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Brian S. Armour; Centers for Disease Control and Kerr L. White Institute
Carol Friedman, Centers for Disease Control
M. Melinda Pitts, Federal Reserve Bank of Atlanta
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Linda Alley, Centers for Disease Control and Kerr L. White Institute
Jeff Etchason, Centers for Disease Control and Kerr L. White Institute

Abstract: The objective of the paper is to estimate the effect of physician bonus eligibility on CRC screening while controlling for patient and primary care physician characteristics. The study is retrospective, using a managed care plan's claims data on fifty-year-old commercially insured patients in the years 2000 and 2001. The data also include links to enrollment and provider files. Multivariate logistic regression models are used to assess the association between CRC screening receipt and physician bonus eligibility. The results indicate that the probability that a patient received a CRC screening was approximately 3 percentage points higher in the year physicians were eligible for a bonus. There were also significant differences according to the gender of both the patient and physician, income, and race.

JEL classification: I10

Key words: managed care, primary care physicians, bonuses, colorectal cancer screening

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Please address questions regarding content to M. Melinda Pitts, Research Department, Federal Reserve Bank of Atlanta, 1000 Peachtree Street, NE, Atlanta, GA 30309-4470, 404-498-7009, melinda.pitts@atl.frb.org.

The Influence of Year-End Bonuses on Colorectal Cancer Screening

1. Introduction

Colorectal cancer (CRC) is the second leading cause of cancer-related death in the United States. The American Cancer Society (ACS) estimates that there will be 147,500 newly diagnosed cases of CRC and almost 57,100 deaths in 2003.(1) In addition, CRC is expensive to treat with costs estimated at $6.5 billion per year.(2) Several national organizations (3-6) have recommended fecal occult blood testing (FOBT), flexible sigmoidoscopy, colonoscopy, or double-contrast barium enema (DCBE) as effective screening options for persons aged 50 and older. Despite an increasing body of evidence that screening of asymptomatic persons significantly reduces mortality (7-9), the percentage of individuals who have been screened remains low. Estimates from the 2001 Behavioral Risk Factor Surveillance Survey suggest that 23.5% of respondents aged 50 and older reported having a FOBT in the previous year, and 47.3% reported undergoing lower endoscopy in the last 10 years. (3)

An extensive review of the literature has documented various barriers to all types of cancer services, including screening, in a variety of settings and populations.(10) One explanation offered for the low rates of CRC screening is the growth in managed care reimbursement arrangements.(11,12) Managed care organizations (MCOs) use various physician financial incentives as a means of containing healthcare costs. However, such incentives are controversial and have been the subject of intense public scrutiny and litigation (13) because it is generally perceived that physicians with managed care contracts face perverse financial incentives to limit access to services.(14-17) In regard to cancer services, little information is available on how the structure and financing of MCOs affect access to and outcomes of cancer care.(11,12) Beginning in January 2001, a large managed care health plan

operating in the southeastern U.S. implemented a year-end bonus program that was designed, in part, to improve CRC screening use among primary care physicians (PCPs). The purpose of this study is to estimate the effect of physician bonus eligibility on CRC screening controlling for patient and PCP characteristics.

2. Methods

2.1 Data

Managed care health plan claims data for 2000 and 2001 for all commercially insured persons aged 50 as of January 1, 2000 and 2001 were retrospectively linked to enrollment and provider files to examine the association between CRC screening rates and the year-end bonuses. The patient data included: patient enrollment information; patient demographic characteristics (age and gender), zip code and CRC procedure codes. Several patient characteristics, including race, income, and educational attainment, are associated with colorectal cancer screening receipt. (18-24) Because these variables were not collected by the health plan, we imputed this information using patient five digit zip codes that were linked to the Georgia 2000 U.S. Census Bureau Summary File 3. (25) Race was defined as the percentage of the population in each zip code that is black. Income was defined as income per capita by zip code. Educational attainment information was used to create three variables that categorized the patient's neighborhood as follows: percent with less than a high school education, percent high school graduates, and percent college graduates.

The provider data included PCP characteristics such as gender, year of medical school graduation, medical specialty and whether the provider was eligible for the year-end bonus. PCP experience was measured in years and was calculated by subtracting the date of a patient screening from the date of their provider's medical school graduation. For patients not screened,

physician experience was calculated by subtracting the midpoint in the year (July 1) from the year of medical school graduation.

The selection criteria used to determine PCP bonus program eligibility are proprietary. Thus to avoid potential bias associated with selection of PCPs into the bonus program, we excluded providers and data on the patients of those providers who were ineligible for the bonus program. We also limited our sample to 50 year-old patients who were continuously enrolled in the health plan in calendar years 2000 and 2001, respectively.

The Center for Medicare and Medicaid Services (CMS) procedure coding system (HCPCS) and the Current Procedural Terminology codes (CPT) were used to identify CRC screening procedures, including: FOBT, flexible sigmoidoscopy, colonoscopy, and DCBE (Table A.1). The codes were used to identify 50 year-old patients who received any one of these CRC screening procedures in 2000 and the year of bonus eligibility, 2001. PCPs eligible for a bonus were given credit for a screening if the plan had a claim in calendar year 2001 that included one of the procedure codes.

2.2 Data Analysis

A multivariate logistic regression model was used to estimate the effect that PCP bonus eligibility had on CRC screening use. The dependent variable was an indicator variable denoting whether a patient received a CRC screening. To examine the effect of the bonus, we used the year of bonus eligibility to approximate the effects of bonuses on the likelihood of CRC screening. Independent variables were patient gender (female) (26, 27), race (black) (27-29), per capita income (30) and education (30-32). In addition to the variable denoting the year of bonus eligibility, we included the following PCP characteristics: gender (female) (33) and experience (34,35). The independent variable "years of experience" was squared to capture any potential

non-linear effects of physician experience on CRC use. We also included a term to assess the interaction between female patient and female provider. Previous studies have shown that female patients treated by female physicians were more likely to receive mammograms and Pap smears. (36) This interaction term allowed us to determine whether this finding extends to CRC screening. Finally, an indicator variable that distinguished PCPs with an internal medicine (IM) specialty from other specialties was included to control for any unobserved differences in CRC screening between specialties.

All analyses were performed using SAS software, version 8 (SAS Institute, Cary, NC). Statistical significance was evaluated at the 5% level. This study was approved by the Institutional Review Board of the Centers for Disease Control and Prevention, Atlanta, Georgia.

3. Results

Sociodemographic characteristics of patients are shown in Table 1. At the zip code level, we estimate that 28% of the population was black and per capita income averaged $24,508. Sixteen percent of the population had less than a high school education, 55% were high school graduates and 29% had attended college. Approximately 53% of the patients were female and approximately 20% of all patients had a female PCP. Physician experience averaged 19.6 years. Slightly more than half of the patients' PCPs (52.1%) listed internal medicine as their specialty.

Of the 6,749 patients included in our analysis, approximately 25% received a CRC screening. Overall CRC screening use increased approximately 3 percentage points between 2000 and 2001 (23.4% to 26.4%; p=<0.01). Most of the increase in CRC use was attributed to a 2.77 percentage point increase in the use of FOBTs (17.8% to 20.6%; p<0.01). The percentage of patients who received a flexible sigmoidoscopy/colonoscopy increased 1.3 percentage points between 2000 and 2001 (8.6% to 9.8%; p=0.07).

Total CRC screening use differed by gender, with females more likely than males to have received a CRC screening test in 2000 (54.2% v. 45.8%; $p<0.01$) and 2001(52.6% v. 47.4%; $p<0.01$). Most of the gender difference in CRC use over time was attributed to FOBT receipt (Table 2). In 2000 and 2001, twice as many females as males received a FOBT.

Table 3 shows the odds of receiving a CRC screening procedure in the bonus year (2001), controlling for patient and PCP characteristics. The coefficient on the key variable of "bonus eligibility" is positive and statistically significant ($p<0.01$), indicating that patients were more likely to have received a CRC screening in 2001, the year the bonus program took effect.

The sign on the coefficient for the female patient variable is positive and statistically significant ($p<0.01$), indicating that women were more likely than men to have received a CRC screening. The coefficient on black race is negative and statistically significant ($p=0.03$), suggesting that blacks were less likely than non-blacks to have received a CRC screening. The coefficient on the per capita income variable is positive but not statistically significant ($p=0.54$). Patients with less than a high school education were less likely to have received a CRC screening than those with a high school education, however the difference was not statistically significant ($p=0.74$). Also, college educated patients were more likely than high school educated patients to have received a CRC screening, although this difference was not statistically significant ($p=0.21$).

The sign on the coefficient of the variable indicating whether a patient's physician was female is negative but not statistically significant ($p=0.23$). However, the interaction term of female patient with female physician is positive and statistically significant ($p=0.02$). This suggests that female patients treated by female PCPs were more likely to have received a CRC screening. Both PCP experience and experience squared had no statistically significant effects

on CRC screening. Physicians with internal medicine listed as their specialty were more likely to provide CRC screening ($p<0.01$).

Table 4 shows reestimation of the logistic regression model using FOBT and, in turn, flexible sigmoidoscopy/colonoscopy as the dependent variables. Because of small sample size, we combined flexible sigmoidoscopy and colonoscopy procedures into one variable. For the model that had FOBT as the dependent variable, the coefficient on bonus eligibility is positive and statistically significant ($p<0.01$). This result indicated that the odds that a patient received a FOBT increased in the bonus year. The sign on the coefficient for the female variable is positive and statistically significant ($p<0.01$) indicating that women were more likely than men to have received a FOBT. The coefficient on black is negative and statistically significant ($p<0.01$), suggesting that blacks were less likely than non-blacks to have received a FOBT.

For the model that had flexible sigmoidoscopy /colonoscopy as the dependent variable the coefficient on bonus eligibility is positive but not statistically significant ($p=0.08$). There was not a statistically significant difference in flexible sigmoidoscopy/colonoscopy use based on the gender or race of the patients. The coefficient on the per capita income variable is positive and statistically significant ($p=0.02$). A $10,000 increase in income would increase the probability of flexible sigmoidoscopy/colonoscopy screening by approximately 2 percentage points.

4. Discussion

Our analysis shows that CRC screening use increased significantly between 2000 and 2001, suggesting that year-end bonuses targeted at individual physicians were effective in improving delivery of CRC cancer screening procedures. This finding differs from previous work which suggested that bonuses targeted at physician group practices were ineffective in

improving physician delivery of cancer screening procedures to female Medicaid managed care beneficiaries.(37) However, our finding is consistent with previous empirical evidence that bonuses are more effective if they are targeted at individuals as opposed to a physician group. (38)

Previous research suggests that gender and racial differences may affect CRC screening rates by type of procedure.(27) Among Medicare beneficiaries, women were more likely than men to receive a FOBT and less likely to receive invasive procedures.(27) To determine whether results from previous research were generalizable to a commercially insured population, we re-estimated our logistic regression model using FOBT and, in turn, flexible sigmoidoscopy/colonoscopy as the dependent variables. Consistent with previous work, we found that commercially insured women were more likely than men to have received a FOBT, but found no significant difference for the more invasive screening procedures.

Our results suggest that the previously published finding that black Medicare beneficiaries were less likely than nonblacks to receive a FOBT (27) extends to a commercially insured population. Previous findings pointed to education and income as factors accounting for racial disparities in CRC screening among Medicaid recipients (30-32). Because we controlled for education and income in our model, we minimized these factors as possible confounders for racial differences in FOBT use in a commercially insured population.

Previous findings indicated that blacks were less likely than whites to have received a colonoscopy screening. (27) We found no statistically significant differences in flexible sigmoidoscopy/colonoscopy use by race. We did find that income is a statistically significant predictor of flexible sigmoidoscopy/colonoscopy use. Thus, for the commercially insured population, our result may suggest that costs (in particular co-pays and deductibles), rather than

patient demographics, may be an important barrier to the use of these more expensive invasive procedures. The results shown in Table 4 reveal that there was no statistically significant difference in the use of flexible sigmoidoscopy/colonoscopy procedures between 2000 and 2001. However, PCPs eligible for a bonus increased FOBT use between 2000 and 2001.

Our study had several limitations. First, we analyzed data for two years, the year prior to- and the year coinciding with- the implementation of the year-end bonus program. Thus, we were unable to distinguish the effect of financial bonuses from temporal trends. However, among health plan PCPs who were ineligible for the bonus program, CRC use remained unchanged between 2000 and 2001 (26.8% vs. 26.4%). The presumption that the lack of a temporal trend in CRC use among PCPs ineligible for the bonus is applicable to PCPs eligible for a bonus provides credence to the effectiveness of the bonus program. Nevertheless, more research is needed to examine the effect of various financial incentive programs over a longer time period to better distinguish these effects. Second, we analyzed data for commercially insured patients residing in one state; therefore, our findings may not be generalizable to other areas of the country. Third, we were unable to distinguish between CRC procedures for screening versus diagnostic purposes. Consequently, we may have overestimated the CRC screening rates.

CRC screening is recommended for persons aged 50 years and older. However, our analysis was limited to persons aged 50 years as of January 1, 2000 and 2001. The exclusion of older persons was designed to reduce problems associated with the time frame surrounding current guidelines for CRC screening. For example, the ACS recommends flexible sigmoidoscopy every 3-5 years beginning at age 50 for persons at average risk for CRC. (39) Given that we were limited to two years of data we would have been unable to determine with

certainty whether persons aged 52 years and older had previously received one of the more invasive types of screening procedures within the ACS recommended timeframe. Thus, by excluding older aged individuals we avoid understating CRC screening rates. We plan future studies with at least five years of data to determine whether our findings extend to older aged commercially insured persons.

Several patient characteristics including race, income and educational attainment that are associated with CRC screening receipt were unavailable in the data. We imputed this information using neighborhood information obtained at the zip code level from the U.S. Bureau of the Census. By approximating this information, these variables are only suggestive of the true effects of race, income and education on CRC screening use. However, in the absence of individual information this approach is considered standard in the economics literature and has been employed in cancer research. (21, 40, 41)

5. Conclusion

The results from our study suggest that bonuses targeted at individual providers resulted in an increase in the use of CRC screening tests among a commercially insured population. However, more research is needed to examine the effect of performance-based incentives on resource use and the quality of medical care. In particular, there is a need to determine how physicians respond to the magnitude of bonus amounts at the individual and group levels. There is also a need to investigate whether explicit financial incentives are effective in reducing racial disparities in the quality of patient care. This has particular relevance for CRC screening given that blacks are less likely to be screened, have higher CRC incidence and mortality rates compared to other racial groups, and screening has been shown to be more cost-effective in this population. (27, 42, 43)

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Table 1. Patient and Primary Care Physician (PCP) Characteristics by Year.

	2000 n=3058	2001 n=3691	Total n=6749
Patient Characteristics			
Female	54.19%	52.64%	53.34%
Male	45.81%	47.36%	46.66%
Race			
Black	28.45%	27.97%	28.18%
White	64.55%	64.92%	64.76%
Hispanic	5.42%	5.38%	5.40%
Income (per capita)	$24,333	$24,653	$24,508
Education			
Less High School	16.49%	16.07%	16.27%
High School	54.81%	54.28%	54.52%
College	28.70%	29.65%	29.21%
CRC Screening Total*	23.38%	26.44%	25.06%
FOBT †	17.82%	20.59%	19.34%
Flex. Sig. or Colonoscopy‡	8.57%	9.83%	9.26%
Barium Enema	1.34%	1.16%	1.24%
Multiple Tests	4.19%	4.77%	4.50%
PCP Characteristics			
Female PCP	18.93%	19.80%	19.41%
Experience (years)	19.24	19.95	19.63

Table 1. Patient and Primary Care Physician (PCP) Characteristics by Year. (cont.)

Specialty	51.73%	52.45%	52.12%
Internal Medicine	46.89%	46.17%	46.50%
Family Practitioner	1.38%	1.38%	1.38%
General Practitioner			

* The colorectal cancer (CRC) screening percentages by procedure type do not sum to the screening total since 4.19% of patients in 2000, 4.77% in 2001 and 4.50% overall received one or more of the screening procedures.

†FOBT denotes fecal occult blood test.

‡Because of small sample size we combined flexible sigmoidoscopy and colonoscopy procedures into one variable.

Table 2. Patient and Primary Care Physician (PCP) Characteristics by Type of Colorectal Cancer (CRC) Screening Procedure and Year.

	Colorectal Cancer Screening Receipt*					
	FOBT†		Flex. Sig. / Colonscopy‡		CRC Screening Total §	
	2000 n=545	2001 n=760	2000 n=262	2001 n=363	2000 n=715	2001 n=976
Patient Characteristics						
Female	67.71%	67.37%	52.67%	50.96%	62.80%	63.63%
Male	32.29%	32.63%	47.30%	49.04%	37.20%	36.37%
Race						
Black	25.67%	25.48%	28.91%	27.34%	26.36%	26.61%
White	66.80%	66.96%	64.56%	65.53%	66.38%	67.00%
Hispanic	5.98%	5.88%	4.96%	5.58%	5.66%	5.71%
Income (per capita)	$25,464	$25,556	$26,063	$25,887	$25,641	$25,678
Education						
Less High School	15.52%	15.41%	14.34%	15.46%	15.13%	15.34%
High School	53.38%	53.33%	53.63%	53.44%	53.51%	53.39%
College	31.10%	31.26%	32.03%	31.10%	31.36%	31.27%
PCP Characteristics						
Female PCP	20.18%	25.13%	18.70%	20.66%	19.30%	23.87%
Experience (years)	19.49	19.70	18.62	19.34	19.26	19.67

Table 2. Patient and Primary Care Physician (PCP) Characteristics by Type of Colorectal Cancer (CRC) Screening Procedure and Year. (cont.)

Specialty						
Internal Medicine	54.86%	57.50%	59.92%	56.75%	54.55%	57.07%
Family Practitioner	43.67%	41.71%	38.55%	41.87%	44.05%	41.91%
General Practitioner	1.47%	0.79%	1.53%	1.38%	1.40%	1.02%

*Descriptive statistics for the barium enema procedure were excluded because so few patients (41patients in 2000 and 43 patients in 2001) received this type of test.

†FOBT denotes fecal occult blood test.

‡Because of small sample size we combined flexible sigmoidoscopy and colonoscopy procedures into one variable.

§ The colorectal cancer (CRC) screening totals for FOBT and flexible sigmoidoscopy/colonoscopy do not sum to the overall total because patients may have received more than one screening procedure.

Table 3. Predictors of Colorectal Cancer (CRC) Screening Use (N=6,749)

Variable	Adjusted Odds Ratios (95% CI)	Marginal Effects * (p- value)
Patient Characteristics †		
Female	1.61 (1.42, 1.83)	8.72 (<0.01)
Black	0.77 (0.61, 0.98)	-4.82 (0.03)
Income (per capita) ‡	1.01 (0.99, 1.02)	0.08 (0.54)
Education		
LHS	0.84 (0.30, 2.35)	-3.22 (0.74)
College	1.83 (0.71, 4.71)	11.17 (0.21)
PCP Characteristics		
Bonus Eligibility	1.18 (1.05, 1.32)	3.02 (<0.01)
Female PCP	0.84 (0.64, 1.12)	-3.05 (0.23)
Experience	1.02 (0.99, 1.04)	2.90 (0.19)
Experience Squared	1.00 (0.99, 1.00)	-0.01 (0.15)
Internal Medicine	1.18 (1.05, 1.32)	3.04 (<0.01)
Female* Provider Female§	1.49 (1.07, 2.05)	7.84 (0.02)

* Due to the nonlinear nature of the logistic regression model, a coefficient is not equal to the derivative of an expected value with respect to a variable. Thus, in addition to the odds ratios, the marginal effects were estimated at the sample means and are reported as percentage point changes for each variable. The marginal effects were reported, in part, because the presenter at an Econometric Methods workshop, sponsored by the Centers for Disease Control and Prevention, questioned the public's understanding of odds ratio units. (44) The odds ratio gives the change in the probability of a dummy variable. (44) Patients may not think in terms of odds ratio units but they do think in terms of change (e.g. if income increases by $10,000 the probability they received a flexible sigmoidoscopy or colonoscopy increased by approximately 0.8 percentage points). (44) Therefore, the marginal effects were reported since they are more intuitive, particularly when it comes to interpreting the effects of continuous explanatory variables such as income.

† The referent group is male, non-black, high school educated, male PCP, family or general practitioner in the year 2000.

‡ The income variable is measured in thousands of dollars.

§ This term denotes the interaction between the female variable and the provider female variable.

Table 4 -- Predictors of Fecal Occult Blood Test (FOBT) and Flexible Sigmoidoscopy or Colonscopy Screening Use

	CRC Screening Procedure			
Variable	Fecal Occult Blood Test (FOBT)		Flex. Sig. or Colonscopy†	
Patient Characteristics‡	Adj. Odds Ratios (95% CI)	Marginal Effects§ (p-value)	Adj. Odds Ratios (95% CI)	Marginal Effects§ (p-value)
Female	1.93 (1.68, 2.23)	9.79 (<0.01)	0.88 (0.73, 1.06)	-1.02 (0.19)
Black	0.65 (0.50, 0.85)	-6.49 (<0.01)	1.38 (0.99, 1.93)	2.66 (0.06)
Income (per capita) ▌	0.99 (0.98, 1.01)	-0.08 (0.51)	1.02 (1.01, 1.04)	0.19 (0.02)
Education				
Less than High School	1.67 (0.54, 5.15)	7.71 (0.37)	0.34 (0.07, 1.60)	-8.97 (0.17)
College	3.32 (1.17, 9.37)	18.02 (0.02)	0.57 (0.15, 2.19)	-4.65 (0.41)
PCP Characteristics				
Female PCP	0.85 (0.61, 1.18)	-2.36 (0.32)	0.85 (0.58, 1.24)	-1.29 (0.37)
Experience	1.02 (0.99, 1.04)	0.24 (0.21)	1.00 (0.96, 1.03)	-0.02 (0.91)
Experience Squared	1.00 (0.99, 1.00)	-0.01 (0.26)	1.00 (0.99, 1.00)	-0.00 (0.66)

Table 4 -- Predictors of Fecal Occult Blood Test (FOBT) and Flexible Sigmoidoscopy or Colonscopy Screening Use (cont.)

Internal Medicine	1.19 (1.05, 1.35)	2.57 (<0.01)	1.25 (1.06, 1.48)	1.85 (<0.01)
Bonus Eligibility	1.20 (1.06, 1.36)	2.69 (<0.01)	1.16 (0.98, 1.37)	1.23 (<0.08)
Female* Provider Female¶	1.54 (1.06, 2.22)	7.11 (0.02)	1.27 (0.81, 2.00)	2.09 (0.31)

† Because of small sample size, we combined flexible sigmoidoscopy and colonoscopy procedures into one variable.
‡ The referent group is male, non-black, high school educated with male PCP, family or general practitioner in the year 2000.
§ Due to the nonlinear nature of the logistic regression model, a coefficient is not equal to the derivative of an expected value with respect to a variable. Thus, in addition to the odds ratios, the marginal effects were estimated at the sample means and are reported as percentage point changes for each variable. The marginal effects were reported, in part, because the presenter at an Econometric Methods workshop, sponsored by the Centers for Disease Control and Prevention, questioned the public's understanding of odds ratio units. (44) The odds ratio gives the change in the probability of a dummy variable. (44) Patients may not think in terms of odds ratio units but they do think in terms of change e.g. if income increases by $10,000 the probability they received a flexible sigmoidoscopy or colonoscopy increased by approximately 2 percentage points. (44) Therefore, the marginal effects were reported since they are more intuitive, particularly when it comes to interpreting the effects of continuous explanatory variables such as income.
▌ The income variable is measured in thousands of dollars.

¶ This term denotes the interaction between the female variable and the provider female variable.

Appendix A

Table A.1. Procedure Codes used to identify a Colorectal Cancer Screening.

Colorectal Cancer Screening Procedure	Code
Flex. Sig. or Colonoscopy	CPT4 - 45300 through 45387; 44360 through 44397
	ICD9 - 45.21 through 45.25; 48.23; 48.24
	HCPCS - G0104, G0105
FOBT	CPT4 - 82270
	HCPCS - G0107
Barium enema	CPT4 - 74270, 74280
	HCPCS - G0106