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

OHSU

PRC Prevention Research Centers

ISE EDWARD P. FITTS DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

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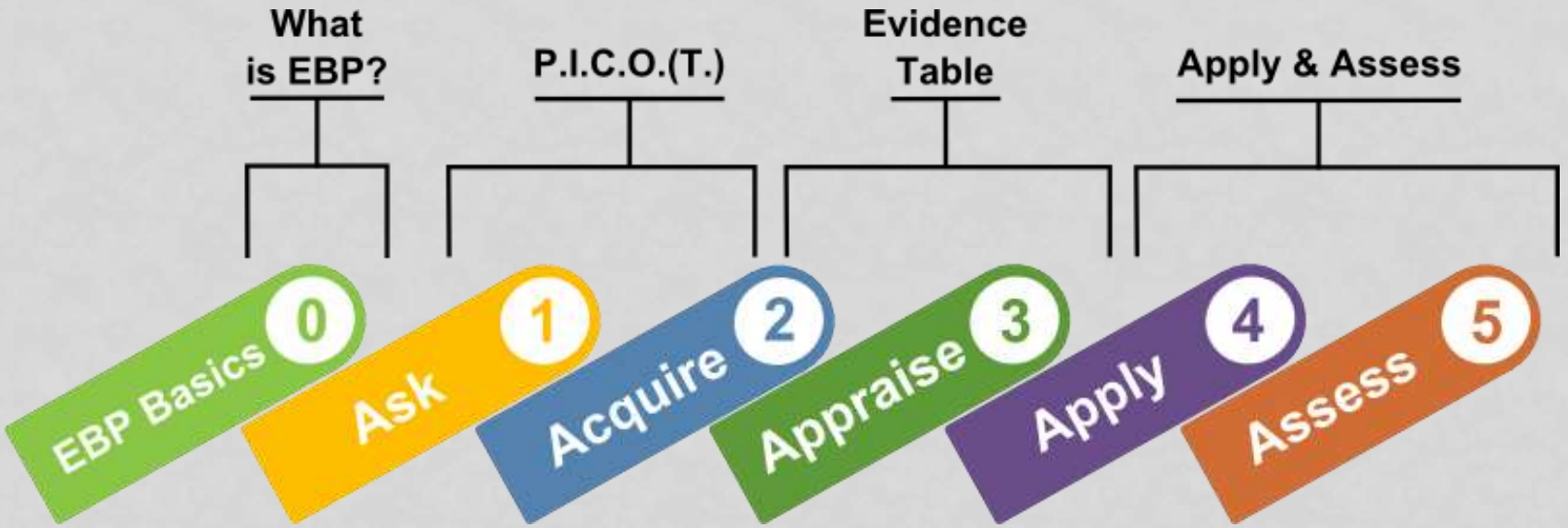
HOW DO WE *TYPICALLY* SELECT EVIDENCE-BASED PRACTICES?



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

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

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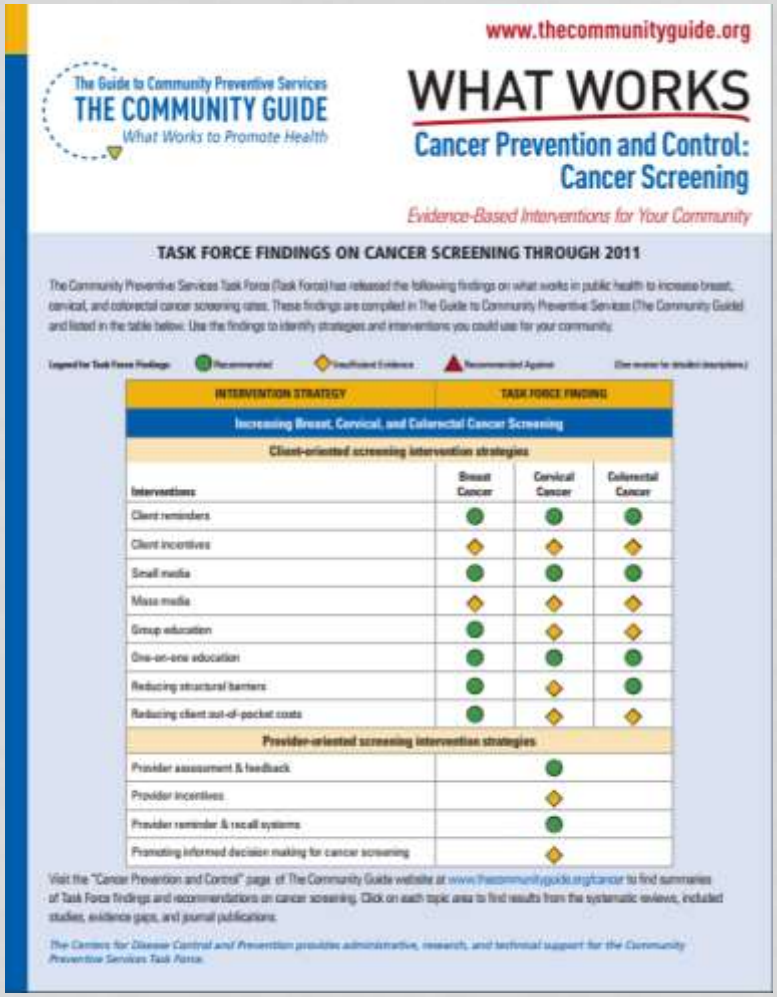


www.thecommunityguide.org

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

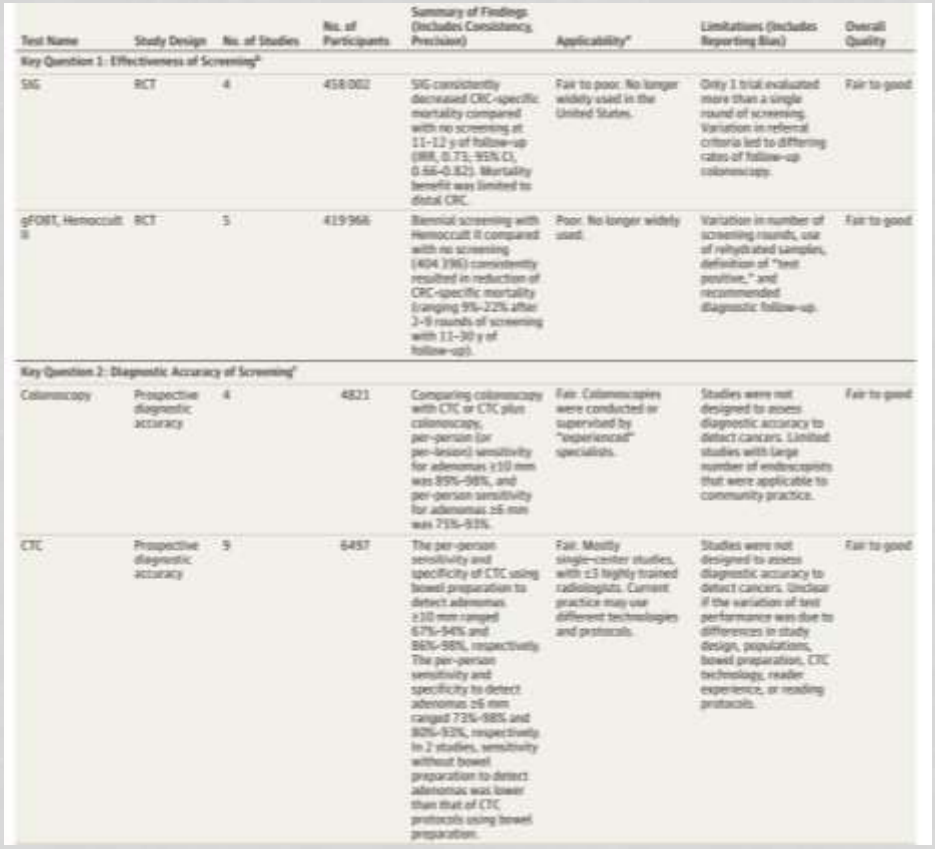
The Community Preventive Services Task Force (Task Force) has released the following findings on what works in public health to increase breast, cervical, and colorectal cancer screening rates. These findings are compiled in The Guide to Community Preventive Services (The Community Guide) and listed 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 review 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*	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 (RR, 0.75; 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 3–9 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	6457	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%–88% 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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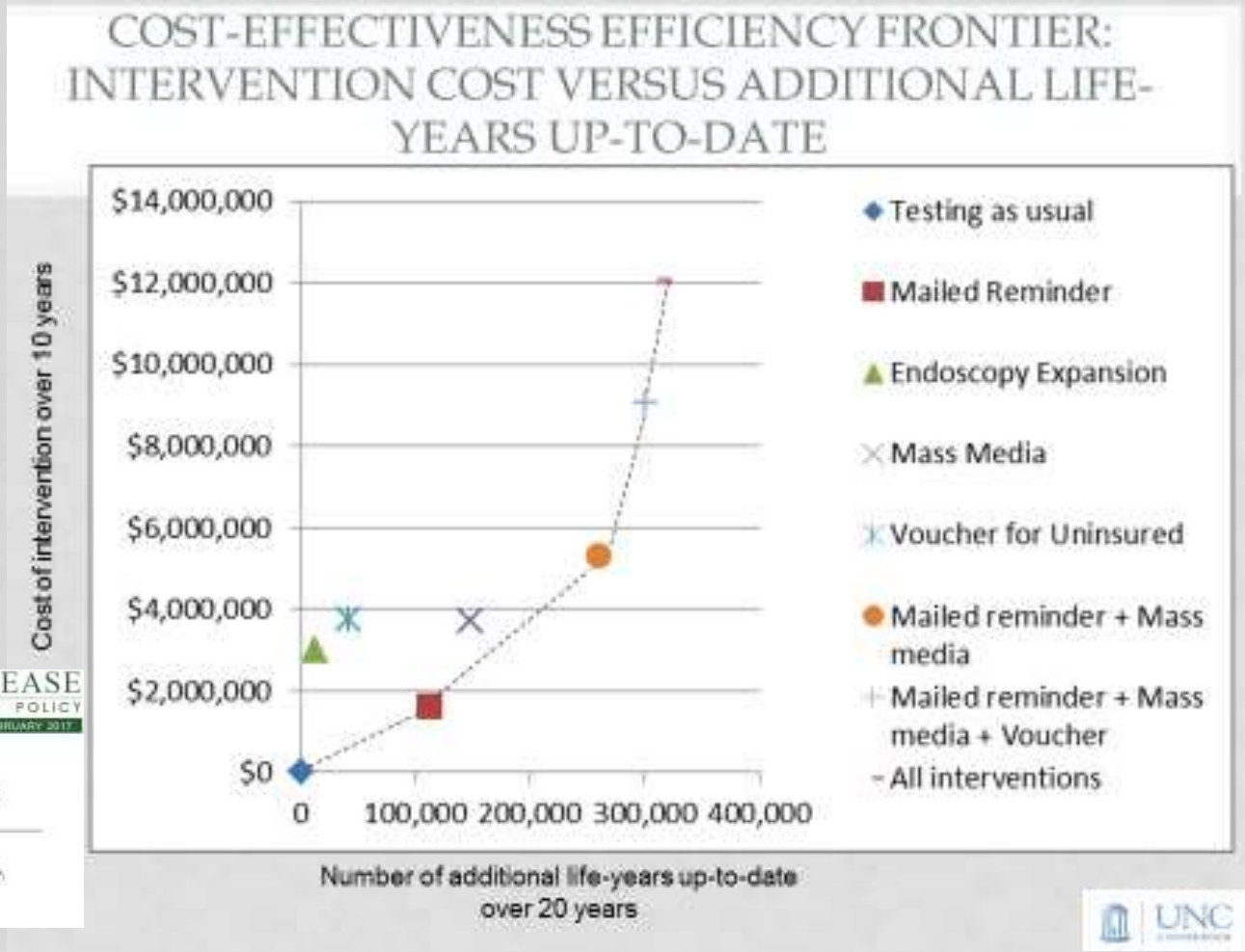
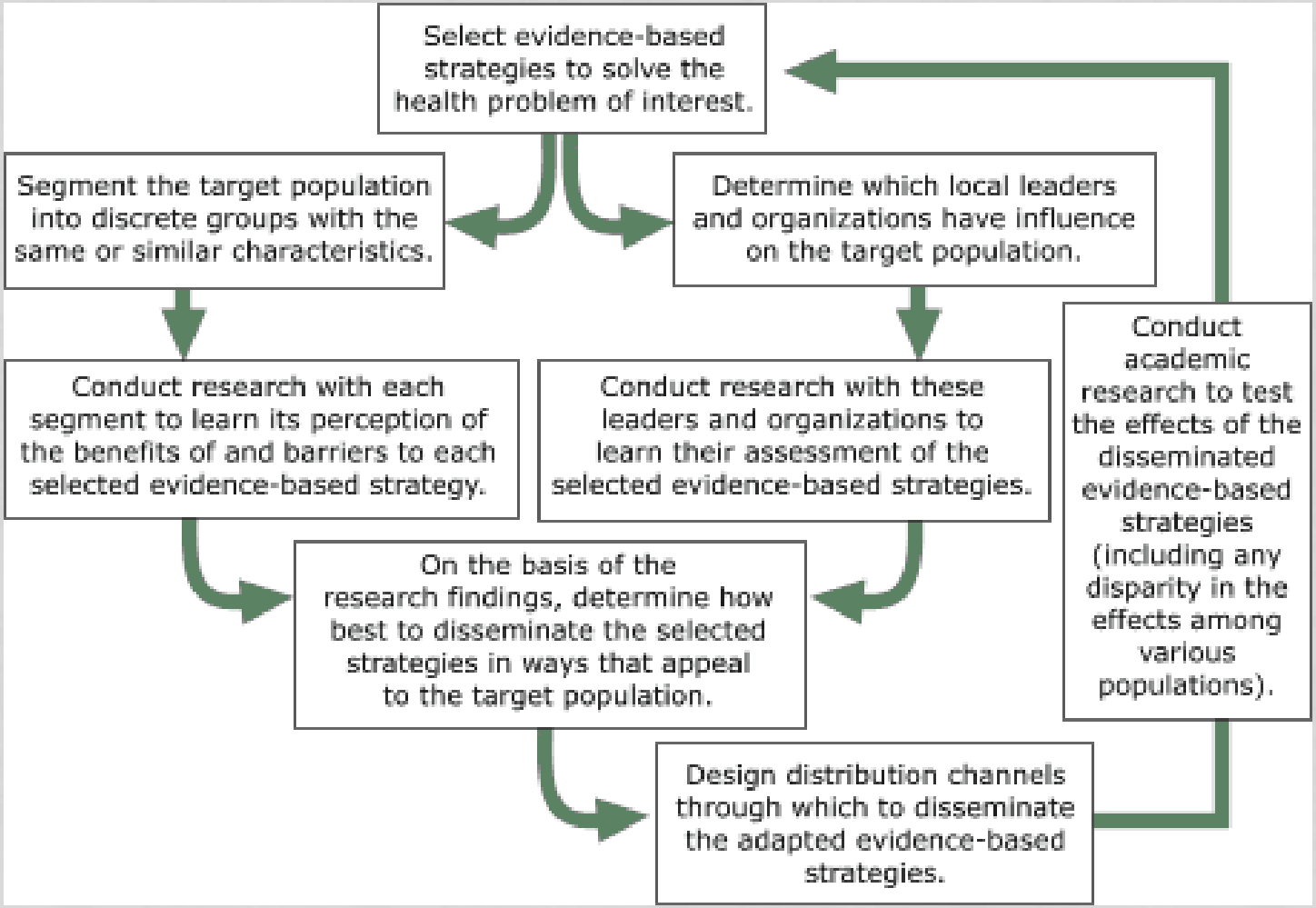



PREVENTING CHRONIC DISEASE
PUBLIC HEALTH RESEARCH, PRACTICE, AND POLICY

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

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

REF: HASSMILLER LICH ET AL., PREVENTING CHRONIC DISEASE



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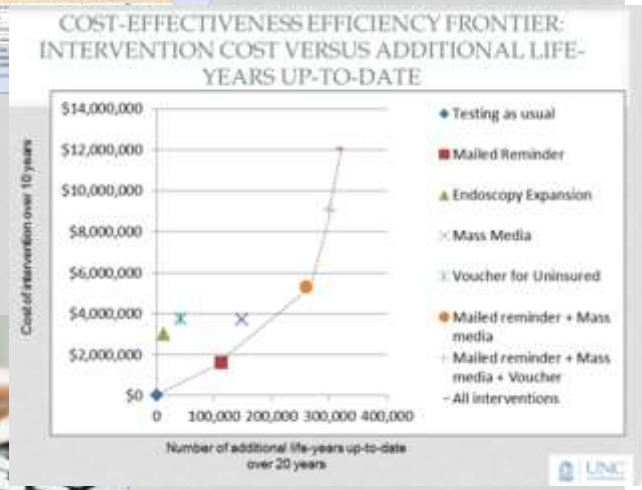
SO… HOW DO WE TYPICALLY SELECT EVIDENCE-BASED PRACTICES?

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

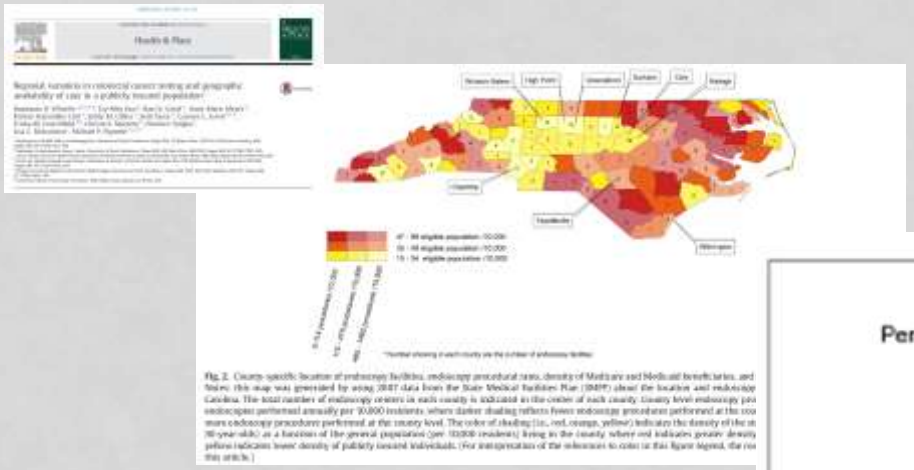
ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

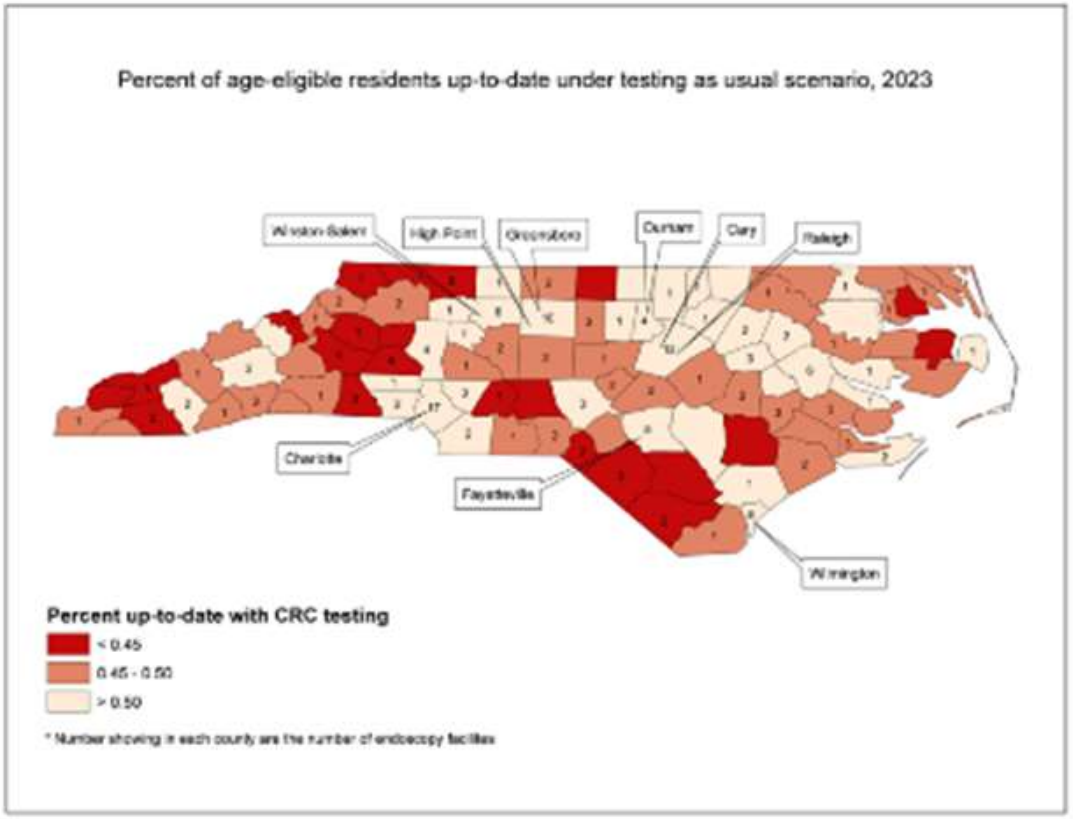
- Differences in the population targeted can change impact!
  - What if my population is older?
  - More racially diverse?
  - Less likely to *stay* insured?
  - More rural?
- What if our state is doing a great job with a subpopulation already?
  - Medicaid screening rates are high
  - Just had a big 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

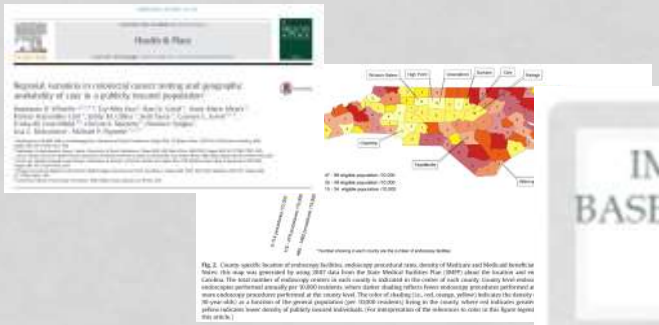
ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

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





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

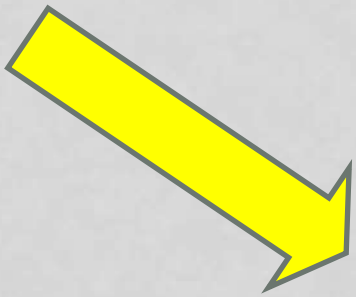
ENGAGING DECISION MAKERS WITH SIMULATION CAN HELP!

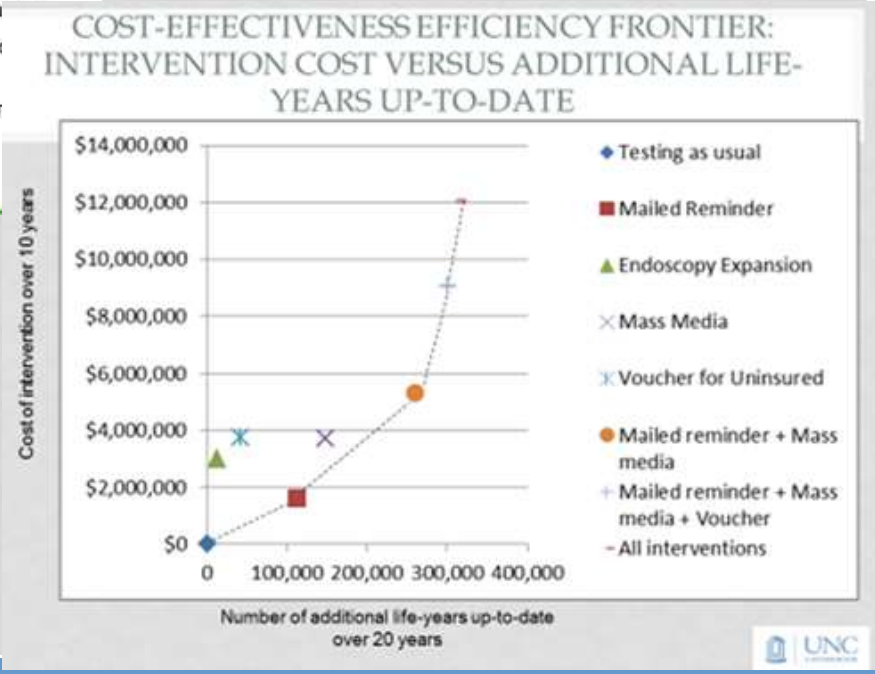
SYSTEM MAPPING

- 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

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

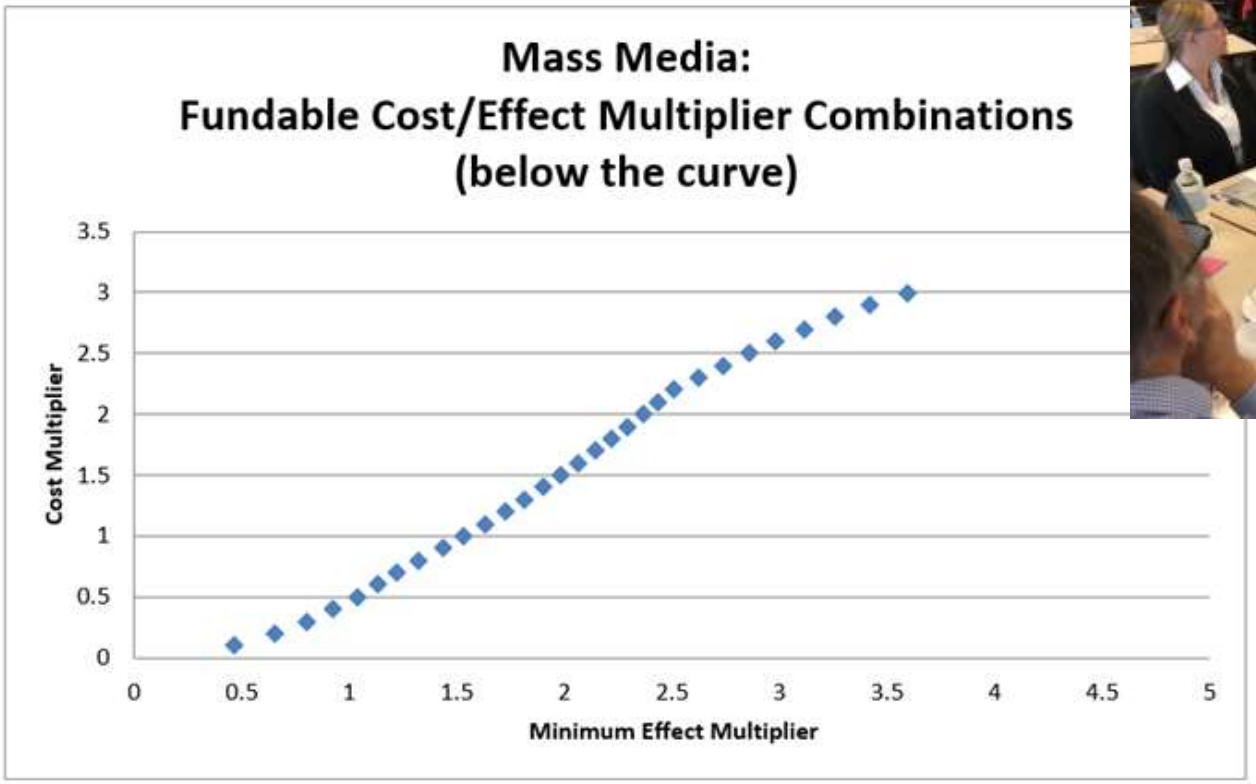




INSTEAD, WE CAN DISCUSS…

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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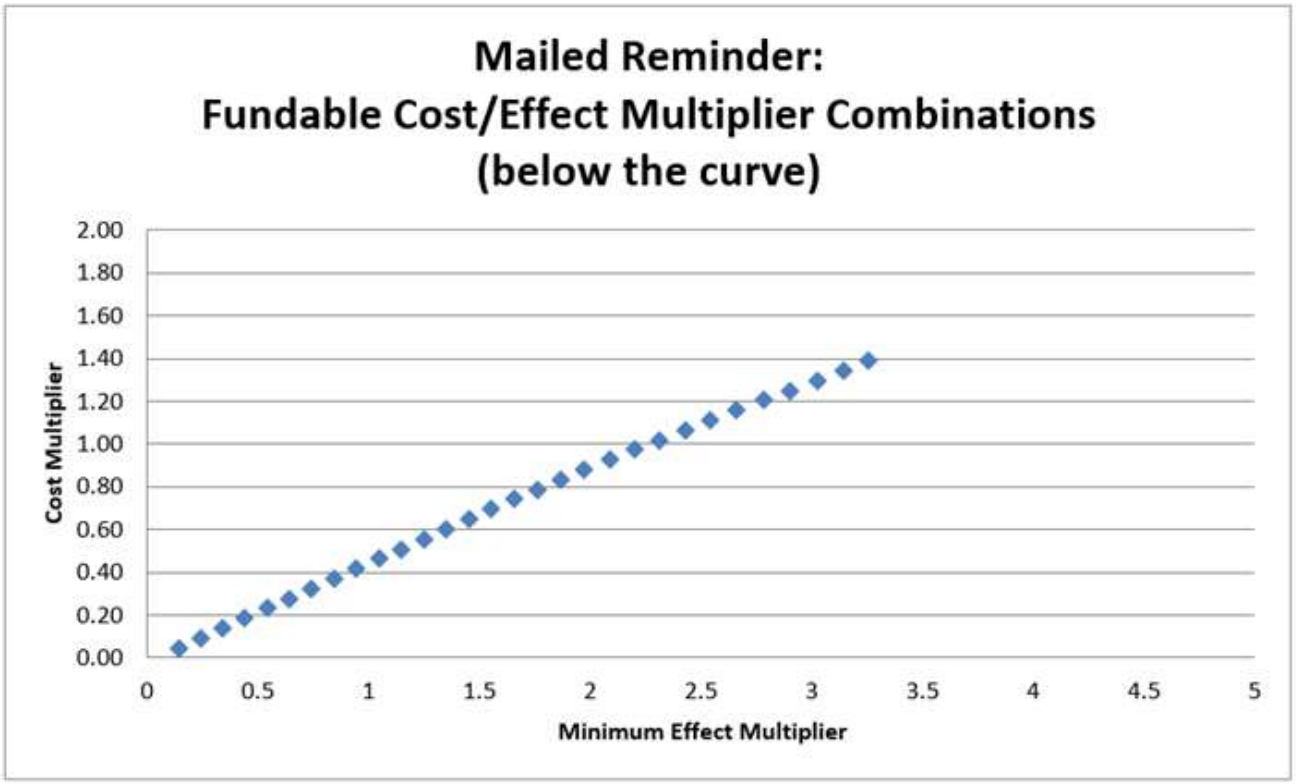
INSTEAD, WE CAN DISCUSS…

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



Reccommendation based on most Life Years UTD

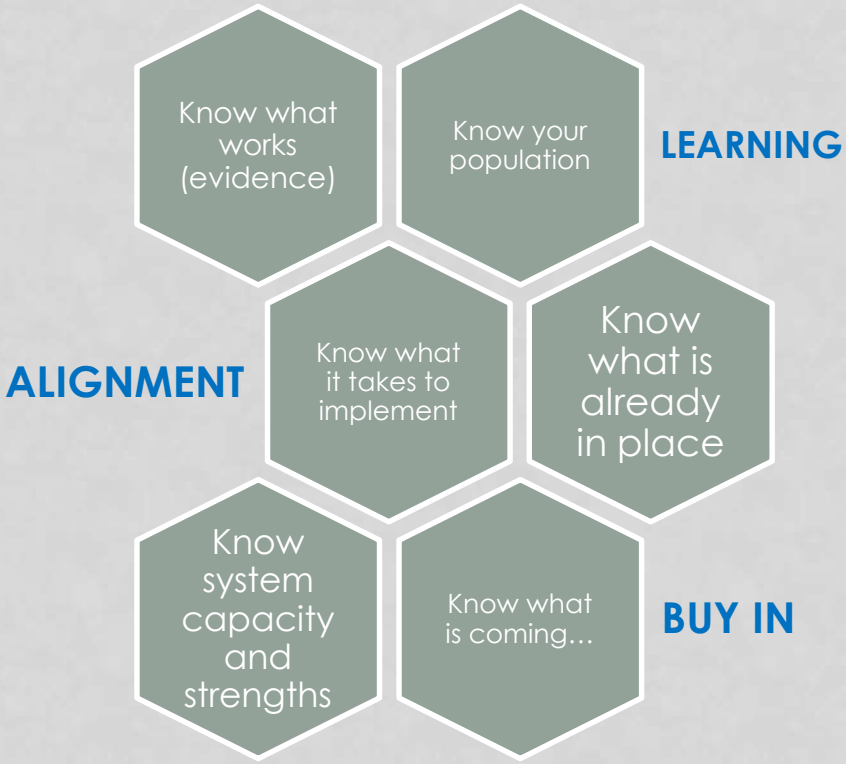
Mass Media Cost	3,000,000
Mailed Reminder Cost	1,679,578

Willingness to pay: 10

Mailed Reminder

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

Mass Media



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!

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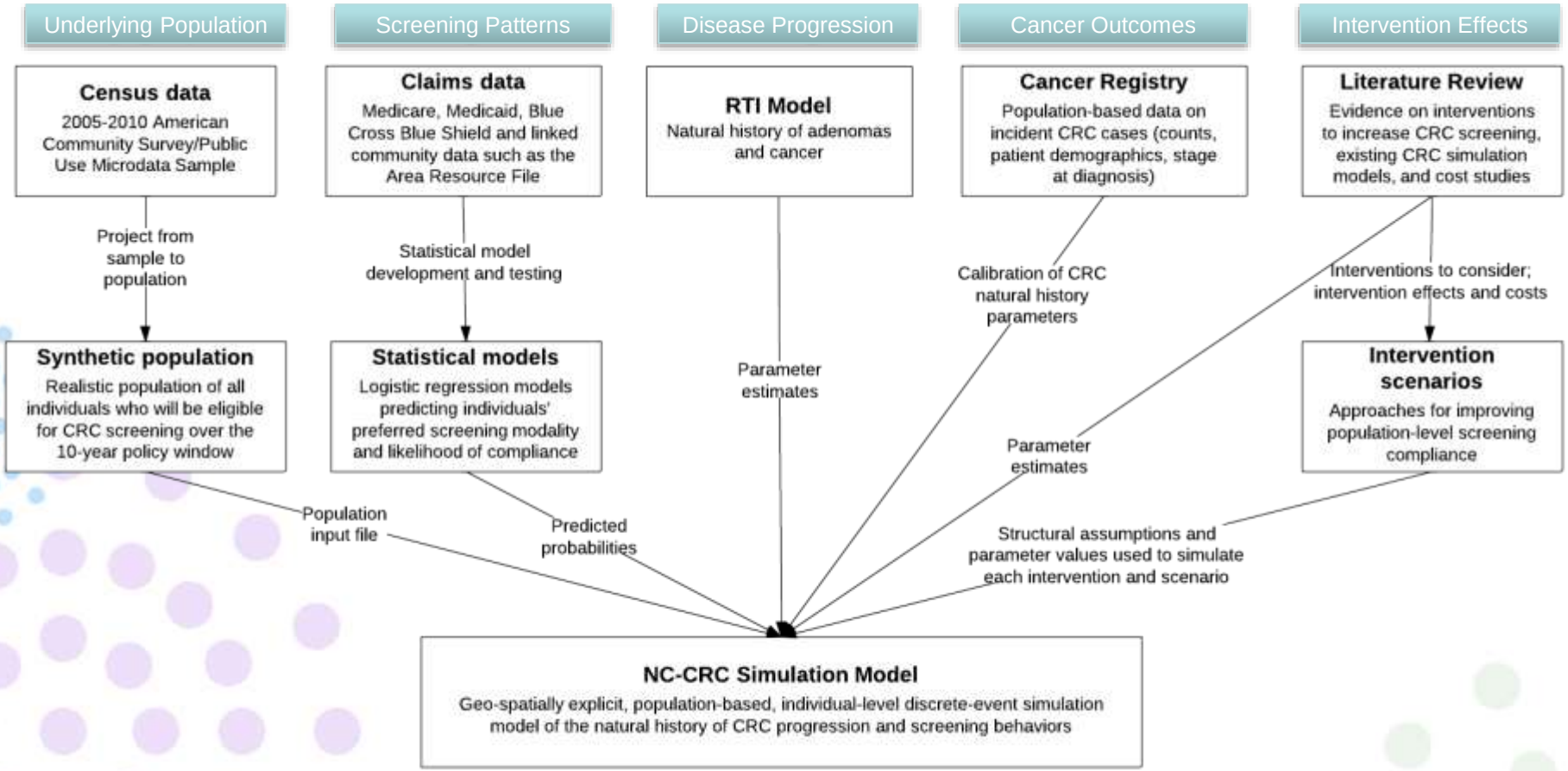
Simulation model components & data sources



CPCRN
Cancer Prevention and Control Research Network