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RESEARCH ARTICLE

Cost Savings from Palliative Care Teams and Guidance for a Financially Viable Palliative Care Program

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Objectives. To quantify the cost savings of palliative care (PC) and identify differences in savings according to team structure, patient diagnosis, and timing of consult.

Data Sources. Hospital administrative records on all inpatient stays at five hospital campuses from January 2009 through June 2012.

Study Design. The analysis matched PC patients to non-PC patients (separately by discharge status) using propensity score methods. Weighted generalized linear model regressions of hospital costs were estimated for the matched groups.

Data Collection. Data were restricted to patients at least 18 years old with inpatient stays of between 7 and 30 days. Variables available included patient demographics, primary and secondary diagnoses, hospital costs incurred for the inpatient stay, and when/if the patient had a PC consult.

Principal Findings. We found overall cost savings from PC of $3,426 per patient for those dying in the hospital. No significant cost savings were found for patients discharged alive; however, significant cost savings for patients discharged alive could be achieved for certain diagnoses, PC team structures, or if consults occurred within 10 days of admission.

Conclusions. Appropriately selected and timed PC consults with physician and RN involvement can help ensure a financially viable PC program via cost savings to the hospital.

Key Words. Palliative care, hospital cost savings

Palliative care (PC) is a relatively new and rapidly growing health care specialty filling important gaps in treatment and care faced by seriously ill patients and their families. PC aims to relieve suffering (physical, emotional, social, and/or spiritual) and improve quality of life (QOL) for seriously ill patients and also support the families of such patients. PC is sometimes inaccurately confused with hospice, but unlike hospice, PC is not limited to the last

6 months of life, PC patients need not be considered terminally ill, and patients may continue disease-modifying treatments while receiving care from a PC team (Center to Advance Palliative Care [CAPC] 2013; Centers for Medicaid and Medicare Services [CMS] 2013; National Concensus Project [NCP] 2013; National Hospice and Palliative Care Organization [NHPCO] 2013; World Health Organization [WHO] 2013).

The prevalence of PC teams in American hospitals has increased from 24.5 percent in 2000 to 65.7 percent in 2010, although this prevalence varies significantly by hospital size with 56.5 percent of medium-sized hospitals (50 to 299 beds) and 87.9 percent of large hospitals (300+ beds) having a PC program in 2010 (Center to Advance Palliative Care [CAPC] 2011). This growth can be attributed in part to the growing awareness of the clinical and QOL improvements offered by a PC program.

Among general patient populations, interdisciplinary PC teams have proven effective in addressing patients' physical, emotional, social, and spiritual needs (Casarett et al. 2008; Lorenz et al. 2008). In a multicenter randomized controlled trial, hospital patients receiving PC consultation reported greater satisfaction with their care experience and providers' communication, more advance directives completion, fewer ICU admissions on readmission, and lower total health care costs in the 6 months following hospital discharge (Gade et al. 2008). PC has also proven effective in meeting the needs of bereaved family members whose loved ones died in the acute care hospital (Gelfman, Meier, and Morrison 2008).

Perhaps most interestingly, early PC consultation has been associated not only with many of the qualitative benefits noted above for inpatient PC consultation but also with a significant survival advantage. Temel et al. (2010) performed a study in which 151 ambulatory patients with newly diagnosed metastatic non–small-cell lung cancer were randomized to receive either standard oncologic care or an integrated care plan that included both standard oncologic care and early PC. Although no significant differences were noted between the two groups at baseline, patients receiving standard oncologic intervention integrated with PC reported a higher QOL, less depression,

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fewer aggressive end-of-life care interventions, and had a significant survival advantage compared with those receiving standard oncologic care alone.

These now well-established benefits of PC for patients and families are the result of more "high-touch" than "high-tech" interventions, yet such time and personnel-intense interventions are historically poorly compensated. Thus, hospital administrators focused on quality and seeking to enhance care for the most seriously ill patients have been challenged by the PC financial model. Focusing specifically on the financial impact of PC, Morrison et al. (2008) conducted a study across eight hospitals in six states to assess its potential cost savings in a hospital setting. PC patients discharged alive had net savings of $1,696 in direct costs per admission and $279 per day, and those who died in the hospital had adjusted net savings of $4,908 in direct costs per admission and $374 per day. In a similar analysis, Penrod et al. (2010) estimated slightly higher average savings of $464 per day. Focusing specifically on the Medicaid population in a single state (NY), Morrison et al. (2011) attributed an average savings of $4,098 in hospital costs per PC consult for patients discharged alive and a savings of $7,563 for patients who died in the hospital.

Our analysis extends the current literature on the financial implications of in-hospital PC. Using claims data on all inpatient stays across five hospitals in the Dallas/Ft-Worth region, we estimate the average cost savings associated with in-hospital PC consults, with costs measured as the direct costs of care incurred by the hospital for a given inpatient stay. A PC consult is defined as a documented visit by a member of the PC team, data for which are collected and maintained electronically as part of a system-wide dataset. We estimate the overall average cost savings associated with a PC consult as well as the average cost savings for each hospital, the average cost savings based on primary diagnosis, and the average cost savings based on the timing of the consult (i.e., within 3 days of admission, from 3 to 5 days from admission, etc.). In all analyses, we consider separately patients who died in the hospital versus those who were discharged alive.

Our analysis contributes to the existing literature in two important ways. First and most simply, our study was conducted in a different health care market and involved different hospitals compared with those in the Morrison studies when it comes to end-of-life care. One important area of distinction is in the level of hospice utilization among the hospitals being analyzed. Qualitatively, hospice care and PC overlap in terms of the type of care that is provided, although unlike hospice, PC is not limited only to end-of-life care. Due to this overlap with regard to end-of-life care, hospice utilization may impact the cost savings from in-hospital PC, where hospitals with high utilization of hospice care may benefit less from an in-hospital PC team as those hospitals may already have an established process for end-of-life treatment.

Data from the *Dartmouth Atlas of Health Care* for the years 2003–2007 indicate that Texas had significantly higher hospice utilization (both enrollment percentage and hospice days) than the areas included in the Morrison studies. This was despite the fact that Texas has lagged behind other parts of the country in developing hospital-based PC programs, as indicated in Table 1.

Similarly, hospitals in our current study already had high hospice utilization before the advent of our hospital-based PC teams. Over the years from 2003 to 2007, *Dartmouth Atlas of Health Care* data reveal that hospice enrollment among this study's hospitals was 32.8 percent higher than the national average and hospice days were 33.1 percent higher than the national average. In that same timeframe, percent hospice enrollment for the four academic centers in Morrison et al. (2008) were 12.5 percent lower than the national aver-

Table 1: Hospice Enrollment Statistics, 2003–2007

Facility	*% Hospice Enrollment*	*Hospice Days*	*Hospice Impact Factor**	*Medicare Spending†*
U.S. average	36.9	13.9	513	$14,275
New York average	23.8	8.8	209.4	$20,838
Texas average	44.4	19.6	870.2	$13,601
Morrison et al. academic hospitals				
UCSF	28.7	10.2	293	
U Minnesota, Fairview	39.1	14.1	551	
Mt. Sinai	17.3	6.4	92	
Froedtert	43.9	15.7	689	
Average	32.3	11.6	375	
Current academic hospital (D)	49	18.5	907	
Morrison et al. community hospitals				
Central Baptist	49.5	21.7	1,074	
Mount Carmel	41.3	18.3	756	
Mount Carmel St. Ann's	44	19	836	
Average	44.9	19.7	885	
Current community hospitals‡				
Hospital B	55.6	22.8	1,268	
Hospital C	54	20.1	1,085	
Hospital E	61	18.8	1,146	
Average	56.9	20.6	1,172	

*Calculated as % hospice enrollment percentage times hospice days.
†Calculated as average Medicare spending per beneficiary over the last 6 months of life.
‡Data on hospital A not available during full 2003–2007 time period.
Source: *Dartmouth Atlas of Health Care* and Morrison et al. (2008, 2011).

age and hospice days were 16.5 percent lower. Put another way, the hospice impact factor (% hospice enrollment × hospice days) for the academic hospital in our current study (Hospital E) was 76.8 percent higher than the national average for all hospitals and 141 percent higher than the average for the four academic hospitals in Morrison et al. (2008). The current study's community hospitals also had relatively higher hospice enrollment and hospice days than the community hospitals in Morrison et al. (2008). The Morrison et al. (2008) study also involved relatively large hospitals, with all but one of the hospitals having more than 300 beds, while the 2011 study focused only on Medicaid patients at four urban hospitals in New York. Due to differences in hospital size, patient populations, and utilization of hospice, these widely cited studies may not generalize to other hospital systems in other areas. In a different health care market, with a range of hospital bed sizes and relatively high hospice utilization even before the development of hospital-based PC teams, do hospital-based PC teams still have the potential for significant cost savings?

Second, we estimate different average treatment effects as a function of the timing of PC consult, the patient's diagnosis, and hospital. Conversely, the Morrison et al. (2008) and Penrod et al. (2010) papers focus on the overall average cost savings from a PC consult, implicitly assuming homogeneous average treatment effects among the patient cohort of interest.

Potential differences in average treatment effects across observable characteristics (e.g., across different patient diagnoses, structure of the PC team, or the timing of the PC consult) are important, given the growth of PC programs over time and the fact that no clear rule-of-thumb currently exists detailing which (or when) patients should receive a PC consult. Although there are general guidelines regarding who may receive PC consults, these guidelines leave room for interpretation and allow for variation in how PC teams are deployed across facilities (Weissman and Meier 2011). As such, there remains a knowledge gap in the literature regarding how best to implement a PC program. Our results therefore offer important guidance as to how to maximize the financial benefits of a PC program, potentially improving the financial viability of PC teams in practice.

METHODS

We obtained data from all inpatient stays at five hospital campuses with in-hospital PC programs in the same hospital system from January 2009 through June 2012. All hospitals were located in the Dallas Fort-Worth region. Table 2

Table 2: Hospital Size and Palliative Care Team Structure

	Hospital									
	A		*B*		*C*		*D*		*E*	
Hospital type	Community		Community		Community		Academic		Community	
Staffed beds	234		222		240		769		342	
PC team	2009	2012	2009	2012	2009	2012	2009	2012	2009	2012
Physicians	0.1	1.0	0	0	0.15	0.15	0.5	1.8	0	0
Nurse practitioners	0	0	1.0	1.0	.5	1.0	0	1.0	1.0	1.0
Registered nurses	1.0	1.0	0	0	0	0	2.0	1.4	0	0
Social workers	0.25	0.25	0	0	.5	.25	0.2	0.2	.5	1.0
Chaplains	0.2	0.2	0.25	0.25	0.10	0.1	0.5	1.0	0.5	0.5

Source: Hospital administrative records.

summarizes the structure of the PC program at each facility as of the beginning and end of the study period. We also note that our primary empirical analysis includes year and facility-fixed effects, which will generally control for differences in the structure of the PC teams at different facilities and system-wide changes over time.[1]

Following Morrison et al. (2008, 2011), the patient sample included all patients aged 18 years or older with a length of stay between 7 and 30 days. A PC consult is defined as a formal in-hospital consultation by a member of the PC team at a given facility, and data on these PC consults were collected from a structured, system-wide database in which clinicians contemporaneously enter the details of each PC consult. These details include the name of the patient, name of the facility, primary diagnosis, the date of the consult, information regarding the patient's Advance Directives, and other patient identifying information from billing data. Importantly, an in-hospital PC consult is fundamentally different from hospice care in our data, the latter of which is only pursued after the patient is discharged from the hospital.

We merged to these PC data a comprehensive administrative dataset containing detailed information for each inpatient stay, including demographic information, payer type, facility, admit and discharge dates, diagnosis codes, and hospital costs. We categorize a patient's primary diagnosis according to the Clinical Classification Software (CCS) codes from the Agency for Healthcare Research and Quality (AHRQ), which groups ICD-9 diagnosis codes into a smaller set of mutually exclusive diagnostic categories. We take as our measure of costs the direct costs of care incurred by the hospital for the inpatient stay, excluding overhead as well as any fees billed by non-hospital employees. Inpatient stays with costs less than $1,000 were identified as outliers and excluded from the analysis.

The analysis first matched PC patients to non-PC patients based on observable characteristics present on admission, including primary CCS diagnosis, Charlson comorbidity index (CCI), payer type, race, gender, age, and hospital. Patients in the PC group were matched to non-PC patients (with replacement) using a propensity score matching algorithm within a radius of 0.20 standard deviations of the logit of propensity score (Austin 2011; Imbens and Wooldridge 2009; Rubin 2001; Rubin and Thomas 1996; Weissman and Meier 2011). Matching was performed separately by discharge status (discharged alive vs. died in hospital), with propensity scores estimated using logistic regression. Unmatched patients (either in the PC or non-PC group) were excluded from the analysis.

For each matched patient cohort, we estimated a series of weighted generalized linear model (GLM) regressions specifying direct cost as a function of age, payer type, diagnosis, race, gender, CCI, hospital, and an indicator for whether or not the patient received a PC consult. Observations were weighted using inverse probability weighting based on each subject's estimated propensity score (Imbens and Wooldridge 2009). All models specified a gamma distribution with log link function (Manning and Mullahy 2001). The use of propensity score matching to limit the sample is a common technique that helps to improve balance in the covariate distribution across treatment and control groups without biasing the estimate of the treatment effect (Rubin 2001; Rubin and Thomas 1996).

We first estimated GLM regressions similar to those of Morrison et al. (2008, 2011). We then extended those models by including in the regression specification several interaction terms of treatment status with hospital, diagnosis, and time of consult (measured as the day during the inpatient stay in which the consult took place). These interaction terms allow for differences in average treatment effects, identifying when a PC consult should take place to achieve cost savings and for whom savings associated with PC is the largest.

RESULTS

With the exclusion restrictions discussed above, we identified a total of 38,465 consecutive inpatient stays, consisting of 2,392 PC patients (1,819 discharged alive and 573 who died in the hospital) and 36,058 non-PC patients (34,810 discharged alive and 1,248 who died in the hospital). Among patients discharged alive, 1,816 PC patients were matched to 33,574 non-PC patients, and among those who died in the hospital, 572 PC patients were matched to 1,246 non-PC patients. The matching process therefore discarded 3 PC patients discharged alive and 1,236 non-PC patients discharged alive, and matching discarded 1 PC patient who died in the hospital and 2 non-PC patients who died in the hospital.

Summary Statistics

Summary statistics for patients discharged alive and those who died in the hospital are presented in Table 3. Overall summary statistics for the entire sample are presented alongside weighted summary statistics for the matched sample. Also included is the normalized difference in means (or proportions) between the matched PC and non-PC groups. Current guidelines suggest 0.25 as a threshold normalized difference value, with differences above 0.25 reflecting large differences across the two groups (Imbens and Wooldridge 2009). With normalized difference values consistently below 0.10, the matched data columns reflect a well-balanced dataset across the treatment and control groups.

Overall GLM Regression Results

Our initial GLM regressions focused on the overall effect of PC, introduced in the regression model as an indicator variable set to 1 if the patient received a PC consult and 0 otherwise. Overall regression results for patients discharged alive and for those who died in the hospital are summarized in Table S1. Also included in the regression model but excluded from the table for brevity were hospital, diagnosis, payer, year, and CCI-fixed effects.

Primary interest lies in the “PC Consult” coefficient, with significant negative coefficients representing a cost savings from PC. The results indicate that, among patients discharged alive, no significant cost savings on average are associated with PC consults. Meanwhile, among patients who died in the hospital, the results reveal a significant cost savings from PC.

We estimated the dollar-value effect of PC using the method of recycled predictions (Basu and Rathouz 2005; Basu 2005), which reflects the average marginal effect of PC across all observations. Among those who died in the hospital, adjusted inpatient costs without a PC consult were estimated to be $33,075 compared to adjusted costs of $29,649 for patients with a PC consult. PC consults were therefore associated with a savings of $3,426 per inpatient stay for patients who died in the hospital.

Treatment Effects by Timing of Consult, Diagnosis, and Hospital

In addition to the overall average cost savings from PC estimated above, the analysis estimated different average treatment effects as a function of (1) the timing of the PC consult; (2) the patient’s diagnosis; and (3) the admitting hospital. We quantified these effects with the inclusion of a series of dummy variables or interaction terms between the PC indicator and the various categories of interest, in addition to the original indicator variable set to 1 if the patient had a PC consult and 0 otherwise. For example, to assess differences in savings based on the timing of the consult, we included in the GLM regression five indicator variables for whether the consult took place between 3 and 4 days, 5 and 6 days, 7 and 9 days, 10 and 14 days, or 15 days or more, all of which

Table 3: Summary Statistics for Patients Discharged Alive and for Patients Dying in Hospital

	Patients Discharged Alive					*Patients Dying in Hospital*				
	Unmatched Data		*Matched Data*			*Unmatched Data*		*Matched Data*		
	With PC	*No PC*	*With PC*	*No PC*	*Normalized Difference*	*With PC*	*No PC*	*With PC*	*No PC*	*Normalized Difference*
N	1,819	34,810	1,816	33,574		573	1,248	572	1,246	
Direct cost	$18,853	$20,545	$20,700	$20,402	n/a	$28,461	$34,030	$29,444	$33,209	n/a
	(12,145)	(20,420)	(13,836)	(20,099)		(19,708)	(32,104)	(21,089)	(31,765)	
Length of stay	13.78	12.53	14.53	12.50	n/a	14.16	13.42	15.34	14.30	n/a
	(5.55)	(5.03)	(6.04)	(5.00)		(5.83)	(5.73)	(5.67)	(5.65)	
Age	68.80	61.34	62.70	62.36	0.020	65.41	65.75	65.25	65.42	−0.011
	(15.34)	(16.85)	(16.34)	(16.63)		(15.87)	(15.23)	(15.65)	(15.51)	
CCI	6.22	3.78	4.31	4.02	0.106	5.09	4.43	4.64	4.66	−0.009
	(3.19)	(2.75)	(2.71)	(2.83)		(2.91)	(2.73)	(2.67)	(2.91)	
Male, %	43.7	48.6	47.6	47.8	−0.003	48.0	54.6	54.1	52.4	0.034
White, %	64.5	62.6	61.4	62.7	−0.027	59.7	67.1	63.5	64.2	−0.014
Payer type, %										
Medicaid	8.1	7.8	6.4	8.0	−0.061	9.2	6.8	8.0	7.6	0.014
Medicare	70.2	56.6	63.0	58.6	0.091	62.1	60.6	59.8	61.0	−0.026
Managed care	18.2	27.9	24.8	26.6	−0.041	23.4	27.4	26.7	26.0	0.015
Self-pay	3.5	7.8	5.7	6.8	−0.045	5.2	5.2	5.6	5.3	0.011
Primary diagnosis, %										
Circulatory	0.9	1.4	1.4	1.3	0.012	1.1	0.8	0.6	0.7	−0.017
Cancer	19.2	10.8	12.6	11.7	0.029	16.9	12.6	13.6	14.3	−0.020
Cardiovascular	14.6	20.4	19.0	20.4	−0.036	13.8	20.0	18.0	17.9	0.004
Endocrine	2.5	4.0	3.9	3.9	0.003	0.5	1.6	2.3	1.3	0.078
GI	7.9	12.3	13.3	11.9	0.045	8.2	9.4	9.7	9.1	0.019

continued

Table 3. *Continued*

	Patients Discharged Alive					*Patients Dying in Hospital*				
	Unmatched Data		*Matched Data*			*Unmatched Data*		*Matched Data*		
	With PC	*No PC*	*With PC*	*No PC*	*Normalized Difference*	*With PC*	*No PC*	*With PC*	*No PC*	*Normalized Difference*
Genitourinary	5.6	3.9	3.4	4.1	−0.035	1.8	2.5	2.4	2.2	0.014
Infection	19.8	11.6	12.5	12.4	0.001	27.4	24.6	24.9	25.3	−0.010
Injury or poison	7.3	15.1	13.4	13.7	−0.007	10.8	10.7	10.4	10.7	−0.007
Musculoskeletal	2.3	3.2	2.6	3.2	−0.039	0.5	0.6	0.4	0.6	−0.024
Nervous system	3.0	2.2	2.1	2.3	−0.016	2.3	2.6	2.5	2.4	0.001
Pulmonary	14.2	9.5	10.3	10.1	0.007	13.8	12.2	12.1	12.6	−0.017
Other	2.8	5.6	5.5	5.2	0.014	3.0	2.5	3.2	2.9	0.016
Hospital, %										
A	13.0	12.2	7.9	12.6	−0.157	11.2	9.1	8.7	9.6	−0.032
B	13.3	9.5	8.7	10.0	−0.042	14.1	4.7	7.5	7.9	−0.013
C	16.1	9.4	8.7	10.0	−0.046	16.9	8.0	10.5	10.6	−0.003
D	29.1	54.2	56.9	51.4	0.112	44.9	69.2	62.4	61.5	0.018
E	28.5	14.8	17.8	16.1	0.047	12.9	9.1	11.0	10.5	0.015

Note. Standard deviations presented in parentheses. Summary statistics for the "matched data" are weighted by the inverse propensity score. Normalized difference denotes the difference in means of each relevant variable in the "matched data," divided by the square root of the sum of the variances (Imbens and Wooldridge 2009). A normalized difference of "n/a" denotes the variable was not used as part of the matching criteria because the variable itself is a potential outcome.
Source: Authors' analysis of study data.

were set to 0 if the patient had no consult. Similarly, to assess differences by diagnosis or hospital, we included interaction terms between diagnosis or hospital indicators and the PC indicator.

Each category of interest (timing of consult, diagnosis, and hospital) was investigated separately with its own GLM regression. Results from these six additional regressions (three regressions for each of two patient cohorts) are summarized in Tables S2–S4. The regression results reveal significant differences in the cost savings of PC depending on the timing of the consult, the patient's diagnosis, and the admitting hospital; however, interpreting the coefficients in terms of the estimated effect on dollars saved is more complicated due to the nonlinear nature of the GLM and the interaction terms included in each model. Statistical inference is also more complicated as the interaction terms are inherently correlated with the fixed effects in each model.

To account for these difficulties, we used bootstrapping to estimate the dollar-value effects in each model and the respective 95 percent confidence intervals (Cameron and Trivedi 2005). At each bootstrap iteration, we estimated the GLM regression of interest and calculated the dollar-value effect via the method of recycled predictions (Basu 2005; Basu and Rathouz 2005). We replicated this process 2,000 times, ultimately forming an empirical distribution of dollar-value effects. We then formed the 95 percent confidence intervals by taking the 2.5 and 97.5 percentiles from each empirical distribution. The results of this process are summarized in Table 4.

The top section of Table 4 presents the results for patients discharged alive, and the bottom section presents analogous results for patients who died in the hospital. Among both patient cohorts, the results reveal important differences in the savings of PC across diagnoses, hospitals, and time of consult. In particular, PC consults were associated with significant cost savings for patients with a primary diagnosis of cancer, with an average savings of $3,647 for patients discharged alive and an average savings of $7,126 for patients who died in the hospital. Similarly, PC consults initiated within the first 10 days of the inpatient stay exhibited significant savings in both patient cohorts, with a weighted average savings of $2,696 among patients discharged alive and $9,689 among patients who died in the hospital.

Discussion

Consistent with the existing literature, the results illustrate significant cost savings from PC for patients who died in the hospital; however, contrary to the

Table 4: Estimated Dollar-Value Effects of Palliative Care for Patients Discharged Alive and for Patients Dying in Hospital

	Sample Size		*Adjusted Costs*		*Estimated Savings (Loss) from PC*		
	No PC	*With PC*	*No PC*	*With PC*	*Average*	*Lower 95%*	*Upper 95%*
For patients discharged alive							
Overall effect	33,574	1,816	$20,231	$21,311	($1,081)	($1,969)	$185
Effects by hospital							
Hospital A	4,234	237	$24,463	$21,284	$3,179	$1,038	$5,497
Hospital B	3,288	241	$15,477	$19,791	($4,314)	($6,312)	($2,306)
Hospital C	3,261	293	$15,220	$19,637	($4,417)	($6,082)	($2,677)
Hospital D	17,647	529	$21,114	$21,153	($38)	($1,477)	$1,961
Hospital E	5,144	516	$20,355	$22,425	($2,070)	($3,813)	($322)
Effects by primary diagnosis							
Cancer	3,769	348	$24,379	$20,733	$3,647	$1,452	$5,766
Infection	4,083	359	$19,762	$24,087	($4,325)	($6,411)	($2,165)
Cardiovascular	6,960	265	$24,945	$23,470	$1,475	($1,197)	$4,451
Pulmonary	3,296	258	$17,676	$19,992	($2,316)	($4,485)	($214)
Effects by timing of consult							
Days 1–2	33,574	343	$20,171	$18,008	$2,163	($83)	$5,004
Days 3–4	33,574	316	$20,171	$17,469	$2,702	$459	$4,921
Days 5–6	33,574	291	$20,171	$16,716	$3,455	$1,922	$4,978
Days 7–9	33,574	383	$20,171	$18,290	$1,881	$326	$3,531
Days 10–14*	26,470	304	$22,177	$23,821	($1,644)	($3,666)	$502
Days 15 or more†	10,268	179	$31,240	$36,603	($5,363)	($8,220)	($1,698)
For patients dying in the hospital							
Overall effect	1,246	572	$33,075	$29,649	$3,426	$1,370	$5,612
Effects by hospital							
Hospital A	114	64	$38,825	$37,364	$1,461	($7,090)	$9,544
Hospital B	58	81	$27,966	$31,792	($3,826)	($9,574)	$1,768
Hospital C	100	96	$27,046	$25,972	$1,075	($3,673)	$5,096
Hospital D	861	257	$33,236	$28,353	$4,883	$2,122	$7,695
Hospital E	113	74	$36,742	$32,382	$4,360	($3,181)	$12,419
Effects by primary diagnosis							
Cancer	157	97	$35,737	$28,611	$7,126	$1,331	$13,659
Infection	307	157	$29,679	$27,910	$1,769	($1,430)	$4,986
Cardiovascular	249	78	$37,118	$31,262	$5,856	$524	$11,711
Pulmonary	151	79	$29,050	$36,744	($7,695)	($15,568)	($110)
Effects by timing of consult							
Days 1–2	1,246	60	$32,909	$27,557	$5,352	($554)	$10,747
Days 3–4	1,246	60	$32,909	$20,263	$12,647	$8,796	$16,164
Days 5–6	1,246	67	$32,909	$22,788	$10,121	$6,517	$13,265
Days 7–9	1,246	106	$32,909	$22,713	$10,196	$6,923	$12,861
Days 10–14*	1,084	141	$35,588	$27,571	$8,017	$5,409	$10,407
Days 15 or more†	585	138	$47,448	$44,134	$3,313	($1,332)	$8,510

Note. Effects calculated using method of recycled predictions, with bootstrapped confidence intervals calculated by taking the 2.5 and 97.5 percentiles from 2,000 bootstrap iterations.
*Among patients with minimum 10 days in hospital.
†Among patients with minimum 15 days in hospital. All other results based on patients with between 7 and 30 days in hospital as discussed in text.
Source: Authors' analysis of study data.

existing literature, we find no significant overall cost savings for patients discharged alive. But among those patients discharged alive, the analysis shows that the lack of cost savings was driven by specific hospitals, patients with a pulmonary or infection diagnosis, and/or patients with a PC consult after 10 days in the hospital (particularly after 15 days). In terms of the financial viability of PC programs, these results speak of the importance of the structure of the PC team, the identification of the appropriate patients for PC, and the appropriate timing of the intervention.

For patients discharged alive and for those who died in the hospital, the observed differences in savings across hospitals speaks to the impact of the PC team structure on cost savings. Comparing the estimated cost savings for each hospital in Table 4 to the overall structure of each PC team in Table 2, we see that hospitals with the least financial benefit of PC correlated with the least physician and/or RN involvement on the PC team at the time of the study and the facility with the greatest overall financial benefit had the most physician and RN involvement on the PC team.

Regarding timing of consult, early PC intervention clearly offers the largest potential cost savings; however, the practical relevance of this finding is limited without additional analysis. For example, among admissions with a late PC consult, were there signs that a PC consult may be needed earlier in the inpatient stay? To assess this question, we randomly selected 25 (of 179) patients who were discharged alive and who had a PC consult after the 15th day of the inpatient stay. The charts of these 25 patients were then reviewed by the clinical director of PC for our hospital system (RF), who has over 20 years experience as a physician and is a fellow of the American Academy of Hospice and Palliative Medicine. The charts were reviewed to identify (if possible) an earlier point at which a PC consult could have been pursued. Depending upon whether a patient was in the ICU or on a regular hospital floor, we applied one of two different screening tools we have used to help non-PC professionals identify cases that might be appropriate for a PC consult. These screening tools are included as Appendix SA1 and SA2, where scores of 5 or higher are deemed appropriate for PC consultation. If a patient had a score below 5 on admission, we noted the day at which the patient developed a score of 5 or higher. We then noted the difference between the first date that a patient had a positive screening score and the date of actual consult request.

The screening tool revealed 13 patients had a positive screening score of 5 or more. The number of days between a positive screening score and an actual consult request ranged from 6 to 23 days. The total days delayed between positive screening score and request for consultation for these 13 patients were 181 days, or an average of 13.9 days per case. There were two additional cases that did not have a positive screening score, but whose families requested limitation of one or more life sustaining medical interventions. The delay between family request to limit intervention and PC consult was 7 and 6 days in the two different cases. In three additional cases, including a post-CPR anoxic brain injury, a metastatic cancer of unknown primary, and chronic debility with progressive decline in the acute care hospital, patients never reached a positive PC screening score, yet a PC professional retrospectively reviewing these three cases suggests a consult could have come 9, 7, and 13 days sooner than actually requested. Finally, seven cases did not necessarily warrant an earlier consultation than the one actually requested.

Ultimately, in the majority of cases reviewed (18 of 25, or 72 percent), circumstances allowed for an earlier request for consult than what was ultimately observed. Although this 72 percent was based on a small sample size and therefore inappropriate for broader inference, the findings qualitatively support the claim that there exists an opportunity to initiate a consult earlier than we currently observe in the data. As such, our findings regarding the timing of consult offer meaningful guidance for hospitals considering how best to deploy an in-hospital PC team.

The limitations of our findings are similar to those of other retrospective, observational studies. Although our propensity score and regression analysis attempt to adjust for the observational nature of the data and provide a valid comparison between PC and non-PC patients, there are potentially important differences among the patient cohorts that are not observable at admission. In particular, psychosocial factors that are not generally observed in hospital administrative data may sometimes dictate a PC consult more than a patient's clinical symptoms. Unobserved complications or changes in a patient's condition throughout the inpatient stay may also influence our estimates of the cost savings from PC consults. This speaks of the appropriateness of our control group and to potential unobserved selection between PC and non-PC patients. Intuitively, to the extent such unobserved factors influence our treatment effects estimates, they would tend to be positively correlated with a PC consult and therefore could introduce an upward bias in our estimates.

As a sensitivity analysis, we therefore estimated a series of alternative regressions. First, we considered the possibility that our propensity score approach could exacerbate the role of unobserved confounders (Brooks and Ohsfeldt 2013). To do so, we estimated standard GLM regressions without any propensity score matching or weighting. Results revealed an average savings of $3,010 among PC patients who died in the hospital, and an average loss of $1,808 among PC patients discharged alive. These results are broadly consistent with the overall effects in Table 4, suggesting that the presence of unobserved confounders is not worsened by our propensity score approach.

We also considered restricting the sample in our study to more comparable patient groups. Among patients discharged alive, a discharge to hospice could intuitively reflect unobserved characteristics at the time of admission (e.g., severity of illness and patterns of care within an inpatient stay). Patients who did not receive PC but were ultimately discharged to hospice may therefore be more comparable to patients who received in-hospital PC. GLM regressions, again without a propensity score adjustment, among the subset of patients discharged to hospice revealed an average loss of $1,222 for patients receiving PC, again similar to the results in Table 4. However, we also stress that discharge status is a potential outcome from PC care, and we have therefore avoided relying on hospice discharge as a matching criteria or as a control variable in our primary analysis.

Second, we attempted to more explicitly control for potential unobserved confounders by estimating alternative GLM regressions in which indicator variables for the attending physician were used as instruments (Penrod, Goldstein, and Deb 2009; Penrod et al. 2010). Due to the nonlinear nature of the regression model, we estimated the instrumental variables GLM using two-stage residual inclusion (Terza, Basu, and Rathouz 2008). The first stage of this analysis specified a linear OLS model for PC consults with indicators for attending physician used as instruments. The overall results were similar to the GLM results discussed previously, with a coefficient on the PC variable of -0.102 ($p = .02$) for patients who died in the hospital and a coefficient of 0.054 ($p = .25$) for patients discharged alive. Although a standard Hausman test indicated the presence of endogeneity of PC consults among patients discharged alive, the similarity between our original results in Table 4 and those of the 2SRI analysis suggests that potential unobserved confounders do not appear to significantly bias our results.

Third, we considered an ordinary least squares (OLS) estimation in lieu of our non-linear GLM specification, again without any propensity score matching. The results were comparable to those presented in Table 4, with an overall average loss of $632 among PC patients discharged alive and an overall average savings of $3,700 among PC patients who died in the hospital. The average effects by timing of consult, primary diagnosis, and hospital were also comparable to those reported in Table 4. Although these OLS estimates are relatively inefficient, the results indicate that our inferences for the effect of

PC on in-hospital costs are robust to a simpler OLS regression. Collectively, our sensitivity analysis suggests that the presence of any unobserved confounding factors does not significantly affect our cost saving estimates.

It is also possible that physicians could engage in palliative-style care even without requesting a formal PC consult. To the extent such behavior exists, this would tend to reduce our estimated cost savings associated with PC consults. However, such behavior would not necessarily bias our results but would instead require our results to be more narrowly interpreted as the estimated cost savings from a formal, in-hospital PC program (as opposed to PC in general).

Our study is also geographically limited to select hospitals in the Dallas-Fort Worth region. Importantly, however, our data include an academic, tertiary care, safety-net hospital as well as four community hospitals with bed sizes ranging from approximately 100 to 600. In Table 1, we compare hospice impact factors for our academic center with the four academic centers in the Morrison et al. (2008) study, and our community hospitals with the community hospitals in the same study. We like to say that "no one comes to the academic rescue hospital to die" and believe it is no accident that across the country, tertiary care academic "rescue" hospitals typically have lower hospice utilization than community hospitals, not only because of supply and physician preference factors as demonstrated in the *Dartmouth Atlas of Health Care*, but because of patient selection into these rescue hospitals.

Conclusion

Overall, we find that a PC program offers a financial benefit via cost reduction for institutions willing to invest in such programs, even in a market and in hospitals that already have high hospice utilization. The greatest financial benefit was derived from those patients who died in the hospital, particularly for those with a PC consultation within 15 days of admission.

For patients discharged alive, cost savings during the index admission could only be demonstrated when consultation occurred within 10 days of admission. In a subsequent review of randomly selected PC patients who were discharged alive, we identified significant opportunity to have engaged in a PC consult earlier in the inpatient stay. In fact, among patients for whom a consult was ordered more than 15 days after admission, fully one-half qualified for a PC consult 6 to 23 days sooner than the consult actually occurred. We therefore conclude that PC programs have the potential to reduce costs at the index admission among patients ultimately discharged alive, provided such consults are pursued in a timely manner.

Although PC tends to reduce inpatient costs, the overall financial implications ultimately depend on the hospital's payer mix. For Medicare and other prospective payment models, the estimated savings would be captured wholly by the hospital, but where care is reimbursed on a cost-plus basis, the savings would be captured by the payer. Nonetheless, with the movement toward alternative payment models, including bundled payments and shared savings, PC may ultimately generate savings both for providers and payers.

Ultimately, hospital-based interdisciplinary palliative care (as distinct from hospice) for seriously ill patients and their families is a priceless benefit, the full measure of which is not often appreciated by many until the moment of need. It is morally incumbent on hospitals to meet that need, and our study demonstrates that it is financially possible to do so based upon the cost savings associated with appropriately selected and timed palliative care consultation with physician and RN involvement in the PC program.

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Note

1. Results were unchanged by also including year and facility interaction terms.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: PC Screening Tool for Patients in ICU.

Appendix SA3: PC Screening Tool for Non-ICU Patients.

Table S1: GLM Regression Results for Overall Effect of PC.

Table S2: GLM Regression Results for Effect of PC Based on the Timing of the Consult.

Table S3: GLM Regression Results for Effect of PC Based on Primary Diagnosis.

Table S4: GLM Regression Results for Effect of PC Based on Hospital.