Trends and Outcomes of Early and Late Palliative Care Consultation for Adult Glioblastoma Patients: A SEER-Medicare Retrospective Study

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Abstract

Purpose

Glioblastoma (GBM) carries a poor prognosis despite standard of care. Early palliative care (PC) has been shown to enhance survival and quality of life while reducing healthcare costs for other cancers. No study has investigated differences in PC timing on GBM patient outcomes.

Methods

This study used Surveillance, Epidemiology and End Results (SEER)-Medicare data from 1997-2016. Based on ICD codes, three groups were defined: (1) early PC within 10 weeks of diagnosis, (2) late PC, and (3) no PC. Outcomes were compared between the three groups.

Results

Out of 10,812 GBM patients, 1,648 (15.24%) patients had PC consultation with an overall positive trend over time. There were no significant differences in patient characteristics. There were significant differences in survival among the three groups (P<0.001), with early PC patients with the lowest mean time to death from diagnosis (3.99 ± 4.22 months). The early PC group had significantly lower overall cost of home health aid (1901 ± 3025, p<0.0001) and overall healthcare costs (82842 ± 52726, p<0.0001) compared to other groups.

Conclusion

We present the first investigation of PC consultation prevalence and outcomes, stratified by early versus late timing, for adult GBM patients. Despite an overall increase in PC consultations, only a minority of GBM patients receive PC. Patients with late PC had the longest survival times. Early PC was associated with lower healthcare costs and resource utilization when accounting for the patients' entire disease course. Prospective studies can provide additional valuable information about this unique population of GBM patients.

Introduction

Glioblastoma (GBM), the most common primary brain malignancy diagnosed in adults, carries a poor prognosis despite standard of care treatment. With an overall median survival of 16-21 months, GBM patients suffer from neurologic and cognitive symptoms, undergoing treatments that further affect their body and mind[1,2]. Palliative care (PC) is defined by the World Health Organization as "an approach that improves the quality of life of patients and their families facing…life-threatening illness, through the prevention and relief of suffering…" in a broad manner [3]. Literature about PC and its benefits for patients with advanced cancers is relatively developed, stating improvements in not only survival but also symptoms, mood, quality of life and healthcare costs [4,5]. In particular, early PC was investigated as an intervention in a well-known clinical trial, revealing survival benefit for non-small cell lung cancer (NSCLC) patients receiving PC consultation within 8 weeks of diagnosis [6].

Early PC for GBM patients has not been studied in detail and warrants additional attention given the neurocognitive symptoms associated with both the disease and treatment course [7].[7] Our retrospective study based on a nationwide cancer registry characterizes the landscape of early and late PC for adult GBM patients.

Methods

Data source

This study used the Surveillance, Epidemiology and End Results (SEER)-Medicare Linked Database. SEER is a national program of cancer registries collecting clinical, demographic and cause of death information for persons with cancer. Medicare is a Center for Medicare and Medicaid Services health insurance program covering the elderly (65 or older), people with certain disabilities or end stage renal failure from eligibility to death. Medicare data is composed of claims as enrollees navigate through the covered healthcare services.

We used SEER-Medicare 1997-2016 with claims from the five following files: (1) Medicare Provider Analysis and Review files, which includes all Part A short stay, long stay, and skilled nursing facility with one summarized record per admission (2) Carrier Claims files, which includes collected physician/supplier (Part B) bills for 100 percent of all claims (3) Outpatient files, which contain Part B claims for 100 percent for each calendar year from institutional outpatient providers (4) Home Health Agency, which contains 100 percent of all claims for home health services (5) Hospice files which contains claims data submitted by providers.

Patient selection

We searched for GBM patients with ICD-O-3 site code C710-C719, histology code 9440–9442. Only malignant, microscopically confirmed cases were retained. We included decedents during study years (1997-2016), aged 66 years and above. Additional inclusion criteria are continuous enrollment in Medicare Part A and B from 3 months before diagnosis through death. Exclusion criteria included individuals enrolled in Health Management Organization (HMO) programs at any point in this period and patients who received their first palliative care (PC) consultation on the day of death, because of lack of time to evaluate patterns of care at the end of life.

PC encounter was identified using International Classification of Diseases, Ninth Revision (ICD-9) code V66.7 and ICD-10 code Z51.5 from Medicare data [8,9]. For those with >1 PC encounter, only the first instance was included. Three analysis groups were defined: (1) the early PC group whose first PC encounter occurred within 10 weeks of diagnosis, (2) the late PC group whose first PC encounter occurred after 10 weeks of diagnosis, and (3) the no PC group. The timing of 10 weeks was selected based on previous publications citing a range of timing for implementing early PC for other advanced cancer diagnoses [6,10].

Patient characteristics

Patients' characteristics include age at diagnosis, comorbidities, GBM location and treatment related information. The Elixhauser score was used to account for the burden of comorbidities [11]. We used the adaptation to ICD-9-CM codes developed by Quan et al [12]. Comorbidities were evaluated during 3 months before diagnosis.

Outcomes of Interest

We assessed the following measures of health care utilization and cost from diagnosis to death, within 30 days and 6 months leading to death: (1) number of emergency room (ER) visits, intensive care unit (ICU) admissions, outpatient visit, hospital admission, home health aid (HHA) use and hospice use; (2) total number of days for ICU stay, and total of days for hospital stay; (3) the Medicare payment to outpatient, hospital, HHA and hospice use, respectively; (4) Total Medicare payment. Payments were inflation adjusted to 2016 US dollars using the medical component of the consumer price index (accessible through the United States Bureau of Labor Statistics website) [13]. The analysis of outcomes within the last 30 days and 6 months of life were performed in subgroups of those who survived at least 30 and 60 days after diagnosis, respectively. We also evaluated survival.

Statistical method

Demographics were compared using Kruskal Wallis test for continuous variables and Chi-square test for categorical variables among the groups. To obtain comparative groups by accounting for bias due to observed confounders, inverse probability of treatment weight (IPTW) technique was used [14]. A propensity score was calculated using a logistic regression model where the group was the dependent variable and all patient characteristics were included as independent variables. For each person, the weight was calculated as the sample size adjusted inverse of the propensity of getting the PC that they actually got. Post IPTW covariate balance was evaluated. Outcomes were compared between the three groups using IPTW-weighted generalized linear regression, negative binomial regression for the number of healthcare utilization encounters and linear regression on log-transformed values for payments. All tests were 2-sided and a p-value < 0.05 as considered statistically significant. Statistical analyses were performed with SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

Patient Characteristics

A total of 10,812 patients over age 66 who were diagnosed with glioblastoma (GBM), had Medicare insurance and records, and were deceased prior to 2017 were included (**Figure 1**). 1,648 (15.24%) GBM patients had PC consultation at any point during their disease course prior to death. Early PC involvement was defined as consultation within 10 weeks of GBM diagnosis. Temel et al. enrolled and randomized their early PC patients with metastatic lung cancer within 8 weeks of diagnosis, whereas another group defined early PC as within 12 weeks of diagnosis for adult patients with solid malignancies [6, 10]. 676 (6.25%) GBM patients in our study met criteria for early PC consultation. 972 (8.99%) GBM patients had late PC consultation.

Following IPTW matching, there were no significant differences in demographics characteristics among groups of patients who either did not receive or received early or late PC. The average age across the three subgroups (no PC, early PC, and late PC) was 76 ± 6 years, and the majority of GBM patients were male (no PC: 54.7%; early PC: 51.9%; late PC: 54.%) (**Table 1**). The Elixhauser Index is a measure of mortality based on 31 co-morbidities, and most GBM patients within each subgroup had scores over 3 [15]. There were no significant

differences in tumor location among the PC subgroups. Furthermore, GBM patients within each PC subgroup underwent similar rates of biopsy, surgical resection, radiation therapy, and chemotherapy.

Patient Survival among Palliative Care Subgroups

Following IPTW matching, there were significant differences in the survival curves among GBM patients (P<0.001) (**Figure 2**). GBM patients who received early PC had a mean time to death from diagnosis as 3.99 ± 4.22 months, while GBM patients who received late PC had the longest mean time to death from diagnosis as 11.72 ± 13.20 months (**Supplemental Table 1**). Those who did not receive any PC during their disease had overall mean survival time of 7.76 ± 9.23 months.

Healthcare Utilization among Palliative Care Subgroups

Various aspects of healthcare utilization were categorized for each PC subgroup of GBM patients and divided into the last 30 days of life, the last 6 months prior to death, and overall rates occurring in the time from GBM diagnosis to death (**Table 2**).

In some areas of healthcare utilization, the subgroup of GBM patients who received late PC had the highest healthcare resource utilization over the entire disease course. This group demonstrated significantly higher average numbers of ER visits (3.46 ± 2.92, ICU admissions (1.50 ± 1.14), overall inpatient hospital admissions (4.48 ± 2.71), outpatient visits (19.38 ± 23.09), and length of stay in days (48.02 ± 48.73). On the other hand, patients in the late PC subgroup also had significantly greater use of hospice (2.25 ± 2.60) and HHA (1.32 ± 1.37).

In terms of Medicare payments and costs over the patients' disease courses, the early PC group had significantly lower overall cost of HHA (1901 ± 3025, p<0.0001), cost of outpatient visits (6033 ± 11779, p<0.0001), and overall healthcare costs (82842 ± 52726, p<0.0001) compared to both the no PC and late PC groups. Conversely, the late PC subgroup demonstrated significantly higher overall costs of inpatient admissions (74091 ± 51143), outpatient visits (17690 ± 28623), and overall healthcare (129236 ± 76892).

When accounting for healthcare costs in the last 6 months prior to death for GBM patients who had received PC, the late PC subgroup had significantly greater overall Medicare payments (62650 ± 41081) compared to patients with early PC (47215 ± 30923). Likewise, in the last 6 months prior to death, the late PC subgroup had significantly greater numbers of ER visits (1.99 ± 1.69), ICU admissions (0.51 ± 0.85), hospital admissions (2.14 ± 1.99), outpatient admissions (9.95 ± 8.81), overall days for length of stay (23.02 ± 32.04) compared to GBM patients without PC and those who received early PC.

Some of these differences between early and late PC were abrogated when examining the last month prior to death, such as numbers of ICU admissions, hospital admissions, days for length of stay as well as HHA and hospice use. The healthcare costs associated with PC are significantly greater than for those who did not receive PC in the last month of life.

Trends in Palliative Care Utilization

From 1997 to 2015, there was an overall increase in PC use for GBM patients with a positive trend from 2.64% in 1997 to 42.54% in 2015 (Figure 3; Supplemental Table 2). For early PC consultation, the proportion of GBM patients meeting this criterion rose from 1.13% in 1997 to 20.63% by 2015. Likewise, the percentage of GBM patients who received late PC also increased from 1.51% in 1997 to 21.92% in 2015 (Supplemental Table 2). Similarly, for GBM patients who underwent biopsy or craniotomy, there was also an increase in PC use.

Discussion

Our retrospective study investigated early versus late PC use for 1,648 adult GBM patients from a cohort of 10,812 patients. Existing studies on PC for patients with primary brain malignancies are already rare, with those focusing on GBM even more so. A minority of adult GBM patients received PC consultations (34-40%) [16]. For those who received PC, patients and caregivers reported improved quality of life [17]. This study offers two unique features as it is the first study examining the landscape of PC use and effects of early versus late PC consultation as well as the first utilizing a national claims database to study PC for GBM patients.

In general, there was a positive trend in PC consultation over our study period. A separate study on patients with primary brain malignancies, which include GBM, found that rates of inpatient PC also rose from 2.3% in 2007 to 11.9% in 2011 [18]. The rise in PC use among GBM patients reflects a general trend of greater adoption in cancer care [19, 20]. However, it is worth noting that, while historically regarded as end-of-life care, PC has been formally defined as applicable earlier in a patient's disease course. And, just as GBM management has transformed over time to incorporate new protocols, palliative and supportive care have also changed [21, 22].

Our analysis yielded no significant differences in patient or tumor characteristics among the three subgroups. Understanding prognosis is a key component—and benefit—of promoting timely PC implementation [23, 24]. We would have assumed that certain patient or disease characteristics could influence providers' decision-making in consulting PC early or at all. Several large-scale retrospective studies and predictive models have identified various factors, such as gender, functional status, and tumor location, as significant in prognosticating GBM [25-27]. However, no factor was necessarily correlated with PC use in our analysis.

Furthermore, there were no differences in biopsy versus surgery rates among the subgroups. Patients with brain metastases who underwent neurosurgery had significantly lower rates of PC consultation [28]. Another study on patients with primary brain malignancies indicated that those who received inpatient PC were less likely to undergo treatments, including surgery [18]. There was no analysis on timing of PC with regards to procedures for our study due to database limitations.

The difference among subgroup survival times is striking. Patients with late PC consultation had the longest median survival time, whereas the early PC group had the shortest. Other published studies on early PC and survival time for patients with advanced cancer showed variable results. A cohort of NSCLC patients who had PC within 8 weeks of diagnosis experienced better quality of life, received aggressive end-of-life care less often, and ultimately had longer survival [6].[6] Early PC was also found to positively influence quality-of-life and increased reported scores across a synthesis of seven randomized control trials on patients with incurable cancers [29]. However, the four studies that reported survival data did not reveal differences in efficacy. Quality-of-life was higher among patients with incurable solid tumor cancers who received PC consultation within 12 weeks of diagnosis [10]. But, no significant difference in survival time between the early PC and standard oncologic care groups was identified.

Early PC involvement may depend on opinions about optimal timing, which vary greatly among physicians. A focus group study involving patients with various cancers indicated that the best timing of PC implementation was not necessarily soon after diagnosis but after failure of curative treatment, disease recurrence, and other signs of progressive poor prognosis [30]. Perhaps, our study's early-PC patients were deemed among the most likely to have poor survival by their providers, despite no significant differences in patient characteristics. Involvement of PC later in patients' disease course had survival benefit over no PC involvement. Currently, no randomized clinical trials investigating the influence of early PC for glioma patients have yet been published, though one group designed a proposal for PC integration within 4 weeks of primary or recurrent GBM diagnosis [31].

While Temel et al. established the benefits of early PC, a few subsequent studies provide contradictory findings regarding PC timing and healthcare resource utilization. A large retrospective study of over 23,000 patients with advanced lung cancer determined that PC involvement resulted in lower healthcare resource utilization; however, no distinction regarding timing of consultation was made [32]. Similarly, while quality of life and mood among patients improved with early PC involvement, there was no significant difference found in healthcare utilization between groups of patients with early versus late PC consultation [33]. Our study's results are corroborated with a Swedish study on patients with various cancers, which found that those who received specialized palliative home care had significantly higher numbers of unplanned admissions (OR 4.35; 95% CI [3.22-5.91], $p<0.001$) and unplanned re-admissions within 30 days (OR 5.8; 95% CI [4.12-8.19], $p<0.001$). Another group found that early PC led to increased utilization of community-based and palliative-related resources but also resulted in higher numbers of unplanned ED visits (1.47 [95% CI 1.32-1.64]) [34]. Potentially, these admissions are due to worsening of the patients' disease condition and other complications and symptoms that require acute care.

Results from healthcare cost analyses have also been variable. In our study, greater utilization of expensive services, such as ICU and ER visits, was reflected by higher healthcare costs for the late PC group over the whole disease course. Temel et al.'s clinical trial underwent cost analysis that showed no significant differences in total costs among patient groups [35].[35] However, in general, earlier PC implementation had an overall greater cost-reducing effect for several different patient cohorts [36]. One study on general long-term trends of Medicare payments demonstrated that both "aggressive", such as ICU admissions, and "nonaggressive", like hospice, care have increased over time [37].

While some results from our study on PC use in the GBM patient population are different from other studies, GBM itself is a different disease from other advanced cancers. With short overall survival times, malignant gliomas present an especially challenging course for patients and caregivers due to early and significant functional and neurocognitive decline [38]. In comparison to other oncologic patients, brain tumor patients present to hospitals more frequently for social issues and neurological and cognitive complications [39]. The European Association for Neuro-Oncology acknowledged that glioma patients were mostly referred to PC services in late stages of disease [39].

Limitations

The retrospective nature of our study presents several limitations. Selection bias is inherent to retrospective studies, although we utilized IPTW-matching to control for covariates. The SEER database is limited by each hospital's coding practices, which may affect the sensitivity and specificity of patients identified in our study. We were also limited by the lack of standardization of PC. Furthermore, the database does not include data related to location of death, symptoms, or any patient-reported outcomes, which are also important outcomes to consider in PC studies [6]. Functional status and frailty metrics, in addition to other potentially salient information that could influence providers' decision-making about early PC implementation, are also missing. The strengths of our study lie in the national sampling of GBM patients from a comprehensive, well-utilized database, which allows for investigation of PC effects on a rare but deadly cancer.

Conclusion

We present the first investigation of PC consultation, stratified by early versus late timing, for adult GBM patients. Despite an overall increase in PC consultations over time, only a minority of GBM patients receive PC despite the poor prognosis. Patients with PC, albeit after ten weeks from diagnosis, had the longest survival times. Early PC within 10 weeks of diagnosis did not necessarily indicate longer survival times but was associated with lower healthcare costs and resource utilization when accounting for the entire disease course. Prospective studies and randomized controlled trials are required to provide valuable information about for the impact of PC for the unique population of GBM patients.

Declarations

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Availability of Data: The authors will provide data upon request.

Code Availability: The authors will provide code upon request.

Authors' Contributions: A.W. and S.S. conceived project idea and parameters of interest. B.U. and D.W. performed data analysis and constructed figures and tables. A.W. wrote the manuscript with support from S.S., G.H., M.B. S.S. and G.H. supervised the project. All authors discussed the results and contributed to the final manuscript.

Compliance with Ethical Standards

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Tables

Table1: Patient demographics and tumor characteristics separated into groups of patients who received no palliative care (PC) consultation versus early PC referral versus late PC referral. Inverse probability of treatment weight (IPTW) technique was used to match and obtain comparable groups by accounting for bias due to confounders. Statistical significance was obtained if p value was less than or equal to 0.5.

	Unmatched			P value			IPTW matched			
	[1] No PC (n=8932)	[2] Early PC (n=676)	[3] Late PC (n=972)	[2] vs. [1]	[3] vs. [1]	[3] vs. [2]	[1] No PC (weighed n=8935)	[2] Early PC (weighed n=661)	[3] Late PC (weighed n=977)	P value
Age at diagnosis				**<.0001**	**<.0001**	**<.0001**				0.173
Mean (SD)	76 ± 6	77 ± 7	74 ± 6				76 ± 6	76 ± 6	76 ± 6	
Median (Q1, Q3)	75 (71,80)	77 (72,82)	73 (70,78)				75 (71,80)	75 (71,80)	75 (71,80)	
Min-Max	66-98	66-98	66-94				66-98	66-98	66-98	
Sex				0.8311	0.8936	0.7943				0.3605
Male, n(%)	4887 (54.7%)	367 (54.3%)	534 (54.9%)				4887 (54.7%)	343 (51.9%)	528 (54.1%)	
Female, n(%)	4045 (45.3%)	309 (45.7%)	438 (45.1%)				4045 (45.3%)	318 (48.1%)	449 (45.9%)	
Race				0.7403	0.475	0.7106				0.6406
White, n(%)	8256 (92.4%)	622 (92%)	888 (91.4%)				8247 (92.3%)	609 (92.1%)	910 (93.2%)	
Black, n(%)	307 (3.4%)	27 (4%)	37 (3.8%)				313 (3.5%)	26 (3.9%)	26 (2.6%)	
Other/unknown, n(%)	369 (4.1%)	27 (4%)	47 (4.8%)				375 (4.2%)	26 (3.9%)	41 (4.2%)	
Marital Status				**0.038**	**<.0001**	**<.0001**				0.4053
Married, n(%)	5685 (63.7%)	397 (58.7%)	689 *70.9%)				5717 (64%)	404 (61.6%)	625 (64%)	
Unmarried, n(%)	2972 (33.3%)	255 (37.7%)	250 (25.7%)				2937 (32.9%)	236 (35.8%)	328 (33.6%)	
Unknown, n(%)	275 (3.1%)	24 (3.6%)	33 (3.4%)				280 (3.1%)	21 (3.1%)	23 (2.4%)	
Elixhauser Index				**0.008**	**0.0725**	**0.005**				0.9401
(3 mo to diagnosis)										
0, n (%)	1609 (18%)	97 (14.4%)	204 (21%)				1613 (18.1%)	126 (19%)	188 (19.2%)	
1, n (%)	1671 (18.7%)	110 (16.3%)	164 (16.9%)				1642 (18.4%)	114 (17.3%)	178 (18.2%)	
2, n (%)	1615 (18.1%)	122 (18.1%)	161 (16.6%)				1603 (17.9%)	116 (17.5%)	167 (17.1%)	
3+, n (%)	4037 (45.2%)	347 (51.3%)	443 (45.6%)				4077 (45.6%)	306 (46.2%)	444 (45.5%)	
Tumor location				**<.0001**	**0.0003**	**<.0001**				0.8114
Frontal, n (%)	2235 (25%)	188 (27.8%)	268 (27.6%)				2273 (25.4%)	159 (24%)	266(27.3%)	
Temporal, n(%)	2322 (26%)	139 (20.6%)	293 (30.1%)				2326 (26%)	177 (26.8%)	268 (27.4%)	
Parietal, n (%)	1581 (17.7%)	94 (13.9%)	149 (15.3%)				1540 (17.2%)	115 (17.3%)	153 (15.7%)	
Occipital, n (%)										
Cerebellar, n (%)									53 (5.4%)	

Multifocal, n (%)	479 (5.45%)	23 (3.4%)	54 (5.6%)				469 (5.3%)	32 (4.8%)	32 (3.3%)	
	325 (3.6%)	31 (4.6%)	30 (3.1%)				326 (3.7%)	28 (4.2%)	204 (20.9%)	
	1990 (22.3%)	201 (29.7%)	178 (18.3)				2000 (22.4%)	152 (22.9%)		
Biopsy				**<.0001**	**<.0001**	**<.0001**				0.8956
Yes, n (%)	2834 (31.7%)	313 (46.3%)	205 (21.1%)				2832 (31.7%)	215 (32.5%)	306 (31.4%)	
Surgery				**<.0001**	**<.0001**	**<.0001**				0.1533
Yes, n (%)	6084 (68.1%)	357 (52.8%)	778 (80%)				6096 (68.2%)	427 (64.6%)	667 (68.3%)	
Radiation				**<.0001**	**<.0001**	**<.0001**				0.7683
No, n (%)	2870 (32.1%)	411 (60.8%)	100 (10.3%)				2856 (32%)	222 (33.5%)	317 (32.4%)	
Yes, n (%)	5839 (65.4%)	253 (37.4%)	859 (88.4%)				5869 (65.7%)	427 (64.5%)	633 (64.8%)	
Unknown, n (%)	223 (2.5%)	12 (1.8%)	13 (1.3%)				209 (2.3%)	13 (2%)	27 (2.7%)	
Chemotherapy				**<.0001**	**<.0001**	**<.0001**				0.3983
Yes, n (%)	554 (6.2%)	21 (3.1%)	100 (10.3%)				570 (6.4%)	41 (6.3%)	73 (7.5%)	
MRI Brain, CT Head				**0.0002**	**<.0001**	0.0755				0.0962
Yes, n (%)	8611 (96.4%)	667 (98.7%)	967 (99.5%)				8652 (96.8%)	634 (95.9%)	935 (95.7%)	

Table 2: Patient outcomes and healthcare utilization for GBM patients who had no PC referral versus early PC referral versus late PC referral.

		IPTW Matched					
		[1] No Palliative	[2] Early Palliative	[3] Late Palliative	p-value		
	Outcomes, Mean (SD)				[2] vs [1]	[3] vs [1]	[3] vs [2]
Healthcare use for all patients from dx to death		(weighed n=8935)	(weighed n=661)	(weighed n=977)			
count	# of ER visit	1.96 ± 2.03	1.94 ± 1.98	3.46 ± 2.92	**0.0306**	**<.0001**	**<.0001**
	# of ICU admissions	1.12 ± 0.94	1.19 ± 0.88	1.5 ± 1.14	0.391	**<.0001**	**<.0001**
	# of days for ICU stay	4.02 ± 6.17	4.97 ± 6.91	5.29 ± 7.39	**<.0001**	**<.0001**	0.1915
	# of outpatient visit	11.37 ± 18.15	6.07 ± 9.99	19.38 ± 23.09	**<.0001**	**<.0001**	**<.0001**
	# of Hospital admission	3.12 ± 2.33	3.02 ± 2.08	4.48 ± 2.71	**0.0011**	**<.0001**	**<.0001**
	# of days for LOS	33.92 ± 39.4	34.75 ± 36.17	48.02 ± 48.73	0.591	**<.0001**	**<.0001**
	# of home health aide use	0.93 ± 1.4	0.63 ± 0.82	1.32 ± 1.37	**<.0001**	**<.0001**	**<.0001**
	# of Hospice use	2.02 ± 2.98	1.84 ± 2.24	2.25 ± 2.6	**0.0082**	**0.0026**	**<.0001**
payment	Payment for outpatient visit	9771 ± 20454	6033 ± 11779	17690 ± 28623	**0.0005**	**<.0001**	**<.0001**
	Payment for hospital admission	56446 ± 48057	55940 ± 40382	74091 ± 51143	0.795	**<.0001**	**<.0001**
	Payment for HHA use	2865 ± 4850	1901 ± 3025	4464 ± 5426	**<.0001**	**<.0001**	**<.0001**
	Payment for hospice use	7215 ± 12587	6241 ± 11657	7908 ± 12270	0.07	0.0885	**0.0108**
	Total Medicare payment	94621 ± 70028	82842 ± 52726	129236 ± 76892	**<.0001**	**<.0001**	**<.0001**
Healthcare use in the last 30 days		(weighed n=8225)	(weighed n=542)	(weighed n=977)			
count	# of ER visit	0.33 ± 0.6	0.47 ± 0.66	0.59 ± 0.74	**<.0001**	**<.0001**	**0.0019**
	# of ICU admissions	0.1 ± 0.32	0.18 ± 0.39	0.18 ± 0.45	**<.0001**	**<.0001**	0.9773
	# of days for ICU stay	0.46 ± 2.06	0.88 ± 2.71	0.79 ± 2.53	**0.0021**	**0.0007**	0.7024
	# of outpatient visit	0.75 ± 1.51	1.01 ± 1.69	0.79 ± 1.41	**0.0014**	0.3437	**0.0434**
	# of Hospital admission	0.43 ± 0.78	0.68 ± 0.93	0.69 ± 0.92	**<.0001**	**<.0001**	0.7832
	# of days for LOS	3.37 ± 6.97	5 ± 7.75	4.65 ± 7.24	**0.002**	**0.0008**	0.661
	# of HHA use	0.1 ± 0.31	0.1 ± 0.29	0.1 ± 0.31	0.8025	0.6568	0.6276
	# of Hospice use	0.98 ± 0.76	1 ± 0.63	1.06 ± 0.69	0.6377	**0.008**	0.2055
payment	Payment for outpatient visit	411 ± 1327	656 ± 1834	455 ± 1257	**<.0001**	0.2992	**0.0035**
	Payment for hospital admission	5407 ± 12194	8726 ± 13814	8259 ± 13793	**<.0001**	**<.0001**	0.4827
	Payment for HHA use	211 ± 888	263 ± 956	181 ± 777	0.1487	0.3452	0.0797
	Payment for hospice use	2691 ± 3222	2552 ± 3133	2912 ± 3143	0.3399	**0.0365**	**0.041**
	Total Medicare payment	10267 ± 13994	14593 ± 16225	13702 ± 15900	**<.0001**	**<.0001**	0.244
Healthcare use in the last 6 months		(weighed n=3265)	(weighed n=55)	(weighed n=617)			
count	# of ER visit	1.37 ± 1.52	1.25 ± 1.54	1.99 ± 1.69	0.7847	**<.0001**	**0.0083**
	# of ICU admissions	0.34 ± 0.68	0.29 ± 0.61	0.51 ± 0.85	0.5669	**<.0001**	**0.0452**
	# of days for ICU stay	1.48 ± 4.76	1.56 ± 6.22	2.12 ± 5.14	0.8495	**0.0057**	0.5016

	# of outpatient visit	7.8 ± 7.79	7.01 ± 7.36	9.95 ± 8.81	0.3972	**<.0001**	**0.0134**
	# of Hospital admission	1.54 ± 1.95	1.27 ± 1.54	2.14 ± 1.99	0.3616	**<.0001**	**0.0072**
	# days for LOS stay	18.02 ± 30.59	17.07 ± 28.98	23.02 ± 32.04	0.8508	**0.0066**	0.3051
	# of HHA use	0.72 ± 1.05	0.48 ± 0.79	0.82 ± 0.96	0.1118	**0.0241**	**0.0323**
	# of Hospice use	2.66 ± 2.7	3.12 ± 2.59	2.44 ± 2.21	0.1297	**0.0424**	**0.0348**
payment	Payment for outpatient visit	6878 ± 12464	9224 ± 16020	11248 ± 16658	0.1397	**<.0001**	0.3249
	Payment for hospital admission	22882 ± 35703	17552 ± 25091	29812 ± 34823	0.3348	**<.0001**	0.0565
	Payment for HHA use	2250 ± 3670	1096 ± 2271	2550 ± 3733	0.1125	0.0523	0.0641
	Payment for hospice use	10056 ± 12023	11761 ± 13478	8511 ± 10430	0.2542	**0.0052**	**0.0278**
	Total Medicare payment	50735 ± 41432	47215 ± 30923	62650 ± 41081	0.5476	**<.0001**	**0.0201**

Figures

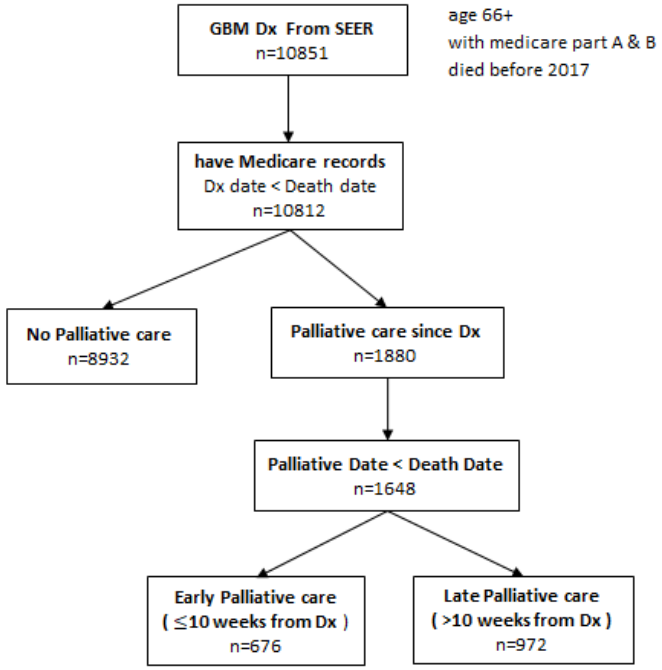

Figure 1

Flow chart of glioblastoma (GBM) decedents included for analysis, derived from SEER-Medicare database of 1997-2016.

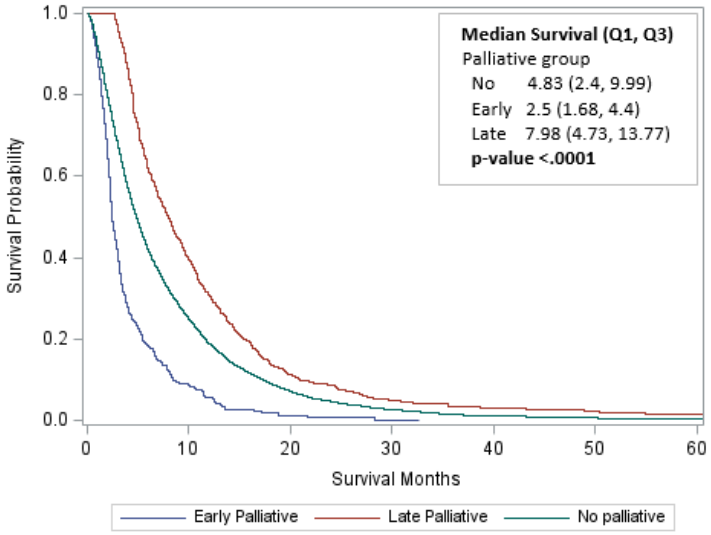

Figure 2

Kaplan-Meier survival curve depicting survival probability over time for GBM patients who had no PC referral versus early PC referral versus late PC referral. Statistical significance among all three curves was depicted by p value < 0.0001.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTables.docx