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Impact of Incident Cancer on Short-Term Coronary Artery Disease–Related Healthcare Expenditures Among Medicare Beneficiaries

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Abstract

Background: Healthcare spending for coronary artery disease (CAD)–related services is higher than for other chronic conditions. Diagnosis of incident cancer may impede management of CAD, thereby increasing the risk of CAD-related complications and associated healthcare expenditures. This study examined the relationship between incident cancer and CAD-related expenditures among elderly Medicare beneficiaries.

Patients and Methods: A retrospective longitudinal study was conducted using the SEER-Medicare linked registries and a 5% noncancer random sample of Medicare beneficiaries. Elderly fee-for-service Medicare beneficiaries with preexisting CAD and with incident breast, colorectal, or prostate cancer (N=12,095) or no cancer (N=34,237) were included. CAD-related healthcare expenditures comprised Medicare payments for inpatient, home healthcare, and outpatient services. Expenditures were measured every 120 days during the 1-year preindex and 1-year postindex periods. Adjusted relationship between incident cancer and expenditures was analyzed using the generalized linear mixed models.

Results: Overall, CAD-related mean healthcare expenditures in the preindex period accounted for approximately 32.6% to 39.5% of total expenditures among women and 41.5% to 46.8% among men. All incident cancer groups had significantly higher CAD-related expenditures compared with noncancer groups (P<.0001). Men and women with colorectal cancer (CRC) had 166% and 153% higher expenditures, respectively, compared with their noncancer counterparts. Furthermore, men and women with CRC had 57% and 55% higher expenditures compared with those with prostate or breast cancer, respectively.

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Conclusions: CAD-related expenditures were higher for elderly Medicare beneficiaries with incident cancer, specifically for those with CRC. This warrants the need for effective programs and policies to reduce CAD-related expenditures. Close monitoring of patients with a cancer diagnosis and preexisting CAD may prevent CAD-related events and expenditures.

Background

Cardiovascular disease, including coronary artery disease (CAD) and cerebrovascular disease, has the highest healthcare expenditures (~$231.1 billion in 2013).[1] Healthcare spending for CAD-related services is higher than that for other chronic conditions.[2–4] Furthermore, CAD-related healthcare expenditures in the United States are projected to increase 198% by 2030 because of the aging population.[2]

Evidence also suggests that individuals with CAD have many preexisting conditions or may develop new conditions. The most common preexisting or existing conditions in patients with CAD include cancer, hyper-tension, diabetes, and other cardiovascular diseases.[5] For these individuals, CAD-related expenditures can be higher than for those who only have CAD.[4,6] Specifically, CAD-related expenditures may be higher among individuals with incident cancer (and CAD) during the period immediately after cancer diagnosis, because cardiotoxicity from specific cancer treatments can exacerbate preexisting CAD,[7,8] and diagnosis of incident cancer may impede management of CAD, thereby increasing the risk of CAD-related complications, given that cancer is considered a dominant condition.[9]

However, there is a dearth of studies on the impact of incident cancer diagnosis on CAD-related expenditures. It is important to analyze CAD-related expenditures among Medicare beneficiaries because there are significant differences in healthcare expenditures directly attributed to CAD and total expenditures associated with CAD.[2] Specifically, published studies suggest that inpatient spending accounts for nearly 43% of total expenditures for cardiovascular diseases.[10] Furthermore, CAD-related expenditures may be higher among elderly individuals (aged ≥65 years) as a result of comorbidities related to aging. For example, Dieleman et al[1] reported that 65.2% of expenditures for CAD and related diseases were for elderly individuals, suggesting that these individuals account for most of the expenditures associated with CAD care. Because nearly 84% of elderly patients are covered by Medicare,[11] payments made by Medicare for CAD are substantial, suggesting that it is important to estimate Medicare payments for CAD care. In 2012, Medicare paid $273 billion for heart disease–related expenditures, with a per-person cost of $10,345.[12]

Estimating the extent to which incident cancer affects CAD-related expenditures can help payers with emerging healthcare delivery reform initiatives. These initiatives are focused on financial incentives to improve healthcare quality with lower expenditures. For example, new payment models from the Centers for Medicare & Medicaid Services (CMS) support bundled payments for episodes of care. One experimental initiative will support bundled payments for clinicians providing care to patients with CAD.[13] Such models have the potential to be extended to individuals who develop cancer after CAD. For example, the Medicare Access and CHIP Reauthorization Act of 2015 (MACRA) created alternative payment models,[13] providing value-based care and penalties for poor quality of care. These models require risk adjustment for patients,[14–16] and therefore identifying those at risk for high cost is important.

The present study examined the impact of incident cancer on CAD-related expenditures using data from a cohort of elderly fee-for-service (FFS) Medicare beneficiaries with and without cancer. The cancer cohort consisted of elderly patients with incident breast, colorectal, or prostate cancer. These cancers were selected because they have a higher prevalence among the elderly population,[17] and preexisting CAD is highly prevalent in this population diagnosed with these cancers.[18–23]

Patients and Methods

Conceptual Framework

The conceptual framework of this study was adapted based on Andersen's Behavioral Model of Health Service Use for understanding CAD-related healthcare expenditures and a priori selection of independent variables.[24,25] This model posits that an individual's predisposing, enabling, and need factors; personal health practices; healthcare use; and external environment may influence healthcare expenditures.[26]

Study Design

A retrospective observational longitudinal cohort design with 12-month preindex and postindex periods was used. Index date was defined as the date of incident cancer diagnosis for the cancer cohort and pseudo-diagnosis date for the noncancer cohort. Pseudo-diagnosis dates were randomly selected from the dates of service. Each individual was observed for 48 months (Figure 1).

Data Sources

Data were derived from claims in the SEER-Medicare linked registries, 5% noncancer random sample of Medicare beneficiaries in the SEER region (living in the same SEER areas as those in the cancer registry), American Community Survey (census tract information),[27] and the Area Health Resources Files (county-level healthcare environment factors).[28]

Study Population

The study population comprised beneficiaries with preexisting CAD, who were further categorized into those with incident breast, colorectal, or prostate cancer and those without cancer. The cancer cohort comprised the total number of incident cases and not the random sample. CAD was identified using a validated algorithm developed by CMS[29] that used ICD-9-CM codes. Individuals with at least 2 inpatient, outpatient, and carrier claims (clinician encounters only), or home healthcare agency (HHA) service Medicare claims with a primary or secondary diagnosis of CAD during the baseline were classified as preexisting CAD. Incident cancer, defined as new cancer diagnosis during the study period (January 2008 through December 2011), was identified using the ICD-O-3 codes from the SEER registries.

Other inclusion criteria were age ≥68 years, alive with continuous FFS Medicare Parts A and B enrollment during the entire study period, continuous Part D enrollment during the preindex and postindex periods, no missing information on county, and total expenditures > $0 during the preindex and postindex periods. In the cancer cohort, individuals with missing data on cancer type and stage and those diagnosed postmortem were excluded (Figure 2).

Measures

Dependent Variable: CAD-Related Expenditures—CAD-related healthcare and total expenditures consisted of Medicare payments for inpatient, HHA, and out-patient services for CAD-related care, measured every 120 days (t_1, t_2, t_3, t_4, t_5, and t_6). CAD-related services were identified using ICD-9-CM primary and secondary diagnosis codes for CAD.[30,31] Prescription medication and durable medical equipment (DME) expenditures were not included because of the challenges in identifying CAD-related expenditures in DME and prescription drug claims. Short-term healthcare expenditures >12 months in the postindex period were examined. Healthcare expenditures were adjusted by the Consumer Price Index for medical services[32] and expressed in 2012 USD.

Key Independent Variables: Sex and Cancer Type—Because the study included women with breast cancer and men with prostate cancer, the key time-invariant independent variable accounted for both sex and cancer type and was categorized into 6 mutually exclusive groups: women with breast cancer, women with colorectal cancer (CRC), women with no cancer, men with prostate cancer, men with CRC, and men with no cancer.

Other Independent Variables

Predisposing Factors: Age measured at index month of incident cancer diagnosis and race/ethnicity were time-invariant independent variables.

Enabling Factors: Medicare Part D coverage gap (measured every 120 days) and census tract–level education attainment and poverty status (based on income threshold that varied by family size and composition; measured at baseline).

Need-Based Factors: Physical health conditions were measured at baseline and categorized into concordant (cardiac arrhythmias, congestive heart failure, diabetes, hyperlipidemia, hypertension, and stroke) and discordant (dementia, asthma, chronic obstructive pulmonary disease, arthritis, hepatitis, HIV, and osteoporosis). Mental health conditions included severe mental illness (schizophrenia, bi-polar disorder, and psychoses; measured at baseline), anxiety, and depression (measured every 120 days). For CAD severity, a proxy measure, which was measured at baseline, was constructed based on the CMS hierarchical condition category (HCC) classification system, in which each of the HCC codes for CAD was assigned a specific score based on the risk and severity, ranging from 0.231 to 0.349. Higher scores represented severe manifestations of CAD.[33]

Personal Healthcare Practices: Tobacco and alcohol abuse[34,35] were measured every 120 days.

Healthcare Use: Primary care visits, cardiologist visits, and adherence to statins or angiotensin converting enzyme inhibitors (ACEIs), angiotensin II receptor blockers (ARBs), or β-blockers measured every 120 days. Adherence was defined as proportion of days covered (PDC), calculated among those who filled ≥2 prescriptions for either statins or any 2 prescriptions of ACEIs/ARBs/b-blockers. Individuals with PDC ≥80% were considered adherent and those with PDC <80% were considered non-adherent.[36] PDC measure is recommended by the Pharmacy Quality Alliance[37] and used by CMS in its rating of an insurance plan.[38] Adherence was classified into 5 mutually exclusive groups (supplemental eAppendix 1, available with this article at JNCCN.org).

External Environment Factors: These time-invariant external environment factors were measured at baseline. This domain included SEER region, county metropolitan status, and percentage of cardiologists and oncologists in the county. This study also controlled for time (t_1–t_6) to better reflect changes associated with time in treatment practices.

Statistical Analyses

Unadjusted subgroup differences in time-invariant characteristics between cancer and noncancer categories by sex (6 groups) were tested with chi-square statistics. Our preliminary analyses indicated that there were significant group differences in age, race/ethnicity, concordant and discordant physical health conditions, mental health conditions, SEER region, and index year between the categories. Therefore, inverse probability treatment weights (IPTWs) were derived using the multinomial logistic regression on cancer and noncancer categories, with sex, age, race/ethnicity, SEER region, and index year as independent variables; these weights were used when modeling expenditures to adjust for the differences in these variables between cancer and non-cancer cohorts. The weighting enabled us to balance the differences among cancer and noncancer cohorts. Supplemental eAppendix 2 summarizes the findings from the multinomial logistic regression used to calculate IPTW.

Because CAD-related healthcare expenditures were measured every 120 days during the preindex and postindex periods, each individual had 6 observations. These observations were not independent, and therefore the authors used generalized linear mixed models (GLMMs) with gamma distribution and log-link to analyze adjusted relationships between cancer and noncancer groups and CAD-related healthcare expenditures. This is the most commonly used approach in previous cost analyses.[39,40] These GLMMs included predisposing, enabling and need factors, external environmental characteristics, and time.

Results

Characteristics of the Study Cohorts Before and After IPTW Adjustment

The study cohort comprised 46,332 elderly FFS Medicare beneficiaries with preexisting CAD (12,095 with cancer and 34,237 without cancer). After adjusting with IPTW, no significant differences were seen in independent variables between cancer diagnoses (Table 1).

Expenditures for t_1, t_2, and t_3 were aggregated to represent the preindex period, and expenditures for t_4, t_5, and t_6 were aggregated to represent the postindex period (Table 2). CAD-related expenditures in the postindex period were approximately 3 times higher for men and women with CRC, 2 times higher for women with breast cancer, and 1.5 times higher for ment with prostate cancer. The postindex CAD-related expenditures for the noncancer group, in comparison, were similar to those in the preindex period.

CAD-Related Expenditures Over Time by Cancer and Noncancer Status

When time was included as an adjuster, the time coefficient was positive across all cancer groups, suggesting that CAD-related expenditures increased over time for all cancer groups (Figure 3). However, no such differences were observed for noncancer groups.

Adjusted Relationships Between Cancer and CAD-related Healthcare Expenditures

Total CAD-related expenditures are presented in Table 3 and inpatient and outpatient CAD-related expenditures are presented in Table 4. CAD-related healthcare expenditure comparisons by cancer status, sex, and cancer type are detailed as follows.

Cancer Versus No Cancer—Patients with breast, colorectal, or prostate cancer had higher outpatient and total CAD-related expenditures compared with their noncancer counterparts. Inpatient expenditures were significantly higher for CRC, but not for breast or prostate cancer, compared with their noncancer counterparts.

Men Versus Women—Women with CRC or no cancer had lower total inpatient, outpatient, and CAD-related expenditures compared with men with CRC or no cancer, respectively.

Cancer Type—Both men and women with CRC had higher inpatient and total CAD-related expenditures compared with men with prostate cancer and women with breast cancer, respectively.

Relationship Between Other Independent Variables and Expenditures

Factors associated with significantly increased expenditures included age ≥80 years, concordant and discordant physical health conditions, mental health conditions, higher CAD severity, tobacco use, alcohol use, visit to primary care physician or cardiologist, and nonadherence to one or both medication classes (for those using both medication classes; supplemental eAppendix 1).

Discussion

This is the first study to estimate short-term CAD-related expenditures among cancer and noncancer FFS Medicare beneficiaries with preexisting CAD. In general, CAD accounted for a substantial portion of total expenditures before and after cancer diagnosis, and these expenditures were higher for those with cancer compared with those without. The authors speculate that part of the CAD-related expenditures among patients with cancer may result from cancer treatments.[7,8] For patients undergoing cancer surgery, CAD may need to be stabilized using medical management,[7] further adding to their overall CAD-related expenditures. Moreover, it is plausible that cancer may take precedence over CAD management and impede the recommended care for CAD, thereby increasing CAD-related complications[9] and leading to higher CAD-related expenditures.

Notably, CAD-related expenditures were highest among patients with CRC compared with those with breast, prostate, or no cancer. Furthermore, CAD-related expenditures were highest during the 120-day interval immediately after CRC diagnosis. Most patients in our study had advanced-stage CRC (63.0%), treatment of which consists of surgery and adjuvant chemotherapy (eg, 5-fluorouracil and capecitabine).[41] This suggests that CAD-related expenditures may be higher among those with CRC due to chemotherapy-related cardiotoxicity. Additionally, nonadherence to statins and ACEIs/ARBs/β-blockers was significantly higher in patients with CRC who had undergone surgery (81%). Nonadherence to these medications may increase the risk of CAD-related complications and hospitalizations, thereby increasing inpatient expenditures.[42]

Another noteworthy finding was that women had lower CAD-related expenditures compared with men. Chiha et al[43] assessed the differences in CAD severity among men and women and noted that women were more likely to have normal coronary arteries or less severe disease than age-matched men. Although we controlled for severity of CAD with HCC, future research needs to explore whether the lower expenditures among women are because of sex-related differences in severity of CAD.

Finally, CAD-related expenditures increased over time for all cancer groups. Our findings indicated that expenditures were highest during the 120-day interval immediately after cancer diagnosis, suggesting that the period after cancer diagnosis may be crucial for CAD management.

Policy Implications

New bundled payment models and the Medicare Shared Savings Program use risk adjustment to calculate expenditure benchmarks needed to provide care and obtain shared savings from the CMS.[13,44] These value-based frameworks have been designed to improve the quality and affordability of care. These frameworks aim to ensure that the cost of overall care, including treatment, interventions, and prescriptions, reflect the benefits for better quality of life. There are few notable value frameworks in oncology that account for each stake-holder’s perspective. Collectively, our findings can help payers calculate these benchmark expenditures by adjusting for case mix of Medicare beneficiaries, specifically those with preexisting CAD and incident cancer.[14–16] In addition, our findings can help capture the episode-specific contribution of individual risk factors (eg, age, sex, comorbidities, episode severity) to resource use, similar to risk models implemented by the PROMETHEUS Payment model.[16,45] PROMETHEUS is a bundled payment model that uses algorithms to create episodes with relevant services. It helps determine appropriate reimbursement rates for payment for multiple medical conditions and procedures in an episode-of-care system. Currently, no specific payment models account for cancer and CAD, but available models such as PROMETHEUS can be tailored to specific patterns of resource use within CAD. Therefore, it is crucial to understand the extent to which a specific cancer contributes to CAD-related expenditures to implement these models. Based on our study findings, it is apparent that resource allocation for CAD-related expenditures should be higher for patients with CRC, followed by prostate and breast cancer.

The authors also found that CAD-related inpatient expenditures accounted for two-thirds of the overall CAD-related healthcare expenditures. Heart failure as a comorbidity can greatly diminish the patient's quality of life, limit the therapeutic dose of anticancer treatment, and significantly affect the patient's use of healthcare services, with frequent hospital readmissions. Although CMS has imposed penalties for potential hospital readmissions and preventable hospitalizations, such as inpatient admissions for angina without procedures,[46] these may not be effective in patients with complex conditions such as CAD and cancer. In this context, future research needs to focus on collaborative care models, such as the patient-centered medical home, because such models have been shown to reduce inpatient use.[47,48]

Strengths and Limitations

This study adopted a longitudinal design and compared expenditures over time between cancer and noncancer groups. We also used statistical adjustment for selection bias in observed and unobservable characteristics. Use of Medicare FFS claims data enabled us to track individuals across various providers and settings, and calculate expenditures and measure variables for specific periods. The study also adjusted for a comprehensive list of factors that can influence CAD-related expenditures and included individuals with significant medical comorbidities.

Our findings cannot be generalized to all Medicare beneficiaries, because the study population is restricted to those residing in SEER regions and those with FFS Medicare plans. Furthermore, SEER-Medicare data are not developed for research purposes, and therefore have limitations associated with their use for estimating healthcare expenditures. There might be underestimation of CAD-related diagnosis, which in turn may undermine CAD-related expenditures for several reasons. It is possible that CAD diagnosis may be undercoded or misclassified in claims data, because these data are dependent on professional ICD coding. Furthermore, 1 year of follow-up may not be long enough to assess advanced-stage incident cancer, which might influence the link between increased spending and incidence cases. In addition, SEER-Medicare data do not capture all procedures performed. The overall cost burden of CAD in incident cancer cases might be an underestimate as a result of not including end-of-life care and broader expenditures, such as out-of-pocket costs or productivity issues. Finally, we were not able to control for family history, patient-level lifestyle health behaviors, knowledge, attitude, and preferences, or number of cancer-related complications, treatment-related adverse effects, and cost-related factors that may affect CAD-related expenditures.

Conclusions

Our findings showed that incident cancer diagnosis was associated with higher short-term CAD-related expenditures compared with patients without cancer. Specifically, inpatient expenditures for patients with CRC were considerably higher than outpatient expenditures, suggesting the need for greater emphasis on preventing cardiac events in the outpatient setting to reduce more expensive inpatient encounters. Future studies are needed to explore whether the emerging payment reforms and collaborative care models can lower costs while maintaining high-quality CAD care for patients with and without cancer.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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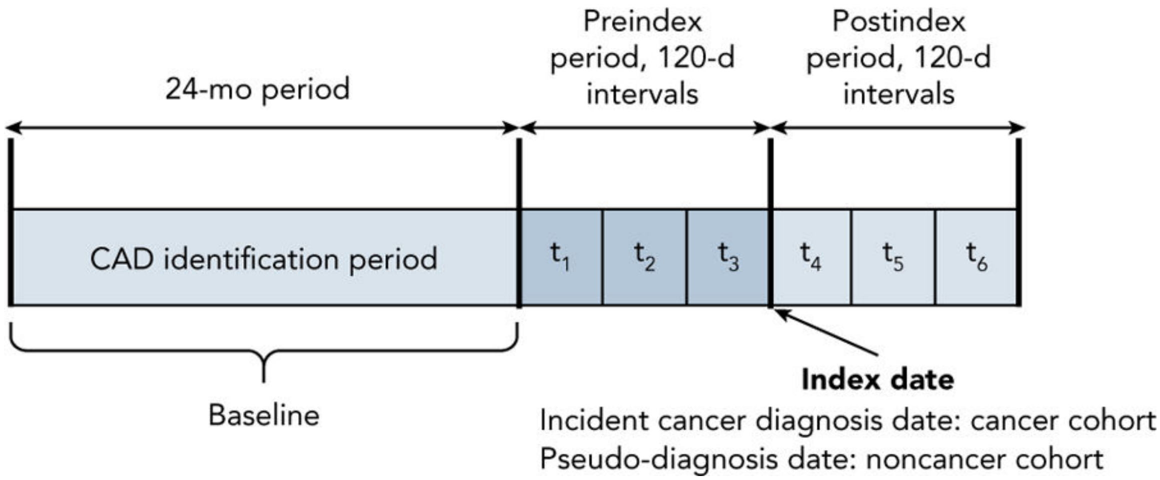

Figure 1.

Schematic of the study design. Each individual was observed for 48 months with a 24-month baseline (for identification of CAD and baseline characteristics), 12-month preindex, and 12-month postindex period. CAD-related healthcare expenditures and selected independent variables were measured repeatedly every 120 days during the preindex (t_1, t_2, and t_3) and postindex (t_4, t_5, and t_6) periods, yielding a total of 6 repeated measures for every individual. Abbreviation: CAD, coronary artery disease.

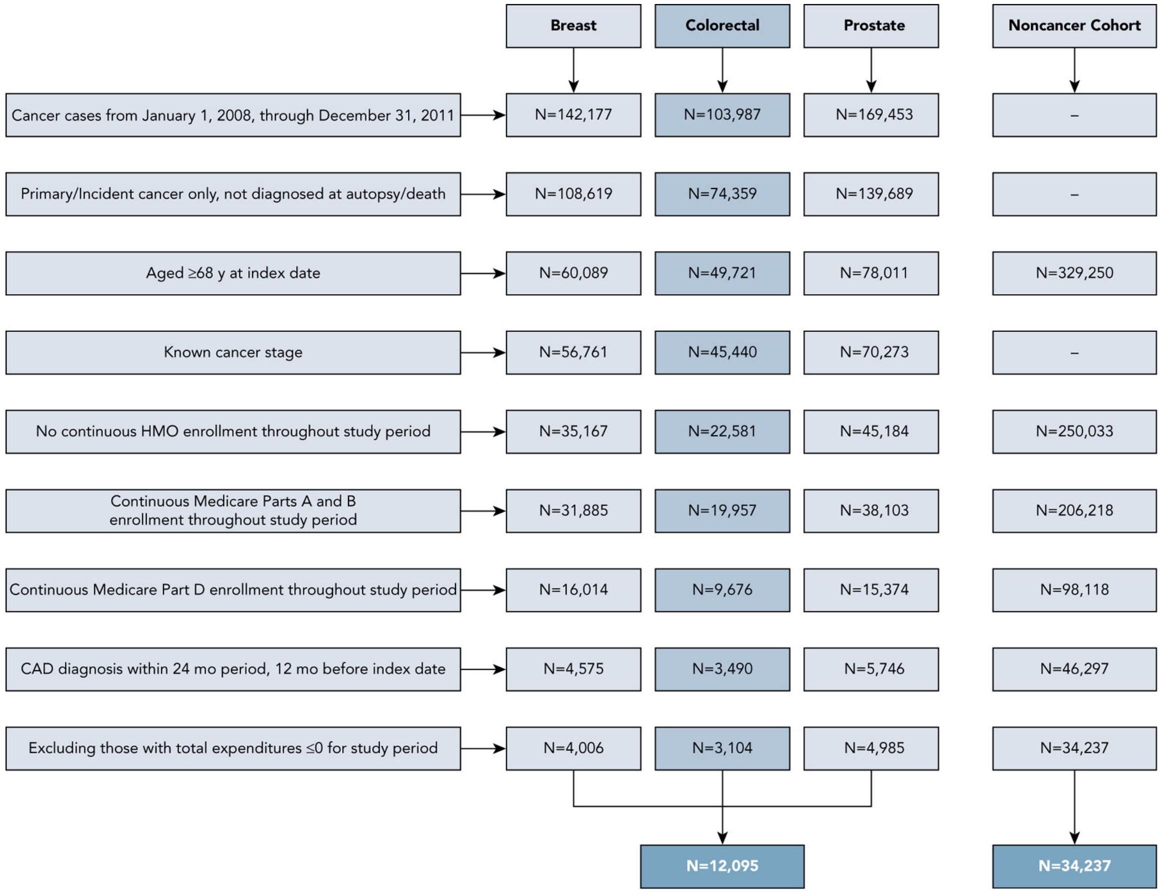

Figure 2.

Schematic presentation of selection criteria for study cohort.

Abbreviation: CAD, coronary artery disease.

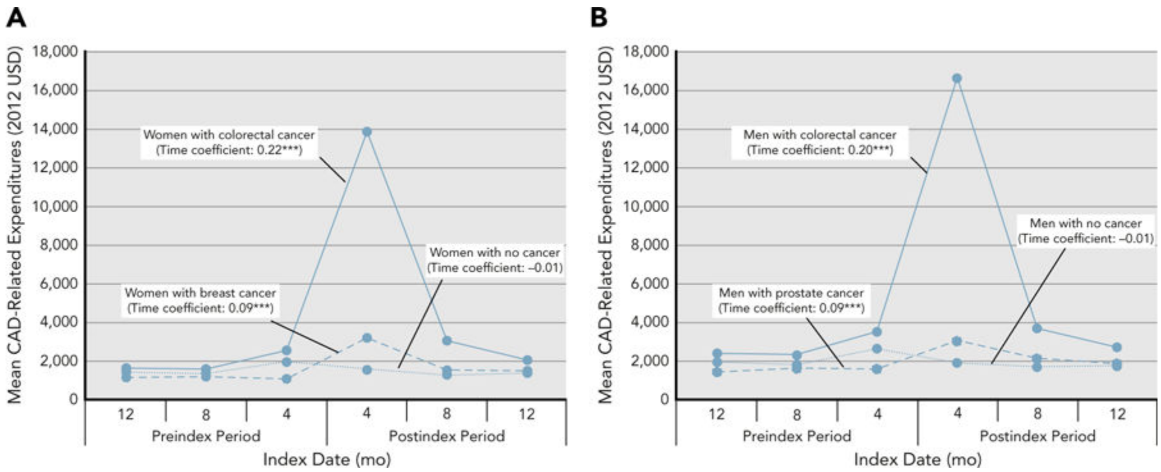

Figure 3.

Weighted average CAD-related expenditures among cancer and noncancer cohorts in (A) women and (B) men during 120-day intervals. Based on 46,332 elderly fee-for-service Medicare beneficiaries with preexisting CAD between 2008 and 2011 (cancer cohort: n=12,095; noncancer cohort: n=34,237). Individuals with incident breast, colorectal, or prostate cancer were derived from the SEER registries, and individuals with no cancer were derived from the 5% noncancer sample from the SEER region. Weights were derived using the inverse probability treatment weights approach. Asterisks represent significant differences in cancer and noncancer groups.

Abbreviation: CAD, coronary artery disease.

****P*<.001; **.001≤*P*<.01; *.01≤*P*<.05.

Table 1.

Unweighted and Weighted Percent of Selected Characteristics by Cancer Diagnosis Categories

	Before IPTW (%) for Cancer Groups							After IPTW (Weighted %) for Cancer Groups						
Characteristics	Breast	Colorectal (Women)	Colorectal (Men)	Prostate	None (Women)	None (Men)	Sig[a]	Breast	Colorectal (Women)	Colorectal (Men)	Prostate	None (Women)	None (Men)	Sig[a]
Age, y							***							NS
68–70	13.8	9.2	14.7	21.4	13.7	22.4		17.0	16.6	16.7	16.5	16.8	16.9	
71–74	19.8	14.5	23.4	30.5	17.2	23.8		20.7	20.8	20.7	20.6	20.6	20.6	
75–79	26.0	22.2	25.0	27.8	21.2	23.4		22.8	23.5	23.4	23.0	23.1	22.9	
≥80	40.4	54.1	36.9	20.3	47.9	30.4		39.5	39.2	39.2	39.9	39.5	39.6	
Race/Ethnicity							***							NS
White	82.5	78.7	82.8	82.7	75.0	77.6		77.5	77.0	77.1	76.0	77.2	77.1	
African American	9.4	11.2	4.9	7.6	10.4	5.7		8.7	8.8	8.7	9.0	8.7	8.7	
Hispanic	2.9	2.3	2.1	2.6	4.3	4.0		3.7	3.6	4.1	4.2	3.9	4.0	
Other	5.2	7.8	10.2	7.1	10.3	12.7		10.0	10.6	10.0	10.8	10.2	10.2	
Concordant PHC[b]							***							NS
Yes	95.5	96.4	95.4	94.6	94.0	92.4		93.8	93.4	94.0	94.3	93.9	93.9	
No	4.5	3.6	4.6	5.4	6.0	7.6		6.2	6.6	6.0	5.7	6.1	6.1	
Discordant PHC[b]							***							
Yes	48.1	51.4	37.5	31.7	50.1	33.9		43.2	43.9	43.4	43.9	43.5	43.8	
No	51.9	48.6	62.5	68.3	49.9	66.1		56.8	56.1	56.6	56.1	56.5	56.2	
MHC[b]							***							
Yes	13.0	13.1	8.9	5.7	15.2	9.3		12.1	12.6	12.4	12.6	12.2	12.6	
No	87.0	86.9	91.1	94.3	84.8	90.7		87.9	87.4	87.6	87.4	87.8	87.4	
SEER region							***							NS
Northeast	24.1	26.3	24.0	20.0	22.7	18.9		21.9	21.6	21.7	20.1	21.6	21.7	
South	25.1	25.4	22.2	24.6	25.6	23.8		24.9	24.5	24.7	25.2	24.7	24.5	
North-Central	13.9	14.5	12.8	14.2	11.8	10.5		12.1	11.5	12.1	12.8	12.0	11.9	
West	36.9	33.8	41.0	41.1	39.9	46.8		41.1	42.3	41.5	41.9	41.6	41.9	

Characteristics	Before IPTW (%) for Cancer Groups							After IPTW (Weighted %) for Cancer Groups						
	Breast	Colorectal (Women)	Colorectal (Men)	Prostate	None (Women)	None (Men)	Sig[a]	Breast	Colorectal (Women)	Colorectal (Men)	Prostate	None (Women)	None (Men)	Sig[a]
Index year							**							NS
2008	24.0	25.1	24.9	24.6	23.9	23.4		24.1	25.9	23.7	22.8	23.9	24.7	
2009	24.5	23.9	23.8	25.1	23.8	24.7		23.8	23.7	24.9	23.6	24.2	24.2	
2010	25.4	25.6	25.3	23.8	26.1	24.8		26.0	25.7	25.6	25.5	25.4	25.2	
2011	26.1	25.3	25.9	26.5	26.3	27.1		26.2	24.7	25.7	28.1	26.6	25.9	

Time-invariant characteristics included cancer diagnosis categories, age, race/ethnicity, poverty status, high school education, concordant and discordant physical health conditions, severe mental illness, SEER region, and county-level characteristics. Time-variant characteristics included tobacco use, alcohol use, depression, anxiety, routine follow-up with primary care physician and/or cardiologist, and donut hole.

Abbreviations: CAD, coronary artery disease; IPTW, inverse probability treatment weighting; MHC, mental health conditions; NS, nonsignificant; PHC, physical health conditions; sig, significance.

[a]Asterisks represent significant differences in time-invariant patient-level characteristics based on chi-square tests.

[b]Concordant physical health conditions consisted of diabetes, hyperlipidemia, hypertension, stroke, cardiac arrhythmia, and congestive heart failure. Discordant physical health conditions consisted of arthritis, asthma, chronic obstructive pulmonary disease, osteoporosis, dementia, human immunodeficiency virus, and hepatitis. Mental health conditions included anxiety, depression, severe mental illness (schizophrenia, bipolar disorder, psychoses).

*** P<.001

** .001≤P<.01

* .01≤P<05. Column percentages are reported

Table 2.

CAD-Related Expenditures Adjusted With Inverse Probability Treatment Weights

	Preindex			Postindex			
	Total	CAD-Related		Total	CAD-Related		
Cancer and Noncancer Groups	Wt Mean (SD)[b]	Wt Mean (SD)[b]	% CAD-Related[c]	Wt Mean (SD)[b]	Wt Mean (SD)[b]	% CAD-Related[c]	Significance[a]
Women							
Breast	10,493 (18,644)	3,423 (10,504)	32.6	29,596 (27,749)	6,154 (14,419)	20.8	
Colorectal	14,504 (27,138)	5,722 (15,071)	39.5	55,895 (45,829)	18,916 (27,102)	33.8	***
None (Ref)	12,099 (22,579)	4,662 (13,670)	38.5	10,656 (22,379)	4,164 (13,370)	39.1	
Men							
Colorectal	17,548 (31,452)	8,220 (19,298)	46.8	56,849 (48,323)	23,021 (28,781)	40.5	***
Prostate	11,089 (18,689)	4,603 (12,063)	41.5	28,040 (27,099)	7,022 (16,316)	25.0	*
None (Ref)	13,943 (26,758)	6,380 (16,668)	45.8	11,659 (26,681)	5,377 (15,594)	46.1	

Abbreviations: CAD, coronary artery disease; Wt, weighted.

[a] Asterisks represent significant differences in cancer and noncancer categories. Significance was derived from unadjusted generalized linear model with gamma distribution and log-link. The analysis included 6 repeated observations.

[b] All expenditures reported in 2012 USD.

[c] Percentage $\text{CAD}-\text{related} = \frac{CAD - related\ expenditures}{Total\ expenditures} \times 100.$

*** $P<.001$

** $.001 \le P < .01$

* $.01 \le P < .05$.

Table 3.

Parameter Estimates From GLMMs on Total CAD-Related Expenditures With Inverse Probability Treatment Weights

Cancer Diagnosis Categories	Coefficient	SE	*P* Value	% Change[a]
Cancer vs noncancer (Ref: none [women])				
Breast	0.13	0.04	.002	14%
Colorectal (women)	0.92	0.05	.000	151%
Intercept	4.01	0.14		
Cancer vs noncancer (Ref: none [men])				
Colorectal (men)	0.97	0.05	.000	164%
Prostate	0.11	0.04	.008	12%
Intercept	4.25	0.14		
Sex differences (Ref: none [men])				
None (women)	−0.24	0.03	.000	−21%
Intercept	4.25	0.14		
Sex differences (Ref: colorectal [men])				
Colorectal (women)	−0.29	0.07	.000	−25%
Intercept	5.22	0.15		
Cancer type differences (Ref: breast)				
Colorectal (women)	0.79	0.06	.000	55%
Intercept	4.93	0.15		
Cancer type differences (Ref: prostate)				
Colorectal (men)	0.85	0.06	.000	57%
Intercept	5.22	0.15		

Abbreviations: CAD, coronary artery disease; GLMMs, generalized linear mixed models.

[a]Percent change for GLMMs was calculated as $(e^{(\text{intercept} + \beta)} - e^{\text{intercept}})/e^{\text{intercept}}$.

Table 4.

Parameter Estimates From GLMMs on Inpatient and Outpatient CAD-Related Expenditures With Inverse Probability Treatment Weights

	Inpatient CAD-Related Expenditures				Outpatient CAD-Related Expenditures			
Cancer Diagnosis Categories	**Coefficient**	**SE**	***P* Value**	**% Change[a]**	**Coefficient**	**SE**	***P* Value**	**% Change[a]**
Cancer vs noncancer (Ref: none [women])								
Breast	0.11	0.08	.15	12%	0.43	0.04	.000	54%
Colorectal (women)	1.22	0.08	.000	239%	0.39	0.05	.000	48%
Intercept	2.36	0.20			3.13	0.12		
Cancer vs noncancer (Ref: none [men])								
Colorectal (men)	1.25	0.08	.000	249%	0.41	0.06	.000	51%
Prostate	0.10	0.07	.152	11%	0.27	0.04	.000	31%
Intercept	2.71	0.20			3.47	0.11		
Sex differences (Ref: none [men])								
None (women)	−0.35	0.06	.000	−30%	−0.35	0.03	.000	−30%
Intercept	2.71	0.20			3.47	0.11		
Sex differences (Ref: colorectal [men])								
Colorectal (women)	−0.38	0.10	.000	−32%	−0.37	0.07	.000	−31%
Intercept	3.96	0.21			3.89	0.13		
Cancer type differences (Ref: breast)								
Colorectal (women)	1.11	0.1	.000	67%	−0.04	0.06	.522	−4%
Intercept	3.58	0.21			3.52	0.13		
Cancer type differences (Ref: prostate)								
Colorectal (men)	1.14	0.09	.000	68%	0.14	0.09	.056	13%
Intercept	3.96	0.21			3.89	0.13		

Abbreviations: CAD, coronary artery disease; GLMMs, generalized linear mixed models.

[a]Percent change for GLMM was calculated as $(e^{(\text{intercept} + \beta)} - e^{\text{intercept}})/e^{\text{intercept}}$.