Colorectal Cancer CISNET program

Micro-simulation modeling for colorectal cancer

Example: How much can current interventions reduce colorectal cancer in the United States?
  - What are best short term and long term choices for cancer control interventions?
I am the biostatistician for National Polyp Study
- National Polyp Study (NPS) was RCT for colonoscopic surveillance intervals for adenoma patients
- Provided study data from NPS to assess a policy model for natural history predicting adenoma and colorectal cancer outcomes

Microsimulation model (MISCAN)
- Preliminary fit to observed data was not good
- When changed model to assume some adenomas regress, then good fit of model
  - Adenoma regression was novel at the time
  - Regression is now more accepted
What CMS reimbursement for a new FOBT test?

$4.50

$ to be determined

Guaiac FOBT

Immunochemical FOBT
Cost Effectiveness of Immunochemical FOBT of CMS

- What CMS reimbursement relative to increase in effectiveness?
- CRC CISNET modeling for AHRQ and CMS
  - Immunochemical FOBT approved for reimbursement
  - Cost effectiveness estimate used in setting reimbursement fee

$22
Other Examples of CISNET Modeling to Inform Health Policy Decisions

- Impact of screening, treatment, and risk factor effects on CRC incidence and mortality 1975-2000
- Clinical processes that affect survival and quality of care for CRC for Cancer Care Quality Measurement Project (Canqual)
- Customizing colonoscopy screening by race and age to begin screening
- Impact of missing diminutive adenomas with virtual colonoscopy
Microsimulation Modeling of Colorectal Cancer
Adenoma to Carcinoma Pathway

Normal Epithelium → Small Adenoma → Advanced Adenoma → Colorectal Cancer
Natural History of Colorectal Cancer

Datasources:
- Adenoma
  - Autopsy studies
  - Colonoscopy studies
- Preclinical Cancer
  - Dwell time
- Clinical Cancer
  - SEER Incidence
- Death
  - US Mortality

Adenoma
- <=5 mm
- =>10 mm
- 6-9 mm

No lesion

No lesion

Progressive

Non-progressive (regression)

Preclinical screen-detectable adenoma phase

Preclinical screen-detectable cancer phase

Clinical cancer phase

Death colorectal cancer

Adenoma

Preclinical stage I

Preclinical stage II

Preclinical stage III

Preclinical stage IV

Clinical stage I

Clinical stage II

Clinical stage III

Clinical stage IV
Interventions on Colorectal Cancer

Risk Factors

- No lesion
- Adenoma <= 5 mm (non-progressive (regression))
  - Adenoma 6-9 mm
  - Adenoma >= 10 mm

Screening

- ADENOMA Preclinical screen-detectable adenoma phase
  - Adenoma 6-9 mm
  - Adenoma >= 10 mm

- Preclinical CANCER screen-detectable cancer phase
  - Preclinical stage I
  - Preclinical stage II
  - Preclinical stage III
  - Preclinical stage IV

Treatment

- Clinical CANCER phase
  - Clinical stage I
  - Clinical stage II
  - Clinical stage III
  - Clinical stage IV

Datasources:

- Adenoma
  - Autopsy studies
  - Colonoscopy studies

- Preclinical Cancer
  - Dwell time

- Clinical Cancer
  - SEER Incidence

- Death
  - US Mortality

Death colorectal cancer
Projecting Colorectal Cancer Mortality to 2020

How much can current interventions reduce colorectal cancer mortality in the United States?

What are best short term and best long term choices of cancer control interventions?
Between 2003 and 2010, to reach the HP2010 mortality goals, mortality would have to drop by:

- 12% for female breast cancer
- 17% for lung cancer
- 27% for colorectal cancer

Goals are the same for all race/sex groups
- Drop in CRC mortality needed to achieve goal
  - WM (38%), WF (10%), BM (57%), BF (39%)
Population Simulation Model

Risk factor trends
Screening behavior
Diffusion of new treatments
CRC Model
CRC Incidence & mortality

Upstream
Downstream
Downstream Goal for Colorectal Cancer Mortality – White Men

Developing scenarios for WM, WF, BM, BF

CRC Deaths per 100,000 (standardized)

- 22.4 in 2003
- HP2010 Goal: 13.9 (38% reduction)
Upstream Factors Modeled: Colorectal Cancer

- **Risk Factors:** Smoking, Obesity, Physical Activity, Multivitamin Use, Red Meat, Aspirin, Fruit and Vegetable Consumption, Hormone Replacement Therapy

- **Screening:** FOBT, Endoscopy (Sigmoidoscopy / Colonoscopy)

- **Treatment:** Stage III Adjuvant Chemo, Stage IV Chemo
### Scenarios Modeled for Upstream Factors – Colorectal Cancer

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
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<tbody>
<tr>
<td>Conservative</td>
<td>Upstream factors remain frozen at levels achieved in 2005</td>
</tr>
<tr>
<td>Continued Trends</td>
<td>Continuation of past trends</td>
</tr>
<tr>
<td>HP2010 Upstream Goals Met</td>
<td>Use continued trends for factors with no explicit upstream goals</td>
</tr>
<tr>
<td>Optimistic</td>
<td>Difficult but feasible “best case” levels of upstream factors</td>
</tr>
</tbody>
</table>
Projection Questions

- Given reasonable projections of screening, treatment and risk factor levels, what level will CRC mortality reach in 2010 and beyond?

- What are the best cancer control opportunities?
  - Best short term opportunities
  - Best long term opportunities
Obesity

RR=1.5 for BMI $\geq 27$ vs $<21$
Risk Factor Example: Obesity

Percent of White Men (Age 25-84) who are Obese (BMI ≥30 kg/m²) (RR=1.5)

Trend for Observed Data

Continued Trends and Conservative

Optimistic

HP2010 Target

HP2010 Goals Met

Data Source: NHANES Surveys
Colorectal Cancer Screening: FOBT, Flexible Sigmoidoscopy, Colonoscopy

Fiberoptic sigmoidoscope
Screening Example: Endoscopy
Percent of Adults (Age 50+) Who Ever Had a Colorectal Endoscopy (sigmoidoscopy or colonoscopy)

Data Source: NHIS
Chemotherapy for Colorectal Cancer
Treatment Example: Stage IV Treatment in White Men 70-74

Data Sources: SEER Based Patterns of Care Studies, SEER-Medicare (older patients), NICCQ survey (5 metro areas)
If we meet all the upstream goals, how close can we come to meeting the mortality goal?

22.4 in 2003

HP2010 Goal
13.9 (38% reduction)

Conservative
Continuing
Optimistic
Healthy People Upstream Goals Met
What is the Potential Mortality Impact of Meeting Optimistic Goals for the Delivery of Screening, Treatment, and Prevention by 2015?

![Graph showing CRC deaths per 100,000 (standardized) from 1975 to 2020 for White Men. The graph includes lines for Past Delivery (19%), Future Delivery (15%), Conservative, and Optimistic scenarios. The HP2010 Goal is marked at 22.4 in 2003. The line for Discovery & Development (66%) shows a significant reduction by 2015.]
What is the Potential Mortality Impact of Meeting Optimistic Goals for the Delivery of Screening, Treatment, and Prevention by 2020?

22.4 in 2003

HP2010 Goal

White Men

CRC Deaths per 100,000 (standardized)
What is the contribution of screening, treatment and risk factors to the mortality decline?

- **Screening**
- **Treatment**
- **Risk Factors**

**HP2010 Goal**

CRC Deaths per 100,000 (standardized)

22.4 in 2003

White Men
“Optimistic” Results by Sex and Race

CRC Death Rates per 100,000 (standardized)

By Sex
- Males
- Females
- HP2010 Target

By Race
- Black
- White
- HP2010 Target
Colorectal Interactive Graphs - MISCAN Model

Projected colorectal cancer mortality rate, by calendar year and scenario

Deaths per 100,000

26
24
22
20
18
16
14
12
10
8
6
4
2
0

2000
2010
2020

Year

HP 2010 Goal
US Vital Statistics
MISCAN : PT - ALL
MISCAN : PT - 2004
MISCAN : DFG - ALL

Baseline
☑ Continuation of current trends (PT ALL)
☑ Continuation of 2004 levels (PT 2004)

Difficult but Feasible Goals Met
☑ All difficult but feasible goals met (DFG ALL)
☑ All Risk Factors (DFG RF)
☑ Screening (DFG SCR)
☑ Risk Factors and Screening (DFG RF-SCR)
☑ Treatment is best available (DFG TT-TD)
☑ More treated with best available (DFG TT)
☑ More patients are treated (DFG TD)
☑ Body Mass Index (BMI) (DFG ODA)
☑ Multivitamin (DFG MV)
☑ Smoking (DFG SMK)

Healthy People 2010 Goals Met
☑ All HP2010 goals met (HPG ALL)
☑ All Risk Factors (HPG RF)
☑ Screening (HPG SCR)
☑ Risk Factors and Screening (HPG RF-SCR)
☑ Body Mass Index (BMI) (HPG ODA)
☑ Multivitamin (HPG MV)
☑ Smoking (HPG SMK)

* Age-adjusted to the 2000 standard population using age groups <1y, 1-4y, 5-14y, 15-24y, 25-34y, 35-44y, 45-54y, 55-64y, 65-74y, 75-84y, 85+y
† Treatment-related goals were not included in the Healthy People 2010 goals. We included treatment goals to evaluate the potential impact on colorectal cancer mortality
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