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Depression treatment and healthcare expenditures among elderly Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer

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Abstract

Objectives—Depression is associated with high healthcare expenditures, and depression treatment may reduce healthcare expenditures. However, to date, there have not been any studies on the effect of depression treatment on healthcare expenditures among cancer survivors. Therefore, this study examined the association between depression treatment and healthcare expenditures among elderly with depression and incident cancer.

Methods—The current study used a retrospective longitudinal study design, the linked Surveillance, Epidemiology, and End Results–Medicare database. Elderly (≥ 66 years) fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer (N = 1502) were followed for a period of 12 months after depression diagnosis. Healthcare expenditures were measured every month for a period of 12-month follow-up period. Depression treatment was identified during the 6-month follow-up period. The adjusted associations between depression treatment and healthcare expenditures were analyzed with generalized linear mixed model regressions with gamma distribution and log link after controlling for other factors.

Results—The average 1-year total healthcare expenditures after depression diagnosis were \$38 219 for those who did not receive depression treatment; \$42 090 for those treated with antidepressants only; \$46 913 for those treated with psychotherapy only; and \$51 008 for those treated with a combination of antidepressants and psychotherapy. As compared to no depression treatment, those who received antidepressants only, psychotherapy only, or a combination of antidepressants and psychotherapy had higher healthcare expenditures. However, second-year expenditures did not significantly differ among depression treatment categories.

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Conclusions—Among cancer survivors with newly diagnosed depression, depression treatment did not have a significant effect on expenditures in the long term.

Keywords

cancer; expenditures; oncology; SEER-Medicare

1 | Introduction

Depression is highly prevalent among cancer survivors, and it has been reported that cancer survivors with depression incur higher healthcare expenditures as compared to those without depression.¹ Among elderly prostate cancer survivors, those with depression had 33.3% higher healthcare expenditures during the 12 months after cancer diagnosis as compared to those without depression.¹ Among adults with cancer, those with depression had 31.7% higher 1-year healthcare expenditures as compared to those without depression.² While depression leads to increased healthcare expenditures, depression treatment may lead to a reduction in healthcare expenditures because of improved health outcomes.

However, to date, there have not been any studies that have examined the association between depression treatment and healthcare expenditures in real-world settings. Therefore, we infer the association between depression treatment and healthcare expenditures using findings from studies among elderly individuals. These studies have shown a positive association between depression treatment and healthcare expenditures. A study among elderly fee-for-service Medicare beneficiaries with prevalent depression and chronic physical conditions seeking care in real-world practice settings found that treatment for depression with antidepressants (20%) and treatment with psychotherapy with/without antidepressants (29%) was associated with an increase in short-term total healthcare expenditures.³ A longitudinal study in real-world practice settings found that elderly who received antidepressant treatment had 32% higher outpatient expenditures as compared to those without antidepressant treatment.⁴

The abovementioned studies suggest that the relationship between depression treatment and healthcare expenditures among cancer survivors is not yet established. To the best of our knowledge, there are no studies that examine whether depression treatment can reduce healthcare expenditures among cancer survivors seeking care in real-world settings. Therefore, the primary objective of the current study is to compare healthcare expenditures by depression treatment categories among elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer. It is important to understand the association between depression treatment and healthcare expenditures for many reasons. First, depression is associated with poor health-related quality of life, higher healthcare utilization and expenditures,^{1,5} and unplanned readmissions.^{6–8} Depression treatment can improve health outcomes and may reduce healthcare utilization and expenditures. However, in the short term, depression treatment may lead to higher healthcare cost because of continuous care to treat depression and fragmented healthcare. Understanding the association between depression treatment and healthcare cost is particularly important, as a large portion of Medicare healthcare

expenditures is attributed to the treatment of coexisting health conditions.⁹ Furthermore, Medicare has implemented many payment reforms to ensure high-quality care at lower costs.¹⁰ Given the importance of reducing healthcare spending among Medicare beneficiaries, the current study can provide important information on cost saving of depression treatment to payers, policy makers, and providers.

2 | Methods

2.1 | Design

This study used a retrospective longitudinal study design with a 12-month baseline (April 2006 through December 2011) and a 12-month follow-up period (April 2007 through December 2012). The baseline period was based on a depression diagnosis date and consisted of the 12 months before the depression diagnosis date. Healthcare expenditures were measured every month for a period of 12 months after depression diagnosis. To capture the variations in healthcare expenditures at different time point of follow-up period, we used the repeated measures statistical models. As independent measure design often measures aggregated healthcare expenditures at the follow-up period, repeated measures were used because it allowed us to capture the expenditures during and after depression treatment.

Depression treatment was measured during the first 6 months after depression diagnosis. Other explanatory variables were measured during the 12 months before depression diagnosis and during the follow-up period.

2.2 | Data sources

This study used the linked Surveillance, Epidemiology, and End Results (SEER)–Medicare database files. The SEER Program collects data on all incident cases of cancer that occur in persons residing in 18 SEER regions.¹¹ Data on all incident cases of cancer, demographic characteristics, and cancer stage were derived from SEER database. The SEER data have been linked to Medicare claims files. Medicare claims files consist of inpatient, outpatient, prescription drug, and other files.

2.3 | Study population

The study population is composed of elderly cancer survivors (age ≥ 66 years) who were diagnosed with incident breast, colorectal, or prostate cancer and who were newly diagnosed with depression after cancer diagnosis between 2007 and 2011. We identified the cancer type (breast, colorectal, or prostate cancer) using the International Classification of Diseases for Oncology, 3rd Edition histology codes and the primary site variable.

2.4 | Cancer survivors with newly diagnosed depression

We identified cancer survivors with newly diagnosed depression on the basis of the National Committee on Quality Assurance criteria.¹² To achieve this, we first established a depression-free cancer cohort with incident cancer diagnosis between April 2007 and December 2011. We used a validated algorithm to identify newly diagnosed depression after cancer diagnosis by including only those who were diagnosed with depression after cancer diagnosis and who did not have any antidepressant use 90 days prior to depression

diagnosis.¹³ We used the following codes from the *International Classifications of Diseases, 9th Revision, Clinical Modification*: 296.2 (major depressive disorder, single episode), 296.3 (major depressive disorder, recurrent episode), 298.0 (depressive type psychosis), 300.4 (neurotic depression), 309.1 (prolonged depressive reaction), and 311.0 (depressive disorder, not classified). These codes are widely used to identify depression diagnoses in Medicare beneficiaries.^{1,14,15}

2.5 | Inclusion/exclusion criteria

We required that all individuals have continuous enrollment in Medicare Parts A and B and no enrollment in Medicare managed care plans during the baseline and follow-up periods. We also required that individuals have continuous enrollment in Medicare Part D during 3 months prior to and 12 months after depression diagnosis to identify depression treatment in the follow-up period. We excluded individuals with unknown cancer stage at diagnosis, those diagnosed through autopsy or death certificate, or those who died during the follow-up period. Appendix 1.1 summarizes the analytical population selection process. The final study population consisted of 1502 elderly Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer.

2.6 | Dependent variables

2.6.1 | Type and total healthcare expenditures—Healthcare expenditures were derived from the Medicare claims files and included the amount paid by Medicare. We identified the type of healthcare expenditure on the basis of whether the services were provided in an inpatient, outpatient, prescription drug, or home healthcare setting. The following types of healthcare expenditures were analyzed: inpatient, outpatient, prescription drugs, and others. Other expenditures consisted of Durable Medical Equipment (DME) and Home Health Agency (HHA) expenditures. Total healthcare expenditures were derived as the sum of inpatient, outpatient, prescription drugs, durable medical equipment, and home health agency expenditures.

Total and type of healthcare expenditures were classified into yearly and monthly expenditures during the follow-up period. Yearly expenditures consisted of expenditures for the entire 12-month period after depression diagnosis. Monthly expenditures were calculated for every month after depression diagnosis. All healthcare expenditures were adjusted by the consumer price index and expressed in 2012 constant dollars.

2.7 | Key independent variable

The key independent variable was the depression treatment during the first 6 months after depression diagnosis. Antidepressant use was derived from Medicare Part D claims using the National Drug Codes and generic names. Antidepressants included selective serotonin reuptake inhibitors, selective norepinephrine reuptake inhibitors, tricyclic antidepressants, monoamine oxidase inhibitors, and others (mirtazapine and bupropion). Any cancer survivor with at least one prescription for antidepressants was considered to be using antidepressants. Psychotherapy visits were derived from Medicare outpatient claims using the Current Procedural Terminology codes.

Based on antidepressant use and psychotherapy visits, depression treatment was categorized into 4 mutually exclusive categories: (1) treatment with antidepressants only: individuals received, at least, one prescription of antidepressants and no psychotherapy visits; (2) treatment with psychotherapy only: individuals had, at least, one psychotherapy office visit and no prescription for antidepressants; (3) both antidepressants and psychotherapy: individuals received, at least, one prescription for antidepressants with at least one psychotherapy visit; and (4) no treatment: individuals received no antidepressants and no psychotherapy.

2.8 | Other independent variables

2.8.1 | Time-invariant variables—These variables were measured during the baseline period (ie, 12 months before depression diagnosis). Independent variables included age in years at cancer diagnosis (66-69, 70-74, 75-79, 80) and race (White, African American, and others), marital status (married, divorced/separated/widowed, and never married), cancer type (women with breast cancer, women with colorectal cancer, men with colorectal cancer, and men with prostate cancer), and stage at cancer diagnosis, categorized using the American Joint Committee on Cancer grouped staging (stage 0/I, stage II, and stage III/IV). We have also included the number of chronic physical and mental health conditions during the baseline period, SEER region (Northeast, South, North Central, and West), and the year of cancer diagnosis. Physical conditions included diabetes, heart disease, hyperlipidemia, hypertension, stroke, arthritis, osteoporosis, asthma, and chronic obstructive pulmonary disorder. Mental conditions included Alzheimer and other related disorders, anxiety, and other mental disorders.

2.8.2 | Time-varying independent variables—These were measured every month during the follow-up period (ie, 12 months after depression diagnosis) and included primary care physician (PCP) visits and cancer treatment (chemotherapy, radiation therapy, or surgery).

3 | Statistical Analysis

3.1 | Analyses with repeated measures: short-term healthcare expenditures

As healthcare expenditures were measured for every month during the follow-up period, each individual had 12 observations. These 12 observations were not independent, so standard regression techniques can not be applied. Therefore, the associations between depression treatment and total healthcare expenditures were analyzed with a repeated measure design using generalized linear mixed model (GLMM) regressions with gamma distribution and log link. The GLMM model was selected because we found that 65% of the variation in healthcare expenditures was due to differences within individuals. GLMM regressions account for correlated error terms because of repeated measures from the same person. In these regressions, all independent variables were included. Based on the regression coefficient estimates, expenditures associated with depression treatment categories, as compared to no depression treatment, were calculated.

3.2 | Analyses with repeated measures: long-term healthcare expenditures

We also examined the relationship between depression treatment and long-term expenditures because it may take time to realize the effects of depression treatment. In these analyses, long-term healthcare expenditures were derived for each month during the 13- to 24-month follow-up period. The analyses were restricted to 1224 beneficiaries who had continuous fee-for-service enrollment in Medicare fee-for-service for 36 months (12 months before depression diagnosis and 24 months after depression diagnosis). We followed the same statistical techniques as in the case of short-term healthcare expenditures. We included the same independent variables as in the short-term healthcare expenditures models.

3.3 | Observed selection bias: adjusting for inverse probability treatment weights

Inverse probability treatment weights (IPTW) were used to adjust for observed group differences in depression treatment categories. It is commonly used to balance the confounders between treatment groups in observational data because treatment groups are not randomly assigned.¹⁶ In our study, observed differences in the healthcare costs between the depression treatment groups may reflect differences between the group in the observed covariates rather than effects due to depression treatment. Therefore, we used IPTW to balance the confounders among depression treatment groups. Inverse probability treatment weights were calculated using the inverse probability of receiving depression treatment or no treatment. For each individual, we estimated the predicted probability of receiving depression treatment categories from a multinomial logistic regression with age, race, sex, marital status, primary care visits, cancer type, cancer stage, cancer treatment, chronic conditions, the region of residence, and the year at cancer diagnosis as independent variables. Then we calculated the adjusted weight for each individual on the basis of the inverse of their predicted probability to receive depression treatment. Under this approach, individuals with lower propensity will be upweighted, and those with higher propensity will be downweighted. This helps balance the probability of treatment across the treatment groups. To account for the differences in group sizes of the treatment groups, we further stabilized the weights by dividing them with the sample size of each treatment group.

4 | Results

4.1 | Characteristics of the study population

The study population consisted of 1502 elderly fee-for-service Medicare beneficiaries with incident breast, colorectal, or prostate cancer who had newly diagnosed depression after cancer diagnosis. In this study population, 45.0% were women with breast cancer, 22.8% were women with colorectal cancer, 10.1% were men with colorectal cancer, and 22.1% were men with prostate cancer (Data not presented in tabular form).

4.2 | Description of the study population by depression treatment

Also, we found that 47.4% received antidepressants only, 9.3% received psychotherapy only, 18.9% received both antidepressants and psychotherapy, and 24.4% did not receive any depression treatment. The description of explanatory variables by depression treatment categories are presented in Table 1. We found a significantly higher rate of antidepressant

use among White as compared to African American/others (49.8% vs 36.0%) and a lower rate of no depression treatment among White as compared to African American/others (23.1% vs 31.0%). We also observed that individuals in the South region had a significantly higher rate of antidepressant only use (54.5%), a lower rate of psychotherapy use (5.5%), and a higher rate of no depression treatment (26.3%).

4.3 | IPTW-adjusted yearly healthcare expenditures by depression treatment categories

Table 2 summarizes the average 1-year expenditures for depression treatment categories. The mean 1-year total healthcare expenditures after depression diagnosis were \$38 219 for those who did not receive depression treatment, \$42 090 for those treated with antidepressants only, \$46 913 for those treated with psychotherapy only, and \$51 008 for those treated with a combination of antidepressants and psychotherapy. Average 1-year total healthcare expenditures were significantly higher for those treated with a combination of antidepressants and psychotherapy (P value $< .001$). Also, the average 1-year inpatient and prescription drug healthcare expenditures after depression diagnosis were significantly higher for those treated with a combination of antidepressants and psychotherapy (P value $< .001$).

4.4 | IPTW-adjusted GLMM of short-term monthly expenditures by depression treatment categories

As compared to no depression treatment, depression treatment with antidepressants only was associated with a \$341 increase in total healthcare expenditures; treatment with psychotherapy only was associated with a \$556 increase while treatment with combination of antidepressants and psychotherapy was associated with \$781 increase. As compared to no therapy, we found that treatment with antidepressants only, psychotherapy only, and the combination of antidepressants and psychotherapy was associated with high outpatient healthcare expenditures (Table 3).

4.5 | IPTW-adjusted GLMM of monthly expenditures by sex

We observed that as compared to men with prostate cancer, women with breast cancer had \$525 higher average monthly total healthcare expenditures. Also, as compared to men with colorectal cancer, women with colorectal cancer had \$205 higher average monthly total healthcare expenditures. The IPTW-adjusted GLMM of monthly expenditures for other independent variables are presented in Appendix 1.3.

4.6 | IPTW-adjusted GLMM of long-term monthly expenditures by depression treatment categories

As compared to no depression treatment, we found that treatment with antidepressants only, psychotherapy only, and the combination of antidepressants and psychotherapy was not associated with total, inpatient, outpatient, prescription drug, and other healthcare expenditures (Table 4).

4.7 | Sensitivity analyses

To ensure robustness of the association between depression treatment categories and healthcare expenditures, we conducted sensitivity analyses. These included healthcare expenditures without repeated measures (ie, measuring 1-year healthcare expenditures), mixed effect linear models with log-transformed healthcare expenditures (Table 3 and Appendix 1.2), and instrumental variable regressions that controlled for unobserved selection bias. In the instrumental variable regression, the percentage of psychologists at the county level was used as an instrument and depression treatment was considered as endogenous. Across all models and even after controlling for the unobserved selection bias, depression treatment was associated with higher expenditures as compared to no depression treatment. For example, depression treatment with psychotherapy only was associated with higher total healthcare expenditures as compared to no depression treatment in the GLMM model ($\beta = 0.29$; $SE = 0.09$), the mixed linear model with log-transformed expenditures ($\beta = 0.40$; $SE = 0.10$), the adjusted 1-year healthcare expenditures model ($\beta = 0.31$; $SE = 0.08$), and the instrumental variable regression model ($\beta = 0.01$; $SE = 0.01$).

5 | Discussion

The current study examined the association between depression treatment categories and healthcare expenditures among elderly Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer. To date, the current study is the first one to analyze the association between depression treatment categories and healthcare expenditures. We observed that depression treatment categories were associated with higher short-term healthcare expenditures compared to no depression treatment. However, our analysis of long-term expenditures indicated that there was no statistically significant association between depression treatment and expenditures. Taken together, these findings suggest that it may take time to realize the effects of depression treatment. Our results with short-term healthcare expenditures are consistent with the 1 published study on depression treatment and expenditures among elderly with chronic physical conditions, which found that depression treatment with antidepressants or psychotherapy was associated with an increase in short-term healthcare expenditures.³ The positive association between depression treatment and short-term healthcare expenditures was robust and persisted even after adjustment for other factors and across different model specifications.

The positive association between depression treatment categories and short-term healthcare expenditures among cancer survivors has many plausible explanations. Under fee-for-service healthcare systems, many individuals with both physical and mental health conditions receive fragmented care and such fragmented care may result in increased expenditures in the short term. We found lower short-term healthcare expenditures among those with no depression treatment; future studies may need to compare those who do not receive treatment to “depression-free” cases to explore whether no depression treatment has economic consequences. It is also known that adequate depression treatment is critical in improving health outcomes. A study among adults found that adherence to antidepressant medication treatment for at least 90 days reduced healthcare expenditures.¹⁷

Our findings have significant policy implications. We estimated the average healthcare expenditures over a 12-month period among elderly Medicare with newly diagnosed depression and incident cancer. Therefore, these estimates can be considered as expenditures following a new episode of depression in elderly with incident cancer. Such estimates have an important implication for Accountable Care Organization's Medicare Shared Saving Programs for risk adjustment while also setting the expected expenditure benchmark for individuals with cancer and newly diagnosed depression. Also, our study findings have implications for the Centers for Medicare and Medicaid Service's new bundled payment models as well as a new payment and delivery model, the Oncology Care Model, which aims to improve the quality of care and care coordination while lowering costs for patients receiving chemotherapy. Our findings can help these payment models in building the quality metrics that providers must achieve to maximize their payment.

There were other noteworthy findings in the study. We observed racial disparities and geographical variation in depression treatment. Such racial disparities have been reported among elderly Medicare beneficiaries.^{14,18} Studies have attributed the racial disparities in antidepressant use to cultural factors.¹⁹ We observed higher rates of depression treatment in the Southern region. We can speculate that differences in economic status between South and other regions of the US may have contributed to these differences.²⁰

We observed gender differences in total healthcare expenditures; women with breast cancer had higher total healthcare expenditures as compared to men with prostate cancer. This is not surprising as women with breast cancer have a higher cost of cancer care as compared to other types of cancer¹⁸ and more likely to adhere to antidepressants than men.¹⁹ It is also plausible that there may be gender-specific differences in depression treatment response that may have contributed to gender differences in expenditures.²⁰ For example, females may not respond well to some types of antidepressants such as tricyclics.²⁰

Our study has many strengths; it is the first that has examined the impact of depression treatment on total healthcare expenditures in real-world fee-for-service settings. The use of SEER-Medicare data allowed us to use a longitudinal study design and follow patients for a long period across different providers. Data from Medicare Part D enabled us to identify pharmacological therapy for depression and include expenditures related to prescription drugs. We also tested the robustness of the relationship between depression treatment and healthcare expenditures using various model specifications. The current study has some limitations: the SEER-Medicare data are not developed for research purposes and therefore have limitations associated with its use for estimating total healthcare expenditures. The study findings cannot be generalized to all Medicare beneficiaries because the study population is restricted to those residing in SEER regions, those with fee-for-service Medicare plans, and to elderly Medicare beneficiaries with breast, colorectal, or prostate cancer. Another limitation related to the observational study was the selection bias; although we controlled for the observable and unobservable selection bias using the inverse probability weighting technique and the instrumental variables approach, we cannot completely eliminate them. We used prescription drug claims, and filling prescriptions may not always result in use of medications.

6 | Conclusions

Our study has provided new evidence for the literature on the effect of depression treatment on healthcare expenditures among elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, and prostate cancer seeking care in real-world clinical practice settings. We found that treatment for depression was associated with higher short-term healthcare expenditures and was not associated with long-term healthcare expenditures as compared to no depression treatment. Our findings were robust to different model specifications, even after adjusting for observed and nonobserved selection bias. Future studies are needed to replicate and confirm these findings.

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TABLE 1
Description of the study population by depression treatment categories before and after inverse probability treatment weights (IPTW)
elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer SEER-
Medicare database, 2007-2012

	Before IPTW Adjustment										After IPTW Adjustment			
	AD Only					Psych					AD Only		Psych	
	N	%	N	%	N	N	%	N	%	N	Wt%	sig	Wt%	sig
Total	712	47.4	139	9.3	284	18.9	367	24.4	47.4	9.3	18.9	24.0		
Age in years														
66-69	194	50.0	37	9.5	73	18.8	84	21.6	48.2	8.8	19.0	24.0		
70-74	186	47.8	33	8.5	66	17.0	104	26.7	47.3	9.4	18.5	24.7		
75-79	150	47.9	22	7.0	62	19.8	79	25.2	50.1	6.8	18.3	24.8		
>80	182	44.2	47	11.4	83	20.1	100	24.3	46.3	10.0	19.1	24.6		
Race														
White	619	49.8	107	8.6	231	18.6	287	23.1	47.7	8.9	18.8	24.5		
AA/others	93	36.0	32	12.4	53	20.5	80	31.0	48.2	8.7	18.6	24.5		
Cancer type														
Women breast	338	50.0	55	8.1	122	18.0	161	23.8	48.1	9.0	17.5	25.3		
Women colorectal	155	45.2	37	10.8	66	19.2	85	24.8	47.8	9.0	19.8	23.4		
Men colorectal	67	44.4	20	13.2	27	17.9	37	24.5	46.7	9.5	18.5	25.3		
Men prostate	152	45.8	27	8.1	69	20.8	84	25.3	47.7	8.3	20.3	23.8		
Cancer stage														
Stage 0/I/II	557	47.5	103	8.8	226	19.3	287	24.5	47.9	8.8	18.9	24.4		
Stage III/IV	155	47.1	36	10.9	58	17.6	80	24.3	47.4	9.4	18.4	24.9		
Cancer treatment														
Bef. dep. dx	464	46.6	98	9.8	206	20.7	228	22.9	47.7	9.1	18.8	24.4		
At or after dep. dx	191	55.0	16	4.6	40	11.5	100	28.8	48.3	8.6	17.7	25.4		
No treatment	57	35.8	25	15.7	38	23.9	39	24.5	47.5	8.2	20.6	23.7		
Cardiovascular														
Yes	644	47.2	120	8.8	271	19.9	329	24.1	47.9	8.8	18.8	24.4		

	Before IPTW Adjustment								After IPTW Adjustment			
	AD Only		Psych Only		AD & Psych		No Therapy		AD Only		Psych Only	
	N	%	N	%	N	%	N	%	N	%	N	%
No	68	49.3	19	13.8	13	9.4	38	27.5	46.8	9.6	18.0	26.6
Dementia	<i>c</i>											
Yes	78	38.4	31	15.3	65	32.0	29	14.3	48.7	9.0	19.1	23.2
No	634	48.8	108	8.3	219	16.9	338	26.0	47.7	8.9	18.7	24.7
Anxiety-PTSD	<i>a</i>											
Yes	187	46.6	23	5.7	88	21.9	103	25.7	47.9	8.7	17.8	25.6
No	525	47.7	116	10.5	196	17.8	264	24.0	47.8	9.0	19.1	24.1
Tobacco	<i>a</i>											
Yes	50	37.6	18	13.5	24	18.0	41	30.8	46.8	8.9	18.7	25.6
No	662	48.4	121	8.8	260	19.0	326	23.8	47.9	8.9	18.8	24.4
Region	<i>c</i>											
Northeast	116	39.5	39	13.3	81	27.6	58	19.7	46.6	11.2	19.2	23.0
South	228	54.5	23	5.5	57	13.6	110	26.3	48.3	8.2	18.3	25.2
North Central	85	45.0	23	12.2	46	24.3	35	18.5	46.6	8.3	18.0	27.0
West	283	47.1	54	9.0	100	16.6	164	27.3	48.4	8.4	19.1	24.1
Metro	<i>c</i>											
Metro county	553	45.4	126	10.3	247	20.3	293	24.0	47.5	8.9	19.0	24.5
Nonmetro county	159	56.2	13	4.6	37	13.1	74	26.1	49.1	8.8	17.6	24.6

Abbreviations: AA, African American; AD, antidepressants; Psych, psychotherapy; PTSD, Post Traumatic Stress Disorder; SEER, Surveillance Epidemiology, and End Results; Wt, weighted percentage. Based on 1502 elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer who were continuously enrolled in Medicare Parts A and B during the observation period and Part D during the fol-low-up period. Letters represent significant differences in study population characteristics by depression treatment categories, derived from chi-square statistics.

^a .01 *P* < .05.

^b .001 *P* < .01.

^c *P* < .001.

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Mean \$ (SD) AD Only (N = 712)	sig	Mean \$ (SD) Psych Only (N = 139)	sig	Mean \$ (SD) Combine AD & Psych (N = 284)	sig	Mean \$ (SD) No Depression Treatment (N = 367)	sig
Total healthcare exp enditures							
41 724 (2841)		46 289 (4477)		51 110 (3508)	<i>c</i>	38 177 (2309)	
Outpatient expenditures							
16 569 (1089)		16 934 (1716)		15 692 (1345)		15 242 (885)	
Inpatient expenditures							
17 961 (2180)		21 985 (3435)		26 842 (2692)	<i>c</i>	17654 (1772)	
Prescription drugs expenditures							
4747 (303)	<i>c</i>	3689 (478)		5779 (375)	<i>c</i>	3282 (246)	
Other expenditures							
2451 (312)		3821 (513)	<i>c</i>	2724 (392)	<i>a</i>	2053 (247)	
Among users							
Inpatient expenditures							
AD only (N = 399)		Psych only (N = 76)		Combine AD & Psych (N = 189)		No depression treatment (N = 202)	
31 867 (3325)		40 909 (5330)		40 473 (3928)	<i>a</i>	31 420 (2705)	
Prescription drugs expenditures							
AD only (N = 712)		Psych only (N = 136)		Combine AD & Psych (N = 284)		No depression treatment (N = 361)	
4747 (306)	<i>a</i>	3750 (483)		5779 (377)	<i>c</i>	3333 (249)	
Other expenditures							
AD only (N = 441)		Psych only (N = 94)		Combine AD & Psych (N = 167)		No depression treatment (N = 222)	
3981 (484)		4967 (714)	<i>a</i>	4760 (605)	<i>a</i>	3239 (393)	

Abbreviations: AD, antidepressants; IPTW, Inverse Probability Treatment Weights; Psych, psychotherapy; SEER, Surveillance Epidemiology, and End Results. Based on 1502 elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer who were continuously enrolled in Medicare Parts A and B and Part D during the observation period. Total healthcare expenditures were the sum of inpatient, outpatient, prescription drug, durable medical equipment, and home health agency expenditures. Other expenditures consisted of durable medical equipment and home health agency.

Letters indicate statistical significances in the average healthcare expenditures by depression treatment categories based on t tests.

 $a_{.01} \quad P < .05.$

$P < .001$
 $P < .10$
 q

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TABLE 3

Parameter estimates of depression treatment categories from generalized linear mixed models with IPTW on monthly short-term healthcare expenditures elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer SEER-Medicare database, 2007-2012

Generalized Linear Mixed Model with Log Link and Gamma Distribution Reference Group for Depression Treatment = No Depression Treatment							
	Intercept (SE)	AD Only (SE)	Change#	Psych Only (SE)	Change#	AD & Psych (SE)	Change#
Total	7.45 ^c (0.13)	0.18 ^a (0.07)	\$341	0.28 ^a (0.13)	\$556	0.38 ^c (0.08)	\$781
Outpatient	6.17 ^c (0.11)	0.12 ^a (0.05)	\$63	0.21 ^a (0.09)	\$112	0.25 ^c (0.06)	\$132
Inpatient	6.68 ^c (0.26)	0.17 (0.15)	\$150	0.32 (0.25)	\$301	0.37 ^a (0.16)	\$335
Prescription drugs	5.03 ^c (0.13)	0.33 ^c (0.08)	\$59	0.12 (0.12)	\$20	0.57 ^c (0.10)	\$116
Other	4.58 ^c (0.26)	0.20 (0.14)	\$21	0.37 (0.21)	\$44	0.29 (0.18)	\$32
Mixed linear model with log-transformed expenditures with IPTW							
Reference Group for Depression Treatment = No depression treatment							
	Intercept (SE)	AD only (SE)	% change	Psych only (SE)	% change	AD & Psych (SE)	% change
Total	7.58 ^c (0.16)	0.37 ^c (0.06)	37%	0.40 ^c (0.10)	40%	0.65 ^c (0.07)	65%
Outpatient	7.63 ^c (0.18)	0.16 ^a (0.07)	16%	0.47 ^c (0.11)	47%	0.55 ^c (0.09)	55%
Inpatient	2.76 ^c (0.17)	0.04 (0.06)	4%	0.12 (0.09)	12%	0.21 ^b (0.08)	21%
Prescription drugs	3.61 ^c (0.22)	0.77 ^c (0.09)	77%	0.07 (0.14)	7%	0.80 ^c (0.11)	80%
Other	1.15 ^c (0.24)	0.09 (0.09)	9%	0.20 (0.15)	20%	0.11 (0.12)	11%

Abbreviations: AD, antidepressants; IPTW, Inverse Probability Treatment Weights; Psych, psychotherapy; SEER, Surveillance Epidemiology, and End Results. Based on 1502 elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer who were continuously enrolled in Medicare Parts A, B, and D during the observation period. Other expenditures consisted of durable medical equipment and home health agency costs. Total healthcare expenditures consisted of inpatient, outpatient, prescription drug, durable medical equipment, and home health agency expenditures.

Change was calculated by first exponentiating the intercept term to calculate the expenditures for no depression treatment. Then, we exponentiated the sum of the intercept and the parameter estimate for depression treatment type to get the expenditures for depression treatment. The differences in these two estimates were reported as the change in healthcare expenditures associated with depression treatment.

Percent change in expenditures was calculated by exponentiating the parameter estimate and subtracting 1 ($e^{\beta} - 1$).

Models adjusted for time in months, depression treatment, age, sex, race/ethnicity, marital status, primary care physician visits during each month of follow-up, cancer type, cancer treatment during each month of follow-up, cancer stage, and number of physical and mental conditions, SEER region, and year of cancer diagnosis. Letters indicate significant differences by depression categories as compared to no depression treatment based on generalized linear mixed model regressions and mixed linear model regressions on healthcare expenditures.

$P > .001$
 $P < .01$
 $P < .001$
 $P < .05$

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TABLE 4
Parameter estimates of depression treatment categories from generalized linear mixed models with IPTW on long-term healthcare expenditures SEER-Medicare database, 2007-2012

	Reference Group = No Depression Treatment			
	Intercept (SE)	AD Only (SE)	Psych Only (SE)	AD & Psych (SE)
Total	4.50 ^c (0.24)	-0.01 (0.13)	0.24 (0.23)	0.19 (0.16)
Outpatient	3.55 ^c (0.28)	-0.16 (0.15)	0.06 (0.26)	0.23 (0.21)
Inpatient	2.20 ^b (0.81)	-0.66 (0.42)	-0.45 (0.57)	-0.38 (0.45)
Prescription drugs	3.64 ^c (0.28)	0.21 (0.13)	0.24 (0.28)	0.30 (0.16)
Other expenditures	0.90 (0.58)	-0.14 (0.30)	0.35 (0.39)	0.22 (0.33)

Abbreviations: AD, antidepressants; IPTW, Inverse Probability Treatment Weights; Psych, psychotherapy; SEER, Surveillance Epidemiology, and End Results. Based on 1224 elderly fee-for-service Medicare beneficiaries with newly diagnosed depression and incident breast, colorectal, or prostate cancer who were continuously enrolled in Medicare Parts A, B, and D during the 24-month observation period. Other expenditures consisted of durable medical equipment and home health agency costs. Total healthcare expenditures consisted of inpatient, outpatient, prescription drug, durable medical equipment, and home health agency expenditures.

Models adjusted for depression treatment, age, sex, race/ethnicity, marital status, primary care physician visits, cancer type, cancer treatment, cancer stage, and number of physical and mental conditions, SEER region, and year of cancer diagnosis. Letters indicate significant differences by depression categories as compared to no depression treatment based on generalized linear mixed model regressions on monthly long-term healthcare expenditures.

^a.01 $P < .05$.

^b.001 $P < .01$.

^c $P < .001$.