Impact of the Affordable Care Act on Colorectal Cancer Screening, Incidence, and Survival in Kentucky

Tong Gan, MD, Heather F Sinner, MD, Samuel C Walling, MD, Quan Chen, DrPH, Bin Huang, DrPH, Tom C Tucker, PhD, Jitesh A Patel, MD, FACS, B Mark Evers, MD, FACS, Avinash S Bhakta, MD

BACKGROUND: Kentucky ranks first in the US in cancer incidence and mortality. Compounded by high poverty levels and a high rate of medically uninsured, cancer rates are even worse in Appalachian Kentucky. Being one of the first states to adopt the Affordable Care Act (ACA) Medicaid expansion, insurance coverage markedly increased for Kentucky residents. The purpose of our study was to determine the impact of Medicaid expansion on colorectal cancer (CRC) screening, diagnosis, and survival in Kentucky.

STUDY DESIGN: The Kentucky Cabinet for Health and Family Services and the Kentucky Cancer Registry were queried for individuals (≥20 years old) undergoing CRC screening (per US Preventative Services Task Force) or diagnosed with primary invasive CRC from January 1, 2011 to December 31, 2016. Colorectal cancer screening rates, incidence, and survival were compared before (2011 to 2013) and after (2014 to 2016) ACA implementation.

RESULTS: Colorectal cancer screening was performed in 930,176 individuals, and 11,441 new CRCs were diagnosed from 2011 to 2016. Screening for CRC increased substantially for Medicaid patients after ACA implementation (+230%, $p < 0.001$), with a higher increase in screening among the Appalachian (+44%) compared with the non-Appalachian (+22%, $p < 0.01$) population. The incidence of CRC increased after ACA implementation in individuals with Medicaid coverage (+6.7%, $p < 0.001$). Additionally, the proportion of early stage CRC (stage I/II) increased by 9.3% for Appalachians ($p = 0.09$), while there was little change for non-Appalachians (−1.5%, $p = 0.60$). Colorectal cancer survival was improved after ACA implementation (hazard ratio 0.73, $p < 0.01$), particularly in the Appalachian population with Medicaid coverage.

CONCLUSIONS: Implementation of Medicaid expansion led to a significant increase in CRC screening, CRC diagnoses, and overall survival in CRC patients with Medicaid, with an even more profound impact in the Appalachian population. (J Am Coll Surg 2019;228:342−355. Published by Elsevier Inc. on behalf of the American College of Surgeons.)

Kentucky ranks first nationally in incidence and mortality of all site cancers.[1,2] The Appalachian region of Kentucky heavily contributes to these poor outcomes, where cancer surpasses heart disease as the leading cause of death.[2,3] The etiology of the disproportionately high cancer rate is multifaceted, but a major factor is the distressed socioeconomic status in Kentucky.[2] For the past decade, Kentucky maintained the fifth highest poverty rate in the nation.[4]

Disclosure Information: Nothing to disclose.

Support: Data collection activities of the Kentucky Cancer Registry are supported by the National Cancer Institute Surveillance Epidemiology and End Results Program (NCI HHSN26100001), and the Centers for Disease Control and Prevention National Program of Cancer Registries (CDC U58 DP005400). This study was also supported by the Markey Cancer Center Support Grant (NCI P30 CA177558) and T32 NIH Training Grant (T32CA160003). The Center for Clinical and Translational Sciences is funded through the NIH National Center for Advancing Translational Sciences (UL1TR001998).

Disclaimer: This article is solely the responsibility of the authors and does not necessarily represent the official views of the grant-funding agencies.

Presented at the Southern Surgical Association 130th Annual Meeting, Palm Beach, FL, December 2018.

Received December 14, 2018; Accepted December 17, 2018.

From the Department of Surgery (Gan, Sinner, Walling, Patel, Evers, Bhakta), Markey Cancer Center (Gan, Sinner, Chen, Huang, Tucker, Patel, Evers, Bhakta), University of Kentucky Medical Center, and the Biostatistics and Bioinformatics Shared Resource Facility (Chen, Huang), Markey Cancer Center, Lexington, KY.

Correspondence address: Avinash S Bhakta, MD, Department of Surgery, University of Kentucky, 800 Rose St, C-246, Lexington, KY 40536. email: avinash.bhakta@uky.edu

Abbreviations and Acronyms
ACA = Affordable Care Act
CRC = colorectal cancer
FPL = federal poverty level
KCR = Kentucky Cancer Registry
KHFS = Kentucky Cabinet for Health and Family Services

Even worse, Appalachian Kentucky has the highest poverty rate in the nation, at an astounding 1.7 times the national average. Of the 54 counties in Appalachia, 38 counties are economically distressed, or rank in the bottom 10% of all US counties.[5]

High poverty levels left a large portion of the Kentucky population uninsured and subsequently unable to seek preventative care.[2,6-8] The Medicaid expansion of the Patient Protection and Affordable Care Act (ACA) was incredibly successful in reducing the uninsured rate in Kentucky.[9] The expansion, enacted in 2014, provided Medicaid coverage to those at 138% of the federal poverty level (FPL). Being 1 of the first 2 states to implement the ACA, uninsured rates dropped in Kentucky by more than half, from 13.6% pre-ACA to 6.1% 2 years post-ACA. At the same time, the national uninsured rate dropped from 14.7% to 9.4%. Medicaid expansion in the neighboring state of Illinois had a slightly smaller impact; its uninsured rate dropped from 12.9% to 7.0%. Conversely, Tennessee, a state that did not expand Medicaid, experienced a modest decrease in the uninsured rate (from 13.8% to 10.2%). The population most affected by the expansion of Medicaid was those under 138% of national poverty level, which demonstrated a nearly 3-fold drop in the rate of uninsured individuals (from 25.0% to 9.4%).[10]

When looking specifically at colorectal cancer (CRC), Kentucky ranks first nationwide for incidence (50.0 cases per 100,000) and fifth for mortality (17.2 deaths per 100,000).[1,2] As expected, Appalachian Kentucky has an even higher incidence (55.1 cases per 100,000) and mortality (20.2 deaths per 100,000).[2] Screening for CRC has been demonstrated to significantly decrease incidence and mortality.[11,12] The US Preventative Services Task Force recommended screening for CRC beginning at the age of 50, with 1 of the following tests: high-sensitivity fecal occult blood testing annually, sigmoidoscopy every 5 years, or colonoscopy every 10 years.[13] In the past, Kentucky has reported low rates of CRC screening. In 1999, only 34.7% of the Kentucky population received CRC screening of any type, ranking 49th in the nation.[14] These results prompted several state-wide screening initiatives, including the establishment of the Kentucky Colon Cancer Screening Program and the Kentucky Colon Cancer Screening Advisory Committee in 2002. As a result, CRC screening rates improved to 65.9% in those 50 years old or older in 2012. However, CRC screening rates, although improved in western and central Kentucky, remained low in eastern Appalachian Kentucky.[15,16] The purpose of this study was to evaluate the effect of ACA Medicaid expansion on CRC screening, incidence, and survival in the Kentucky population, with a particular focus on Appalachian Kentucky.

METHODS

Data sources

Kentucky CRC screening, incidence, and outcomes data were obtained from 2 distinct databases. Screening data on CRC were obtained from the Kentucky Hospital Discharge Database, which resided in the Kentucky Cabinet for Health and Family Services (KHFS). Ethical approval for the use of this database was obtained from the University of Kentucky's Office of Research Integrity Institutional Review Board. The sample population included all patients older than 20 years who underwent CRC screening from January 1, 2011 to December 31, 2016. Each screening occurrence was captured through the CPT code involving either screening or diagnostic colonoscopy, sigmoidoscopy, guaiac-based fecal occult test, fecal immunochemical test, or fecal DNA test. Each case was then confirmed with the ICD (9 and 10) code for screening visits, allowing for the capture of recoded endoscopic procedures from screening to diagnostic due to positive findings.

Colorectal cancer demographics, incidence, and cancer outcomes data in the state of Kentucky were obtained through the Institutional Review Board-approved collaboration with the Kentucky Cancer Registry (KCR). A data use agreement was obtained between the investigator and KCR in April 2018. The KCR is a population-based registry and has been awarded the highest level of certification by the North American Association of Central Cancer Registries for an objective evaluation of completeness, accuracy, and timeliness every year since 1997. In addition, KCR is a National Cancer Institute Surveillance, Epidemiology, and End Results population-based cancer registry. The KCR also links its database annually with the State Death Certificate data and National Death Index to capture the most accurate survival information.[17] The study population included all patients 20 years and older, who were diagnosed with CRC between January 1, 2011 and December 31, 2016. Only the first invasive primary CRC was included in the analysis. Cases captured through autopsy or death certificates were

excluded. Measures obtained include demographics (age at diagnosis, sex, race, metropolitan status, Appalachian status) and insurance coverage (Medicaid, Medicare, other public insurance, private insurance, and no insurance) based on payer information at the time of diagnosis from the KCR. Other variables of interest, such as socioeconomics (percentage below poverty status at the county level, high school education ascertainment at the county level) and clinical information (tumor grade, stage at diagnosis, and survival) were also included in the data analysis.

For the purpose of this study, the post-ACA implementation time period was defined as the implementation of Medicaid expansion on January 1, 2014, to December 31, 2016. The pre-ACA period was defined as an equal length of time before ACA implementation from January 1, 2011 to December 31, 2013. County of residence at time of discharge from the KHFS or time of diagnosis from the KCR were used to define patients' geographic regions. Metropolitan status was based on the 2013 Urban-Rural Continuum codes, with the values of 1 to 3 as urban and 4 to 9 as rural.[18] The county-level Appalachian status was defined according to the Appalachia Regional Commission, as the 54 counties in Eastern Kentucky.[5] The 2008 to 2012 American Community Survey was used to create the poverty status and high school education ascertainment variables, which were collapsed into 4 levels based on the quartiles of their distributions. Poverty status was categorized as low (<16.2%), moderate (16.2% to 18.1%), high (18.2% to 21.7%), and very high (>21.7%); education ascertainment was categorized as very low (<75.8%), low (75.8% to 84.3%), moderate (84.4% to 88.0%), and high (88.1% to 91.8%). Stage at diagnosis was also categorized as early (stages I and II) and late stage (stages III and IV). Survival was defined as length of time from date of diagnosis to death or end of the study period.

Statistical analysis

Descriptive analysis was conducted for all variables. Chi-square tests were performed to examine the association between ACA status and other covariates, stratified by insurance status. Kaplan-Meier plots and log-rank tests were conducted by ACA status for each insurance type separately. Cox regression analysis was performed to determine whether ACA status is associated with survival while controlling for other variables, Goodness of fit and proportional hazard assumption were examined. Analyses were 2-sided with a p value ≤ 0.05 used to identify statistical significance. All analyses were performed using SAS Statistical Software version 9.4 (SAS Institute, Inc).

RESULTS

Patient characteristics

A total of 930,176 patients were screened for CRC from 2011 to 2016. The highest proportion of patients screened was in 2015, and the lowest proportion screened was in 2011 (Table 1). As expected, the highest proportion of those screened were in the ages 51 to 65 group. Interestingly, 8.2% of those screened were younger than 40 years old, which may be secondary to the high incidence of familial causes of CRC in Kentucky.[19] More females were screened than males. The majority of patients who received screening were white (92.7%) and a small proportion were black (6.0%), which is slightly lower than the overall percentage of black patients in Kentucky (8.4%), demonstrating a screening disparity.[20] When looking at insurance coverage, nearly half of those screened had private insurance (47.8%), while 9.7% of patients had Medicaid and 1.4% were uninsured. About a fourth of the patients who received screening were Appalachian. When looking specifically at the Medicaid subgroup, higher proportions of female (62.6%) and black patients (9.6%) received screening compared with all insurance types. Nearly half of the Medicaid patients who received screening were Appalachian (42.3%).

Impact of Affordable Care Act expansion on colorectal cancer screening

A total of 408,500 patients were screened pre-ACA and 521,676 were screened after ACA implementation, an increase of 27.7% (Table 2). Colonoscopy was used as the major screening method in 72.7% of patients. The 51 to 65 years age group had the highest increase in screening, while both sexes increased proportionally. When comparing screening rates based on insurance coverage, patients with Medicaid demonstrated the highest increase in CRC screening. A total of 69,328 Medicaid patients received screening after ACA implementation compared with 20,980 individuals who were screened pre-ACA, representing an increase of 230%. Screening rates for patients with private insurance increased by 10.2% and Medicare patients increased by 29.9%. Overall, 43.7% more Appalachian patients received CRC screening after ACA implementation compared with pre-ACA.

When looking specifically at Medicaid patients, individuals in the 51 to 65 age group had the highest improvement in screening (+292.5%). There was also a higher proportional increase in screening in males compared with females after ACA implementation. The increase of coverage in all races remained proportional. Similar to the overall Kentucky trend, Medicaid coverage

Table 1. Patient Demographics

Patient characteristic	n	%
All Kentucky patients, 2011–2016, n = 930,176		
ACA Status		
Pre-ACA*	408,500	43.9
Post-ACA	521,676	56.1
Year screened		
2011	124,049	13.3
2012	142,166	15.3
2013	142,285	15.3
2014	151,956	16.3
2015	194,406	20.9
2016	175,314	18.9
Age		
20–40 y	75,923	8.2
41–50 y	129,050	13.9
51–65 y	422,588	45.4
66–70 y	118,714	12.8
>71 y	183,901	19.8
Sex		
Female	517,830	55.7
Male	412,346	44.3
Race		
White	862,144	92.7
Black	55,742	6.0
Other	12,290	1.3
Insurance		
Not insured	14,064	1.5
Private	444,794	47.8
Medicare	367,974	39.6
Medicaid	90,308	9.7
Other public†	13,036	1.4
Stage		
I	2,444	21.8
II	2,600	23.2
III	2,789	24.9
IV	2,224	19.8
Unknown	1,152	10.3
Appalachian status		
Non-Appalachian	682,545	73.4
Appalachian	247,631	26.6
Medicaid patients only, 2011–2016, n = 90,308		
ACA Status		
Pre-ACA*	20,980	23.2
Post-ACA	69,328	76.8
Year screened		
2011	6,606	733
2012	7,282	8.1
2013	7,092	7.8
2014	20,394	22.6
2015	27,772	30.8
2016	21,162	23.4
Age		
20–40 y	19,762	21.9
41–50 y	21,052	23.3
51–65 y	48,151	53.3
66–70 y	664	0.7
>71 y	679	0.8
Sex		
Female	56,510	62.6
Male	33,798	37.4
Race		
White	79,798	88.4
Black	8,661	9.6
Other	1,849	2.0
Appalachian status		
Non-Appalachian	52,112	57.7
Appalachian	38,196	42.3
Stage		
I	195	19.7
II	207	20.9
III	237	24.0
IV	255	25.8
Unknown	95	9.6

*Pre-Affordable Care Act (ACA) from 2011 to 2013; post-ACA from 2014-2016.
†Includes TRICARE, Veterans Affairs, and military insurances.

of Appalachian patients increased by 199.0% while uninsured Appalachian patients decreased by 77.7% after ACA implementation (Fig. 1).

Impact of Affordable Care Act expansion on colorectal cancer incidence

From January 1, 2011 to December 31, 2016, 11,441 Kentucky patients were diagnosed with CRC. After ACA Medicaid expansion, there was not a significant increase in incidence (5,665 pre-ACA vs 5,776 after ACA implementation), but there was a change in the distribution (Table 3). The CRC incidence in the 20 to 49 age group increased by 22.8%, while the age 75 to 90 group decreased by 7.5%, indicating a shift toward an increase in incidence in the younger population consistent with national CRC trends.[21] When separated by insurance, the proportion of Medicaid patients who were diagnosed with CRC increased by 132.4% after Medicaid expansion. In patients who had Medicaid, there were no

Table 2. Bivariate Analysis of Pre-Affordable Care Act and Post-Affordable Care Act Colorectal Cancer Screening

Patient characteristic	Colorectal cancer screening, n (%)		p Value
	Pre-ACA* (n = 408,500)	Post-ACA (n = 521,676)	
Age			< 0.0001
20–40 y	36,002 (8.8)	39,921 (7.7)	
41–50 y	59,825 (14.7)	69,225 (13.3)	
51–65 y	182,362 (44.6)	240,226 (46.0)	
66–70 y	50,355 (12.3)	68,359 (13.1)	
>71 y	79,956 (19.6)	103,945 (19.9)	
Sex			< 0.0001
Female	228,830 (56.0)	289,000 (55.4)	
Male	179,670 (44.0)	232,676 (44.6)	
Race			< 0.0001
White	379,190 (93)	482,954 (93)	
Black	23,817 (6)	39,125 (6)	
Other	5,493 (1)	6,797 (1)	
Insurance			< 0.0001
Uninsured	10,617 (2.6)	3,447 (0.7)	
Private	211,618 (51.8)	233,176 (44.7)	
Medicare	160,027 (39.2)	207,947 (39.8)	
Medicaid	20,980 (5.1)	69,328 (13.3)	
Other public†	5,258 (1.3)	7,778 (1.5)	
Appalachian status			< 0.0001
No	306,880 (75.1)	375,665 (72.0)	
Yes	101,620 (24.9)	146,011 (28.0)	

*Pre-Affordable Care Act (ACA) from 2011–2013, post-ACA from 2014–2016.
†Includes TRICARE, Veterans Affairs, and military insurances.

significant differences in regard to poverty and education level, indicating a similar population before and after ACA implementation. Consequently, there was a 4-fold decrease in incidence in the uninsured group.

When evaluating patients who had Medicaid coverage, there was an increase in Appalachian CRC incidence (87.8%) (Fig. 2). When separating out incidence by stage in this group, the proportion of early stage diagnoses

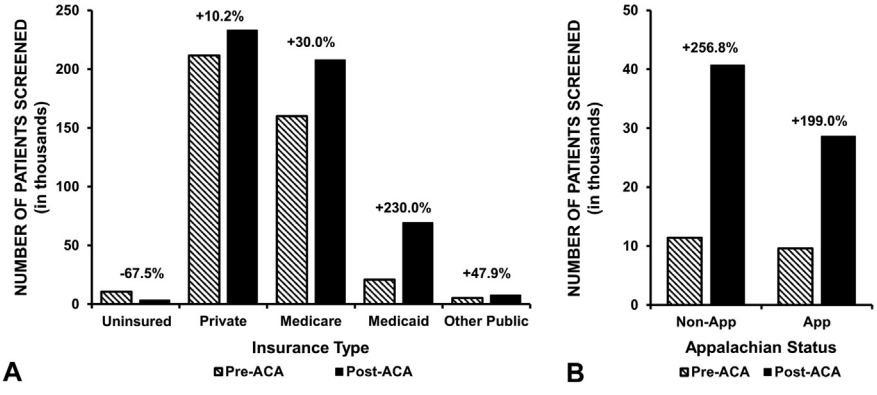

Figure 1. Colorectal cancer (CRC) screening by insurance and Appalachian (App) status. Colorectal cancer screening data were obtained from the Kentucky Cabinet for Health and Family Services from January 1, 2011 to December 31, 2016. (A) All screening cases were separated by insurance status depending on pre-Affordable Care Act (ACA) (screening obtained in 2011 to 2013) or post-ACA status (screening obtained in 2013-2016). (B) Patients with Medicaid coverage who received screening were separated by Appalachian and non-Appalachian status and compared pre- and post-ACA implementation.

Table 3. Bivariate Analysis of Pre-Affordable Care Act and Post-Affordable Care Act Colorectal Cancer Incidence Separated by All Insurance Types and Medicaid Only

Patient characteristic	Pre-ACA* (n = 5,665), n (%)	Post-ACA (n = 5,776), n (%)	p Value
All insurance types			
Age			< 0.001
20–49 y	648 (11.4)	796 (13.8)	
50–64 y	2,005 (35.4)	2,072 (35.9)	
65–74 y	1,456 (25.7)	1,468 (25.4)	
≥75 y	1,556 (27.5)	1,440 (24.9)	
Sex			0.915
Female	2,641 (46.6)	2,687 (46.5)	
Male	3,024 (53.4)	3,089 (53.5)	
Race			0.007
White	5,237 (92.4)	5,302 (91.8)	
Black	365 (6.5)	368 (6.4)	
Other	63 (1.1)	106 (1.8)	
Insurance			< 0.001
Uninsured	310 (5.5)	67 (1.2)	
Private	1,788 (31.5)	1,810 (31.3)	
Medicare	3,001 (53.0)	2,964 (51.3)	
Medicaid	299 (5.3)	695 (12.0)	
Other public†	267 (5.7)	240 (4.2)	
Appalachian status			0.131
No	3,888 (68.6)	3,888 (67.3)	
Yes	1,777 (31.4)	1,888 (32.7)	
Tumor grade			< 0.001
Well differentiated	265 (4.7)	437 (7.6)	
Moderately differentiated	3,731 (65.9)	3,735 (64.6)	
Poorly differentiated	424 (7.5)	439 (7.6)	
Undifferentiated	466 (8.2)	425 (7.4)	
Unknown	779 (13.7)	740 (12.8)	
Medicaid only			
Age, y			0.003
20–49	78 (26.1)	220 (31.7)	
50–64	183 (61.1)	433 (62.3)	
65–74	19 (6.4)	23 (3.3)	
75–90	19 (6.4)	19 (2.7)	
Sex			0.059
Female	152 (50.8)	308 (44.3)	
Male	147 (49.2)	387 (55.7)	
Race			0.633
White	268 (89.6)	603 (86.8)	
Black	28 (9.4)	83 (11.9)	
Other	3 (1.0)	9 (1.3)	
Appalachian status			0.008
No	160 (53.5)	434 (62.5)	
Yes	139 (46.5)	261 (37.5)	
Poverty level‡			0.072
Low	51 (17.1)	148 (21.3)	
Moderate	62 (20.7)	166 (23.9)	

(Continued)

Table 3. Continued

Patient characteristic	Pre-ACA* (n = 5,665), n (%)	Post-ACA (n = 5,776), n (%)	p Value
High	72 (24.1)	172 (24.7)	
Very high	114 (38.1)	209 (30.1)	
High school education[§]			0.084
Very low	121 (40.5)	217 (31.2)	
Low	69 (23.1)	167 (24.0)	
Moderate	85 (28.4)	237 (34.1)	
High	24 (8.0)	74 (10.7)	

*Pre-Affordable Care Act (ACA) from 2011–2013, post-ACA from 2014–2016.
†Includes TRICARE, Veterans Affairs, and military insurances.
‡Low: under poverty level ≤ 16.2%; Moderate: under poverty level 16.3%–18.1%; High: under poverty level 18.2%–21.7%; Very High: under poverty level ≥ 21.8%.
§Very Low: completed high school ≤ 75.8%; Low: completed high school 75.9%–84.4%; Moderate: completed high school 84.5%–88.1%; High: completed high school ≥ 88.2%.

(stage I/II) increased by 9.3% for Appalachians (p = 0.09), which was not noted in non-Appalachians (−1.5%, p = 0.60). There was no effect on late stage diagnosis.

Impact of Affordable Care Act expansion on colorectal cancer survival

When evaluating the role of ACA expansion in CRC survival, both Medicaid and Appalachian patients benefited while uninsured patients suffered. After ACA implementation, Medicaid patients exhibited improved survival compared with patients before instituting ACA (Fig. 3). Conversely, the remaining uninsured patients who did not receive coverage from ACA implementation had a worse survival compared to pre-ACA implementation. There were no significant differences in survival for private insurance and Medicare with regard to ACA expansion. Notably, the survival differences after ACA implementation were evident in Medicaid patients after the first year and increased each year thereafter (eTable 1). We noted an overall worse survival (hazard ratio [HR] 2.12, 95% CI 1.23 to 3.67, p = 0.048) in the black uninsured population compared with the white population, consistent with national trends.[22] This effect was not seen in any other insurance groups.

When controlling for age, sex, race, cancer stage, and grade, Cox regression analysis revealed that all Medicaid patients had improved survival after ACA implementation compared with pre-ACA implementation (HR 0.73, 95% CI 0.58 to 2.11; p = 0.008). Interestingly, when looking specifically at Appalachian patients with Medicaid coverage, there was significantly improved survival after ACA implementation compared with the period pre-ACA (Fig. 4). However, there was no difference in

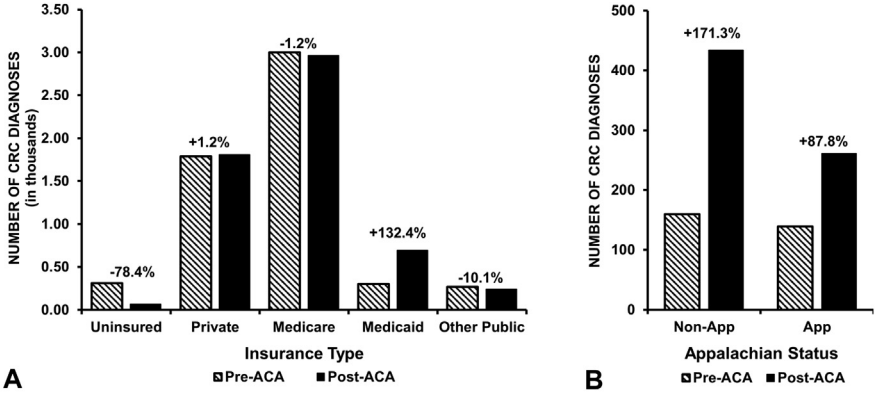

Figure 2. Colorectal cancer (CRC) incidence by insurance and Appalachian (App) status. The CRC incidence from January 1, 2011 to December 31, 2016 was obtained from the Kentucky Cancer Registry. Pre-ACA was defined as the time period from 2011 to 2013 while post-ACA was from 2014 to 2016. (A) All cases of CRC were separated out by insurance types and compared before and after ACA implementation. (B) Incidence rates of CRC were compared in all Medicaid patients separated by Appalachian and non-Appalachian status.

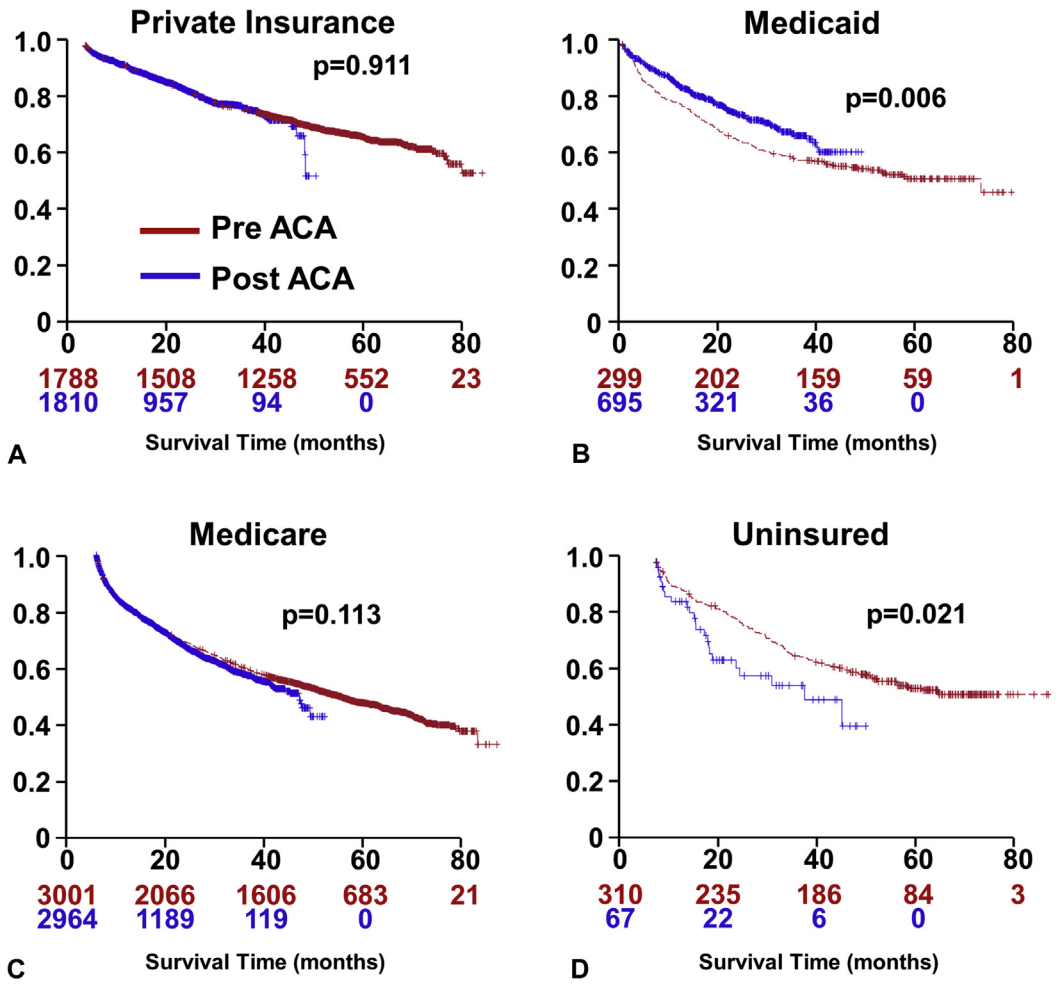

Figure 3. Colorectal cancer (CRC) survival after Affordable Care Act (ACA) by insurance type. Survival analysis was performed via Kaplan-Meier plots. Pre-ACA was defined as the time period between 2011 and 2013, and post-ACA was defined as the time period between 2014 and 2016. All CRC cases were separated by insurance status: (A) private; (B) Medicaid; (C) Medicare; and (D) no insurance.

survival in the Medicaid non-Appalachian population, indicating the improvement in overall Medicaid patient survival after ACA implementation was heavily contributed by the Appalachian population.

DISCUSSION

The ACA Medicaid expansion has had unprecedented success in providing Medicaid coverage for the uninsured population in Kentucky. Earlier studies demonstrated that implementation of the expansion increased screening in prostate cancer,[23] cervical cancer,[24-26] and breast cancer.[25,27] In Kentucky, improved coverage was also associated with earlier diagnosis of breast cancer and improved treatment quality.[27] We set out to evaluate the impact of ACA expansion on CRC screening. We found the expansion of Medicaid in Kentucky significantly increased CRC screening, particularly in the Appalachian population. Moreover, ACA expansion was associated with increased CRC incidence in the Medicaid population with a shift toward early stage diagnosis in Appalachian patients. Importantly, we demonstrated for the first time that ACA expansion significantly increased CRC survival in both the Medicaid and Kentucky Appalachian populations.

Our study established the substantial impact of insurance coverage in amplifying CRC screening. Over the past 2 decades, Kentucky has implemented several programs to expand CRC screening.[15] The major barriers to CRC screening include lack of insurance coverage and lack of provider recommendation.[6-8,28,29] Our study demonstrated that the ACA Medicaid expansion decreased

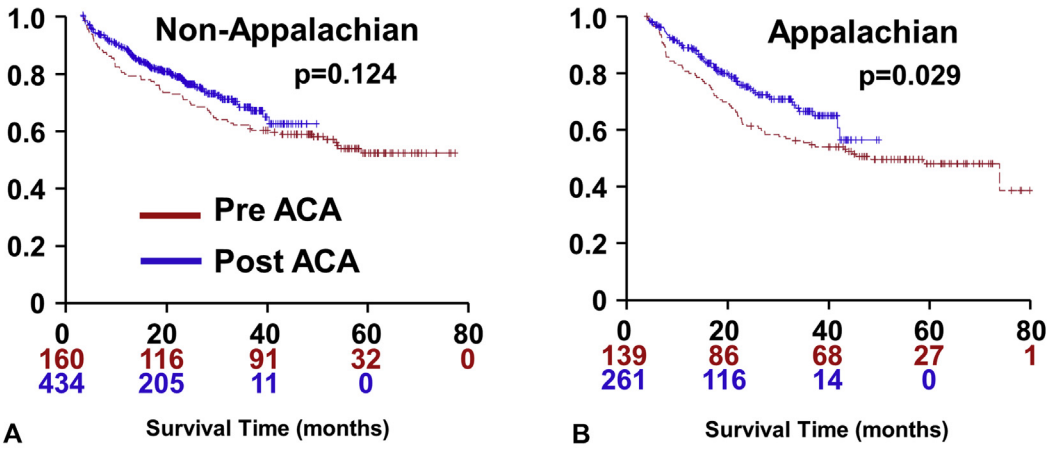

Figure 4. Colorectal cancer (CRC) survival for Medicaid patients after Affordable Care Act (ACA) by Appalachian status. Medicaid patients who were diagnosed with CRC were identified in the Kentucky Cancer Registry from January 1, 2011 to December 31, 2016. Survival analysis was performed with Kaplan-Meier plots to evaluate survival in the (A) non-Appalachian and (B) Appalachian population.

the number of low-income uninsured patients in Kentucky, helping to alleviate barriers to health care access. By 2015, in the second year of expansion, there was 12% increased access to primary care physicians, allowing more than 85% of low-income patients to easily obtain physician visits.[30] Improved health care system contact led to increased preventative screening by enabling access to primary care physicians.[9] The Behavioral Risk Factor Surveillance System reported in 1999 that the CRC screening rate in Kentucky was 34.7% compared with 43.9% nationally. Screening for CRC plateaued just before ACA implementation, at 65.7%. After ACA implementation in 2014, screening in Kentucky further increased to 69.6% compared with 66.6% nationally.[14,31] However, Appalachian Kentucky screening lagged behind, at 63.0%.[2] The most recent 2016 data revealed further improvement of screening rates to 70.1% compared with 67.7% nationally.[14,31] Similarly, we identified a larger than 3-fold increase in CRC screening 3 years after Medicaid expansion.

In Kentucky, additional insurance coverage increased CRC incidence immediately after ACA implementation. The incidence of CRC has steadily decreased over the past 40 years.[32,33] Microsimulation models suggest the largest contribution comes from screening, while risk factor reduction and treatment improvements are minor contributors.[33,34] Early detection of precursor lesions would have immediate reduction of CRC incidence within the first 2 years and maximal reduction by 15 years.[32,34-38] We would expect an immediate increased incidence in newly insured Medicaid patients as existing cancers are identified. In addition, this population may also have a shift toward earlier stage diagnosis.[39,40] However, as expected, the removal of pre-cancerous lesions would decrease cancer progression, leading to decreased incidence rates.[11] Similarly, we identified an increase of incidence in the Medicaid and Appalachian population immediately after ACA implementation. We demonstrated a trend toward higher rates of early stage (I and II) CRC diagnosis in the Appalachian population, which was not seen in the uninsured population. Because this study evaluated the short-term effects of Medicaid expansion, we would not expect a decrease in CRC incidence.

Screening for CRC is very effective in reducing the cancer-specific mortality risk. Zauber and colleagues[12] demonstrated a 53% reduction of 10-year survival in patients who received a screening colonoscopy. In fact, the impact of CRC screening on survival continues for up to 2 decades.[41] Even so, CRC mortality in Kentucky remain behind national standards. In 2011 to 2015, the mortality rate of CRC nationally was 14.5 per 100,000 compared with 17.0 per 100,000 in the state of Kentucky.[2] Appalachian Kentucky mortality was even higher, with a more profound benefit from screening.[42,43] In just a short time interval after ACA implementation, we showed that Medicaid patients had a 27% lower risk of death compared with pre-ACA, while those who were uninsured had an overall worse survival. Notably, the Kentucky Appalachian patients also had a significantly improved survival associated with the dramatic expansion of Medicaid coverage as a result of increased CRC screening.

We demonstrated a markedly improved survival in both the Medicaid and Kentucky Appalachian population in just a short time after ACA implementation.

In fact, the significant survival improvement was evident within the first year. Similarly, several studies including a large meta-analysis demonstrated a survival difference at 3 years after receiving CRC screening, with the maximal effect at 15 years.[44,45] The short-term effects of a CRC screening program implementation on survival was also found in a Kaiser Permanente health system, demonstrating a significant decrease in mortality within 4 years.[11] Our survival follow-up time was greater than 6 years for the pre-ACA group and greater than 4 years for the after ACA implementation group. Because CRC incidence can drop within 2 years after improved screening, survival differences can be seen within our follow-up time period, partly due to early detection and treatment.[35] Importantly, the improved survival after ACA implementation was not evident in the private, Medicare, and uninsured populations, indicating the specific association of survival after CRC screening with Medicaid patients.

The results of this study could be generalized to other states that have expanded Medicaid coverage. Nonetheless, there are several limitations to this study. The CRC screening data may contain a small number of patients who underwent more than 1 screening procedure, so were counted twice. However, it is extremely unlikely for a second procedure to be coded as a screening procedure, and more likely to be coded as a diagnostic procedure. In addition, before 2016, post-hoc manipulation of CPT codes was legal. As a result, there may be a bias among the colonoscopies that had CPT codes converted from screening to diagnostic as a result of a positive finding during the procedure. This would have underestimated screening colonoscopies before 2016. Next, the significant survival benefit identified in the Medicaid population after ACA implementation may be contributed by other factors that were not included in the analysis. For example, before ACA implementation, only the most impoverished adults (less than half of FPL) were covered by Medicaid. After implementation, the coverage included up to 138% of the FPL. This higher income group was likely more health conscious and had better access to care, which was evident by the decreased survival in the uninsured population, suggesting that only patients with the lowest level of access remain uninsured after ACA implementation. However, these individual socioeconomic and health access factors were not available for the data analysis. Last, cancer survival is also related to reliable quality treatment, which is not accounted for in our survival analysis. However, due to our demonstration of improvement in survival post-ACA, poor quality treatment would unlikely effect our results negatively.

CONCLUSIONS

The incidence and mortality of colorectal cancer in Kentucky are among the highest in the United States. Affordable Care Act Medicaid expansion has positively affected insurance coverage in this population, leading to improved CRC screening and improved short-term survival. Future long-term survival studies are needed, but the short-term benefits of the ACA expansion have bridged a gap in CRC disparities in Kentucky.

Author Contributions

Study conception and design: Gan, Sinner, Walling, Chen, Huang, Tucker, Patel, Evers, Bhakta
Acquisition of data: Gan, Sinner, Chen, Huang
Analysis and interpretation of data: Chen, Huang
Drafting of manuscript: Gan, Sinner
Critical revision: Gan, Sinner, Walling, Chen, Huang, Patel, Evers, Bhakta, Tucker

Acknowledgment: We would like to acknowledge and thank the Markey Cancer Center Biostatistics and Bioinformatics Shared Resource Facility for statistical analyses, as well as the Center for Clinical and Translational Sciences for assistance with data extraction. We would also like to thank the Cancer Research Information Shared Resource Facility for obtaining Kentucky colorectal cancer patient data and analysis from the Kentucky Cancer Registry. Lastly, we would like to thank the University of Kentucky Research Communications Office for aiding in figure preparation for the manuscript.

REFERENCES

1. Cancer Statistics Center. 2018. Available at: https://cancerstatisticscenter.cancer.org. Accessed October 8, 2018.
2. Rodriguez SD, Vanderford NL, Huang B, Vanderpool RC. A social-ecological review of cancer disparities in Kentucky. Southern Med J 2018;111:213–219.
3. Stats of the State of Kentucky. Centers for Disease Control and Prevention. 2016. Available at: https://www.cdc.gov/nchs/pressroom/states/kentucky.htm. Accessed October 8, 2018.
4. US Census Bureau. Income and poverty in the United States: 2017. 2018. Available at: https://www.census.gov/topics/income-poverty/data/tables.html. Accessed October 4, 2018.
5. County Economic Status, Fiscal Year 2019. 2018. Available at: https://www.arc.gov/reports/custom_report.asp?REPORT_ID=75. Accessed September 25, 2018.
6. Meissner HI, Klabunde CN, Breen N, Zapka JM. Breast and colorectal cancer screening: U.S. primary care physicians' reports of barriers. Am J Preventive Med 2012;43:584–589.
7. Knight JR, Kanotra S, Siameh S, et al. Understanding barriers to colorectal cancer screening in Kentucky. Preventing Chronic Dis 2015;12:E95.
8. Bennett JM, Sarojini K, Redmond J, et al. Barriers to colon cancer screening in Kentucky. J Kentucky Med Assoc 2011;109.

9. Benitez JA, Creel L, Jennings J. Kentucky's Medicaid Expansion showing early promise on coverage and access to care. Health Affairs 2016;35:528–534.
10. Study of the Impact of the ACA Implementation in Kentucky. 2017. Available at: https://www.healthy-ky.org/res/images/resources/Impact-of-the-ACA-in-KY_FINAL-Report.pdf. Accessed October 9, 2018.
11. Levin TR, Corley DA, Jensen CD, et al. Effects of organized colorectal cancer screening on cancer incidence and mortality in a large, community-based population. Gastroenterol 2018;155:1383–1391.
12. Zauber AG, Winawer SJ, O'Brien MJ, et al. Colonoscopic polypectomy and long-term prevention of colorectal-cancer deaths. N Engl J Med 2012;366:687–696.
13. Final Recommendation Statement: Colorectal Cancer: Screening. 2014. Available at: https://www.uspreventiveservicestaskforce.org/Page/Document/RecommendationStatementFinal/colorectal-cancer-screening. Accessed September 11, 2018.
14. BRFSS Prevalence & Trends Data. 2015. Available at: https://www.cdc.gov/brfss/brfssprevalence/. Accessed September 10, 2018.
15. Kentucky Colon Cancer Screening Program Annual Report 2013–2014, Kentucky Department for Public Health, Chronic Disease Prevention Branch. 2014. Available at: https://chfs.ky.gov/agencies/dph/dpqi/cdpb/Documents/KYColonCancer20132014Annual.pdf. Accessed October 8, 2018.
16. Colorectal Cancer Facts & Figures 2014-2016. American Cancer Society. Available at: https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/colorectal-cancer-facts-and-figures/colorectal-cancer-facts-and-figures-2014-2016.pdf. Accessed October 9, 2018.
17. About the Kentucky Cancer Registry. Kentucky Cancer Registry. Available at: https://www.kcr.uky.edu/about.php. Accessed September 18, 2018.
18. Parker T. Rural-urban continuum codes. Available at: 2016. https://www.ers.usda.gov/data-products/rural-urban-continuum-codes. Accessed October 8, 2018.
19. Clendenning M, Baze ME, Sun S, et al. Origins and prevalence of the American Founder Mutation of MSH2. Cancer Res 2008;68:2145–2153.
20. United States Census Bureau Quick Facts Kentucky. 2017. Available at: https://www.census.gov/quickfacts/ky. Accessed October 8, 2018.
21. Siegel RL, Fedewa SA, Anderson WF, et al. Colorectal cancer incidence patterns in the United States, 1974–2013. J Nat Cancer Inst 2017;109:djw322.
22. Alexander DD, Waterbor J, Hughes T, et al. African-American and Caucasian disparities in colorectal cancer mortality and survival by data source: an epidemiologic review. Cancer Biomark 2007;3:301–313.
23. Sammon JD, Serrell EC, Karabon P, et al. Prostate cancer screening in early Medicaid Expansion states. J Urology 2018;199:81–88.
24. Choi SK, Adams SA, Eberth JM, et al. Medicaid Coverage Expansion and implications for cancer disparities. Am J Public Health 2015;105:S706–S712.
25. Sabik LM, Tarazi WW, Bradley CJ. State Medicaid expansion decisions and disparities in women's cancer screening. Am J Preventive Med 2015;48:98–103.
26. Hendryx M, Luo J. Increased cancer screening for low-income adults under the Affordable Care Act Medicaid Expansion. Med Care 2018;56:944–949.
27. Ajkay N, Bhutiani N, Huang B, et al. Early impact of Medicaid Expansion and quality of breast cancer care in Kentucky. J Am Coll Surg 2018;226:498–504.
28. Vital signs: colorectal cancer screening test use—United States, 2012. MMWR Morbidity Mortality Weekly Rep 2013;62:881–888.
29. Jones RM, Devers KJ, Kuzel AJ, Woolf SH. Patient-reported barriers to colorectal cancer screening: a mixed-methods analysis. Am J Preventive Med 2010;38:508–516.
30. Sommers BD, Blendon RJ, Orav EJ, Epstein AM. Changes in utilization and health among low-income adults after Medicaid Expansion or expanded private insurance. JAMA Int Med 2016;176:1501–1509.
31. Tucker TN J. Uses of Central Cancer Registry Data. In: Mench HGD, Griffin A, Mulvihill L, et al., eds. Cancer Registry Management Principles and Practice. Dubuque, IA: Kendall Hunt Publishing; 2011.
32. Murphy CC, Sandler RS, Sanoff HK, et al. Decrease in incidence of colorectal cancer among individuals 50 years or older after recommendations for population-based screening. Clin Gastroenterol Hepatol 2017;15:903–909.e906.
33. Edwards BK, Ward E, Kohler BA, et al. Annual report to the nation on the status of cancer, 1975-2006, featuring colorectal cancer trends and impact of interventions (risk factors, screening, and treatment) to reduce future rates. Cancer 2010;116:544–573.
34. Wolf AMD, Fontham ETH, Church TR, et al. Colorectal cancer screening for average-risk adults: 2018 guideline update from the American Cancer Society. CA 2018;68:250–281.
35. Atkin WS, Edwards R, Kralj-Hans I, et al. Once-only flexible sigmoidoscopy screening in prevention of colorectal cancer: a multicentre randomised controlled trial. Lancet 2010;375:1624–1633.
36. Zauber AG. The impact of screening on colorectal cancer mortality and incidence: has it really made a difference? Dig Dis Sciences 2015;60:681–691.
37. Brenner H, Hoffmeister M, Arndt V, et al. Protection from right- and left-sided colorectal neoplasms after colonoscopy: population-based study. J Nat Cancer Inst 2010;102:89–95.
38. Singh H, Nugent Z, Demers AA, et al. The reduction in colorectal cancer mortality after colonoscopy varies by site of the cancer. Gastroenterology 2010;139:1128–1137.
39. Soni A, Simon K, Cawley J, Sabik L. Effect of Medicaid Expansions of 2014 on overall and early-stage cancer diagnoses. Am J Public Health 2018;108:216–218.
40. Jemal A, Lin CC, Davidoff AJ, Han X. Changes in insurance coverage and stage at diagnosis among nonelderly patients with cancer after the Affordable Care Act. J Clin Oncol 2017;35:3906–3915.
41. Chen C, Stock C, Hoffmeister M, Brenner H. How long does it take until the effects of endoscopic screening on colorectal cancer mortality are fully disclosed?: A Markov model study. Int J Cancer 2018;143:2718–2724.
42. Mark Dignan EP, Lengerich Eugene. The cancer burden in Appalachia 2009. 2009. Available at: www.accnweb.com/docs/CancerBurdenAppalachia2009.pdf. Accessed September 12, 2018.
43. Seiber EE, Camacho F, Zeeshan MF, et al. Disparities in colorectal cancer treatment delay within Appalachia — the

role of for-profit hospitals. J Rural Health 2015;31:382–391.
44. Tang V, Boscardin WJ, Stijacic-Cenzer I, Lee SJ. Time to benefit for colorectal cancer screening: survival meta-analysis of flexible sigmoidoscopy trials. BMJ 2015;350:h1662.
45. Lee SJ, Boscardin WJ, Stijacic-Cenzer I, et al. Time lag to benefit after screening for breast and colorectal cancer: meta-analysis of survival data from the United States, Sweden, United Kingdom, and Denmark. BMJ 2013;346:e8441.

Discussion

DR HIRAM C POLK, JR (Louisville, KY): It is really going to be profound in 2020 when states begin to have to carry their share of the Medicaid expansion. It is a phenomenal problem, so early data like these are very, very valuable. We did the same thing last year with respect to breast cancer, showing expansion of Medicaid into a particular population was highly effective.

I am dumbfounded by the fact that you are able to show increased survival so promptly. What is it about the biology of colorectal cancer that makes survival show up so quickly? The typical time of death for them is somewhere between 3 and 3.5 years. It is uncommon to see this, and I would like to hear why the authors think they have been able to show this.

There is another point I would like to make that I think is new, and there is a paper that is in e-publication from *Diseases of the Colon & Rectum* by the group at Brigham looking at the same problem nationally. They noted something that is very troublesome. It is the same observation in the African-American population—a sharp increase in screening with all the benefits that might come from that. What they did show that is most worrisome is the Hispanic population did not take part in this expanded access. This is a real problem that needs to be addressed by all of us—why one group and not the other, because we ought to achieve this in all of them. But I am still concerned about what, how, and why it would be that colorectal cancer survival would show up within 2 years of the onset of this material.

DR STEVEN C STAIN (Albany, NY): This is a very timely paper. In many ways, I see it as a political statement. Simply stated, the authors have shown that the Affordable Care Act (ACA) saved lives of patients with colorectal cancer in Kentucky, especially in those Medicaid patients from the Appalachian regions. I want to emphasize a few facts from this excellent manuscript and ask a few questions. Interestingly, although the paper makes several points about the increase in Medicaid coverage, it is noteworthy that nearly half of the patients (49.7%) had private insurance. It seems that privately insured and Medicare patients both had increased colon cancer screening, but there were not corresponding increases in survival. Why do the authors believe this did not occur in these patients?

The increased screening and subsequent improvement in survival were most pronounced in the Appalachian populations. Were there specific efforts besides access to Medicaid to increase screening in these populations? I was wondering if there was an analogous approach to what has been used to improve prostate cancer screening in black men by using churches.

Colonoscopy was the screening method used for 72.7% of the patients, and I would suspect that the physician's ability to get paid for the colonoscopy would improve patient access. Was colonoscopy used more in the post-ACA time period?

I would like you to address the potential reasons for the improvements in survival. In the manuscript, you state that your modeling suggests that the largest contribution to survival improvements were screening and were more important than risk factor reduction and treatment improvements. I believe I understand how the shift to earlier stage cancers may be responsible, but screening does not cure cancer. It only allows referral to a surgical resection. Was there a corresponding increase in surgical resections in the Appalachian region?

DR JOHN STEWART (Chicago, IL): With respect to implementation of screening, having screening accessible to the population in Appalachia does not necessarily mean that they will get to the appointment. Can you speak to us about navigation programs and other ways to make sure that these patients who now have new access to this process are able to get to it?

Can you speak about some of the environmental and structural violence issues that might affect the biology of colon cancers that were discovered during the screening process?

DR GREG KENNEDY (Birmingham, AL): Did you do a cost analysis and would you propose that the increased screening has led to decreased costs? I wonder if you might hypothesize that perhaps with the increase in screening guidelines, you have also seen an increase in the adherence to treatment guidelines that perhaps has led to some of that decrease or improvement in survival.

DR ERRINGTON THOMPSON (Huntington, WV): We just completed a questionnaire that showed several barriers to colorectal screening. One of the barriers was access, money, time, and discomfort with the procedure. The question that I have is, which of the barriers do you think mostly account for the reason for this improvement? Was it just increase in access, or were there other factors that could explain this?

DR MAX LANGHAM (Memphis, TN): I have a conflict to declare. I am a pediatric surgeon who would be financially benefit from Medicaid expansion in Tennessee, which has not happened. While I philosophically would love to just accept this paper at face value, my question is about the Will Rogers effect. By looking at Medicaid differences, you do not know whether people have moved from insured to Medicaid or from uninsured to Medicaid, and what has happened to the uninsured patients. I would love to have a little bit of data about the other comparison groups to let us know whether or not this is really an all-up improvement.

DR RONDA HENRY-TILLMAN (Little Rock, AR): Decreasing cost, decreasing use, and reaching an unscreened population is

eTable 1. Lifetable by Insurance Status

	Pre-ACA		Post-ACA		
Insurance, y	**Surviving**	**95% CI**	**Surviving**	**95% CI**	**p Value**
Private					0.7877
0	1.000	—	1.000	—	
1	0.900	(0.886—0.914)	0.903	(0.888—0.916)	
2	0.820	(0.803—0.839)	0.826	(0.805—0.844)	
3	0.764	(0.744—0.784)	0.764	(0.736—0.789)	
Medicare					0.1980
0	1.000	—	1.000	—	
1	0.753	(0.738—0.768)	0.755	(0.739—0.771)	
2	0.658	(0.641—0.675)	0.631	(0.612—0.650)	
3	0.579	(0.561—0.596)	0.552	(0.528—0.575)	
Medicaid					0.0024
0	1.000	—	1.000	—	
1	0.779	(0.727—0.822)	0.838	(0.807—0.864)	
2	0.641	(0.584—0.693)	0.739	(0.700—0.773)	
3	0.570	(0.511—0.624)	0.662	(0.613—0.707)	
Uninsured					0.0335
0	1.000	—	1.000	—	
1	0.841	(0.795—0.877)	0.695	(0.560—0.796)	
2	0.733	(0.679—0.779)	0.620	(0.475—0.736)	
3	0.647	(0.590—0.697)	0.540	(0.376—0.679)	

ACA, Affordable Care Act.