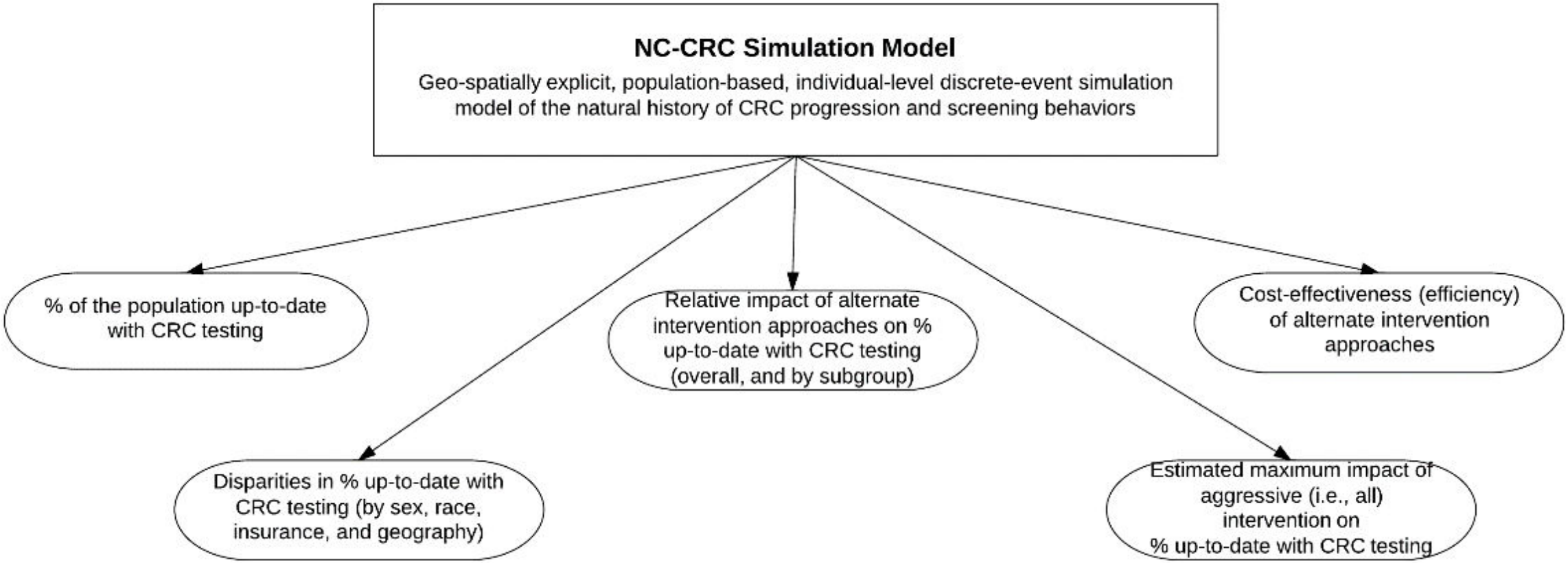
Model Structure



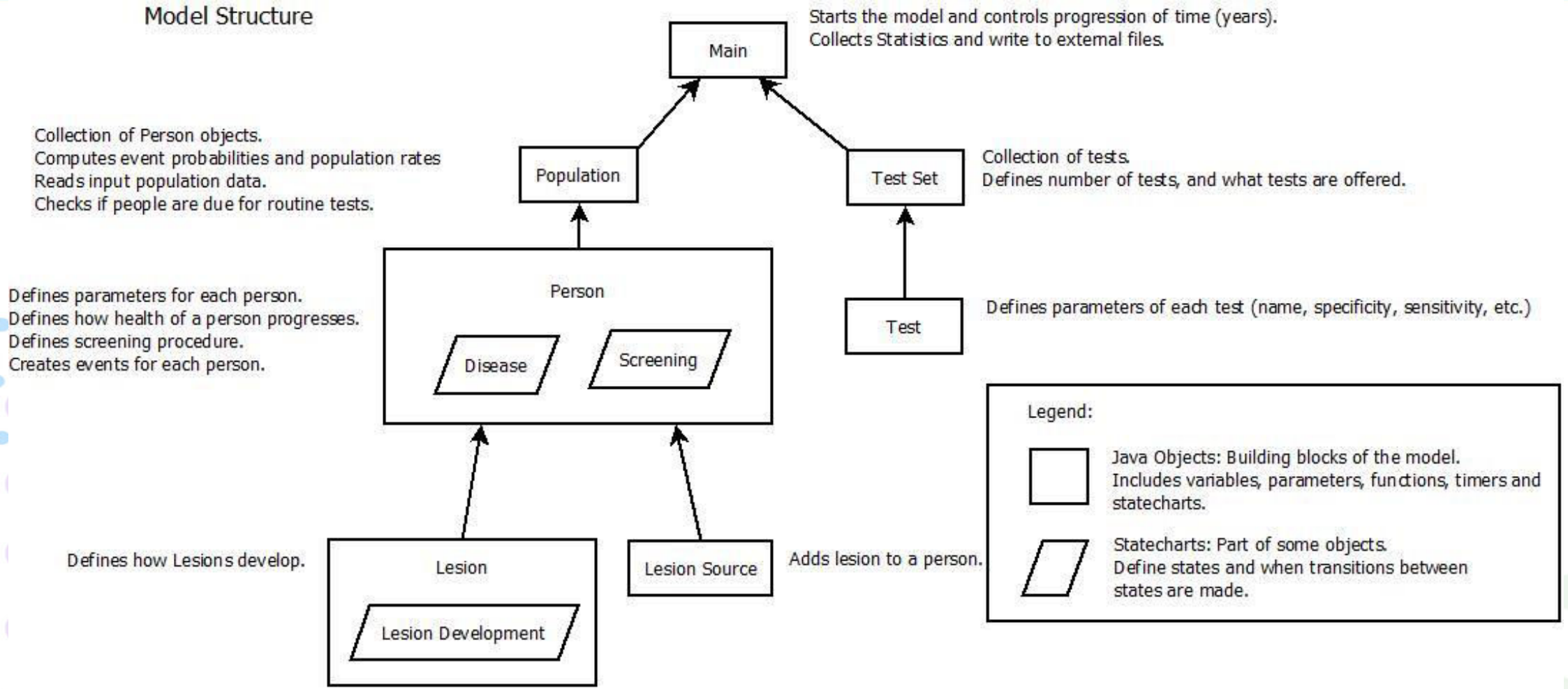
Elements of Models



Parameters- Output



Object Based Model Structure



Limitations and Challenges

- Model is highly data intensive.
- Meant to inform population guidelines and is based on general population trends.
- Model can end up requiring extensive computational resources.

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Future of CRC Simulation Models

- Optimization algorithms to generate candidate follow-up strategies for specific patient subgroups.

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Questions/Discussions/Comments?

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Additional Slides

Assumptions(MISCAN)

- Demography Assumptions
  - The life table differs per birth cohort.
  - Death from colorectal cancer and death from other causes are considered independent from each other.
- Natural History Assumptions
  - Focus on the initiation, progression and response to treatment of colorectal cancer in the model.
- Screening Assumptions
  - Focus on all aspects of screening, including compliance and operational characteristics of the screening process.

Statistical Model Description

$$logit(\pi_{ij}) = Y_{ij} = \beta_{0j} + \sum_{k} \beta_k X_{ik} + \sum_{l} \beta_l X_{jk} + \epsilon_{ij}$$

$$\pi_{ij} = \frac{e^{Y_{ij}}}{1 + e^{Y_{ij}}}$$

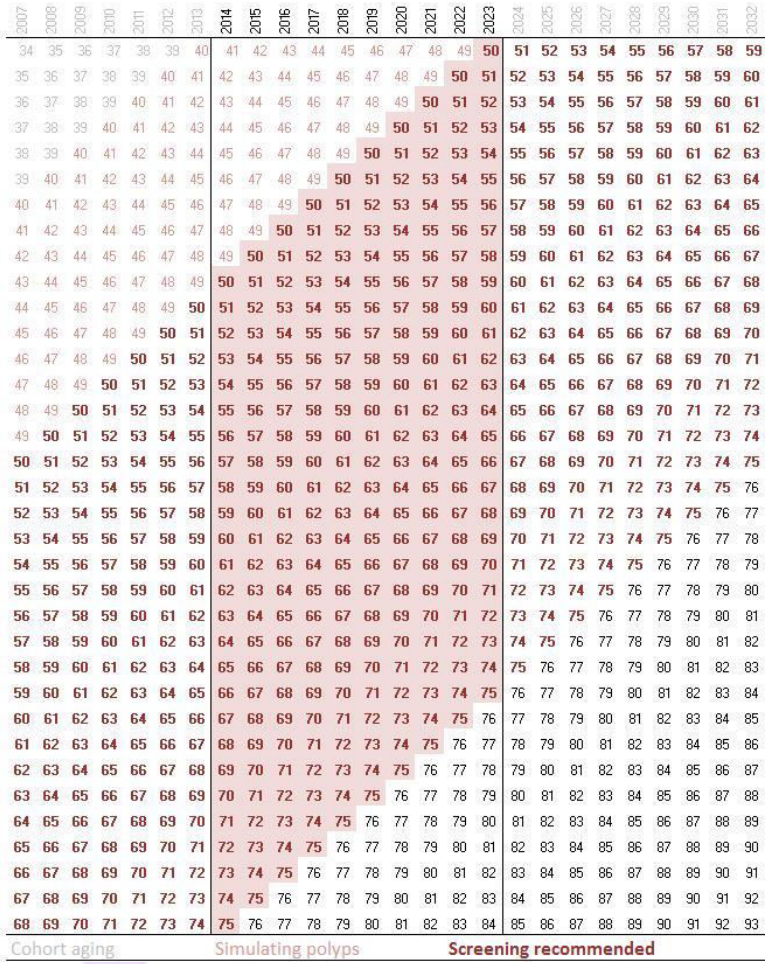
$\boldsymbol{\pi_{ij}}$ - Probability of binary outcome (CRC Screening vs No Screen or Colonoscopy vs FOBT) for person i at county j

$\boldsymbol{\beta_{0j}}$ - County level intercept

$\boldsymbol{X_{ik}}$ - Person level attributes (race, gender, etc)

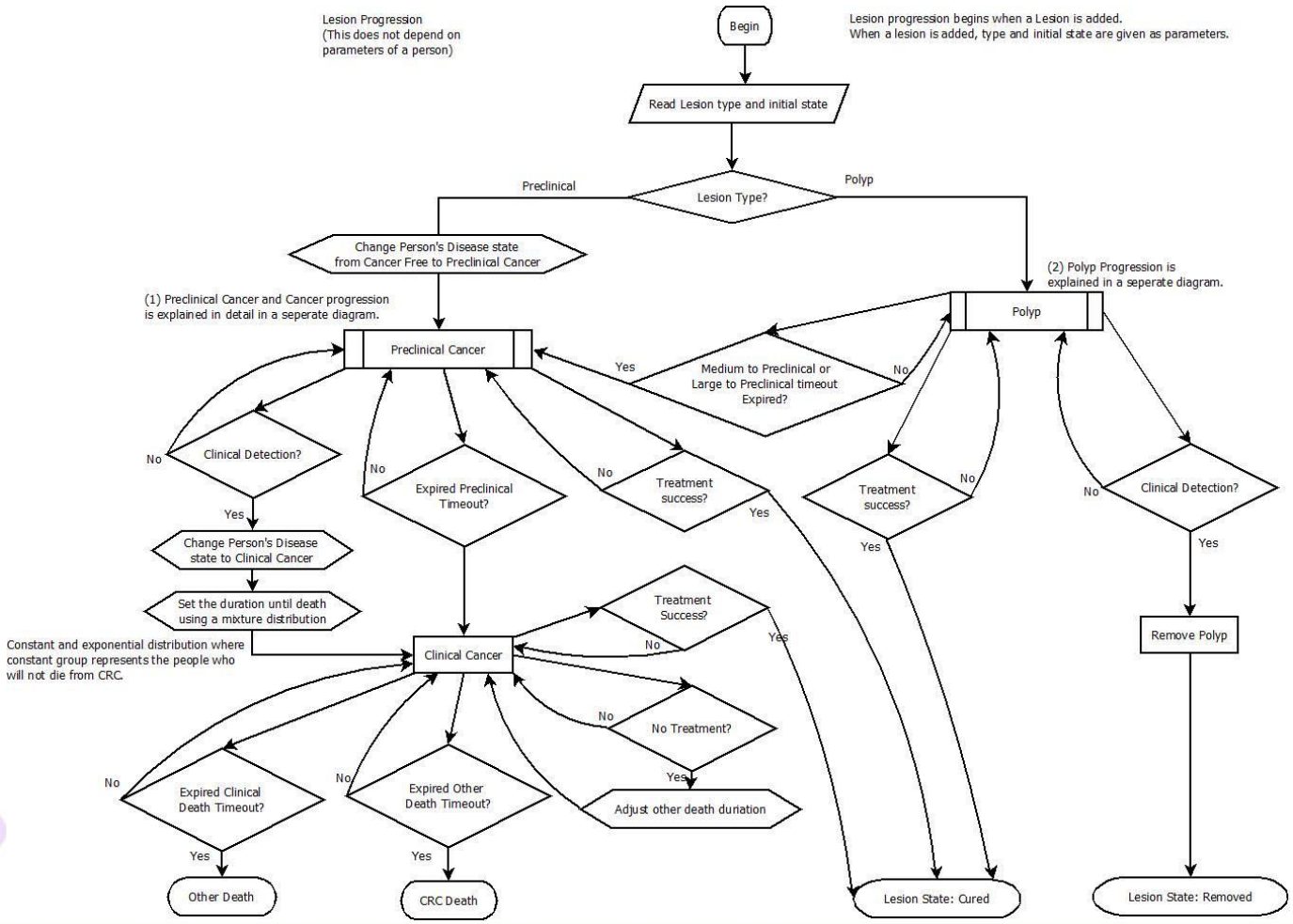
$\boldsymbol{X_{jk}}$ - County level attributes (distance to endoscopy facility)

Age Cohorts Included In Model

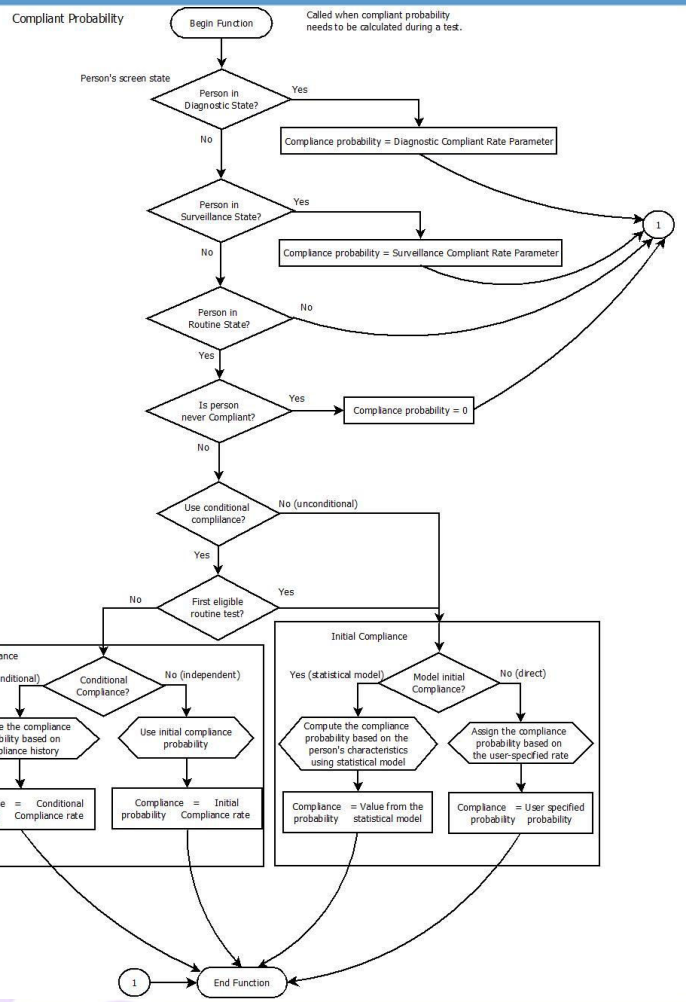


- Age;
- Sex;
- Race (white, black, Hispanic, other);
- Smoking status (current, former, never);
- Household income (<$25,000, $25,000-<$50,000, ≥$50,000);
- Insurance status (none, private, Medicare, Medicaid, dual Medicare and Medicaid);
- Education (not complete college, completed college);
- Residential location (zip code).
- State health insurance program participation (SHEP, not a participant, participant)
- Marital status for privately insured individuals (married, unmarried, unknown)

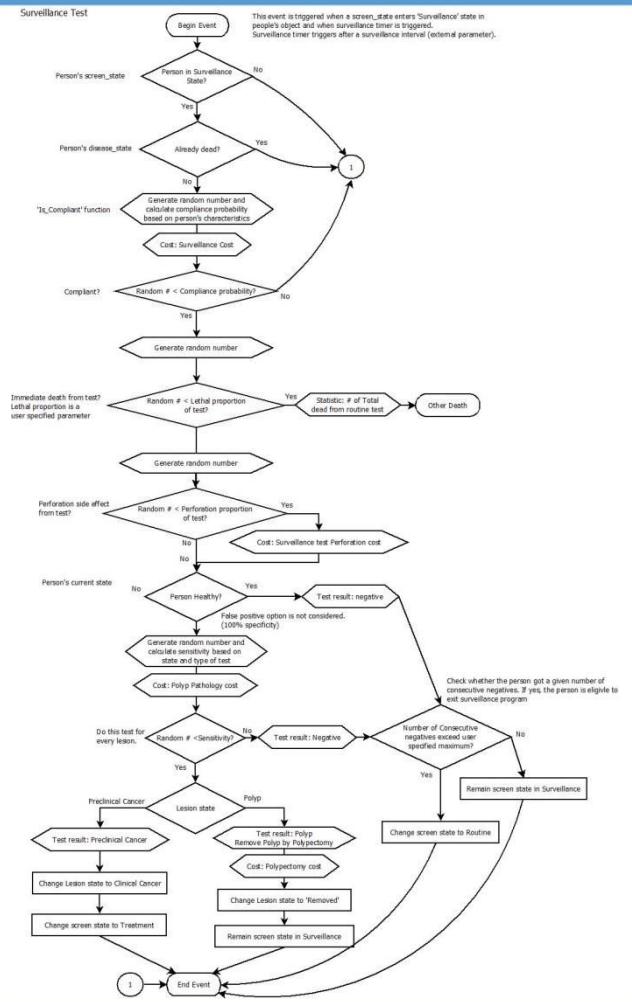
Process flow of lesion progression



Compliance process flow



Testing process flow



USING INDIVIDUAL-BASED SIMULATION MODELING TO INTEGRATE BIG DATA AND INTERVENTION EVIDENCE TO INFORM INTERVENTION SELECTION, ADAPTATION, AND EVALUATION: AN EXAMPLE ON COLORECTAL CANCER SCREENING

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UNC GILLINGS SCHOOL OF GLOBAL PUBLIC HEALTH

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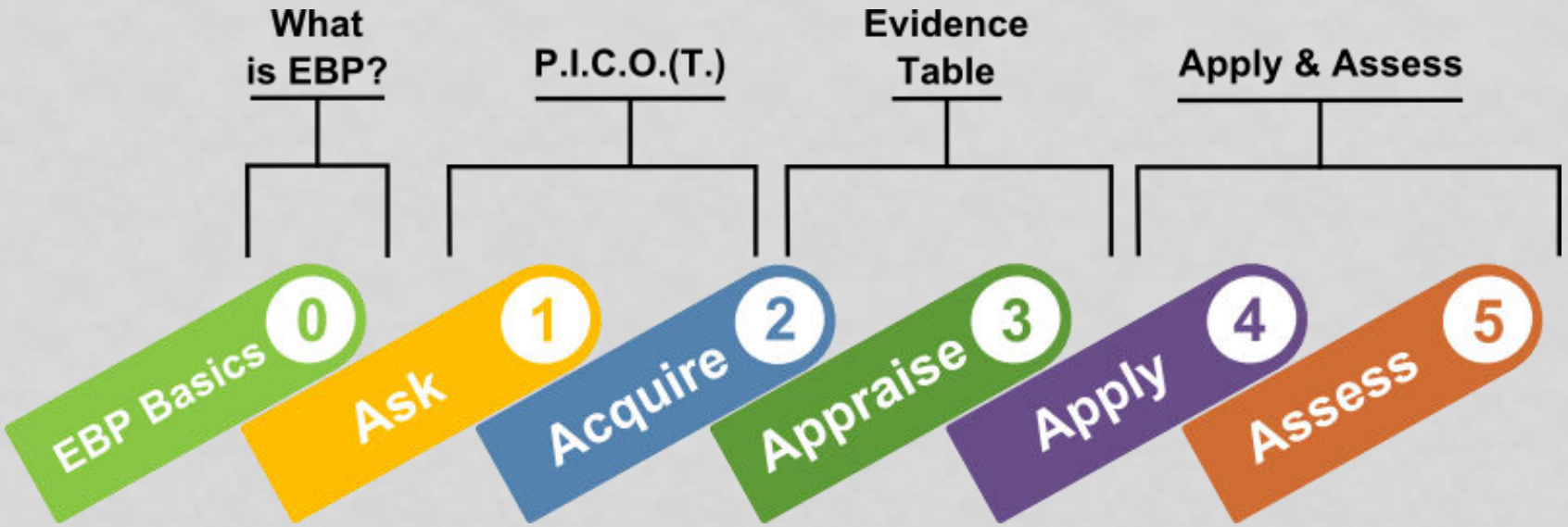
UNC LINEBERGER

HOW DO WE *TYPICALLY* SELECT EVIDENCE-BASED PRACTICES?

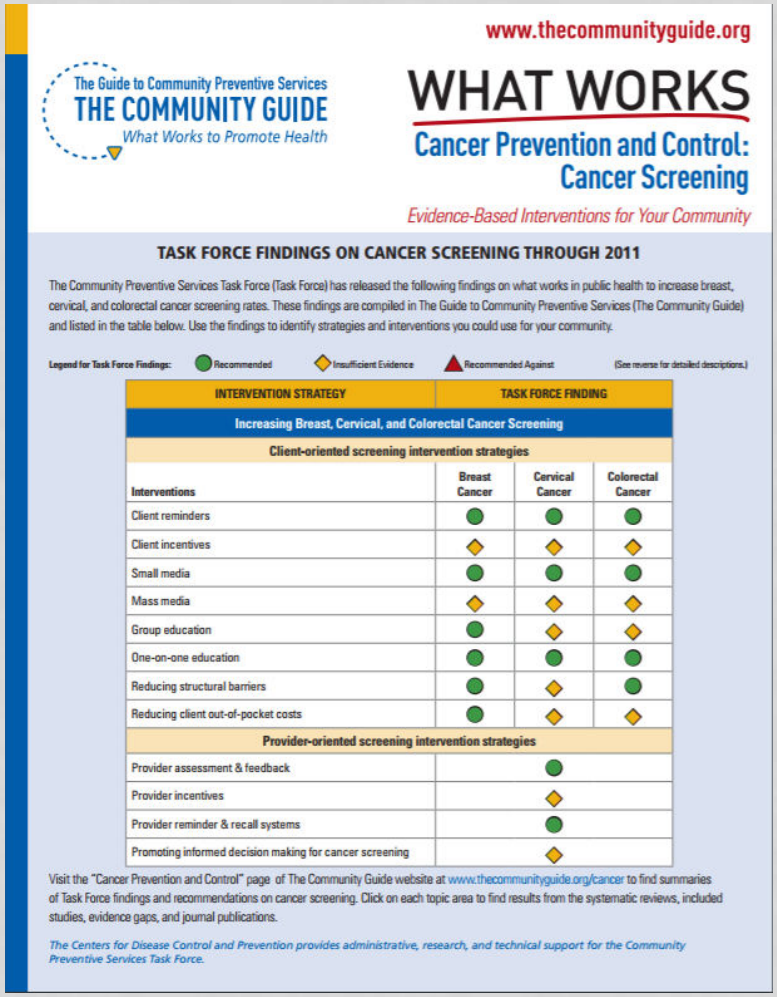


SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

HTTP://GUIDES.LIBRARY.UWM.EDU/EBPTUTORIAL

SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

HTTPS://WWW.CDC.GOV/PCD/ISSUES/2013/12_0275.HTM



www.thecommunityguide.org

The Guide to Community Preventive Services
THE COMMUNITY GUIDE
What Works to Promote Health

WHAT WORKS

Cancer Prevention and Control: Cancer Screening

Evidence-Based Interventions for Your Community

TASK FORCE FINDINGS ON CANCER SCREENING THROUGH 2011

The Community Preventive Services Task Force (Task Force) has released the following findings on what works in public health to increase breast, cervical, and colorectal cancer screening rates. These findings are compiled in The Guide to Community Preventive Services (The Community Guide) and listed in the table below. Use the findings to identify strategies and interventions you could use for your community.

Legend for Task Force Findings: ● Recommended ◆ Insufficient Evidence ▲ Recommended Against (See reverse for detailed descriptions.)

INTERVENTION STRATEGY	TASK FORCE FINDING		
Increasing Breast, Cervical, and Colorectal Cancer Screening			
Client-oriented screening intervention strategies			
Interventions	**Breast Cancer**	**Cervical Cancer**	**Colorectal Cancer**
Client reminders	●	●	●
Client incentives	◆	◆	◆
Small media	●	●	●
Mass media	◆	◆	◆
Group education	●	◆	◆
One-on-one education	●	●	●
Reducing structural barriers	●	◆	●
Reducing client out-of-pocket costs	●	◆	◆
Provider-oriented screening intervention strategies			
Provider assessment & feedback		●	
Provider incentives		◆	
Provider reminder & recall systems		●	
Promoting informed decision making for cancer screening		◆	

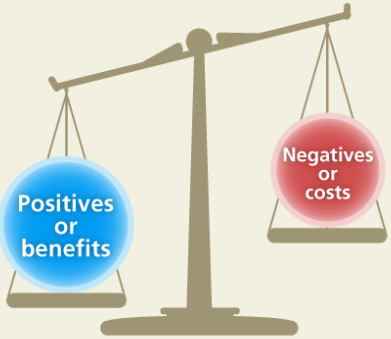
Visit the "Cancer Prevention and Control" page of The Community Guide website at www.thecommunityguide.org/cancer to find summaries of Task Force findings and recommendations on cancer screening. Click on each topic area to find results from the systematic reviews, included studies, evidence gaps, and journal publications.

The Centers for Disease Control and Prevention provides administrative, research, and technical support for the Community Preventive Services Task Force.

Test Name	Study Design	No. of Studies	No. of Participants	Summary of Findings (Includes Consistency, Precision)	Applicability[a]	Limitations (Includes Reporting Bias)	Overall Quality
Key Question 1: Effectiveness of Screening[b]							
SIG	RCT	4	458 002	SIG consistently decreased CRC-specific mortality compared with no screening at 11-12 y of follow-up (IRR, 0.73; 95% CI, 0.66-0.82). Mortality benefit was limited to distal CRC.	Fair to poor. No longer widely used in the United States.	Only 1 trial evaluated more than a single round of screening. Variation in referral criteria led to differing rates of follow-up colonoscopy.	Fair to good
gFOBT, Hemoccult II	RCT	5	419 966	Biennial screening with Hemoccult II compared with no screening (404 396) consistently resulted in reduction of CRC-specific mortality (ranging 9%-22% after 2-9 rounds of screening with 11-30 y of follow-up).	Poor. No longer widely used.	Variation in number of screening rounds, use of rehydrated samples, definition of "test positive," and recommended diagnostic follow-up.	Fair to good
Key Question 2: Diagnostic Accuracy of Screening[c]							
Colonoscopy	Prospective diagnostic accuracy	4	4821	Comparing colonoscopy with CTC or CTC plus colonoscopy, per-person (or per-lesion) sensitivity for adenomas ≥10 mm was 89%-98%, and per-person sensitivity for adenomas ≥6 mm was 75%-93%.	Fair. Colonoscopies were conducted or supervised by "experienced" specialists.	Studies were not designed to assess diagnostic accuracy to detect cancers. Limited studies with large number of endoscopists that were applicable to community practice.	Fair to good
CTC	Prospective diagnostic accuracy	9	6497	The per-person sensitivity and specificity of CTC using bowel preparation to detect adenomas ≥10 mm ranged 67%-94% and 86%-98%, respectively. The per-person sensitivity and specificity to detect adenomas ≥6 mm ranged 73%-98% and 80%-93%, respectively. In 2 studies, sensitivity without bowel preparation to detect adenomas was lower than that of CTC protocols using bowel preparation.	Fair. Mostly single-center studies, with ≤3 highly trained radiologists. Current practice may use different technologies and protocols.	Studies were not designed to assess diagnostic accuracy to detect cancers. Unclear if the variation of test performance was due to differences in study design, populations, bowel preparation, CTC technology, reader experience, or reading protocols.	Fair to good

SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

(SOURCE: COMMUNITY GUIDE AND USPSTF REPORTS)



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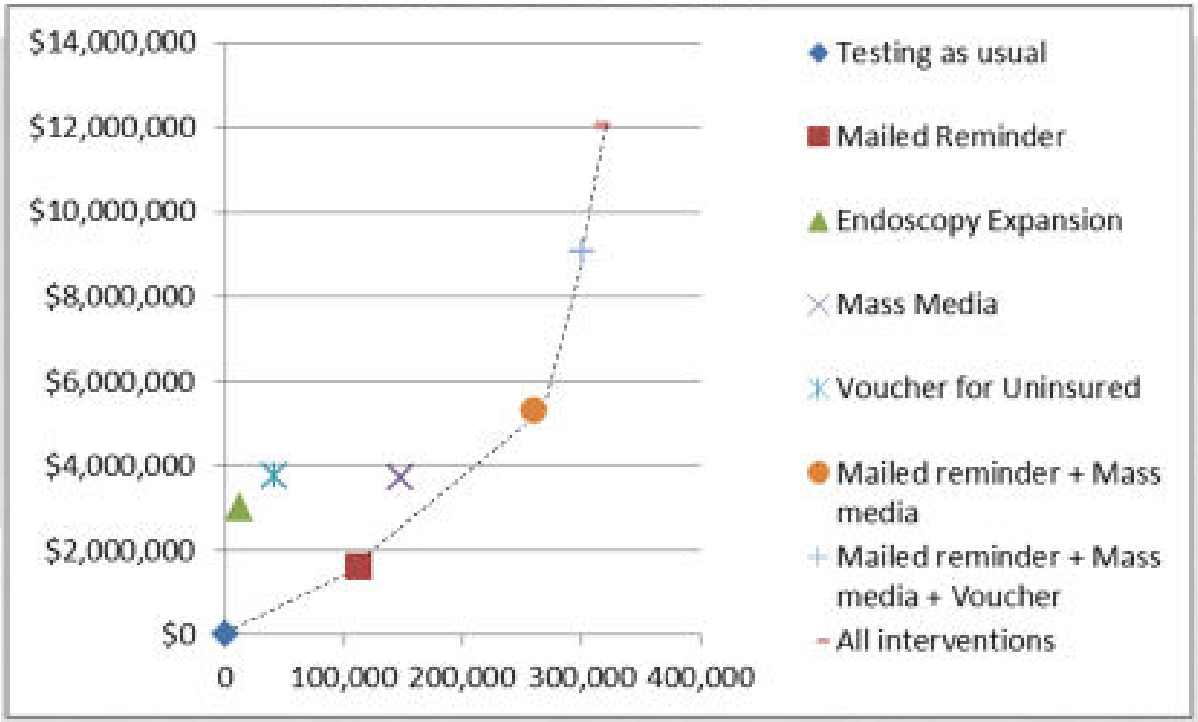
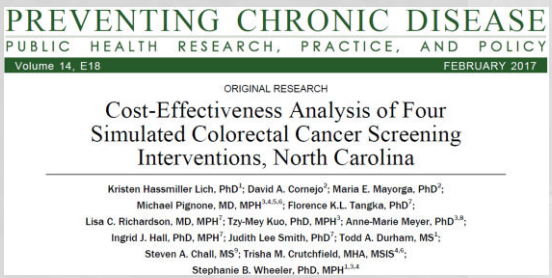
COST-EFFECTIVENESS EFFICIENCY FRONTIER: INTERVENTION COST VERSUS ADDITIONAL LIFE-YEARS UP-TO-DATE




PREVENTING CHRONIC DISEASE
PUBLIC HEALTH RESEARCH, PRACTICE, AND POLICY
Volume 14, E18 FEBRUARY 2017

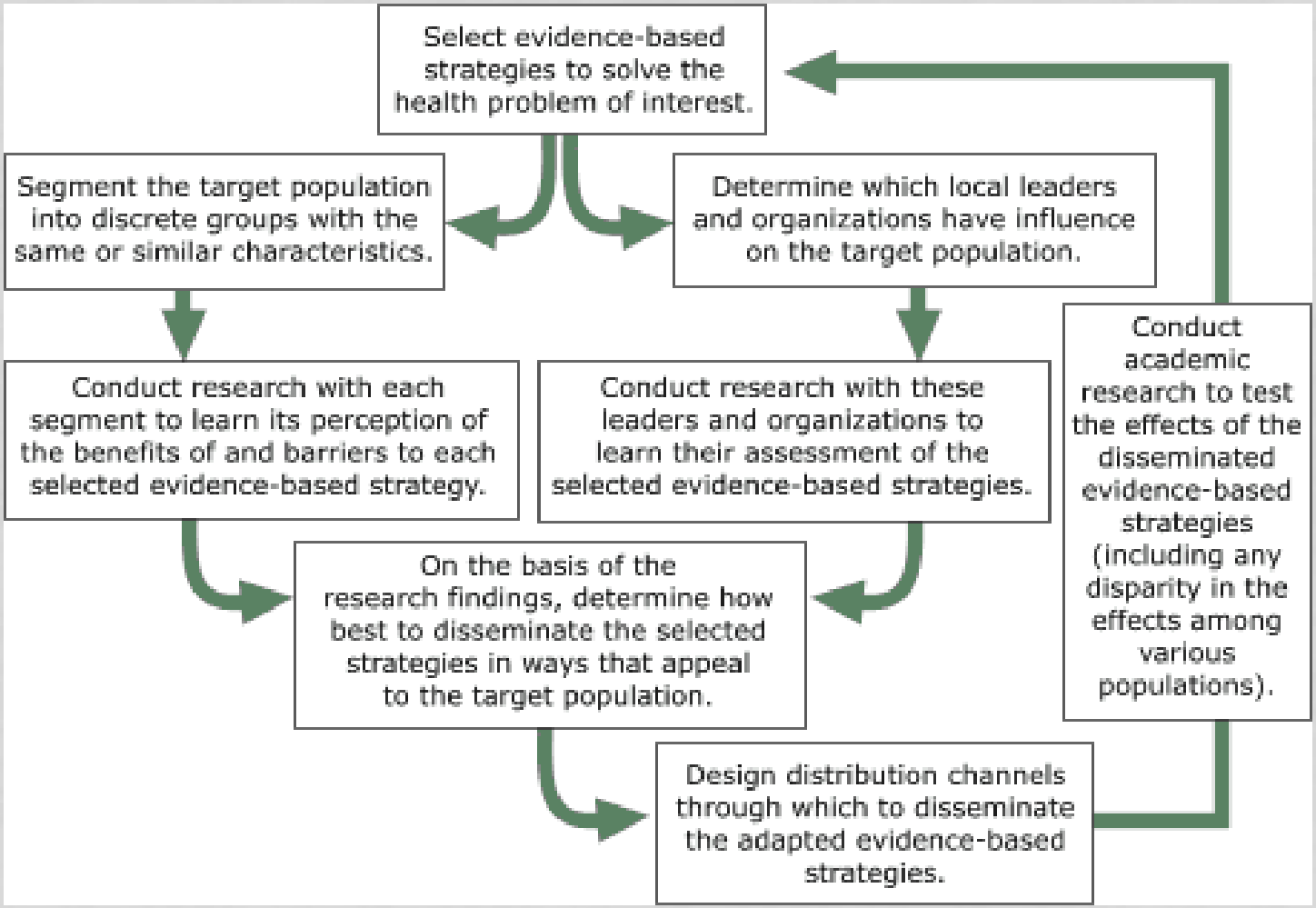
ORIGINAL RESEARCH

Cost-Effectiveness Analysis of Four Simulated Colorectal Cancer Screening Interventions, North Carolina

Kristen Hassmiller Lich, PhD[1]; David A. Cornejo[2]; Maria E. Mayorga, PhD[2]; Michael Pignone, MD, MPH[3,4,5,6]; Florence K.L. Tangka, PhD[7]; Lisa C. Richardson, MD, MPH[7]; Tzy-Mey Kuo, PhD, MPH[3]; Anne-Marie Meyer, PhD[3,8]; Ingrid J. Hall, PhD, MPH[7]; Judith Lee Smith, PhD[7]; Todd A. Durham, MS[1]; Steven A. Chall, MS[9]; Trisha M. Crutchfield, MHA, MSIS[4,6]; Stephanie B. Wheeler, PhD, MPH[1,3,4]

SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

REF: HASSMILLER LICH ET AL., PREVENTING CHRONIC DISEASE



SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

HTTPS://WWW.CDC.GOV/PCD/ISSUES/2007/OCT/07_0025.HTM

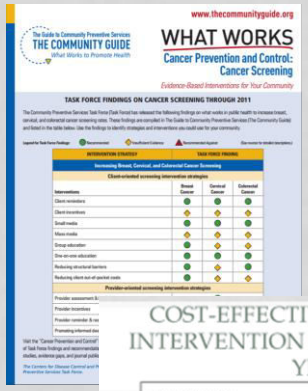
SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

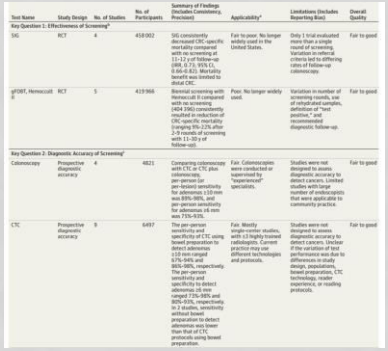
HTTP://AZHIN.ORG/CUMMINGS/RE-AIM

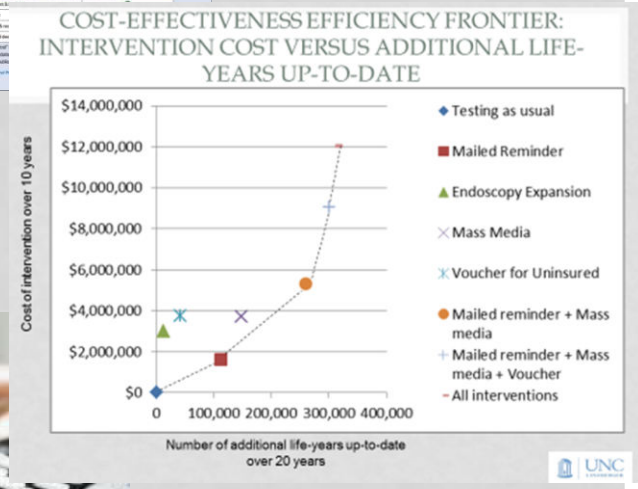
HOW COULD WE LEVERAGE *SIMULATION*?

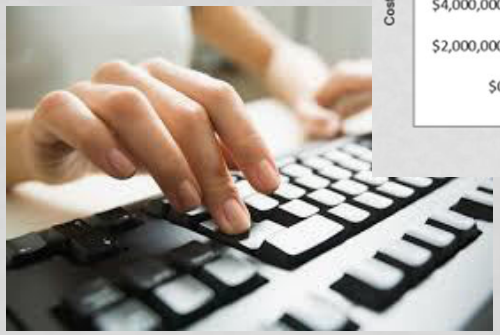
THE PUZZLE OF **LOCAL** DECISION MAKING

ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!









THE PUZZLE OF **LOCAL** DECISION MAKING

ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

- Differences in the population targeted can change impact!
  - What if my population is older?
  - More racially diverse?
  - Less likely to *stay* insured?
  - More rural?
- What if our state is doing a great job with a subpopulation already?
  - Medicaid screening rates are high
  - Just had a big colonoscopy initiative
- What if an intervention requires something that isn't in place?
  - Mass media encouraging colonoscopy… *but no access?*
- We address this by:
  - Projecting screening to **the local population** (census data is key)
  - Basing **current screening estimates** on local data (claims, administrative)

THE PUZZLE OF **LOCAL** DECISION MAKING

ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

SIMULATION ALLOWS DECISION MAKERS TO PROJECT CURRENT SCREENING PATTERNS TO THE **LOCAL POPULATION**

Health & Place

Regional variation in colorectal cancer testing and geographic availability of care in a publicly insured population

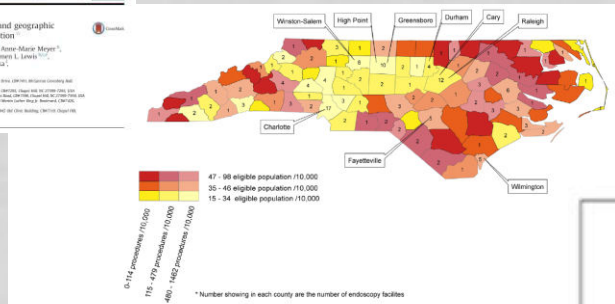
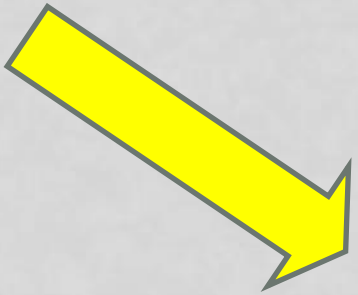
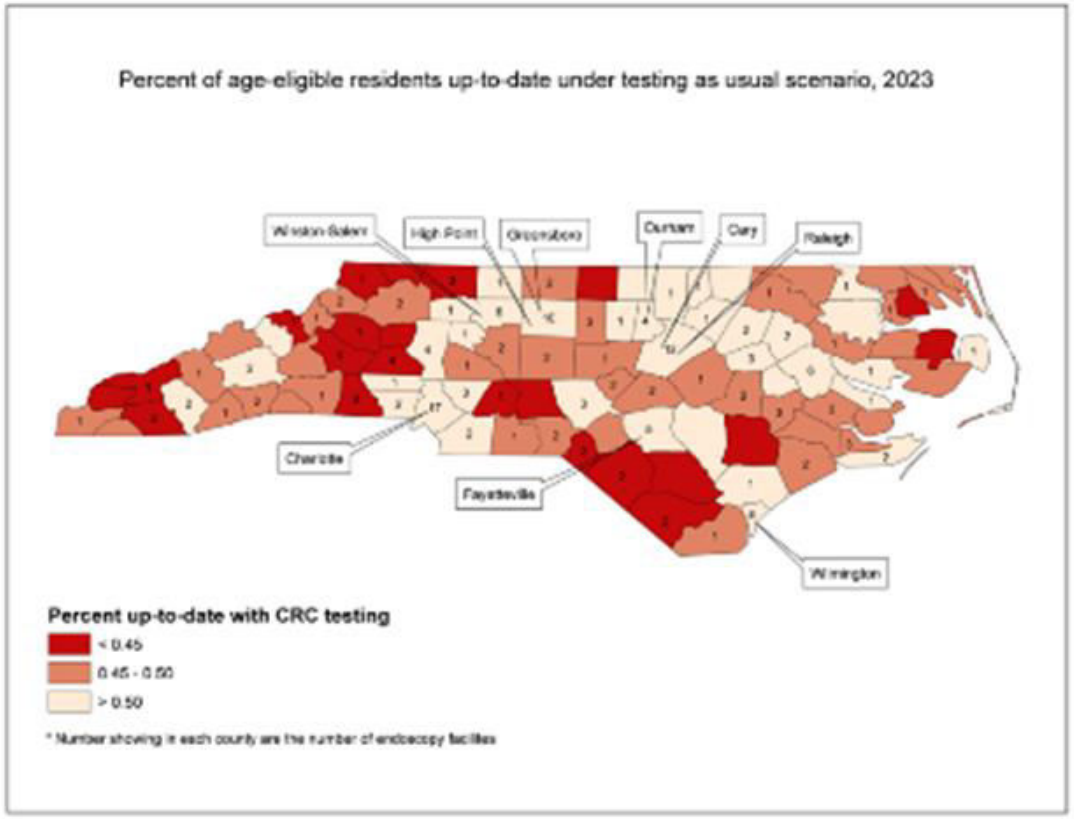
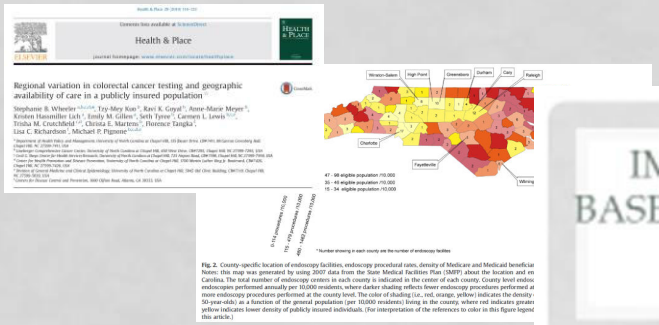


Fig. 2. County-specific location of endoscopy facilities, endoscopy procedural rates, density of Medicare and Medicaid beneficiaries, and
Notes: this map was generated by using 2007 data from the State Medical Facilities Plan (SMFP) about the location and endoscopy
Carolina. The total number of endoscopy centers in each county is indicated in the center of each county. County level endoscopy pro
endoscopies performed annually per 10,000 residents, where darker shading reflects fewer endoscopy procedures performed at the cou
more endoscopy procedures performed at the county level. The color of shading (i.e., red, orange, yellow) indicates the density of the st
50-year-olds) as a function of the general population (per 10,000 residents) living in the county, where red indicates greater density
yellow indicates lower density of publicly insured individuals. (For interpretation of the references to color in this figure legend, the rea
this article.)





SIMULATION ALLOWS DECISION MAKERS TO PROJECT **CURRENT SCREENING PATTERNS** TO THE LOCAL POPULATION


Health & Place

Regional variation in colorectal cancer testing and geographic availability of care in a publicly insured population

IMPACT ON % UP-TO-DATE IN 10TH YEAR OF POLICY WINDOW BASELINE AND % AGE POINT INCREASES FOR EACH INTERVENTION

	Testing as usual	Mailed Reminder	Endoscopy Expansion	Mass Media	Voucher for Uninsured
Overall	53.6%	+0.3%	+0.0%	+0.4%	+0.1%
By sex					
Males	54.7%	+0.3%	+0.0%	+0.6%	+0.2%
Females	52.4%	+0.5%	+0.0%	+0.5%	+0.1%
By race					
Whites	54.7%	+0.3%	+0.0%	+0.4%	+0.1%
Blacks	51.4%	+0.9%	+0.0%	+1.4%	+0.2%
Others	47.5%	+0.5%	+0.0%	+0.4%	+0.4%
By insurance					
Private	56.2%	+0.0%	+0.0%	+0.5%	+0.0%
Medicaid	50.3%	+4.6%	+0.2%	+0.8%	+0.0%
Medicare	51.3%	+0.0%	+0.0%	+0.4%	+0.0%
Dual	44.8%	+3.5%	+0.1%	+0.7%	+0.0%
Uninsured	14.6%	+0.0%	+0.0%	+0.6%	+1.1%

- Challenges:
  - The "system" is big!
  - … and constantly changing
  - Micro costing is difficult
  - Uncertainty in evidence

THE PUZZLE OF **LOCAL** DECISION MAKING

ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

SYSTEM MAPPING

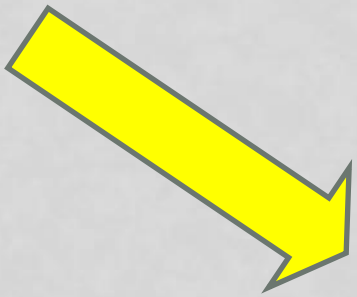
- Many practical and systematic ways for groups to document current systems
  - Process flow diagramming to describe current or proposed practices
  - Whole system mapping to document current programs, services, initiatives
  - Asset mapping or system support mapping to elicit resources, strengths, needs

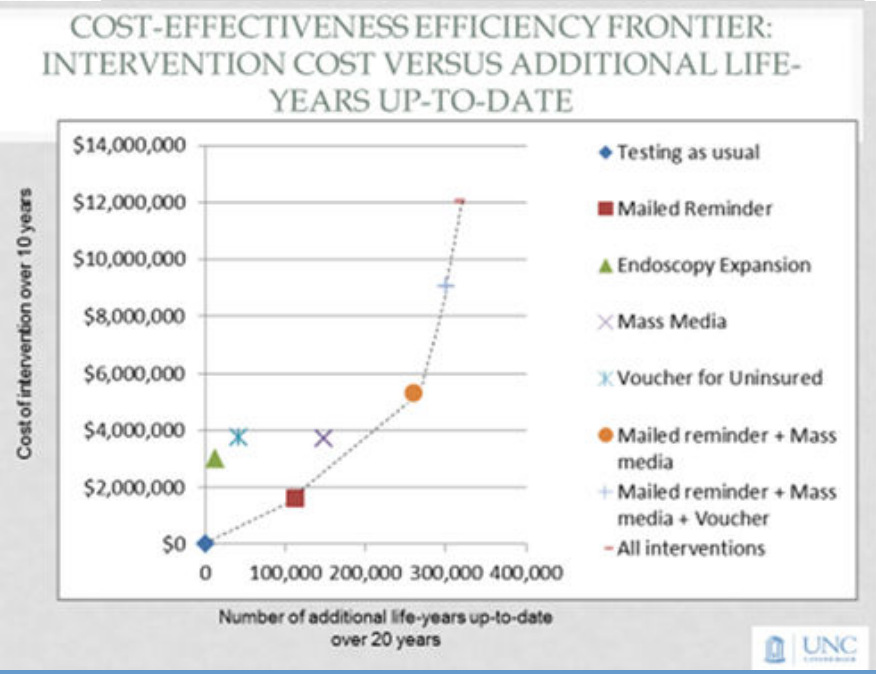
WE TYPICALLY ESTIMATE COST/IMPACT AND COMPARE


Health & Place

Regional variation in colorectal cancer testing and geographic availability of care in a publicly insured population

Intervention	Effect Size	Base ($)	Cost Components
Medicaid Mailed Reminder	5%age point increase in p(screen)	$10,000	Develop registry & content (one-time)
		$200 / year	Programming time
		$0.71 / reminder	Materials (postage, paper, ink)
		$3,850 / year	Mail reminders
Endoscopy Expansion	Individually-specific predicted p(screen) based upon claims-based statistical models	$500,000 / facility	Financial incentive to locate facility in 6 underserved a
Targeted Mass Media	Will reach 80% of blacks, 2%age point increase in p(screen)	$368,000 / year	Content devel (one-time)
	Will reach 40% of non-blacks, 1%age point increase in p(screen)	$332,000 / year	Advertising for month
Voucher for uninsured	500 uninsured individuals turning 50 will receive colonoscopies	$750 / person	Voucher for colonoscopy

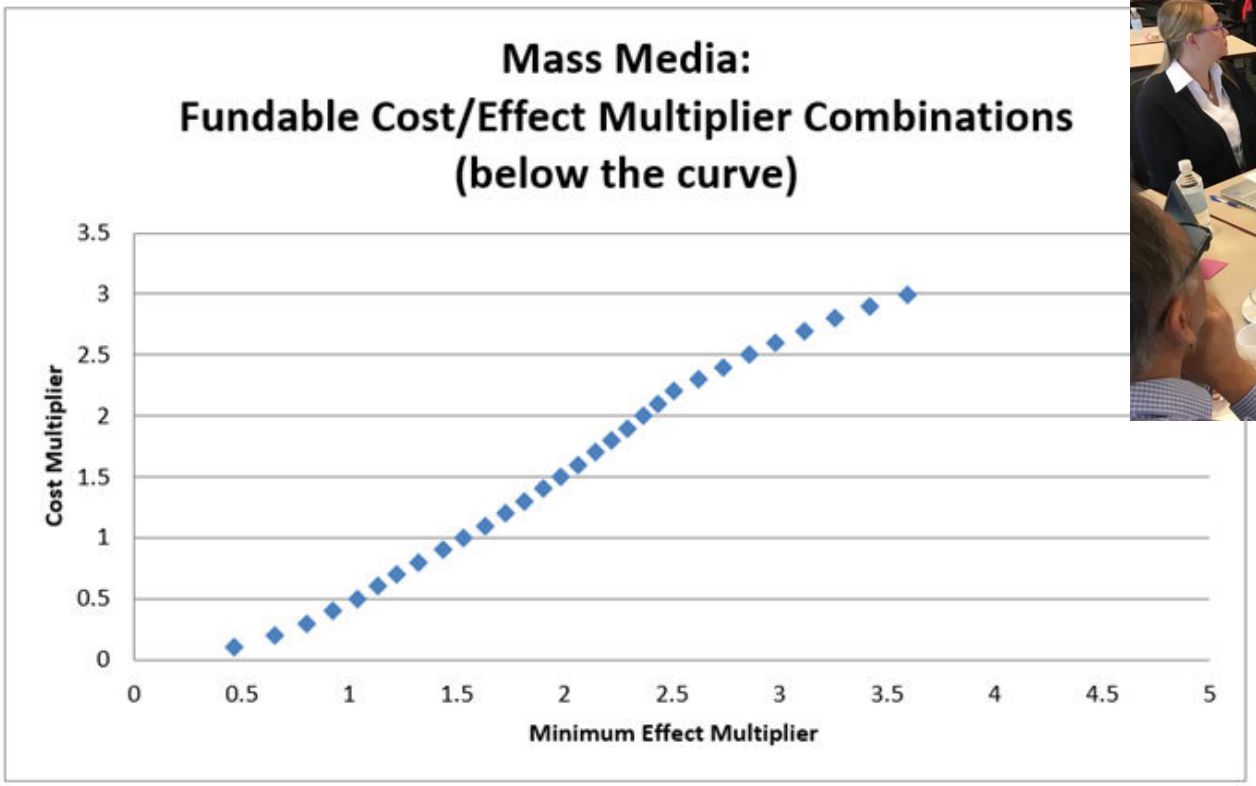




INSTEAD, WE CAN DISCUSS…

What Combination of Cost Multipliers & Effect Multipliers are fundable for a given willingness to pay level?

Mass Media Intervention Cost	$3,000,000
Willingness to pay (WTP)	WTP $10



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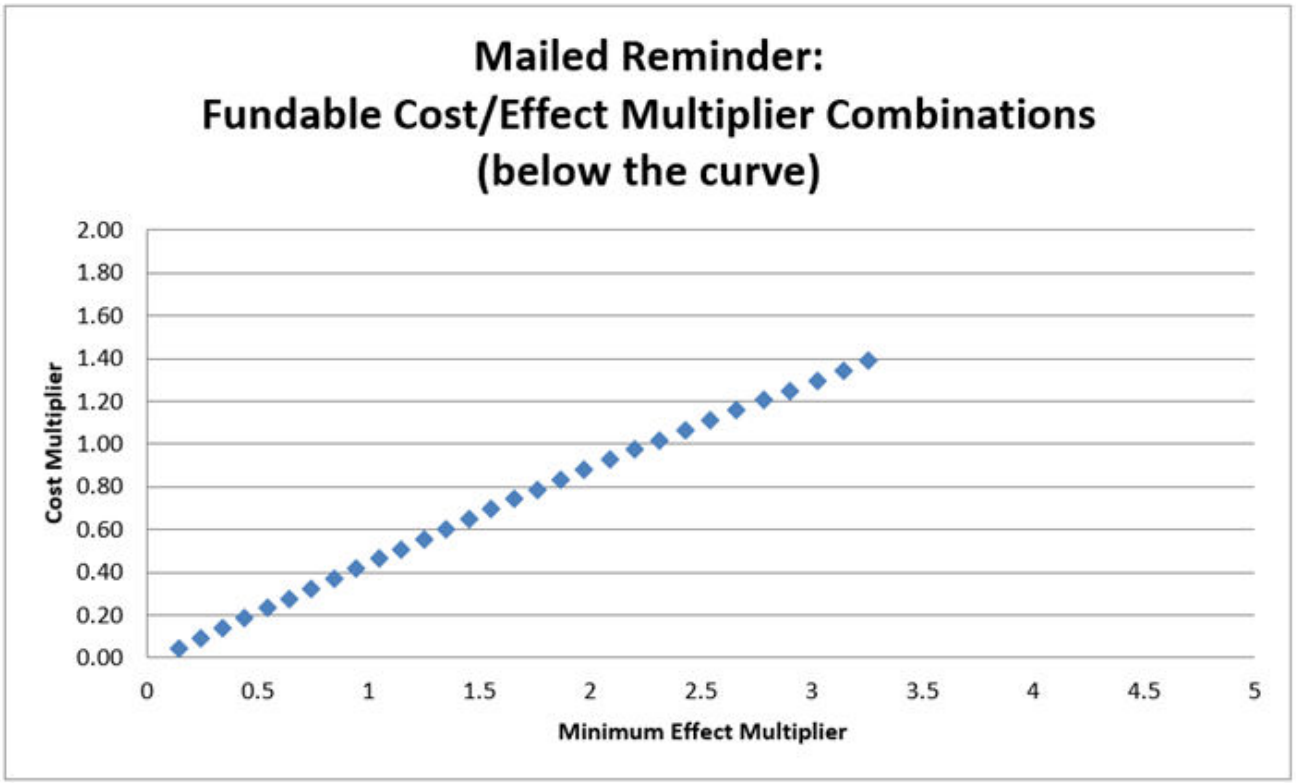
INSTEAD, WE CAN DISCUSS…

Mailed Reminder Intervention Cost	$1,619,578
Willingness to pay (WTP)	WTP $10



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Reccommendation based on most Life Years UTD

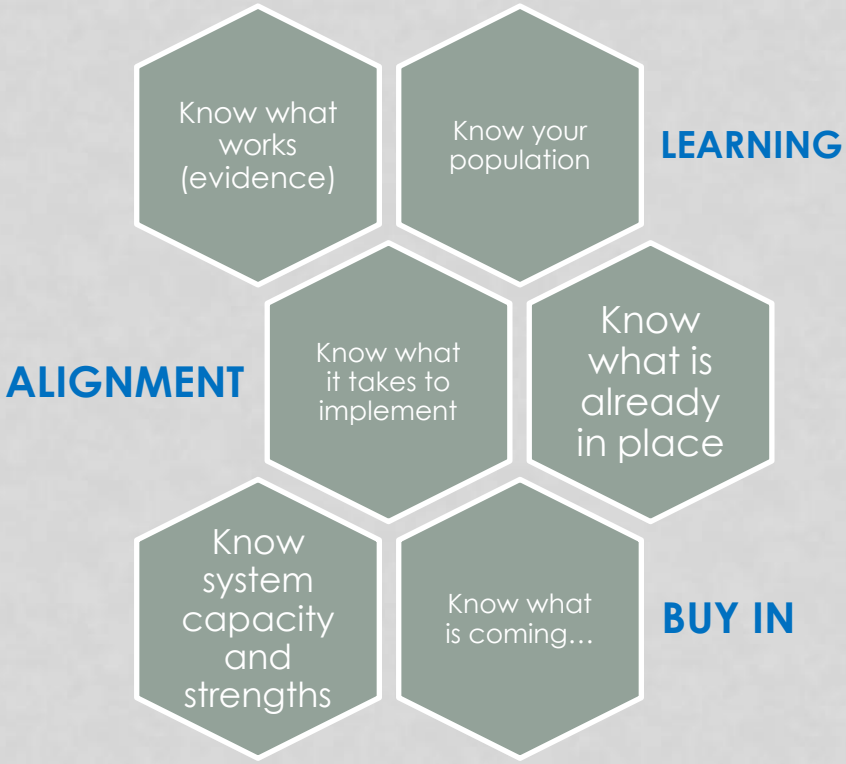
Mass Media Cost	3,000,000
Mailed Reminder Cost	1,679,578
Willingness to pay	10

Mailed Reminder

Max Total Cos	Yrs UTD
$218,150	21,815
$325,920	32,592
$434,080	43,408
$541,350	54,135
$647,600	64,760
$756,590	75,659
$862,070	86,207
$968,280	96,828
$1,072,940	107,294
$1,180,930	118,093
$1,285,770	128,577
$1,394,040	139,404
$1,500,980	150,098
$1,601,910	160,191
$1,708,530	170,853
$1,810,920	181,092
$1,917,090	191,709
$2,016,130	201,613
$2,116,370	211,637
$2,210,260	221,026
$2,306,400	230,640
$2,399,190	239,919
$2,491,250	249,125
$2,586,020	258,602
$2,682,070	268,207
$2,771,200	277,120
$2,858,850	285,885
$2,946,020	294,602
$3,034,230	303,423

Mass Media

Max Total Cos	Yrs UTD	Effect	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3
$54,350	5,435	0.2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$125,050	12,505	0.3	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$221,050	22,105	0.4	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$350,370	35,037	0.5	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$507,620	50,762	0.6	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$689,530	68,953	0.7	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$901,850	90,185	0.8	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$1,136,140	113,614	0.9	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$1,398,600	139,860	1	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$1,694,950	169,495	1.1	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$2,024,030	202,403	1.2	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$2,331,030	233,103	1.3	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$2,606,950	260,695	1.4	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$2,899,460	289,946	1.5	N	N	N	N	N	N	N	N	N	N	N	N	N	N	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR	MR
$3,210,460	321,046	1.6	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$3,513,470	351,347	1.7	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$3,848,570	384,857	1.8	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$4,200,280	420,028	1.9	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$4,554,260	455,426	2	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$4,931,800	493,180	2.1	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$5,324,040	532,404	2.2	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$5,733,080	573,308	2.3	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$6,155,260	615,526	2.4	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$6,581,640	658,164	2.5	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$6,842,500	684,250	2.6	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$7,094,760	709,476	2.7	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$7,348,660	734,866	2.8	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$7,599,340	759,934	2.9	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM
$7,842,640	784,264	3	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM	MM



THE PUZZLE OF **LOCAL** DECISION MAKING

ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

TARGET AUDIENCES

- **State or local public health leaders and policy makers** who want to know the benefits and trade-offs of public health interventions
- **Organizations responsible for specifying clinical and public health practice guidelines** (e.g., the US Preventive Services Task Force, the American Cancer Society, and the Centers for Disease Control and Prevention);
- State systems such as **health plans, accountable care organizations, or coalitions**
- Local systems such as **healthcare and hospital systems, large employers, Federally Qualified Health Centers, AHEC regions**
- Clinician and/or public health **researchers**
- **Patients and patient advocates** in the community

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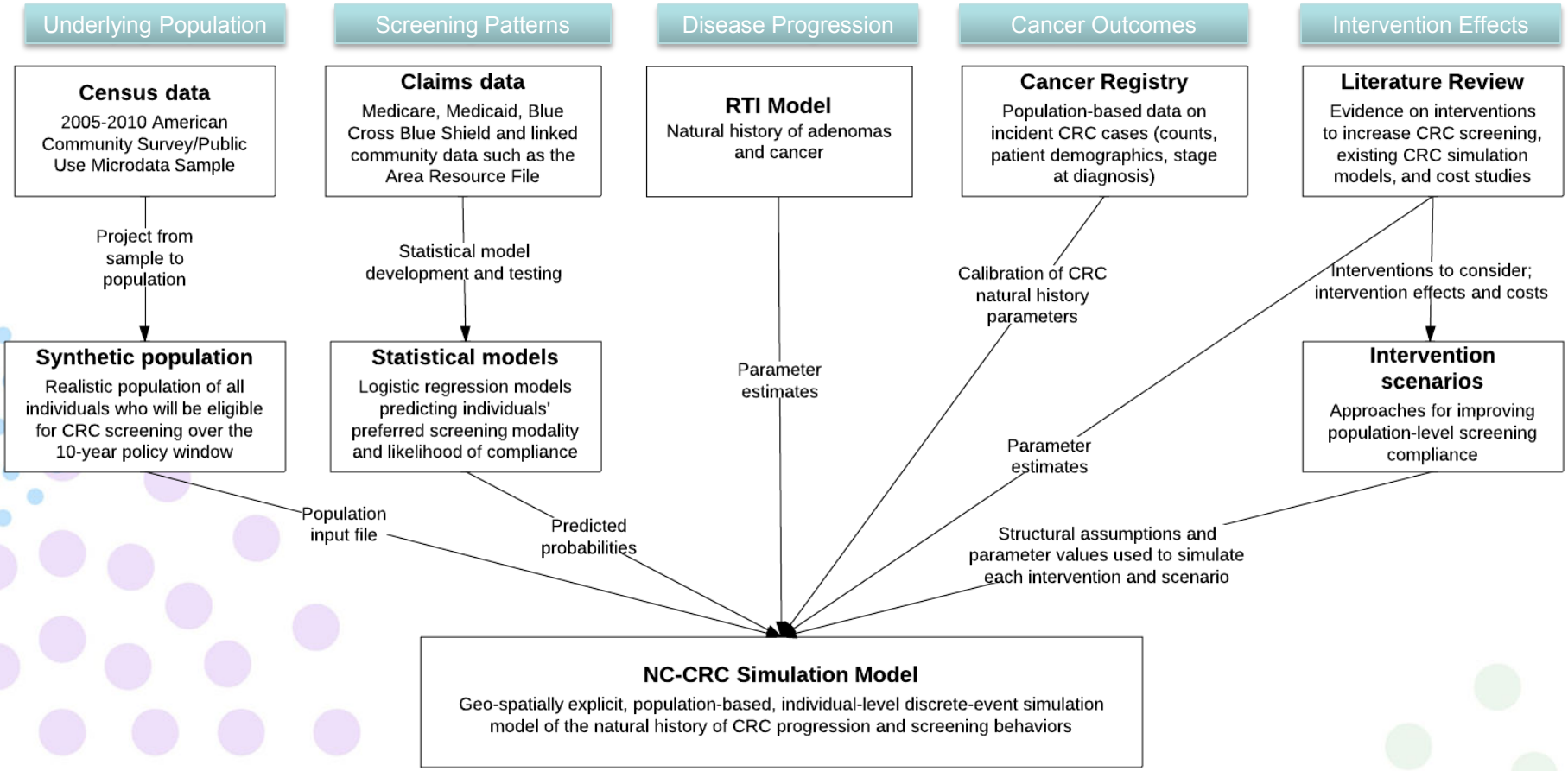
THANK YOU!

klich@unc.edu

Simulation model components & data sources



CPCRN Cancer Prevention and Control Research Network