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Relationship Between Quality of Comorbid Condition Care and Costs for Cancer Survivors

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QUESTION ASKED: Is there an association between the quality of care for cancer survivors' comorbid conditions and costs? Is the association similar for patients without a cancer history?

SUMMARY ANSWER: Having fewer avoidable events was associated with lower costs of care, while higher quality measured by recommended visits or procedures was often associated with higher costs in the short-term. The association was generally similar for cancer survivors and patients without a cancer history.

WHAT WE DID: We obtained data from the Surveillance, Epidemiology and End Results-Medicare linked database. We identified breast, prostate, and colorectal cancer survivors who were diagnosed in 2004 and were enrolled in Medicare fee-for-service for at least 12 months before diagnosis and survived at least 3 years. Quality-of-care was assessed using nine process indicators for chronic conditions, and a composite indicator representing seven avoidable outcomes. Total costs on the basis of Medicare amount paid were grouped as inpatient and outpatient. We examined the association between care quality and costs for cancer survivors, and compared this association among matched non-cancer controls. Our methods of comparison included comparisons of means and generalized linear regressions.

WHAT WE FOUND: Our sample included 8,661 cancer survivors and 17,332 matched non-cancer-controls. Having no avoidable events was associated with lower inpatient, outpatient and total costs. Receipt of recommended care was associated with higher outpatient costs for eight indicators, and higher inpatient and total costs for five indicators. For three measures, costs for cancer survivors receiving recommended care increased less than for non-cancer controls. An annual eye exam for patients with diabetes was associated with lower inpatient costs.

BIAS, CONFOUNDING FACTOR(S), DRAWBACKS: This retrospective study of cancer survivors is not a retrospective cohort study because study population members were identified post hoc, and end-of-life patients were not included. Quality indicators focused more on processes than outcomes. Our findings demonstrated a stronger association between outcomes and costs than between processes and costs. If the process indicators improve outcomes, cost-effectiveness warrants further evaluation. Our sample was limited to those over age 65 in the fee-for-service program. This study had a two-year observation period, so our results do not provide information on long-term cost savings. The Charlson index is an imperfect control for overall health. The quality indicators do not account for the severity of the comorbidities.

REAL-LIFE IMPLICATIONS: While the cost differences are larger than the cost of recommended outpatient care, our findings serve as a first step in demonstrating the link between quality and costs and whether quality saves money, is good for patients, and attainable at a reasonable cost. A pay-for-performance system will need to reward higher quality with higher reimbursement until more research is done to demonstrate whether the quality measures are also associated with better outcomes (Fig). JOP

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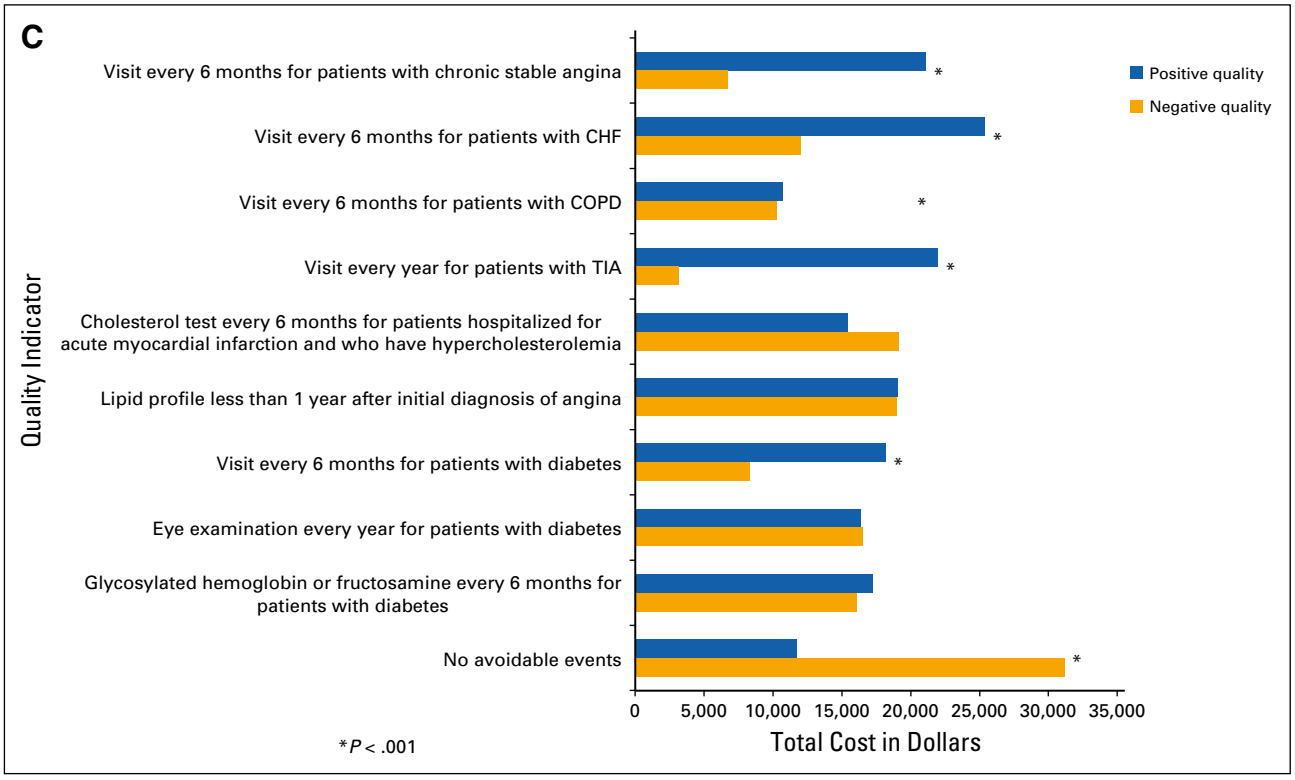

FIG. (C) Total cost by positive or negative quality indicator. CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack.

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Abstract

Purpose

To estimate the association between cancer survivors' comorbid condition care quality and costs; to determine whether the association differs between cancer survivors and other patients.

Methods

Using the SEER–Medicare-linked database, we identified survivors of breast, prostate, and colorectal cancers who were diagnosed in 2004, enrolled in Medicare fee-for-service for at least 12 months before diagnosis, and survived ≥ 3 years. Quality of care was assessed using nine process indicators for chronic conditions, and a composite indicator representing seven avoidable outcomes. Total costs on the basis of Medicare amount paid were grouped as inpatient and outpatient. We examined the association between care quality and costs for cancer survivors, and compared this association among 2:1 frequency-matched noncancer controls, using comparisons of means and generalized linear regressions.

Results

Our sample included 8,661 cancer survivors and 17,332 matched noncancer controls. Receipt of recommended care was associated with higher outpatient costs for eight indicators, and higher inpatient and total costs for five indicators. For three measures (visit every 6 months for patients with chronic obstructive pulmonary disease or diabetes, and glycosylated hemoglobin or fructosamine every 6 months for patients with diabetes), costs for cancer survivors who received recommended care increased less than for noncancer controls. The absence of avoidable events was associated with lower costs of each type. An annual eye examination for patients with diabetes was associated with lower inpatient costs.

Conclusion

Higher-quality processes of care may not reduce short-term costs, but the prevention of avoidable outcomes reduces costs. The association between quality and cost was similar for cancer survivors and noncancer controls.

ASSOCIATED CONTENT

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BACKGROUND

The organization of technology used in medical care can have an impact on the health of the population and the associated costs.[1-4] Pay for performance is predicated on incentivizing health care organizations to provide high-quality care to yield better outcomes. Incentivizing practitioners to

avoid the provision of unnecessary care should help cut costs, but higher-quality care may cost more.

Costs of care can be particularly high for complex patients, including cancer survivors with comorbid conditions.[5] The number of cancer survivors in the United States is growing[6] as a result of population aging, improved screening technologies, greater participation in screening, and more effective treatments.[7] Because greater than half the incident cases between 2007 and 2011 were individuals aged 65 years and older,[8] many cancer survivors have comorbid conditions. The combination of newer screening and treatment methods affecting cancer survivors' quality and length of life, the greater number of cancer survivors, and the prevalence of comorbid conditions among cancer survivors suggests that the care of cancer survivors will increasingly affect the aggregate ability of the health care system to have an impact on the health of the US population.

Previous research has demonstrated that quality of care for comorbid conditions varies across cancer types.[9] However, the association between comorbid condition care quality and costs for cancer survivors has not been investigated. Quality measures include both process indicators and outcomes, including avoidable events such as hospitalizations as a result of complications. Higher-quality care may lead to a more rational resource allocation,[10,11] but some process measures of quality may be associated with greater resource utilization and higher costs. For policy purposes, better outcomes accompanying higher costs may be deemed worthwhile.

This article investigates the association between cost and quality by using measures of quality that reflect treatment of chronic conditions and the avoidance of complications, and it then compares the findings for cancer survivors with a more general population. This research is a first step in informing the design of a pay-for-performance system, in which providing higher-quality care would be rewarded with higher reimbursement.

METHODS

Study Design

We performed a retrospective study of cancer survivors during the time period when they had completed active cancer treatment and were transitioning to survivorship. Assuming that cancer treatment would occur in the first year after diagnosis, we examined the association between care quality and costs starting on day 366 postdiagnosis and continuing through day 1,095. The association between comorbid condition care quality and costs was compared between cancer survivors and noncancer controls. The Johns Hopkins School of Medicine Institutional Review Board deemed this project exempt.

Data Source

We used the SEER–Medicare-linked database, which combines clinical information from the SEER registries with Medicare claims.[12] SEER–Medicare also provides data for a 5% random sample of Medicare beneficiaries who live in the SEER regions and who do not have a history of cancer to enable comparisons with noncancer controls.

Study Population

Cancer survivors included in the analysis were those diagnosed with locoregional breast, prostate, or colorectal cancer in the year 2004 who survived for at least 3 years. Patients not continuously enrolled in fee-for-service Medicare from 1 year prior to diagnosis through 3 years postdiagnosis were excluded. Because this analysis focused on comorbid condition care quality in cancer survivors who had completed acute treatment, we excluded patients with a subsequent cancer diagnosis, or if they received chemotherapy, radiation, or hospice care during days 366 to 1,095 postdiagnosis. We frequency-matched controls 2:1 by cancer type on the basis of the SEER region (combining Atlanta with rural Georgia and combining all California regions), sex, ethnicity (white, black, and other), and age (65 to 74 and $\geq$ 75 years).

Variables

The primary outcome variable was cost of care during days 366 to 1,095. Costs were calculated by summing the Medicare payment amounts from all claims in the defined time period and were categorized as inpatient or outpatient (ie, all costs other than inpatient). Costs were adjusted for inflation to 2007 (the end of the data period), using SEER–Medicare-specific adjusters (M. Brown, personal communication, March 2010).

The independent variable was care quality as assessed using published indicators specifically designed for use with claims data and applied in previous studies.[9,13,14] Patients were included in the denominator only for the indicators for which they were eligible (ie, diabetic eye examination was only evaluated in patients diagnosed with diabetes). Process quality indicators included a visit every 6 months for patients with chronic stable angina; a visit every 6 months for patients with congestive heart failure; a visit every 6 months for patients

with chronic obstructive pulmonary disease (COPD); a visit every year for patients with transient ischemic attack (TIA); a cholesterol test every 6 months for patients hospitalized for acute myocardial infarction (AMI) and who have hypercholesterolemia; a lipid profile less than 1 year after initial diagnosis of angina; a visit every 6 months for patients with diabetes; an eye examination every year for patients with diabetes; and a measure of glycosylated hemoglobin or fructosamine every 6 months for patients with diabetes.

Avoidable events included the following: among patients with known angina, ≥ 3 emergency department visits for cardiovascular-related diagnoses in 1 year; among patients with known cholelithiasis, diagnosis of perforated gallbladder; among patients with known diabetes, admission for hyperosmolar or ketotic coma; among patients with known COPD, subsequent admission for a respiratory diagnosis; among patients with known emphysema, subsequent admission for a respiratory diagnosis; among patients with pneumonia, diagnosis of lung abscess or empyema; and nonelective admission for congestive heart failure. The avoidable use measure analyzed was coded as no avoidable events compared with any.

Covariates included age, sex, SEER region, ethnicity, precancer-diagnosis Charlson-weighted comorbidity index score [0/1/2/3+],[15-17] census tract median income, and census tract proportion with high school education. Covariates are suggested by a health services utilization model and include predisposing (sex, SEER region, and ethnicity), enabling (income and education), and need (age and Charlson comorbidity index score) factors[18] that confound the relationship between the quality of care received and costs.

Analysis

We descriptively compared the costs among those with positive and negative indicators of quality and then ran regressions to compare differences in the association between quality and cost by cancer survivor versus control status, adjusting for covariates. Regressions were run using the generalized linear model specifying a log link and gamma family error term,[19] with the results interpreted in actual dollars. Analyses estimated the effect of care quality (positive *v* negative) of noncancer controls, the incremental effect for cancer survivors, and the total effect for cancer survivors. This allowed us to make inferences regarding the statistical significance of the association between quality and cost both within and between cancer survivors and noncancer controls.

RESULTS

A total of 8,661 cancer cases were matched to 17,322 noncancer controls (descriptive statistics are given in Table 1). Reflecting the matching, the proportions for sex, ethnicity, and SEER region were the same for survivors and controls, whereas the Charlson comorbidity index scores showed slightly greater levels of comorbidity among survivors. The sample was approximately 65% male, 85% white, and the cancer cases include 52.6% prostate, 25.8% colorectal, and 21.6% breast

Table 1. Characteristics of the Sample (N = 25,983)

	Cases		Matched Controls	
Characteristic	No.	%	No.	%
SEER case	8,661	100	0	0
Match	0	0	17,322	100
Sex				
Male	5,614	64.8	11,228	64.8
Female	3,047	35.2	6,094	35.2
Ethnicity				
White	7,330	84.6	14,660	84.6
Black	721	8.3	1,442	8.3
Other	610	7.0	1,220	7.0
Tumor type*				
Breast	1,871	21.6	—	—
Colorectal	2,231	25.8	—	—
Prostate	4,559	52.6	—	—
SEER region†				
Connecticut	621	7.2	1,242	7.2
Detroit	586	6.8	1,172	6.8
Hawaii	131	1.5	262	1.5
Iowa	620	7.2	1,240	7.2
New Mexico	215	2.5	430	2.5
Seattle	633	7.3	1,266	7.3
Utah	356	4.1	712	4.1
Metropolitan Atlanta	233	2.7	466	2.7
California	2,905	33.5	5,810	33.5
Kentucky	579	6.7	1,158	6.7
Louisiana	572	6.6	1,144	6.6
New Jersey	1,210	14.0	2,420	14.0
Charlson comorbidity index score				
0	6,114	70.6	12,474	72.0
1	1,764	20.4	3,143	18.1
2	503	5.8	1,071	6.2
3	280	3.2	634	3.7

*The matched controls did not have tumors but were matched in exact proportion.
†Combining Atlanta with rural Georgia and combining all California regions.

cancer survivors. Approximately 70% had a Charlson comorbidity index score of zero.

Table 2 shows the proportion of all study subjects as well as cancer survivors and matched controls eligible for each quality measure who had a positive quality indictor (either receiving recommended care or having no avoidable events). Combining the cancer survivors and controls, the proportion receiving high-quality care ranged from 19% for patients who were hospitalized for an AMI and who had hypercholesterolemia and had a cholesterol test every 6 months to 96% for patients who had a visit every year after a TIA. Twenty-one percent of individuals experienced an avoidable event. Cancer survivors and controls did not differ substantially.

Appendix Fig A1A (online only) shows outpatient, inpatient, and total costs, respectively, for those who did and who did not receive recommended care, combining cancer survivors and matched controls. For outpatient costs, appropriate care on most quality indicators was associated with higher costs. However, no avoidable events was associated with lower costs; a cholesterol test every 6 months for patients with hypercholesterolemia and a history of AMI was not statistically significant. For inpatient costs, the indicators of visits every 6 months or year for angina, congestive heart failure, COPD, TIA, and diabetes were associated with higher costs; annual eye examinations for patients with diabetes were associated with lower inpatient costs. Subjects who experienced no avoidable events had lower inpatient costs. For total costs, many statistically significant associations with higher costs were similar to those for inpatient costs; however, an eye examination for patients with diabetes was not associated with lower total costs.

Table 3 reports differences in costs for noncancer controls with positive versus negative quality indicators, the incremental differences for cancer survivors, and total differences for cancer survivors, all adjusting for covariates. For two indicators (a visit every year after a TIA, and a cholesterol test for patients with a history of AMI and hypercholesterolemia), differences in inpatient costs between cancer survivors and controls could not be estimated as a result of insufficient variation. Reflecting the findings without adjusting for covariates that were shown in Appendix Fig A1A, higher-quality care on the basis of these indicators was generally associated with higher costs for both the matched controls and the cancer survivors; however, an eye examination for patients with diabetes was associated with lower inpatient costs. Furthermore, no avoidable events was consistently associated with lower costs. Few differences between cancer survivors and noncancer controls were found in the associations between cost and quality. The incremental total, inpatient, and outpatient costs for cancer survivors were statistically significantly less than noncancer controls for the indicators of a visit every 6 months for patients with COPD and patients with diabetes. However, the added costs for cancer survivors were still statistically significantly higher for total and outpatient costs for patients who received recommended care compared with those who did not.

DISCUSSION

The aging of the US population and the associated increase in the number of cancer survivors—particularly those with comorbid conditions—intensify the importance of providing efficient, quality care. This study examined the association between nine process indicators of care quality and one composite outcome indicator of avoidable complications for a population of cancer survivors and noncancer controls. The process quality indicators were not associated with short-term cost savings. The smaller number of statistically significant associations with inpatient costs than with outpatient costs is a logical result if the indicators are proxies for appropriate outpatient care. Associations between quality indicators and higher inpatient costs may reflect that appropriate hospitalizations are being facilitated by more appropriate care.

Alternatively, these process indicators may reflect care intensity instead of quality. Specifically, heavier user of medical care may be more likely to meet process quality indicators without this translating into cost savings, because the patients are higher utilizers overall and are not receiving either coordinated or rational care. A patient seen by a variety of providers including oncologists, other specialists, and primary care physicians has a higher probability of achieving process measures of quality simply through repeated contact with the health care system. In fact, a separate analysis demonstrated that the cancer survivors in this sample who were classified as being at high risk for poor care coordination because they had many providers were more likely to receive the recommended care.[20] Thus a key to less costly care may be the opportunity to coordinate care.

We have also previously examined the association between the care density (ie, the extent to which providers share patients in common) and costs and quality.[21] Higher care density was associated with lower costs of care and lower hospitalization

Table 2. Positive Quality Indicators Among Those Survivors Eligible

Quality Measure	No. Eligible	Positive Quality Indicator, No. (%)
Visit every 6 months for patients with chronic stable angina		
Total	1,487	1,275 (85.7)
Cancer survivor	449	389 (86.6)
Control	1,038	886 (85.4)
Visit every 6 months for patients with CHF		
Total	2,765	2,355 (85.2)
Cancer survivor	1,031	884 (85.7)
Control	1,734	1,471 (84.8)
Visit every 6 months for patients with COPD		
Total	3,190	2,553 (80.0)
Cancer survivor	1,281	1,054 (82.3)
Control	1,909	1,499 (78.5)
Visit every year for patients with TIA		
Total	800	766 (95.8)
Cancer survivor	266	259 (97.4)
Control	534	507 (94.9)
Cholesterol test every 6 months for patients hospitalized for acute myocardial infarction and who have hypercholesterolemia		
Total	150	29 (19.3)
Cancer survivor	45	7 (15.6)
Control	105	22 (21.0)
Lipid profile less than 1 year after initial diagnosis of angina		
Total	1,487	1,063 (71.5)
Cancer survivor	449	308 (68.6)
Control	1,038	755 (72.7)
Visit every 6 months for patients with diabetes		
Total	5,753	4,733 (82.3)
Cancer survivor	1,984	1,696 (85.5)
Control	3,769	3,037 (80.6)
Eye examination every year for patients with diabetes		
Total	5,753	2,734 (47.5)
Cancer survivor	1,984	937 (47.2)
Control	3,769	1,797 (47.7)
Glycosylated hemoglobin or fructosamine every 6 months for patients with diabetes		
Total	5,753	1,606 (27.9)
Cancer survivor	1,984	536 (27.0)
Control	3,769	1,070 (28.4)
No avoidable events		
Total	10,199	8,071 (79.1)
Cancer survivor	3,740	2,996 (80.1)
Control	6,459	5,075 (78.6)

Abbreviations: CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack.

rates, and patients who received primary care visits were more likely to receive recommended care than those who did not. Taken together, these findings suggest that more sophisticated approaches for assessing care quality, including concepts of care coordination, can provide critical information beyond the process indicators used alone.

One notable association between high quality and lower costs is between eye examinations for patients with diabetes and lower inpatient costs. In addition, the composite outcome measure of experiencing "no avoidable events" was associated with lower costs. Avoidable events can be expensive. Additional study would be necessary to determine how the patients managed to avoid the events and whether some of the costs were offset by extra care. Although there is no guarantee that the costs of avoiding the events that did occur would offset the additional care needed to do so, this looks promising.

Quality seems to be associated with costs in similar ways for cancer survivors and matched noncancer controls. In only three cases was higher quality associated with lower costs for the cancer survivors compared with controls on at least one of the three cost measures (total, outpatient, or inpatient). These findings suggest cancer survivorship does not affect the association between care quality and costs.

This study has limitations. This retrospective study of cancer survivors is not a retrospective cohort study because study population members were identified post hoc, and end-of-life patients were not included. Using all cancer patients would have created another methodological issue—whether

Table 3. Regression Results for Differences in Costs for Positive Versus Negative Quality Indicators Among and Between Cancer Survivors and Matched Controls

Quality Measure	Cost Difference for Positive Quality	Total Costs in 2007 Dollars (SD)	Inpatient Costs in 2007 Dollars (SD)	Outpatient Costs in 2007 Dollars (SD)
Visit every 6 months for patients with chronic stable angina; n = 1,487	Difference for matched controls	17,805* (2,668)	9,391* (2,309)	8,966* (1,043)
	Incremental difference for cancer survivors	4,770 (4,349)	6,884 (3,914)	−59 (1,698)
	Cancer survivors total difference	22,575*	16,275*	8,907*
Visit every 6 months for patients with CHF (n = 2,765)	Difference for matched controls	15,142* (2,373)	9,149* (1,906)	6,033* (870)
	Incremental difference for cancer survivors	−634 (3,676)	−245 (2,944)	−214 (1,355)
	Cancer survivors total difference	14,508*	8,904*	5,819*
Visit every 6 months for patients with COPD; n = 3,190	Difference for matched controls	15,084* (2,154)	7,762* (1,755)	7,577* (640)
	Incremental difference for cancer survivors	−8,831† (3,184)	−6,568‡ (2,617)	−2,670† (931)
	Cancer survivors total difference	6,253‡	1,194	4,907*
Visit every year for patients with TIA; n = 800	Difference for matched controls	36,549* (7,175)	26,702* (5,789)	14,545* (2,237)
	Incremental difference for cancer survivors	13,085 (13,844)	§	−350 (4,276)
	Cancer survivors total difference	49,634*	§	14,195*
Cholesterol test every 6 months for patients hospitalized for acute myocardial infarction and who have hypercholesterolemia; n = 150	Difference for matched controls	−3,887 (6,647)	−5,141 (5,166)	−1,383 (2,241)
	Incremental difference for cancer survivors	−16,447 (15,303)	‖	−981 (4,983)
	Cancer survivors total difference	−20,334	‖	−2,364
Lipid profile less than 1 year after initial diagnosis of angina; n = 1,487	Difference for matched controls	−159 (1,901)	−1,947 (1,547)	1,766‡ (738)
	Incremental difference for cancer survivors	−1,041 (3,262)	−1,851 (2,681)	−250 (1,250)
	Cancer survivors total difference	−1,200	−3,798	1,516

(continued on following page)

Table 3. Regression Results for Differences in Costs for Positive Versus Negative Quality Indicators Among and Between Cancer Survivors and Matched Controls (continued)

Quality Measure	Cost Difference for Positive Quality	Total Costs in 2007 Dollars (SD)	Inpatient Costs in 2007 Dollars (SD)	Outpatient Costs in 2007 Dollars (SD)
Visit every 6 months for patients with diabetes; n = 5,753	Difference for matched controls	12,706* (1,342)	6,262* (1,043)	6,520* (474)
	Incremental difference for cancer survivors	−5,739† (2,218)	−4,063‡ (1,761)	−1,768‡ (771)
	Cancer survivors total difference	6,968*	2,199	4,753*
Eye examination every year for patients with diabetes; n = 5,753	Difference for matched controls	−540 (936)	−1,777‡ (747)	1,240* (335)
	Incremental difference for cancer survivors	154 (1,546)	−345 (1,220)	166 (548)
	Cancer survivors total difference	−387	−2,122‡	1,406†
Glycosylated hemoglobin or fructosamine every 6 months for patients with diabetes; n = 5,753	Difference for matched controls	115 (1,057)	−1,174 (831)	1,192* (371)
	Incremental difference for cancer survivors	−2,738 (1,729)	−1,694 (1,359)	−1,334‡ (604)
	Cancer survivors total difference	−2,623	−2,868†	−142
No avoidable events; n = 10,199	Difference for matched controls	−13,255* (950)	−8,744* (875)	−4,429* (296)
	Incremental difference for cancer survivors	287 (1,353)	−639 (1,149)	840 (450)
	Cancer survivors total difference	−12,937*	−9,383*	−3,589*

Abbreviations: CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; SD, standard deviation; TIA, transient ischemic attack.
*$P < .001$.
†$P < .01$.
‡$P < .05$.
§The regression for inpatient costs for having an annual visit after a TIA included a term for quality but did not include an interaction term between quality and being a cancer survivor. The regression did not converge when the interaction term was included. The regression with fewer variables was run to determine whether the results in Fig A1B were robust to the inclusion of confounders. The result includes all cases and is the average cost difference for both the cancer survivors and the matched controls.
||The regression with inpatient costs for having a cholesterol test every 6 months for patients with hypercholesterolemia who were hospitalized as a result of an acute myocardial infarction did not converge when the interaction term between quality and being a cancer survivor was included. The regression did converge when the interaction term and the SEER region indicators were excluded. The regression with fewer variables was run to determine whether the results in Fig A1B were robust to the inclusion of confounders. The result includes all cases and is the average cost difference for both the cancer survivors and the matched controls.

quality measures are appropriate for end-of-life patients. Given the tradeoff, we chose to assess the associations in the increasingly prevalent survivor group. Quality indicators focused more on processes than outcomes. Our findings demonstrated a stronger association between outcomes and costs than between processes and costs. If the process indicators result in better quality and length of life, the cost effectiveness of these process measures warrants further evaluation.

As with all SEER–Medicare analyses, our sample was limited to those older than age 65 in the fee-for-service

program, which is a minor limitation because the prevalence of cancer and comorbid conditions is highest in older adults. Nevertheless, samples were small for some of the quality indicators, making some regression analyses impossible. This study had a 2-year observation period; thus our results do not provide information on long-term cost savings. The Charlson comorbidity index is an imperfect control for overall health. However, there is no reason to believe that this would create a substantial bias nor one that varies between cancer survivors and noncancer controls. Finally, the quality indicators do not account for the severity of the comorbidities; those with less severe comorbid conditions may need less frequent follow-up. This provides an impetus for further refinement of the quality measures.

The quality–cost relationship is complex. This study has shown that process quality indicators are generally associated with higher costs, which is not surprising given that many measures were for visits or tests. The association between quality and lower costs seems strongest for the outcome-based measure of zero avoidable events. A pay-for-performance system will need to reward higher quality with higher reimbursement until more research is done to demonstrate whether the quality measures are also associated with better outcomes. Although the cost differences are larger than the cost of recommended outpatient care, our findings serve as a first step in demonstrating the link between quality and costs and whether quality saves money, is good for patients, and is attainable at a reasonable cost. JOP

Authors' Disclosures of Potential Conflicts of Interest
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References

1. Bunker JP: The role of medical care in contributing to health improvements within societies. Int J Epidemiol 30:1260-1263, 2001

2. Cutler DM, McClellan M: Is technological change in medicine worth it? Health Aff (Millwood) 20:11-29, 2001

3. Milstein A, Shortell S: Innovations in care delivery to slow growth of US health spending. JAMA 308:1439-1440, 2012

4. Okunade AA, Murthy VN: Technology as a 'major driver' of health care costs: A cointegration analysis of the Newhouse conjecture. J Health Econ 21:147-159, 2002

5. Legler A, Bradley EH, Carlson MD: The effect of comorbidity burden on health care utilization for patients with cancer using hospice. J Palliat Med 14:751-756, 2011

6. American Cancer Society. Cancer Treatment and Survivorship Facts & Figures 2014-2015. American Cancer Society, Atlanta. 2014

7. DeSantis CE, Lin CC, Mariotto AB, et al: Cancer treatment and survivorship statistics, 2014. CA Cancer J Clin 64:252-271; (Epub ahead of print), 2014

8. National Cancer Institute: Age distribution (%) of incidence cases by site, 2007-2011. http://seer.cancer.gov/csr/1975_2011/results_merged/topic_age_dist.pdf

9. Snyder CF, Frick KD, Herbert RJ, et al: Quality of care for comorbid conditions during the transition to survivorship: Differences between cancer survivors and noncancer controls. J Clin Oncol 31:1140-1148, 2013

10. Skolarus TA, Zhang Y, Hollenbeck BK: Understanding fragmentation of prostate cancer survivorship care: Implications for cost and quality. Cancer 118:2837-2845, 2012

11. Henry NL, Hayes DF, Ramsey SD, et al: Promoting quality and evidence-based care in early-stage breast cancer follow-up. J Natl Cancer Inst 106:dju034, 2014

12. National Cancer Institute: SEER-Medicare: Brief description of the SEER-Medicare database. Available at: http://healthservices.cancer.gov/seermedicare/overview/brief.html

13. Asch SM, Sloss EM, Hogan C, et al: Measuring underuse of necessary care among elderly Medicare beneficiaries using inpatient and outpatient claims. JAMA 284:2325-2333, 2000

14. Earle CC, Neville BA: Under use of necessary care among cancer survivors. Cancer 101:1712-1719, 2004

15. Charlson ME, Pompei P, Ales KL, et al: A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis 40:373-383, 1987

16. Deyo RA, Cherkin DC, Ciol MA: Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 45:613-619, 1992

17. Klabunde CN, Potosky AL, Legler JM, et al: Development of a comorbidity index using physician claims data. J Clin Epidemiol 53:1258-1267, 2000

18. Andersen R, Aday LA: Access to medical care in the U.S.: Realized and potential. Med Care 16:533-546, 1978

19. Seal B, Sullivan SD, Ramsey SD, et al: Comparing hospital-based resource utilization and costs for prostate cancer patients with and without bone metastases. Appl Health Econ Health Policy 12:547-557; (Epub ahead of print), 2014

20. Snyder CF, Frick KD, Herbert RJ, et al: Comorbid condition care quality in cancer survivors: Role of primary care and specialty providers and care coordination. J Cancer Surviv 9:641-649, 2015

21. Pollack CE, Frick KD, Herbert RJ, et al: It's who you know: Patient-sharing, quality, and costs of cancer survivorship care. J Cancer Surviv 8:156-166, 2014

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Relationship Between Quality of Comorbid Condition Care and Costs for Cancer Survivors

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Appendix

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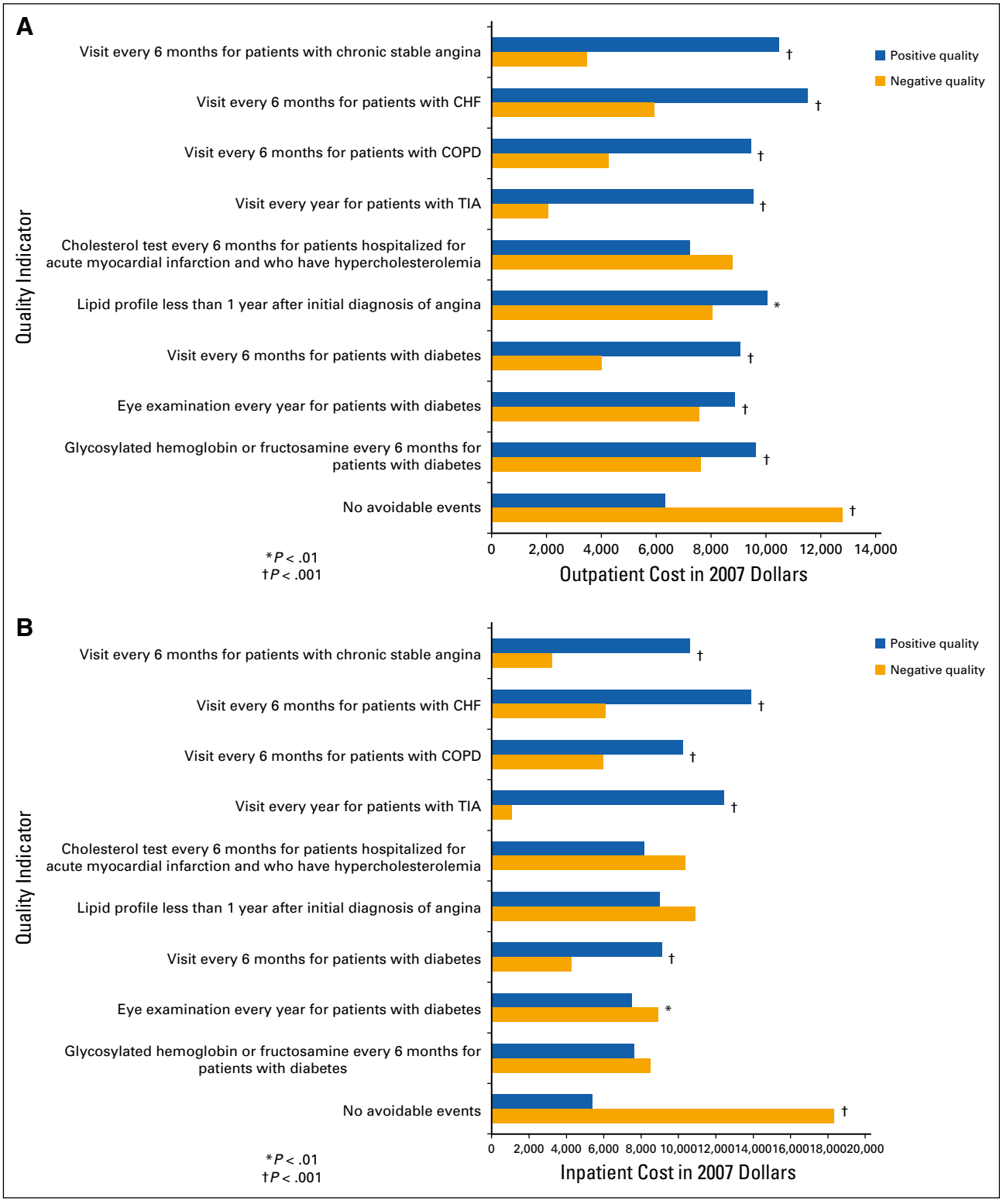

FIG A1. (A) Outpatient cost by positive or negative quality indicator. (B) Inpatient cost by positive or negative quality indicator. (C) Total cost by positive or negative quality indicator. CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; TIA, transient ischemic attack.

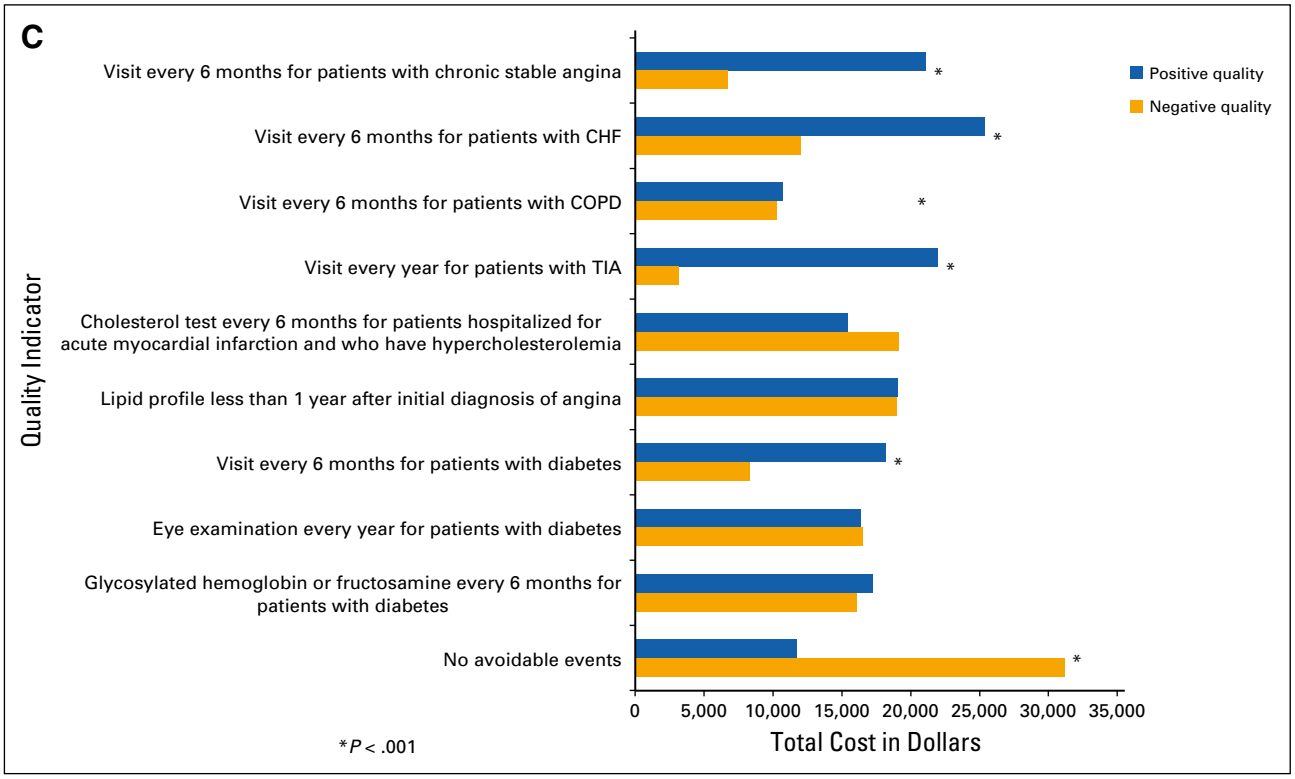

FIG A1. (Continued)