

# Impact of Payment Reform on Chemotherapy at the End of Life

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## Abstract

**Purpose:** To assess the impact of 2005 and 2006 reductions in chemotherapy reimbursement, mandated in the Medicare Modernization Act, on patterns of chemotherapy receipt in the last 14 days of life.

**Patients and Methods:** Included in the study were Medicare beneficiaries dying with poor-prognosis cancer from 2003 to 2007. We compared pre- and postreform probability and frequency of chemotherapy receipt in the last 14 days of life, a validated quality measure, using linear models. We assessed changes in chemotherapy use in physician offices (where prescribing is often directly linked to physician income) and hospital outpatient departments (where the link is indirect and likely weaker).

**Results:** Among patients receiving chemotherapy in the 6 months before death in physicians' offices before the policy im-

plementation (2003 to 2004), 18% received chemotherapy in the last 14 days of life. Those dying after implementation (2006 to 2007) were 3.5 percentage points (95% CI,  $-5.4$  to  $-1.6$ ;  $P < .001$ ), or 20%, less likely to receive chemotherapy in the 14 days before death than those dying before implementation. By contrast, there was no significant change in the percentage of patients receiving chemotherapy in the last 14 days of life in hospital outpatient departments between 2003 and 2004 and 2006 to 2007.

**Conclusion:** In physician offices, where drugs generate the majority of revenue and prescribing patterns can determine physician income, use of chemotherapy at the end of life fell significantly after reimbursement reductions; no concurrent change occurred in hospital outpatient departments. These results suggest that payment reform may be used to better align appropriate financial incentives with better quality of care.

## Introduction

In the early 2000s, Medicare drug reimbursements provided high margins under an average wholesale price system, which permitted physicians to obtain drugs well below reimbursed rates.<sup>1</sup> In response to concerns about rapid growth in the use of chemotherapy drugs with high margins, the Medicare Modernization Act (MMA) changed reimbursements to more closely reflect acquisition costs.<sup>2</sup> The MMA reduced payments to 106% of manufacturer-reported average sales prices while increasing drug administration fees; the change took effect in physician offices in 2005 and in hospital outpatient departments in 2006. The Government Accountability Office estimated that the MMA reform would reduce the average profit margin on infused chemotherapy drugs from 22% to 6%.<sup>1</sup> Payments for chemotherapy and anemia medications dropped by \$1.2 billion between 2004 and 2005, after implementation of the reform in physicians' offices.<sup>3</sup> This payment change had a large impact on oncologist practice revenue, because drug reimbursement accounted for 77% and drug administration accounted for approximately 10% of practice revenue during this time period.<sup>4</sup>

Policy makers have noted the potential conflicts of interest inherent in the pre-MMA system of payment for chemotherapy treatments.<sup>3,5-10</sup> Studies assessing the effect of MMA reimbursement changes on access to and use of chemotherapy in patients with newly diagnosed cancer have generated mixed

results.<sup>2,11-14</sup> Despite fears that physicians would cease to offer chemotherapy services in their offices, restricting access to care and increasing volume in hospital outpatient departments,<sup>7</sup> two studies found no meaningful effects on access to chemotherapy as measured by wait time, travel time, or infusion locale.<sup>13,14</sup> Using Medicare data 6 and 10 months into the payment change, respectively, the Medicare Payment Advisory Commission<sup>2</sup> and Jacobson et al<sup>12</sup> found increased use of chemotherapy in patients with newly diagnosed cancer and evidence of switching to more costly agents. However, these studies focused on newly diagnosed patients cared for in a short window after MMA implementation and provide little sense of how changes affected quality of care.

The effect of financial incentives on service delivery may be most pronounced in cases of marginal or low value,<sup>11</sup> such as chemotherapy at the end of life, where aggressive anticancer therapies may prove to be more toxic than beneficial, use is not related to probability of benefit, and appropriately timed cessation of chemotherapy is integral to a patient's terminal quality of life.<sup>15-17</sup>

We augment evidence on the impact of payment reform for Part B drugs and provider response to financial incentives through a study of end-of-life chemotherapy treatment.<sup>11-14,18,19</sup> We expand current understanding in three ways. We examined a measure of the quality of cancer care—chemotherapy receipt in the last 14 days of life, a validated quality measure now included as a

benchmark for improving clinical practice in the Quality Oncology Practice Initiative (QOPI).<sup>16,20</sup> Second, we examined the effects of payment changes in physician office settings separately from hospital outpatient department settings to leverage differences in financial incentives. In office settings, chemotherapy use is often directly related to physician income and makes up a large portion of practice revenue; in the hospital outpatient setting, drug reimbursement makes up a much smaller proportion of the revenue mix, and the link between physician income and prescribing patterns is indirect and likely weaker. We hypothesized changes in chemotherapy payment were more likely to alter prescribing decisions in physicians' offices; modeling the groups separately allowed us to disentangle changes in behavior as a result of reimbursement from broader trends in end-of-life care. Finally, by examining data through 2007, we were able to observe effects of the policy change that occurred over a longer time horizon compared with previous studies and thus did not limit our assessment to immediate policy response.

## Patients and Methods

We used Medicare claims data for beneficiaries dying with poor-prognosis cancer from 2003 to 2007 and assessed pre- (2003 to 2004) and post- (2006 to 2007) reform probability and frequency of chemotherapy receipt in the last 14 days and 3 months of life. We analyzed trends in treatment before and after reform by treatment location (physician offices and hospital outpatient departments).

### Cohort Definition

From the 20% Medicare denominator files spanning 2003 to 2007, we identified fee-for-service Medicare beneficiaries who died between age 66 to 99 years and had continuous Parts A and B coverage in the last 6 months of life. Decedents were included in the study if they had at least one hospital claim or at least two clinician visits in the last 6 months of life with poor-prognosis cancer.<sup>21,22</sup> Poor-prognosis cancer was defined by Iezzoni et al<sup>21</sup> using claim diagnosis codes associated with high rates of death during hospital admissions, thus permitting us to create a cohort for whom providers likely understood prognosis to be poor in the last 6 months of life. We categorized decedents into one of 26 cancer types based on their predominant cancer diagnosis.<sup>20a</sup>

### Outcomes

For each patient, we used billing codes to assess receipt of outpatient chemotherapy (administered by a clinician or facility) in the last 6 months of life, last 3 months of life, and last 14 days of life (codes defined in Appendix Table A1, online only). Our main outcome of interest was receipt of chemotherapy in the last 14 days of life, conditional on receipt in the last 6 months of life. We chose this measure because it is similar to the quality metric defined by Earle et al.<sup>16,23,24</sup> We determined setting of chemotherapy infusion based on claim file type and place of service code during the last 6 months of life (hospital outpatient department, physician office, or both). We also as-

essed the number of chemotherapy treatments in each time window among those who received chemotherapy, defined as the number of days of treatment.

### Patient Characteristics

From Medicare files, we obtained patient age at death, race (dichotomized as black or nonblack), state of residence, and sex. We used the methods of Iezzoni et al<sup>21</sup> to assign patients up to eight noncancer chronic conditions based on one inpatient or two outpatient International Classification of Diseases, Ninth Revision, diagnosis claims occurring between 6 months and 1 month before death (Table 1).<sup>25</sup> We categorized patients' metastatic cancer status using the definitions of Iezzoni et al.<sup>21</sup> Each patient's residential zip code was used to assign an estimated household income based on US Census tract data and the proportion of the population in that area in poverty.<sup>26,27</sup> Models included these patient characteristics as well as cancer type and age squared.

### Analyses

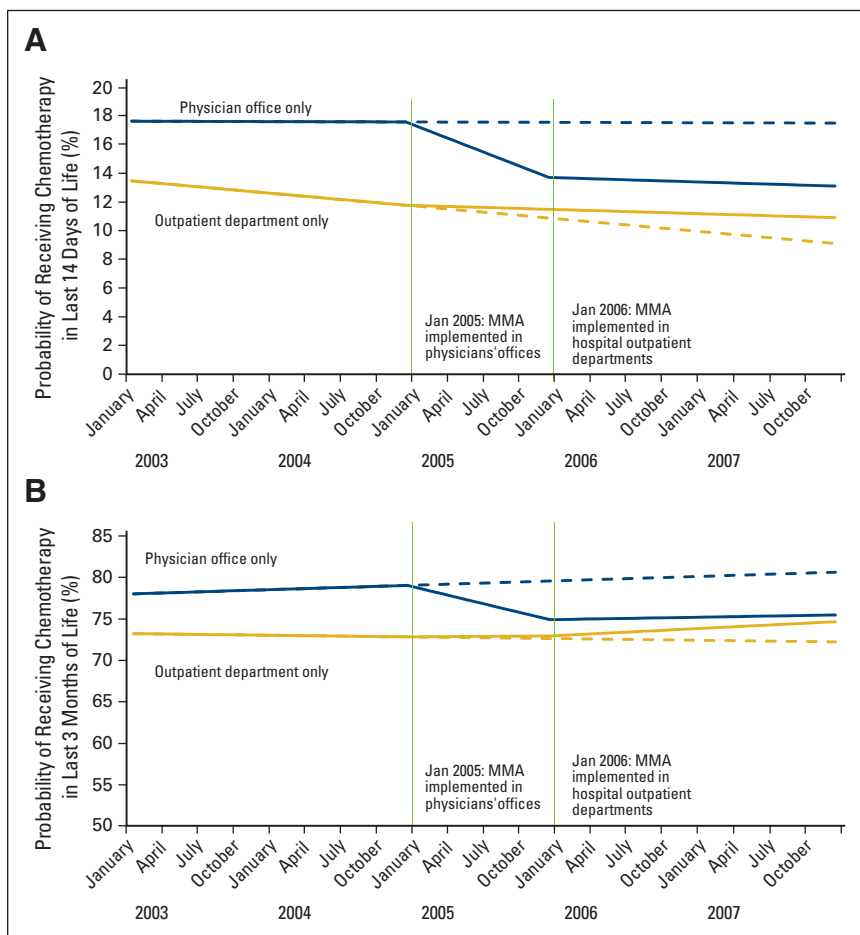
We conducted two sets of analyses. We modeled the distinct individual monthly impacts of the 2005 and 2006 policy implementations and then considered their impact collectively as a single payment change, implementation of which spanned 12 months.

We plotted regression-adjusted mean predicted probabilities that a patient received chemotherapy in the last 2 weeks of life and last 3 months of life by setting of treatment (Fig 1). We estimated ordinary least squares models of the probability of chemotherapy receipt or frequency of chemotherapy receipt as a function of payment change, where the patient was the unit of analysis. We captured payment change with a linear time trend with coefficients to capture changes in the time trend in January 2005 and January 2006. We chose the linear time trend because it fit the raw data accurately and is readily interpretable. In sensitivity tests of the specification, we obtained similar results estimating probability of chemotherapy receipt using logistic regression. All regression models controlled for a linear time trend to capture trends in end-of-life treatment during the full time period. We estimated models for the entire cohort and separate models by site of chemotherapy receipt in the last 6 months (physician office or outpatient department). We also predicted each outcome without payment reform, assuming the time trend from the period before the payment change (2003 to 2004) persisted (ie, as if changes in trend in January 2005 and January 2006 were zero).

We repeated these models after dropping patients who died in 2005 and estimated the cumulative effect of the payment change in January 2005 (physician offices) and January 2006 (hospital outpatient departments) as a single event, controlling for a linear time trend and the same covariates. This model has two advantages. It estimates the magnitude of the overall effect of the MMA on probability and frequency of chemotherapy receipt, allowing for a transition period as the payment change in physicians' offices had been in place for 1 year. Second, it excludes the cohort whose last 6 months before death spanned

**Table 1.** Descriptive Characteristics of End-of-Life Cancer Cohort of Medicare Beneficiaries Dying With Poor-Prognosis Cancer: 2003 to 2007

Characteristic	Decedent Cancer Cohort				Lung Cancer Cohort			
	Total	Received Chemotherapy in Last 6 Months of Life			Total	Received Chemotherapy in Last 6 Months of Life		
		Physician Office Only	Outpatient Department Only	Both Settings		Physician Office Only	Outpatient Department Only	Both Settings
No. of patients	235,821	55,450	15,503	4,073	74,581	18,857	4,610	1,155
Age at death, years	78.1	76.0	74.7	74.5	76.9	74.7	73.9	73.9
Black race, %	9.2	8.0	10.2	8.2	8.4	7.0	10.2	8.0
Female sex, %	48.6	41.7	46.9	44.1	44.4	39.2	41.2	38.5
Zip code								
Income level, \$	44,482	45,459	45,240	45,760	43,675	44,740	43,258	44,101
Poverty rate, %	10.5	10.0	10.5	9.9	10.6	10.0	11.1	10.4
Type of cancer, %								
Metastatic	54.7	66.2	67.1	67.1	48.0	61.2	62.1	64.7
Lung	31.6	34.0	29.7	28.4	—	—	—	—
Breast	5.3	7.5	8.0	7.4	—	—	—	—
Prostate	5.9	12.7	6.3	10.2	—	—	—	—
Pancreatic	6.4	6.4	6.5	6.7	—	—	—	—
Hematologic	8.9	7.1	8.3	10.7	—	—	—	—
Colorectal	8.1	9.5	9.4	10.2	—	—	—	—
Liver	3.1	1.3	1.8	1.5	—	—	—	—
Unknown primary	9.6	3.1	5.8	2.7	—	—	—	—
Comorbidities, %								
Chronic pulmonary disease	42.0	40.3	36.2	35.1	68.1	67.1	63.1	64.5
Coronary artery disease	31.2	29.6	25.7	26.2	34.2	32.9	30.3	30.4
Congestive heart failure	30.3	25.9	21.9	24.5	32.1	27.2	24.5	28.1
Peripheral vascular disease	9.8	8.3	7.0	6.7	12.3	10.8	9.9	9.4
Severe chronic liver disease	2.3	1.2	1.7	1.0	0.9	0.6	0.8	0.5
Diabetes with end organ damage	4.2	3.5	3.2	3.3	3.6	3.1	3.0	2.8
Chronic renal failure	12.2	10.5	9.0	8.5	9.7	7.2	7.2	5.2
Dementia	10.6	4.6	3.8	2.9	9.5	3.6	3.6	3.0
Year of death, %								
2003	20.4	20.8	17.2	23.4	20.4	21.0	17.4	22.9
2004	20.4	21.2	18.6	24.3	20.3	20.8	19.3	26.0
2005	20.4	20.8	20.2	24.1	20.5	21.0	20.0	22.6
2006	19.6	19.0	21.3	14.1	19.7	19.2	20.5	13.8
2007	19.2	18.2	22.7	14.1	19.2	18.0	22.8	14.7
Outcomes, %								
Received chemotherapy in last 6 months of life	32	100	100	100	33	100	100	100
Received chemotherapy in last 3 months of life	77	77	73	89	79	79	74	87
Received chemotherapy in last 14 days of life	15	16	12	19	17	18	13	21
No. of chemotherapy treatments (among receivers)								
Last 6 months of life	6.7	6.7	5.5	10.1	7.0	7.1	5.6	10.0
Last 3 months of life	4.1	4.1	3.4	5.5	4.3	4.3	3.5	5.7
Last 14 days of life	1.5	1.5	1.4	1.6	1.5	1.5	1.4	1.8



**Figure 1.** Probability of receiving chemotherapy in (A) last 14 days of life and (B) last 3 months of life by location of chemotherapy receipt. Sample includes those who received chemotherapy in the last 6 months of life (physician office,  $n = 55,450$ ; hospital outpatient department,  $n = 15,503$ ). Mean predicted probabilities control for patient demographics, comorbidities, cancer type, metastatic disease, and linear time trend. The 2005 payment change is significant in physician offices but not significant in hospital outpatient departments; the 2006 payment change is not significant in either setting. Solid lines incorporate the linear effect of the payment change; dashed lines indicate the counterfactual, if prepayment reform trends had continued. Probabilities for those receiving care in both locations are not shown because the sample is small. MMA, Medicare Modernization Act.

the pre-2005 and post-2005 periods, yielding a cleaner definition of the pre- and postperiod observations. We adjusted variance estimates for the correlation of observations within state and time period (before January 2005, after December 2005) using Huber-White sandwich estimators.<sup>28,29</sup> Because previous publications studying effects of the MMA have focused specifically on incident lung cancer,<sup>12</sup> we repeated our analysis for the subset of patients with lung cancer.

## Results

### Descriptive Characteristics

Overall, 235,821 patients met inclusion criteria; 32% received chemotherapy in the last 6 months of life ( $n = 75,026$ ; Table 1). Mean age at death was 78.1 years; 49% were women; 9% were black. The most common cancer types were: lung cancer (32%), cancer of unknown primary (10%), and hematologic cancer (9%). Among patients who received chemotherapy within 6 months of death, 74% received all chemotherapy treatments in a physician's office, 21% received all treatments in

a hospital outpatient department, and 5% received treatment in both places. Receipt of chemotherapy in hospital outpatient departments increased over the time period (from 18% in 2003 to 25% in 2007). Demographics varied by setting of administration, with those receiving chemotherapy in a physician's office significantly more likely to be older, nonblack, male, and from a wealthier zip code. Those with more comorbidities were treated in physicians' offices. Setting-specific population characteristics were similar among the subset of patients with lung, although these patients were more likely to be younger, nonblack, and poorer and have more comorbidities relative to the full sample.

### Unadjusted Outcomes

Among those receiving chemotherapy in the last 6 months of life, 77% received chemotherapy in the last 3 months of life, and 15% received chemotherapy in the last 14 days of life over the full 2003 to 2007 time period (Table 1). Overall, chemotherapy receipt near the end of life was significantly more likely for those treated in physician office settings versus hospital out-

patient departments. Of those treated in physician offices, 77% received chemotherapy in the last 3 months of life, and those who received chemotherapy in this window averaged 4.1 days of treatment. In physicians' offices, 16% received chemotherapy in the last 14 days of life and averaged 1.5 days of treatment. Of those using outpatient departments for treatment, 73% received chemotherapy in the last 3 months of life (averaging 3.4 days of treatment), and 12% received chemotherapy in the last 14 days (averaging 1.4 days of treatment). All of these differences across settings are statistically significant, with *P* values below .05. Patterns were similar among the subset of patients with lung cancer.

### Regression-Adjusted Results

Figure 1 graphically presents results from models considering the two policy implementation events separately. It indicates that within both time windows (14 days and 3 months) before death, the probability of chemotherapy receipt dropped significantly after the payment change in physician offices, whereas it increased slightly in hospital outpatient departments. Patterns were similar among those with lung cancer.

Table 2 lists the coefficients on the payment change when transitional data from 2005 are dropped, and the payment change is measured as a one-time shift, controlling for patient demographics, comorbidities, cancer type, metastatic disease, and a linear time trend. Comparing 2006 and 2007 with 2003 and 2004, the rate of chemotherapy receipt in the last 14 days of life fell 2.6 percentage points (or 2.6 per 100 patients), a drop of approximately 20% (95% CI,  $-4.2$  to  $-1.0$ ; *P* = .002). The drop was driven entirely by reductions in terminal chemotherapy in physician offices, where the probability of chemotherapy in the last 14 days dropped 3.5 per 100 patients (95% CI,  $-5.4$  to  $-1.6$ ; *P* < .001) relative to the mean of 18% in the preperiod. For those who received treatment in a hospital outpatient department, there was no significant change over the same time period (95% CI,  $-2.4$  to  $4.4$ ; *P* = .541). We also observed significant reductions in chemotherapy for the last 6 months of life (2.5 per 100 patients; 95% CI,  $-3.7$  to  $-1.3$ ; *P* < .001) and the last 3 months of life (4.2 per 100 patients; 95% CI,  $-6.1$  to  $-2.2$ ; *P* < .001). In the lung cancer cohort, there were no significant changes in chemotherapy in the last 14 days, but estimates of changes in probability in the last 3 and 6 months were similar in significance and magnitude to the full cohort. Because the composition of cancer type varied across the two settings, and differences in treatment for lung cancer (such as epidermal growth factor receptor inhibitors as a later line of therapy) could be a possible confounder, we estimated a model excluding patients with lung cancer. The results were unchanged.

In the full cohort who received chemotherapy during the window, the number of treatments per patient declined by 0.95 treatments in the last 6 months (95% CI,  $-1.3$  to  $-0.6$ ; *P* < .001) and 0.61 treatments in the last 3 months (95% CI,  $-0.8$  to  $-0.4$ ; *P* < .001). Taking into account the reductions in probability of receipt and frequency of receipt after the payment change in this cohort of patients with poor-prognosis cancers,

we estimate that during a 2-year period, there were 546,000 fewer chemotherapy treatments in the last 6 months of life, and the number of patients treated in the last 14 days fell by 7,900. Using the postreform 2006 average payment per chemotherapy treatment (\$720) leads to an estimated additional cost savings (through the reduction in quantity) of roughly \$400 million.

### Discussion

The MMA entailed sharp cutbacks in chemotherapy payments from 2005 to 2006. In this study, we found that chemotherapy receipt in the last 14 days of life fell 20% for patients treated in physicians' offices after the MMA legislation was implemented, with no corresponding decline among those treated in hospital outpatient departments. Previous articles have examined responses to the MMA in use of chemotherapy in newly diagnosed patients but have provided little evidence to determine whether treatment changes improved or degraded quality of care.<sup>2,12</sup> Near the end of life, aggressive anticancer therapies may prove to be more toxic than beneficial, their use may not be related to probability of providing benefit, and appropriately timed cessation of chemotherapy is integral to a patient's terminal quality of life.<sup>15,16,24,30</sup>

Can chemotherapy in the last 14 days of life be used as an outcome measure? Clearly, the right rate of treatment in the last 14 days is not zero, because some deaths, even for those with metastatic cancer where chemotherapy is appropriate, occur unexpectedly. Yet chemotherapy in the last 14 days is a well-established and validated quality measure.<sup>15,16,24</sup> Furthermore, there is little reason why the unanticipated mortality rate for patients being treated with chemotherapy should have declined between 2003 and 2004 and 2006 to 2007 only in physicians' offices but not in hospital outpatient departments.

Why are the effects of payment reform so much greater in physicians' offices compared with hospital outpatient departments? One reason may be that in hospital outpatient departments, physicians have no direct incentive to order chemotherapy of marginal benefit, and the fraction of total revenue composed of drug reimbursement is small. If the decrease in the use of end-of-life chemotherapy at this time were driven by broader trends such as diffusion of quality standards by oncology groups, the increasing acceptance of palliative care,<sup>31</sup> or the introduction of new drugs, we would expect to see equivalent changes in both settings. Unfortunately, we cannot observe the differences between practices in treatment of drug revenue; some practices decouple personal income from chemotherapy use. This should also be considered as a policy option.

An important potential limitation to our study is the simultaneous cultural shift seen in the oncology community driven by end-of-life cost/benefit concerns and emerging models addressing the demands for better physician and patient communication.<sup>32</sup> Hospice referral and discussions about end-of-life care have become recognized as critical needs for patients with cancer. We controlled for trends in chemotherapy that might be driven by this practice shift. A differential trend in hospice awareness for hospital outpatient and office settings could lead

**Table 2.** Effect of MMA Reimbursement Change on Chemotherapy Receipt by Location of Administration in Medicare Beneficiaries Dying With Poor-Prognosis Cancer (2006 to 2007 v 2003 to 2004)

Setting	Change in Probability of Receipt in Last:			Change in No. of Treatments in Last:*		
	14 Days	3 Months	6 Months	14 Days	3 Months	6 Months
All patients						
No. of patients	57,656	57,656	182,426	8,602	44,203	57,656
All settings						
Mean (2003 to 2004)	17%	78%	32%	1.5	4.5	7.3
Coefficient	-0.026†	-0.042†	-0.025†	-0.087	-0.607†	-0.953†
SE	0.008	0.012	0.005	0.050	0.098	0.164
Physician office only						
Mean (2003 to 2004)	18%	78%	100%	7.3	4.5	1.5
Coefficient	-0.035†	-0.055†		-0.084	-0.684†	-0.998†
SE	0.009	0.013		0.054	0.110	0.178
Outpatient department only						
Mean (2003 to 2004)	12%	73%	100%	1.5	3.7	5.9
Coefficient	0.010	0.008		-0.030	0.094	-0.286
SE	0.017	0.025		0.101	0.146	0.236
Physician office and outpatient department						
Mean (2003 to 2004)	20%	89%	100%	1.6	6.0	10.9
Coefficient	-0.024	-0.004		-0.113	-0.979†	-1.131
SE	0.035	0.030		0.260	0.372	0.671
Lung cancer cohort						
No. of patients	18,937	18,937	57,663	3,201	14,898	18,937
All settings						
Mean (2003 to 2004)	19%	80%	33%	1.5	4.8	7.8
Coefficient	-0.014	-0.046†	-0.023†	-0.038	-0.877†	-1.373†
SE	0.014	0.017	0.010	0.092	0.139	0.247
Physician office only						
Mean (2003 to 2004)	20%	81%	100%	1.5	4.8	7.9
Coefficient	-0.007	-0.051†		-0.004	-0.948†	-1.389†
SE	0.017	0.019		0.108	0.164	0.272
Outpatient department only						
Mean (2003 to 2004)	15%	74%	100%	1.5	4.1	6.2
Coefficient	-0.047	-0.022		-0.201	-0.173	-0.806‡
SE	0.034	0.036		0.227	0.273	0.399
Physician office and outpatient department						
Mean (2003 to 2004)	21%	88%	100%	1.7	6.1	10.8
Coefficient	-0.022	-0.044		0.320	-1.227	-1.699
SE	0.081	0.069		0.514	0.810	1.124

NOTE. The all-settings group includes patients from each of the three mutually exclusive groups (ie, physician office only, outpatient department only, both). No. of patients applies to the all-settings group. Models control for patient demographics, comorbidities, cancer type, metastatic disease, and linear time trend. Heteroskedastic-robust SEs are clustered at the state level and pre-post time period.

Abbreviation: MMA, Medicare Modernization Act.

\* Beneficiaries were only included in No. of treatments model if they received chemotherapy in the specified time window.

† Indicates significance at the 95% level.

‡ Indicates significance at the 90% level.

to biased estimates, but we saw no evidence of any such differential trends before the policy change. Chemotherapy at the end of life may be a sensitive metric with which to assess these cultural shifts. The American Society of Clinical Oncology (ASCO) QOPI addresses these metrics, but during our study period, it had limited penetration into oncology practices.

(QOPI became available to all ASCO physicians in March 2006 as a voluntary quality measurement project, and 87 practices participated in 2006 [ $< 9\%$  of practices currently participating and a smaller proportion of all oncology practices].) We detected a change in prescribing behavior in the last 6 months and last 3 months of life as well, where the 14-day quality metric

would have had less impact. These reductions in use of chemotherapy 3 and 6 months before death indicate that payment reform in the MMA may have been too blunt of an instrument. Although quality of care may have improved in the 14 days before death, it may have been at the expense of quality in earlier time periods. As in all pre- and postpolicy analyses, a limitation of our study is possible omitted trends. Our results could potentially have been influenced by patient compositional changes in hospital outpatient departments versus physician offices. If the composition of those treated in physician offices shifted toward populations that typically receive less intense end-of-life therapy, then our findings could have resulted from composition changes. However, there were no appreciable changes in the composition of measured demographic characteristics such as race and sex in either setting, making it less likely that differential trends in unmeasured characteristics could explain our results.

Our study provides evidence that for a range of services with marginal value, a reduction in fee-for-service reimbursement can better align payment with quality-of-care goals. Our findings are in accordance with a study that found MMA reimbursement changes were associated with reduced use of discretionary or inappropriate androgen deprivation therapy but were not associated with any changes to appropriate use of androgen deprivation therapy.<sup>11</sup> These studies provide support for removing incentives promoting drug use from cancer care through reform including value-based insurance design,<sup>33</sup> bundled payment for chemotherapy,<sup>8,34</sup> and capitated or prospective payment models.<sup>35,36</sup>

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## Appendix

**Table A1.** Codes Used to Identify Receipt of Chemotherapy

Code	Description
ICD-9 codes V58.1x, V67.2	Encounter for chemotherapy or postchemotherapy care
ICD-9 code 99.25	Injection/infusion of chemotherapy
HCPCS beginning with J9xxx, 90,586, G0355, G0356, G0359-61, G9021-G9032, J8510, J8520, J8521, J8560, J8565, J8600, J8700	Agent-specific chemotherapy administration codes
HCPCS J8999	Prescription of oral chemotherapy
CPT 964xx, 96,542, 96,545, 96,549	Outpatient chemotherapy administration
CPT 99,555	Home infusion of chemotherapy
HCPCS Q-codes Q0083 Q0084 Q0085	Home administration of chemotherapy
Revenue center codes 0331, 0332, 0335	Oral, injected, or intravenous chemotherapy

Abbreviations: CPT, Current Procedural Terminology; HCPCS, Healthcare Common Procedure Coding System; ICD-9, International Classification of Diseases, Ninth Revision.