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Impact of Palliative Medicine Involvement on End-of-Life Services for Patients With Cancer With In-Hospital Deaths

Alison Wiesenthal, Debra A. Goldman, and Deborah Korenstein

Memorial Sloan Kettering Cancer Center; and Weill Cornell Medical College, New York, NY

Corresponding author: Alison Wiesenthal, MD, Memorial Sloan Kettering Cancer Center, 1275 York Ave, New York, NY 10065; e-mail: pallimedMD@gmail.com.

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QUESTION ASKED: Does early outpatient involvement of specialist palliative care (PC), as compared with no PC or PC consultation only during patients' final hospital admission, influence the services delivered immediately before death to patients with cancer who die in hospital?

SUMMARY ANSWER: Overall, patients dying in hospital received medications addressing comfort needs, and few received cancer-directed treatments. There was less use of diagnostic testing including venipuncture blood draws and x-ray studies, as well as less administration of anticoagulants and statins, in patients with subspecialty PC involvement, and this trend was even more pronounced with earlier PC involvement. The rates of most other services were similar across groups.

WHAT WE DID: Through retrospective review of the medical records of adult patients with solid tumor cancer who died in hospital between 2012 and 2014, we determined the services, including laboratory testing, imaging, blood products, medications, diet orders, do not resuscitate (DNR) orders, and specialty consultations, delivered within 3 days of death and assessed differences among services delivered to patients with outpatient PC, inpatient PC only (during that hospitalization), and no PC involvement. We also looked at the timing of DNR orders placed before the final admission.

WHAT WE FOUND: During patients' final admission, pain medications were prescribed for 99.9% of all patients, regardless of PC involvement. Only 11.2% of patients received radiation therapy, and 12.5% received tumor-directed therapy, with no differences on the basis of PC involvement ($P = .09$ to .17). In the last 3 days of life, imaging tests were performed in fewer patients with outpatient (43.5%) and inpatient-only (47.3%) PC than in those with no PC involvement (58.1%, $P = .048$). DNR orders were in place within the 6 months before final admission for a higher proportion of patients with outpatient PC (22%) than for those with inpatient-only PC (8%) or no PC involvement (12%; $P = .002$).

BIAS/COMPOUNDING FACTORS: Our study reflects care at a single cancer center and may not be generalizable to other centers, locations, or populations. This study was retrospective and cannot determine the clinical appropriateness of specific services. We did not control for the degree of PC involvement in either of the PC groups, which ranged from one visit to many visits; this may have led us to underestimate the impact of close involvement with PC.

REAL-LIFE IMPLICATIONS AND CONCLUSION: Most patients with cancer dying in hospital receive comfort-related medications; few receive cancer-directed therapies at the end of life. Involvement of specialist PC positively influences the receipt of some services that are unlikely to promote comfort. As patients transition to the end of life, clinicians should pause to consider whether active orders including diagnostic tests and specific medications promote patient goals and should seek to optimize symptom control without adding burden. JOP

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Abstract

Purpose

Palliative care (PC) has been shown to improve the quality of care and resource utilization for inpatients. We examined the relationship between PC consultation before and during final admission and patterns of care for dying patients at our tertiary cancer center.

Methods

We retrospectively reviewed adult patients with solid tumor cancer with a length of stay ≥ 3 days who died in hospital between December 2012 and November 2014. We recorded services, including laboratory testing, imaging, blood products, medications, diet orders, do not resuscitate orders, and consultations, delivered within 3 days of death. We assessed the differences among services delivered to patients with outpatient PC, inpatient PC only, and no PC involvement.

Results

Of 695 patients, 21% received outpatient PC, 46% received inpatient PC only, and 33% received no PC. During their final admission, 11.2% of patients received radiation therapy, and 12.5% received tumor-directed therapy, with no differences on the basis PC involvement (P = .09 to .17). In the last 3 days of life, imaging tests occurred in 50.1%; patients with outpatient or inpatient-only PC underwent fewer studies (43.5% and 47.3%) than did those with no PC involvement (58.1%; P = .048). Do not resuscitate orders were in place within the 6 months before final admission at a greater rate for patients with outpatient PC (22%) than for patients with inpatient-only PC (8%) or those with no PC involvement (12%; P = .002).

Conclusion

In this retrospective cohort of patients with solid tumor dying in hospital, few patients received cancer-directed therapies at the end of life. Involvement of PC was associated with a decrease in diagnostic testing and other services not clearly promoting comfort as patients approached death.

ASSOCIATED CONTENT

Appendix available online

INTRODUCTION

Palliative care (PC) involvement with the patient with cancer has been shown to improve the quality of life before death.[1-3] Evidence of the influence of PC involvement on the place of death or resource use at the end of life (EOL) is mixed. Between one fifth and one half of patients with cancer continue to die in hospital,[4-6] and some interventions including diagnostic testing and other services may not promote comfort at EOL.[7] Previous studies have described the services

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delivered to patients with cancer during the last month[8] or several months of life[9] or focus on specific services such as chemotherapy near death,[10,11] but none describe the use of more routine tests and treatments performed in hospitalized patients who are dying as a result of cancer. PC consultation during hospital admission has been shown to reduce EOL resource use in a general population, but the specific impact of outpatient PC consultation on the services delivered to dying inpatients with cancer is not clear.

We evaluated the services delivered to patients with solid tumors who died in our tertiary cancer center over a 2-year period. We focused on this population because their impending deaths were more likely to be anticipated by the medical staff. We examined the differences between services rendered to patients with outpatient PC consultation within the 6 months before their final admission, patients with PC consultation during their final admission only, and patients with no PC involvement. We hypothesized that involvement of PC before the final admission would be associated with lower use of these services compared with later (during final admission) PC involvement and no PC involvement.

METHODS

With institutional review board approval, we used our institutional database to identify adult patients (18 years and older) with a solid tumor who died during admission between December 1, 2012, and November 30, 2014, at our tertiary cancer center. We limited our analysis to patients with a length of stay of $\geq$ 3 days to eliminate patients with rapid decline, in whom death may have been unexpected. We queried cancer registry, phlebotomy, order entry, pharmacy, and radiology databases to collect patient-level demographics and the timing of delivered services, including laboratory testing, imaging, blood products, medications, consultation services, total parenteral nutrition and tube feeding orders, do not resuscitate (DNR) orders, and diet nil per os (NPO) orders, occurring between hospital admission and death. Data on chemotherapy within 14 days of death regardless of admission status were also collected. Children, patients who died in intensive care or a surgical unit, and patients with primary hematologic malignancies were excluded to create a more homogeneous sample.

Services Evaluated: Categorizations and Exclusions

Medications were categorized on the basis of the foundational database of Multum Medisource Lexicon. We excluded those classified as general anesthetics, miscellaneous agents, and radiologic agents, and medications missing a categorization. Opioids and other analgesic medications were classified as CNS agents. Drugs appearing multiple times with different doses were collapsed into a single use of the drug. A detailed breakdown of medication categorizations is given in Appendix Table A1 (online only). All interventional radiology procedures were excluded from radiologic studies because these were considered procedures and not pure radiographic scans. Multiple blood draws from a single patient taken within 15 minutes were considered to be part of the same draw and were collapsed into one record.

We grouped consultations into MD, Physical or Occupational Therapy, Swallowing, Integrative Medicine, Nutrition, and Chaplaincy or Social Work. For PC consultations, patients were classified into the following three categories: inpatient PC only, if they had no outpatient PC exposure but were consulted during their final admission; none, if they never met with a PC practitioner; and outpatient PC, if they had had at least one outpatient PC consultation within the 6 months before the final admission. Patients in the outpatient PC category may or may not have also received an inpatient PC consultation.

Statistical Analysis

We calculated the proportion of patients who had each service within 3 days before death, broken down by PC status. All patients had at least 3 days of admission, so the denominator was equal to the total sample size. We also calculated the proportion of patients who had chemotherapy within 14 days of death, regardless of admission status. We assessed differences in treatment rates using Fisher's exact test. All P values were adjusted for multiple comparisons using the false-discovery rate correction, and adjusted P values $<$ .05 were considered statistically significant.

For the last 14 days of admission, we determined the cumulative proportion of patients who had a DNR order on each day. The patients with a DNR order in place before 14 days were counted in the initial denominator. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Patient Characteristics

The patient sample included 695 patients with a median age of 64 years (range, 19 to 93 years). The sample was divided evenly

between male (n = 348 [50%]) and female (n = 347 [50%]) patients. The majority identified as white (n = 488 [70%]); 11.5% (n = 80) were black, and 7.6% (n = 53) were Asian. Patients were largely insured through Medicare (n = 321 [46.2%]) or through commercial or private insurance (n = 317 [45.6%]). Patients were admitted for a median length of stay of 9 days (range, 3 to 160 days; Table 1). Of the 695 patients, 147 (21%) received outpatient PC consultation within the 6 months before admission, 319 (46%) received inpatient PC consultation only, and 229 (33%) had no PC exposure. Among the patients receiving inpatient PC, consultations were ordered a median of 6 days before death (range, 0 to 97 days).

Patients who had outpatient PC were generally younger (median, 57 years; range, 23 to 87 years) compared with patients with inpatient PC only (median, 65 years; range, 20 to 93 years) and patients with no PC (median, 68 years; range, 19 to 90 years; $P < .001$). No differences in PC involvement were seen on the basis of ethnicity ($P = .54$) or sex ($P = .26$; Table 1).

Length of Stay

Patients with inpatient PC only had the longest length of stay (median, 12 days; range, 3 to 160 days) compared with patients with outpatient PC (median, 8 days; range, 3 to 89 days) or those with no PC (median, 7 days; range, 3 to 74 days; $P < .001$).

Laboratory Studies

Within 3 days before death, 541 patients (77.8%) had laboratories drawn; 334 (48.1%) had venipuncture (VP) and 413 (59.4%) had blood drawn without VP (eg, from an indwelling catheter). No differences on the basis of PC involvement were

Table 1. Patient Characteristics Within 3 Days Before Death on the Basis of Palliative Care Consult Status (N = 695)

	Palliative Care Consult				
Characteristic	Outpatient	Inpatient Only	None	All Patients	*P**
Age at death, years, median (range)	56.61 (23.12-87.30)	64.83 (19.86-93.07)	67.96 (19.45-89.99)	64.32 (19.45-93.07)	< .001
Sex					
Male	67 (45.6)	173 (54.2)	108 (47.2)	348 (50.1)	.261
Female	80 (54.4)	146 (45.8)	121 (52.8)	347 (49.9)	
Ethnicity					
White	96 (65.3)	222 (69.6)	170 (74.2)	488 (70.2)	
Hispanic	7 (4.8)	26 (8.2)	15 (6.6)	48 (6.9)	
Black	22 (15)	36 (11.3)	22 (9.6)	80 (11.5)	
Asian	13 (8.8)	25 (7.8)	15 (6.6)	53 (7.6)	
Native American	0 (0)	1 (0.3)	0 (0)	1 (0.1)	
Other or unknown	9 (6.1)	9 (2.8)	7 (3.1)	25 (3.6)	
Religion					
Other or unknown	7 (4.8)	10 (3.1)	12 (5.2)	29 (4.2)	
Jewish	30 (20.4)	52 (16.3)	38 (16.6)	120 (17.3)	
Muslim	4 (2.7)	6 (1.9)	2 (0.9)	12 (1.7)	
Catholic	36 (24.5)	138 (43.3)	90 (39.3)	264 (38)	
Non-Catholic Christian	34 (23.1)	68 (21.3)	47 (20.5)	149 (21.4)	
None	36 (24.5)	45 (14.1)	40 (17.5)	121 (17.4)	
Insurance type					
None or unknown	7 (4.8)	9 (2.8)	4 (1.7)	20 (2.9)	
Medicaid	16 (10.9)	13 (4.1)	8 (3.5)	37 (5.3)	
Medicare	41 (27.9)	153 (48)	127 (55.5)	321 (46.2)	
Commercial or private	83 (56.5)	144 (45.1)	90 (39.3)	317 (45.6)	
Length of stay, days, median (range)	8 (3-89)	12 (3-160)	7 (3-74)	9 (3-160)	< .001
DNR within 6 months before admission	33 (22.4)	26 (8.2)	27 (11.8)	86 (12.4)	.002

NOTE. Data are presented as frequencies with percentages of the total sample in parentheses, unless otherwise specified.
Abbreviations: DNR, do not resuscitate.
*All *P* values have been adjusted for multiple hypothesis testing.

seen in the proportion of patients who received blood draws overall ($P = .39$) or non-VP blood draws ($P > .95$). A lower proportion of patients with outpatient PC (42.2%) had VP blood draws compared with those with inpatient PC only (45.1%) or those with no PC (55.9%; $P = .050$; Table 2).

Blood Products: Packed RBCs or Platelet Transfusions

Within 3 days before death, 114 patients (16.4%) in the full cohort received blood products. Twenty-four patients with outpatient PC (16.3%), 58 patients with inpatient PC only (18.2%), and 32 patients without PC (14.0%) received blood products ($P = .55$; Table 2).

Imaging Tests

Within 3 days before death in the full cohort, 358 patients (50.1%) received imaging tests. X-rays and computed tomography scans were the most common studies; a few patients underwent positron emission tomography scanning (Table 2). Overall, a lower proportion of patients with outpatient PC (43.5%) received imaging tests compared with those with inpatient PC only (47.3%) or no PC (58.1%; $P = .048$). This difference was driven largely by a difference in receipt of x-ray studies ($P = .051$), with 38.1%, 41.1%, and 52.0% of patients with outpatient PC, inpatient PC only, and no PC receiving x-rays, respectively.

Diet Orders: NPO, TPN, and Tube Feedings

Within 3 days before death, 79 patients (11.4%) had NPO orders in place. No differences were seen in the proportion of NPO patients who had received outpatient PC (9.5%), inpatient PC only (10.3%), or no PC consultation (14%; $P = .49$). Six patients (0.9%) received total parenteral nutrition, and 22 patients (3.2%) received tube feedings. No differences were noted on the basis of PC consultation ($P = .28$ to $.85$).

Treatments and Medications

Within 3 days before death, 29 patients (4.2%) received radiation, and 30 patients (4.3%) received chemotherapy. There were no significant differences on the basis of PC involvement in the rates of radiation ($P = .10$) or chemotherapy ($P = .19$) within 3 days before death. Within 14 days before death, 113 patients (16.3%) received chemotherapy regardless of admission status. No differences were seen on the basis of PC involvement (Table 3).

All patients had medications administered within 3 days before death; the most common medications were CNS agents (694 of 695 [99.9%]), respiratory agents (675 of 695 [97.1%]), GI agents (675 of 695 [97.1%]), topical medications (517 of 695 [74.4%]), and anti-infectives (493 of 695 [70.9%]; Table 3). A lower proportion of patients with outpatient PC involvement

Table 2. Blood Draws, Blood Products, Scans, and Nutrition Within 3 Days Before Death on the Basis of Palliative Care Consult Status

	Palliative Care Consult				
Service Rendered	Outpatient	Inpatient Only	None	All Patients	*P**
Total blood draws	110 (74.8)	244 (76.5)	187 (81.7)	541 (77.8)	.385
VP	62 (42.2)	144 (45.1)	128 (55.9)	334 (48.1)	.052
Non-VP	87 (59.2)	190 (59.6)	136 (59.4)	413 (59.4)	> .950
Total blood products	24 (16.3)	58 (18.2)	32 (14.0)	114 (16.4)	.546
Total scans	64 (43.5)	151 (47.3)	133 (58.1)	348 (50.1)	.048
PET	0 (0.0)	1 (0.3)	1 (0.4)	2 (0.3)	> .950
CT	11 (7.5)	43 (13.5)	38 (16.6)	92 (13.2)	.102
MRI	2 (1.4)	9 (2.8)	10 (4.4)	21 (3.0)	.415
XR	56 (38.1)	131 (41.1)	119 (52.0)	306 (44.0)	.051
US	9 (6.1)	31 (9.7)	22 (9.6)	62 (8.9)	.546
Total parenteral nutrition	1 (0.7)	4 (1.3)	1 (0.4)	6 (0.9)	.851
Tube feedings	3 (2.0)	15 (4.7)	4 (1.7)	22 (3.2)	.287

NOTE. Data are presented as No. (%).

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; PET, positron emission tomography; US, ultrasound; VP, venipuncture; XR, x-ray imaging.

*All *P* values have been adjusted for multiple hypothesis testing.

Table 3. Treatment and Medication Use Within 3 Days Before Death on the Basis of Palliative Care Consult Status

Treatment and Medication Use	Palliative Care Consult			All Patients	P*
	Outpatient	Inpatient Only	None		
Treatment					
Radiation	12 (8.2)	11 (3.4)	6 (2.6)	29 (4.2)	.102
Chemotherapy	8 (5.4)	8 (2.5)	14 (6.1)	30 (4.3)	.188
Chemotherapy within 14 days†	24 (16.3)	47 (14.7)	42 (18.3)	113 (16.3)	.594
Medications					
Anti-infectives	99 (67.3)	232 (72.7)	162 (70.7)	493 (70.9)	.566
Cardiovascular agents	66 (44.9)	176 (55.2)	136 (59.4)	378 (54.4)	.077
CNS agents	147 (100.0)	318 (99.7)	229 (100.0)	694 (99.9)	> .950
Coagulation modifiers	61 (41.5)	149 (46.7)	137 (59.8)	347 (49.9)	.005
GI agents	140 (95.2)	310 (97.2)	225 (98.3)	675 (97.1)	.408
Genitourinary agents	8 (5.4)	22 (6.9)	15 (6.6)	45 (6.5)	> .950
Cortical steroid hormone agents	79 (53.7)	161 (50.5)	99 (43.2)	339 (48.8)	.233
Other hormonal agents	33 (22.4)	65 (20.4)	59 (25.8)	157 (22.6)	.488
Antihyperlipidemic agents	7 (4.8)	21 (6.6)	31 (13.5)	59 (8.5)	.024
Other metabolic agents	33 (22.4)	108 (33.9)	71 (31.0)	212 (30.5)	.109
Nutritional products	62 (42.2)	149 (46.7)	118 (51.5)	329 (47.3)	.385
Psychotherapeutic agents	82 (55.8)	180 (56.4)	91 (39.7)	353 (50.8)	.002
Respiratory agents	140 (95.2)	310 (97.2)	225 (98.3)	675 (97.1)	.408
Topical agents	113 (76.9)	245 (76.8)	159 (69.4)	517 (74.4)	.261

NOTE. Data are presented as No. (%).
*All *P* values have been adjusted for multiple hypothesis testing.
†Chemotherapy within 14 days of death regardless of admission status.

(41.5%) received coagulation modifiers compared with patients with inpatient PC only (46.7%) and those without PC (59.8%; $P = .005$). Similarly, a lower proportion of patients with outpatient PC (4.8%) received antihyperlipidemic agents compared with patients with inpatient PC only (6.6%) and those without PC (13.5%; $P = .024$). More patients with outpatient (55.8%) and inpatient (56.4%) PC consultations received psychotherapeutic agents compared with patients without PC involvement (39.7%; $P = .002$). No other significant differences on the basis of PC involvement were seen for other medication categories ($P = .08$ to $> .95$; Table 3).

Other Consultations

Within 3 days before death, 279 patients (40.1%) received consultations, of which the plurality was physician specialist consultations (47.3%). Patients with outpatient PC involvement had the lowest rate of MD consultations (11.6%) compared with those with inpatient PC only (19.7%) or no PC (22.7%); however, this difference was not significant ($P = .08$). A higher proportion of patients with inpatient PC only (16.9%) had chaplaincy or social work consultations compared with those with outpatient PC (10.9%) or no PC (5.2%; $P = .001$). No differences were seen among patients receiving outpatient, inpatient only, or no PC for physical or occupational therapy (10.2% *v* 11.6% *v* 18.3%, respectively; $P = .10$), swallowing (2.7% *v* 5.3% *v* 4.8%, respectively; $P = .55$), or integrative medicine (7.5% *v* 6.3% *v* 4.4%, respectively; $P = .55$) consultations.

Advanced Care Directives: DNR Orders

A greater proportion of patients with outpatient PC had a DNR order in place within the 6 months before admission (22%) compared with patients with inpatient PC only (8%) or those with no PC involvement (12%; = .002). During the final admission, the cumulative proportion of patients with DNR orders rose exponentially, from 27.1% of patients on day 14 before death to 92.1% by the day of death. Figure 1 illustrates the trend in DNR orders on the basis of PC consultation status.

DISCUSSION

In our retrospective cohort of patients with solid tumors dying in the hospital, prior involvement of PC specialists in the outpatient setting was associated with lower use, during the last 3 days of the final hospitalization, of services that may not have promoted the patients' comfort or other goals at this critical

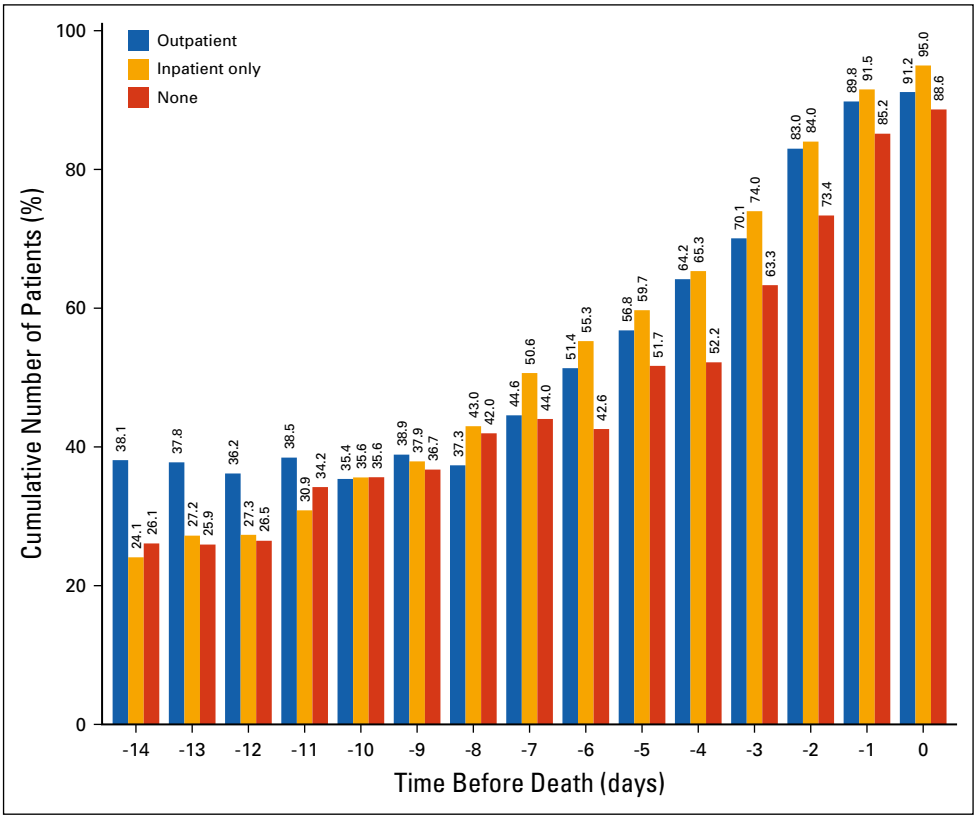

Fig 1. Cumulative proportion of patients with do not resuscitate (DNR) orders per day on the basis of palliative medicine consultation status. This figure represents the cumulative percentage of patients with a DNR order in place by a given day relative to their own death. Each percentage includes those from the previous days plus those who had a DNR order placed on that day. All percentages include those who had a DNR order in place before 14 days of death. This figure demonstrates that patients with outpatient palliative consultations started with a higher proportion of DNR orders, followed by patients with inpatient-only palliative consultation. In addition], this figure demonstrates the exponential trend of increased DNR orders as death approaches.

time. Such services included diagnostic testing by VP blood draw and x-ray studies, which often require transport of patients around the hospital, as well as administration of anticoagulants and statins.[12] Patients who received outpatient PC or inpatient PC only were more likely to receive psychotherapeutic agents, including antidepressants, which may have improved the patient experience at EOL,[13] and inpatient PC consultation strengthened the interdisciplinary support for patients through increased involvement of social work and chaplaincy, which also enhances quality of life.[14-17] These associations were observed in a cohort of patients of a median younger age; EOL care is often more intensive in younger patients.[18]

Regardless of specialist PC involvement, nearly all patients in this cohort received analgesic medications at EOL, suggesting that primary and subspecialty PC addressed the key concern expressed by dying patients for relief of their pain.[19,20] Chemotherapy administration was rare among all groups, reflecting recognition of the limited benefit of continued antineoplastic treatment of patients with solid tumors who are approaching death.[10,21] Diagnostic testing was more common, with the majority of patients undergoing blood draws and imaging tests during the last 3 days of life. Whether the potential benefits of such testing outweighed the potential discomforts or other harms to patients cannot be determined from this analysis. We also cannot determine the net benefit or harm of coagulation modifiers, administered to almost one half of all patients in the last 3 days of life, often by subcutaneous injection, anti-infectives, nutritional agents (eg, vitamins), and blood products. In some situations, such services may have promoted comfort and been consistent with patient goals. In others, continuing re-evaluation of potential harms, including patient distress, and clarification of goals of care may support a decision to discontinue services not clearly promoting the patient's comfort, especially when those services use scarce resources.[23-25]

There are several possible explanations for a greater impact of earlier, outpatient PC consultation, compared with later, in-hospital PC consultation, on the delivery of certain services. First, PC consultation often entails addressing patient and family coping with, understanding of, and education about the illness.[26,27] These communication interventions may enhance patients' and families' prognostic awareness.[28,29] Recognition of life-limiting illness earlier in the disease course, and in the outpatient setting, may help patients and their families share in proactive medical decision making that prioritizes comfort at EOL.[30-32]

In the group of patients receiving inpatient PC consultations only, these consultations were requested a median of 6 days before death for patients with a median hospitalization of 12 days. Late referral of patients with longer and likely complicated admissions may have limited the impact of inpatient PC.

Our study has several limitations. First, the study was retrospective and we cannot distinguish the net benefit or harm to the patient of specific services. We also cannot identify the point at which the patient was considered by his or her clinician to be actively dying. However, prognostication in patients with solid tumors has been well described.[33,34] Second, given the nature of our study, we were unable to capture nuanced patient information such as the level of consciousness or cancer stage at the time of admission; some of these factors may have differed among PC groups and may have influenced care. In addition, we did not control for the degree of PC involvement in either of the PC groups, which ranged from one visit to many visits. It is possible that some patients were newer to our system than others and had less opportunity to receive outpatient PC during the 6 months leading to the index admission. These factors may have led us to underestimate the impact of close involvement with PC. Our study reflects care at a single cancer center and the findings may not be generalizable to other centers, locations, or populations. Finally, we do not know why these particular patients had in-hospital deaths or whether hospice was involved in their care before admission. Given that rates of in-hospital cancer deaths remain substantial,[4-6] our findings are relevant to a large population of patients.

In this retrospective cohort of patients with solid tumors dying in hospital, most patients received medications addressing comfort needs and did not receive cancer-directed treatments as they approached death. Involvement of PC was associated with a decrease in diagnostic testing and other services that were not clearly promoting patient comfort. Future studies should prospectively address the impact of current practice, including the involvement of PC specialists in outpatient and inpatient settings, on patient quality of life and other outcomes as patients approach death. JOP

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Authors' Disclosures of Potential Conflicts of Interest

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Author Contributions

Conception and design: All authors
Collection and assembly of data: Alison Wiesenthal, Debra A. Goldman
Data analysis and interpretation: All authors
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

Corresponding author: Alison Wiesenthal, MD, Memorial Sloan Kettering Cancer Center, 1275 York Ave, New York, NY 10065; e-mail: pallimedMD@gmail.com.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Impact of Palliative Medicine Involvement on End-of-Life Services for Patients With Cancer With In-Hospital Deaths

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Alison Wiesenthal
No relationship to disclose

Debra A. Goldman
No relationship to disclose

Deborah Korenstein
Honoraria: Vedanta Biosciences (I)

Appendix

Table A1. Drug Categorizations

Drug Category	Includes
Anti-infectives	Aminoglycosides
	Anthelmintics
	Antifungals
	Antimalarial agents
	Antituberculosis agents
	Antiviral agents
	Carbapenems
	Cephalosporins
	Glycopeptide antibiotics
	Leprostatics
	Lincomycin derivatives
	Macrolide derivatives
	Miscellaneous antibiotics
	Penicillins
	Quinolones
	Sulfonamides
	Tetracyclines
	Urinary anti-infectives
Chemotherapy	BCR-ABL tyrosine kinase inhibitors
	EGFR inhibitors
	HER2 inhibitors
	VEGF and VEGFR inhibitors
	Alkylating agents
	Antimetabolites
	Antineoplastic antibiotics
	Antineoplastic detoxifying agents
	mTOR inhibitors
	Miscellaneous antineoplastics
	Mitotic inhibitors
	Multikinase inhibitors
Cardiovascular agents	Agents for pulmonary hypertension
	Aldosterone receptor antagonists
	Angiotensin II inhibitors
	Angiotensin-converting enzyme inhibitors
	Anti-adrenergic agents, centrally acting
	Anti-adrenergic agents, peripherally acting
	Anti-anginal agents
	Anti-arrhythmic agents
	Anticholinergic chronotropic agents
	Antihypertensive combinations
	β-adrenergic blocking agents
	Calcium channel blocking agents
	Catecholamines
	Diuretics
	Inotropic agents
	Miscellaneous cardiovascular agents
	Vasodilators
	Vasopressin antagonists
CNS agents	CNS stimulants
	Analgesics
	Anticonvulsants
	Anti-emetic and antivertigo agents
	Antiparkinson agents
	Anxiolytics, sedatives, and hypnotics
	Cholinergic agonists
	Miscellaneous CNS agents
	Muscle relaxants

(continued in next column)

(continued on following page)

Table A1. Drug Categorizations (continued)

Drug Category	Includes
Coagulation modifiers	Anticoagulants
	Antiplatelet agents
	Heparin antagonists
	Miscellaneous coagulation modifiers
	Platelet-stimulating agents
	Thrombolytics
GI agents	5-aminosalicylates
	GI stimulants
	H2 antagonists
	Antacids
	Antidiarrheals
	Digestive enzymes
	Functional bowel disorder agents
	Gallstone solubilizing agents
	Laxatives
	Miscellaneous GI agents
	Proton pump inhibitors
Genitourinary agents	Miscellaneous genitourinary tract agents
	Urinary antispasmodics
	Urinary pH modifiers
Cortical steroid hormone agents	Adrenal cortical steroids
Other hormonal agents	5-α-reductase inhibitors
	Anti-androgens
	Antidiuretic hormones
	Aromatase inhibitors
	Calcitonin
	Gonadotropin-releasing hormone antagonists
	Selective estrogen receptor modulators
	Sex hormones
	Somatostatin and somatostatin analogs
	Thyroid hormones

(continued in next column)

Table A1. Drug Categorizations (continued)

Drug Category	Includes
Antihyperlipidemic agents	Antihyperlipidemic agents
Other metabolic agents	Antidiabetic agents
	Antigout agents
	Antihyperuricemic agents
	Bone resorption inhibitors
	Glucose elevating agents
Nutritional products	Iron products
	Minerals and electrolytes
	Vitamin and mineral combinations
	Vitamins
Psychotherapeutic agents	Antidepressants
	Antipsychotics
Respiratory agents	Antihistamines
	Antitussives
	Bronchodilators
	Decongestants
	Expectorants
	Leukotriene modifiers
	Miscellaneous respiratory agents
	Respiratory inhalant products
	Upper respiratory combinations
Topical agents	Anorectal preparations
	Antiseptics and germicides
	Dermatologic agents
	Mouth and throat products
	Nasal preparations
	Ophthalmic preparations
	Vaginal preparations

Abbreviations: BCR-ABL, breakpoint cluster region protein-Abelson murine leukemia viral oncogene homolog; EGFR, epidermal growth factor receptor; HER2, human epidermal growth factor receptor 2; mTOR, mammalian target of rapamycin; VEGF, vascular endothelial growth factor; VEGFR, vascular endothelial growth factor receptor.