Cancer Intervention and Surveillance Modeling Network

NCI's Consortium for Population Modeling to Guide Public Health Research and Priorities

National Academies of Sciences, Engineering, and Medicine's ad hoc Committee on a National Strategy for Cancer Control in the United States

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➢ NCI Sponsored Collaborative Consortium (U01) of Modelers in Breast, Prostate, Colorectal, Lung, Esophagus, and Cervical cancers formed in 2000

➢ Synthesize trial, epidemiologic, and surveillance data using simulation modeling to guide public health research and priorities

  ◆ Help address the formidable and growing gap between the rapid pace of innovation in cancer research and our ability to efficiently harness it to improve population health


https://cisnet.cancer.gov/

2
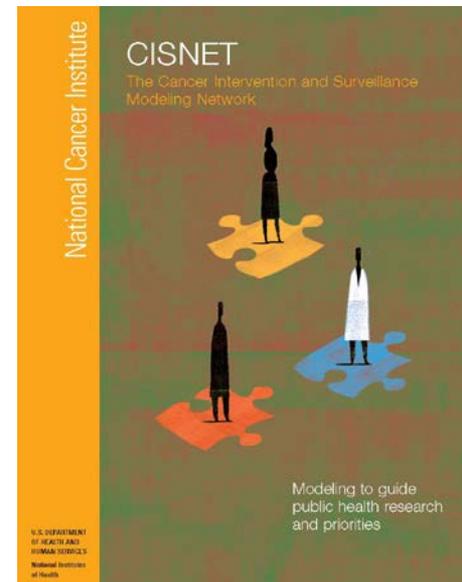
Previously individual modeling efforts yielded different results that were difficult to reconcile

Approach Innovated by CISNET: Systematic Comparative Modeling

➢ Central questions to be addressed by groups collaboratively with a common set of inputs and outputs

- ◆ Reproducibility across models adds credibility to results
- ◆ Differences point out areas for further study in a systematic way

➢ Six multiple-PI grants each focused on a different cancer site with a coordinating center and between 3-6 modeling groups

Cancer-Site Specific Coordinating Center — Modeling Group 1, Modeling Group 2, Modeling Group 3, Modeling Group 4, Modeling Group 5, Modeling Group 6
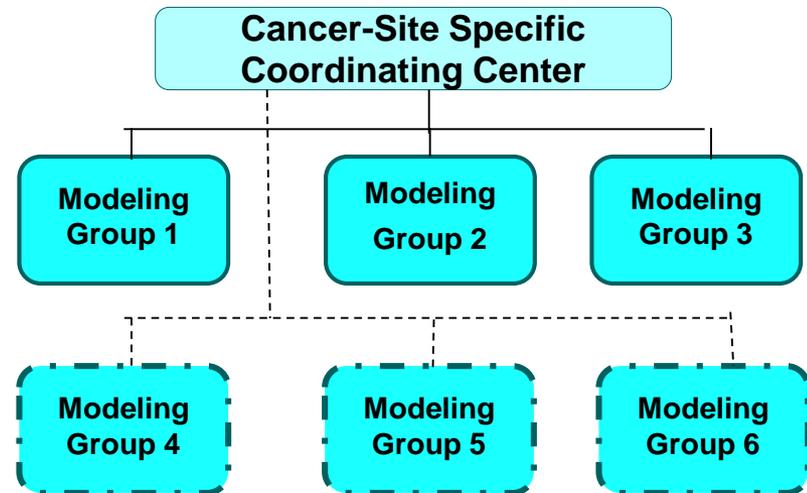
➢ Affiliate members can join for specific collaborations
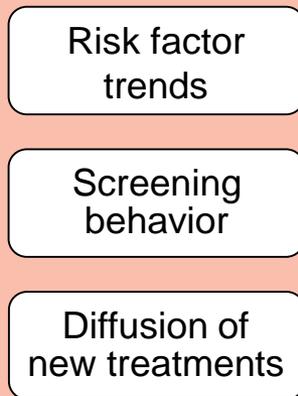
➢ Simulates individual life histories with respect to:
  ◆ Year of birth
  ◆ Development of risk factors for cancer or background risk for those born in specific years

Natural History

  ◆ Development of pre-cancerous lesions (e.g. polyps, Barrett's esophagus), initiation of cancer
  ◆ Rate of growth of cancer
  ◆ Diagnosis of cancer through symptoms
  ◆ Basic treatment (in some base year prior to treatment advances that will be modeled)
  ◆ Death from cancer or other causes
  All calibrated to as many data sources as possible

➢ We then intervene on these individuals (advances in prevention, screening, and treatment) which changes their life history
  ◆ Parallel lives with and without interventions

➢ Summing together these individuals the modelers can represent what happens under real or hypothetical scenarios and the impact of each intervention (by comparing runs)
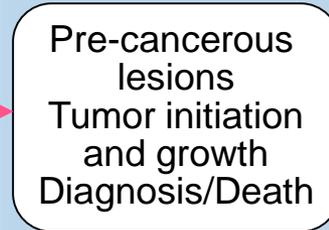
Common Input Generators

Individual Cancer Simulation Models

Common Outputs: Costs & Benefits of Interventions

- Risk factor trends
- Screening behavior
- Diffusion of new treatments

Pre-cancerous lesions
Tumor initiation and growth
Diagnosis/Death

Examples of outputs:
- Mortality
- Quality-adjusted life years
- Overdiagnosis
- Direct medical costs

Calendar Time

1970   1980   1990   2000   2010   2020   2030
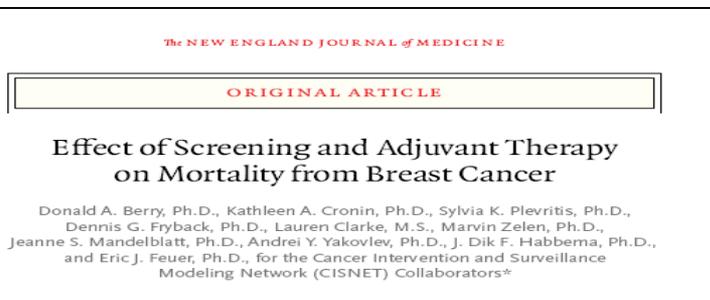
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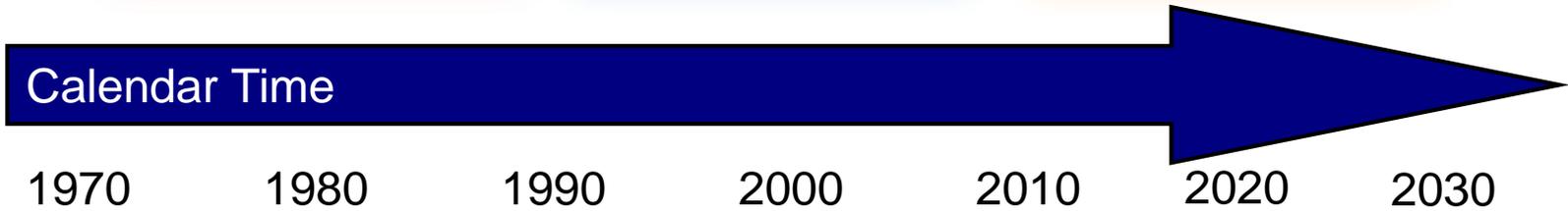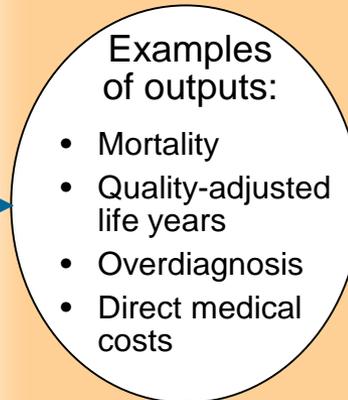
Three Examples of CISNET Work

➢ Prior to CISNET the USPSTF contracted for systematic evidence reviews, but rarely used modeling

➢ CISNET has assisted the USPSTF for colorectal (2008, 2016), breast (2009, 2016), lung (2014), cervical (2017-draft recommendations)

➢ CISNET extrapolated from actual trials or other studies to help determine screening regimens that are on the "efficiency frontier" (e.g. most deaths averted for a specified # of screens) and allowing policymakers to weigh this against potential harms of each regimen (e.g. false +'s, overdiagnosis, radiation induced cancers)

➢ CISNET had a major influence in:

♦ Changing mammography recommendations from every 1-2 years to every 2 years

♦ Evaluating all of the different modalities of CRC screening

➢ The CRC group did work for CMS to determine reimbursement levels for new screening modalities (FIT, CT Colonography, stool DNA tests)

♦ Determining an "optimal" strategy for lung cancer screening by comparing hundreds of approaches

♦ Changing cervical cancer screening by adding the recommendation of hrHPV testing alone every 5 years in women 30-65

US Breast Cancer Mortality, 1975-2012
Women Age 30-79

NATIONAL CANCER INSTITUTE®
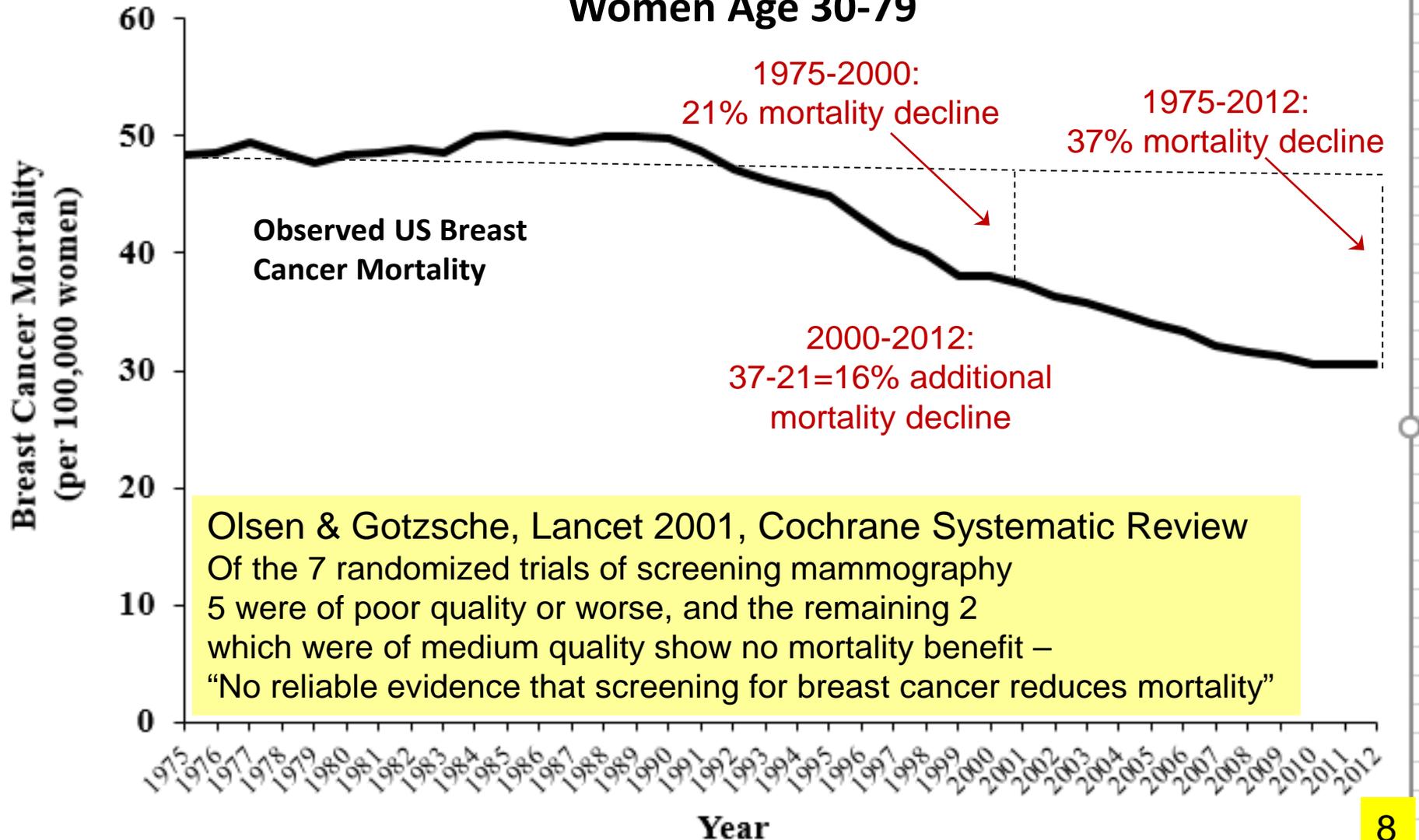
Berry et al. NEJM, Oct. 2005
(Cited over 1000 times)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Effect of Screening and Adjuvant Therapy on Mortality from Breast Cancer

Donald A. Berry, Ph.D., Kathleen A. Cronin, Ph.D., Sylvia K. Plevritis, Ph.D., Dennis G. Fryback, Ph.D., Lauren Clarke, M.S., Marvin Zelen, Ph.D., Jeanne S. Mandelblatt, Ph.D., Andrei Y. Yakovlev, Ph.D., J. Dik F. Habbema, Ph.D., and Eric J. Feuer, Ph.D., for the Cancer Intervention and Surveillance Modeling Network (CISNET) Collaborators*
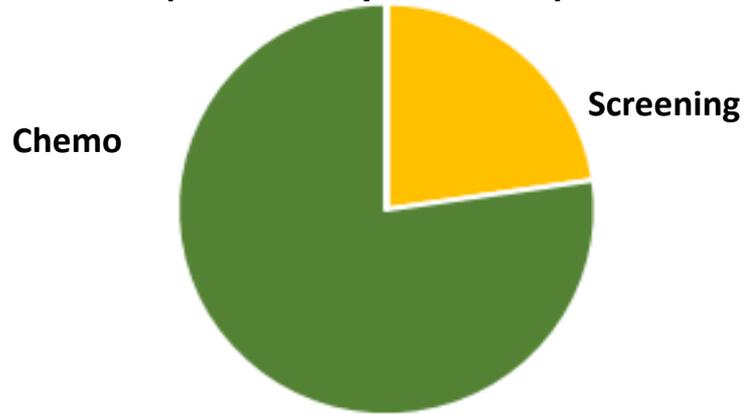
From NEJM, Berry et al, Effect of Screening and Adjuvant Therapy on Mortality from Breast Cancer, 353, 1784-92 Copyright © 2005 Massachusetts Medical Society. Reprinted with permission.

Dana Faber - Zelen
Erasmus - Habbema
Georgetown - Mandelblatt
MD Anderson - Berry
Rochester - Yakovlev
Stanford - Plevritis
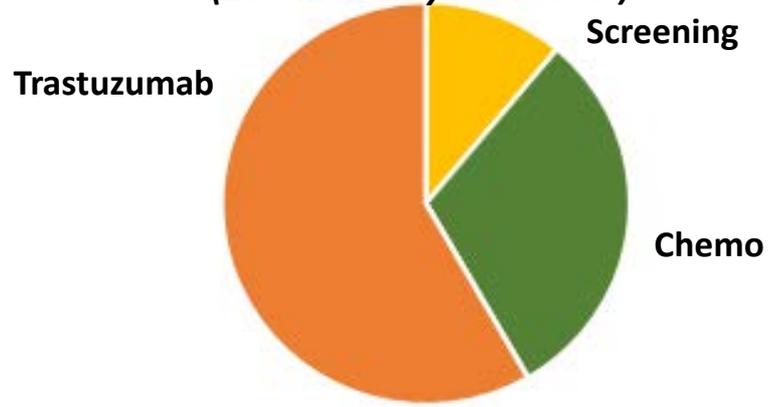**W**isconsin – Fryback

Modeled % Reduction in Breast Cancer Mortality
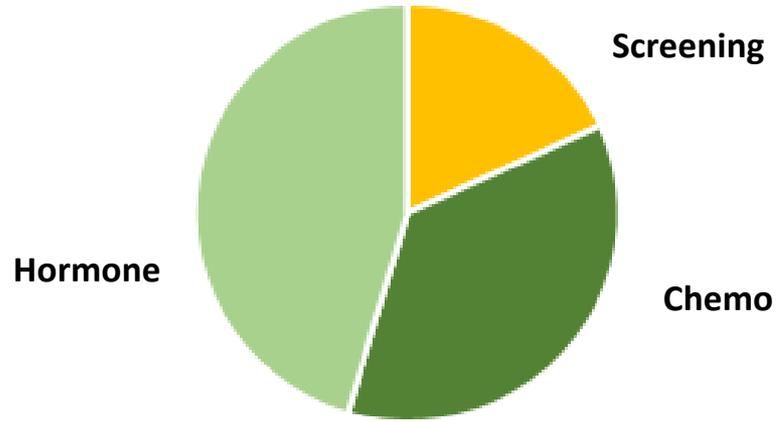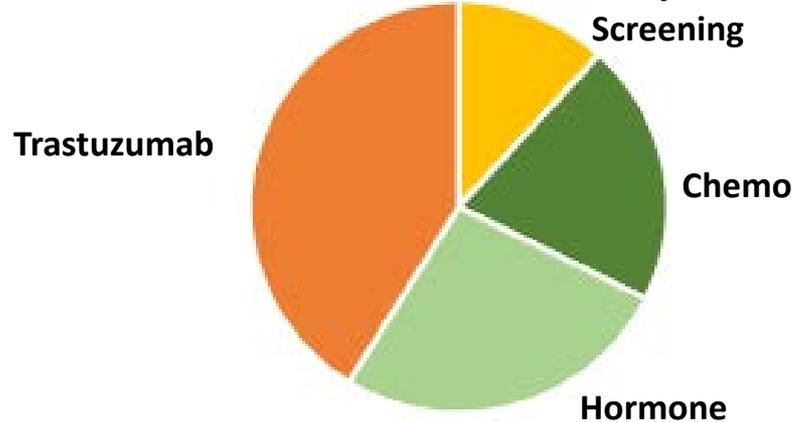Due to Adjuvant Therapy and to Screening Mammography

11

JAMA Original Investigation
Association of Screening and Treatment with Breast Cancer Mortality by Molecular Subtype in US Women, 2000-2012

JAMA, January 9, 2018
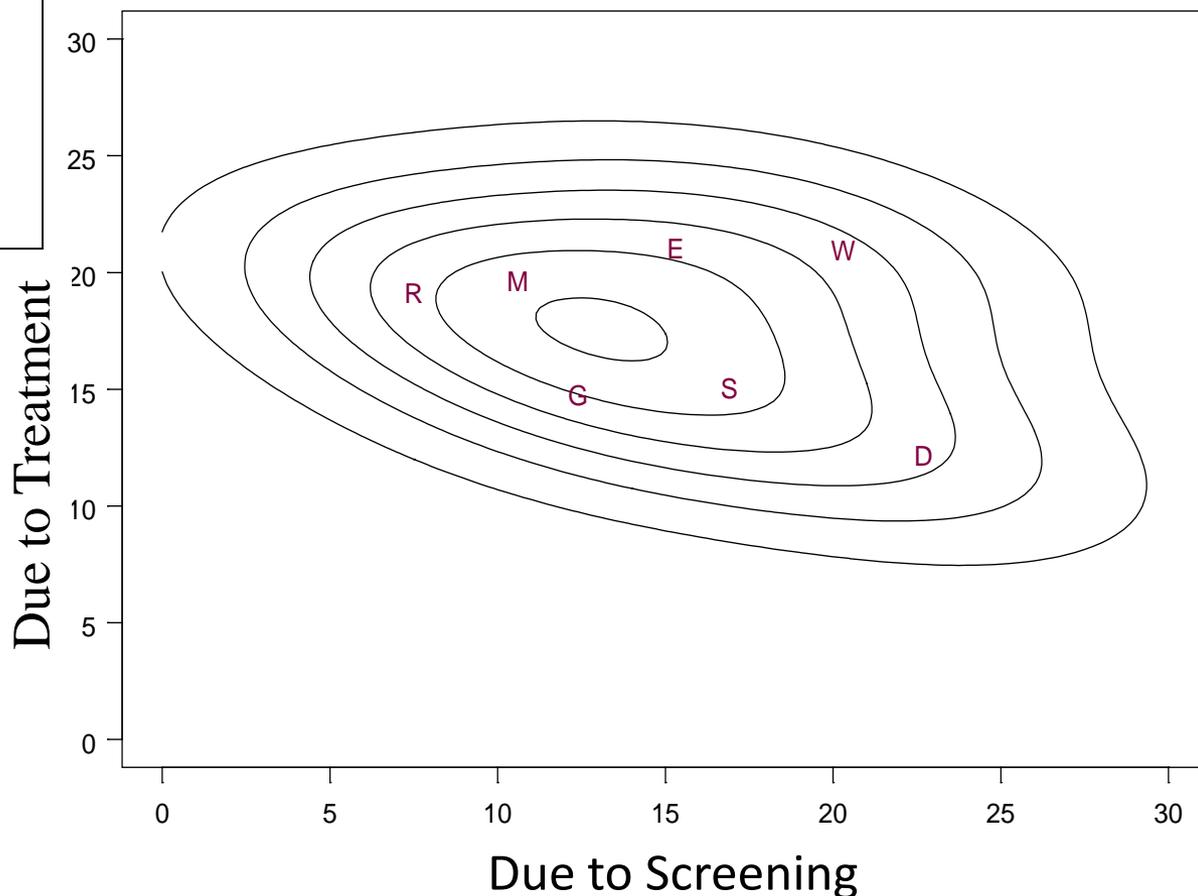
ER-, HER2-
(8% mortality reduction*)

Chemo · Screening

ER-, HER2+
(15% mortality reduction*)

Trastuzumab · Screening · Chemo

ER+, HER2-
(12% mortality reduction*)

Screening · Chemo · Hormone

ER+, HER2+
(19% mortality reduction*)

Trastuzumab · Screening · Chemo · Hormone

**Relative to modeled mortality in 2012 in the absence of the interventions and subtracting out contributions 1975-2000

12

South Carolina non-elderly population: **4.0M** (of which **770k** are uninsured) Budget: **2.0M** over **2 years**
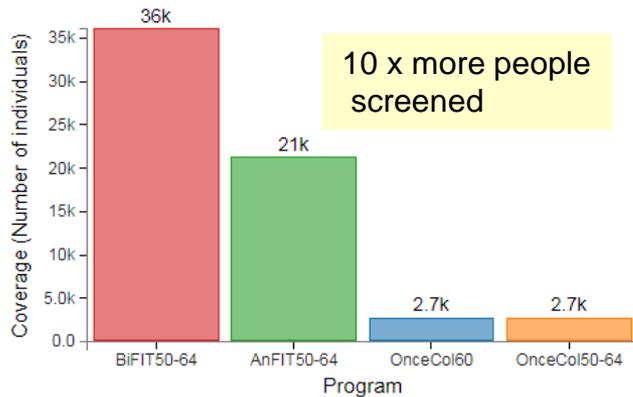
Proportion of non-elderly insured versus non-elderly uninsured population:

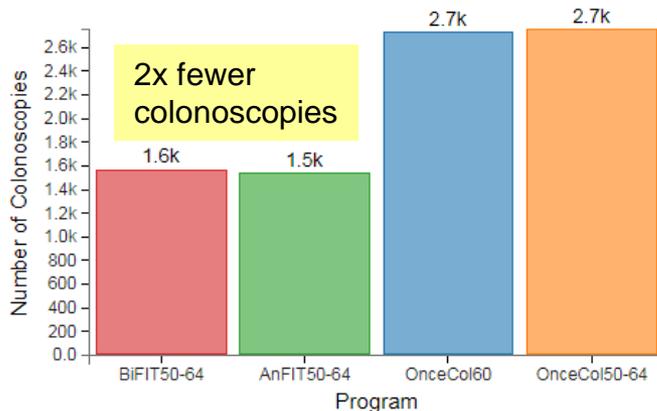| Insured: 80.7% | Uninsured: 19.3% |

Demographic breakdown of the non-elderly uninsured population (**WM**=White male, **WF**=White female, **BM**=Black male, **BF**=Black female):

| WM: 33.3% | WF: 30.7% | BM: 18.7% | BF: 17.3% |

Number of Individuals Screened

10 x more people screened

Number of Colonoscopies

2x fewer colonoscopies

Colorectal Cancer Deaths Prevented

Program Stop Year (2015)

BiFIT50-64: **29**
AnFIT50-64: **25**

4x more CRC deaths prevented

OnceCol50-64: **6.1**
OnceCol60: **5.4**
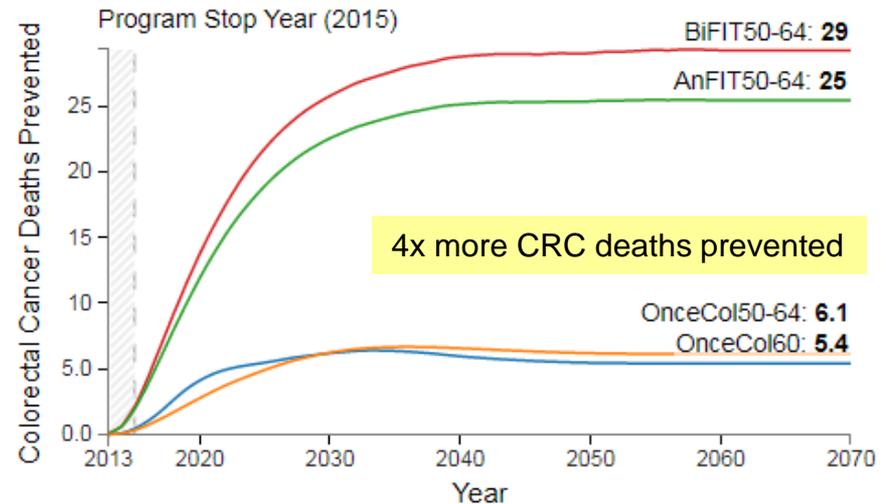
FIT screening program prevents more CRC deaths than a colonoscopy screening program <u>when a state's budget for CRC screening supports screening of only a fraction of the target population</u>

van der Steen, Health Services Research, 2015

13

https://survey.erasmusmc.nl/miscanstate/#about

Summary

➢ Modeling has the ability to evaluate the impact of cancer control interventions and to help optimize their implementation in population settings

➢ Invite you to view the library of CISNET publications organized by cancer site and by topic area

  ◆ https://cisnet.cancer.gov/publications/

➢ CISNET modeling is imbedded in other grants & investigators are open to collaborations with those interested in specific applications

Accomplishments: *Over 400 impactful publications*

➢ My contact: rf41u@nih.gov

➢ CISNET website: https://cisnet.cancer.gov/