Emergency Cancer Care

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Variables associated with admission rates among cancer patients presenting to emergency departments: a CONCERN group study

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Abstract

Background Patients with cancer visit the emergency department often and have a high rate of admission compared to other patients. Admission rates by institution may vary widely, even after accounting for patient and hospital-specific characteristics.

Objectives To review the variables that affect admission rates among patients with cancer in the emergency department.

Methods We performed a secondary analysis of a prospective cohort study of patients with cancer at 18 emergency departments between March 1, 2016, and January 30, 2017, to examine differences in patient populations between hospitals with varying admission rates. We calculated the percentage admitted by hospital and used it to categorize hospitals into quartiles. We compared outcomes, patient demographics, and disease characteristics between the admission quartiles using linear or logistic regression.

Results A total of 1075 patients were included. The median age of our sample was 64, and 51% of patients were female, 84% were white, and 13% were Black. Of the 1075 patients, 615 (57.2%) were admitted as inpatients with a range from 21.2 to 81.7% by hospital. Differences between admission quartiles were found for education, mode of arrival, and recent chemotherapy ($p < 0.05$). There were no significant differences among quartiles in age, gender, race, or ECOG score. We found significant difference between admission quartiles in 30-day emergency department revisits. Differences in readmission rates and mortality did not appear to be significant between the various quartiles.

Conclusions In our study, we observed several differences among patients with cancer receiving care at hospitals with different admission rates. These included patients' education level, mode of arrival, and whether they had received recent chemotherapy. Emergency Severity Index (ESI) score may have also contributed to admission rate variability. Further study into unmeasured factors influencing hospital admissions, such as local culture, resources,

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and pathways, could identify generalizable findings to reduce avoidable admissions and reduce variation among similar patients in different hospitals.

Keywords Admission rate, Variability, Cancer, Emergency department, Readmission, Revisits

Background

The number of patients with cancer is growing, driven by an increase in older adult patients with cancer. Investigators estimate that this population will grow from 15.5 million cancer survivors in 2015 to 26.1 million by 2040 [1]. In 2018 alone, patients with cancer in the United States (US) visited the emergency department (ED) approximately 4,884,000 times, representing 4.2% of all visits [2]. Hospitalizations with a principal or secondary diagnosis of cancer accounted for 10.5% of adult hospitalizations with a total cost of US $49.8 billion in 2017 [3]. In various studies, admission rates for patients with cancer in the ED are higher than for the general population, ranging from 58 to 62% while only being 16.3% for the general ED population [4–7]. Patients with cancer admitted through the ED are more acutely ill than others, with one institution reporting that 13% of patients with cancer who visited their ED were admitted to the ICU and 11% died during hospitalization [8].

In patients without cancer, condition-specific admission rates vary widely among EDs, even after adjusting for patient acuity and complexity [9–14]. Variability in admission rates has not been consistently linked to patient or hospital characteristics [15]. In an analysis of the ED component of the 2010 National Ambulatory Care Survey, whether a patient was admitted was dependent not just on their clinical factors but also on which ED evaluated them [16]. Because of this, prospective, multicenter studies to properly understand the variables that influence ED patient admission to the hospital are needed.

Founded in 2015, the National Cancer Institute (NCI) sponsored the Comprehensive Oncologic Emergencies Research Network (CONCERN) with the goal of identifying knowledge gaps and accelerating knowledge generation for patients with cancer requiring emergent care [17]. We previously described the disposition of patients with cancer in the ED to whether they received observation unit care and short stay and long stay inpatient admission [18]. Understanding the key drivers of ED admissions among patients with cancer can illuminate how to maximize healthcare quality through appropriate admissions and reducing unneeded resource utilization. Such knowledge may also improve patient comfort and satisfaction by preventing unnecessary hospital admissions and maximizing time at home, a patient-centered outcome that is increasingly noted to be important in cancer care [19]. In this secondary analysis of our prospective, multicenter observation study, we describe patient characteristics leading to inpatient admission to the hospital among patients with cancer visiting the ED [20].

Methods

Design and setting

We conducted a planned secondary analysis of the CONCERN data obtained between March 1, 2016, and January 30, 2017, to examine differences in patient populations between hospitals with varying admission rates. The percent admitted by hospital was calculated and used to categorize hospitals into quartiles. We previously published the protocol for this 18-site, prospective observational cohort study [20]. This study included adults ≥ 18 years of age with active cancer defined as (1) antineoplastic therapy within the past 12 months, (2) previously diagnosed or emergency physician-diagnosed cancer recurrence or metastasis, or (3) cancer-related symptoms. Exclusion criteria included pregnancy, incarceration, psychiatric chief complaint, chief complaint due to trauma, non-English speaking, previous enrollment in this same study, or being too ill or otherwise unable to participate in survey administration. The 18 sites were primarily urban academic EDs, all of which were affiliated with centers that provide comprehensive cancer care. Thirteen of the sites are affiliated with NCI-designated comprehensive cancer centers. Each participating site's institutional review board approved all study procedures.

Data collection

Trained research personnel approached patients in the ED, obtained informed consent, and administered the study questionnaire. Study personnel then conducted a chart review to identify patients who revisited the ED over the subsequent 30 days. Collected information included demographics, cancer type and status, medical history, current treatments and medications, functional status, symptom burden, palliative/hospice care utilization, clinical data including ED lab tests, ED disposition, hospital use/length of stay, Eastern Cooperative Group performance status (EGOG), Functional Assessment of Cancer Therapy-General Measure (FACT-G7), Condensed Memorial Symptom Assessment Scale (CMSAS), and up to four ED diagnoses using the International Statistical Classification of Diseases and Related Health

Problems 10th Revision [21–23]. We grouped International Classification of Diseases-10 (ICD-10) codes using the Clinical Classifications Software (CCS) to explore the most common themes of conditions managed in each setting [24]. Chart review data included comorbidities sufficient to calculate the Charlson Comorbidity Index (CCI) [25].

We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines [26] and have previously published a description of the missing values and inter-rater reliability [27].

Outcome measures

We accessed key patient demographic and health history items (e.g., age, sex, cancer type), ED and hospital length of stay (LOS) and diagnoses, and initial ED disposition. The primary outcomes were the overall and department-specific inpatient admission rates. Secondary outcomes included the 30-day readmission rate, the 30-day ED revisit rate, and the 30-day mortality rate.

Statistical analysis

The percent of hospital admission was calculated for each center, and the EDs were grouped based on the data distribution in order to partition centers into quartiles by admission rate.

Descriptive statistics were used to characterize the demographic and clinical characteristics of the study population overall and by quartile of readmission. Characteristics between the quartiles were compared using univariate logistic regression for dichotomous variables or univariate linear regression for continuous variables. Each model included the ED to account for clustering unless small numbers prohibited clustering. Each outcome (admitted to hospital for > 24 h within 30 days, admitted to hospital for > 24 h within 30 days OR died within 30 days, return to ED within 30 days, and 30-day mortality) was compared between the quartiles using univariate logistic regression. Those with unknown mortality were set to missing prior to comparison. SAS 9.4 (SAS Institute, Inc., Cary, NC, USA) and Stata 16.1 (StataCorp LLC, College Station, TX, USA) were used in the analyses. We considered a p-value of 0.05 statistically significant for all analyses.

Results

We included 1051 patients from 18 participating EDs. The median age was 64. Females comprised 51% of patients, 84% of patients were white, 13% were Black/African American, and 7% were Hispanic or Latino (see Table 2). The top five diagnoses and the percent of patients that presented with these diagnoses were (1) abdominal and pelvic pain (9.3%), (2) fever (8.1%), (3) abnormalities of breathing (7.2%), (4) nausea and vomiting (5.6%), and (5) pain in throat and chest (4.7%) [20].

Table 1 describes the site enrollment characteristics. The total admission rate in our sample was 58.5% ($n=615$) with the unadjusted admission rate among the individual EDs ranging from 21.2 to 81.7%. We partitioned the EDs into quartiles based on natural groups in the admission rate distribution. The admission rates of each quartile were Q1 21–38%, Q2 47–56%, Q3 60–66%, and Q4 69–82% (see Table 1). The baseline ED admission rate for all diagnoses (including non-cancer) at each site was collected and was Q1 30%, Q2 20%, Q3 30%, and Q4 30%. The overall readmission rate within 30 days ranged from 0 to 43.1%. There was no correlation between the initial ED admission rate and the readmission rate (Fig. 1). A minority of the centers were not NCI-designated cancer centers ($n=6$) and were distributed across Q2, Q3. and Q4.

Patient characteristics by admission rate quartile are presented in Table 2. There were no significant differences among quartiles in age, gender, race, marital status, ECOG score, or ED arrival day. Sunday to Thursday was compared to Friday and Saturday as there is generally less outpatient follow-up available on Saturday and Sunday for patients discharged from the ED. Although the Emergency Severity Index (ESI) data was not documented in 17% ($n=42$) of patients in Q1, there appeared to be a higher percentage of patients with ESI 1 and 2 in the higher admission EDs. In order to test this, we attributed all the undocumented or missing ESI data from Q1 into category ESI 1 or 2. This still showed a lower number of ESI scores of 1 or 2 present in Q1 (Q1 33.9% [$n=86$], Q2 32.9% [$n=52$], Q3 46% [$n=161$] and Q4 66.5% [$n=208$], $p<0.001$). Q1 had a higher percentage of patients with a bachelor's degree (Q1 55% [$n=137$] vs. Q4 35% [$n=106$], $p<0.01$). Q4 had a higher rate of patients arriving by private vehicle (Q4 70% [$n=218$] vs. Q1 27% [$n=69$], Q2 49% [$n=77$], Q3 32% [$n=111$], $p<0.001$) though this is difficult to analyze due to the large number of patients who either had undocumented or missing data as a mode of arrival (Q1 50% [$n=125$], Q2 32% [$n=51$], Q3 41% [$n=143$], Q4 8% [$n=26$]).

We illustrate cancer type and treatment grouped by admission quartile in Table 3. The use of traditional chemotherapy was lower in Q1 than in other groups (Q1 39% [$n=99$] vs. Q2 59% [$n=83$], Q3 41% [$n=142$], Q4 55% [$n=171$], $p=0.001$) as was the use of radiotherapy (Q1 7% [$n=17$] vs. Q2 14% [$n=22$] vs 9% [$n=30$] vs. 12% [$n=39$], $p=0.004$). There was no difference found between solid

Table 1 Site enrollment characteristics

Quartile	Site ID	Patients per site	Number admitted	Overall percent admitted	Overall percent readmitted	Percent readmitted for > 24 h within 30 days of those admitted	Number discharged	Percent readmitted for > 24 h within 30 days of those discharged
1	22	66	14	21.2%	24.2%	21.4%	50	26.0%
	15	71	22	31.0%	18.3%	13.6%	49	20.4%
	14	48	16	33.3%	22.9%	37.5%	28	17.9%
	7	69	26	37.7%	21.7%	30.8%	41	17.1%
2	10	70	33	47.1%	28.6%	24.2%	20	32.4%
	6	18	10	55.6%	0.0%	0.0%	8	0.0%
	21	70	39	55.7%	18.6%	15.4%	31	22.6%
3	9	45	27	60.0%	15.6%	18.5%	18	11.1%
	4	71	45	63.4%	23.9%	33.3%	2	8.0%
	13	22	14	63.6%	31.8%	35.7%	2	25.0%
	12	72	47	65.3%	43.1%	42.6%	25	44.0%
	18	70	46	65.7%	21.4%	23.9%	24	16.7%
	19	70	46	65.7%	32.9%	34.8%	24	29.2%
4	20	71	49	69.0%	28.2%	24.5%	20	35.0%
	1	70	50	71.4%	24.3%	26.0%	20	20.0%
	3	70	51	72.9%	24.3%	27.5%	18	16.7%
	11	42	31	73.8%	40.5%	38.7%	11	45.5%
	17	60	49	81.7%	25.0%	24.5%	11	27.3%

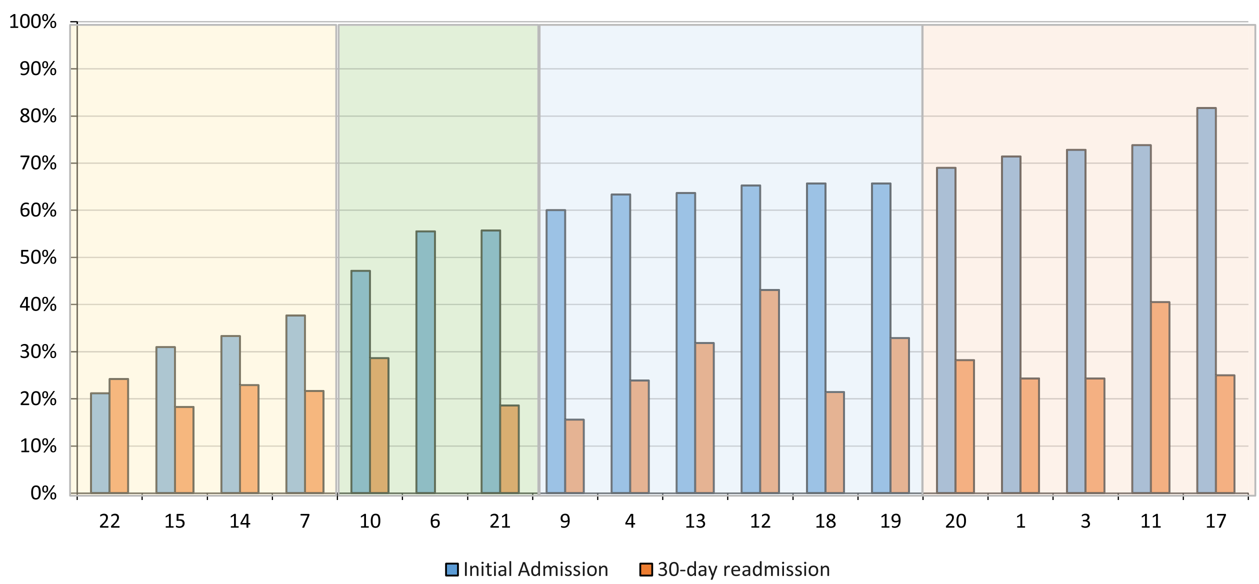

Fig. 1 Initial admission and 30-day readmission rates by site. The shading indicates quartiles defined by initial admission: Q1 21–38% (yellow), Q2 47–56% (green), Q3 60–66% (blue), and Q4 69–82% (orange)

tumors and hematologic malignancies. Table 4 details the symptoms and symptom treatment by admission quartile. The use of long-acting opiates was higher in Q4 than in the other quartiles (Q4 13% [$n = 40$] vs. Q1 5% [$n = 13$], Q2 1% [$n = 2$], and Q3 6% [$n = 21$]. There was no significant difference in quartiles in terms of the presence of fever, pain, nausea, or shortness of breath.

We show 30-day readmission, 30-day ED revisits, and 30-day mortality by quartile in Table 5. Thirty-day ED revisits were higher in Q3 and Q4 than in Q1 and Q2 (Q4 28% [$n = 88$}, Q3 29% [$n = 100$], Q2 25% [$n = 25$%], Q1 23% [$n = 59$], $p < 0.001$). There was no significant difference between 30-day readmission and 30-day mortality in the different quartiles.

Table 2 Adults with active cancer presenting to the emergency department characteristics by admission quartiles

Variable	Level	Total (*n* = 1075)	Q1 21.2–37.7% (*n* = 254)	Q2 47.1–55.7% (*n* = 158)	Q3 60.0–64.7% (*n* = 350)	Q4 69.0–81.7% (*n* = 313)	Main effects *p*-value[a]
Age	Median (IQR) (min, max)	Missing = 1 63.5 (54, 71) (19, 90)	Missing = 1 61 (50, 71) (19, 90)	Missing = 0 62 (53, 69) (24, 89)	Missing = 0 65 (54, 72) (22, 90)	Missing = 0 65 (57, 73) (23, 90)	0.381
Gender							
	Female	553 (51%)	137 (54%)	84 (53%)	171 (49%)	161 (51%)	0.078
	Male	511 (48%)	110 (43%)	74 (47%)	178 (51%)	149 (48%)	
	Unspecified	4 (0%)	3 (1%)	0 (0%)	0 (0%)	1 (0%)	
	Missing	7 (1%)	4 (2%)	0 (0%)	1 (0%)	2 (1%)	
Race	White	847 (84%)	193 (83%)	104 (74%)	279 (83%)	271 (88%)	0.017
	Black/African American	129 (13%)	23 (10%)	31 (22%)	42 (13%)	33 (11%)	
	Other	38 (4%)	14 (6%)	5 (4%)	14 (4%)	5 (2%)	
Ethnicity	Hispanic or Latino	76 (7%)	24 (10%)	18 (11%)	29 (8%)	5 (2%)	0.080
	Not Hispanic or Latino	977 (93%)	220 (90%)	138 (85%)	315 (92%)	304 (98%)	
Marital status							
	Divorced or separated	153 (14%)	34 (14%)	24 (15%)	49 (14%)	46 (15%)	0.329[b]
	Married/domestic partnership	639 (60%)	146 (58%)	88 (56%)	210 (60%)	195 (63%)	
	Never married	151 (14%)	45 (18%)	28 (18%)	47 (13%)	31 (10%)	
	Refused	2 (0%)	0 (0%)	1 (1%)	0 (0%)	1 (0%)	
	Widowed	123 (11%)	25 (10%)	17 (11%)	43 (12%)	38 (12%)	
	Missing	7 (1%)	4 (2%)	0 (0%)	1 (0%)	2 (1%)	
Education	Not a high school graduate	85 (8%)	14 (6%)	18 (12%)	35 (10%)	18 (6%)	< 0.001[b]
	High school graduate (including equivalency)	270 (26%)	43 (17%)	48 (31%)	102 (30%)	77 (25%)	
	Some college or associates degree	283 (27%)	56 (22%)	40 (26%)	83 (24%)	104 (34%)	
	Bachelor's degree	225 (21%)	68 (27%)	32 (20%)	65 (19%)	60 (20%)	
	Graduate or professional degree	195 (18%)	69 (28%)	19 (12%)	61 (18%)	46 (15%)	
ED arrival day							
	Sun-Thurs	841 (78%)	184 (72%)	127 (80%)	279 (80%)	251 (80%)	
	Fri-Sat	209 (19%)	55 (22%)	31 (20%)	67 (19%)	56 (18%)	
	Missing	25 (2%)	15 (6%)	0 (0%)	4 (1%)	6 (2%)	0.924
Mode of arrival							
	Ground ambulance/aeromedical	244 (23%)	52 (20%)	30 (19%)	95 (27%)	67 (21%)	
	Other	227 (21%)	83 (33%)	29 (18%)	99 (28%)	16 (5%)	
	Private vehicle	475 (44%)	69 (27%)	77 (49%)	111 (32%)	218 (70%)	
	Unknown/not documented	118 (11%)	42 (17%)	22 (14%)	44 (13%)	10 (3%)	
	Missing	11 (1%)	8 (3%)	0 (0%)	1 (0%)	2 (1%)	< 0.001[b]

Table 2 (continued)

Variable	Level	Total (*n* = 1075)	Q1 21.2–37.7% (*n* = 254)	Q2 47.1–55.7% (*n* = 158)	Q3 60.0–64.7% (*n* = 350)	Q4 69.0–81.7% (*n* = 313)	Main effects *p*-value[a]
Emergency severity index (ESI) score at presentation							
	1—most urgent	10 (1%)	1 (0%)	0 (0%)	1 (0%)	8 (3%)	
	2—emergent	430 (40%)	27 (11%)	51 (32%)	157 (45%)	195 (62%)	
	3—urgent	542 (50%)	158 (62%)	103 (65%)	180 (51%)	101 (32%)	
	4—less urgent	20 (2%)	6 (2%)	3 (2%)	9 (3%)	2 (1%)	
	5—nonurgent	6 (1%)	4 (2%)	0 (0%)	0 (0%)	2 (1%)	
	Not documented	46 (4%)	42 (17%)	1 (1%)	2 (1%)	1 (0%)	
	Other—ESI not used	10 (1%)	8 (3%)	0 (0%)	0 (0%)	2 (1%)	
	Missing	11 (1%)	8 (3%)	0 (0%)	1 (0%)	2 (1%)	[c]
ECOG							
	0 (ECOG 0 or 1)	626 (58%)	156 (61%)	85 (54%)	208 (59%)	177 (57%)	
	1 (ECOG 2–4)	433 (40%)	91 (36%)	73 (46%)	140 (40%)	129 (41%)	
	Missing	16 (1%)	7 (3%)	0 (0%)	2 (1%)	7 (2%)	0.313
Functional status							
	Fully active, able to carry on all pre-disease performance without restriction	302 (28%)	86 (34%)	32 (20%)	106 (30%)	78 (25%)	
	Restricted in physically strenuous activity but ambulatory and able to carry out work of a light or sedentary nature	324 (30%)	70 (28%)	53 (34%)	102 (29%)	99 (32%)	
	Ambulatory and capable of all self-care but unable to carry out any work activities. Up and about > 50% of waking hours	202 (19%)	49 (19%)	41 (26%)	57 (16%)	55 (18%)	
	Capable of only limited self-care, confined to bed or chair more than 50% of waking hours	199 (19%)	32 (13%)	32 (20%)	70 (20%)	65 (21%)	
	Completely disabled. Cannot carry on any self-care. Totally confined to bed or chair	32 (3%)	10 (4%)	0 (0%)	13 (4%)	9 (3%)	
	Missing	16 (1%)	7 (3%)	0 (0%)	2 (1%)	7 (2%)	0.236

[a] Test of any difference between quartiles across levels of a variable

[b] Cluster factor not included in model

[c] Unable to be calculated due to missing data

Discussion

In this secondary analysis of CONCERN's prior prospective study of patients with cancer visiting EDs, we found a wide variation in admission rates among the participating sites. Various factors may have contributed to this finding. Variability in patient severity

Table 3 Cancer type and treatment by admission quartile for adults presenting to the emergency department

Variable	Level	Q1 21.2–37.7% (*n* = 254)	Q2 47.1–55.7% (*n* = 158)	Q3 60.0–64.7% (*n* = 350)	Q4 69.0–81.7% (*n* = 313)	Main effects *p*-value[a]
Primary active cancer						
	Do not know	4 (2%)	5 (3%)	5 (1%)	3 (1%)	
	Hematologic	38 (15%)	24 (15%)	50 (14%)	42 (13%)	
	Solid	208 (82%)	128 (81%)	294 (84%)	266 (85%)	
	Missing	4 (2%)	1 (1%)	1 (0%)	2 (1%)	0.966
Cancer-related therapies within previous 30 days						
	No	83 (33%)	35 (22%)	103 (29%)	73 (23%)	
	Yes	166 (65%)	123 (78%)	246 (70%)	238 (76%)	
	Missing	5 (2%)	0 (0%)	1 (0%)	2 (1%)	0.139
Traditional chemo-therapy	No	155 (61%)	75 (47%)	208 (59%)	142 (45%)	
	Yes	99 (39%)	83 (53%)	142 (41%)	171 (55%)	0.001
Targeted drug therapy	No	205 (81%)	133 (84%)	285 (81%)	274 (88%)	
	Yes	49 (19%)	25 (16%)	65 (19%)	39 (12%)	0.341
Systemic corticosteroids	No	229 (90%)	135 (85%)	299 (85%)	268 (86%)	
	Yes	25 (10%)	23 (15%)	51 (15%)	45 (14%)	0.718
Radiotherapy	No	237 (93%)	136 (86%)	320 (91%)	274 (88%)	
	Yes	17 (7%)	22 (14%)	30 (9%)	39 (12%)	0.004
Surgery for cancer	No	225 (89%)	143 (91%)	327 (93%)	295 (94%)	
	Yes	29 (11%)	15 (9%)	23 (7%)	18 (6%)	0.202
None of the above	No	254 (100%)	157 (99%)	345 (99%)	311 (99%)	
	Yes	0 (0%)	1 (1%)	5 (1%)	2 (1%)	[b]
Do you have a living will or advance directive?						
	Do not know	11 (4%)	12 (8%)	34 (10%)	12 (4%)	
	No	106 (42%)	80 (51%)	157 (45%)	152 (49%)	
	Yes	132 (52%)	65 (41%)	158 (45%)	147 (47%)	
	Missing	5 (2%)	1 (1%)	1 (0%)	2 (1%)	0.175
Do you currently receive care services?						
	No	180 (71%)	147 (93%)	320 (91%)	280 (89%)	
	Yes	18 (7%)	10 (6%)	27 (8%)	31 (10%)	
	Missing	56 (22%)	1 (1%)	3 (1%)	2 (1%)	0.879
Do you currently receive hospice care?						
	No	243 (96%)	154 (97%)	340 (97%)	307 (98%)	
	Yes	4 (2%)	3 (2%)	9 (3%)	4 (1%)	
	Missing	7 (3%)	1 (1%)	1 (0%)	2 (1%)	0.673

[a] Test of any difference between quartiles across levels of a variable

[b] Small cell counts so no comparison made

among the participating sites, as measured by ESI, may have contributed to admission rate variability. ECOG score did not appear to factor into this variation. Previous studies show that ESI predicts patient disposition in the ED, and Adler et al. previously demonstrated that ESI was predictive of patient disposition to outpatient or hospital care in this sample as well [28–30]. Future studies regarding ED admission rate variability could consider the use of ESI as a variable.

There were other differences in patient factors between the different admission rate quartiles in our analysis. The first was education level. Patients from Q1 EDs were more likely to have a bachelor's degree or higher than those from Q3 and Q4 hospitals. One study showed that lower education levels in patients with cancer had an OR of 1.92 for having at least one symptomatic visit to the ED or for hospital admission [31]. In another qualitative study, physicians frequently

Table 4 Symptoms and symptom treatment by admission quartile among adults with active cancer presenting to the emergency department

Variable	Level	Q1 21.2–37.7% (*n* = 254)	Q2 47.1–55.7% (*n* = 158)	Q3 60.0–64.7% (*n* = 350)	Q4 69.0–81.7% (*n* = 313)	Main effects *p*-value[a]
Pain (any)						
	No	107 (42%)	59 (37%)	123 (35%)	105 (34%)	
	Yes	138 (54%)	98 (62%)	226 (65%)	206 (66%)	
	Missing	9 (4%)	1 (1%)	1 (0%)	2 (1%)	0.411
Chest pain						
	No	208 (82%)	122 (77%)	297 (85%)	266 (85%)	
	Yes	36 (14%)	36 (23%)	52 (15%)	45 (14%)	
	Missing	10 (4%)	0 (0%)	1 (0%)	2 (1%)	0.698
Shortness of breath						
	No	179 (70%)	94 (59%)	228 (65%)	192 (61%)	
	Yes	66 (26%)	64 (41%)	121 (35%)	119 (38%)	
	Missing	9 (4%)	0 (0%)	1 (0%)	2 (1%)	0.054
Nausea						
	No	181 (71%)	110 (70%)	222 (63%)	214 (68%)	
	Yes	64 (25%)	48 (30%)	127 (36%)	97 (31%)	
	Missing	9 (4%)	0 (0%)	1 (0%)	2 (1%)	0.311
Abdominal pain						
	No	160 (63%)	106 (67%)	244 (70%)	209 (67%)	
	Yes	84 (33%)	52 (33%)	105 (30%)	102 (33%)	
	Missing	10 (4%)	0 (0%)	1 (0%)	2 (1%)	0.741
Urinary symptoms (burning, frequency, flank pain, suprapubic pain)						
	No	208 (82%)	139 (88%)	294 (84%)	261 (83%)	
	Yes	35 (14%)	18 (11%)	55 (16%)	50 (16%)	
	Missing	11 (4%)	1 (1%)	1 (0%)	2 (1%)	0.838
Were pain medications administered in the ED?						
	No	122 (48%)	66 (42%)	198 (57%)	145 (46%)	
	Yes	122 (48%)	80 (51%)	151 (43%)	166 (53%)	
	Missing	10 (4%)	12 (8%)	1 (0%)	2 (1%)	< 0.001
Antiemetics in the ED	No	196 (77%)	120 (76%)	269 (77%)	230 (73%)	0.873
	Yes	58 (23%)	38 (24%)	81 (23%)	83 (27%)	
Was new systemic anticoagulation started when the patient was in the ED or inpatient setting for treatment of the thromboembolism?						
	No	16 (6%)	3 (2%)	8 (2%)	9 (3%)	
	Yes	13 (5%)	4 (3%)	10 (3%)	10 (3%)	
	Missing	225 (89%)	151 (96%)	332 (95%)	294 (94%)	
Nonsteroidal anti-inflammatories (NSAIDs), non-selective	Checked	11 (4%)	12 (8%)	16 (5%)	13 (4%)	0.749
	Unchecked	243 (96%)	146 (92%)	334 (95%)	300 (96%)	
NSAID, selective (celecoxib, etc.)	Checked	3 (1%)	0 (0%)	2 (1%)	5 (2%)	0.320
	Unchecked	251 (99%)	158 (100%)	348 (99%)	308 (98%)	
Acetaminophen (alone or as part of a combination product)	Checked	48 (19%)	20 (13%)	40 (11%)	56 (18%)	0.261
	Unchecked	206 (81%)	138 (87%)	310 (89%)	257 (82%)	
Tramadol	Checked	4 (2%)	7 (4%)	1 (0%)	1 (0%)	[b]
	Unchecked	250 (98%)	151 (96%)	349 (100%)	312 (100%)	
Short acting opioid/narcotic	Checked	78 (31%)	57 (36%)	100 (29%)	102 (33%)	0.076
	Unchecked	176 (69%)	101 (64%)	250 (71%)	211 (67%)	
Long-acting opioid	Checked	13 (5%)	2 (1%)	21 (6%)	40 (13%)	< 0.001
	Unchecked	241 (95%)	156 (99%)	329 (94%)	273 (87%)	

Table 4 (continued)

Variable	Level	Q1 21.2–37.7% ($n=254$)	Q2 47.1–55.7% ($n=158$)	Q3 60.0–64.7% ($n=350$)	Q4 69.0–81.7% ($n=313$)	Main effects *p*-value[a]
Other	Checked	6 (2%)	1 (1%)	6 (2%)	5 (2%)	0.528
	Unchecked	248 (98%)	157 (99%)	344 (98%)	308 (98%)	
Do not know	Checked	0 (0%)	1 (1%)	0 (0%)	0 (0%)	[b]
	Unchecked	254 (100%)	157 (99%)	350 (100%)	313 (100%)	
The presence of fever in ED	No	229 (90%)	144 (91%)	325 (93%)	283 (90%)	0.773
	Yes	25 (10%)	14 (9%)	25 (7%)	30 (10%)	
The presence of fever ≤ 24 h prior to or in ED	No	208 (82%)	135 (85%)	308 (88%)	267 (85%)	
	Yes	46 (18%)	23 (15%)	42 (12%)	46 (15%)	0.058

[a] Test of any difference between quartiles across levels of a variable

[b] Small cell counts so no comparison made

Table 5 Univariate outcomes by admission quartiles

Variable	Level	Total ($n=1075$)	Q1 21.2–37.7% ($n=254$)	Q2 47.1–55.7% ($n=158$)	Q3 60.0–64.7% ($n=350$)	Q4 69.0–81.7% ($n=313$)	Main effects *p*-value[a]
Admitted to hospital for > 24 h within 30 days							
	No	790 (73%)	191 (75%)	125 (79%)	249 (71%)	225 (72%)	
	Yes	274 (25%)	55 (22%)	33 (21%)	100 (29%)	86 (27%)	
	Missing	11 (1%)	8 (3%)	0 (0%)	1 (0%)	2 (1%)	0.108
Admitted to hospital for > 24 h within 30 days OR died within 30 days							
	No	719 (67%)	174 (69%)	118 (75%)	228 (65%)	199 (64%)	
	Yes	312 (29%)	63 (25%)	38 (24%)	112 (32%)	99 (32%)	
	Missing	44 (4%)	17 (7%)	2 (1%)	10 (3%)	15 (5%)	0.011
Return to ED within 30 days							
	No	778 (72%)	187 (74%)	119 (75%)	249 (71%)	223 (71%)	
	Yes	286 (27%)	59 (23%)	39 (25%)	100 (29%)	88 (28%)	
	Missing	11 (1%)	8 (3%)	0 (0%)	1 (0%)	2 (1%)	< 0.001
30-day mortality							
Note, unknown was set to missing prior to running the analyses	No	965 (90%)	222 (87%)	150 (95%)	318 (91%)	275 (88%)	
	Unknown	37 (3%)	10 (4%)	2 (1%)	10 (3%)	15 (5%)	
	Yes	62 (6%)	14 (6%)	6 (4%)	21 (6%)	21 (7%)	
	Missing	11 (1%)	8 (3%)	0 (0%)	1 (0%)	2 (1%)	0.062

[a] Test of any difference between quartiles across levels of a variable

changed management plans based on their patients' socioeconomic status in an effort to enhance outcomes [32]. Other studies have also linked health literacy, low educational levels, and low socioeconomic status to higher ED utilization and hospital admission rates [33–36]. Perhaps patients with higher education levels are better able to advocate for themselves, or they may have access to better support at home such as home nursing or fewer barriers to access to care. Mode of transportation was also statistically significant in our study. Patients arriving by private vehicle was higher in Q4 than in the other quartiles. This may have been due to the locations of the individual hospitals in areas with high versus low utilization of public transportation or with different rates of private vehicle ownership. Unfortunately, the categories "other" and "unknown/not documented" do not allow sufficient analysis into the alternative modes of transportation such as public transportation, taxi, and rideshare, which could provide better insight into this difference.

Q4 had the highest percentage of patients receiving traditional chemotherapy. This was expected due to the high rate of complications among patients receiving traditional chemotherapy, such as infections, anemia, nausea, vomiting, and dehydration that can lead to admission [37]. Additionally, there was a higher percentage of patients using long-acting opiates at home in Q4. Patients taking long-acting opiates may have pain that is more difficult to control and fewer outpatient options available, hence requiring admission for symptom control. There also may have been unmeasured differences between study sites that led to this finding, such as opioid prescribing practices and other socioeconomic factors, such as the degree of family support.

The variability in admission rates between EDs did not appear to affect the 30-day readmission rate. There was no significant difference between the ED quartile groups in the 30-day readmission rate or the 30-day mortality rate. On the other hand, ED 30-day revisits were lower in Q1 and Q2 than in Q3 and Q4. These findings imply that a lower initial admission rate may not necessarily lead to subsequent ED visits and hospital revisits. One possible explanation for this may have been lower patient severity in the EDs with lower admission rates. It may also be due to improved outpatient algorithms or coordination of care by those respective sites in treating their patient population. These results are analogous to other studies in other patient populations that have demonstrated that variations in ED disposition generally do not impact the treatment plan nor patient outcomes [38, 39].

There are several limitations to our study. This study includes patients from mostly large, urban academic medical centers, and therefore, not all these results are generalizable to the overall population of EDs caring for patients with cancer. As this study only included patients visiting the CONCERN group EDs, some of the patients may have had ED revisits and readmissions at other hospitals outside of the study. While our dataset included the ESI and CCI, some institutions did not have all the data to compute those individual values. As such, we were unable to use these variables to risk adjust, and risk-adjust adjusting may have demonstrated variation not attributable to patient severity. Likewise, we were unable to compare admission rates based on ED diagnosis as the number of patients within each diagnosis grouping was too small to analyze [20]. Analyses of these data may have yielded further insight into differing ED practices in managing individual diagnoses. In addition, we did not have sufficient power to analyze this data set by hospital variables/characteristics. It would be interesting to determine if hospital characteristics, e.g., visit volume, rural vs urban, and academic vs non-academic, contribute to this variation. The only two standalone cancer hospitals with a closed ED in our study were in Q1 and Q2, suggesting there may have been more standardized protocols for patients at these institutions and improved coordination of care and outpatient follow-up.

Approximately, 7% of approached patients in this study were "too ill or otherwise unable to participate," accounting for roughly 21% of ineligible patients. The exclusion of patients too ill to participate may have underestimated hospital admission rates, hospital revisit rates, readmission rates, and 30-day mortality. Past research suggests that emergency physicians vary significantly in the decisions they make for treating patients with common, low-mortality conditions such as chest pain without clear evidence of acute myocardial infarction, soft tissue infections, urinary tract infections, asthma, and COPD [40]. Meanwhile, there is little variation in treatment decisions for high-risk conditions such as confirmed acute myocardial infarction, sepsis, or kidney failure [41]. It is possible that by excluding patients too ill to participate, our study highlighted a population of patients subject to physician discretion while excluding a population with little variation in care. Non-English-speaking patients were also excluded from this study and comprised approximately 6% of those assessed for eligibility and 18% of those deemed ineligible. This may have skewed admission rates depending on the individual site's baseline population.

Conclusions

Overall, our study showed variations in ED admission rates among the different sites in this study. Some factors that appear to have contributed to this may have been patient severity, patient education level, recent exposure to chemotherapy, and the use of long-acting opiates. There were fewer 30-day ED revisits in the lower admission rate hospitals. Differences in readmission rates and mortality were no different between EDs with high and low admission rates. Further study into the practices, cultures, and supports that allow for lower admission rates in certain EDs is warranted. Broad implementation of those practices could lead to potential benefits such as substantial cost savings for the healthcare system and increased patient satisfaction.

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Authors' contributions
All authors conceived the study. JFR and JMC were responsible for data acquisition. JAS performed the statistical analysis working closely with JFR, JMC, and CWB. JFR, CWB, and JAS drafted the manuscript, and all authors contributed substantially to its revision. JFR, JMC, CWB, and JAS designed the statistical analysis. JFR takes responsibility for the paper as a whole.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from CONCERN on reasonable request. https://epi.grants.cancer.gov/concern/#con.

Declarations

Ethics approval and consent to participate
Each participating site's institutional review board approved all study procedures.

Consent for publication
N/A.

Competing interests
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