# Colorectal Cancer Screening

## Differential Costs for Younger Versus Older Americans

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**Background:** Colorectal cancer (CRC) incidence rises with age, and most CRC arises from adenomatous polyps. It was therefore hypothesized that increased use of CRC screening and polypectomy in younger persons might yield CRC-related savings later in life for payers such as Medicare.

**Methods:** Using a decision analytic Markov model, the impact of increased CRC screening uptake on healthcare payers for younger Americans versus payers for older Americans, such as Medicare, was projected.

**Results:** As screening uptake increased, CRC incidence and mortality decreased, and annual costs related to CRC care and testing increased for younger persons, but decreased for older persons. Compared with current screening uptake of 40%, screening 75% of the U.S. population aged 50 to 80 increased annual costs related to CRC care and testing from $3.6 billion to $5.0 billion for 50- to 64-year-olds, but decreased annual costs from $5.9 billion to $5.6 billion for those aged 65 years and older. Sensitivity analyses suggest that future costs for other diseases could offset CRC care savings in older Americans that are attributable to screening. However, even without net cost savings for any age group, screening remained relatively cost-effective.

**Conclusions:** Investments in screening and polypectomy in younger persons may decrease CRC-related costs, including screening and surveillance, for healthcare payers for older Americans, including Medicare. While these savings could potentially be offset by future health costs for other diseases, screening would still be cost-effective. Widespread CRC screening beginning at age 50 must remain a national priority.

(Am J Prev Med 2006;30(5):378–384) 

### Introduction

Colorectal cancer (CRC) is the second leading cause of cancer-related death in the United States, with approximately 150,000 new cases and 57,000 deaths per year.[1] Screening combined with polypectomy can decrease both CRC incidence and mortality and is relatively cost-effective.[2–9] However, only approximately 40% of Americans currently undergo CRC screening,[10–12] which contrasts sharply with the 70% to 80% screening rates for cervical and breast cancer.[11]

In 2001, Medicare began covering screening colonoscopy in adults at average risk for CRC, and some commercial insurers have followed this lead. Given that CRC incidence begins to rise exponentially at approximately age 50,[13] and that most CRCs arise from adenomatous polyps with a dwell time of many years,[3] the current study hypothesized that widespread CRC screening could have contrasting effects on healthcare payers for younger compared to older people. Investments into increased screening in younger people, including polypectomy, could potentially result in CRC care savings later in life.

A decision analytic model was developed to estimate the potential effectiveness and cost-effectiveness of established and emerging CRC screening strategies.[7,9,14,15] Previous cost-effectiveness analyses of CRC screening have focused on screening starting at age 50 and have not examined the impact on healthcare payers for younger versus older people.[16] In the current analysis, the focus was on the potential consequences of widespread CRC screening for healthcare payers for people younger than 65 versus payers for those aged 65 years and older, including Medicare. Screening beginning at age 50 versus age 65 was first compared to estimate the incremental benefit of screening before the typical age for Medicare coverage. Then, the potential in CRC-related costs between healthcare payers

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0749-3797/06/$–see front matter
doi:10.1016/j.amepre.2005.12.010

for younger versus older Americans that could result from increased CRC screening was explored.

## Materials and Methods

### Decision Analytic Model

This decision analytic Markov model (in TreeAge Pro, TreeAge Software Inc., Williamston MA, 2004) of the natural history of CRC in the United States and its inputs (Table 1) have been described in detail.[7,9,14,15] The principal states in the model are normal; small (<10 mm) adenomatous polyp; large (≥10 mm) adenomatous polyp; localized, regional, or distant CRC; and dead. Approximately 85% of CRCs develop through a polypoid adenoma. Without screening, CRCs are diagnosed only when they lead to symptoms. Diagnosed CRCs are treated, resulting in stage-specific survival.[7,14,15] Beginning at age 50, adults progress through the model for 50 1-year cycles, until age 100 or death. Age-specific non-CRC mortality rates reflect U.S. life table data.[17]

The natural history model is calibrated to reproduce the age-specific prevalence at autopsy of small and large adenomatous polyps,[18–22] and age and stage-specific CRC incidence data from the Surveillance, Epidemiology, and End Result (SEER) program from the early 1990s.[13] CRC screening was uncommon then,[23] permitting the assumption that CRC incidence was not affected significantly by screening in the 1980s.[9]

In addition to appropriate calibration, several observations suggest that the model has validity.[9] First, the natural history model's predicted national CRC incidence,[9,15] based on 2000 census data,[24] is consistent with epidemiologic data.[1] Second, the natural history model predicts that 2.4% of deaths are attributable to CRC, compared to 2.6% in the SEER data.[13] Third, as noted previously,[9,14] this model's predictions regarding the impact of screening are consistent with available clinical data.[9,25–28] Finally, these results are comparable to those of other models constructed independently.[4–6,8]

The current analyses were performed in 2004–2005.

### Screening Strategies and Surveillance

Screening was superimposed onto the natural history model. The strategies included annual fecal occult blood testing (FOBT), flexible sigmoidoscopy every 5 years (FS), FOBT/FS combined, and colonoscopy every 10 years (COLO).[2,29]

With COLO, polyps were removed and CRCs were biopsied if detected. If FOBT or FS detected a small or large polyp or CRC, colonoscopy followed, with polypectomy or biopsy as necessary. If colonoscopy was normal after a positive screening test, screening resumed in 10 years with the primary screening strategy. CRC was managed, and symptomatic CRC could be detected, as in the natural history model. After polyp detection, patients underwent surveillance colonoscopy every 5 years.[29] Those developing CRC underwent colonoscopy at diagnosis, 3 years later, and every 5 years thereafter.[29]

This model's results were previously reported for the individual strategies.[9,14,15] Here, the focus is on screening at the national level, consisting of a mix of strategies. The clinical and economic consequences of each strategy were estimated, and then weighted averages were calculated, reflecting current utilization rates among those screened, as reported by Seeff et al.[30]: FOBT, 25%; FS, 20%; FOBT/FS, 20%; and COLO, 35%.

### Cost Inputs

The determination of cost inputs in 2003 dollars was recently detailed.[14,15,31] Published cost estimates were updated to 2003 dollars using the medical services component of the consumer price index, and average values were calculated for all inputs (Table 1). Procedure cost estimates ranged from those derived from Medicare fee schedules (including professional fees and procedure reimbursement) to those from a health maintenance organization.[5] Complication costs were derived from relevant diagnostic-related groups.[32] Costs for care of stage-specific CRC were taken from a report to the National Cancer Institute,[4] reports from health maintenance organizations,[33,34] and estimates for Medicare enrollees.[35]

### Clinical and Economic Outcomes and Cost-Effectiveness: Screening for Ages 50 to 80 versus Ages 65 to 80

For each strategy, for a hypothetical cohort of 100,000 50-year-olds, the model yielded the number of CRC cases by stage, deaths by cause, and discounted (3% annually[36]) average life-years and costs per person. Data on utilities for the relevant health states are limited and have been obtained from patients, not the general population.[37–39] Thus, life-years were estimated instead of quality-adjusted life-years.

There is no recommended stopping age for CRC screening. The incremental cost/life-year gained of screening was analyzed with the mix of strategies as reported by Seeff et al.[30] with different stopping ages. Screening through ages 70, 80, or 90 yielded progressively more life-years per person at increasing incremental costs per life-year gained. Screening for ages 50 to 90 cost $182,000 per life-year gained compared to screening for ages 50 to 80, which cost $104,000 per life-year gained compared to screening for ages 50 to 70. Screening through age 80 was chosen for further analyses and for the national projections.

The cost-effectiveness of screening starting at age 50 or 65 was estimated, compared to no screening. Finally, the incremental cost-effectiveness of screening was calculated beginning at age 50 compared to age 65.

### Projected Impact for Healthcare Payers at the National Level

The national impact of screening 40% of the population, reflective of current uptake,[30] was compared to screening 75% of the population, which is comparable to current cervical and breast cancer screening rates.[11] We itemized costs into CRC care, testing (screening and surveillance), and testing complications, and separated costs into those incurred by adults aged <65, and those aged ≥65 years. In sensitivity analyses, screening uptake was varied from 0% to 100%.

To produce the national estimates, a steady state was assumed for the population size and age distribution, as in year 2000 U.S. census data.[24] Undiscounted age-specific model outputs were determined, and these were adjusted by the fraction of people surviving to a given age after 50. These corrected outputs were multiplied by the number of people

**Table 1.** Variables in decision analytic model

| Variable | Base case value | References |
|---|---|---|
| Polyp prevalence at age 50, %[a] | 15 | Vatn (1982),[18] Williams (1982),[19] Clark (1985),[20] |
| Small polyp, %[a] | 95 | Williams (1982),[19] Arminski (1964),[21] Rickert (1979)[22] |
| Large polyp, %[a] | 5 | Williams (1982),[19] Arminski (1964),[21] Rickert (1979)[22] |
| Annual transition rate to small polyp from normal, %[a] | Age specific, 1.1–1.9 | Vatn (1982),[18] Willliams (1982),[19] Clark (1985),[20] Arminski (1964),[21] Rickert (1979),[22] |
| Annual transition rate to large polyp from small polyp, %[a] | 1.5 | Williams (1982),[19] Arminski (1964),[21] Rickert (1979),[22] Yee (2001)[43] |
| Annual transition rate to cancer without polypoid precursor, %[a] | Age specific, 0.006–0.086 | Wagner (1996),[4] Ries (1997),[13] Vatn (1982),[18] Willliams (1982),[19] Clark (1985),[20] |
| Annual transition rate to cancer from large polyp, %[a] | 5 | Wagner (1996),[4] Ries (1997),[13] Vatn (1982),[18] Willliams (1982),[19] Clark (1985),[20] |
| Symptomatic presentation of localized cancer, %[a] | 22/y over 2y | Ries (1997),[13] |
| Symptomatic presentation of regional cancer, %[a] | 40/y over 2y | Ries (1997),[13] |
| Mortality rate from treated localized cancer, % | 1.74/y in first 5y | Ries (1997),[13] |
| Mortality rate from treated regional cancer, % | 8.6/y in first 5y | Ries (1997),[13] |
| Mean survival from distant cancer, y | 1.9 | Ries (1997),[13] |
| Mortality rate from cancer treatment, % | 2 | Winawer (1997),[3] Wagner (1996)[4] |
| Fecal occult blood testing sensitivity for cancer, % | 40 | Winawer (1997),[3] Wagner (1996)[4] |
| Fecal occult blood testing sensitivity for large polyp, % | 10 | Winawer (1997),[3] Wagner (1996)[4] |
| Fecal occult blood testing sensitivity for small polyp, % | 8[b] | Winawer (1997),[3] Wagner (1996)[4] |
| Fecal occult blood testing specificity, % | 92 | Winawer (1997),[3] Wagner (1996)[4] |
| Polyps or cancer within reach of sigmoidoscope, % | 50 | Winawer (1997),[3] Wagner (1996)[4] |
| Sigmoidoscopy sensitivity for cancer within reach of sigmoidoscope, % | 90 | Winawer (1997),[3] Wagner (1996)[4] |
| Sigmoidoscopy sensitivity for large polyp within reach of sigmoidoscope, % | 80 | Winawer (1997),[3] Wagner (1996),[4] |
| Sigmoidoscopy sensitivity for small polyp within reach of sigmoidoscope, % | 70 | Winawer (1997),[3] Wagner (1996)[4] |
| Sigmoidoscopy specificity for lesions within reach of sigmoidoscope, % | 95 | Winawer (1997),[3] Wagner (1996)[4] |
| Colonoscopy sensitivity for cancer, % | 95 | Winawer (1997),[3] Wagner (1996)[4] |
| Colonoscopy sensitivity for large polyp, % | 90 | Winawer (1997),[3] Wagner (1996)[4] |
| Colonoscopy sensitivity for small polyp, % | 85 | Winawer (1997),[3] Wagner (1996)[4] |
| Colonoscopy major complication rate, % | 0.1 | Winawer (1997),[3] Wagner (1996)[4] |
| Sigmoidoscopy major complication rate, % | 0.01 | Winawer (1997),[3] Wagner (1996)[4] |
| Colonoscopy mortality rate, % | 0.01 | Winawer (1997),[3] Wagner (1996)[4] |
| Sigmoidoscopy mortality rate, % | 0.001 | Winawer (1997),[3] Wagner (1996),[4] |
| Cost, $[c] | | |
| Fecal occult blood testing | 20 | Wagner (1996),[4] Frazier (2000),[5] Ladabaum (2001),[7] Song (2004),[14] Winawer (1993),[28] |
| Flexible sigmoidoscopy | 290 | Wagner (1996),[4] Frazier (2000),[5] Ladabaum (2001),[7] Song (2004),[14] Winawer (1993)[28] |
| Flexible sigmoidoscopy with biopsy | 440 | Wagner (1996),[4] Frazier (2000),[5] Ladabaum (2001),[7] Song (2004),[14] Winawer (1993),[28] |
| Colonoscopy | 820 | Wagner (1996),[4] Frazier (2000),[5] Ladabaum (2001),[7] Song (2004),[14] Winawer (1993),[28] |
| Colonoscopy with biopsy or lesion removal | 1,200 | Wagner (1996),[4] Frazier (2000),[5] Ladabaum (2001),[7] Song (2004),[14] Winawer (1993),[28] |
| Endoscopy complication | 26,000 | Wagner (1996),[4] Frazier (2000),[5] Ladabaum (2001),[7] Song (2004),[14] Winawer (1993),[28] |

*(continued on next page)*

**Table 1.** (*continued*)

| Variable | Base case value | References |
|---|---|---|
| Colorectal cancer care by stage | | |
| Localized | 46,000 | Wagner (1996),[4] Ladabaum (2001),[7] Song (2004),[14] Fireman (1997),[33] Taplin (1995),[34] Brown (1999),[35] |
| Regional | 68,000 | Wagner (1996),[4] Ladabaum (2001),[7] Song (2004),[14] Fireman (1997),[33] Taplin (1995),[34] Brown (1999),[35] |
| Distant | 71,000 | Wagner (1996),[4] Ladabaum (2001),[7] Song (2004),[14] Fireman (1997),[33] Taplin (1995),[34] Brown (1999),[35] |

[a]Derived from epidemiologic and autopsy data.
[b]Sensitivity for small polyp of 8% reflects specificity of 92%, since it is assumed that the test does not detect small polyps.
[c]Derived from Centers for Medicare and Medicaid Services and published data.
y, year.

of that age in the United States.[24] Finally, the estimates were adjusted to represent a given screening uptake rate for each strategy, given a certain overall screening rate. Adding the results for all ages under each strategy yielded the total annualized national estimates.[9] Adding the results for ages 50 to 64 and separately adding the results for ages 65 to 100 yielded the annualized national estimates for these age subgroups.

### Threshold Analysis on Cost of Program to Increase Screening Adherence

A specific program may be needed to improve screening uptake, but it is not known what such a program would entail. The cost that such a program could incur, while maintaining the cost-effectiveness of screening <$50,000 per life-year gained was determined.

### Sensitivity Analyses on Future Health Costs Not Related to Colorectal Cancer

Those spared CRC morbidity and mortality may incur future costs related to other diseases. These future costs are difficult to estimate and are rarely included in cost-effectiveness analyses.[40] Threshold analyses were performed to determine the magnitude of future costs that would raise the cost-effectiveness of screening to >$50,000 per life-year gained. These thresholds were compared to average annual health-related expenditures per older American.[41] Whether future costs might offset savings in CRC care at the national level was then taken into consideration.

## Results

### Screening for Ages 50 to 80 Versus Ages 65 to 80

Screening for ages 65 to 80 decreased the number of CRC cases by 40%, shifted the stage of disease at diagnosis toward earlier stages, decreased the fraction of deaths attributable to CRC by 49%, and thereby increased average life expectancy by 0.023 discounted life-years per person compared with no screening (Table 2). Screening was not cost-saving because decreases in CRC care expenditures were smaller than increases in testing-related expenditures, but screening cost approximately $9000 per life-year gained (Table 2).

When screening was performed for ages 50 to 80, the impact was more dramatic than when it was performed for ages 65 to 80 (Table 2). Screening beginning at this

**Table 2.** Clinical and economic outcomes for cohort of 100,000 persons aged 50 through 100

| | No screening | Screening for age 65 to 80[a] | Screening for age 50 to 80[a] |
|---|---|---|---|
| CRC incidence | 5918 | 3530 | 2180 |
| Localized | 40% | 51% | 58% |
| Regional | 37% | 33% | 30% |
| Distant | 23% | 16% | 12% |
| Deaths attributable to CRC | 2.4% | 1.2% | 0.6% |
| Life years/person after age 50[b] | 18.686 | 18.709 | 18.744 |
| Lifetime cost/person after age 50[b] | $1813 | $2018 | $ 2,736 |
| Cost/life year gained compared with no screening | | $9008 | $15,809 |
| Cost/life year gained compared with screening and surveillance for age 65–80 years | | | $20,529 |

[a]Weighted to reflect current utilization rates[30]: fecal occult blood test 25%, flexible sigmoidoscopy 20%, fecal occult blood test/flexible sigmoidoscopy 20%, colonoscopy 35%.
[b]Annual discount rate of 3%.
CRC, colorectal cancer.

**Table 3.** National costs related to CRC care, testing, and complications ($ billions/year) with screening for persons aged 50 to 80 years

| | No screening | 40% screening uptake[a] | 75% screening uptake[a] |
|---|---|---|---|
| **For persons aged 50–64 years** | | | |
| CRC care | 2.1 | 1.7 | 1.3 |
| Testing | 0.07 | 1.9 | 3.6 |
| Testing complications | 0.002 | 0.04 | 0.08 |
| Total | 2.1 | 3.6 | 5.0 |
| **For persons aged ≥65 years** | | | |
| CRC care | 6.0 | 4.3 | 2.9 |
| Testing | 0.28 | 1.5 | 2.6 |
| Testing complications | 0.01 | 0.04 | 0.07 |
| Total | 6.2 | 5.9 | 5.6 |

[a]Weighted to reflect current utilization rates[30]: fecal occult blood test 25%, flexible sigmoidoscopy 20%, fecal occult blood test/flexible sigmoidoscopy 20%, colonoscopy 35%.
CRC, colorectal cancer.

earlier age decreased the number of CRC cases by 63%, led to CRC diagnosis at the localized stage in 51% of cases, and decreased the fraction of deaths attributable to CRC by 75% compared with no screening. Screening for ages 50 to 80 cost approximately $16,000 per life-year gained compared with no screening, and approximately $21,000 per life-year gained compared with screening beginning at age 65 (Table 2).

## Projected Impact for Healthcare Payers at the National Level

**Screening uptake of 40% for ages 50 to 80.** Without screening, the projected annual national costs related to CRC care and testing were $2.1 billion for adults aged 50 to 64 years, and $6.2 billion for those aged ≥65 years (Table 3). These costs were almost exclusively for CRC care.

With current screening uptake of 40%, annual national costs for adults aged 50 to 64 years decreased for CRC care, owing to decreases in CRC incidence and mortality (Table 2), but costs for testing and related complications increased (Table 3). The net result was an increase in costs to $3.6 billion for this age group.

In contrast, annual national costs for those aged ≥65 years decreased to $5.9 billion. While costs for testing and related complications also increased in this subgroup (Table 3), the fall in CRC incidence and mortality (Table 2) resulted in decreases in CRC care costs that more than offset increases in testing costs (Table 3).

**Screening uptake of 75% compared with 40% for ages 50 to 80.** If screening uptake increased from 40% to 75% of the population for ages 50 to 80, annual national costs for adults aged 50 to 64 years increased from $3.6 billion to $5.0 billion (Table 3). At the same time, annual national costs for those aged ≥65 years decreased from $5.9 billion to $5.6 billion (Table 3).

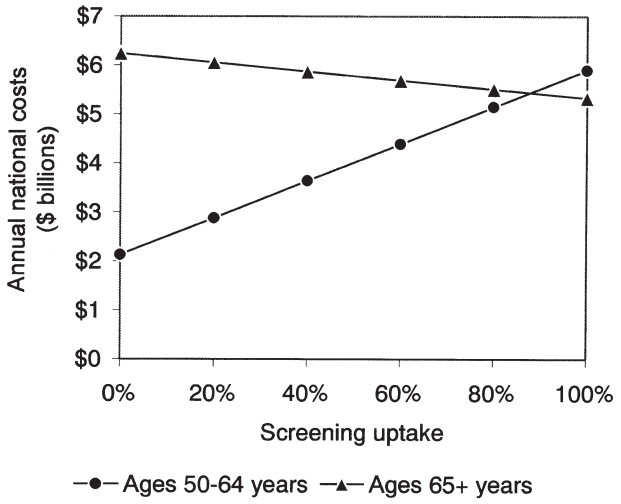


**Figure 1.** Sensitivity analysis on the impact of colorectal cancer (CRC) screening uptake rate on national costs related to CRC care, testing, and complications. Weighted averages for the four screening strategies are shown, reflecting current utilization rates among those screened.[30] Screening and surveillance were modeled for people aged 50 to 80 years. Increased screening uptake resulted in progressive increases in costs for people aged 50 to 64 years, but less-marked progressive decreases in costs for people aged ≥65 years.

**Sensitivity analysis on screening uptake rate for ages 50 to 80.** Increased screening uptake resulted in progressive increases in total costs for adults aged 50 to 64 years, but progressive decreases in total costs for those aged ≥65 years (Figure 1). As screening uptake increased, the rate of increase in costs for adults aged 50 to 64 years was greater than the rate of decrease in costs for those aged ≥65 years. Therefore, total national costs for all ages combined increased as screening uptake increased.

## Threshold Analysis on Cost of Program to Increase Screening Adherence

If a program were needed to raise screening adherence to 75%, such a program could cost as much as $1975 per person from age 50 until death ($108/person/year discounted at 3%/year) and the cost-effectiveness of screening including such a program would remain <$50,000 per life-year gained.

## Sensitivity Analyses on Future Health Costs Not Related to CRC

Screening from ages 50 to 80 cost <$50,000 per life-year gained even if future health costs not related to CRC were as high as $34,000 annually per person. This threshold is significantly higher than the average health expenditure of $8000 per year for older Americans not in the last year of life, but comparable to the average $36,000 spent in the last year of life.[41]

The modest average life-expectancy benefit of screening (Table 2) resulted from average gains of

approximately 4 undiscounted life-years per person for the small minority who actually benefited from screening. Thus, the additional future health costs resulting from improved survival in this small minority would average ($8000 × 3) + ($36,000 × 1) = $60,000 over 4 years. This figure is comparable to the cost of caring for CRC (Table 1). Therefore, at the national level, the savings in CRC care afforded by screening (Table 3) could potentially be offset by future health costs incurred as a result of decreased CRC incidence and mortality. Given the uncertainty surrounding future health costs, these analyses must be considered preliminary.

## Discussion

A decision analytic model of the natural history of CRC in the United States was used to compare the consequences of screening for ages 50 to 80 or 65 to 80, and to explore the economic consequences of increased CRC screening uptake on healthcare payers for people younger than 65, and payers for those aged 65 and older, including Medicare. The principal finding is that widespread screening for ages 50 to 80 may increase total national costs related to CRC care and testing, but this would include increases in costs for adults aged 50 to 64 years, and decreases in costs for those aged 65 years and older. This contrasting effect by age group is explained by the fact that screening decreased CRC care costs and increased testing-related costs, but most testing costs were incurred by younger people, while decreases in CRC care costs were most profound for older people.

Current guidelines recommend that CRC screening begin at age 50 for those at average risk for CRC.[29] In this model, a cohort of adults taking up CRC screening only for ages 65 to 80 experienced reductions of 40% in the incidence of CRC and 49% in the fraction of deaths attributable to CRC, assuming current utilization rates for the individual strategies (Table 2). If instead this cohort took up screening for ages 50 to 80, it experienced reductions of 63% in the incidence of CRC and 75% in the fraction of deaths attributable to CRC (Table 2). The costs per life-year gained were lower with screening beginning later than with screening beginning earlier, but the incremental costs per life-year gained by earlier compared with later screening were less than $21,000 per life-year gained. Thus, the results lend support to recommendations to begin screening at age 50, which is before the age of Medicare eligibility for most people.

What are the implications of this analysis for Medicare, which covers approximately 50% of its beneficiaries' health costs not in the last year of life and approximately 64% in the last year of life?[41] Although widespread screening may decrease total CRC care and testing costs for those aged 65 years and older, total health costs may not decrease, as those spared CRC morbidity and mortality will incur future costs for other diseases. We estimated that if these future costs equal the average health costs for older Americans,[41] screening would remain relatively cost-effective, but cost savings in CRC care could potentially be offset by costs of care for future diseases, resulting in total cost increases even for payers for older Americans. However, costly new treatments are being adopted for treating node-positive and widely metastatic CRC.[42] If the costs of care for later-stage CRC increase significantly compared to this model's inputs, the cost-effectiveness of screening should improve, and the savings to health payers derived from CRC prevention and early detection should increase.

Efforts at increasing CRC screening uptake have met with limited success. It is possible that specific programs may increase uptake, but it is not known what such programs would entail or cost, and who would pay for them. Depending on those factors, these national estimates may underestimate the true cost of widespread screening. However, given that CRC screening is highly cost-effective, we estimate that a program to increase screening uptake could incur substantial costs and still be cost-effective.

These economic projections depend on the validity of the model's results concerning CRC incidence reductions with screening, because screening before age 65 produced savings after age 64 due to decreased CRC incidence. This model's predicted CRC incidence and mortality reductions with FOBT closely match the results of randomized trials,[9,25,26] and its predictions of the impact of FS and COLO are consistent with available data on the impact of sigmoidoscopy and colonoscopy with polypectomy.[9,27,28] Thus, we believe that this model's predicted reductions in CRC incidence with a mix of screening strategies in the population are consistent with available clinical data. These national projections take into account imperfect screening uptake, and therefore reflect the less profound reductions in CRC incidence and mortality that may be achievable in reality, even with optimistic assumptions.

This analysis has limitations. In order to produce national cost estimates, multiple sources were chosen and used to calculate averages for the cost inputs. This analysis demonstrates trends in national costs for younger versus older people as a function of CRC screening uptake, and thus the results can be considered to reflect the perspective of healthcare payers for adults in these age subgroups. However, these results may not reflect actual expenditures from the perspective of specific healthcare payers because the actual reimbursement for services related to CRC care, testing and complications by these payers may differ from the cost inputs used in this analysis. Actually analyzing the true reimbursements by payer would require much more detailed information on utilization and reimbursements than is available. The current analysis focused on direct medical costs and the potential impact

on healthcare payers, and therefore excluded indirect costs, such as patient time costs for screening or CRC treatment. Inclusion of these costs might affect cost-effectiveness estimates, but not the estimated direct national costs.

In conclusion, investments in CRC screening and polypectomy for people aged 50 to 65 may decrease total CRC-related costs, including screening and surveillance, for healthcare payers for older Americans, including Medicare. Future costs for other diseases could offset CRC care savings in older Americans that are attributable to CRC screening, but screening is likely to remain cost-effective. Widespread CRC screening beginning at age 50 must remain a national priority.

This study was supported in part by National Institutes of Health grant R01 CA101849-01A1.

No financial conflict of interest was reported by the authors of this paper.

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