Costs of cancer care across the disease continuum

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Purpose: To estimate Medicare payments for cancer care during the initial, continuing, and end-of-life phases of care for ten malignancies, and to examine variation in expenditures according to patient characteristics and cancer severity.

Methods: We used linked SEER-Medicare data to identify patients aged 66-99 years who were diagnosed with one of the following ten cancers: Prostate, bladder, esophageal, pancreatic, lung, liver, kidney, colorectal, breast or ovarian from 2007 through 2012. We attributed payments for each patient to a phase of care (i.e., initial, continuing or end-of-life), based on time from diagnosis until death or end of study interval. We summed payments for all claims attributable to the primary cancer diagnosis and analyzed the overall and phase-based costs and then by differing demographics, cancer stage, geographic region, and year of diagnosis.

Results: We identified 428,300 patients diagnosed with one of the ten malignancies. Annual payments were generally highest during the initial phase. Mean expenditures across cancers were: $14,381 during the initial phase, $2,471 for continuing, and $13,458 at end-of-life. Payments decreased with increasing age. Black patients had higher payments for 4 of 5 cancers with statistically significant differences. Stage III cancers posed the greatest annual cost burden for 4 cancer types. Overall payments were stable across geographic region and year.

Conclusion: Considerable differences exist in expenditures across phases of cancer care. By understanding the drivers of such payment variations across patient and tumor characteristics, we can inform efforts to decrease payments and increase quality, thereby reducing the burden of cancer care.

As a leading cause of morbidity and mortality, a cancer diagnosis creates a human and financial impact. In the United States, total spending for cancer exceeds $125 billion annually [1]. Despite declining cancer incidence, national expenditures for cancer care over the continuum are projected to increase further through 2020 [2]. This is despite current policy efforts, some initiated by the passage of the Affordable Care Act (ACA) in 2010, aimed at decreasing aggregate health care expenditures.

Underlying these aggregate trends are the costs of cancer care over the continuum from diagnosis, through treatment and survivorship or end of life. In an era of increasing focus on enhancing value not only through improved quality, but also through decreasing payments, understanding current expenditures across phases of cancer care, and how they vary according to patient characteristics, is critical for both improving patient care and guiding health care policy. These data would provide unique insights into health care utilization and potential practice pattern variations and how these practices have changed over time. Identifying differences in payments over various patient demographics generates hypotheses that can be further evaluated and used to improve health care quality and decrease costs. In addition, it is critical to evaluate these differences prior to the initiation of alternative payment models in oncology (e.g., the Oncology Care Model from CMS), where an improved understanding of utilization and payments is critical both in terms of successfully constructing the policy and for physicians considering engaging in it. While the costs of cancer over the disease continuum have been previously estimated and future costs of cancer projected [2, 3], our analyses incorporate estimates around varying patient characteristics, and include data for years subsequent to passage of the ACA.

In this context, we used linked Surveillance, Epidemiology and End Results (SEER)-Medicare data to estimate payments made by the Medicare program for cancer care over the disease continuum (i.e., initial, continuing, and end of life phase) for ten different cancers. We further examined overall and phase-based payments according to patient demographics, cancer stage, geographic region, and year of diagnosis.

Methods:

Data

We utilized data from Surveillance, Epidemiology and End Results (SEER) registries linked with Medicare claims from July 2007 through 2012 SEER-Medicare is a patient-level dataset that links Medicare claims with information about clinical characteristics, patient demographics, and outcomes from the SEER registries. Claims from this dataset are divided into five files: MEDPAR (readmissions, index, skilled nursing facility [SNF]), Carrier (Professional), Outpatient, Home Health, and Hospice payment files. We used all five files for our analyses.

Patient selection

Our study cohort included patients aged 66-99 years who were diagnosed with one of ten cancers (prostate, bladder, esophageal, pancreatic, lung, liver, kidney, colorectal, breast, or ovarian) between 2006 through 2012. We initially identified these patients in SEER's PEDSF file using the ICD-0-3 cancer site recode for the cancer of interest. We then confirmed the diagnosis by only including patients with the relevant ICD-0-3 histology codes for each cancer. We excluded cases where the diagnosis was noted exclusively by autopsy or on the death certificate. We further excluded patients without continuous Medicare Parts A and B enrollment from 12 months prior to diagnosis until end of study interval or death, and patients who participated in Medicare Health Maintenance Organizations (HMOs).

Attribution of patients to phases of care

Cancer care over its continuum has been described as occurring in three phases: the initial phase – the first 12 months after diagnosis, the continuing phase – the period of time between the initial and end-of-life phases, and the end of life phase – the last 12 months of life. Using these definitions, each patient was attributed to at least one phase of care, creating a patient-phase dyad (i.e., individual patient in one phase of care). For patients who died during the study interval, the end of life phase was assigned first, then the initial phase, and last, the continuing phase. For patients who were diagnosed during the study interval and alive at the conclusion of the study interval, the first 12 months after diagnosis were assigned to the initial phase and the subsequent months to the continuing care phase. These attribution methods are consistent with other evaluations [2, 4]. Appendix Figure 1 provides an illustration of the patient attribution methods. Payments were evaluated for each patient-phase dyad distinctly from the other phases with the exception of the overall estimates, where only patients attributed to all three phases were included in our analyses.

Estimating standardized costs of cancer care

For each patient-phase of care dyad, we aggregated all standard payments for claims with a primary diagnosis code for the corresponding cancer for each Medicare data file [Medicare provider analysis and review (MEDPAR), Carrier Claims (NCH), outpatient, home health, and hospice]. These methods are consistent with those previously published from our group [4]. We estimated the average payment per beneficiary in each data file and then for each beneficiary across all files. To account for differences in Medicare reimbursement based on geography, teaching status, and disproportionate share payments, we price-standardized all costs using methods previously described by our research team [5]. These methods were adapted from the Dartmouth Institute for Health Policy and Clinical Practice and the Medicare Payment Advisory Commission (MedPAC).

Patient characteristics, tumor stage, and hospital characteristics

We determined patient demographic and cancer characteristics, including gender, age, race, year of diagnosis, cancer stage, and histologic grade using the SEER (PEDSF) file. Age was defined as the diagnosis date minus the birth date. It was then made a categorical variable. We limited race to White, Black, and other. Charlson co-morbidities were identified using established methods We used the American Hospital Association Annual Survey data to determine hospital geographic region, which was categorized according to Census regions: Northeast, Midwest, South, and West.

Statistical Analyses

To determine payments and whether the costs of cancer varied by patient demographics, geographic region, cancer stage, and year of diagnosis, we fit phase-specific generalized estimating equation models with the gamma distribution and log link for each cancer type. We fit this model in order to better account the non-normal distribution of cost data and to adjust for hospital level effects (i.e., differing numbers of patients receiving care at different hospitals). Finally, for each cancer type, we fit multivariable models to estimate the association between individual variables and spending across phases of care. The models included patient (gender, age, race, number of Charlson co-morbidities) cancer (stage, year of diagnosis), and hospital (geographic region) characteristics as well as phase of cancer care.

All analyses were performed using SAS v 9.4 (Cary, NC) and at the 5% significance level. The University of Michigan's institutional review board deemed this study exempt from review.

Results

We identified 428,300 patients who were diagnosed with one of ten cancers from 2006 through 2011. The distribution of patients by site of primary tumor was as follows: 23% lung, 22% prostate, 18% breast, 15% colon, 9% bladder, 5% pancreatic, 4% kidney, 2% each for esophageal, liver, and ovarian.

Figure 1 presents costs of cancer care by phase for each cancer type. For almost all cancer types, average annual costs are highest during the initial and end of life phases. In terms of phase-specific expenditures, pancreatic, esophageal, and colorectal cancers had the highest costs for the initial phase at $22,964, $20,433, and $19,161, respectively; ovarian, pancreatic, and liver cancer were highest for the continuing phase, with estimated costs of $4,522, $4,154, and $3,250, respectively;

and colorectal, esophageal, and pancreatic were the highest at end of life, with estimated costs of $18,929, $18,760, and $17,141 (Figure 1).

Overall, males had statistically significant higher expenditures for 3 of 7 cancer types (lung, bladder, and colorectal). Although not statistically significant, esophageal had the greatest absolute difference by gender ($2,501, p=0.101). Payments for males with colorectal and bladder cancer were, on average, $2,402 (p=<0.001) and $677 (p<0.001), respectively, more than for females. When evaluating costs by cancer phase, males had statistically significant higher costs of care for 3 of 7 cancers in the initial phase (lung, liver, colorectal), 2 in the continuing phase (liver, colorectal), and 2 at the end of life (lung, bladder) (Table 1).

Costs of cancer care decrease with patient age both overall and for individual phases of care (Appendix Figure 2). Across all phases and cancers, costs for patients ≥ 80 years old were 18% lower than for patients between the ages of 65-79. For 3 cancer sites (pancreatic, esophageal, and ovarian) spending differentials exceeded $10,000 from the youngest to oldest age category. One exception was bladder cancer, where the price differential between youngest and oldest was only $421.

Figure 2 presents estimated expenditures by race. Black patients had higher overall expenditures for 4 of the 5 cancers (prostate, lung, bladder, and colorectal) where we identified statistically significant differences by race. However, the largest differential occurred in pancreatic cancer where average annual expenditures were $24,070 in White patients compared to $19,729 in Black patients (p=0.008). Black patients incurred significantly higher expenditures for three cancer types in the initial phase (prostate, pancreatic, breast), three in the continuing (prostate, colorectal, breast), and three at the end of life (lung, bladder, breast).

As illustrated in Appendix Figure 3, overall spending was similar across geographic regions. Although differences were modest, patients treated in the Northeast had the highest expenditures for four of ten cancers. Differences between regions were smallest for patients with bladder and kidney cancer, with spending differentials of less than $450 dollars between highest and lowest cost regions.

Average annual payments varied by cancer stage at diagnosis. Overall, annual costs were highest for patient presenting with stage II tumors for three cancers (pancreatic, lung, and liver), stage III tumors for four cancers (esophageal, bladder, breast, and ovarian), and stage IV tumors for three cancers (prostate, colorectal, and kidney) (Appendix Table 1). Overall costs of cancer care remained stable from 2008-2011 (Figure 3), although phase-specific payments increased for continuing care during this same time period. As an illustration, treatment in the continuing phase for pancreatic cancer diagnosed in 2011 had $4,580 higher costs than that diagnosed in 2008.

The variables independently associated with payments for cancer care, by cancer type, are presented in Table 2. Age, number of Charlson co-morbidities, cancer stage, year of diagnosis and cancer phase were fairly consistently associated with payments, while geographic region had little association.

Discussion

In this study, we provide estimates of the costs of cancer across the care continuum for Medicare beneficiaries with ten cancer types. We further classify these costs by care phase (i.e., initial, continuing, and end of life), patient demographics, and tumor characteristics. Considerable differences in payments exist across cancer type and discrete phases of care delivery. Expenditures tend to be highest in the initial phase, followed closely by payments during the end of life (i.e., last 12 months). In the initial phase, payments are highest for patients with the more aggressive tumors included in this analysis, such as esophageal and pancreatic cancer. In terms of patient characteristics, annual payments decrease with increasing age, vary by race for several cancers, but are largely stable for patients treated in different geographic regions. Overall payments tend to be the greatest when patients are diagnosed with Stage II disease. Finally, aggregate expenditures remain fairly stable during the four-year study period.

Collectively, our findings are consistent with previous literature estimating costs of care over the cancer continuum [2, 3]. Our estimates are similar to previous analyses that only include payments for claims with the cancer of interest as the primary diagnosis, a method that is known to yield more conservative estimates for healthcare expenditure [4]. In contrast, our figures are lower than prior investigations that used non-cancer controls to calculate costs. Our more modest estimates capture payments more specific to the cancer diagnosis and are thus perhaps more actionable on the part of the provider directly caring for the cancer patient. Our analyses further extend this literature by using more recent data and evaluate differences in costs by patient characteristics and cancer stage.

There are several potential reasons for the observed differences in expenditures by patient characteristics. First, the differing costs across gender, age, and race likely result from differences in health care utilization and patterns of care. For instance, prior studies have shown that treatment factors, including the use of chemo- and radiation therapy, play a significant role in differences in cancer expenditures [6, 7]. Chemotherapy is underutilized in women, Black patients, and the elderly [8-10], perhaps contributing to the lower expenditures for these populations identified in this analysis. Additionally, women are less likely to undergo surgery at the time of diagnosis (i.e., initial phase) [11, 12], potentially further contributing to gender differences in initial phase expenditures. Likewise, older cancer patients may receive less aggressive care [13], possibly aimed at palliation rather than treatment, thus decreasing costs across all phases. Even older patients who are admitted to the hospital with advanced cancer have lower expenditures than their younger counterparts [14].

In contrast to the lower expenditures identified for women and patients older than 80 years of age, we observed higher costs for Black patients across many cancer types and phases. The reasons for this finding are unclear. Although not evaluated specifically herein, one possibility is differences in access to care. Namely, prior research has determined that Black patients with cancer often have less access to routine cancer care (including diagnostic tests and therapeutic interventions), with resultant increases in intensive care unit stays and inpatient hospital admissions at the end of life [15-17].

Finally, the observed temporal stability in aggregate payments for Medicare patients highlight the potential impact (although admittedly early) of the Affordable Care Act and its emphasis on value-based care and decreasing health care costs [2]. This finding among Medicare beneficiaries is, in fact, consistent with other work indicating that, while total expenditures for cancer care in the United States have increased, the share of costs paid by Medicare has decreased relative to patients with private insurance and Medicaid [19]. That being said, while the overall costs remained stable, payments in the continuing phase increase during the study interval. This finding may reflect, among other factors, the growing prevalence of more expensive chronic systemic therapies that allow patients to have longer survival in the continuing phase.

Our study has several limitations. First, we estimated costs of cancer care only for the Medicare population. As a result, our findings may not generalize to younger patients with cancer. Nonetheless, estimates from the Medicare program are very policy relevant given the burden of cancer in this population, including an incidence rate that is ten times higher, and a death rate from cancer that is sixteen times greater, than for patients < 65 years [20]. Second, we do not include claims from Medicare Part D, including those for oral chemotherapy regimens. Moreover, our analyses focus on years prior to the introduction of some of the more expensive immunotherapy agents. The net effect of these concerns is that we will underestimate costs for certain cancers (e.g., kidney cancer) where the prevalence of such therapies increased rapidly during the study interval. In addition, there has been an increased emphasis on early palliative care and less use of chemotherapy at the end-of-life in the past five years, which our data would not capture. However, our data does include an important period of time spanning the implementation of the ACA, so the trends reported herein may foreshadow those for more recent years of the Medicare program. Third, we only include costs from claims associated with a primary diagnosis code of the diagnosed cancer. While this approach may underestimate the true overall costs of cancer care, it is consistent with prior work and ensures substantial specificity for cancer-related expenditures [4]. Furthermore, although using non-cancer controls to evaluate payments may capture complications not otherwise included with a primary cancer diagnosis code, it is difficult to determine if these complications are directly related to the cancer diagnosis or rather reflect managing a cancer patient's comorbid conditions, so we decided to take the more conservative approach [3]. In addition, our analyses use actual, not projected payments made to Medicare, which is more applicable to Medicare policy. Fourth, we only include data from the geographic regions included in the SEER program; these regions differ from the national population in terms of the proportion of white persons, cancer mortality rates, measures of socioeconomic status, and the availability of specialty health care services. Nonetheless, the ability to analyze data for most Medicare beneficiaries in these regions across ten cancer types ensures that these findings are relevant for ongoing evaluations of cancer care delivery and policy in the United States. Fourth, we do not include claims from Medicare Part D, including those for oral chemotherapy regimens. Moreover, our analyses focus on years prior to the introduction of some of the more expensive immunotherapy agents. The net effect of these concerns is that we will underestimate costs for certain cancers (e.g., kidney cancer) where the prevalence of such therapies increased rapidly during the study interval. However, our data does include an important period of time spanning the implementation of the ACA, so the trends reported herein may foreshadow those for more recent years of the Medicare program.

These limitations notwithstanding, our findings have important implications for both payers and policymakers. For payers, while some organizations are currently testing alternative payment models in oncology, many object to these out of concern that underlying disease and patient characteristics cannot be appropriately captured [21]. This work demonstrates the breadth of additional research that is required before oncology care payment bundles are initiated, specifically with regards to differences in costs by age, gender, race and stage. For policymakers, the variation in costs across patient demographics indicates that important differences exist in how care is provided to and/or accessed by varying patient populations. Policy changes to address these disparities could potentially lead to improved patient care and cost savings across cancer types.

Moving forward, additional research needs to be performed on variations in treatment patterns, guideline concordant care, and access across gender, age, race, and stage. A critical component to these analyses is to evaluate the component payments of the overall costs, with particular attention paid to areas of over- and under- spending. Some interesting questions to consider are: How has the use of oral chemotherapy changed over time? Are the lower expenditures with advanced age and for women secondary to underutilization of life extending services and/or care that is discordant with current guidelines? Are the higher expenditures in Black patients' secondary to poor access, resulting in lower chemotherapy use, but also increased utilization of more acute hospital based services?

It will also be critical to evaluate what drives expenditure differentials prior to implementation of bundled services and to continue to assess these differences for ongoing value based purchasing efforts. For example, the Oncology Care Model, a bundled payment model introduced by CMS to improve care coordination and guideline concordant care for patients undergoing chemotherapy [22], has already been adjusted to define different target prices for high- and low-risk bladder and prostate cancer.

Third, evaluating the effects of the Oncology Care Model across patient demographics and tumor characteristics will be critical for understanding how payer incentivized reimbursement models can impact quality and costs. In addition, there has been an increased emphasis on palliative care and reduced chemotherapy utilization at the end of life. Recognizing that cancer care at the end-of-life is personal, it will be essential to seek clarity on what components of care at the end of life may be reduced with no patient detriment and potentially improved quality of life.

Finally, as new and expensive immunotherapies are being introduced, it will be critical to understand how these agents impact both cost and survival and how they can be incorporated into alternative payment models. Only by understanding the drivers of payment differentials across patient demographics, cancer characteristics, and time can we both decrease costs and increase quality, thereby reducing the burden of cancer care.

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