Decision Analysis of Colorectal Cancer Screening Tests by Age to Begin, Age to End, and Screening Intervals:

Report to the United States Preventive Services Task Force from the Cancer Intervention and Surveillance Modeling Network (CISNET)

Institute of Medicine, Washington DC
February 25, 2008

MISCAN

Memorial Sloan-Kettering Cancer Center - Ann Zauber
Erasmus MC - Marjolein van Ballegooijen, Iris Lansdorp-Vogelaar, Janneke Wilschut

SimCRC
University of Minnesota – Karen Kuntz
Massachusetts General Hospital – Amy Knudsen
Questions to CRC CISNET from USPSTF on CRC screening

Microsimulation modeling
  - MISCAN
  - SimCRC

Methodology

Results

Discussion

Costs
2007 USPSTF addresses colorectal cancer screening recommendations

Task Force requested a decision analysis for recommended CRC screening tests for

- age to begin
- age to end
- rescreening interval
- Should the current recommendations be changed?

Microsimulation models (MISCAN and SimCRC) of CISNET consortium used for the decision analysis.

NO DECISION ANNOUNCED BY TASK FORCE
Microsimulation Modeling of Adenoma Carcinoma Sequence with Screening Intervention

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

Screening

ADENOMA
Preclinical screen-detectable adenoma phase

Preclinical CANCER screen-detectable cancer phase

Clinical CANCER phase

No lesion

adenoma <=5 mm

adenoma 6-9 mm

adenoma >=10 mm

preclinical stage I

preclinical stage II

preclinical stage III

preclinical stage IV

clinical stage I

clinical stage II

clinical stage III

clinical stage IV

dead colorectal cancer
MISCAN has a shorter dwell time from adenoma to clinically detected cancer *on average* (10 years)

SimCRC has a longer dwell time *on average* (22 years)

Dwell time is an unmeasured ‘deep’ parameter

**Implications of differences in dwell time to the screening strategies:**

- More life years gained from screening for SimCRC
- Additional benefit of increasing screening frequency will be greater for MISCAN
Colorectal Cancer Screening Tests
Colorectal Cancer Screening Strategies
Cohort of 40 year olds in 2005

Screening Tests
- Hemoccult II
- Hemoccult SENSA
- FIT
- Flex Sig*
- Flex Sig* + SENSA
- Colonoscopy (No Screening)

Age Begin
- 40
- 50
- 60

Rescreening Intervals
- 1,2,3 – FOBT
- 5,10,20- Endos

Age End
- 75
- 85

Surveillance**
- No stop age

Compliance 100%

* With biopsy

** 3 year for advanced adenomas, 5-10 (5) for non-advanced adenomas
Colorectal Cancer Screening Strategies
Current Age and Interval Recommendations*

**Screening Tests**
- Hemoccult II
- Hemoccult SENSA
- FIT
- Flex Sig
- Flex Sig + SENSA
- Colonoscopy

**Age Begin**
50

**Rescreening Intervals**
- 1 – FOBT
- 5 – Flex Sig
- 10 - Colonoscopy

**Age End**
None

**Surveillance**
No stop age

* MultiSociety and ACS
### Colorectal Cancer Screening Strategies

#### Current CMS reimbursement

<table>
<thead>
<tr>
<th>Screening Tests</th>
<th>CMS reimbursement*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaiac FOBT (II or SENSA)</td>
<td>$4.50</td>
</tr>
<tr>
<td>Immunochemical FOBT (FIT)</td>
<td>$22.22</td>
</tr>
<tr>
<td>Flex Sig</td>
<td>$161/$348</td>
</tr>
<tr>
<td>Flex Sig + SENSA</td>
<td>$165/$352</td>
</tr>
<tr>
<td>Colonoscopy</td>
<td>$498/$649</td>
</tr>
</tbody>
</table>

*CMS Report 2007*
<table>
<thead>
<tr>
<th>Test Characteristics</th>
<th>Hemoccult II</th>
<th>Hemoccult SENSA</th>
<th>FIT</th>
<th>Sigmoidoscopy*</th>
<th>Colonoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td>98%</td>
<td>92.5%</td>
<td>95%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenomas ≤0.5</td>
<td>2%</td>
<td>7.5%</td>
<td>5%</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>0.6-0.9</td>
<td>5%</td>
<td>12%</td>
<td>10%</td>
<td>85%</td>
<td>85%</td>
</tr>
<tr>
<td>≥1.0</td>
<td>12%</td>
<td>24%</td>
<td>22%</td>
<td>95%</td>
<td>95%</td>
</tr>
<tr>
<td>Cancers</td>
<td>40%</td>
<td>70%</td>
<td>70%</td>
<td>95%</td>
<td>95%</td>
</tr>
<tr>
<td>Reach</td>
<td>Whole colorectum</td>
<td>Whole colorectum</td>
<td>Whole colorectum</td>
<td>80% reach sigmoid-descending colon junct (60 to sigmoid-desc and 80 splenic)</td>
<td>95% reach cecum</td>
</tr>
</tbody>
</table>

*Sensitivity for CRC for Sigmoidoscopy for whole colon comparable to Evidence Review*
### Table 1: Test Characteristics

**SENSITIVITY ANALYSIS – (Worst and Best)**

<table>
<thead>
<tr>
<th>Test Characteristics</th>
<th>Hemoccult II</th>
<th>Hemoccult SENA</th>
<th>FIT</th>
<th>Sigmoidoscopy</th>
<th>Colonoscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specificity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adenomas ≤0.5</td>
<td>98% (95-99)</td>
<td>92.5% (90-95)</td>
<td>95% (92.5-98)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>0.6-0.9</td>
<td>2% (1-5)</td>
<td>7.5% (5-10)</td>
<td>5% (2-7.5)</td>
<td>75% (70-79)</td>
<td>75% (70-79)</td>
</tr>
<tr>
<td>≥1.0</td>
<td>5% (5-14)</td>
<td>12% (10-26)</td>
<td>10% (7.5-24)</td>
<td>85% (80-92)</td>
<td>85% (80-92)</td>
</tr>
<tr>
<td>Cancers</td>
<td>12% (10-28)</td>
<td>24% (16-48)</td>
<td>22% (16-48)</td>
<td>95% (92-99)</td>
<td>95% (92-99)</td>
</tr>
<tr>
<td></td>
<td>40% (29-50)</td>
<td>70% (50-87)</td>
<td>70% (50-87)</td>
<td>95% (92-99)</td>
<td>95% (92-99)</td>
</tr>
<tr>
<td><strong>Reach</strong></td>
<td>Whole colorectum</td>
<td>Whole colorectum</td>
<td>Whole colorectum</td>
<td>80% reach sigmoid-descending colon junct (60 to sigmoid-desc and 80 splenic)</td>
<td>95% reach cecum</td>
</tr>
</tbody>
</table>
Outcome Measures

Most effective = Greatest life years gained relative to no screening

Weigh effectiveness against resources required and exposure to risks:

Colonoscopy as resource and risk indicator
- Endoscopy resources
- Perforation risk

Life years gained (LYG) vs Total colonoscopies in lifetime
(per 1000 persons in population)
Effectiveness-Risk Analysis to evaluate 145 strategies

If strategy requires more colonoscopies but has fewer life years gained (LYG) (*ie less effective*) then eliminate.

Of the remaining strategies, derive relative to each other

- Incremental number of colonoscopies = \( \Delta \text{Col} \)
- Incremental LYG = \( \Delta \text{LYG} \)
- Incremental number colonoscopies to gain a life yr = \( \Delta \text{Col} / \Delta \text{LYG} \)
- If strategy is less effective with a higher \( \Delta \text{Col} / \Delta \text{LYG} \) than another, then this strategy is eliminated due to *extended dominance*

**Efficiency frontier** – all strategies NOT dominated

**Near the efficiency frontier** – those strategies that are with 98% of the LYG on the frontier
Comparisons

First compare strategies within a screening test

Efficient frontier derived for each screening test or combination test

$\Delta\text{Col}/\Delta\text{LYG}$ – ‘Efficiency Ratio’

* A measure of the additional number of colonoscopies required to gain one year of benefit when considering a more effective strategy relative to the next less effective strategy

* Colonoscopy resources across tests are comparable but burden of all testing is not
# Efficient Colonoscopy Strategies

<table>
<thead>
<tr>
<th>Strategy*</th>
<th># Col (per 1000)</th>
<th># LYG (per 1000)</th>
<th>ΔCol (per 1000)</th>
<th>ΔLYG (per 1000)</th>
<th>ΔCol/ΔLYG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MISCAN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>COL, 60-75, 20</td>
<td>2,175</td>
<td>156</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>COL, 50-75, 20</td>
<td>3,325</td>
<td>203</td>
<td>1,150</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>COL, 50-75, 10</td>
<td>4,136</td>
<td>230</td>
<td>811</td>
<td>27</td>
</tr>
<tr>
<td>4</td>
<td>COL, 50-85, 10</td>
<td>4,534</td>
<td>236</td>
<td>398</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>COL, 50-75, 5</td>
<td>5,895</td>
<td>254</td>
<td>1,362</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>COL, 50-85, 5</td>
<td>6,460</td>
<td>257</td>
<td>565</td>
<td>4</td>
</tr>
<tr>
<td><strong>SimCRC</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>COL, 60-75, 20</td>
<td>1,780</td>
<td>165</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>COL, 50-75, 20</td>
<td>2,885</td>
<td>252</td>
<td>1,106</td>
<td>82</td>
</tr>
<tr>
<td>3</td>
<td>COL, 50-75, 10</td>
<td>3,756</td>
<td>271</td>
<td>871</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>COL, 50-85, 10</td>
<td>4,114</td>
<td>281</td>
<td></td>
<td>ext dom</td>
</tr>
<tr>
<td>5</td>
<td>COL, 50-75, 5</td>
<td>5,572</td>
<td>293</td>
<td>1,816</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>COL, 50-85, 5</td>
<td>6,031</td>
<td>294</td>
<td>459</td>
<td>0.5</td>
</tr>
</tbody>
</table>

* Test, begin age – end age, interval
ΔCol = incremental number of colonoscopies compared with the next best strategy
ΔLYG = incremental number of life years gained compared with the next best strategy
Colonoscopy-SimCRC

Colonoscopies per 1,000 persons

Life-years gained per 1,000 persons

Colonoscopy strategies

Frontier

Start age 40

Frontier 40
Hemoccult SENSA-MISCAN

![Graph showing life-years gained per 1,000 persons against colonoscopies per 1,000 persons.]

- Sensa® Strategies
- Frontier
- Start age 40
- Frontier 40
FIT-MISCAN

Colonoscopies per 1,000 persons vs. Life-years gained per 1,000 persons.

Key:
- FIT Strategies
- Frontier
- Start age 40
- Frontier 40
Flexible Sigmoidoscopy-MISCAN

![Graph showing life-years gained per 1,000 persons against colonoscopies per 1,000 persons. The graph includes data for different age ranges and flexible sigmoidoscopy strategies.]

- Flexible sigmoidoscopy strategies
- Frontier
- Start age 40
- Frontier 40
Combination-MISCAN

- Colonoscopies per 1,000 persons
- Life-years gained per 1,000 persons

- Fsig+Sensa® strategies

- Startage 40

- Frontier

- Frontier 40
Sensitivity Analyses

Best Case and Worst Case scenarios on sensitivity and specificity

- Worst case scenarios had lower life years gained than base case
- Best case scenarios had higher life years gained
- $\Delta \text{Col}/\Delta \text{LYG}$ lower for worst case and higher for best case for those on the efficient frontier

Mainly support the findings of the base case

Exceptions differ for the two models
Comparisons Among Tests

To compare among tests, it is important to consider that tests other than colonoscopy are required (ie, FOBT, Flex Sig)

To pick an efficient strategy for each test we would expect to find an ordering to the efficiency ratios as follows:

COL > SENSA > [FIT, HII] > [FSig, FSig+SENSA]

Eg, SENSA should require fewer colonoscopies to gain a benefit of 1 year compared with COL because of the added number of FOBTs needed in addition to the colonoscopies to achieve that benefit.
Approach to Choosing Efficient Strategies

Assume that a single start and end age would be recommended for screening

Select strategies from all tests (including combination of tests) that:

1. are efficient (or near efficient) within the test
2. have efficiency ratios with expected ordering (to account for the burden of other testing)
3. have comparable effectiveness (LYG)

Example: start age = 50; stop age = 75; anchored with 10-year colonoscopy (as a starting strategy)
Efficient (near efficient) strategies for start age 50 and stop age 75-(Table 9 bolded strategies)

<table>
<thead>
<tr>
<th>Strategy*</th>
<th># Col (per 1000)</th>
<th># LYG (per 1000)</th>
<th>ΔCol/ΔLYG</th>
<th># FOBT</th>
<th># Fsig</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISCAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COL, 50-75, 10</td>
<td>4,136</td>
<td>230</td>
<td>29.6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SENSA®, 50-75, 1</td>
<td>3,350</td>
<td>230</td>
<td>30.9</td>
<td>9,541</td>
<td>0</td>
</tr>
<tr>
<td>FIT, 50-75, 1</td>
<td>2,949</td>
<td>227</td>
<td>25.9</td>
<td>11,772</td>
<td>0</td>
</tr>
<tr>
<td>Hem II®, 50-75, 1</td>
<td>1,982</td>
<td>194</td>
<td>14.3</td>
<td>16,232</td>
<td>0</td>
</tr>
<tr>
<td>Fsig, 50-75, 5</td>
<td>1,911</td>
<td>203</td>
<td>9.7</td>
<td>0</td>
<td>4,139</td>
</tr>
<tr>
<td>FsigSENSA®, 50-75, 5,3</td>
<td>2,870</td>
<td>230</td>
<td>16.3</td>
<td>6,145</td>
<td></td>
</tr>
<tr>
<td>SimCRC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COL, 50-75, 10</td>
<td>3,756</td>
<td>271</td>
<td>34.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SENSA®, 50-75, 1</td>
<td>2,654</td>
<td>259</td>
<td>22.9</td>
<td>9,573</td>
<td>0</td>
</tr>
<tr>
<td>FIT, 50-75, 1</td>
<td>2,295</td>
<td>256</td>
<td>19.7</td>
<td>11,830</td>
<td>0</td>
</tr>
<tr>
<td>Hem II®, 50-75, 1</td>
<td>1,456</td>
<td>218</td>
<td>9.6</td>
<td>16,239</td>
<td>0</td>
</tr>
<tr>
<td>Fsig, 50-75, 5</td>
<td>995</td>
<td>199</td>
<td>8.4</td>
<td>0</td>
<td>4,483</td>
</tr>
<tr>
<td>FsigSENSA®, 50-75, 5,3</td>
<td>1,655</td>
<td>257</td>
<td>7.0</td>
<td>9,679</td>
<td></td>
</tr>
</tbody>
</table>
‘Best’ Test is the One Which Gets Done-
SJ Winawer re Adherence
### Adherence: 80% and 50% by Screening Behavior Type

<table>
<thead>
<tr>
<th>Screening Behavior Group</th>
<th>Overall Adherence</th>
<th>80%</th>
<th>50%</th>
<th>Follow-up Positive test</th>
<th>Surveillance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never Screened (10%)</td>
<td>0</td>
<td>0</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td>Low (30%)</td>
<td>0.78</td>
<td>0.39</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>Moderate (30%)</td>
<td>0.89</td>
<td>0.56</td>
<td>0.85</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>High (30%)</td>
<td>1.00</td>
<td>0.72</td>
<td>0.95</td>
<td>0.95</td>
</tr>
</tbody>
</table>

100% compliance for all also presented on graph
Bolded strategies varied by overall adherence to screening (Table 10)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>50% adherence</th>
<th>80% adherence</th>
<th>100% adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Col (per 1000)</td>
<td># LYG (per 1000)</td>
<td># Col (per 1000)</td>
</tr>
<tr>
<td><strong>MISCAN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COL, 50-75, 10</td>
<td>2,250</td>
<td>140</td>
<td>3,193</td>
</tr>
<tr>
<td>SENSA®, 50-75, 1</td>
<td>1,752</td>
<td>149</td>
<td>2,427</td>
</tr>
<tr>
<td>FIT, 50-75, 1</td>
<td>1,510</td>
<td>145</td>
<td>2,116</td>
</tr>
<tr>
<td>Hem II®, 50-75, 1</td>
<td>962</td>
<td>113</td>
<td>1,395</td>
</tr>
<tr>
<td>Fsig, 50-75, 5</td>
<td>1,150</td>
<td>128</td>
<td>1,373</td>
</tr>
<tr>
<td>FsigSENSA®, 50-75, 5,3</td>
<td>1,553</td>
<td>147</td>
<td>2,063</td>
</tr>
<tr>
<td><strong>SimCRC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COL, 50-75, 10</td>
<td>1,977</td>
<td>168</td>
<td>2,904</td>
</tr>
<tr>
<td>SENSA®, 50-75, 1</td>
<td>1,361</td>
<td>182</td>
<td>1,920</td>
</tr>
<tr>
<td>FIT, 50-75, 1</td>
<td>1,140</td>
<td>177</td>
<td>1,629</td>
</tr>
<tr>
<td>Hem II®, 50-75, 1</td>
<td>666</td>
<td>130</td>
<td>993</td>
</tr>
<tr>
<td>Fsig, 50-75, 5</td>
<td>544</td>
<td>122</td>
<td>711</td>
</tr>
<tr>
<td>FsigSENSA®, 50-75, 5,3</td>
<td>770</td>
<td>168</td>
<td>1,153</td>
</tr>
</tbody>
</table>
MISCAN Adherence Plot

- COL
- SENS
- FIT
- Hem
- FSIG
- FSIG-SENSA

Adherence:
- 50%
- 80%
- 100%
SimCRC Adherence Plot

- COL
- SENSA
- FIT
- HemII
- FSIG
- FSIG-SENSA

Adherence:
- 50%
- 80%
- 100%

Life years gained per 1,000 screened vs. Colonoscopies per 1,000 screened.
Evidence Review from Oregon done concurrently

Reassessment of test parameters:
- Slight difference in specificity for Hemoccult SENSA
  CISNET of 92.5%; ER of 87%
- Difference in sensitivity for Hemoccult II
  CISNET of 40%; ER of 25%

Sensitivity analysis
- Specificity Hemoccult Sensa 87%
- Sensitivity Hemoccult II 20 and 25% with 95% Specificity
## Results for Additional Sensitivity Analysis

<table>
<thead>
<tr>
<th>Strategy</th>
<th>MISCAN</th>
<th># Col / 1000</th>
<th># LYG / 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENSA®, 50-75,1 (basecase)</td>
<td>3,350</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>SENSA®, 50-75,1 (87% specificity)</td>
<td>3,832 (+14%)</td>
<td>233 (+1%)</td>
<td></td>
</tr>
<tr>
<td>HII®, 50-75,1 (basecase)</td>
<td>1,942</td>
<td>194</td>
<td></td>
</tr>
<tr>
<td>HII®, 50-75,1 (95% Sp; 20% Se)</td>
<td>2,600 (+34%)</td>
<td>173 (-11%)</td>
<td></td>
</tr>
<tr>
<td>HII®, 50-75,1 (95% Sp; 25% Se)</td>
<td>2632 (+36%)</td>
<td>182 (-6%)</td>
<td></td>
</tr>
<tr>
<td>SENSA®, 50-75,1 (basecase)</td>
<td>2,654</td>
<td>259</td>
<td></td>
</tr>
<tr>
<td>SENSA®, 50-75,1 (87% specificity)</td>
<td>3,104 (+17%)</td>
<td>263 (+1.5%)</td>
<td></td>
</tr>
<tr>
<td>HII®, 50-75,1 (basecase)</td>
<td>1,456</td>
<td>218</td>
<td></td>
</tr>
<tr>
<td>HII®, 50-75,1 (95% Sp; 20% Se)</td>
<td>2,016 (+38%)</td>
<td>181 (-17%)</td>
<td></td>
</tr>
<tr>
<td>HII®, 50-75,1 (95% Sp; 25% Se)</td>
<td>2,032 (+40%)</td>
<td>192 (-12%)</td>
<td></td>
</tr>
</tbody>
</table>
Current recommended guidelines* are on or close to the efficiency frontier

Beginning at age 50 balances life years gained and number of colonoscopies required and associated risk of perforation

To increase efficiency of current guidelines*, stop screening at age 75

*should depend on life expectancy of person rather than strict chronological age

*MultiSociety and ACS
Annual SENSA or FIT have similar LYG as colonoscopy every 10 years but with lower colonoscopy requirements — *PROVIDED high compliance for all tests*

FlexSig every 5 years with annual FOBT with Sensitive FOBT not recommended (high efficiency ratio)

- Original strategy for Flex Sig+ FOBT was for Hemoccult II with lower sensitivity
- Combination of Flex Sig and Hemoccult SENSA® could have one mid-interval FOBT between the 5 year repeat Flex Sig screening rather than annual FOBT

FlexSig every 5 years and Hemoccult II not as good in terms of effectiveness
Adherence conclusions

- Life years gained and colonoscopies decreased with decreased adherence BUT
- The overall conclusions did not change substantially as adherence varied from 50% to 100%.

- Hemoccult II and flexible sigmoidoscopy every 5 years remained the least two attractive alternatives re life years gained
- Colonoscopy every 10 years improved a bit relative to the other strategies when adherence was 80% but lost its health benefit advantage when adherence as 50%
Limitations

Analyses for whole population – not specific by sex or race
- Potential of more proximal disease in older women and blacks
- Age of onset may vary by sex and race

Simulation models rely on assumptions of natural history of disease
- Comparing two models provides sensitivity analysis of natural history assumptions

“All models are wrong, some are useful.”
- George Box, 1979
“I’d have been here sooner if it hadn’t been for early detection.”
COSTS

Screening

Complications

Colorectal Cancer Treatment
Thank You
Payer (CMS) and Society prospective

Per unit test –
- Guaiac FOBT $4.54 (Hemoccult II or SENSA)
- Immunochemical test $22.22
- *Note this from point of view of payer*

July 2001, Medicare coverage of colonoscopy every 10 years in average risk population
CPT codes for endoscopy tests

- Drs. John Allen and Joel Brill- gastroenterologists
- National unadjusted payment amounts under the physician fee schedule
- Unadjusted costs rather than RVUs
- Points of service (*Bill Larson and Chuck Shih*)
  - Outpatient prospective payment system (OPPS)
  - Ambulatory Surgery Center (ASC) with associated facility charge
  - Physician fee schedule (PFS)
  - *No inpatient screening*

- Weighted average of screening procedure costs per point of service setting with inclusion of facility charges as allowed
Screening Costs for CMS (3)

Polypectomy and Pathology
- Polypectomy CPT codes (as above)
- Pathology costs per setting
  - Multiple polyps in one specimen jar per segment of colon
  - 1.38 times pathology fee to account for multiple specimens for patients with polyps (A Zauber personal communication from National Colonoscopy Study)

Incomplete colonoscopies
- Repeat the colonoscopy
- Assumed 5% required repeat colonoscopy to clear

Sedation – included in cost of colonoscopy
- Propofol sedation not included

Bowel prep not covered
Pre-visit not covered except for part of overall deductible
Weighted average of CPT code costs by percentage with procedures by point of service

Procedures could be overweighted for therapeutic colonoscopies rather than screening colonoscopy

Screening colonoscopy is a colonoscopy \textit{planned} for screening and procedure with no polyps detected

Colonoscopy planned for screening but \textit{with} polyps detected are classified as therapeutic colonoscopies

Currently can’t get out just screening colonoscopies with and without polypectomy costs.
<table>
<thead>
<tr>
<th>Screening test</th>
<th>CMS cost, $</th>
<th>Societal cost, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guaiac Hemoccult (II or SENSA)</td>
<td>4.54</td>
<td>21.54</td>
</tr>
<tr>
<td>Immunochemical fecal occult blood test (FIT)</td>
<td>22.22</td>
<td>39.22</td>
</tr>
<tr>
<td>Flexible sigmoidoscopy</td>
<td>160.78</td>
<td>270.30</td>
</tr>
<tr>
<td>Flexible sigmoidoscopy with biopsy</td>
<td>348.19</td>
<td>497.37</td>
</tr>
<tr>
<td>Colonoscopy without polypectomy</td>
<td>497.59</td>
<td>834.69</td>
</tr>
<tr>
<td>Colonoscopy with polypectomy or biopsy</td>
<td>648.52</td>
<td>1,019.02</td>
</tr>
</tbody>
</table>
Complication costs

Literature review of complications
- General practice
- Screening studies
- Medicare data (Warren, Klabunde)

DRG codes for similar procedures because of complications

Physician fee not included because of difficulty in obtaining such from CMS reporting
Table 4. Summary of costs and risks of endoscopy complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Rate per 1000</th>
<th>Cost, $2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>With colonoscopy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perforation</td>
<td>0.7</td>
<td>12,446</td>
</tr>
<tr>
<td>Serosal burn</td>
<td>0.3</td>
<td>5,208</td>
</tr>
<tr>
<td>Bleed with transfusion</td>
<td>0.4</td>
<td>5,208</td>
</tr>
<tr>
<td>Bleed without transfusion</td>
<td>1.1</td>
<td>320</td>
</tr>
<tr>
<td>With flexible sigmoidoscopy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perforation</td>
<td>0.02</td>
<td>12,446</td>
</tr>
</tbody>
</table>
  - Hospital Wage Index and Medicare Economics Index used to adjust for inflation in Medicare parts A and B estimates
  - Geographical variability in costs of care adjusted

New biological therapies sparsely represented in these data of 1998-2003

Phase specific costs of CRC

Cost of care used rather than billed charges

Payments for Medicare A (inpatient services) and B (outpatient services) calculated separately

Time costs for cancer care adjusted (*Yabroff 2007*)
Modified Societal Costs

Added copayments (beneficiary costs) and time costs to the payer costs

For cancer related costs, estimated patient deductibles and coinsurance expenses added by adjusting Part A and B payment with Medicare reimbursement ratios provided by CMS Office of the Actuary.
Table 5. Net payments for CRC care during 1998-2003 (in $2007)* Yabroff and Brown

<table>
<thead>
<tr>
<th>AJCC Stage</th>
<th>Initial Phase</th>
<th>Continuing Phase</th>
<th>Last Year of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Died of Cancer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Died of Other Causes</td>
</tr>
<tr>
<td>I</td>
<td>25,491</td>
<td>2,028</td>
<td>45,697</td>
</tr>
<tr>
<td>I</td>
<td>35,179</td>
<td>1,891</td>
<td>45,567</td>
</tr>
<tr>
<td>III</td>
<td>42,891</td>
<td>2,702</td>
<td>48,013</td>
</tr>
<tr>
<td>IV</td>
<td>56,009</td>
<td>8,377</td>
<td>64,438</td>
</tr>
<tr>
<td>Direct Medical Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>28,668</td>
<td>2,395</td>
<td>51,935</td>
</tr>
<tr>
<td>I</td>
<td>39,700</td>
<td>2,237</td>
<td>51,712</td>
</tr>
<tr>
<td>III</td>
<td>48,951</td>
<td>3,249</td>
<td>54,776</td>
</tr>
<tr>
<td>IV</td>
<td>64,801</td>
<td>10,419</td>
<td>73,522</td>
</tr>
<tr>
<td>Societal Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>21,000</td>
<td>2,028</td>
<td>45,697</td>
</tr>
<tr>
<td>I</td>
<td>31,179</td>
<td>1,891</td>
<td>45,567</td>
</tr>
<tr>
<td>III</td>
<td>38,891</td>
<td>2,702</td>
<td>48,013</td>
</tr>
<tr>
<td>IV</td>
<td>56,009</td>
<td>8,377</td>
<td>64,438</td>
</tr>
</tbody>
</table>

*The initial phase of care is the first 12 months following diagnosis, the last year of life phase is the final 12 months of life, and the continuing phase is all the months between the initial and last year of life phases. Cancer-related costs in the continuing phase of care are an annual estimate.
<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Care</td>
<td>$26,800</td>
</tr>
<tr>
<td>Annual Continuing Cost</td>
<td>$2,100</td>
</tr>
<tr>
<td>Terminal Care Costs of those dying of CRC</td>
<td>$21,700</td>
</tr>
</tbody>
</table>

Based on 1990-1994 SEER Medicare case control and updated to 2002
Thank You