Predictors of the Use of Specific Critical Care Therapies in Patients With Metastatic Cancer

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Abstract

Objective: Understanding which factors are associated with the use of critical care therapies (CCTs) can help with clinical decision-making and goals of care discussion. The goal of this study was to describe the predictors of CCT use (eg, mechanical ventilation, tracheostomy, percutaneous endoscopic gastrostomy tube, total parenteral nutrition, acute use of dialysis) in hospitalized patients with metastatic cancer.

Methods: We used the 2010 California State Inpatient Databases sponsored by the Agency for Healthcare Research and Quality to identify all hospitalizations with a diagnosis of metastatic cancer (patients aged ≥ 18 years). We examined the predictors of any CCT use (and invasive mechanical ventilation [IMV] use), stratified by do-not-resuscitate (DNR) status, using multivariable logistic regression models.

Results: We identified 99,085 hospitalizations involving patients with metastatic cancer; 9.4% received any CCTs and 4.7% received IMV. Predictors of CCT use in the no-DNR group included principal diagnosis of infections (vs cancer-related), greater burden of comorbidities, and presence of weight loss. Predictors of CCT use in the DNR group were similar, but also included non-white races. Liver disease was also a predictor of IMV use in the no-DNR group. Patients with metastatic lung cancer (vs breast and genitourinary) with no DNR were more likely to receive CCT (and IMV). **Conclusions:** Higher burden of comorbidities, weight loss, liver disease, lung cancer subtype, and diagnosis of infections were associated with higher odds of receiving CCTs or IMV. These findings may help clinicians determine in whom to prioritize discussions around goals of care, especially in the group without a DNR status.

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Introduction

Spending for cancer care in United States exceeds \$125 billion annually,¹ with the highest costs seen among patients with advanced cancer, a stage at which the disease generally is not amenable to curative treatments.² Hospitalization secondary to complications related to cancer and cancer treatments represents one area of high spending, with the highest costs arising from aggressive care at the end of life.^{3–5} Advances in the supportive management of patients with cancer undergoing treatment have led to significant improvements in survival among those requiring hospitalization.

Several existing models have been developed to identify patients who are at risk of chemotherapy-related hospitalization or emergency department vis-

its.^{6,7} These models can identify high-risk patients who can be targeted with strategies such as early discussion of advanced directive and palliative care evaluation and end-of-life planning.^{8,9} However, there is still a large proportion of patients with metastatic cancer who are hospitalized, especially those on systemic chemotherapy with a reported hospitalization rate as high as 92%.^{3,10,11} Many of these patients will receive invasive critical care therapies (CCTs) during their hospitalization.^{4,12} Given the high risk of mortality among those receiving CCTs, understanding which factors are associated with the use of these therapies could help clinicians prepare patients and families for the possibility of bad outcomes during hospitalization. This knowledge would also encourage clinicians to develop strategies to avoid CCT use in patients unlikely to benefit, including addressing goals of

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care early in the hospitalization for patients at the highest risk.

Using a large state inpatient database, we aimed to describe the predictors of CCT use (eg, mechanical ventilation, tracheostomy, percutaneous endoscopic gastrostomy [PEG] tube, total parenteral nutrition [TPN], acute use of dialysis) in hospitalized patients with metastatic cancer.

Methods

Design, Setting, and Subjects

We used the California State Inpatient Databases (CA SID) sponsored by the Agency for Healthcare Research and Quality (AHRQ). The CA SID contains administrative claims data from all California hospital discharges. We chose the CA SID because it is the largest state inpatient database that includes information on do-not-resuscitate (DNR) status. We conducted a cross-sectional study and identified all hospitalizations with a diagnosis of metastatic cancer among patients aged ≥ 18 years between January 1 to December 31, 2010.

Metastatic cancer was defined using ICD-9-CM diagnostic codes (see supplemental eAppendix 1, available with this article at JNCCN.org).^{13–16} Only patients with diagnoses of solid tumors were included in this study because some advanced hematologic malignancies may still be cured.

Patient and Hospital Characteristics

We collected patient demographics (age, sex, race), payer, admission status (nonelective vs elective), comorbidities, DNR status, cancer subtype, discharge ICD-9-CM code, and hospital characteristics. For analysis, we grouped age into quartiles: age < 55 years, 55 to 64 years, 65 to 74 years, and ≥ 75 years. We defined a modified combined comorbidity score derived from the Elixhauser and Charlson comorbidity index to evaluate comorbidities.¹⁷ Metastatic cancer, weight loss, any tumor, and HIV/AIDS were excluded from this score to avoid redundancy with inclusion criteria.¹⁷ Analyses included additional individual comorbidities that might impact prognosis in metastatic cancer, such as end-stage renal disease (ESRD; ICD-9-CM codes 549.8 and 399.5, excluding acute kidney injury [AKI] codes 584.5–585.9), weight loss, and liver disease. In the CA SID, patients were considered DNR if the order was written at the time of or within first 24 hours of hospital admission.^{18,19}

We grouped primary cancer type into lung, breast, genitourinary (GU), colorectal (CRC), other/multiple, or unidentified using ICD-9-CM codes (see supplemental eAppendix 2).¹³ We classified the principal discharge diagnosis for the hospitalization using AHRQ's Clinical Classification Software.²⁰

We used the American Hospital Association Annual Survey database to obtain hospital characteristics, which contains responses from 6,300 hospitals nationwide, and information on institutions organizational structure, facility and service lines, inpatient and outpatient care utilization, expenses, and staffing.²¹ The following hospital characteristics were included: teaching status, location (rural or urban), and bed size (small: < 200 ; medium: 200–399; large: ≥ 400).

Outcomes

The primary outcome was the use of any CCT. Receipt of CCTs was based on the following ICD-9-CM diagnostic and procedure codes: invasive mechanical ventilation (IMV): 96.70–96.72; PEG tube: 43.11; AKI requiring dialysis, requiring both 584.5–585.9 and 39.95; TPN, 99.15; and tracheostomy, 31.1, 31.21, and 31.29. In addition, we also separately evaluated receipt of IMV.

Secondary outcomes included in-hospital mortality, hospital length of stay, cost of care, and discharge disposition for patients. Because the CA SID contains hospital charges calculated by hospital accounting systems, we used Healthcare Cost and Utilization Project hospital-specific cost-to-charge ratios to convert charges to costs.²²

Analyses

We compared the characteristics and outcomes of patients who received any CCT versus those did not. We used counts and percentages, means and standard deviations (SD), and percentile distributions to describe patient characteristics. We compared patients who received CCTs and those did not using chi-square tests for categorical variables and Wilcoxon rank-sum tests for continuous variables.

To examine predictors of any CCT use (including IMV, PEG, AKI requiring dialysis, TPN, and tracheostomy), we used multivariable logistic regression with generalized estimating equations to account for hospital clustering. Before creating the models, we tested variables for evidence of interaction. We found that there was a statistically significant interaction

between DNR status and several variables, including age, race, and cancer type. We therefore opted to stratify the models by DNR status to account for this effect modification. All available patient characteristics were included in the model. Because IMV is associated with the highest mortality compared with some of the other CCTs, we also created models examining only IMV use ($\pm$ other CCTs), again stratified by DNR status. All analyses were carried out using SAS 9.3 (SAS Institute Inc., Cary, NC). The Baystate Medical Center IRB determined that the project did not constitute human subjects research.

Results

Demographics, Clinical, and Hospital Characteristics

For 2010, we identified 99,085 admissions among patients with metastatic cancer at 318 hospitals. The mean age of the patients was 64.6 years (SD, 14.6) and 46% were male. Most (61%) were white and 51% had Medicare listed as their primary insurance. DNR within 24 hours of admission was documented in 16% of the admissions. Most principal diagnoses were cancer-related (51%) followed by infections (11%). The average modified comorbidity score was low (1; SD, 1.8). For cancer subtype, 15% of cancers originated in the lung, 9% originated in the breast, and 10% were classified as CRC and 10% as GU cancer; 76% of admissions were nonelective. Half of the patients were seen at teaching hospitals and 30% were seen at hospitals that had ≥ 400 beds. Characteristics of the patients who received CCTs and those who did not are shown in Table 1.

Outcomes

Of the 99,085 admissions with metastatic cancer, 4.7% received IMV, 3.7% received TPN, 1.4% received PEG, 0.7% received tracheostomy, and 0.7% had AKI requiring dialysis. Nearly 10% of patients received ≥ 1 CCT (1.5% received ≥ 2 , and 0.3% received ≥ 3 CCTs). In-hospital mortality was 10% among all admissions, whereas in-hospital mortality among patients who received CCTs was 33%. Mean hospital length of stay was 6.8 days (SD, 9.2) for all patients and 14.8 days (SD, 15.6) for those who received CCTs. Median cost of admission was \$12,858 for all patients (interquartile range [IQR], \$7,071–\$23,842) and \$35,422 (IQR, \$18,978–\$63,403) for patients who received CCTs. Among those who sur-

vived the hospitalization, 15% were discharged to skilled-nursing or intermediate-care facilities (Table 2). Outcomes in patients who received CCTs versus those who did not are shown in Table 2.

Multivariable Analyses

When we stratified by DNR status, we observed that 9.6% of patients (8,000/83,708) who were not DNR received CCTs, and 4.6% (3,879/83,708) received IMV. Interestingly, among patients who were DNR at admission, the rates of CCT use were slightly lower, but IMV use was similar (8.8% [1,346/15,369] received CCTs; 4.8% [735/15,369] received IMV). We found that significant predictors for use of CCTs in the group without DNR orders included age between 55 and 74 years (55–64 vs <55 years: odds ratio [OR], 1.09; 95% CI, 1.02–1.17; and 65–74 vs <55 years: OR, 1.12; 95% CI, 1.02–1.22), private insurance versus Medicare (OR, 1.14; 95% CI, 1.05–1.23), higher burden of comorbidities (comorbid score ≥ 2 vs ≤ 0 : 2.51; 95% CI, 2.36–2.67), and presence of weight loss (OR, 3.23; 95% CI, 3.04–3.42; Table 3). In contrast, patients with ESRD (OR, 0.55; 95% CI, 0.41–0.68) were less likely to receive CCTs. Compared with patients with lung cancer, those with CRC (OR, 1.67; 95% CI, 1.51–1.83) were more likely to receive CCTs, whereas patients with GU cancer (OR, 0.89; 95% CI, 0.79–0.99) and breast cancer (OR, 0.71; 95% CI, 0.62–0.80) were less likely to receive CCTs. Administration of CCTs was more common in admissions with a principal diagnosis related to infectious causes along with other pulmonary and gastrointestinal disorders compared with a principal diagnosis of cancer-related causes.

Predictors for CCT use in admissions with DNR orders were similar, except that we saw a very clear trend in decreasing use of CCTs among older patients. Patients aged ≥ 75 years and who had a DNR status were much less likely to receive CCTs than those aged <55 years (OR, 0.62; 95% CI, 0.48–0.76). Black patients and those of “other” race in the DNR group were also more likely to receive CCTs. Among patients who were DNR, the odds of patients with breast or GU cancers receiving CCTs were not significantly different from those with lung cancer (whereas patients with GU and breast cancer who were not DNR were less likely to receive CCTs than patients with lung cancer), but patients with CRC were still more likely to receive CCTs than those

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Characteristics	All Admissions (n=99,085)	Received CCTs (n=9,348)	Did Not Receive CCTs (n=89,737)	P Value
Age, mean (SD), y	64.6 (14.6)	65.1 (13.8)	64.5(14.7)	.0177
Age, y (%)				
<55	23,371 (23.6)	1,979 (21.2)	21,392 (23.8)	<.0001
55–64	23,875 (24.1)	2,319 (24.8)	21,556 (24.0)	
65–74	24,653 (24.9)	2,539 (27.2)	22,114 (24.6)	
≥75	27,186 (27.4)	2,511 (26.9)	24,675 (27.5)	
Sex ^a (%)				
Male	45,716 (46.3)	4,594 (49.2)	41,122 (46.0)	<.0001
Race ^b (%)				
White	58,285 (60.8)	5,272 (58.9)	53,013 (61.0)	<.0001
Black	8,011 (8.4)	905 (10.1)	7,106 (8.2)	
Hispanic	17,614 (18.4)	1,588 (17.7)	16,026 (18.4)	
Other	11,901 (12.4)	1,189 (13.3)	10,712 (12.3)	
Payer ^c (%) ^w				
Medicare	50,512 (51.0)	4,901 (52.4)	45,611 (50.8)	.0241
Medicaid	15,111 (15.3)	1,407 (15.1)	13,704 (15.3)	
Private insurance	29,986 (30.3)	2,732 (29.2)	27,254 (30.4)	
No charge/other	1,396 (1.4)	135 (1.4)	1,261 (1.4)	
Self-pay	2,076 (2.1)	173 (1.9)	1,903 (2.1)	
DNR ^d (%)				
No	83,708 (84.5)	8,000 (85.6)	75,708 (84.3)	.0018
Yes	15,369 (15.5)	1,346 (13.9)	14,023 (15.6)	
Cancer subtype (%)				
Lung	15,055 (15.2)	1,301 (13.9)	13,754 (15.3)	<.0001
Breast	9,105 (9.2)	451 (4.8)	8,654 (9.6)	
Colorectal	10,068 (10.2)	1,223 (13.1)	8,845 (9.9)	
Genitourinary	10,297 (10.4)	738 (7.9)	9,559 (10.7)	
Other cancer or >1 cancer subtype	28,732 (29.0)	3,412 (36.5)	25,320 (28.2)	
No identified subtype	25,828 (26.1)	2,223 (23.8)	23,605 (26.3)	
Elective admission ^e (%)				
No	75,607 (76.3)	7,622 (81.5)	67,985 (75.8)	<.0001
Yes	23,445 (23.7)	1,725 (18.5)	21,720 (24.2)	
Comorbidity score, mean (SD)	1.2 (1.8)	1.9 (1.9)	1.1 (1.8)	<.0001
Principal diagnosis (%)				
Cancer-related	50,040 (50.5)	4,185 (44.8)	45,855 (51.1)	<.0001
Infections	11,350 (11.5)	1,833 (19.6)	9,517 (10.6)	
Other pulmonary disorders	4,888 (4.9)	876 (9.4)	4,012 (4.5)	
Other cardiovascular and circulation disorders	5,173 (5.2)	340 (3.6)	4,833 (5.4)	
Other neurological disorders	3,229 (3.3)	137 (1.5)	3,092 (3.5)	
Other GI disorders	7,989 (8.1)	922 (9.9)	7,067 (7.9)	
Fluid and electrolyte/renal disorders	4,178 (4.2)	368 (3.9)	3,810 (4.3)	
Others	12,238 (12.4)	687 (7.4)	11,551 (12.9)	
Teaching hospital ^f (%)	48,885 (49.8)	4345 (50.1)	44,540 (50.1)	<.0001
Urban ^g (%)	96,674 (98.6)	9155 (98.5)	87,519 (98.5)	.0001
Bed size ^g (%)				
Small (<200)	24,338 (24.8)	2463 (26.6)	21,875 (24.6)	<.0001
Medium (200–399)	44,057 (44.9)	3975 (43.0)	40,082 (45.1)	
Large (≥400)	29,682 (30.3)	2808 (30.4)	26,874 (30.2)	

Abbreviations: CCTs, critical care therapies; DNR, do not resuscitate; GI, gastrointestinal.

^a297 missing.

^b3,274 missing.

^c4 missing.

^d8 missing.

^e33 missing.

^f1,008 missing.

^g2,411 missing.

with lung cancer (OR, 1.85; 95% CI, 1.43–2.27). Insurance status and ESRD were not predictors of CCTs in the DNR group.

When we limited the examination to IMV use, non-white races and greater comorbidity burden were significant predictors of IMV use in both groups with

Table 2. Outcomes of Patients With Metastatic Cancer Who Did and Did Not Receive CCTs				
Characteristics	All Admissions (n=99,085)	Received CCTs (n=9,348)	Did Not Receive CCTs (n=89,737)	P Value
Discharge disposition ^a				
Home	52,798 (59.2)	1,990 (31.7)	50,808 (61.3)	<.0001
Short-term hospital	2,426 (2.7)	383 (6.1)	2,043 (2.5)	
SNF, ICF, facility	13,188 (14.8)	1,627 (25.9)	11,561 (14.0)	
Home health care	18,761 (21.1)	2,110 (33.6)	16,651 (20.1)	
AMA	547 (0.6)	27 (0.4)	520 (0.6)	
Discharge alive, unknown	1,415 (1.6)	149 (2.4)	1,266 (1.5)	
Total cost ^b				
Median (IQR)	12,858 (7,071–23,842)	35,422 (18,978–63,403)	11,860 (6,707–21,087)	<.0001
Length of stay, d ^c				
Mean (SD)	6.8 (9.2)	14.8 (15.6)	5.9 (7.8)	<.0001
In-hospital mortality ^a	9,944 (10.0)	3,046 (33.3)	6,884 (7.7)	<.0001

Abbreviations: AMA, against medical advice; CCTs, critical care therapies; ICF, intermediate care facilities; IQR, interquartile range; SNF, skilled nursing facilities.
^aPatients who survived the hospitalizations; denominator = 89,135; 6 missing.
^bBased on cost/charge ratio; 15,626 missing.
^c15 missing.

or without DNR orders (Table 4). Among patients who did not have a DNR order, those with weight loss (OR, 1.83; 95% CI, 1.69–1.98) and liver diseases (OR, 1.33; 95% CI, 1.14–1.52) were more likely to receive IMV, whereas patients with ESRD were less likely to receive IMV (OR, 0.77; 95% CI, 0.56–0.97). None of these comorbidities were predictors of IMV use in the group with DNR orders. Younger patients (aged <55 years) were more likely than older patients (≥75 years) to receive IMV among those who had DNR orders. Similar to the use of CCTs, among patients who were not DNR, those who had breast and GU cancers were less likely to receive IMV compared with those with lung cancer, but these associations were not statistically significant in the group with DNR orders (and, in fact, the direction of the OR for breast cancer was switched in the DNR group).

Discussion

Using data from the CA SID we found that, not surprisingly, patients with metastatic cancer who received CCTs had much worse outcomes than those who did not, including a 4 times greater rate of in-hospital death, 3 times longer hospital stays, and 3 times higher costs of care. More importantly, we identified that CCT use varied across several patient and clinical characteristics, which may help clinicians as they assess the likelihood that a patient with metastatic cancer may require CCTs when being admitted to the hospital.

A number of predictors found in our study are important for clinical practice. Patients of non-white race with DNR orders were more likely to receive CCTs. Non-white race was also associated with IMV use in patients with and without DNR orders. This may be due to the fact that patients of non-white race are less likely to have DNR orders and more likely to have a preference for life-prolonging care.^{23–25} Non-white patients are also more likely to change their DNR orders during hospitalization to a more aggressive level of care.²⁶ Among patients with DNR orders, those who were older had lower odds of receiving CCTs compared with younger patients, reflecting the fact that younger patients were more likely to have their DNR orders changed while hospitalized. Age was not a predictor of IMV use in patients without DNR orders.

Not surprisingly, patients with or without DNR orders who had a higher burden of comorbidities were more likely to receive CCTs, indicating their underlying severity of illness. Despite having DNR orders, it is interesting that patients with a higher burden of comorbidities were still more likely to receive IMV, indicating that the goals-of-care discussion is an ongoing discussion in the hospital. Nevertheless, physicians should be mindful that a high comorbidity burden is still associated with a high rate of in-hospital deaths.¹² Weight loss was associated with greater CCT use in patients with or without DNR orders and greater IMV use in patients

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Table 3. Predictors of CCT Use Stratified by DNR Status

Variables	CCT Use Adjusted Odd Ratios (95% CI)	
	No DNR (n=15,369)	DNR (n=83,708)
Age, y		
<55	1 (referent)	1 (referent)
55–64	1.09 (1.02–1.17)	0.89 (0.72–1.06)
65–74	1.12 (1.02–1.22)	0.86 (0.67–1.06)
≥75	0.98 (0.89–1.07)	0.62 (0.48–0.76)
Sex		
Male	1 (referent)	1 (referent)
Female	0.95 (0.90–1.00)	1.01 (0.89–1.14)
Race		
White	1 (referent)	1 (referent)
Hispanic	0.96 (0.89–1.03)	1.08 (0.89–1.27)
Black	1.07 (0.98–1.15)	1.31 (1.08–1.54)
Other	1.07 (0.97–1.17)	1.41 (1.09–1.72)
Payer		
Medicare	1 (referent)	1 (referent)
Medicaid	1.07 (0.97–1.17)	0.95 (0.73–1.18)
Private insurance	1.14 (1.05–1.23)	1.16 (0.95–1.37)
No charge/other	1.07 (0.83–1.30)	0.79 (0.33–1.26)
Self-pay	0.93 (0.75–1.11)	1.23 (0.65–1.81)
Elective admission		
Yes	0.97 (0.91–1.04)	1.17 (0.90–1.44)
Comorbidity score		
≤0	1 (referent)	1 (referent)
1	1.70 (1.59–1.82)	1.33 (1.11–1.55)
≥2	2.51 (2.36–2.67)	1.56 (1.33–1.80)
Comorbidities		
Weight loss	3.23 (3.04–3.42)	2.23 (1.94–2.52)
ESRD	0.55 (0.41–0.68)	0.82 (0.43–1.20)
Liver diseases	1.00 (0.89–1.12)	0.85 (0.64–1.07)
Cancer subtype		
Lung	1 (referent)	1 (referent)
Breast	0.71 (0.62–0.80)	1.11 (0.81–1.41)
Colorectal	1.67 (1.51–1.83)	1.85 (1.43–2.27)
Genitourinary	0.89 (0.79–0.99)	0.98 (0.74–1.22)
Other cancer or >2 subtypes	1.64 (1.51–1.77)	1.52 (1.26–1.78)
No identified cancer subtype	1.11 (1.02–1.20)	1.40 (1.15–1.65)
Principal diagnosis		
Cancer-related	1 (referent)	1 (referent)
Infections	1.62 (1.50–1.74)	1.87 (1.59–2.16)
Other pulmonary disorders	2.03 (1.83–2.23)	2.57 (2.07–3.07)
Other cardiovascular and circulation disorders	0.67 (0.58–0.76)	1.11 (0.82–1.41)
Other neurologic and psychiatric disorders	0.53 (0.43–0.63)	0.40 (0.22–0.58)
Other GI disorders	1.20 (1.10–1.31)	1.36 (1.07–1.66)
Fluid and electrolyte/renal disorders	0.99 (0.87–1.12)	0.84 (0.59–1.09)
Others	0.64 (0.58–0.70)	0.67 (0.51–0.83)

Abbreviations: CCT, critical care therapy; DNR, do-not-resuscitate status; ESRD, end-stage renal disease; GI, gastrointestinal.

Variables	IMV Use Adjusted Odds Ratios (95% CI)	
	DNR (n=15,369)	No DNR (n=83,708)
Age, y		
<55	1 (referent)	1 (referent)
55–64	1.02 (0.92–1.13)	0.84 (0.62–1.05)
65–74	1.12 (0.98–1.26)	0.86 (0.61–1.11)
≥75	0.93 (0.81–1.06)	0.56 (0.39–0.73)
Sex		
Male	1 (referent)	1 (referent)
Female	0.94 (0.87–1.00)	0.91 (0.76–1.06)
Race		
White	1 (referent)	1 (referent)
Hispanic	1.04 (0.94–1.14)	1.52 (1.18–1.87)
Black	1.18 (1.05–1.30)	1.59 (1.23–1.95)
Other	1.25 (1.10–1.39)	1.95 (1.42–2.49)
Payer		
Medicare	1 (referent)	1 (referent)
Medicaid	1.12 (0.98–1.26)	0.98 (0.68–1.28)
Private insurance	1.08 (0.96–1.20)	1.08 (0.82–1.34)
No charge/other	1.35 (0.96–1.74)	1.17 (0.38–1.96)
Self-pay	1.02 (0.74–1.29)	1.78 (0.83–2.75)
Elective admission		
Yes	1.08 (0.97–1.18)	1.27 (0.88–1.65)
Comorbidity score		
≤0	1 (referent)	1 (referent)
1	2.25 (2.01–2.50)	1.41 (1.09–1.74)
≥2	3.81 (3.43–4.19)	1.76 (1.40–2.12)
Comorbidities		
Weight loss	1.83 (1.69–1.98)	1.17 (0.95–1.39)
ESRD	0.77 (0.56–0.97)	1.19 (0.55–1.82)
Liver diseases	1.33 (1.14–1.52)	1.00 (0.67–1.32)
Cancer subtype		
Lung	1 (referent)	1 (referent)
Breast	0.75 (0.63–0.87)	1.00 (0.65–1.34)
Colorectal	0.94 (0.81–1.06)	1.05 (0.70–1.39)
Genitourinary	0.71 (0.61–0.80)	0.75 (0.51–0.99)
Other cancer or >2 subtypes	0.97 (0.87–1.07)	1.04 (0.81–1.27)
No identified cancer subtype	0.86 (0.77–0.95)	1.15 (0.90–1.41)
Principal diagnosis		
Cancer-related	1 (referent)	1 (referent)
Infections	2.97 (2.69–3.24)	3.18 (2.52–3.83)
Other pulmonary disorders	3.89 (3.45–4.34)	5.13 (3.91–6.35)
Other cardiovascular and circulation disorders	1.09 (0.91–1.26)	1.66 (1.10–2.22)
Other neurologic and psychiatric disorders	0.72 (0.54–0.91)	0.60 (0.25–0.95)
Other GI disorders	0.59 (0.49–0.70)	0.84 (0.50–1.17)
Fluid and electrolyte/renal disorders	0.34 (0.25–0.45)	0.16 (0.01–0.31)
Others	0.60 (0.52–0.69)	0.67 (0.42–0.91)

Abbreviations: DNR, do-not-resuscitate status; ESRD, end-stage renal disease; GI, gastrointestinal; IMV, invasive mechanical ventilation.

without DNR orders. This finding supports prior studies showing weight loss as a prognostic indicator and reinforces the importance of asking all admitted patients with metastatic cancer about recent (and profound) weight loss, which can help clinicians to identify and address a group of patients at high risk for CCT use.^{27,28} Liver disease was associated with a higher likelihood of IMV use in the group without DNR orders. Intervention, such as a goals-of-care discussion, could be potentially targeted to this group of patients who also have a higher risk of in-hospital mortality (shown in our prior study¹²: OR, 1.58; 95% CI, 1.15–2.00). The higher in-hospital mortality rate in patients with cancer with hepatic failure was also shown in a study by Kress et al.²⁹

One notable comorbidity that did not increase the use of CCTs was ESRD; in fact, patients with ESRD without DNR orders were less likely to receive CCTs. This is also an important finding because patients with ESRD and metastatic cancer are clearly among those at the highest risk for CCT use and death. It raised the question of why CCT was used less in this group. We suspect that clinicians, families, and patients are able to recognize the high risk of morbidity and mortality in this group and opt for a less aggressive approach in the setting of an acute illness (17% of patients with ESRD had an encounter with palliative care, based on ICD-9-CM diagnosis code V66.7). This finding is somewhat encouraging, because it may indicate that when it is clear that the prognosis is not good, patients, families and clinicians opt to forgo CCTs (eg, changing code status, opting for hospice care, or choosing a do-not-hospitalize approach). This may not have been captured in the database, because the DNR orders were recorded within 24 hours of admission. This is supported by prior studies showing that advance directives were present only in 6% to 35% of patients on chronic dialysis.³⁰ When these patients were admitted, 45% had their care changed from disease-directed to symptom-directed in the hospital and 34% had a palliative care team involved.³¹

Our data suggest that oncologists and internists can approach the management of patients with a high number of comorbidities or, specifically, end-stage liver disease in a similarly cautious way. Patients admitted with infections or pulmonary disorders were 4 times more likely to receive

IMV. An admission for a patient with metastatic cancer and a new infection or a pulmonary diagnosis with or without DNR orders should be considered at high-risk for CCT use. Potential interventions, such as early initiation of close monitoring, need to be studied in this at-risk population. Additionally, discussion of risks and benefits of invasive treatment along with goals-of-care discussions should be prioritized.

We made some observations when we analyzed cancer subtypes and the use of CCTs. Within the group without a DNR order, patients with lung cancer had a higher likelihood of receiving CCTs and IMV compared with those with breast and GU cancers. These differences were attenuated in the DNR group. Patients with CRC had a higher likelihood of receiving CCTs than those with lung cancer. We attributed these findings to the fact that patients with lung cancer are usually sicker, with frequent presence of underlying primary lung disease. The higher use of TPN likely explained the high rate of CCT use in patients with CRC. Although selection bias or inherent risk may factor into decision-making, knowing the risk of receiving CCTs for patients with varying cancer types stratified by DNR status offers important information for clinicians as they help patients and families make treatment decisions.

Given that all the variables collected in our study are accessible through most electronic health records (EHRs), creating EHR tools to help clinicians during the admitting process could help identify the highest risk patients in real time. Having this information will help clinicians develop strategies to avoid CCT use in patients unlikely to benefit. On the other hand, for patients who may benefit from CCTs, strategies such as more intensive monitoring or early transfer to the intensive care unit can be considered. However, these strategies need to be studied further before they are adopted in clinical practice.

Our study is limited by its retrospective nature. Because there are clearly selection issues (some patients were not eligible to receive CCTs because of patient, family, or physician decision-making), our findings need to be interpreted carefully and should not be considered an examination of the effectiveness of CCTs. We used a large administrative database, which lacked clinical information such as laboratory data or vital signs. Similarly, we therefore

lacked the ability to identify severity of illness at admission. Given that we evaluated the use of CCTs, it is very likely that the presenting severity played an important role that we were unable to assess. Definitions of metastatic cancer are based on ICD-9 codes that have not been validated. Additionally, we were not able to retrieve information related to cancer severity and treatments.

Conclusions

Patient characteristics, such as non-white race, higher burden of comorbidities, weight loss, liver disease, lung cancer subtype, and diagnosis of infections or pulmonary disorders, were associated with higher odds of receiving CCTs or IMV. These findings may help clinicians admitting these patients (especially those without DNR orders) to determine in whom to prioritize discussions around goals of care and wishes for the end of life.

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