

# Trends in Low-Value Cancer Care During the COVID-19 Pandemic

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Low-value health care services confer costs and risks to patients that exceed the services' benefits.<sup>1</sup> The importance of low-value services in US health care has been demonstrated by several lines of research outside of cancer care, and low-value health care has been a frequent target of performance-based measures from alternative payment models.<sup>2-4</sup> Study findings have demonstrated how specific tests or treatments fail to produce health gains warranting their costs or adverse events; many such services have been highlighted by medical specialty societies through the Choosing Wisely initiative.<sup>5</sup>

Low-value services are prevalent in cancer care, with rates of certain metrics such as bone scans in low-risk prostate cancer and tumor markers in nonmetastatic breast cancer reaching over 50%.<sup>6</sup> In 2020, the onset of the COVID-19 pandemic caused a dramatic shift in cancer care delivery in an effort to reduce the risks of exposing patients with cancer to health care settings.<sup>7</sup> During this period of disruption, health systems and clinicians may have seized the opportunity to reduce the use of lower-value services because of the potential for increased visits and hospitalizations to spread the virus among vulnerable populations.<sup>8</sup> Alternatively, clinicians may have preferred to use more low-value therapeutics—including off-pathway supportive care medications and systemic therapies—to avoid patients receiving clinic-based infusion therapy. However, prior evidence suggests considerable avoidance of cancer therapy during the pandemic with relatively minimal transition to oral chemotherapies, arguing against this hypothesis.<sup>9,10</sup>

We investigated the relationship between the onset of the COVID-19 pandemic and changes in several metrics of low-value cancer care. We hypothesized that the COVID-19 pandemic resulted in decreased provision of low-value cancer care. We assumed that health systems and patients would have sought to minimize potential COVID-19 exposure for vulnerable patients with cancer and thus decreased utilization of services that may have been unnecessary during the pandemic. Furthermore, we would expect that any practice changes induced by the pandemic would be magnified among low-value practices, which may be marginal and thus more likely to change. We define low-value care using population-based metrics based on clinical guidelines, as per other studies outside of cancer care.<sup>11,12</sup>

## ABSTRACT

**OBJECTIVE:** To assess the association between the onset of the COVID-19 pandemic and change in low-value cancer services.

**STUDY DESIGN:** In this retrospective cohort study, we used administrative claims from the HealthCore Integrated Research Environment, a repository of medical and pharmacy data from US health plans representing more than 80 million members, between January 1, 2016, and March 31, 2021.

**METHODS:** We used linear probability models to investigate the relation between the onset of the COVID-19 pandemic and 4 guideline-based metrics of low-value cancer care: (1) conventional fractionation radiotherapy instead of hypofractionated radiotherapy for early-stage breast cancer; (2) non-guideline-based antiemetic use for minimal-, low-, or moderate- to high-risk chemotherapies; (3) off-pathway systemic therapy; and (4) aggressive end-of-life care. We identified patients with new diagnoses of breast, colorectal, and/or lung cancer. We excluded members who did not have at least 6 months of continuous insurance coverage and members with prevalent cancers.

**RESULTS:** Among 117,116 members (median [IQR] age, 60 [53-69] years; 72.4% women), 59,729 (51.0%) had breast cancer, 25,751 (22.0%) had colorectal cancer, and 31,862 (27.2%) had lung cancer. The payer mix was 18.7% Medicare Advantage or Medicare supplemental and 81.2% commercial non-Medicare. Rates of low-value cancer services exhibited minimal changes during the pandemic, as adjusted percentage-point differences were 3.93 [95% CI, 1.50-6.36] for conventional radiotherapy, 0.82 [95% CI, -0.62 to 2.25] for off-pathway systemic therapy, -3.62 [95% CI, -4.97 to -2.27] for non-guideline-based antiemetics, and 2.71 [95% CI, -0.59 to 6.02] for aggressive end-of-life care.

**CONCLUSIONS:** Low-value cancer care remained prevalent throughout the pandemic. Policy makers should consider changes to payment and incentive design to turn the tide against low-value cancer care.

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## METHODS

### Design

This retrospective cohort study examined trends in low-value care metrics for patients with cancer using a large database of commercial insurance claims. The study was exempt from the University of Pennsylvania's institutional review board approval because it involved a limited study database with masked identifiers.

### Data Sources

We used administrative claims and health plan enrollment data from the HealthCore Integrated Research Environment for information on diagnoses, use of cancer treatment, costs, comorbidities, and rendering of clinician identifiers. The HealthCore Integrated Research Environment is a repository of medical and pharmacy claims data for approximately 80 million geographically diverse members enrolled in individual, employer-sponsored, and Medicare Advantage plans starting in 2006. In 2016, the HealthCore Integrated Research Environment covered 6.6% of adults 20 years or older in the US.

### Study Sample

We identified enrollees in the health plans who were 18 years or older in fully insured or self-insured plans and who had received a new diagnosis of breast, colorectal, or lung cancer between January 1, 2016, and March 31, 2021. We identified new cancer cases using *International Classification of Diseases, Ninth Revision* or *International Statistical Classification of Diseases, Tenth Revision* diagnosis codes for breast, colorectal, or lung cancer (see **eAppendix Table 1** [eAppendix available at [ajmc.com](http://ajmc.com)] for all diagnostic and procedure codes). We required members to have at least 6 months of continuous insurance coverage prior to their initial cancer diagnosis date. We excluded individuals with cancers that had been previously diagnosed because it is difficult to ascertain the prevalence of low-value cancer care practices across a heterogeneous cohort that may have received previous lines of therapy and are at different points in their cancer course. To exclude prevalent cancers and isolate incident cases, we excluded individuals who had any diagnosis code for an eligible cancer in the 6 months prior to incident index cancer diagnosis between 2016 and 2021. We further identified eligible populations for each low-value care outcome analysis as per published guidelines (**eAppendix Tables 1 and 2**) such that each analysis for each low-value care outcome contained a different denominator of eligible patients. Baseline patient characteristics were measured during the 6-month period prior to diagnosis.

### Low-Value Care Outcomes

The primary outcome for all analyses was receipt of low-value cancer care, defined as the percentage of eligible patients per period who received a low-value service. Although there are no

## TAKEAWAY POINTS

Among adults with newly diagnosed cancer, rates of low-value cancer services persisted throughout the COVID-19 pandemic in areas ranging from peridiagnosis imaging to end-of-life care.

- ▶ Educational campaigns and payment reforms, including the Center for Medicare and Medicaid Innovation Oncology Care Model, have had limited success in curbing low-value cancer care.
- ▶ The COVID-19 pandemic caused a dramatic decrease in health care utilization, leading many to suspect that low-value cancer services would decrease.
- ▶ We found that low-value care in areas ranging from cancer treatment to supportive care to end-of-life care remained stubbornly high even during the height of stay-at-home orders in the US.
- ▶ Policy makers should consider more targeted changes to payment and incentive design to turn the tide against low-value cancer care.

consensus definitions of low-value care in oncology care, we included published metrics from guideline bodies or peer-reviewed literature. These measures spanned across the cancer care continuum, from diagnosis to treatment to survivorship and end of life. We intentionally did not include metrics of cancer screening because the pandemic's impact on a decline in cancer screening has been well described.<sup>13,14</sup> Low-value care measures were identified from the American Society of Clinical Oncology and American Society for Radiation Oncology Choosing Wisely campaigns,<sup>15,16</sup> the Hutchinson Institute for Cancer Outcomes Research,<sup>17</sup> Anthem's Cancer Care Quality Program treatment pathways,<sup>18</sup> National Comprehensive Cancer Network guidelines,<sup>19</sup> and peer-reviewed literature on low-value antiemetic use.<sup>20</sup> We defined 4 measures of low-value cancer care spanning the cancer care continuum (eAppendix Table 2): (1) conventional fractionation radiotherapy instead of hypofractionated radiotherapy for early-stage breast cancer only<sup>15</sup>; (2) non-guideline-based antiemetic use for minimal-, low-, or moderate- to high-risk chemotherapies across breast, colorectal, and lung cancers<sup>16,19,20</sup>; (3) off-pathway systemic therapy across breast, colorectal, and lung cancers<sup>18</sup>; and (4) aggressive end-of-life care (chemotherapy in the last 14 days of life, multiple emergency department visits in the last 30 days of life, intensive care unit utilization in the last 30 days of life, hospice initiation  $\leq 3$  days before death, and/or no hospice care receipt before death) across breast, colorectal, and lung cancers.<sup>17</sup> We intentionally chose measures of low-value care that involved both additional health care encounters (eg, conventional radiotherapy, aggressive end-of-life care) and selection of lower-value diagnostics or treatment without increased encounters (eg, low-value antiemetics, off-pathway systemic therapy). We hypothesized that metrics reflecting increased encounters would disproportionately decrease, compared with other low-value metrics, during the pandemic.

### Covariates

We collected covariates for statistical adjustment including sex (male vs female), age in years, Deyo-Charlson Comorbidity Index score, insurance type (Medicare Advantage, Medicare supplemental, commercial), geographic region (Northeast, Midwest, South, West), urban vs rural domicile, and area-level socioeconomic status.

## TRENDS FROM THE FIELD

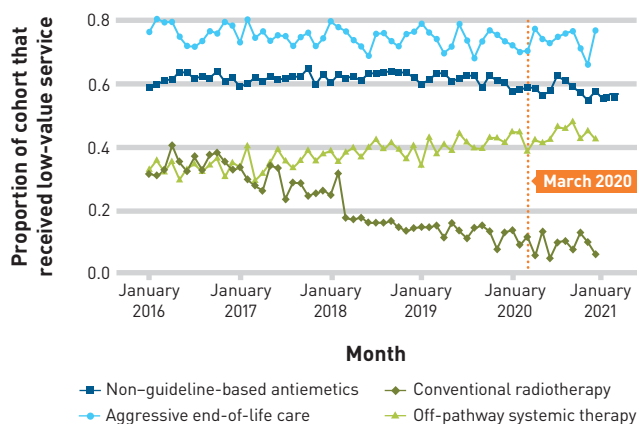
**TABLE 1.** Demographic Characteristics of the Cohort

Characteristics	Pre-COVID-19 period (January 2016-February 2020)	COVID-19 period (March 2020-December 2020)
Number of members <sup>a</sup>	103,765	13,351
Age in years, median (IQR)	60 [53-69]	59 [51-67]
Female, n (%)	75,167 (72%)	9632 (72%)
Cancer type, n (%)		
Breast	52,920 (51%)	6809 (51%)
Colorectal	22,721 (22%)	3030 (23%)
Lung	28,383 (27%)	3479 (26%)
Urban domicile, n (%)	81,397 (78%)	10,363 (78%)
Region, n (%)		
Northeast	17,847 (17%)	2070 (16%)
Midwest	25,761 (25%)	3828 (29%)
South	34,419 (33%)	4638 (35%)
West	24,867 (24%)	2791 (21%)
Insurance type, n (%)		
Medicare	18,980 (18%)	2947 (22%)
Commercial	84,785 (82%)	10,404 (78%)
Eligible populations in each low-value metric		
Conventional radiotherapy	10,123	2090
Non-guideline-based antiemetics	69,511	11,804
Off-pathway systemic therapy	35,924	5563
Aggressive end-of-life care	19,566	2096

<sup>a</sup>Number of unique members identified across measures.

Source: HealthCore Integrated Research Environment.

**FIGURE.** Unadjusted Patient-Level Trends in Receipt of Low-Value Cancer Care Metrics, January 2016 to December 2020<sup>a</sup>



<sup>a</sup>Points represent monthly proportions of eligible patients who received the low-value care measure in question in the pre-COVID-19 (January 2016 to February 2020) and COVID-19 (March 2020 to December 2020) periods. Dotted line represents March 1, 2020, which we defined as the beginning of the COVID-19 pandemic period. Cohort refers to the eligible cohort for each measure.

Source: HealthCore Integrated Research Environment.

Area-level socioeconomic status was specified as first quartile (lowest) to fourth quartile (highest) based on validated socioeconomic indicators such as median home value, median family income, the ratio of population below poverty, ratios of the population with less than high school education and at least 4 years of college, and unemployment rates, as developed by the Agency for Healthcare Research and Quality and applied to American Community Survey data.<sup>21</sup> For the conventional radiotherapy outcome, additional covariates (based on a prior study<sup>22</sup>) included service-site facility (office vs outpatient facility), county-level radiation oncologist density, and a post-2018 indicator because the American Society for Radiation Oncology released guidance recommending hypofractionated radiotherapy for all patients with early-stage breast cancer at that time.

### Statistical Analysis

To verify the disruption in cancer care induced by the pandemic in this sample, we first described trends in cancer diagnosis rates. Linear probability models applied to patient-month-level data were then used to evaluate the association of the COVID-19 period with each of the 4 low-value outcomes. The COVID-19 period was defined as March 2020 to December 2020 due to the initiation of many state stay-at-home orders in March 2020. All analyses included a month fixed effect to account for seasonality and a linear time trend to account for secular changes in the outcome over time and were adjusted for the above covariates. Linear time trends were defined as the month entering the regressions (eg, month 1, 2, 3, etc), and we controlled for differential trends in the pre-COVID-19 and COVID-19 periods. The key regression terms of interest were an indicator for the COVID-19 period and an interaction between that indicator and a linear time trend. After conducting each linear regression model, we used the Stata margins command to calculate the marginal effect of the COVID-19 period; these calculated marginal effects provide adjusted estimates that incorporate both changes in the outcome level and changes in the linear temporal trend in the outcome during the COVID-19 period. All analyses were conducted using Stata 16.1 (StataCorp LLC). Statistical significance was set at .05, and all tests were 2-sided.

## RESULTS

Among 117,116 members (median [IQR] age, 60 [53-69] years; 72.4% women), 59,729 (51.0%) had breast cancer, 25,751 (22.0%) had colorectal cancer, and 31,862 (27.2%) had lung cancer (Table 1). The payer mix was 18.7% Medicare Advantage or Medicare supplemental and 81.2% commercial non-Medicare. We observed an initial steep decline in overall cancer diagnosis rates at the start of the COVID-19 pandemic for all cancers that returned to baseline (eAppendix Figure). In unadjusted analyses, rates of low-value cancer care in the pre-COVID-19 vs COVID-19 periods were 22.1% vs 9.4% for conventional fractionation radiotherapy (n = 12,213), 61.2% vs 58.1% for non-guideline-based antiemetics (n = 81,315), 36.7% vs 43.2% for off-pathway systemic therapy (n = 41,487), and 75.7% vs 73.3% for aggressive end-of-life care (n = 21,662) (Figure). In adjusted

**TABLE 2.** Association Between COVID-19 Pandemic and Select Low-Value Cancer Care Metrics\*

Low-value care metric	Pre-COVID-19 cohort size, n	COVID-19 cohort size, n	Unadjusted pre-COVID-19 rate (95% CI)	Unadjusted COVID-19 rate (95% CI)	Adjusted percentage-point difference (95% CI)	P
Conventional radiotherapy	10,123	2090	22.1% (21.3%-23.0%)	9.4% (8.2%-10.7%)	3.93 (1.50-6.36)	.002
Non-guideline-based antiemetics	69,511	11,804	61.2% (60.8%-61.5%)	58.1% (57.3%-59.0%)	-3.62 [-4.97 to -2.27]	<.001
Off-pathway systemic therapy	35,924	5563	36.7% (36.2%-37.2%)	43.2% (41.9%-44.5%)	0.82 [-0.62 to 2.25]	.262
Aggressive end-of-life care	19,566	2096	75.7% (75.2%-76.4%)	73.3% (71.4%-75.2%)	2.71 [-0.59 to 6.02]	.108

\*Models used robust SEs, clustered at year-month level (eg, January 2018). Adjusted percentage-point differences are estimated from linear probability models adjusted for age, Deyo-Charlson Comorbidity Index score, insurance type (Medicare Advantage, Medicare supplemental, commercial), urban/rural status, region (Northeast, Midwest, South, West), and area-level socioeconomic status. The conventional radiotherapy outcome was additionally adjusted for county-level radiation oncologist density. The cohort size refers to the eligible populations who satisfied the inclusion criteria and were included in the analysis for each measure. Pre- and post-COVID-19 rates refer to unadjusted rates.

Source: HealthCore Integrated Research Environment.

analyses, the COVID-19 period, relative to the pre-COVID-19 period, was not associated with significant changes in off-pathway systemic therapy (adjusted percentage-point difference, 0.82; 95% CI, -0.62 to 2.25;  $P = .262$ ) and aggressive end-of-life care (adjusted percentage-point difference, 2.71; 95% CI, -0.59 to 6.02;  $P = .108$ ) (Table 2). The COVID-19 period was associated with an increase in conventional radiotherapy (adjusted percentage-point difference, 3.93; 95% CI, 1.50-6.36;  $P = .002$ ) and a decrease in non-guideline-based antiemetics (adjusted percentage-point difference, -3.62; 95% CI, -4.97 to -2.27;  $P < .001$ ).

## DISCUSSION

Among adults with breast, colorectal, or lung cancer, the onset of the COVID-19 pandemic was not associated with consistent changes in low-value cancer care. Rates of low-value cancer services persisted throughout the pandemic. Importantly, utilization-related metrics (conventional radiation, aggressive end-of-life care) did not show declines compared with metrics other than utilization that reflected discretionary care decisions (eg, non-guideline-based antiemetics). Indeed, conventional radiation had a strong declining secular trend prior to the pandemic that appeared to plateau during the pandemic.

Prepandemic evidence suggests substantial physician variation in low-value practice patterns among both primary care and oncology clinicians.<sup>11,23,24</sup> Our study results suggest that pandemic-related guidance to avoid unnecessary health care visits did not change low-value practice patterns of oncology clinicians. This is in line with prior evidence from smaller, limited-institution studies not focusing on cancer, which suggests that pandemic-related disruptions did not meaningfully change metrics of hospice utilization near patients' end of life.<sup>25</sup> Of note, findings from a national study among Medicare beneficiaries in 2020 showed some decreases in low-value cancer screening but increases in low-value opioid use—thus representing an inconsistent effect.<sup>26</sup> Another national study of several low-value care practices outside of oncology care found a sharp decline in April 2020 that normalized by the end of 2020, in line with the findings of this study.<sup>27</sup> Our study's results run counter to prevailing notions that the utilization shock induced by the

pandemic would disproportionately decrease low-value services.<sup>7,8</sup> Indeed, both low-value and non-low-value cancer services may have decreased proportionately during the pandemic. Additionally, we have previously demonstrated that, despite clinical guidelines suggesting avoidance of discretionary infusion-based therapies during the pandemic, the prevalence of transitions from infusion or injection therapies to oral therapies was minimal.<sup>10</sup> It is possible that utilization declines were countered by practices intentionally increasing low-value services to mitigate revenue losses during the pandemic; future studies should investigate this troubling possibility. Of note, although the pandemic was associated with statistically significant changes in 2 low-value metrics (conventional radiotherapy, non-guideline-based antiemetics), the changes were less than 5 percentage points in absolute value and were relatively low compared with the underlying prevalence of low-value care for each of these metrics; furthermore, these do not represent consistent effects, and thus we interpret these findings as not clinically impactful.

Oncology is a particular target of insurers' efforts to curb expensive and potentially unnecessary health care services.<sup>28</sup> By definition, low-value cancer care may pose additional costs and harms—including high out-of-pocket spending, medication adverse events, and care inconsistent with patient goals—to patients and the health care system, without meaningful benefits in patient outcomes. Thus, curbing low-value care represents an important policy priority given efforts to limit the costs of cancer care. Our study has implications for future strategies to curb low-value cancer care in oncology and beyond. Educational efforts, such as the American Board of Internal Medicine Choosing Wisely campaign, and broad-based payment reform, including the Center for Medicare and Medicaid Innovation Oncology Care Model, have had limited success in substantially curbing low-value cancer care.<sup>29-31</sup> Given that rates of low-value cancer care were persistently high through a massive health care disruption such as the COVID-19 pandemic, it is clear that low-value care is a persistent and difficult problem.

## Limitations

There are several limitations to our analysis. Claims-based analyses are unable to account for unmeasured patient-, provider-, practice-,

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or system-related factors that, if associated with the COVID-19 pandemic, may have influenced our results. Thus, other factors may have affected rates of low-value cancer care during the study period, although our analytic approach accounted for observed confounders, temporal trends, and unobserved confounders that were stable over time. Additionally, there is no consensus definition of low-value cancer care metrics after the point of cancer screening. Although we chose several metrics that spanned the cancer care continuum, our selected metrics were not exhaustive. Greater efforts to define low-value cancer care practices are necessary. Finally, it is possible that certain low-value metrics such as low-value antiemetic use may be prone to measurement error because claims lack information on chemotherapy dosing. However, we assume that any measurement error would be constant across time and not affected by COVID-19 such that comparing rates post COVID-19 with those before COVID-19 would still be valid. ■

## CONCLUSIONS

Low-value cancer care remained prevalent throughout the pandemic. Policy makers should consider changes to payment and incentive design to turn the tide against low-value cancer care.

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**Authorship Information:** Concept and design (RBP, YC, JEB, ALS); acquisition of data (RBP, YC, PO, GS, JEB, ALS); analysis and interpretation of data (RBP, YC, PO, GS, JEB, ALS); drafting of the manuscript (RBP, YC, GS, JEB, ALS); critical revision of the manuscript for important intellectual content (YC, PO, DD, MJF); statistical analysis (RBP, YC, PO, GS, JEB, ALS); provision of patients or study materials (RBP, YC, PO, DD, MJF, GS, JEB, ALS); obtaining funding (RBP, YC, JEB, ALS); and administrative, technical, or logistic support (RBP, YC, PO, DD, MJF, JEB, ALS).

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**eAppendix Table 1.** Diagnosis and Procedure Codes

<b>Main Cohort</b>			
	<b>Diagnosis</b>		
<b>Condition or procedure</b>	<b>ICD-9</b>	<b>ICD-10</b>	
Breast Cancer Diagnosis	start with 1740, 1741, 1742, 1743, 1744, 1745, 1746, 1748, 1749, 1750, 1759	start with C50011, C50012, C50019, C50021, C50022, C50029, C50111, C50112, C50119, C50121, C50122, C50129, C50211, C50212, C50219, C50221, C50222, C50229, C50311, C50312, C50319, C50321, C50322, C50329, C50411, C50412, C50419, C50421, C50422, C50429, C50511, C50512, C50519, C50521, C50522, C50529, C50611, C50612, C50619, C50621, C50622, C50629, C50811, C50812, C50819, C50821, C50822, C50829, C50911, C50912, C50919, C50921, C50922, C50929	
Colorectal Cancer Diagnosis	starts with 1530, 1531, 1532, 1533, 1534, 1535, 1536, 1537, 1538, 1539, 1540, 1541	starts with C180, C181, C182, C183, C184, C185, C186, C187, C188, C189, C19, C20	
Lung Cancer Diagnosis	start with 1622, 1623, 1624, 1625, 1628, 1629	start with C3400, C3401, C3402, C3410, C3411, C3412, C342, C3430, C3431, C3432, C3480, C3481, C3482, C3490, C3491, C3492	
<b>Conventional Radiotherapy</b>			
	<b>Diagnosis</b>		
<b>Condition or procedure</b>	<b>ICD-9</b>	<b>ICD-10</b>	
Distant metastasis	196.xx-199.xx (excluding 196.0, 196.3, 198.2, 198.81)	C77%-C79% (exclude: C77.0%, C77.3%, C79.2%, C79.81%)	
Axillary lymph node involvement	196.3x	C77.3%	
	<b>Procedure</b>		
	<b>ICD-9</b>	<b>ICD-10</b>	<b>CPT/HCPCS</b>
Mastectomy	85.4, 85.41-85.48	OHTT% OHTU% OHTV%	19180,19182,19200,19220, 19240,19303,19304, 19305,19306, 19307

Lumpectomy	85.2, 85.20-85.25	0HBT% 0HBU% 0HBV% 0HBY% 0H5W% 0H5X% 0H5T%; 0H5U%; 0H5V%; 0HBW% 0HBX% 0HTW% 0HTX% 0HTY%	19110, 19120, 19125, 19126, 19160, 19162, 19301, 19302	
Any code for radiation therapy	<b>Diagnosis</b>		<b>Procedure</b>	
	<b>ICD-9</b>	<b>ICD-10</b>	<b>ICD-9</b>	<b>ICD-10</b>
	V58.0, V66.1, V67.1	Z51.0	92.2, 92.20-92.27, 92.29, 92.3, 92.30- 92.39, 92.4, 92.41	DM0% DM1% DMY07% DMY0F% DMY17% DMY1F%
	<b>CPT/HCPCS</b>	<b>Revenue Center Code</b>		
	77371, 77372, 77373, 77401-77525, 77761- 77799, G0251, G0339, G0340	0330, 0333		
Actual treatment with brachytherapy	<b>Procedure</b>			
	<b>ICD-9</b>	<b>ICD-10</b>	<b>CPT/HCPCS</b>	
	92.27	DM1%	77761-77799	
	<b>CPT/HCPCS</b>			
Placement of single-entry brachytherapy catheter	C9714, C9715, 19296, 19297, C1715, C1728			
trastuzumab	<b>CPT/HCPCS</b>	<b>GPI8</b>		
	J9355	21353070		
<b>Aggressive end-of-life care</b>				
	<b>Diagnosis</b>			
<b>Condition or procedure</b>	<b>ICD-9</b>	<b>ICD-10</b>		

Breast Cancer Diagnosis	start with 1740, 1741, 1742, 1743, 1744, 1745, 1746, 1748, 1749, 1750, 1759	start with C50011, C50012, C50019, C50021, C50022, C50029, C50111, C50112, C50119, C50121, C50122, C50129, C50211, C50212, C50219, C50221, C50222, C50229, C50311, C50312, C50319, C50321, C50322, C50329, C50411, C50412, C50419, C50421, C50422, C50429, C50511, C50512, C50519, C50521, C50522, C50529, C50611, C50612, C50619, C50621, C50622, C50629, C50811, C50812, C50819, C50821, C50822, C50829, C50911, C50912, C50919, C50921, C50922, C50929
Colorectal Cancer Diagnosis	starts with 1530, 1531, 1532, 1533, 1534, 1535, 1536, 1537, 1538, 1539, 1540, 1541	starts with C180, C181, C182, C183, C184, C185, C186, C187, C188, C189, C19, C20
Lung Cancer Diagnosis	start with 1622, 1623, 1624, 1625, 1628, 1629	start with C3400, C3401, C3402, C3410, C3411, C3412, C342, C3430, C3431, C3432, C3480, C3481, C3482, C3490, C3491, C3492

**Non-guideline-based antiemetics**

Condition or procedure	Diagnosis		Procedure	
	ICD-9	ICD-10	ICD-9	ICD-10
Chemotherapy	V58.1, V66.2, V67.2	Z51.1%	99.25	3E0%%0%
	<b>CPT/HCPCS</b>	<b>Revenue Center Code</b>	<b>GPI</b>	
	HCPCS: Q0083, Q0084, Q0085, J8520, J8521, J8530, J8540, J8560, J8597, J8610, J8999, J9000-J9999 (exclude J9003, J9165, J9175, J9202 J9209, J9212, J9213, J9214, J9215, J9216, J9217, J9218, J9219, J9220, J9221, J9222 J9223, J9224, J9225, J9226,	0331,0332, 0335	50250025	



	J9240, J9295, J9381, J9395), CPT: 96400-96549			
<b>Off-pathway systemic therapy</b>				
	<b>Diagnosis</b>		<b>Procedure</b>	
<b>Condition or procedure</b>	<b>ICD-9</b>	<b>ICD-10</b>	<b>ICD-9</b>	<b>ICD-10</b>
	V58.1, V66.2, V67.2	Z51.1%	99.25	3E0%%0%
	<b>CPT/HCPCS</b>	<b>Revenue Center Code</b>	<b>GPI</b>	
Chemotherapy	HCPCS: Q0083, Q0084, Q0085, J8520, J8521, J8530, J8540, J8560, J8597, J8610, J8999, J9000-J9999 (exclude J9003, J9165, J9175, J9202 J9209, J9212, J9213, J9214, J9215, J9216, J9217, J9218, J9219, J9220, J9221, J9222 J9223, J9224, J9225, J9226, J9240, J9295, J9381, J9395), CPT: 96400-96549	0331, 0332, 0335	50250025	

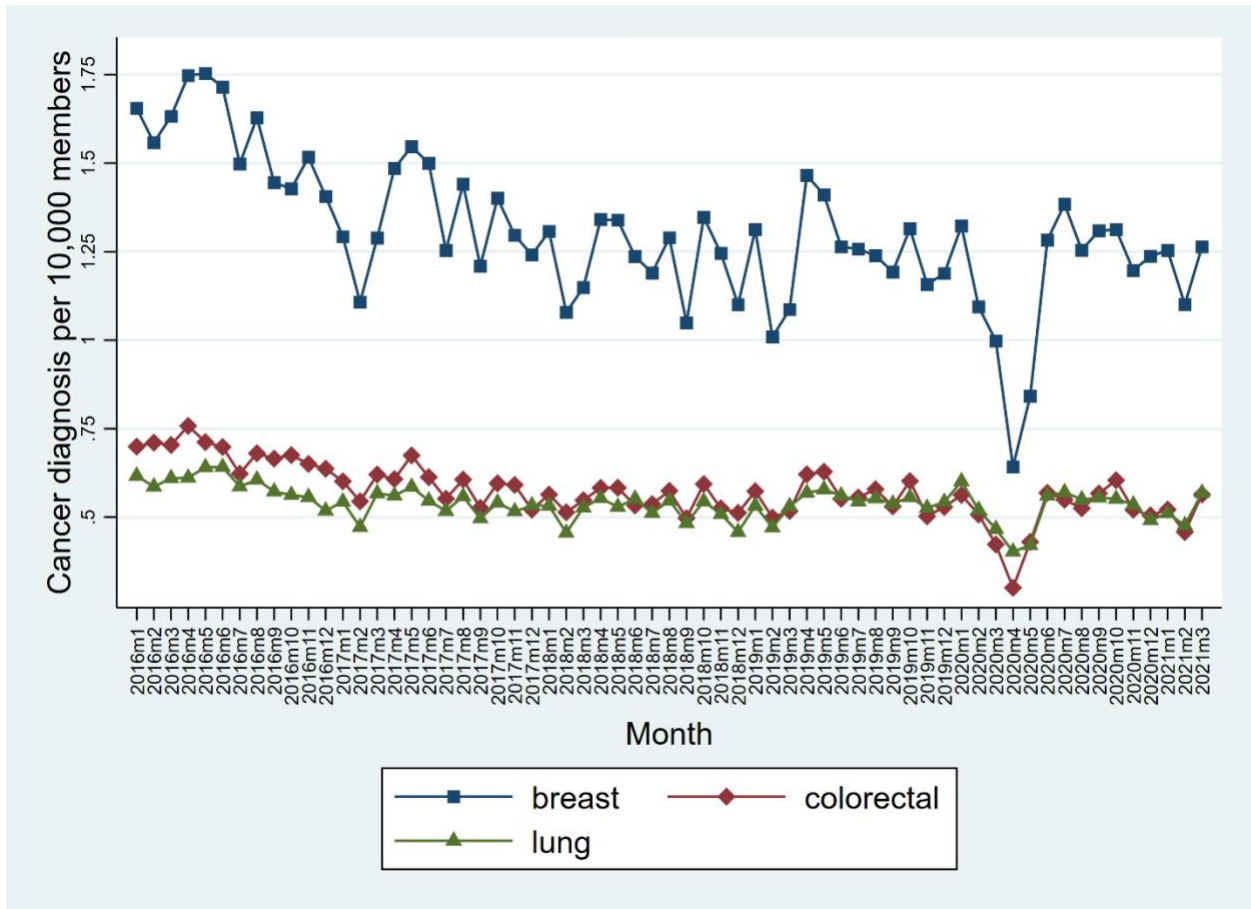
**eAppendix Table 2.** Low-Value Care Metrics

Measure	Inclusion Cohort	Definition	Reference	Rationale for Low-Value Designation
Conventional radiotherapy	We included patients with 12 months of coverage before and one month coverage after the radiotherapy start date; and we excluded patients with less than 11 or more than 40 radiation treatments as well as those who received mastectomy or brachytherapy.	We define conventional radiotherapy as the presence of 25 to 40 treatment fractions among those who were eligible for hypofractionated radiotherapy, which is defined as the presence of 11 to 24 radiation treatments.	Hahn C., et al. (11) Parikh, R. B., et al. (18)	Conventional radiotherapy exposes patients to additional fractions of radiation with no measurable benefit.
Non-guideline-based antiemetics	We included all patients diagnosed with breast, colorectal, or lung cancer and with at least one oral or intravenous chemotherapy claim as well as 12 months of coverage before and one month coverage after the initiation of chemotherapy.	This is based on whether the antiemetic use at the initial chemotherapy treatment was consistent with the ASCO or NCCN guidelines. First, chemotherapy is grouped based on administration route as oral vs intravenous. Second, all initial chemotherapy agents are assigned into risk categories as specified in the ASCO and NCCN guidelines such as intravenous moderate to high risk, intravenous low risk, intravenous minimal risk, oral moderate to high risk, and oral minimal to low risk. Third, using medical and pharmacy claims, we identified antiemetic claims that are completed between 2 weeks before chemotherapy through the date after chemotherapy initiation (16 days) and are not consistent with the ASCO and NCCN recommended regimens based on chemotherapy administration and risk groups. Then, we created patient level indicators for those non-guideline based antiemetic claims.	Encinosa, W., & Davidoff, A. J. (16) Berger, M. J., et al (15)	Non-guideline-based antiemetics expose patients to additional antiemetics that are not commensurate with risk of systemic therapy.

		<p>As per Encinosa and Davidoff, 2017 we characterized the chemotherapy regimen based on the presence of therapeutic classes and selected National Drug Codes and the Healthcare Common Procedural Coding System on claims. Chemotherapy was also characterized based on administration route (oral vs intravenous), identified by the Healthcare Common Procedural Coding System. When more than 1 agent was administered, we assigned the regimen based on the highest CINV-risk chemotherapy drug. Some chemotherapy agents are assigned to a CINV-risk category based on quantity per body surface area. Because we did not have this information, we used a conservative approach and assigned those chemotherapy drugs to the higher risk of the potential categories. In addition, some moderate-risk intravenous chemotherapy agents (eg, carboplatin, irinotecan, and methotrexate) have been highly emetogenic in some patients. Using a conservative approach, we labeled these agents as high risk for all patients.</p>		
Off-pathway systemic therapy	We included patients with 3 months of continuous coverage before and 3 months of coverage after the initial chemotherapy date.	<p>This indicator is created based on whether the initial chemotherapy regimen was not an evidence-based drug regimen (i.e., whether it was in Anthem Aim Pathway Regimen list). Using claims-based algorithm, disease settings are classified into mutually exclusive categories such as adjuvant, neoadjuvant, and metastatic. Then patient-level indicators created if the identified regimens are not consistent with the evidence-based regimen list based on disease settings as well as the combination and frequency of cancer drug prescriptions.</p>	Bekelman, J. E., et al. (14)	Off-pathway systemic therapies are generally higher-cost without offering significant benefit to patients.

<p>Aggressive end-of-life care</p>	<p>We included patients whose date of death is identified, and those who were diagnosed with breast, colorectal, or lung cancers and had six months of coverage prior to death through the date of death</p>	<p>We define aggressive end of life care as the presence of at least one of the following: i) two or more emergency department visits in the last 30 days prior to death; ii) use of ICU in the last 30 days prior to death; iii) receiving chemotherapy in the last 14 days prior to death; iv)receiving the first hospice care in the last two days or no hospice care prior to death.</p>	<p>Hutchinson Institute for Cancer Outcomes Research (13)</p>	<p>Intensive end-of-life care practices expose patients to morbidity and costs without increasing mortality.</p>
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**eAppendix Figure.** Trends in Cancer Diagnoses, January 2016 to March 2021



**Source:** HealthCore Integrated Research Environment.

**Legend:** Points represent monthly number of newly diagnosed cancer patients in the pre-COVID (January 2016 to February 2020) and COVID (March to December 2020) periods.

Dx = Diagnoses