

# Differences in Spending on Provider-Administered Chemotherapy by Site of Care in Medicare

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**C**hemotherapy is a common cancer treatment modality and a significant contributor to the cost of cancer treatment.<sup>1</sup> Many chemotherapy drugs are available in injectable forms, which are administered by providers in clinical settings.<sup>2</sup> Provider-administered drugs are usually reimbursed under the medical benefit of an insurance policy instead of the pharmacy benefit.<sup>2</sup> In Medicare, they are reimbursed by Part B coverage for outpatient medical services. Providers purchase drugs and then submit claims to Medicare for reimbursement of the drugs and associated administration costs.<sup>2</sup> Most Part B-covered drugs are administered in physician offices or hospital outpatient departments (HOPDs).

Over the past decade, the site of provider-administered cancer drugs has shifted from physician offices to HOPDs.<sup>3</sup> This trend has led to a concern that cancer care costs may increase because of differences in care costs between HOPDs and physician offices. Spending on cancer care in commercial settings is considerably higher in HOPDs than in physician offices, mainly due to higher payment rates for chemotherapy drugs and other services in HOPDs.<sup>4,7</sup>

However, these findings may not apply to Medicare. Medicare typically reimburses hospitals and physicians the same fee for Part B-covered drugs: 106% of the manufacturer's average sales price (ASP; the budget sequestration of 2013 reduced payments received by providers to 104.3% of ASP).<sup>8</sup> No consistent pattern exists in Medicare's reimbursement for drug administration. Some administration codes are paid more in HOPDs, whereas others are paid more in physician offices. In general, payments are higher in HOPDs. For example, in 2011, 14 of 20 administration codes payable in both settings were paid more in HOPDs.<sup>3</sup> However, administration fees are much smaller than chemotherapy drug costs. Thus, differences in chemotherapy-related costs in Medicare Part B mainly come from differences in chemotherapy drug utilization, such as the quantity of chemotherapy or use of more expensive chemotherapeutic agents.

A report by The Moran Company compared spending on chemotherapy between HOPDs and physician offices in Medicare using 2009-2011 claims data.<sup>3</sup> The report documented that the average number of chemotherapy claims per patient was slightly higher in HOPDs than in physician offices and average spending per patient

## ABSTRACT

**OBJECTIVES:** To compare Medicare spending on provider-administered chemotherapy in hospital outpatient departments (HOPDs) and physician offices after controlling for cancer type.

**STUDY DESIGN:** Secondary data analysis.

**METHODS:** We used 2010-2013 claims data for a random sample of Medicare fee-for-service beneficiaries who had cancer and received chemotherapy services either in physician offices or in HOPDs. We constructed 2 spending measures: (1) spending on chemotherapy drugs and (2) spending on chemotherapy administration. Each spending measure was the allowed payment, which includes both Medicare reimbursement and patient out-of-pocket spending. We compared the spending measures in the 2 care settings using regression analysis to control for certain patient risk factors, including cancer type. We also compared the number of chemotherapy and administration claims per beneficiary and spending per claim by cancer type to understand differences in utilization patterns in the 2 care settings.

**RESULTS:** Risk-adjusted chemotherapy drug spending per beneficiary was \$2451 lower in HOPDs compared with physician offices. Risk-adjusted chemotherapy administration spending was \$322 higher in HOPDs than in physician offices. Patients in physician offices received chemotherapy drugs more frequently than those in HOPDs. However, the chemotherapy spending per claim line was higher in HOPDs than physician offices.

**CONCLUSIONS:** Chemotherapy drug spending per Medicare beneficiary was lower in HOPDs than in physician offices, driven by less frequent use of chemotherapy in HOPDs. As the site of provider-administered chemotherapy shifts from physician offices to HOPDs, continuing assessment of cancer care spending by site of care is necessary.

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on chemotherapy agents was substantially higher in HOPDs. Based on these findings, the Moran report concluded that more and costlier chemotherapy treatments are used in HOPDs than in physician offices, given the same Medicare fees for chemotherapy drugs in both settings. However, the Moran analysis did not adjust for differences in patient risk factors between the 2 settings. An important risk factor is cancer type. The distribution of cancer types differs by setting,<sup>9</sup> and cancer drug utilization patterns differ by cancer type.<sup>10</sup> If patients with specific cancer types requiring expensive chemotherapy are more likely to be treated in HOPDs, the Moran report's conclusion is not valid.

To our knowledge, no study has examined chemotherapy-related spending in Medicare Part B after controlling for patient characteristics, such as cancer type. Our study fills this gap. We compared chemotherapy drug and administration spending in HOPDs and physician offices after controlling for cancer type. In addition, we explored differences in chemotherapy utilization patterns between the 2 settings.

## METHODS

### Data

The primary data sources were the 2010-2013 Medicare Outpatient file, which contains records for services in HOPDs, and the 2010-2013 Medicare Carrier file, which has claims for services by noninstitutional providers. Both files contain information on diagnosis, Healthcare Common Procedure Coding System (HCPCS) code, service date, and payments. Medicare Master Beneficiary Summary files provided beneficiaries' demographic characteristics and disease indicators, including cancer type, and the American Community Survey supplied zip code-level income, education, and unemployment rates.

### Study Population

The study population is a random sample of Medicare fee-for-service beneficiaries with cancer between 2010 and 2013. To select the sample, CMS first identified all patients with cancer from 100% of Medicare claims based on the standard algorithm used to create cancer indicators in the Medicare Chronic Condition Warehouse: having at least 1 inpatient or skilled nursing facility claim with a cancer diagnosis or at least 2 Carrier or Outpatient claims with a cancer diagnosis in a given year. Next, CMS provided us with the data for a random sample of those patients.

We restricted the sample to patients who had at least 1 chemotherapy claim identified by HCPCS Level II (J-codes) in the Outpatient or Carrier data. Chemotherapy includes all antineoplastic drugs (immune, hormonal, and targeted therapy). We selected claims with both cancer diagnosis and chemotherapy J-codes to exclude cases using cancer drugs for other conditions. All cancer diagnosis codes and chemotherapy J-codes used are reported in [eAppendix A](#) (eAppendices available at [ajmc.com](http://ajmc.com)). Claims for chemotherapy

## TAKEAWAY POINTS

Using 2010-2013 Medicare claims data, this study's results demonstrate that:

- ▶ Spending on chemotherapy drugs was \$2451 lower for Medicare beneficiaries receiving chemotherapy in hospital outpatient departments (HOPDs) than in physician offices.
- ▶ The spending on chemotherapy administration was \$322 higher for Medicare beneficiaries receiving chemotherapy in HOPDs than in physician offices.

As chemotherapy infusions are increasingly provided in the hospital outpatient setting, policy makers and payers should be aware that this shift in the site of chemotherapy may influence cancer care patterns and spending.

reported in both Carrier and Outpatient files using the same J-code on the same day were considered duplicates, and duplicate claims in the Carrier file were excluded to avoid double counting. We considered Carrier claims with the service place code of HOPDs as HOPD claims.

We further restricted the sample to patients with cancer who had both Medicare Part A and Part B coverage for the full year, and we excluded those who died within 3 months of diagnosis. We excluded enrollees in Medicare Advantage plans because their claims data are not available to researchers.

The study sample was categorized into 2 groups depending on the site of chemotherapy administration: HOPD-only if they received chemotherapy in HOPDs only and office-only if they received chemotherapy in physician offices only. Patients receiving chemotherapy in both settings, who accounted for 4.4% of the sample, were excluded to make a clean comparison of costs between HOPDs and physician offices.

### Outcome Measures

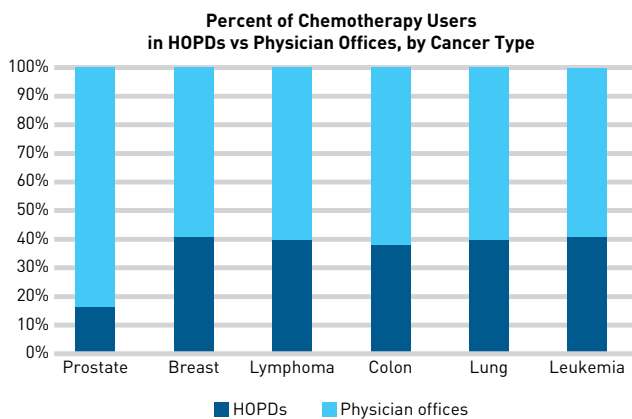
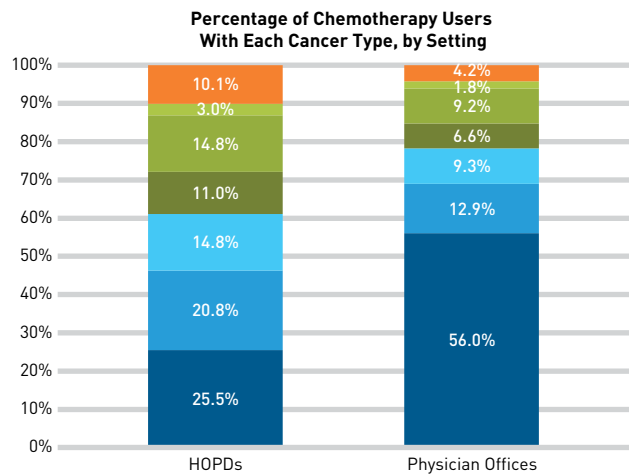
We constructed 2 outcome measures: (1) chemotherapy drug spending per beneficiary and (2) chemotherapy administration spending per beneficiary. These spending variables are allowed payments, including both Medicare reimbursements and patient out-of-pocket spending. We constructed chemotherapy drug spending by summing the allowed payments across each patient's chemotherapy claims with a cancer diagnosis code. Chemotherapy administration spending was created as the sum of the allowed payments across each patient's claims with chemotherapy administration codes and a cancer diagnosis.

### Analyses

We began with a descriptive analysis of 6 cancer types (prostate, breast, lymphoma, colon, lung, and leukemia) for which Part B chemotherapy is frequently used. First, we compared the distribution of cancer types between HOPDs and physician offices. Second, we compared chemotherapy drug and administration spending per beneficiary between the 2 settings for the entire sample and for each cancer type.

We used a linear regression model with clustered standard errors within a zip code. Our unit of analysis was a patient-year. The dependent variables were chemotherapy drug spending and chemotherapy drug administration spending. The key explanatory variable was a binary indicator equal to 1 if the patient received provider-administered chemotherapy only in HOPDs and 0 if she/he

**FIGURE 1.** Distribution of Cancer Types Between HOPDs and Physician Offices Among Medicare Beneficiaries Who Used Chemotherapy



HOPD indicates hospital outpatient department.

received chemotherapy only in physician offices. Key control variables were cancer type indicators, an indicator of cancer metastasis, and the number of cancer-related hospitalizations and outpatient visits in the prior year. To identify metastasis, we used the criterion of at least 2 diagnosis codes of metastatic disease (*International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]* codes 196-199) separated by 30 days or more.<sup>11-13</sup>

The regression also controlled for patient age, gender, race, state buy-in status (an indicator of whether Medicaid pays the patient’s Part B premium), indicators of chronic conditions (ischemic heart disease, diabetes, hypertension, hyperlipidemia, depression, heart failure, chronic pulmonary disease, and cataract), and number of chronic conditions. Area-level variables were average income, percent college educated, and unemployment rates at the zip code level. Finally, we used year dummies to control for year-specific effects that are common to all patients.

Using the regression results, we obtained risk-adjusted spending in each setting. To calculate risk-adjusted chemotherapy drug and administration spending in physician offices, we computed predicted spending by setting the HOPD indicator to 0 and all other covariates to their mean values. Similarly, we obtained risk-adjusted spending in HOPDs by computing predicted spending with the HOPD indicator equal to 1 and the means of all other covariates.

To explore whether chemotherapy utilization patterns differed between HOPDs and physician offices, we compared the number of chemotherapy and administration claims per beneficiary by cancer type. We also assessed spending per claim for chemotherapy drug and administration by cancer type.

### Sensitivity Checks

We performed the following sensitivity checks. First, we performed the regression analysis by year to check if differences in a particular year were driving the overall regression results. We used the same variables as in the primary analysis (except year-specific dummies) and calculated risk-adjusted spending in HOPDs versus physician offices for each year.

Second, we performed the regression analysis separately for each of the 6 cancers (prostate, breast, lymphoma, colon, lung, and leukemia) to check if the results were consistent across major cancer types.

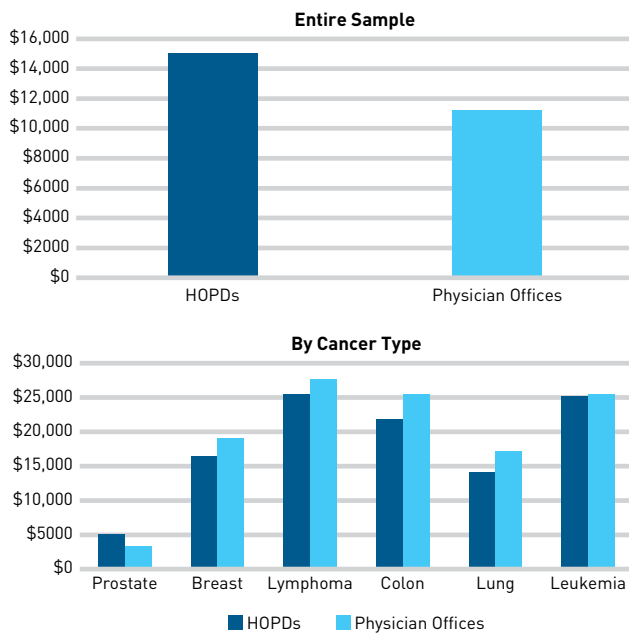
Third, we limited the analysis to separately reimbursable chemotherapy drugs (drugs that are not bundled into a payment group under the Medicare Hospital Outpatient prospective payment system). Medicare determines separately reimbursable drugs based on a threshold daily cost (> \$80 in 2013). Chemotherapy drugs whose daily costs are below the threshold are considered a dependent or ancillary service to the drug administration. Their cost is “bundled” into an Ambulatory Payment Classification<sup>14</sup> and arbitrarily allocated by hospitals. Including them in the analysis may lower the estimates of chemotherapy drug spending per beneficiary in HOPDs. We thus excluded nonseparately reimbursable drugs from both the Carrier and Hospital Outpatient files and checked the sensitivity of the results.

Last, we identified patients with *ICD-9* codes of surgeries for certain cancers for which there is evidence of better outcomes.<sup>15</sup> Individuals who underwent these surgeries are likely to use chemotherapy drugs as adjuvant therapy. We conducted the regression analysis on this subpopulation, who were relatively homogenous in terms of cancer severity, and checked the sensitivity of the results.

## RESULTS

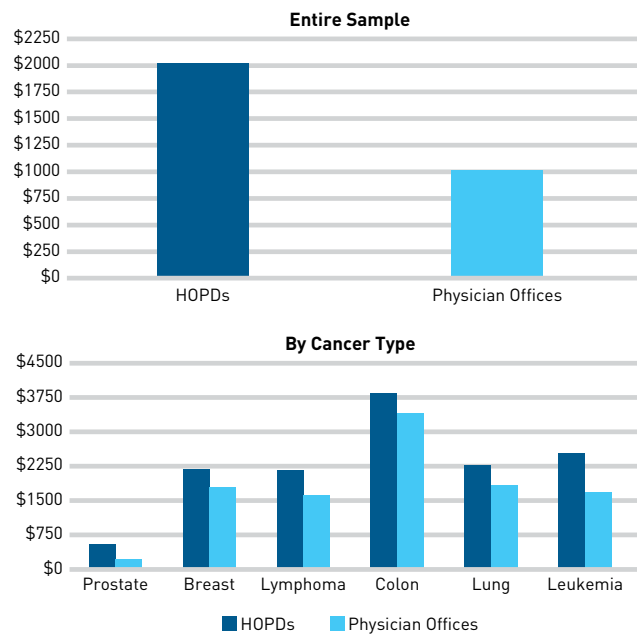
**Figure 1** shows the distribution of cancer types among Medicare chemotherapy users in HOPDs and physician offices. Six cancers accounted for more than 90% of all chemotherapy users in both HOPDs and physician offices, but the distribution of cancer types differed by setting. Prostate cancer accounted for 25% of chemotherapy users in HOPDs but more than 55% of chemotherapy users in physician offices. The bottom panel of **Figure 1** indicates that physician offices were the dominant place of services for all cancer

**FIGURE 2.** Unadjusted Chemotherapy Drug Spending Per Beneficiary in HOPDs vs Physician Offices



HOPD indicates hospital outpatient department.

**FIGURE 3.** Unadjusted Chemotherapy Administration Spending Per Beneficiary in HOPDs vs Physician Offices



HOPD indicates hospital outpatient department.

types. Eighty-four percent of patients with prostate cancer received chemotherapy in physician offices, and about 60% of patients with other cancers used physician offices.

Figure 2 shows that unadjusted average chemotherapy drug spending per beneficiary in the entire sample was about 34% higher in HOPDs than in physician offices (\$15,058 vs \$11,219). However, chemotherapy drug spending for patients with the same cancer type was higher in physician offices than in HOPDs for most cancer types except prostate cancer (bottom panel of Figure 2).

Figure 3 depicts descriptive data on chemotherapy administration spending per beneficiary. Unadjusted average chemotherapy administration spending per beneficiary was higher in HOPDs compared with physician offices, both in the full sample and among patients with the same cancer type.

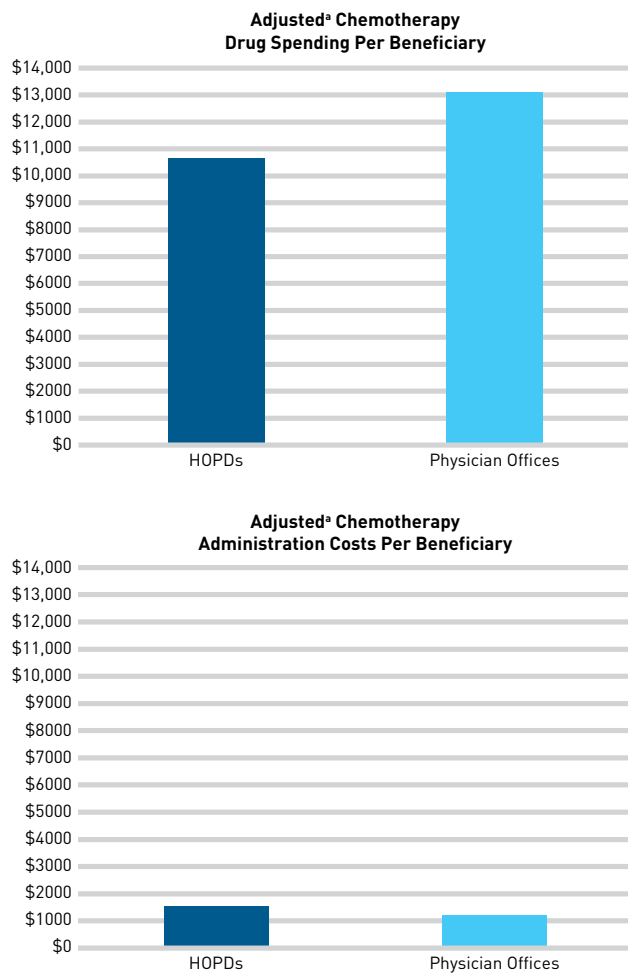
Figure 4 presents risk-adjusted chemotherapy spending in each setting based on the regression results. Risk-adjusted chemotherapy drug spending showed very different patterns than unadjusted spending. Chemotherapy drug spending per beneficiary after risk adjustment was \$2451 lower in HOPDs than in physician offices (\$10,658 vs \$13,109). Risk-adjusted chemotherapy administration spending per beneficiary was \$322 higher in HOPDs compared with physician offices (\$1543 vs \$1221).

The Table reports the number of claims per beneficiary and spending per claim on chemotherapy drugs and administration by cancer type. These data help explain why chemotherapy drug spending was lower in HOPDs compared with physician offices after controlling for cancer type. The frequency of chemotherapy among chemotherapy

users with the same cancer type was higher in physician offices than HOPDs for most cancer types except prostate cancer. For example, patients with colon cancer had 19 chemotherapy drug claims per beneficiary in physician offices versus 13 in HOPDs, on average. On the other hand, spending per claim among patients with colon cancer was \$367 higher in HOPDs compared with physician offices. For other cancers, spending was between \$257 and \$737 higher in HOPDs than in physician offices. Thus, the difference in spending per claim between HOPDs and physician offices is much smaller compared with the difference in spending from adding 1 more claim, which exceeds \$1000 across all cancer types in both settings. These data imply that additional drug claims are an important driver of total chemotherapy drug spending per patient, and more frequent use of chemotherapy led to higher spending in physician offices than HOPDs, after controlling for cancer type.

Similarly, the number of chemotherapy administration claims per beneficiary was higher in physician offices than in HOPDs for most cancer types, except prostate cancer. On the other hand, average spending per administration claim was almost twice as high in HOPDs compared with physician offices for most cancer types. For example, spending per chemotherapy administration claim for colon cancer was \$182 in HOPDs compared with \$100 in physician offices. This difference in spending per claim is large, considering that most administration claims were less than \$200. Thus, higher chemotherapy administration costs per beneficiary in HOPDs compared with physician offices are largely driven by more costly administration claims in HOPDs.

**FIGURE 4.** Adjusted Chemotherapy Drug and Administration Spending Per Beneficiary in HOPDs vs Physician Offices



HOPD indicates hospital outpatient department.

\*Spending was adjusted for patient and market characteristics and year-specific effects. Patient characteristics were age, gender, race, state buy-in status, cancer type (breast cancer, leukemia, lung cancer, colon cancer, prostate cancer, and lymphoma), indicators of common chronic conditions (ischemic heart disease, diabetes, hypertension, hyperlipidemia, depression, heart failure, chronic pulmonary disease, and cataract), the number of chronic conditions, the number of cancer-related hospitalizations in the prior year, and the number of cancer-related physician office visits in the prior year. Market factors were average income, percent college educated, and the unemployment rate.

The results of the sensitivity analysis supported the findings described above. Across all years, risk-adjusted chemotherapy drug spending per beneficiary was lower in HOPDs than in physician offices, and risk-adjusted chemotherapy administration spending per beneficiary was consistently higher in HOPDs compared with physician offices (eAppendix Table). Results from the analysis of each cancer (eAppendix Figure 1) were also consistent with the main analysis. The analysis using only separately reimbursable chemotherapy produced very similar results to the primary analysis (eAppendix Figure 2). Risk-adjusted chemotherapy drug spending per beneficiary was \$2245 lower in HOPDs than in physician offices, driven by the

**TABLE.** Number of Claim Lines and Spending Per Line for Chemotherapy Drugs and Administration

Variable	Number of Lines Per Beneficiary		Spending Per Claim Line (\$)	
	HOPDs	Physician Offices	HOPDs	Physician Offices
<b>Chemotherapy Drugs</b>				
Prostate	3.8	3.1	1328.65	1071.42
Breast	9.6	13.8	1709.36	1372.63
Lymphoma	8.3	10.8	3003.96	2521.80
Colon	12.8	19.2	1688.05	1321.41
Lung	8.9	14.0	1629.19	1249.12
Leukemia	8.2	10.8	3106.72	2370.20
<b>Chemotherapy Administrations</b>				
Prostate	4.0	3.4	138.30	64.30
Breast	10.8	16.2	203.19	111.13
Lymphoma	11.2	15.3	194.49	106.22
Colon	21.2	34.1	181.55	100.02
Lung	10.2	16.3	217.04	111.67
Leukemia	11.0	14.7	224.17	112.99

HOPD indicates hospital outpatient department.

smaller number of separately reimbursable chemotherapy claims in HOPDs. The analysis using patients undergoing a cancer-related surgery also produced results consistent with the main analysis.

## DISCUSSION

Analyzing 2010-2013 Medicare claims data, we found that risk-adjusted chemotherapy drug spending was lower for patients receiving chemotherapy in HOPDs than for patients using physician offices. We explored 2 contributors to these differences: differences in the number of chemotherapy drug claims and spending per chemotherapy claim. We found that chemotherapy users in physician offices received more chemotherapy than those in HOPDs for most cancer types and that average spending per chemotherapy drug claim was slightly higher in HOPDs than physician offices for all cancer types. However, the differences in average spending per claim were not large enough to make substantial differences in total chemotherapy drug spending per beneficiary. These findings indicate that lower utilization per beneficiary was an important driver of lower risk-adjusted chemotherapy drug spending in HOPDs than in physician offices.

Our findings differ from those of the Moran report, which concluded that more and costlier chemotherapy treatments are used in HOPDs than in physician offices.<sup>3</sup> It is important to note that the Moran report did not adjust for patient risk factors, including cancer type. As our results and prior literature indicate, the distribution of cancer types differs by setting<sup>9</sup> and cancer drug utilization patterns differ by cancer type.<sup>10</sup> Further, our data indicated that the frequency of chemotherapy among chemotherapy users with the same cancer was higher in physician offices than HOPDs for most cancer types except prostate cancer. Thus, adjusting for cancer

type is of utmost importance in explaining the cost and utilization differences between the 2 settings.

Our findings also differ from prior research in commercial settings, which consistently found that chemotherapy costs were higher in HOPDs than physician offices.<sup>4,7</sup> However, as mentioned earlier, spending differences in commercial settings are driven by price differences between HOPDs and physician offices rather than differences in the quantity of services.<sup>4,5</sup> Medicare uses the same reimbursement rates for chemotherapy drugs in both settings. It is thus not surprising that chemotherapy spending per Medicare beneficiary is lower in HOPDs than physician offices.

Our analysis also showed that higher chemotherapy spending in physician offices was due to higher utilization. This result is consistent with research in commercial settings. Hayes et al found that the mean number of chemotherapy sessions in employer-sponsored plans was higher in community oncology clinics than in HOPDs.<sup>16</sup> To our knowledge, our analysis is the first to explore differences in chemotherapy utilization by care setting and cancer type in Medicare.

### Limitations

We note several limitations of our study. First, we did not consider costs for other services that patients may have used when receiving chemotherapy. Prior research suggests that patients visiting HOPDs are likely to receive additional services (eg, laboratory tests) that might not be offered in physician offices.<sup>9,17</sup> We did not analyze spending on those services. Second, our findings are not generalizable to the commercial sector, where payment rates for chemotherapy drugs differ substantially by care site.<sup>4,5</sup> Third, we could not completely adjust for cancer severity, such as cancer stage, because detailed clinical information is not available in Medicare data. We partially addressed this issue by using a metastasis indicator, but our approach of identifying metastasis from diagnosis codes may have limited validity.<sup>18-20</sup> Third, the choice of chemotherapy site could depend on patients' preferences. Patients may prefer to use HOPDs because of the availability of other services or a short travel distance. Such patient characteristics might be related to chemotherapy use and spending to some extent. However, our study did not control for those factors. Finally, there was a shift in the site of cancer care from office-based to HOPD-based due to hospitals' acquisition of physician practices during the study period.<sup>21</sup> Although examining chemotherapy use and spending in those practices acquired by hospitals would be informative, it is beyond the scope of our analysis, and we leave it to future research.

### CONCLUSIONS

Chemotherapy drug spending per Medicare beneficiary was lower in HOPDs than in physician offices, driven by less frequent use of chemotherapy. As the site of provider-administered chemotherapy shifts from physician offices to HOPDs, continuing assessment of cancer care spending by care site is necessary. ■

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### REFERENCES

1. The costs of cancer: addressing patient costs. American Cancer Society Cancer Action Network website. [cancer.org/sites/default/files/2017-04/Costs%20of%20Cancer%20-%20Final%20Web.pdf](https://www.cancer.org/sites/default/files/2017-04/Costs%20of%20Cancer%20-%20Final%20Web.pdf). Published April 2017. Accessed July 1, 2017.
2. ASCO in Action brief: physician administered drugs – the evolution of buy & bill. American Society of Clinical Oncology website. [asco.org/advocacy-policy/asco-in-action/asco-action-brief-physician-administered-drugs-%E2%80%94-evolution-buy-bill](https://www.asco.org/advocacy-policy/asco-in-action/asco-action-brief-physician-administered-drugs-%E2%80%94-evolution-buy-bill). Published February 22, 2013. Accessed July 1, 2017.
3. The Moran Company. Cost differences in cancer care across settings. Community Oncology Alliance website. [communityoncology.org/UserFiles/Moran\\_Cost\\_Site\\_Differences\\_Study\\_P2.pdf](https://www.communityoncology.org/UserFiles/Moran_Cost_Site_Differences_Study_P2.pdf). Published 2013. Accessed July 1, 2017.
4. Bach PB, Jain RH. Physician's office and hospital outpatient setting in oncology: it's about prices, not use. *J Oncol Pract*. 2017;13(1):4-5. doi: 10.1200/JOP.2016.018283.
5. Fisher MD, Punekar R, Yim YM, et al. Differences in health care use and costs among patients with cancer receiving intravenous chemotherapy in physician offices versus in hospital outpatient settings. *J Oncol Pract*. 2017;13(1):e37-e46. doi: 10.1200/JOP.2016.012930.
6. Pyenson BS, Fitch KV, Pelizzari PM. Cost drivers of cancer care: a retrospective analysis of Medicare and commercially insured population claim data 2004-2014. Milliman website. [milliman.com/insight/2016/Cost-drivers-of-cancer-care-A-retrospective-analysis-of-Medicare-and-commercially-insured-population-claim-data-2004-2014/](https://www.milliman.com/insight/2016/Cost-drivers-of-cancer-care-A-retrospective-analysis-of-Medicare-and-commercially-insured-population-claim-data-2004-2014/). Published April 14, 2016. Accessed July 1, 2017.
7. Jain RH, Bach PB. Hospital outpatient versus physician office cost for physician administered cancer drugs. Drug Pricing Lab website. [drugpricinglab.org/wp-content/uploads/2017/03/HOPDvsPO\\_010417-1.pdf](https://www.drugpricinglab.org/wp-content/uploads/2017/03/HOPDvsPO_010417-1.pdf). Published January 4, 2017. Accessed July 1, 2017.
8. Chapter 5: Medicare Part B drug and oncology payment policy issues. Medicare Payment Advisory Commission website. [medpac.gov/docs/default-source/reports/chapter-5-medicare-part-b-drug-and-oncology-payment-policy-issues-june-2016-report.pdf?sfvrsn=0](https://www.medpac.gov/docs/default-source/reports/chapter-5-medicare-part-b-drug-and-oncology-payment-policy-issues-june-2016-report.pdf?sfvrsn=0). Published June 2016. Accessed October 1, 2017.
9. Hammelman E. Cost of cancer care by setting of therapy. Avalere Health website. 216.230.117.100/hmd/-/media/Files/Activity%20Files/Disease/NCPF/June%202014%20Workshop/Hammelman.pdf. Published June 2014. Accessed July 1, 2017.
10. Jung JK, Feldman R, McBean AM. The price elasticity of specialty drug use: evidence from cancer patients in Medicare Part D. *Forum Health Econ Policy*. 2017;20(2):20160007. doi: 10.1515/fhep-2016-0007.
11. Rao S, Kubisiak J, Gilden D. Cost of illness associated with metastatic breast cancer. *Breast Cancer Res Treat*. 2004;83(1):25-32. doi: 10.1023/B:BREA.0000010689.55559.06.
12. Jacobson M, O'Malley AJ, Earle CC, Pakes J, Gaccione P, Newhouse JP. Does reimbursement influence chemotherapy treatment for cancer patients? *Health Aff (Millwood)*. 2006;25(2):437-443. doi: 10.1377/hlthaff.25.2.437.
13. Goldman DP, Jena AB, Lakdawalla DN, Malin JL, Malkin JD, Sun E. The value of specialty oncology drugs. *Health Serv Res*. 2010;45(1):115-132. doi: 10.1111/j.1475-6773.2009.01059.x.
14. Hospital outpatient prospective payment system. CMS website. [cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/HospitalOutpaysysfctstTextOnly.pdf](https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNProducts/Downloads/HospitalOutpaysysfctstTextOnly.pdf). Published 2016. Updated December 2017. Accessed June 1, 2018.
15. Cancer surgery volume study: ICD-9 and CPT codes. California HealthCare Foundation website. [chcf.org/wp-content/uploads/2017/12/PDF-CancerSurgeryCaHospitalsICD9Codes.pdf](https://www.chcf.org/wp-content/uploads/2017/12/PDF-CancerSurgeryCaHospitalsICD9Codes.pdf). Published 2017. Accessed October 1, 2017.
16. Hayes J, Hoverman RJ, Brow ME, et al. Cost differential by site of service for cancer patients receiving chemotherapy. *Am J Manag Care*. 2015;21(3):e189-e196.
17. Avalere Health LLC. Total cost of cancer care by site of service: physician office vs outpatient hospital. Community Oncology Alliance website. [communityoncology.org/pdfs/avalere-cost-of-cancer-care-study.pdf](https://www.communityoncology.org/pdfs/avalere-cost-of-cancer-care-study.pdf). Published March 2012. Accessed July 1, 2017.
18. Thomas SK, Brooks SE, Multins CD, Baquet CR, Merchant S. Use of ICD-9 coding as a proxy for stage of disease in lung cancer. *Pharmacoepidemiol Drug Saf*. 2002;11(8):709-713. doi: 10.1002/pds.759.
19. Nordstrom BL, Whyte JL, Stolar M, Mercaldi C, Kallich JD. Identification of metastatic cancer in claims data. *Pharmacoepidemiol Drug Saf*. 2012;21(suppl 2):21-28. doi: 10.1002/pds.3247.
20. Chawla N, Yabroff KR, Mariotto A, McNeel TS, Schrag D, Warren JL. Limited validity of diagnosis codes in Medicare claims for identifying cancer metastases and inferring stage. *Ann Epidemiol*. 2014;24(9):666-672. doi: 10.1016/j.annepidem.2014.06.099.
21. Avalere Health LLC. Hospital acquisitions of physician practices and the 340B program. Alliance for Integrity and Reform of 340B website. [340breform.org/userfiles/Avalere%20Acquisition.pdf](https://www.340breform.org/userfiles/Avalere%20Acquisition.pdf). Published June 2015. Accessed October 1, 2017.

Full text and PDF at [www.ajmc.com](http://www.ajmc.com)

## **eAppendix A**

### 1. Cancer diagnosis codes used in the study:

Breast Cancer: 174.0, 174.1, 174.2, 174.3, 174.4, 174.5, 174.6, 174.8, 174.9, 175.0, 175.9, 233.0, V10.3

Colon Cancer: 153.0, 153.1, 153.2, 153.3, 153.4, 153.5, 153.6, 153.7, 153.8, 153.9, 154.0, 154.1, 230.3, 230.4, V10.05, V10.06

Prostate Cancer: 185, 233.4, V10.46

Lung Cancer: 162.2, 162.3, 162.4, 162.5, 162.8, 162.9, 231.2, V10.11

Leukemia: 204, 205, 206, 207, 208, V10.60, V10.61, V10.62, V10.63, V10.69

Lymphoma: 200, 202, V10.71, V10.79

Others: 157, V10.09, 183, V10.43, 172, V10.82, 189.0, V10.52, 171

### 2. Chemotherapy J-codes used in the study:

J9000-J9999, J8521, J8560, J8520, and J8530

### 3. Chemotherapy administration codes (HCPCS Level I codes) used in the study:

96xxxx

**eAppendix Table.** Adjusted Chemotherapy Drug and Administration Spending Per Beneficiary in HOPDs Versus Physician Offices by Year

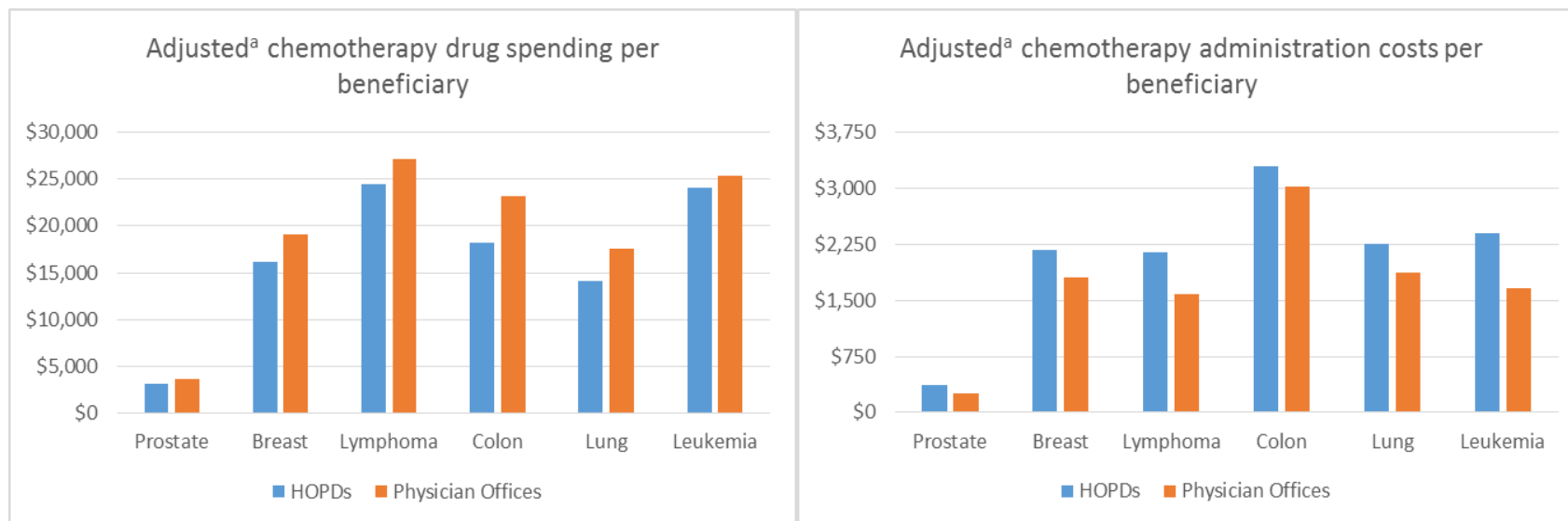
Variable	Adjusted Spending <sup>a</sup> Per Beneficiary			
	2010	2011	2012	2013
<b>Chemotherapy Drug Spending</b>				
HOPDs	\$9850.23	\$10,451.7	\$11,188.26	\$11,000.49
Physician offices	\$12,661.31	\$13,318.21	\$13,437.24	\$13,006.85
<b>Chemotherapy Administration Spending</b>				
HOPDs	\$1600.71	\$1473.96	\$1485.19	\$1602.40
Physician offices	\$1267.20	\$1266.83	\$1171.09	\$1167.75

HOPD indicates hospital outpatient department.

<sup>a</sup>Spending was adjusted for patient and market characteristics. Patient characteristics were age, gender, race, state buy-in status, cancer type (breast cancer, leukemia, lung cancer, colon cancer, prostate cancer, and lymphoma), indicators of common chronic conditions (ischemic heart disease, diabetes, hypertension, hyperlipidemia, depression, heart failure, chronic pulmonary disease, and cataract), the number of chronic conditions, the number of cancer-related hospitalizations in the prior year, and the number of cancer-related physician office visits in the prior year. Market factors were average income, percent college educated, and the unemployment rate.



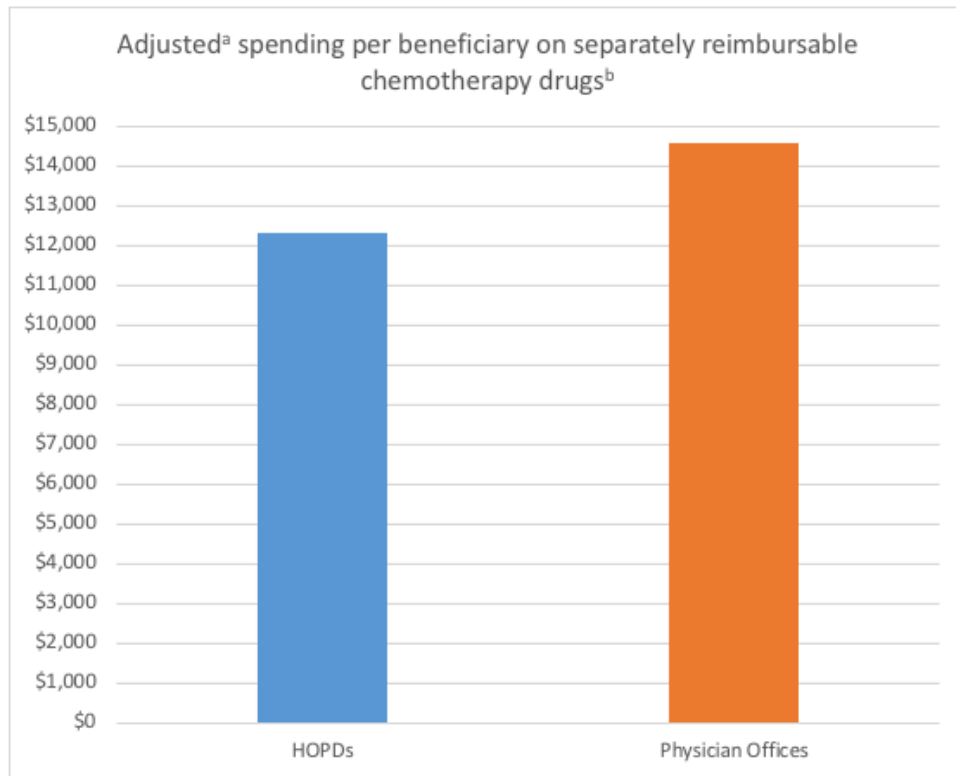
**eAppendix Figure 1.** Adjusted Chemotherapy Drug and Administration Spending Per Beneficiary in HOPDs Versus Physician Offices by Cancer Type



HOPD indicates hospital outpatient department.

<sup>a</sup>Spending was adjusted for patient and market characteristics and year-specific effects. Patient characteristics were age, gender, race, state buy-in status, cancer type (breast cancer, leukemia, lung cancer, colon cancer, skin cancer, pancreatic cancer, sarcoma, prostate cancer, kidney cancer, ovarian cancer, and lymphoma), indicators of common chronic conditions (ischemic heart disease, diabetes, hypertension, hyperlipidemia, depression, heart failure, chronic pulmonary disease, and cataract), the number of chronic conditions, the number of cancer-related hospitalizations in the prior year, and the number of cancer-related physician office visits in the prior year. Market factors were average income, percent college educated, and the unemployment rate.

**eAppendix Figure 2.** Adjusted Spending Per Beneficiary on Separately Reimbursable Chemotherapy Drugs in HOPDs Versus Physician Offices



HOPD indicates hospital outpatient department.

<sup>a</sup>Spending was adjusted for patient and market characteristics and year-specific effects. Patient characteristics were age, gender, race, state buy-in status, cancer type dummies (breast cancer, leukemia, lung cancer, colon cancer, prostate cancer, and lymphoma), indicators of common chronic conditions (ischemic heart disease, diabetes, hypertension, hyperlipidemia, depression, heart failure, chronic pulmonary disease, and cataract), the number of chronic conditions, the number of cancer-related hospitalizations in the prior year, and the number of cancer-related physician office visits in the prior year. Market factors were average income, percent college educated, and the unemployment rate.

<sup>b</sup>Separately reimbursable chemotherapy drugs are chemotherapy drugs that are not bundled into a payment group under the Medicare Hospital Outpatient prospective payment system.