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Contextualizing Oncologic Imaging Utilization through End-of-Life Spending Patterns

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Purpose

- New payment models focusing on value-based, integrated care have become prominent, with Centers for Medicare & Medicaid Services expanding advanced payment model trials into the realm of specialty care with the Oncology Care Model.
- When considering participation in new physician payment models, health systems need to anticipate which patients will require high-cost services, such as high-cost tomographic imaging, in order to efficiently manage their standards of care.
- This study examines the relationship between cost trajectories in end-of-life episodes of care with imaging utilization by identifying patient cost patterns, focusing on how identification of cost trajectories may aid imaging departments in estimating their financial risk under capitated payment plans.

Methods

- Claims between April 2012 and June 2014 and UCSF's institutional cancer registry were used to identify 1,257 cancer decedents with dates of death between April 2013 and June 2014.
- 541 of decedents received at least one high-cost tomographic image in their final year of life, with a total of 2,575 images between the imaged decedents (see **Figure 2** for distribution between imaging modalities)
- Group-based trajectory modeling was used to identify patterns of monthly patient costs (cost to health system) in the final year of life, with monthly cost transformed using a natural logarithm due to the highly skewed nature of the monthly cost distributions
- Logistic regressions were used to model the probability of receiving a CT, MR, PET, or any high-cost tomographic image in the final 3 months of life

Figure 1. Cost trajectories in the final year of life for decedents receiving treatment for malignant neoplasm at an academic comprehensive cancer center, April 2012 to June 2014

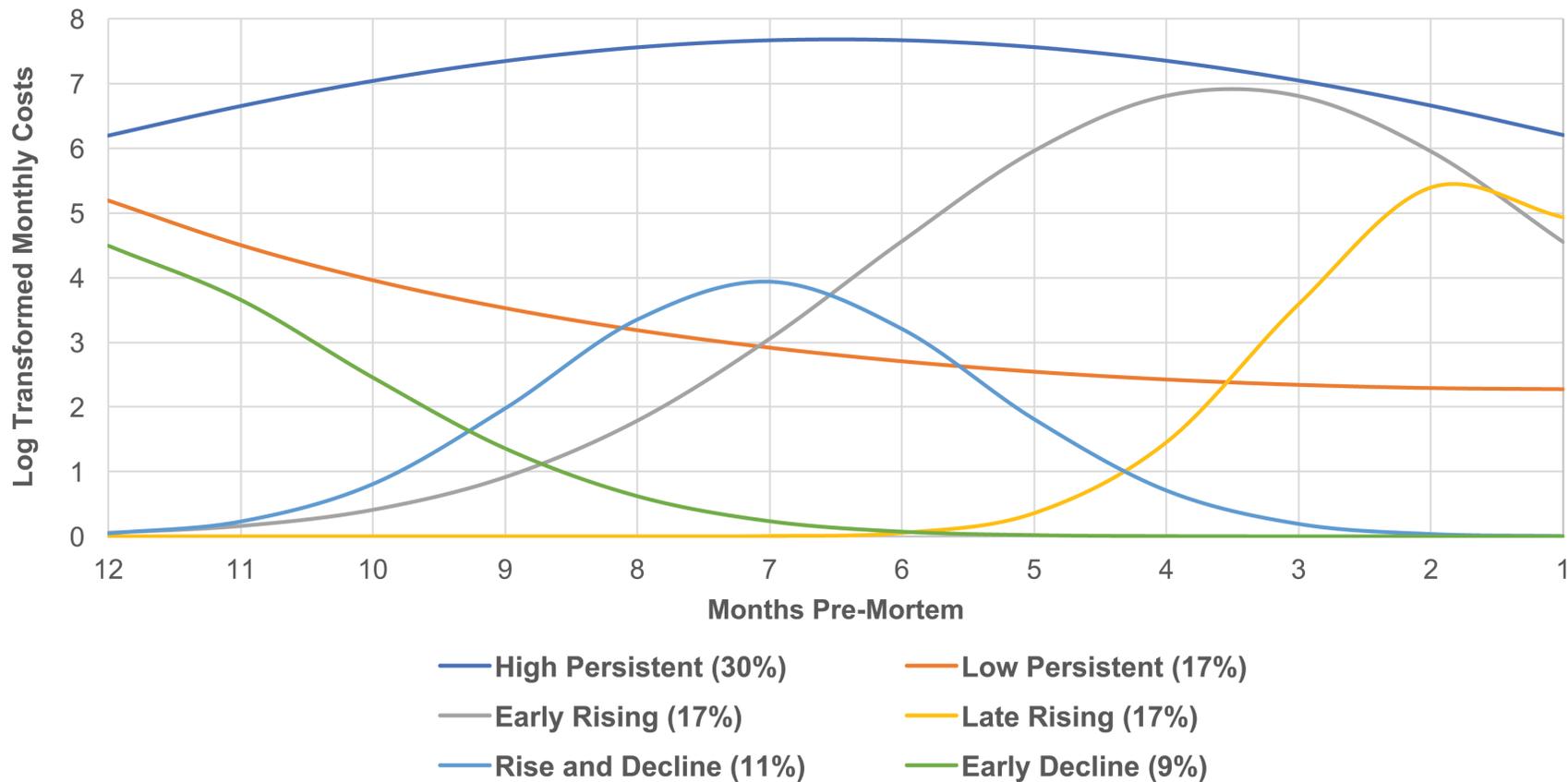


Table 1a. Patient characteristics by end-of-life cost trajectory

	High Persistent % (n=378)	Low Persistent % (n=208)	Early Rising % (n=211)	Late Rising % (n=213)	Rise and Decline % (n=134)	Early Decline % (n=113)	Total % (n=1,257)
Age at Death							
18 to 39	9	7	7	6	4	8	7
40 to 64	54	52	53	46	46	52	51
65+	37	41	41	48	50	40	42
Sex							
Male	48	57	64	57	54	51	55
Female	52	43	36	43	46	49	45
Charlson Index							
Index greater than 2	22	14	13	7	4	5	13
Time of Diagnosis							
Prior to final year of life	86	92	59	54	78	89	77
12 to 6 mo. pre-mortem	13	6	25	5	16	11	12
6 to 3 mo. pre-mortem	1	0	13	15	6	0	5
3 mo. pre-mortem	1	2	2	26	0	0	5
Treatment in Final 3 Mo.							
Received Chemo	48	12	33	20	0	0	25
Received Radiation	19	4	23	20	0	0	14

* Values shown are column percentages

Table 1b. Cancer types by end-of-life cost trajectory

Cancer Type	High Persistent % (n=378)	Low Persistent % (n=208)	Early Rising % (n=211)	Late Rising % (n=213)	Rise and Decline % (n=134)	Early Decline % (n=113)	Total % (n=1,257)
Head, Neck, & Throat	4	6	6	7	6	4	5
Gastrointestinal	28	28	33	32	22	24	28
Respiratory	12	13	17	15	13	8	13
Bone & Skin	16	11	10	12	8	9	12
Breast	13	8	6	8	8	4	9
Male Reproductive	6	7	6	3	7	6	6
Female Reproductive	7	7	3	3	7	11	6
Kidney & Bladder	2	5	9	6	5	6	5
Endocrine	7	11	8	11	19	22	11
Brain & CNS	1	1	0	1	0	1	1
Blood & Lymphatic	5	3	2	2	4	5	4

* Values shown are column percentages

Table 2. Imaging utilization, imaging cost, and total cost by cost trajectory in the final year of life

	High Persistent (n=378)	Low Persistent (n=208)	Early Rising (n=211)	Late Rising (n=213)	Rise and Decline (n=134)	Early Decline (n=113)	Total (n=1,257)
% Imaged in End of Life	24%	27%	65%	75%	49%	27%	43%
Total Images	880	273	698	520	144	60	2,575
Mean Imaging Intensities of Imaged Patients							
All High-Cost Imaging	9.8	4.9	5.1	3.2	2.2	1.9	4.8
CT	6.3	2.9	3.4	2.3	1.2	0.7	3.1
MR	2.0	1.2	1.0	0.6	0.6	0.9	1.0
PET	1.4	0.7	0.6	0.3	0.3	0.3	0.6
Mean imaging cost for imaged patients	\$3,546	\$1,754	\$1,981	\$1,309	\$960	\$807	\$1,827
Mean non-imaging costs for imaged patients	\$179,292	\$70,931	\$92,127	\$58,541	\$28,783	\$36,556	\$83,589
Mean non-imaging cost difference between imaged and un-imaged patients	\$39,747	\$25,513**	\$11,970	\$38,068***	\$8,884*	\$23,869	\$4,787

1) P-values: * p<0.05 ** p<0.01 *** p<0.001

Figure 2. Distribution of end-of-life imaging by modality

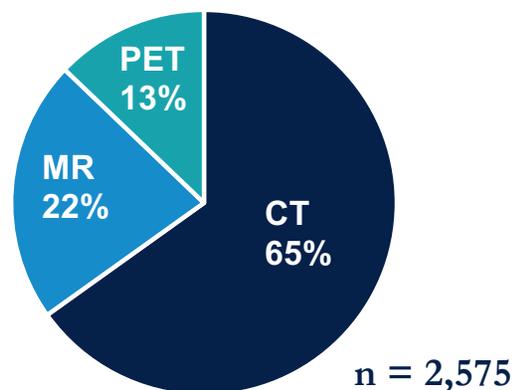


Table 3. Characteristics associated with high-cost imaging utilization in the final 3 months of life by modality

	Any High-Cost Imaging OR (95% CI)	CT OR (95% CI)	MRI OR (95% CI)	PET OR (95% CI)
Trajectories				
High Persistent (ref)	Reference	Reference	Reference	Reference
Low Persistent	1.03 (0.60-1.76)	1.02 (0.57-1.82)	0.75 (0.30-1.85)	0.62 (0.21-1.81)
Early Rising	3.22 (2.06-5.02)	3.38 (2.14-5.35)	3.11 (1.64-5.89)	1.08 (0.49-2.36)
Late Rising	11.61 (7.08-19.03)	9.04 (5.44-15.01)	5.9 (2.99-11.65)	4.02 (1.89-8.56)
Sex				
Male (ref)	Reference	Reference	Reference	Reference
Female	0.56 (0.38-0.82)	0.55 (0.37-0.81)	1.05 (0.63-1.75)	0.44 (0.23-0.85)
Charlson Index				
Index of 2 (ref)	Reference	Reference	Reference	Reference
Index greater than 2	0.53 (0.32-0.88)	0.74 (0.45-1.23)	1.05 (0.50-2.19)	0.54 (0.21-1.36)
Time of Diagnosis				
Diagnosed before EOL (ref)	Reference	Reference	Reference	Reference
Diagnosed 12 to 6 mo. pre-mortem	7.49 (4.64-12.09)	5.26 (3.28-8.42)	4.39 (2.39-8.07)	4.03 (1.99-8.15)
Diagnosed 6 to 3 mo. pre-mortem	1.94 (1.03-3.66)	1.71 (0.92-3.19)	1.09 (0.47-2.53)	1.62 (0.62-4.25)
Diagnosed in the final 3 mo. of life	3.88 (1.93-7.82)	2.67 (1.42-5.01)	2.24 (1.04-4.84)	1.77 (0.70-4.48)
Chemo in final 3 mo. of life				
No chemotherapy	Reference	Reference	Reference	Reference
Received chemotherapy	1.82 (1.26-2.64)	2.2 (1.52-3.20)	1.14 (0.69-1.89)	1.55 (0.87-2.75)

1) Results hold constant age at death, race, cancer type, radiation treatment in final 3 months, and payer class.

2) Rise and Decline and Early Decline patients had no imaging in the final 3 months of life due to the nature of their cost trajectories and were omitted from the model for clarity.

3) Models omitting group trajectories and temporal proximity to death at time of diagnosis not shown

Result Highlights

- Total costs in the final year of life for all patients were \$102,632,577, of which \$988,672 was spent on outpatient tomographic imaging (0.96%).
- Patients with comorbidities besides cancer made up the greatest proportions of the high persistent and low persistent trajectories.
- The early rising and late rising trajectories had the greatest proportions of patients diagnosed in the final year of life, with the early rising patients skewing towards diagnosis 12 to 6 months pre-mortem and late rising patients skewing towards diagnosis in the final 3 months of life.
- None of decedents in the rise and decline and early decline trajectories received chemotherapy, radiation therapy, imaging, or a diagnosis of cancer in their final 3 months of life.
- 46% of breast cancer patients were classified as high-persistent utilizers, compared to 29% of all other cancers ($p=0.000$), and 39% of GI cancer patients were classified as either early or late rising utilizers, compared to 32% of all other cancers ($p=0.020$).
- The early rising and late rising trajectories had the greatest proportions of patients imaged in their final year of life, with 65% and 75% of patients imaged, respectively.
- Membership to the late rising trajectory was the strongest predictor of imaging in the final 3 months of life (OR, 11.61), followed by diagnosis 12 to 6 months pre-mortem (OR, 7.49); these two predictors were also the strongest in predicting CT, MR, or PET imaging in the final 3 months of life.
- Early rising patients were also particularly likely to have had imaging in the final 3 months of life (OR, 3.22).
- Notable among trajectory predictor effects, the likelihood of imaging in the final 3 months of life is no different between high persistent and low persistent patients.

Conclusions

- In this study we demonstrated clinical measures of severity and patient history of utilization must be considered by hospital administrators in their estimation of oncologic imaging utilization.
- Adopting analytic approaches that consider patients cost patterns may aid in evaluating participation in advanced payment models.
- The clear relationship between temporal patterns of health care costs and propensity to be imaged suggest radiologists need to take a more active role in discussing how treatment intensity and disease severity are managed together, rather than separately.