Published in final edited form as:

Med Care. 2020 February ; 58(2): 183–191. doi:10.1097/MLR.0000000000001241.

The Impact of Massachusetts Health Reform on Colorectal and Breast Cancer Stage at Diagnosis

Lindsay M. Sabik, PhD*

University of Pittsburgh, Department of Health Policy and Management, 130 De Soto St.,
Pittsburgh, PA 15261

Kirsten Y. Eom, MPH,

University of Pittsburgh, Department of Health Policy and Management, 130 De Soto St.,
Pittsburgh, PA 15261

Bassam Dahman, PhD,

Virginia Commonwealth University, Department of Health Behavior and Policy, 830 East Main St.,
Richmond, VA 23219

Jie Li, PhD,

University of Pittsburgh, Department of Health Policy and Management, 130 De Soto St.,
Pittsburgh, PA 15261

Nengliang Yao, PhD,

University of Virginia, Department of Public Health Sciences, P.O. Box 800765, Charlottesville, VA
22903

G. J. van Londen, MD, MS,

University of Pittsburgh, Department of Medicine, Divisions of Hematology-Oncology and
Geriatric Medicine, Magee Womens Hospital of UPMC, 300 Halket Street, Room 3526,
Pittsburgh, PA 15213

Cathy J. Bradley, PhD

University of Colorado Comprehensive Cancer Center, 13001 E. 17th Place, Aurora, CO 80045

Abstract

Background: This study examines the expansion of health insurance coverage in Massachusetts under state health reform as a natural experiment to investigate whether expanded insurance coverage reduced the likelihood of advanced stage colorectal cancer (CRC) and breast cancer (BCA) diagnosis.

Methods: Our study populations include CRC or BCA patients ages 50-64 observed in the Massachusetts Cancer Registry and Surveillance Epidemiology and End Results (SEER) registries

*Corresponding Author: lsabik@pitt.edu.

Preliminary results from this study have been presented previously at the 2018 American Society of Health Economists (ASHEcon) Annual Conference and the 2017 Association for Public Policy Analysis and Management (APPAM) Fall Conference.

The authors have no conflicts of interest directly related to this study. Dr. van Londen reports receiving speaker fees from Eisai. The authors have no other relationships to disclose.

for 2001-2013. We use difference-in-differences regression models to estimate changes in the likelihood of advanced stage diagnosis following Massachusetts health reform, relative to comparison states without expanded coverage (Connecticut, New Jersey, Georgia, Kentucky, and Michigan).

Results: We find some suggestive evidence of a decline in the proportion of advanced stage CRC cases. Approximately half of CRC patients in Massachusetts and control states were diagnosed at advanced stages pre-reform; there was a 2 percentage-point increase in this proportion across control states and slight decline in Massachusetts post-reform. Adjusted difference-in-difference estimates suggest a 3.4 percentage point ($p=0.005$) or 7% decline, relative to Massachusetts baseline, in the likelihood of advanced stage diagnosis after the reform in Massachusetts, though this result is sensitive to years included in the analysis. We did not find a significant effect of reform on BCA stage at diagnosis.

Conclusions: The decline in the likelihood of advanced stage CRC diagnosis following Massachusetts health reform may suggest improvements in access to healthcare and CRC screening. Similar declines were not observed for BCA, perhaps due to established BCA-specific safety net programs.

Keywords

cancer; stage at diagnosis; insurance; health reform

Introduction

Colorectal cancer (CRC) is the second leading cause of cancer deaths overall, and breast cancer (BCA) is the second leading cause of cancer deaths among US women.¹ Both cancers generate high financial stress: BCA has the highest medical expenditures of any cancer, followed by CRC, with estimated costs of \$19.3 billion and \$16.3 billion in 2017, respectively.² Both are projected to contribute substantially to growing healthcare costs over the coming years, given current incidence, survival, and costs.³ Although they are two of the most deadly and costly cancers, CRC and BCA can be detected at treatable stages through screening. The US Preventive Services Task Force recommends routine screening for both cancers.^{4,5} However, many age-eligible people do not receive these screenings because they lack insurance coverage, leading to diagnosis at a more advanced stage than if screened regularly.^{6,7}

Expansions of health insurance coverage under the 2006 Massachusetts Health Reform to non-elderly adults not eligible for Medicare provide a context for examining the relationship between insurance and stage at cancer diagnosis. Key provisions of the reform included establishing a health insurance exchange to offer insurance in the individual market at lower costs than previously available, subsidizing coverage for individuals with household incomes below 300% of the federal poverty level, expanding public coverage options, requiring employers to provide insurance coverage, and mandating that individuals obtain health insurance coverage.^{8,9} The reform was successful at substantially increasing coverage among non-elderly adults within the state¹⁰ and served as an example for the Affordable Care Act.

Cross-sectional evidence suggests that individuals with health insurance are more likely to receive cancer screening and to be diagnosed at earlier stages.¹¹⁻¹⁴ Further, evidence from a trial that randomly assigned Medicaid eligibility in Oregon found significant increases in cancer screenings as a result of Medicaid coverage¹⁵, while quasi-experimental evidence suggests rollbacks of public insurance coverage are associated with a shift from earlier to later stage BCA diagnosis among low-income women.¹⁶

Prior to health reform, rates of guideline-recommended screening in Massachusetts were approximately 57% for CRC and 88% for BCA.¹⁷ While these percentages were higher than in many other states, evidence suggests there were increases in screening for both BCA and CRC after health reform implementation in Massachusetts.¹⁷⁻¹⁹ Given improvements in access to care and screening after the reform, we hypothesize that health insurance expansions are associated with a decrease in the likelihood that cases are diagnosed at advanced stages.

We also hypothesize that the impact differs across cancer sites because of important differences in safety-net programs to screen low-income uninsured and underinsured patients. The Centers for Disease Control and Prevention (CDC) provided funding for free breast cancer screenings in low-income, uninsured women in all states over the period we study. However, free CRC screening programs are not as widespread and do not have the longstanding history of the CDC's breast screening program.^{20, 21}

The Massachusetts Health Care Insurance Reform Law aimed to achieve universal health insurance coverage in the state through a combination of mandates, subsidies, and public insurance expansions.⁸ In Massachusetts, there are approximately 37 CRC cases per 100,000 residents annually, and approximately 138 per 100,000 women are diagnosed with invasive breast cancer annually; BCA and CRC represent the second and third leading causes of cancer deaths in the state, respectively.²² The objective of this paper is to assess whether the constellation of policy changes under state health reform was associated with changes in stage at diagnosis for BCA and CRC.

Methods

Data Sources

The primary data source is the Massachusetts Cancer Registry (MCR). Administered through the Massachusetts Department of Public Health, the MCR collects information on cancer diagnosis and treatment and has received gold certification from the North American Association of Central Cancer Registries (NAACCR) for complete, timely, and high-quality data.²³ Data from the MCR include patient age, sex, race/ethnicity, marital status, and geographic area. Cancer-relevant variables include date of diagnosis, primary site, stage at diagnosis, and other tumor details.

We also use Surveillance Epidemiology and End Results (SEER) 18 cancer registry data on CRC and BCA to select appropriate control groups for Massachusetts.²⁴ We consider two groups of control states for Massachusetts. The first group is Connecticut and New Jersey as these states are expected to be more similar to Massachusetts regarding demographics and

economic characteristics than other SEER states.²⁵ However, both implemented limited early Affordable Care Act (ACA) Medicaid expansions during our study period in the years following the Massachusetts Health Reform.^{26, 27} Thus, we consider a second control group, consisting of cases from Michigan, Kentucky, and Georgia, the only three SEER states without early ACA expansions or substantial expansions of coverage to non-elderly adults through waivers during this time period.^{18, 28} Supplemental Digital Content (SDC) Appendix Table 1 lists all available SEER states and expansions over our study period that were considered in selecting control groups. County-level controls capturing population demographic information and health care capacity and infrastructure come from the Area Health Resources Files (AHRF).

Outcome Measures

We model stage as a dichotomous variable, using SEER summary stage (SS) to be consistent over time and in line with other literature examining changes in staging at the population level.^{29, 30} Our primary outcome of interest is whether a CRC or BCA patient was diagnosed at advanced stage, defined as regional or distant disease (SEER SS 2–7) compared with in situ or localized cases (SEER SS 0–1). We estimate models using unknown/unstaged classification as a secondary outcome of interest since we hypothesize fewer unstaged cases are associated with more generous coverage.³¹

Sample inclusion and exclusion criteria

Our study sample for each cancer type included first primary tumors among patients ages 50–64 years diagnosed from 2001–2013. Exclusion criteria applied to the MCR data to identify cases representing first lifetime primary tumors are shown in Figures 1 and 2. We limited the sample to cases among patients with a single sequence number of 0 or 1 in the registry, indicating a first primary tumor. We eliminated a small number of remaining cases for which the patient had a record indicating another diagnosis of the same cancer type within the study period on or before the date of diagnosis of the current case, as well as cases for which diagnosis was established by autopsy or death certificate or diagnosis date was the same as death date, and cases for which the patient has another tumor of the same cancer type diagnosed within 365 days. For BCA analyses, we excluded the small number of non-female patients. We employed the same exclusion criteria to the SEER data for each cancer type.

Statistical Analysis

Difference-in-difference (DD) models are used to estimate the difference in the likelihood of advanced-stage diagnosis between patients in Massachusetts and control states before and after health reform implementation.³² Specifically, using linear probability models we regress each of our outcomes of interest on an indicator of whether the individual resides in Massachusetts; an indicator of whether the case was diagnosed after the full implementation of health reform in Massachusetts in June 2007 (post period); an interaction between the Massachusetts and post period indicators (the DD estimate); a vector of individual (age, marital status, race, and ethnicity) and county-level (primary care physicians, specialist physicians, safety net facilities, and hospital beds per 1000 population; percentage of the population unemployed, with less than a high school diploma, white non-Hispanic, and

urban; and median household income) characteristics; state-fixed effects that control for time-invariant state characteristics; year-fixed effects to control for secular trends in screening; and an individual-specific error term estimated using Huber-White robust standard errors. Our coefficient of interest is the interaction term between Massachusetts and the post period, representing the change in Massachusetts post-reform relative to the change in the control states. By comparing Massachusetts to other states, we control for any general trends in cancer screening or diagnosis due, for example, to changes in guidelines or available technologies. We estimate separate DD models for each cancer site and each set of SEER control states. As a sensitivity analysis, we estimate models that combine all comparison states into a single control group.

In our main models, we define the post period as starting in June 2007 after all provisions of the reform were implemented. Given that the reform law was passed in April 2006 and provisions of the law were implemented over the period from April 2006 through June 2007, we test the robustness of our results compared with models that 1) drop observations from the implementation period or 2) define the post period as beginning with the passage of the reform law in April 2006.

Results

Sample descriptive statistics

There were 11,043 patients in Massachusetts aged 50 to 64 years who had a first primary CRC diagnosis from 2001 to 2013 (Figure 1), and 26,524 female patients in Massachusetts aged 50 to 64 who had a first primary BCA diagnosis from 2001 to 2013 (Figure 2). Control groups included 20,647 and 31,321 CRC patients and 46,417 and 60,201 BCA patients in the Connecticut and New Jersey group and the Georgia, Kentucky, and Michigan group, respectively (SDC Appendix Table 2).

Table 1 Panel A presents characteristics of the CRC samples in Massachusetts and each set of control states during both the pre- and post-reform periods. There was little change in the proportion of CRC patients diagnosed at an advanced stage (regional or distant) in Massachusetts, while the proportion of more advanced stage cases increased in both sets of control states in the post-reform period. About 48% to 52% of CRC patients in Massachusetts and control states were diagnosed with regional or distant disease in the pre-reform period, and there was a 2 percentage-point increase in this proportion across all the control states during the post-reform period. The samples were similar across group on many demographic characteristics. Approximately 57% to 59% of the CRC samples were male across Massachusetts and control states in the pre- and post-reform periods. A higher proportion of CRC patients were married in all three groups of states during the pre-reform period than during the post-reform period. There were more non-white CRC patients in control states than in Massachusetts throughout the entire study period.

Table 1 Panel B reports descriptive statistics for BCA cases and shows that in the pre-reform period, 24% of BCA patients in Massachusetts were diagnosed at advanced stages, and about 29% of BCA patients in Connecticut and New Jersey and 31% of patients in the Georgia, Kentucky, and Michigan sample were diagnosed at an advanced stage. In the post-

reform period, the proportion of BCA patients diagnosed late declined in Massachusetts and in both sets of control states, though the decrease was larger in the New England states than in the second group of control states. Many patterns in demographic characteristics of BCA patients were similar to those observed for the CRC sample.

SDC Appendix Figures 1 and 2 illustrate trends in numbers of cases by stage for each cancer and each set of states over our study period. We also assessed the parallel trends assumption underlying our cross-state DD model in multiple ways. We interacted the indicator for Massachusetts with each year of the study period, omitting 2006 (SDC Appendix Tables 3-6). For CRC, joint F-tests of all pre-period interaction terms reject the null of parallel pre-period trends due to positive coefficients on the Massachusetts-year interactions for the earliest years of the study period. In the years immediately preceding health reform, there is no significant difference in trends between Massachusetts and control states. For BCA, we fail to reject the null hypothesis of similar trends in both control groups. We also limited the data to 2001–2005, prior to the reform, and considered two sets of models to assess differences in stage at diagnosis (early vs. advanced) across years between Massachusetts and comparison states. We conducted 3-way comparisons of state/state group, year, and stage and likelihood ratio tests comparing regression models with and without interaction terms between state and diagnosis year (Appendix Table 7). Across most of these tests p-values are large, indicating that there are no differences across groups/models in the pre-period, in support of the parallel trends assumption.³³ In one instance, when we pool CT and NJ as the comparison group and compare models with and without an interaction term between state group and year, the difference between models is significant at $p = 0.04$. Taken together, these analyses lend reasonable support for the assumptions underlying our models, though suggest that there may have been some pre-period differences in trends when comparing CRC stage for Massachusetts vs. Connecticut and New Jersey.

Regression results

Table 2 presents the DD coefficients comparing whether CRC cancer cases were diagnosed at more advanced stages in Massachusetts relative to comparison groups between the pre- and post-periods. The results for the cross-state DD models consistently suggest a decrease in the likelihood of an advanced stage diagnosis following health reform in Massachusetts relative to control states, with estimates ranging from a 3.5 ($p=0.012$) to 5.6 ($p=0.013$) percentage-point decrease. Compared to a baseline rate of 48% of cases diagnosed at more advanced stage in Massachusetts, the more conservative estimates (using Georgia, Kentucky, and Michigan cases as the comparison group) suggest approximately a 7% decline in the likelihood that a diagnosis is at a regional/distant stage, relative to trends in the control group.

Table 3 reports results for the BCA sample. There was no statistically significant effect of the Massachusetts reform on BCA stage at diagnosis. When we use Georgia, Kentucky, and Michigan as controls, we find a significant difference of 0.6 percentage points ($p=0.002$) in the likelihood of unknown or unstaged cases, which represents an increase in the likelihood of unstaged cancer in the control states compared to no change in Massachusetts, counter to our hypothesis. Full regression results are available in SDC Appendix Tables 8-11.

Robustness checks using alternative reform period definitions support our main findings (SDC Appendix Tables 12-13). Estimates of the impact of reform on advanced stage diagnosis are similar in magnitude and direction when we pool all comparison states to form a single control group, suggesting a statistically significant decrease in the likelihood that CRC cases are diagnosed at advanced stage and no change in BCA diagnosis. Our conclusions are also robust to using logistic regression rather than linear regression models (results not shown).

Discussion

In this study, we examine the impact of the Massachusetts state-wide health insurance reform in 2006 on stage at diagnosis of two prevalent cancers for which morbidity and mortality can be substantially reduced through early detection and treatment. Our estimates suggest about a 3.4 percentage-point decrease in the likelihood that CRC cases are diagnosed at regional/distant stages compared with trends in other states, representing about a 7% decline relative to patterns in the pre-period. Similar to prior research findings,³⁴ we do not find evidence that the likelihood of advanced-stage BCA changed.

The results for CRC cases suggest that expanded health insurance may have facilitated access to screening and diagnostic services that allowed for earlier diagnosis of cancer relative to trends in comparison states. Our more conservative point estimate corresponds to 3,400 fewer advanced stage cases per 100,000 individuals. Given that over 60,000 adults in the US ages 20 to 64 years are diagnosed with CRC annually³⁵ and approximately half of these cases are diagnosed at regional or distant stages, a 7% reduction in advanced-stage cases, as suggested by our estimates, would correspond to over 2,100 fewer late-stage diagnoses among non-elderly patients annually if similar effects were achieved across all states.

The different impacts observed for BCA and CRC may be due to differences in existing safety-net programs to screen for BCA vs. other cancers. The nationwide CDC-funded Breast and Cervical Cancer Prevention and Treatment Program provides access to free breast and cervical cancer screening and diagnosis services to low-income, uninsured women. While some CRC screening safety-net programs exist, they are less widespread and federally funded programs were not in place in the states we examine during our study period.^{36, 37} Thus, the potential for impact of comprehensive health reform on CRC diagnosis is greater than for BCA. Further, out of pocket costs for CRC screening through imaging-based modalities such as colonoscopy are likely to be higher than those for BCA screening when a patient is paying for services without insurance coverage.³⁸⁻⁴⁰ Finally, issues of convenience may also limit access to CRC screening. While BCA screening may be done by regional/local safety-net providers through, for example, mobile mammography units^{41, 42}, CRC screening through colonoscopy requires two days for preparation and screening, time off work, and an accompanying adult to drive the patient.^{43, 44} These may have contributed to lower baseline rates of CRC screening and greater potential for an impact of reduced financial barriers.

The 2006 Massachusetts Health Care Insurance Reform Law established the strategy for coverage expansions utilized under the Affordable Care Act (ACA), including a combination of mandates, subsidies, and public insurance expansions.⁸ Under the law, if individuals do not have health insurance coverage that meets minimum coverage standards and if employers do not provide employee health insurance, they are subject to tax penalties. In addition, government subsidized insurance was expanded to provide coverage for adults under 300% of the Federal Poverty Level (FPL) without another source of insurance, including fully subsidized plans for those below 150% FPL. The law also established a state insurance exchange offering standardized private health insurance plans.

Prior research established that the Massachusetts reform successfully expanded insurance coverage to almost all individuals in the state by about 7% within the first four years (from <87% in 2006 to >94% in 2010).^{10, 45} Early research showed improvements in access along with reports of difficulty obtaining care because providers would not accept new patients, particularly low-income individuals.⁴⁶ Studies of the association between cancer screening and Massachusetts health reform are mixed, but some prior studies are limited by short periods post-reform, lack of appropriate control groups, or both.^{34, 47, 48} Earlier research demonstrates increases in screening due to reform occurring approximately three years post-reform.¹⁸ The only previous study that considers changes in stage at diagnosis after Massachusetts reform does not find an association between reform and earlier stage at diagnosis, though the research was limited by a short time period post-reform and reliance on California as the sole control state.³⁴ California differs from Massachusetts geographically and demographically and implemented a Medicaid coverage expansion waiver in 10 counties starting in 2007, around the same time as the Massachusetts coverage expansions, potentially dampening any expected differences stage at diagnosis.

In this paper, we extend the previous literature by using a longer post-period and two sets of comparison states to account for secular trends in stage and by comparing two prevalent screening-amenable cancers that may be impacted differently by the broad expansion of insurance coverage. Our results have implications for how health insurance coverage may alter the course of cancer for low-income previously uninsured individuals.

Our study has limitations. First, we rely on cancer registry data without information from health care claims, which would provide more detail on screening and diagnostic services over time. Second, while Massachusetts health reform was an exogenous change to the health care system that provides a useful natural experiment, evidence from Massachusetts may not generalize to other states due to higher baseline insurance coverage, average education, and average income than most surrounding states.⁴⁹ Third, we do not have individual-level income or insurance status before diagnosis. Fourth, we cannot identify over screening and overdiagnosis in our analysis. Finally, the impact of local or state safety net programs supporting screening and diagnosis could not be identified. For example, in New Jersey, some residents received free CRC screening through a state-based program starting in 2007,⁵⁰ and in Connecticut, efforts to increase awareness of and testing related to dense breast tissue were associated with increased breast cancer detection during the study period.⁵¹ If anything, these types of programs or initiatives in a control state should bias estimates

of the Massachusetts reform toward zero, suggesting the impact may be slightly larger than our estimates suggest.

Our study is the first to present evidence that the Massachusetts health reform may be associated with a shift to earlier stage cancer diagnosis for CRC relative to trends in control states. Other research has shown that Massachusetts health reform led to a decline in mortality, and changes in health outcomes, such as cancer stage, represent one pathway that may contribute to the observed changes in mortality.⁵² The Massachusetts experience is relevant to the ACA given key elements of the ACA parallel those of the Massachusetts reform. While data on the longer-term impacts of the ACA are still emerging,^{53, 54} our results suggest that coverage expansions under recent national reform may potentially lead to earlier stage diagnosis, particularly for CRC, among patients who gained coverage as a result of the law.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was supported by the American Cancer Society (Research Scholar Grant RSG-16-017-01-CPHPS) and National Cancer Institute Cancer Center Support Grant P30 CA047904. Dr. van Londen was also supported by the Magee-Women's Research Institute and Foundation. The authors thank the Massachusetts Department of Public Health for assistance accessing data.

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Figure 1. Colorectal Cancer Sample Selection and Exclusions in Massachusetts

* We assumed that the cases with missing diagnosis days but with usable months occurred on the 15th of the month (n=25).

** Exclusion is based on subsequent colorectal cancer tumors only. We examined the number of cases for which the patient had a breast cancer (BCA) diagnosis within 12 months. N=24 patients in the final sample had a BCA diagnosis in this timeframe, indicating that only a small number of patients in our sample were likely to have been diagnosed with other cancers for which we did not have data available.

We defined the first case as the case whose sequence number is 0 or 1.

Figure 2. Breast Cancer Sample Selection and Exclusions in Massachusetts

* We assumed that the cases with missing diagnosis days but with usable months occurred on the 15th of the month (n=38).

** Exclusion is based on subsequent breast cancer tumors only. We examined the number of cases for which the patient had a colorectal cancer (CRC) diagnosis within the subsequent 12 months. N=15 patients in the final sample had a CRC diagnosis in this timeframe, indicating that only a small number of patients in our sample were likely to have been diagnosed with other cancers for which we did not have data available.

We defined the first case as the case whose sequence number is 0 or 1.

Table 1.

Sample descriptive statistics for Massachusetts and control states

<i>Panel A. Colorectal cancer (CRC) sample</i>		Massachusetts		Connecticut and New Jersey		Georgia, Kentucky, and Michigan	
		Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform
N		5,796	5,247	10,664	9,983	15,137	16,184
Stage (early vs. late) (%)							
Early (SS 0-1)		49.6	50.3	46.2	43.2	44.4	42.4
Advanced (SS 2-7)		48.2	47.5	49.7	51.3	52.1	54.7
Unknown/Unstaged		2.2	2.2	4.1	5.5	3.6	2.9
Demographics (% / mean (SD))							
Age 50-54		30.1	36.7	28.5	32.6	29.8	31.0
Age 55-59		33.9	29.7	34.0	32.6	34.2	32.9
Age 60-64		36.0	33.6	37.5	34.8	36.0	36.2
Male		59.0	56.8	57.5	57.2	56.8	57.2
Married		65.0	57.4	63.2	56.5	63.2	56.3
Non-Hispanic White		88.3	82.7	73.4	69.4	76.5	69.3
Non-Hispanic Black		4.6	7.0	13.7	13.7	24.0	26.8
Non-Hispanic Other Race		3.5	6.0	4.1	6.0	1.4	2.5
Hispanic		3.6	4.4	8.8	10.9	1.2	1.5
County-level controls							
Median Household Income		55,379.8 (10,178.2)	64,788.0 (12,045.1)	58,831.6 (12,037.9)	68,434.7 (12,748.1)	43,279.7 (11,735.9)	46,176.7 (11,677.2)
PCPs per 1000 pop		1.2 (0.6)	1.2 (0.5)	9.6 (0.3)	0.9 (0.3)	0.7 (0.4)	0.7 (0.4)
Specialist MDs per 1000 pop		2.3 (1.5)	2.5 (1.8)	1.7 (0.7)	1.8 (0.7)	1.2 (1.0)	1.2 (1.1)
Safety Net Hospitals per 1000 pop		0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)
Hospital Beds per 1000 pop		2.3 (1.4)	2.1 (1.3)	2.4 (0.9)	2.2 (0.7)	3.1 (2.5)	2.8 (2.3)
Percent Unemployed, 16+		4.9 (1.0)	7.0 (1.7)	4.9 (1.2)	8.2 (2.1)	5.6 (1.7)	9.3 (2.6)

<i>Panel A. Colorectal cancer (CRC) sample</i>							
	Massachusetts		Connecticut and New Jersey		Georgia, Kentucky, and Michigan		
	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform	
Percent ages 25+ with <HS diploma	11.3 (4.2)	10.7 (4.1)	12.7 (3.9)	11.6 (3.6)	17.6 (7.0)	16.1 (6.3)	
Percent White Non-Hispanic/Latino	81.3 (10.8)	78.1 (10.8)	68.0 (15.7)	63.8 (16.0)	70.3 (19.7)	67.5 (20.3)	
Percent Urban Pop	91.7 (8.8)	91.6 (9.4)	92.29 (11.94)	92.5 (11.7)	71.1 (31.7)	70.9 (32.3)	
<i>Panel B. Breast cancer (BCA) sample</i>							
	Massachusetts		Connecticut and New Jersey		Georgia, Kentucky, and Michigan		
	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform	
N	12,754	13,770	22,083	24,334	28,166	32,035	
Stage (early vs. late)							
Early (SS 0-1)	75.1	77.3	69.4	72.0	68.0	69.3	
Advanced (SS 2-7)	24.3	22.3	28.9	26.4	30.5	30.0	
Unknown/Unstaged	0.6	0.4	1.8	1.6	1.5	0.7	
Demographics							
Age 50-54	35.5	34.8	35.8	35.6	34.4	32.1	
Age 55-59	34.3	32.0	34.3	31.5	35.5	33.3	
Age 60-64	30.2	33.2	29.9	33.0	30.1	34.6	
Married	63.1	61.7	63.2	60.6	63.0	60.4	
Non-Hispanic White	90.5	87.0	79.3	74.9	77.9	72.6	
Non-Hispanic Black	3.8	5.4	9.8	10.7	19.2	23.6	
Non-Hispanic Other Race	2.7	3.5	4.0	5.7	1.5	2.0	
Hispanic	3.0	4.1	6.9	8.7	1.4	1.8	
County-level controls							
Median Household Income	55,898.5 (10,263.2)	66,041.1 (11,760.4)	60,180.8 (12,171.9)	69,845.4 (12,991.3)	45,084.9 (12,028.8)	48,377.8 (11,924.0)	
PCPs per 1000 Pop	1.2 (0.5)	1.2 (0.5)	1.0 (0.3)	1.0 (0.3)	0.8 (0.4)	0.8 (0.4)	
Specialist MDs per 1000 Pop	2.3 (1.4)	2.5 (1.7)	1.7 (0.7)	1.8 (0.7)	1.3 (1.0)	1.4 (1.1)	
Safety Net Providers per 1000 Pop	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	

Panel A. Colorectal cancer (CRC) sample

	Massachusetts		Connecticut and New Jersey		Georgia, Kentucky, and Michigan	
	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform	Pre-MA reform	Post-MA reform
Hospital Beds per 1000 Pop	2.2 (1.3)	2.0 (1.2)	2.4 (0.9)	2.2 (0.7)	3.0 (2.4)	2.7 (2.2)
Percent Unemployed, 16+	4.9 (1.0)	7.0 (1.7)	4.7 (1.1)	8.1 (2.1)	5.5 (1.6)	9.2 (2.6)
Percent ages 25+ with <HS diploma	11.1 (4.1)	10.3 (3.9)	12.3 (3.7)	11.3 (3.5)	16.6 (6.7)	14.8 (5.9)
Percent White Non-Hispanic/Latino	81.8 (10.2)	74.1 (12.7)	69.0 (15.1)	64.7 (15.4)	69.5 (19.5)	65.9 (19.7)
Percent Urban Pop	91.6 (9.2)	91.9 (9.1)	92.2 (11.9)	92.4 (11.7)	75.25 (30.18)	76.8 (29.6)

SD: standard deviation; SS: SEER Summary Stage; Pop: population; HS: High School; Safety Net Providers per 1000 pop are defined as a sum of the proportion of rural health clinics per 1000 pop and the proportion of federally qualified health clinics per 1000 pop.

Table 2.

CRC difference-in-differences regression results among adults 50-64 years old at diagnosis

	Cross-state: CT & NJ as control states	Cross-state: GA, KY, and MI as control states
Advanced stage ^a	-0.056*** (0.013) <i>N = 30,467</i>	-0.035*** (0.012) <i>N = 41,120</i>
Unstaged/Unknown	-0.014*** (0.005) <i>N = 31,688</i>	0.008** (0.004) <i>N = 42,362</i>

NOTES: Coefficient with standard error in parentheses are presented. Number of observations is indicated in italics.

CT: Connecticut; NJ: New Jersey; GA: Georgia; KY: Kentucky; MI: Michigan; SS: SEER Summary Stage Implementation period defined as April 2006 – June 2007.

^a Advanced stage defined as SEER Summary Stages 2 through 7; sample excludes Unstaged/Unknown Cases from sample.***
p<0.01,**
p<0.05,*
p<0.1

Table 3.

BCA difference-in-differences regression results among adults 50-64 years old at diagnosis

	Cross-state: CT & NJ as control states	Cross-state: GA, KY, and MI as control states
Advanced stage ^a	0.015 [*] (0.008) <i>N = 72,041</i>	-0.004 (0.007) <i>N = 85,948</i>
Unstaged/Unknown	0.001 (0.002) <i>N = 72,941</i>	0.006 ^{***} (0.002) <i>N = 86,725</i>

NOTES: Coefficient with standard error in parentheses are presented. Number of observations is indicated in italics.

CT: Connecticut; NJ: New Jersey; GA: Georgia; KY: Kentucky; MI: Michigan; SS: SEER Summary Stage Implementation period defined as April 2006 – June 2007.

^a Advanced stage defined as SEER Summary Stages 2 through 7; sample excludes Unstaged/Unknown Cases from sample.***
p<0.01,**
p<0.05,*
p<0.1