Poster CR05

Cost of Cancer Management by Stage of Diagnosis Among Medicare Beneficiaries

HOPA Virtual Annual Conference April 12-17, 2021

Karen C. Chung,¹ Sheila R. Reddy,² Eunice Chang,² Anuraag R. Kansal¹ ¹GRAIL Inc, Menlo Park, CA USA; ²PHAR LLC, Beverly Hills, CA USA.

INTRODUCTION

o A diagnosis of cancer at earlier stages may offer patients less-extensive and less-costly treatment with decreased morbidity and mortality.

o The advent of blood-based circulating tumor cell-free DNA (cfDNA) to detect and localize multiple cancer types may enable early cancer detection and reduce the burden of cancer.

OBJECTIVE

o To estimate the cancer-related cost of care following a cancer diagnosis among Medicare beneficiaries, by stage at diagnosis.

METHODS

Study Design and Data Source

- o Retrospective cross-sectional design using 2012-2016 claims data (and 2007-2015 registry data) from the linked Surveillance, Epidemiology, and End Results (SEER) registry-Medicare claims database.¹
- o SEER-Medicare data are derived from the linkage between SEER cancer registry data and Medicare administrative claims.¹
- SEER data contain clinical, demographic, and cause of death information on persons with a confirmed case of cancer. • Cancer diagnoses are reported through cancer tumor registries using the International Classification of Diseases for
- Oncology, 3rd edition (ICD-O-3) histology codes and are confirmed using pathology reports and medical records. Medicare data include all claims paid by Medicare for each beneficiary including procedures, inpatient admissions, outpatient services, and pharmacy services.¹
- Data include amounts paid.
- Majority of Medicare beneficiaries become eligible at age 65 and do not leave the system until death.

Patient Population

- o Patients diagnosed with an invasive, primary cancer (single or multiple, any position) from January 1, 2007, to December 31, 2015, identified based on ICD-O-3 codes.
- Examined the following 13 primary cancer types:
- Breast (hormone receptor-positive, HR+), breast (HR-negative, HR–), colon and rectum, esophagus, head and neck, kidney (includes renal pelvis), liver (includes intrahepatic bile duct), lung and bronchus, lymphoid, ovary, pancreas, prostate, and stomach.
- o For patients in each cancer cohort, the start of observation was either the date of diagnosis, the beginning of the study period (January 1, 2012), or the beginning of Medicare fee-for-service (FFS) Parts A/B and Part D enrollment, whichever occurred latest.
- Only month and year of diagnosis were available in SEER; the first day of the diagnosis month was assigned as the date of diagnosis (ie, index date).
- Patients observed until disenrollment, successive primary cancer (see below), death, 5 years since diagnosis, or study end (December 31, 2016), whichever occurred first.
- Observation time varied among patients—no minimum length required.
- Continuous enrollment in Medicare FFS Parts A/B and Part D during the observation period was required.
- o Patients contributed to the calculation of annual costs (Years 1-5) using their observed time after diagnosis; thus, each annualized calculation consisted of a different sample.

Study Measures

- o Demographic characteristics (eg, age and sex) were measured on the index date.
- o Overall healthcare costs and cancer-attributable (ie, cancer-related) care costs were reported.
- Cancer-related care defined as services in claims that included a cancer diagnosis or cancer treatment code.
- Inpatient or outpatient medical claims with an International Classification of Diseases, Ninth or Tenth Revision, Clinical Modification (ICD-9-CM or ICD-10-CM) diagnosis code for any cancer (eg, ICD-9-CM: 140.x-239.x; ICD-10-CM: COO.x-D49.x) in any field.
- Pharmacy claims with:
- National Drug Code (NDC) for antineoplastic agents and adjunctive therapies.
- NDC for a treatment approved by the United States (US) Food and Drug Administration for conditions caused by cancer or its treatment.²
- Total costs were calculated, in addition to cancer-related care, inpatient, outpatient, and pharmacy costs.
- o Costs were calculated in each yearly time period using claims data during that period and, for each patient, were annualized based on the observed time in that period.
- Annualized costs per patient were reported by stage and cancer type.
- All costs adjusted to 2016 US dollars (USD).

Statistical Analysis

- o Descriptive analyses of overall and cancer-related costs calculated for each cancer cohort, by stage and time period.
- o Means and standard deviations (SD) were reported for continuous measures and frequencies and percentages for
- categorical measures. o All statistical analyses were conducted using SAS® version 9.4.

RESULTS

				Stage I		Stage II		Stage III		Stage IV					
Demographics by Stage and Cancer Site					Cancer Site		Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	
o We identified 613,639 Medicare patients who received a cancer diagnosis for one of 13 selected cancers					Breast HR+	Year 1	\$36,627	(38,063)	\$51,173	(54,364)	\$71,497	(58,562)	\$100,116	(103,578)	
(n=6,775-135,663), within 5 years of the 2012-2016 claims period.						Year 5	\$17,906	(50,584)	\$21,902	(52,049)	\$33,654	(100,536)	\$76,514	(82,971)	
 All stages were represented across the 13 cancer cohorts (Stage I, II, III, and IV: 26.9%, 31.2%, 14.4%, and 16.8%, respectively); 10.6% of patients lacked stage information and were removed from the final analysis. The final cancer cohorts included 548,295 Medicare beneficiaries (n=5,667-124,058), representing the ranges of cancer staging at diagnosis (Stage I: n=165,145; Stage II: n=191,215; Stage III: n=88,581; Stage IV: n=103,354) (Table 1). 					Breast HR-	Year 1	\$53,288	(45,852)	\$73,137	(64,903)	\$91,895	(66,233)	\$129,880	(106,263	
						Year 5	\$18,696	(40,368)	\$23,816	(65,940)	\$31,759	(58,340)	\$70,085	(81,881)	
					Colon and rectum	Year 1	\$74,639	(133,030)	\$97,159	(166,404)	\$115,634	(164,430)	\$172,783	(193,432)	
						Year 5	\$25,500	(63,298)	\$26,263	(61,829)	\$31,183	(68,289)	\$60,200	(78,506	
Table 1 Number of Datio	nte by Stago and Ca	acor					Year 1	\$104,425	(131,625)	\$127,097	(134,830)	\$148,923	(173,353)	\$167,732	(175,148)
Table 1. Number of Patients by Stage and Cancer					Esophagus*										
	All Stages	Stage I	Stage II	Stage III	Stage IV		Year 5	\$31,545	(61,680)	\$40,159	(140,134)	\$35,764	(86,091)	\$52,294	(112,171)
Cancer Site	Ν	Ν	Ν	Ν	Ν	Head and	Year 1	\$50,073	(93,712)	\$85,025	(270,412)	\$109,894	(150,119)	\$127,753	(160,436
All Cancer Sites	548,295	165,145	191,215	88,581	103,354	neck*	Year 5	\$23,561	(49,811)	\$23,693	(47,643)	\$26,341	(65,263)	\$27,366	(75,641
Breast HR+	103,386	57,110	32,095	9,556	4,625	Kidney*	Year 1	\$61,345	(130,376)	\$73,180	(133,536)	\$77,241	(143,742)	\$166,594	(194,725
Breast HR-	16,779	6,694	6,609	2,472	1,004		Year 5	\$29,581	(65,479)	\$30,574	(67,807)	\$35,447	(74,235)	\$65,938	(80,313
Colon and rectum	71,047	19,614	20,922	19,351	11,160		Year 1	\$121,515	(162,912)	\$131,844	(184,834)	\$158,580	(166,123)	\$196,302	(205,370
Esophagus* Head and neck*	5,667 23,756	1,336 6,672	1,451 3,584	1,255 3,987	1,625 9,513	Liver*	Year 5	\$52,666	(89,803)	\$56,792	(88,095)	\$64,496	(89,412)	\$80,840	(165,242
Kidney*	28,463	18,655	2,134	4,293	3,381	Lung and	Year 1	\$81,625	(137,846)	\$109,888	(142,802)	\$141,537	(167,185)	\$180,627	(184,351
Liver*	11,671	5,393	2,392	2,215	1,671	bronchus	Year 5	\$35,621	(67,762)	\$40,484	(82,367)	\$46,771	(97,222)	\$63,722	(98,857
Lung and bronchus	92,472	30,539	4,883	22,692	34,358		Year 1	\$105,761	(159,577)	\$135,082	(163,996)	\$145,182	(176,925)	\$171,650	(218,628
Lymphoid*	37,697	11,243	6,041	6,873	13,540	Lymphoid*							· · ·		
Ovary*	9,052	1,697	810	3,781	2,764		Year 5	\$27,638	(54,215)	\$32,000	(72,737)	\$34,872	(69,176)	\$36,997	(85,620
Pancreas*	15,446	1,864	4,929	1,419	7,234	O∨ary*	Year 1	\$68,687	(95,240)	\$87,293	(123,872)	\$117,089	(150,704)	\$151,404	(162,796
Prostate	124,058	626	104,010	9,726	9,696		Year 5	\$22,906	(73,160)	\$30,177	(73,085)	\$55,769	(88,885)	\$68,870	(91,190)
Stomach*	8,801	3,702	1,355	961	2,783	Pancreas*	Year 1	\$129,254	(142,600)	\$160,325	(194,996)	\$146,861	(157,915)	\$183,647	(205,439
HR, hormone receptor. *Cancers currently without routine	screening						Year 5	\$33,784	(71,294)	\$47,776	(79,049)	\$63,595	(68,331)	\$80,749	(92,753
Concers contently without routine	sereering.						Year 1	\$33,033	(46,609)	\$35,085	(50,639)	\$37,138	(52,204)	\$76,314	(108,425
The overall mean (SD) age at cancer diagnosis ranged from 68.0 (11.0) years (breast HR–) to 73.5 (9.5) years (pancreas) (Table 2).					Prostate	Year 5	\$24,723	(49,178)	\$17,852	(45,599)	\$17,882	(40,943)	\$49,633	(85,032	
• Age at diagnosis also varied by stage, although with no consistent pattern.						Stomach*	Year 1	\$115,113	(154,213)	\$127,853	(127,260)	\$162,936	(185,645)	\$183,887	(192,121
0 0	The sex distribution differed greatly across cancers, while much less so by stage (Table 2).						Year 5	\$29,405	(70,130)	\$31,009	(61,279)	\$36,995	(97,511)	\$51,656	(87,647)

- o The sex distribution differed greatly across cancers, while much less so by stage (**Table 2**).

Table 2. Patient Demographics by Stage and Cancer

Cancer Site		All Stages	Stage I	Stage II	Stage III	Stage IV
Breast HR+	Age, mean (SD)	70.4 (9.9)	71.0 (8.9)	70.3 (10.4)	68.1 (11.9)	68.0 (12.4)
	Female, n (%)	102,391 (99.0)	56,816 (99.5)	31,645 (98.6)	9,371 (98.1)	4,559 (98.6)
Breast HR-	Age, mean (SD)	68.0 (11.0)	69.1 (9.2)	67.6 (11.5)	66.2 (12.9)	67.1 (12.5)
	Female, n (%)	16,765 (99.9)	6,692 (100.0)	6,604 (99.9)	2,469 (99.9)	1,000 (99.6)
Colon and rectum	Age, mean (SD)	72.4 (10.8)	73.0 (9.9)	73.8 (10.5)	71.4 (11.0)	70.8 (12.0)
	Female, n (%)	37,111 (52.2)	10,206 (52.0)	11,250 (53.8)	10,073 (52.1)	5,582 (50.0)
Esophagus*	Age, mean (SD)	70.7 (9.7)	72.0 (9.9)	70.4 (9.5)	69.8 (9.6)	70.6 (9.6)
	Female, n (%)	1,372 (24.2)	348 (26.0)	382 (26.3)	301 (24.0)	341 (21.0)
Head and neck*	Age, mean (SD)	68.5 (10.7)	70.6 (10.1)	69.8 (11.0)	68.0 (10.8)	66.8 (10.7)
	Female, n (%)	7,233 (30.4)	2,326 (34.9)	1,241 (34.6)	1,207 (30.3)	2,459 (25.8)
Kidney*	Age, mean (SD)	68.9 (10.4)	68.2 (10.5)	68.1 (10.1)	70.1 (9.5)	71.7 (10.6)
	Female, n (%)	11,597 (40.7)	7,911 (42.4)	820 (38.4)	1,556 (36.2)	1,310 (38.7)
Liver*	Age, mean (SD)	67.8 (10.1)	67.6 (10.3)	65.3 (9.4)	69.2 (9.8)	70.1 (10.1)
	Female, n (%)	3,649 (31.3)	1,766 (32.7)	656 (27.4)	641 (28.9)	586 (35.1)
Lung and bronchus*	Age, mean (SD)	72.2 (9.1)	72.4 (8.7)	70.7 (8.8)	71.8 (9.5)	72.4 (9.3)
	Female, n (%)	48,902 (52.9)	17,294 (56.6)	2,441 (50.0)	11,737 (51.7)	17,430 (50.7)
Lymphoid*	Age, mean (SD)	70.8 (11.7)	71.7 (10.8)	70.1 (12.9)	70.4 (11.6)	70.6 (11.7)
	Female, n (%)	18,777 (49.8)	5,835 (51.9)	3,082 (51.0)	3,387 (49.3)	6,473 (47.8)
O∨ary*	Age, mean (SD)	69.2 (11.2)	67.0 (11.6)	68.7 (10.9)	68.7 (10.9)	71.4 (11.2)
	Female, n (%)	9,052 (100.0)	1,697 (100.0)	810 (100.0)	3,781 (100.0)	2,764 (100.0)
Pancreas*	Age, mean (SD)	73.5 (9.5)	74.8 (10.6)	72.5 (9.1)	72.6 (9.4)	74.0 (9.4)
	Female, n (%)	8,243 (53.4)	1,034 (55.5)	2,647 (53.7)	786 (55.4)	3,776 (52.2)
Prostate	Age, mean (SD)	69.6 (7.2)	73.1 (7.6)	69.6 (7.0)	67.5 (6.0)	71.9 (9.4)
	Female, n (%)	N/A	N/A	N/A	N/A	N/A
Stomach*	Age, mean (SD)	72.8 (10.4)	73.8 (10.3)	71.4 (10.2)	70.9 (10.6)	72.7 (10.4)
	Female, n (%)	3,319 (37.7)	1,508 (40.7)	450 (33.2)	336 (35.0)	1,025 (36.8)

HR, hormone receptor; N/A, not applicable; SD, standard deviation. *Cancers currently without routine screening.

Overall Total Healthcare Costs by Stage and Cancer Site (Year 1 - Year 5)

o In Year 1, total costs (mean [SD]) increased by stage (**Table 3**).

- Stage I range: \$33,033 (46,609) (prostate) to \$129,254 (142,600) (pancreas).
- Stage IV range: \$76,314 (108,425) (prostate) to \$196,302 (205,370) (liver).
- Stage IV total costs were 1.4 (pancreas) to 2.7 (breast HR+, kidney) times the Stage I total costs.
- o Inpatient costs were the largest share of Year 1 total costs for most cancers (results not displayed).
- Stage I range: \$5,558 (23,739) (breast HR+) to \$78,148 (119,143) (pancreas).
- Stage IV range: \$37,399 (90,065) (prostate) to \$123,416 (183,116) (liver).
- o In Years 2-5, total costs were notably lower than in Year 1 but remain higher with later stage; this pattern is shown in **Table 3**, which contrasts expenditures in Year 1 and Year 5.

Table 3. Total Healthcare Costs, by Stage, Time Period, and Cancer

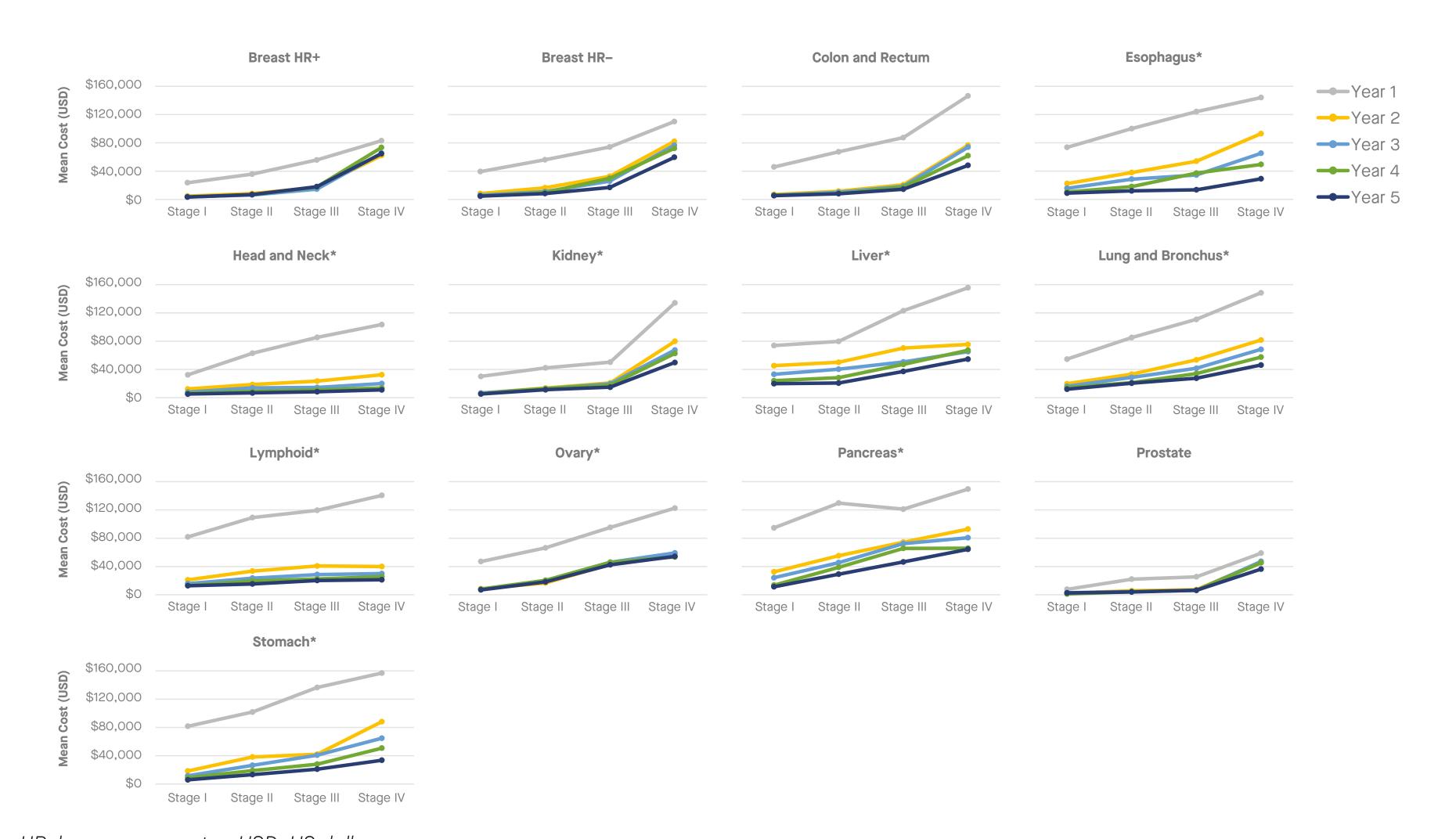
HR, hormone receptor; SD, standard deviation. *Cancers currently without routine screening.

Cancer-Related Healthcare Costs by Stage and Cancer Site (Year 1 - Year 5)

Total Cancer-Related Costs

- o In Year 1, mean (SD) annual total cancer-related costs among Stage I patients were lower than costs for Stage IV patients (Figure 1)
- Stage I range: \$7,640 (17,378) (prostate) to \$94,636 (117,636) (pancreas).
- Stage IV range: \$83,047 (91,225) (breast HR+) to \$156,982 (175,009) (stomach).
- In all but one cohort (pancreas) total costs progressed with each successive stage.
- o In Years 2-5, cancer-related costs were lower than in Year 1 for all cancers, but similarly increased by stage (**Figure 1**).
- Mean (SD) annual total cancer-related costs in Year 5.
- Stage I range: \$2,536 (10,111) (prostate) to \$19,835 (61,850) (liver).
- Stage IV range: \$11,057 (51,134) (head and neck) to \$64,715 (74,905) (breast HR+).

Figure 1. Annual Total Cost of Cancer-Related Care, by Stage



HR, hormone receptor; USD, US dollar. *Cancers currently without routine screening.

Inpatient, Outpatient, and Pharmacy Cancer-Related Costs

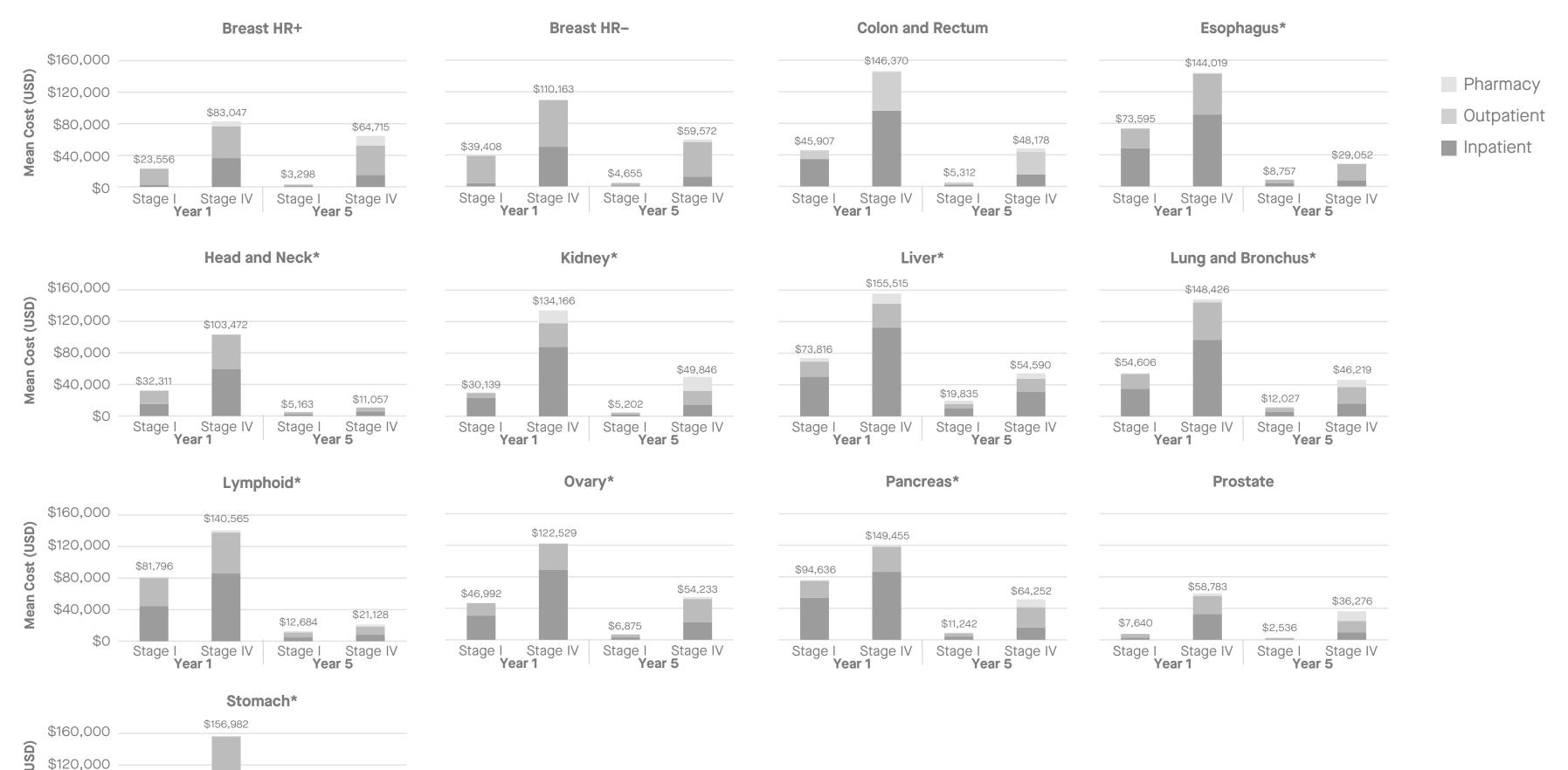
o Total cancer-related costs, broken down by inpatient, outpatient, and pharmacy cancer-related, are shown in (Figure 2).

- o Across cancer groups and stages, inpatient costs in Year 1 varied greatly (Figure 2).
- Stage I range: \$2,586 (11,226) (prostate) to \$66,530 (108,255) (pancreas).
- Stage IV range: \$32,762 (84,571) (prostate) to \$112,200 (164,059) (liver).
- o For most cancers, total cancer-related costs were predominately made up of inpatient costs in Year 1 (Figure 2).
- o Inpatient cost proportions were lower in Stage I vs Stage IV patients, with exceptions: colon and rectum (75.7% vs 65.5%), esophagus (65.8% vs 63.0%), kidney (76.7% vs 65.6%), stomach (70.1% vs 68.9%).
- For patients with breast cancer (HR+/HR–), inpatient costs made up a very small share of total costs (11.0%/10.1%) among patients with Stage I cancer compared to patients with Stage IV cancer whose inpatient cost share was higher (44.0%/45.6%), albeit below that of other cancers.

o In Years 2-5, inpatient costs across cancer types and stages were substantially lower than in Year 1, similar to total costs, and generally constituted a smaller share of total costs (Figure 2).

- Year 5, mean annual inpatient costs (inpatient % of total cost) were:
- Stage I range: \$1,000 (30.3%) (breast HR+) to \$9,756 (49.2%) (liver).
- Stage IV range: \$9,305 (25.7%) (prostate) to \$30,743 (56.3%) in (liver).

Figure 2. Annual Cost Components for Cancer-Related Care



HR, hormone receptor; USD, US dollar. *Cancers currently without routine screening.

Stage | Stage IV Stage | Stage IV Year 1 Year 5

\$5,886

\$81,661

\$80,000

LIMITATIONS

- o Annualizing costs for patients who may have died, and whose healthcare costs at the end of life would likely have been higher than those who disenrolled, may have overestimated the mean costs.
- o Cost comparisons between stages were not adjusted for characteristic differences between stages.
- o Each time frame of measurement comprised a different sample, limiting the comparability of patients over time.

CONCLUSIONS

- o Patients diagnosed at later stages of cancer have considerably higher costs of care than those diagnosed at earlier stages.
- o Inpatient costs are the driver of overall and cancer-related costs in Year 1 for most cancers, while contributing less in Years 2-5.
- o Earlier cancer diagnosis may lead to more efficient treatment and decreased management cost.

References

- 1. Surveillance, Epidemiology, and End Results (SEER) Program Medicare Linked Database (1999-2018)
- (https://healthcaredelivery.cancer.gov/seermedicare/), National Cancer Institute, Centers for Medicare & Medicaid Services, released December 2020.
- 2. National Cancer Institute. https://www.cancer.gov/about-cancer/treatment/drugs/related-conditions.
- Accessed January 21, 2020.

Disclosures

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