Original Article

Early Impact of Medicare Accountable Care Organizations on Cancer Surgery Outcomes

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BACKGROUND: Accountable care organizations (ACOs) were established to improve care and outcomes for beneficiaries requiring highly coordinated, complex care. The objective of this study was to evaluate the association between hospital ACO participation and the outcomes of major surgical oncology procedures. **METHODS:** This was a retrospective cohort study of Medicare beneficiaries older than 65 years who were undergoing a major surgical resection for colorectal, bladder, esophageal, kidney, liver, ovarian, pancreatic, lung, or prostate cancer from 2011 through 2013. A difference-in-differences analysis was implemented to compare the postimplementation period (January 2013 through December 2013) with the baseline period (January 2011 through December 2012) to assess the impact of hospital ACO participation on 30-day mortality, complications, readmissions, and length of stay (LOS). **RESULTS:** Among 384,519 patients undergoing major cancer surgery at 106 ACO hospitals and 2561 control hospitals, this study found a 30-day mortality rate of 3.4%, a readmission rate of 12.5%, a complication rate of 43.8%, and a prolonged LOS rate of 10.0% in control hospitals and similar rates in ACO hospitals. Secular trends were noted, with reductions in perioperative adverse events in control hospitals between the baseline and postimplementation periods: mortality (percentage-point reduction, 0.1%; $P = .19$), readmissions (percentage-point reduction, 0.4%; $P = .001$), complications (percentage-point reduction, 1.0%; $P < .001$), and prolonged LOS (percentage-point reduction, 1.1%; $P < .001$). After accounting for these secular trends, this study identified no significant effect of hospital participation in an ACO on the frequency of perioperative outcomes (difference-in-differences estimator P values, .24-.72). **CONCLUSIONS:** Early hospital participation in the Medicare Shared Savings Program ACO program was not associated with greater reductions in adverse perioperative outcomes for patients undergoing major cancer surgery in comparison with control hospitals. ***Cancer*** **2016;122:2739-46.**

KEYWORDS: accountable care organizations, health policy, Medicare, outcomes, surgery.

INTRODUCTION

Accountable care organizations (ACOs) are a signature reform of the Affordable Care Act intended to create highly integrated delivery systems that improve population health and reduce costs through increased accountability and care coordination.[1] Architects of ACO policies envisioned that physicians and other health care workers would come together as multidisciplinary teams to coordinate and optimize care for complex and expensive patients.[2] Precursors to ACOs, such as the Physician Group Practice (PGP) demonstration, provided a proof of principle that similar models could achieve gains in the quality and cost of care provided to medical patients with multiple comorbidities.[3]

Despite this evidence from primary care, it remains unknown whether ACO participation will have similar benefits for the delivery of more technically complex, specialist-oriented services. Given its organization around multidisciplinary provider teams, cancer care represents an important clinical domain for evaluating this question. It is possible, for instance, that hospital ACO participation could serve as a catalyst for developing integrated teams that collaborate to improve care processes and outcomes for patients undergoing cancer treatment. In this scenario, one group that may derive early benefits from the ACO model is patients undergoing major cancer surgery. For these patients with cancer, the heightened focus on quality and care coordination that accompanies ACO participation might translate quickly into improved perioperative outcomes.

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In this context, we used national Medicare data to examine the early impact of hospital ACO participation on outcomes with major cancer surgery. We specifically performed a difference-in-differences analysis to examine the association between hospital participation in a Medicare Shared Savings Program (MSSP) ACO and the length of stay (LOS), 30-day mortality, major complications, and readmissions after major oncological surgery. We hypothesized that benefits from ACO implementation would most likely occur in the form of decreased rates of readmission and complications and shorter LOS, which would result from improvements in processes of care that are at the forefront of ACO quality-improvement and cost-saving policies.

MATERIALS AND METHODS

Data Sources

We used 3 data sets to perform these analyses. First, we used the MSSP ACO Provider-Level Research Identifiable File (available from the Centers for Medicare and Medicaid Services) to identify hospitals that formally participated in the MSSP during the first performance period from April 2012 through December 2013. Next, we used the American Hospital Association Annual Survey to evaluate hospital characteristics, including the region, number of beds, hospital profit status, hospital teaching status, number of operating rooms, and electronic health record use. Finally, we used the 100% Medicare Provider Analysis and Review File from 2011 through 2013 to identify patient cohorts, demographic and clinical information, and the occurrence of our outcomes of interest.

Identification of ACO-Participating and Control Hospitals

Using the MSSP ACO provider-level data set, we identified acute care and critical access hospitals that enrolled in an MSSP ACO during the first performance period. These hospitals are called ACO hospitals throughout the article; conversely, hospitals that were not formal MSSP ACO participants are called control hospitals. Hospitals with fewer than 10 oncologic procedures overall during the period of interest were excluded.

Identification of the Study Population

We used diagnosis and procedures codes from *International Classification of Diseases, Ninth Revision, Clinical Modification* to identify patients aged 66 to 99 years who had undergone major cancer surgery during the study interval for any of the following 9 solid organ cancers: colorectal, bladder, esophageal, kidney, liver, ovarian, pancreatic, lung, and prostate cancer (Supporting Information 1 [see online supporting information]). We included only those patients who had undergone a procedure and been discharged between January 1, 2011 and November 30, 2013 to ensure adequate follow-up for the ascertainment of postoperative outcomes. We excluded patients who had undergone 2 or more different oncologic procedures on the same day or $\leq$180 days apart.

Outcome Measures

We measured 4 postoperative outcomes: mortality, complications, prolonged LOS, and readmissions. Mortality, complications, and readmissions were identified within 30 days of the index cancer operation. Complications were identified with established methods based on the complication screening program.[4-6] Using this method, we identified events, including infectious, bleeding, pulmonary, renal, cardiac, neurologic, gastrointestinal, and other complications, occurring during the index hospitalization or within 30 days of surgery. Prolonged LOS was defined as an LOS that exceeded the 90th percentile on a procedure-specific basis.

Statistical Analysis

We used the Student *t* test and chi-square tests as appropriate to compare the characteristics of hospitals that participated in an MSSP ACO and those that did not. We also compared demographic characteristics for patients treated in MSSP ACO hospitals and patients treated in control hospitals.

Next, we implemented a difference-in-differences analysis to evaluate the association between hospital participation in an MSSP ACO and changes in perioperative outcomes over time in comparison with control hospitals.[3,7] To do this, we first specified whether each hospital in our sample was an ACO hospital or a control hospital. We then specified a time variable that reflected the period before and after MSSP ACO policy implementation. ACO hospital cases were included in the postimplementation time period, which started on the specific date of ACO enrollment for that hospital (April 1, 2012, July 1, 2012, or January 1, 2013). Control hospital cases were included in the postimplementation era, which began on January 1, 2013 because the majority of ACO-participating hospitals entered their contracts on this date. We refer to the time period before ACO policy implementation as *baseline* and the time period afterward as *postimplementation*.

We initially fit logistic regression models for each outcome across all cancer procedures combined. For each

TABLE 1. Characteristics of ACO and Control Hospitals

	ACO Hospitals (n = 106)	Control Hospitals (n = 2561)	*P*
Annual oncologic surgical volume, median (IQR)	31.3 (10.7-90.3)	23.3 (9.0-58.7)	.06
Geographic region, %			<.001
Northeast	25.5	17.1	
Midwest	48.1	25.0	
South	23.6	37.9	
West	2.8	20.2	
No. of beds			.02
<200	42.5	52.5	
200-349	24.5	27.0	
350-499	19.8	11.3	
≥500	13.2	9.3	
Hospital profit status, %			<.001
For-profit	4.7	17.6	
Nonprofit	86.8	69.0	
Public	8.5	13.4	
Other characteristics			
Teaching hospital, %	48.1	34.1	.002
Urban location, %	84.0	72.4	.01
No. of operating rooms, median (IQR)	11 (5-19)	9 (5-14)	.09
Electronic health record implemented, %	95.7	98.1	.24
Medicare Advantage penetration, %[a]	25.9	25.7	.90
Network participant, %	51.4	40.7	.03

Abbreviations: ACO, accountable care organization; IQR, interquartile range. Groups of percentages may not add to 100 due to rounding.
[a] Medicare Advantage penetration is reported at the county level.

model, we included an interaction term between hospital ACO participation and time to evaluate the effect of the ACO policy. The interaction term allowed the predicted outcome to differ between patients treated in ACO hospitals and control hospitals in both the baseline and postimplementation periods. The difference-in-differences of the predicted outcomes was then the causal effect of ACO on each outcome; after controlling for trends in the control group.[8-10] We adjusted our regression models for the type of surgery (eg, colectomy or prostatectomy); patient characteristics, including age, sex, race, and comorbidities (with the Elixhauser method); and hospital characteristics, including the geographic region, profit status, teaching status, location (rural vs urban), and cancer procedure volume.[11] For each of these models, we implemented robust standard errors to account for the clustering of patient outcomes within hospitals.

In addition to the overall models, we also fit similar cancer procedure–specific models for each of the perioperative outcomes. Finally, we performed 3 sensitivity analyses. First, we evaluated the effect of setting the postimplementation time point for control hospital cases at July 1, 2012, rather than January 1, 2013. Second, we adjusted our overall model for 3 covariates that may act as markers of integration within a hospital delivery system, including electronic health record use, familiarity with managed care contracts (Medicare Advantage penetration), and participation in a hospital network. Last, we evaluated outcomes only in hospital referral regions containing both an ACO hospital and a control hospital. All statistical analyses were performed with Stata 14 (StataCorp LP, College Station, Texas); P values $< .05$ were considered statistically significant. The University of Michigan institutional review board deemed this study exempt from review.

RESULTS

We identified 384,519 patients who underwent major cancer surgery at 106 ACO hospitals and 2561 control hospitals from 2011 through 2013. ACO hospitals were concentrated in the Northeast and Midwest regions, were more often nonprofit, urban, and teaching hospitals, and had a greater number of hospital beds in comparison with control hospitals (Table 1).

We observed small but statistically significant differences in the populations served by these 2 hospital groups. For instance, patients treated at ACO hospitals were more often white and had a higher prevalence of measured comorbid conditions (Table 2). Although statistically significant, differences in the mix of oncological procedures between ACO hospitals and control hospitals were small, with ACO hospitals performing more prostate and ovarian cancer surgeries and control hospitals performing more bladder, lung, and liver cancer procedures.

In the baseline study interval, unadjusted rates of 30-day mortality (3.3% vs 3.4%, $P = .54$), 30-day

TABLE 2. Characteristics of Beneficiaries Treated at ACO and Control Hospitals

	Baseline		After Implementation			
	ACO Hospitals (n = 10,347)	Control Hospitals (n = 252,627)	ACO Hospitals (n = 9092)	Control Hospitals (n = 112,453)	Differential Change for ACO Hospitals Versus Control Hospitals	*P*
Mean age, y	74.44	74.49	74.15	74.39	−0.20	.002
Female, %	42.27	41.87	42.19	42.11	−0.32	.42
Race, %						<.001
White	87.63	86.58	87.25	86.04	.16	
Black	8.74	8.17	8.69	8.14	−.02	
Other	3.63	5.25	4.06	5.83	−.15	
Cancer surgery, %						
Bladder	4.09	4.27	3.86	4.45	−.41	.02
Prostate	18.37	17.40	17.21	16.21	.03	.004
Esophageal	0.98	1.12	1.12	1.20	.06	.19
Pancreas	2.95	3.04	3.28	3.21	.16	.93
Lung	17.19	17.55	17.69	18.21	−.16	.24
Liver	0.74	1.04	1.03	1.16	.17	.01
Kidney	11.82	12.11	12.23	12.69	−.17	.25
Colorectal	39.03	39.00	38.35	38.26	.06	.86
Ovarian	4.83	4.47	5.22	4.60	.26	.001
Comorbid diseases,[a] %						
Congestive heart failure	8.80	7.74	8.36	7.39	−.09	<.001
Valvular disease	5.99	5.77	5.55	5.89	−.56	.91
Pulmonary hypertension	2.37	1.94	2.42	1.96	.04	<.001
Peripheral vascular disease	7.40	6.89	6.74	7.25	−1.02	.62
Paralysis	1.10	0.93	0.87	0.90	−.20	.33
Other neurological disorders	3.63	3.17	3.10	3.24	−0.59	.14
Chronic pulmonary disease	24.81	22.92	23.90	22.92	−0.90	<.001
Diabetes without complications	23.54	22.45	24.42	22.77	0.56	<.001
Diabetes with complications	2.50	2.72	3.32	2.94	0.60	.43
Hypothyroidism	11.48	12.21	12.65	13.02	0.35	.08
Renal failure	0.80	0.84	0.83	0.87	0.00	.56
Liver disease	0.74	1.04	1.03	1.16	0.17	.01
Lymphoma	0.67	0.74	0.70	0.75	0.03	.38
Metastatic cancer	18.14	19.06	18.98	18.48	1.43	.23
Solid tumor without metastases (other than primary)	9.43	9.53	9.76	9.65	0.20	.94
Rheumatologic disorder	2.27	2.27	2.62	2.46	0.16	.34
Coagulopathy	3.73	3.48	4.26	3.67	0.34	.001
Obesity	9.67	8.91	10.67	10.33	−0.42	<.001
Weight loss	9.23	8.72	9.56	8.69	0.37	.001
Electrolyte disorders	22.54	21.86	23.44	22.18	0.58	.001
Blood loss anemia	3.88	3.51	3.56	3.19	0.01	.02
Deficiency anemias	21.45	20.92	21.01	20.12	0.36	.06
Psychoses	1.96	1.87	1.88	1.96	−0.17	.79
Depression	7.95	7.43	8.69	7.95	0.21	<.001
Hypertension	66.17	65.29	66.97	65.65	0.44	.001

Abbreviation: ACO, accountable care organization. Groups of percentages may not add to 100 due to rounding.
[a] Gastrointestinal bleeding, AIDS, alcohol use, and drug use were excluded because of small numbers or redacted data.

readmission (12.5% vs 12.4%, $P = .69$), complications (43.6% vs 43.4%, $P = .65$), and prolonged LOS (10.1% vs 10.2%, $P = .56$) were similar between ACO hospitals and control hospitals. The adjusted rates for these events were also comparable at the baseline between ACO participants and control hospitals (Table 3).

We found that ACO hospitals did not improve at a significantly accelerated rate in comparison with control hospitals. We noted secular trends, with reductions in perioperative adverse events in control hospitals between the baseline and postimplementation periods: mortality (percentage-point reduction, 0.1%; $P = .19$), readmissions (percentage-point reduction, 0.4%; $P = .001$), complications (percentage-point reduction, 1.0%; $P < .001$), and prolonged LOS (percentage-point reduction, 1.1%; $P < .001$). After accounting for these secular trends, we identified no significant effect of hospital participation in an ACO on the frequency of any perioperative outcomes

TABLE 3. Adjusted Rates of Adverse Perioperative Outcomes for Patients Undergoing Cancer Surgery at Hospitals Before and After ACO Policy Implementation

	Control Hospitals		ACO Hospitals	
	Baseline	After Implementation	Baseline	After Implementation
30-day mortality, %	3.4	3.3	3.4	3.2
Readmissions, %	12.5	12.1[a]	12.6	12.0
Complications, %	43.8	42.7[a]	44.0	42.5
Prolonged LOS, %	10.0	8.9[a]	10.0	8.4

Abbreviations: ACO, accountable care organization; LOS, length of stay.
There were statistically significant declines in readmissions, complications, and prolonged LOS for patients undergoing a major cancer surgery at control hospitals, and there were parallel trends in perioperative outcomes at ACO hospitals. The rates were adjusted for the following: surgery type, age, sex, race, region, bed size, hospital profit status, teaching status, rural/urban location, cancer procedure volume, and comorbidities.
[a] Change from the baseline ($P \leq .001$).

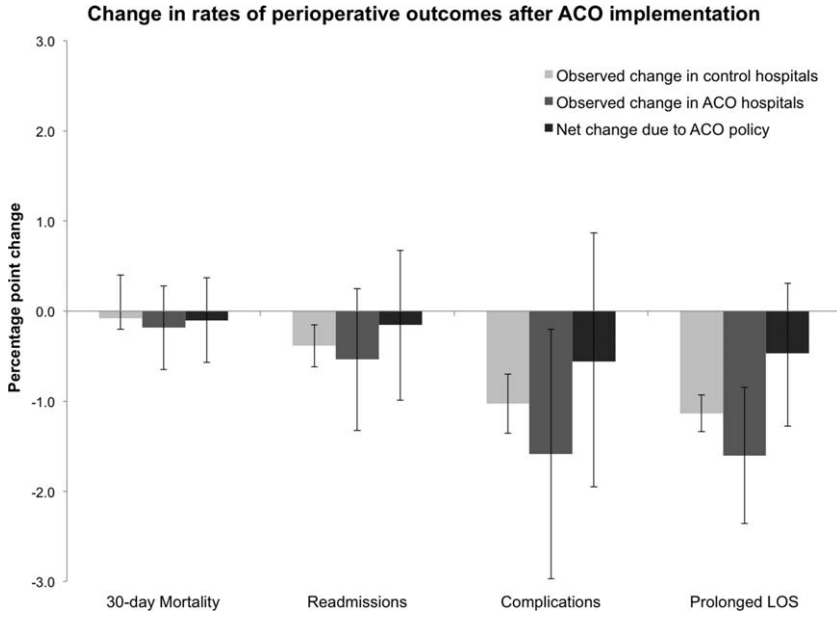

Figure 1. Changes in the rates of perioperative outcomes after ACO implementation. ACO indicates accountable care organization; LOS, length of stay.

(*P* values for the difference-in-differences estimator, .24-.72; Fig. 1).

Finally, when we examined the association between hospital ACO participation and perioperative outcomes for individual cancers, we noted similar patterns, with no greater improvements in perioperative outcomes for ACO hospitals (Supporting Information 2 [see online supporting information]). Table 4 presents site-specific outcomes for several cancers and compares postimplementation outcomes to the baseline. We noted no substantive changes in our results in sensitivity analyses, for which the postimplementation date for control hospitals was changed from January 1, 2013, to July 1, 2012, when we controlled for additional measures of health system integration or when we limited our analyses to only markets containing both an ACO hospital and a control hospital.

DISCUSSION

Our study has 2 principal findings. First, early hospital participation in the MSSP ACO program did not accelerate improvements in several adverse events (ie, 30-day mortality, readmissions, major complications, and prolonged LOS) after major cancer surgery in comparison with control hospitals. Second, with the exception of

TABLE 4. Relative Risk of Adverse Perioperative Outcomes in Control Hospitals During the Postimplementation Period Versus the Baseline Period

	Mortality	Readmissions	Complications	Prolonged Length of Stay
Prostate	0.84 (0.57-1.24)	1.03 (0.95-1.11)	0.97 (0.93-1.02)	0.89 (0.83-0.94)[a]
Bladder	1.14 (0.93-1.41)	1.01 (0.95-1.07)	0.98 (0.96-1.00)	0.89 (0.79-1.00)
Esophagus	0.83 (0.55-1.24)	1.06 (0.90-1.24)	0.92 (0.86-0.99)[a]	0.73 (0.55-0.97)[a]
Pancreas	0.95 (0.75-1.20)	1.01 (0.93-1.10)	0.95 (0.91-0.99)[a]	0.86 (0.74-0.99)[a]
Lung	0.98 (0.89-1.07)	0.91 (0.87-0.95)[a]	0.92 (0.90-0.95)[a]	0.88 (0.84-0.92)[a]
Liver	0.86 (0.59-1.26)	0.92 (0.76-1.11)	0.96 (0.88-1.04)	0.74 (0.60-0.92)[a]
Kidney	1.11 (0.98-1.30)	0.97 (0.91-1.03)	0.99 (0.97-1.01)	0.92 (0.87-0.98)[a]
Colorectal	1.00 (0.95-1.04)	0.96 (0.94-0.99)[a]	0.99 (0.98-1.00)	0.89 (0.86-0.92)[a]
Ovary	0.71 (0.59-0.86)	0.98 (0.90-1.06)	0.98 (0.95-1.01)	0.92 (0.84-1.02)
All cancers	0.97 (0.94-1.01)	0.97 (0.95-0.99)[a]	0.98 (0.97-0.98)[a]	0.88 (0.87-0.90)[a]

[a] $P < .05$.

mortality, the rates of these adverse perioperative outcomes have been improving across hospitals over time, with 0.1% to 1.6% percentage-point reductions in the frequency of observed adverse events from the baseline to the postimplementation period of ACO policies.

Our findings showing no greater benefits for mortality or LOS for patients undergoing cancer surgery in ACO hospitals are consistent with prior work evaluating outcomes for beneficiaries with cancer during the PGP demonstration project.[12] Namely, cancer patients treated at facilities participating in PGP had rates of in-hospital mortality that were equivalent to those for a similar patient cohort treated in non-PGP hospitals. Likewise, there was no effect of PGP participation on the number of days that patients with cancer spent in the hospital.

Although not attributable to ACO participation, there are several potential explanations for the observed decline in readmissions and complications over the study interval. For instance, work by others has demonstrated similar trends associated with concurrent Centers for Medicare and Medicaid Services pay-for-performance initiatives, including the Hospital Readmissions Reduction Program, the Value-Based Purchasing (VBP) Program, and the Hospital-Acquired Conditions (HAC) Reduction Program.[13-16] Although not directed specifically at patients undergoing cancer surgery, processes developed to reduce readmissions in response to the Hospital Readmissions Reduction Program, particularly those directed at surgical admissions, may well have spillover benefits for other surgical patients. Likewise, improvements in care processes and patient safety in response to VBP and HAC metrics may have the collateral benefit of shortening LOS and reducing readmissions for patients undergoing major cancer surgery.[17] Accordingly, the observed longitudinal improvements in cancer surgical outcomes are likely related to a combination of initiatives implemented during the same time period as the MSSP ACO program.

Our study has several limitations. First, most ACO quality metrics are not specifically focused on improving cancer care. Accordingly, further improvements in care delivery may require policies directed at cancer care specifically rather than more general initiatives such as ACOs. However, although these specific surgical outcome measures may not map directly to MSSP ACO quality measures, improvements in perioperative outcomes should translate into lower costs of care, and this is highly relevant for ACO performance. It is also conceivable that incremental improvements in cancer care may be more difficult to achieve through the ACO model because there has long been a focus on care coordination and quality measurement in this patient population. Moreover, organizational change may require more than 1 or 2 years, and effects derived from ACO policies may become stronger over time and as more organizations form. Second, we did not evaluate for improvements in cancer screening, surveillance, and end-of-life care. In many ways, these domains of cancer care may be more responsive to the ACO model than surgical outcomes from both cost and quality perspectives. As a result, future evaluations of cancer care and outcomes in ACOs are needed to define the impact of this model on these distinct phases of cancer care.[18] Third, our study assumes that there were no inherent differences between control hospitals and hospitals that ultimately joined an ACO. Although ACO hospitals and control hospitals are not identical, they have similar patient populations and had equivalent outcome rates at the baseline. In addition, our study design assumes that outcome trends during the baseline period were similar among ACO hospitals and control hospitals. As more data become available, evaluating time trends across the baseline and

postimplementation periods will be important to consider. Finally, hospital affiliation with an ACO represents one mechanism for ACO participation. In addition, physicians can align with an ACO independently of hospital participation. Although our study does not examine the role of physician ACO participation, control hospitals with a large number of ACO-participating physicians may be influenced by ACO policies.

These limitations notwithstanding, our findings have important implications for ACO leadership and policymakers. For ACO leadership, simply committing to the framework, measures, and payment changes that come with ACO participation will not necessarily translate into short-term improvements in perioperative outcomes for cancer patients. Nonetheless, our findings showing improvements in care regardless of the hospital ACO status suggest that ACOs may benefit from other ongoing quality-improvement programs that are affecting care at hospitals nationwide. For instance, reducing surgical site infections after colectomy will positively affect hospital performance with both the VBP and HAC programs while also reducing costs for the ACO.

For policymakers, our findings suggest that at least in this early period, innovative policies based on ACO principles (eg, primary care focus) may have limited impact on inpatient surgical care. Programs directed specifically at improving surgical and cancer-specific outcomes, such as surgical quality-improvement collaboratives or initiatives through oncology groups such as the Institute for Quality of the American Society of Clinical Oncology, may offer alternative and more direct ways for physicians, patients, and health systems to partner to improve outcomes and reduce costs for major cancer surgery.[19,20]

Although longer follow-up is needed, early hospital participation in the MSSP ACO program was not associated with greater reductions in adverse perioperative outcomes for patients undergoing a major cancer surgery in comparison with nonparticipating hospitals. The longitudinal improvements in perioperative outcomes identified during the study interval may reflect the impact of concurrent policies more directly applicable to surgical patients. In the future, studies that inform the impact of ACOs at other points in the cancer care continuum (eg, early detection and end-of-life care) will further clarify the relevance and impact of this model in oncology.

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CONFLICT OF INTEREST DISCLOSURES

Lindsey A. Herrel reports receiving personal fees for providing coding support for health care software development for ArborMetrix. Brent K. Hollenbeck reports receiving personal fees from *Urology* for serving on its editorial board. David C. Miller reports salary support from Blue Cross Blue Shield of Michigan for leadership of the Michigan Urological Surgery Improvement Collaborative.

AUTHOR CONTRIBUTIONS

Lindsey A. Herrel: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing–original draft, writing–review and editing, visualization, supervision, and funding acquisition. **Edward C. Norton**: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing–original draft, writing–review and editing, visualization, supervision, and project administration. **Scott R. Hawken**: Conceptualization, methodology, data curation, writing–review and editing, and visualization. **Zaojun Ye**: Conceptualization, methodology, software, validation, investigation, resources, data curation, writing–review and editing, and visualization. **Brent K. Hollenbeck**: Conceptualization, investigation, resources, writing–review and editing, supervision, project administration, and funding acquisition. **David C. Miller**: Conceptualization, methodology, validation, investigation, resources, data curation, writing–original draft, writing–review and editing, visualization, supervision, project administration, and funding acquisition.

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