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ORIGINAL ARTICLE

Trends in inpatient palliative care use for primary brain malignancies

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Abstract

Introduction Primary brain malignancies (PBMs) pose significant morbidity and poor prognosis. Despite NCCN recommendations that palliative care should be integrated into general oncologic care plans, it has been historically underused in patients with PBM. We sought to examine trends and factors associated with inpatient palliative care use in patients with PBM.
Methods Data from the 2007–2016 National (Nationwide) Inpatient Sample was analyzed for descriptive statistics and trends. Multivariable logistic regression was used to identify factors associated with inpatient palliative care in patients with PBMs.
Results Of the 510,238 observed hospitalizations of adults with PBM in a 10-year period, 37,365 (7.3%) had an associated inpatient palliative care consult. Rates of inpatient palliative care have increased significantly over the 10-year period, from 2.3 in 2007 to 11.9% in 2011. Patients receiving inpatient palliative care were less likely to receive inpatient oncologic treatment such as brain surgery, chemotherapy, or radiation compared to those without palliative care (14.6% with palliative care vs. 42.4% without, $p<0.001$). They were more likely to receive life-sustaining treatments such as intubation, mechanical ventilation, tracheostomy, nutritional support, hemodialysis, or CPR (21.0% with palliative care vs. 10.4% without, $p<0.001$). Palliative care was associated with decreased cost of admission ($18,602 with palliative care vs. $20,077 without). In a multiple variable logistic regression, age, non-elective admission, comorbidities, history of chemotherapy and radiation, and mechanical ventilation were associated with significantly increased odds of receiving palliative care.
Conclusions Inpatient palliative care utilization for patients hospitalized with PBM significantly increased between 2007 and 2016, though the service is still underutilized in the context of the severe symptoms and poor prognosis associated with PBM.

Keywords Primary brain tumors · Palliative care · Chemotherapy · Radiation therapy · Health care utilization

Background

Primary brain malignancies (PBMs) pose significant morbidity and mortality for patients and their families. Patients with high grade gliomas, representing 80–85% of adult brain tumors, have a median survival of 14 months and can have a rapid and sometimes difficult to predict clinical decline [1, 2]. PBM can be associated with significant symptom burden including gait impairment, cognitive or personality changes, motor deficits, seizures, and aphasia [1]. Treatment for PBM involves a combination of surgery, radiation, and/or chemotherapy, all of which can be associated with additional adverse effects [1–3].

The high symptom burden, unpredictable course, and poor prognosis of PBM suggest that patients and families coping with a PBM diagnosis may benefit from palliative care. Palliative care is an interdisciplinary medical specialty focused on improving quality of life through symptom relief, pain management, and psychological and spiritual support for patients with serious illness [4]. While it is often conflated with hospice and end-of-life care, palliative care is a supportive service that can be provided at any stage of disease and alongside disease-directed and curative therapies [4]. The National Comprehensive Cancer Network (NCCN) recommends integration of palliative care into general oncologic treatment and encourages use of palliative care early in the disease course [4].

More information is needed to better understand palliative care use in PBM and to understand factors driving referral to

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this service. Despite research showing benefits of palliative services for patients with PBM, palliative consult services have historically been underutilized in this population, and little research exists in this arena overall [1, 5–7]. The goal of this study is to better understand utilization of palliative care in patients with PBM. We accomplished this using the National Inpatient Survey to establish national estimates and 10-year trends for palliative care utilization and to examine factors associated with inpatient palliative care consultation in patients with PBM.

Methods

We used the National (Nationwide) Inpatient Sample (renamed after redesign in 2012, abbreviated to NIS) to assess national palliative care consultation for adult patients (18 years and older) with PBM. NIS is a survey database developed for the Healthcare and Utilization Project (HCUP) designed to produce national estimates on inpatient health care utilization and outcomes. It is a 20% sample of discharges from all participating hospitals in HCUP; prior to its redesign in 2012, it was a sample of all hospitals participating in data collection [8].

NIS data was evaluated from 2007 to 2016 for patients ages 18 and older with any diagnosis coded for primary malignant brain cancer, defined as ICD-9 codes beginning with “191” and ICD-10 codes beginning with “C71” (Table 1). Inpatient palliative care consults were defined by ICD-9 code V66.7 or ICD-10 code Z51.5, as utilized in previous studies examining palliative care using NIS [5, 9, 10]. Cancer tumor histology, stage, grade, and duration were not available in this dataset and were therefore not analyzed. Comorbid conditions were assessed using the Charlson Comorbidity Index. Life-sustaining therapies, such as intubation, mechanical ventilation, tracheostomy, nutritional support, hemodialysis, or cardiopulmonary resuscitation (CPR), were also identified using ICD-9 and ICD-10 diagnostic or procedure coding, similar to methods used in published studies [10, 11]. NIS data on length of stay, elective admission, discharge disposition, and hospital characteristics were also used in this analysis. Data specifically examining discharge to hospice was only available from 2007 to 2011 and was analyzed separately.

Descriptive analysis was completed using cross-tabulation for categorical variables and means for continuous variables; significance was assessed using chi-squared for categorical variables and *t*-tests for continuous variables. The Cochrane-Armitage test was used to analyze trends in palliative care rates over time. Multivariable logistic regression was used to examine patient and hospital characteristics associated with inpatient palliative care and death during admission while controlling for potential confounding variables. Collinearity was examined using variance inflation factors. All statistical tests were two-sided, and threshold for significance was set to $p < 0.05$.

Survey data was weighted to generate nationally representative statistics. Trend weights were applied to data from 2007 to 2011 to account for changing NIS sampling strategies after 2011 per recommended methodological standards [12]. Costs were calculated using the Healthcare Cost and Utilization Project (HCUP) Cost-to-Charge Ratio Files, and weights were adjusted for missing data when calculating costs. All costs were adjusted for inflation to 2016 U.S. dollars based on the Consumer Price Index. Missing data represented less than 1% of all data for all variables except race, which was coded into a separate category [9]. Accuracy of summary statistics were periodically verified with HCUP NIS published statistics and HCUPnet [12]. This methodology has been validated in previously published papers to assess utilization and trends of palliative care [5, 9, 10]. Stata 15.1 IC was used for all statistical analysis. This study was exempt from Institutional Review Board approval.

Table 1 ICD-9 and ICD-10 diagnosis codes for PBM included in data analysis

ICD code meaning	ICD-9 code	ICD-10 code
Malignant neoplasm of the brain	191	C71
Malignant neoplasm of cerebrum, except lobes and ventricles	191.0	C71.0
Malignant neoplasm of frontal lobe	191.1	C71.1
Malignant neoplasm of temporal lobe	191.2	C71.2
Malignant neoplasm of parietal lobe	191.3	C71.3
Malignant neoplasm of occipital lobe	191.4	C71.4
Malignant neoplasm of ventricles	191.5	C71.5
Malignant neoplasm of cerebellum, not otherwise specified	191.6	C71.6
Malignant neoplasm of brain stem	191.7	C71.7
Malignant neoplasm of other parts of brain	191.8	C71.8
Malignant neoplasm of brain, unspecified	191.9	C71.9

Results

Between 2007 and 2016, there were 104,507 observations in the NIS database of adults with a diagnosis of PBM, weighted to represent 510,238 hospitalizations. During those hospitalizations, 37,365 (7.3%) received inpatient palliative care consultations (Table 2). In 2007, 2.3% of the 48,903 patients admitted for PBM received inpatient palliative care, compared to 11.9% of 53,275 in 2016, with a significant increasing linear trend ($p < 0.001$) (Fig. 1). When adjusting for confounding variables in a multiple variable regression, the odds of receiving an inpatient palliative care consult during admission for PBM have increased by 13.6% each year since 2007 (95% CI 1.12–1.15, $p < 0.001$) (Table 2).

While the patients admitted for PBM were most commonly white (69.6%) and male (57.3%), neither age nor gender was statistically significantly associated with palliative care. The average age overall was 57.5 years (SD 16.1, range 20–104), while the average age for those receiving palliative care consults was 63.0 years (SD 15.3, range 22–98, $p < 0.001$). Mean length of stay was longer for those with a consult compared to those without (8.4 days vs. 6.4 days, $p < 0.001$). Inpatient palliative care was associated with decreased costs of hospital admission (mean cost with palliative care: \$18,602, SD \$26,418, range \$440–\$543,655; without palliative care \$20,077, SD \$22,073, range \$1517–\$935,245; $p < 0.001$).

For those 472,872 observations without an inpatient palliative care consult, 51.1% had routine discharges, compared to 8.8% of the 37,365 with a consult. For those without a consult, 2.4% died during admission, compared to 26.2% with a consult. During the total 10-year period, 24.6% and 17.5% of patients without a consult were transferred to a long-term facility or to home health care, respectively, compared to less than 35.2% and 27.2% of patients, respectively, with a consult. Between 2007 and 2011 for all 215,974 admissions for PBM, 14.7% of discharges to long-term facilities included hospice overlay, and 24.3% of discharges to home health care were for hospice. Of the 10,337 patients with a palliative consult between 2007 and 2011, 42.5% were discharged to hospice at either a facility or at home.

Patients with a palliative care consult received less inpatient chemotherapy or brain surgery compared to those without (1.5% vs. 3.1% for chemotherapy, $p < 0.001$; 11.1% vs. 36.7% for brain surgery, $p < 0.001$). There was no statistically significant difference in inpatient radiation for those receiving palliative care consults compared to those without. Patients with a consult were more likely to have a history of chemotherapy and radiation (10.6% vs. 5.5% for chemotherapy, $p < 0.001$; 15.9% vs. 9.7% for radiation, $p < 0.001$). Based on cross-tabulation without adjustment, patients receiving palliative care were more likely to receive life-sustaining therapies such as intubation, mechanical ventilation, tracheostomy, percutaneous endoscopic gastrostomy tube placement, total parenteral nutrition, dialysis, blood transfusions, and CPR (all $p < 0.05$).

Multivariable logistic regression revealed that increased age, comorbidities, and history of cancer treatment were associated with increased odds of inpatient palliative care (Table 3). All forms of cancer therapy during admission were associated with decreased odds of palliative care (brain surgery OR = 0.23, 95% CI 0.22–0.26, $p < 0.001$; chemotherapy OR = 0.56, 95% CI, $p < 0.001$, and radiation 0.80, 95% CI 0.68–0.93, $p = 0.005$). While all examined life-sustaining therapies were increased in patients with a palliative care consult, when included in multiple variable model, odds of palliative care were decreased with tracheostomy (OR = 0.51, 95% CI = 0.34–0.74, $p < 0.001$) and CPR (OR = 0.62, 95% CI = 0.39–0.98, $p = 0.04$). Blood transfusion, intubation, dialysis, and nutritional interventions, such as TPN and PEG tube, had no significant associations with inpatient palliative care after adjusting for confounders.

The odds associated with in-hospital death have decreased significantly with each additional year since 2007 (OR = 0.96, 95% CI 0.95–0.97, $p < 0.001$; Table 2). In-hospital oncologic therapies were all associated with decreased odds of inpatient palliative care as well as in-hospital death (radiation OR 0.60, 95% CI 0.48–0.75, $p < 0.001$; chemotherapy OR 0.27, 95% CI 0.19–0.39, $p < 0.001$; brain surgery OR 0.31, 95% CI 0.28–0.34, $p < 0.001$). Blood transfusions were associated with increased risk of death (OR 1.71, 95% CI 1.53–1.92, $p < 0.001$), while they had no significant association with inpatient palliative care. Respiratory supportive therapies such as intubation and mechanical ventilation were associated with significant increased odds of death during admission, though intubation was not significantly associated with palliative care. CPR was associated with significant increased odds of death (OR 24.07, 95% CI 15.67–36.97, $p < 0.001$) but was associated with decreased odds of palliative care.

Discussion

This is the first study examining national trends and factors associated with inpatient palliative care utilization for patients with PBM. Between 2007 and 2016, we found a statistically significant trend of increasing inpatient palliative care use for this population, with inpatient palliative care associated with decreased hospital costs. Palliative care was associated with age, non-elective admission, and

Table 2 Demographic characteristics of adults hospitalized for PBM with and without inpatient palliative care, 2007–2016

	No palliative care	Palliative care	Total	*p*-value
Unweighted total — no. (%)	96,901 (92.7%)	7606 (7.3%)	104,507 (100%)	
Weighted total — no. (%)	472,872 (92.7%)	37,365 (7.3%)	510,238 (100%)	
Sex — no. (%)				0.511
Female	201,723 (42.7%)	16,101 (43.1%)	217,825 (42.7%)	
Male	270,569 (57.3%)	21,255 (56.9%)	291,824 (57.3%)	
Race/ethnicity — no. (%)				
White	328,271 (69.4%)	26,969 (72.2%)	355,240 (69.6%)	< 0.001
Black	29,211 (6.2%)	2690 (7.2%)	31,900 (6.3%)	
Hispanic	33,399 (7.1%)	2664 (7.1%)	36,062 (7.1%)	
Asian or Pacific Islander	9477 (2.0%)	911 (2.4%)	10,388 (2.0%)	
Other/missing	72,514 (15.3%)	4133 (11.1%)	76,647 (15.0%)	
Age (years)				< 0.001
Mean (SD)	57.0 (16.0)	63.0 (15.3)	57.5 (16.1)	
Range	20–104	22–98	20–104	
Charlson Comorbidity Index				< 0.001
Mean (SD)	3.0 (1.4)	3.5 (1.7)	3.0 (1.4)	
Range	2–15	2–18	2–18	
Length of stay (days) — mean (SD)				< 0.001
Mean (SD)	6.4 (7.7)	8.4 (10.2)	6.5 (8.0)	
Range	0–365	0–291	0–365	
Cost of admission (2016$) — mean (SD)				< 0.001
Mean (SD)	$20,077 (22,073)	$18,602 (26,418)	$19,968 (22,431)	
Range	$1517–$935,245	$440–$543,655	$1326–$935,245	
Elective admission — no. (%)	150,349 (31.9%)	4540 (12.2%)	154,889 (30.4%)	< 0.001
Discharge disposition — no. (%)				
Routine	241,522 (51.1%)	3274 (8.8%)	244,796 (48.0%)	< 0.001
Transfer to short-term hospital	18,202 (3.8%)	519 (1.4%)	18,720 (3.7%)	
Skilled nursing, intermediate, long-term care	116,536 (24.6%)	13,164 (35.2%)	93,088 (25.4%)	
Home health care	82,907 (17.5%)	10,181 (27.2%)	93,088 (18.2%)	
Died during admission	11,514 (2.4%)	9802 (26.2%)	21,316 (4.2%)	
Other	2186 (0.5%)	425 (1.1%)	2611 (0.5%)	
History of chemotherapy — no. (%)	25,800 (5.5%)	3959 (10.6%)	29,759 (5.8%)	< 0.001
History of radiation — no. (%)	45, 944 (9.7%)	5931 (15.9%)	51,875 (10.2%)	< 0.001
Radiation during admission — no. (%)	12,342 (2.6%)	1024 (2.7%)	13,366 (2.6%)	0.508
Chemotherapy during admission — no. (%)	14,850 (3.1%)	569 (1.5%)	15,420 (3.0%)	< 0.001
Brain surgery during admission — no. (%)	177,997 (37.6%)	4159 (11.1%)	182,155 (35.7%)	< 0.001
Intubation — no. (%)	15,831 (3.3%)	3579 (9.6%)	19,410 (3.8%)	< 0.001
Non-invasive mechanical ventilation — no. (%)	3024 (0.6%)	761 (2.0%)	3785 (0.7%)	< 0.001
Invasive mechanical ventilation — no. (%)	21, 087 (4.5%)	4697 (12.6%)	25,784 (5.1%)	< 0.001
Tracheostomy — no. (%)	2172 (0.5%)	264 (0.7%)	2436 (0.5%)	0.002
Percutaneous endoscopic gastrostomy tube — no. (%)	6744 (1.4%)	885 (2.4%)	7629 (1.5%)	< 0.001
Total parenteral nutrition — no. (%)	2257 (0.5%)	332 (0.9%)	2590 (0.5%)	< 0.001
Dialysis — no. (%)	1146 (0.2%)	142 (0.4%)	1288 (0.3%)	0.020
CPR — no. (%)	1071 (0.2%)	164 (0.4%)	1235 (0.2%)	0.001
Blood transfusion — no. (%)	22,918 (4.8%)	2545 (6.8%)	25,463 (5.0%)	< 0.001
Bed size of hospital — no. (%)				< 0.001
Small	39,881 (8.5%)	3518 (9.5%)	43,400 (8.6%)	
Medium	87,556 (18.6%)	8056 (21.7%)	95,612 (18.8%)	
Large	342, 841 (72.9%)	25,607 (68.9%)	368,448 (72.6%)	

Table 2 (continued)

	No palliative care	Palliative care	Total	*p*-value
Location/teaching status of hospital — no. (%)				< 0.001
Rural	23,524 (5.0%)	2330 (6.3%)	25,853 (5.1%)	
Urban, non-teaching	104,094 (22.1%)	9022 (24.3%)	113,116 (22.3%)	
Urban, teaching	342,661 (72.9%)	25,830 (69.5%)	368,490 (72.6%)	
Region — no. (%)				0.004
Northeast	99,817 (21.1%)	7113 (19.0%)	106,930 (21.0%)	
Midwest	112,279 (23.7%)	8059 (21.6%)	120,337 (23.6%)	
South	161,874 (34.2%)	13,788 (36.9%)	175,662 (34.4%)	
West	98,903 (20.9%)	8406 (22.5%)	107,309 (21.0%)	

[*] Percentages and averages are of the column. Percents are displayed for categorical variables while means are displayed for continuous variables

comorbidities but inversely associated with use of active cancer therapies during the examined admission. Twenty-six percent of patients receiving an inpatient palliative care consult experienced in-hospital death, and many of the same factors associated with palliative care were also associated with in-hospital death.

The increasing utilization of inpatient palliative care for patients with PBM mirrors similar trends in other diseases [10, 13]. The cause of this increase in patients with PBM is likely multifactorial. Recommendations for palliative care are now reflected in expert guidelines by societies such as NCCN, which can increase visibility and knowledge surrounding the potential benefits of this service [4]. Most teaching hospitals now offer specialty palliative care services; therefore, practicing providers and health care professional students have increased exposure to the medical specialty and opportunity to incorporate the palliative approach into hospital care [14]. The majority of palliative care consults for patients with PBM occurred at teaching hospitals, likely due to increased availability of these specialist teams [14, 15].

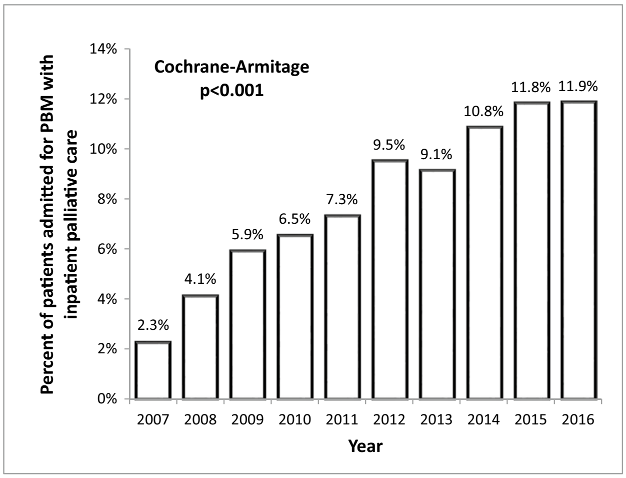

Fig. 1 Palliative care use in patients with primary brain malignancy between 2007 and 2016

Our results reveal an inverse relationship between cancer treatments during admission, such as surgery, chemotherapy, or radiation, and inpatient palliative care use. This may signal a provider bias that palliative care may detract attention from the treatment plan, though it is a recommended part of the treatment process [2, 4]. It may also reflect patient preferences against palliative care secondary to stigma and associations between palliative care and pessimism or end of life [16]. Palliative care was also associated with non-elective admission, another indicator that referral to this service may not occur as part of standard of care but rather in a more reactive manner for a patient in crisis. These relationships highlight the importance of normalizing palliative care by integrating it into standard care for patients with PBM.

Palliative care is often thought of as a service associated with the very end of life, and 26% of PBM patients receiving an inpatient palliative care consult experienced death during admission. Our analysis revealed many of the same factors were associated with both inpatient palliative care and in-hospital death, including age, comorbidities, non-elective admission, lack of inpatient cancer treatment, and life-sustaining therapies such as mechanical ventilation, further supporting the connection between these two concepts. Notable distinctions include blood transfusions and intubation, which were associated with in-hospital death and not palliative care. These practices may signify a potential opportunity to establish triggers for palliative consultation.

While palliative care is often associated with end-of-life care and a delay in palliative care is a common finding in studies examining its use, early referral to palliative care is considered best practice [4]. Palliative care is an approach that improves quality of life for patients and their families who are facing a life-threatening and potentially life-limiting illness and a landmark study found that early integration of palliative care in patients with metastatic non-small

Table 3 Multivariable logistic regression of variables associated with inpatient palliative care and death during admission

	Inpatient palliative care		Death during admission	
	Adjusted odds ratio (95% CI)	*p*-value	Adjusted odds ratio (95% CI)	*p*-value
Female	—[a]		0.86 (0.80–0.92)	< 0.001
Age	1.02 (1.02–1.02)	< 0.001	1.01 (1.01–1.01)	< 0.001
Elective admission	0.51 (0.47–0.56)	< 0.001	0.75 (0.68–0.84)	< 0.001
Length of stay	1.02 (1.02–1.03)	< 0.001	1.01 (1.01–1.01)	< 0.001
Years since 2007	1.14 (1.12–1.15)	< 0.001	0.96 (0.95–0.97)	< 0.001
Charlson Comorbidity Index	1.11 (1.10–1.13)	< 0.001	1.11 (1.09–1.14)	< 0.001
History of radiation	1.26 (1.15–1.38)	< 0.001	—	
History of chemotherapy	1.32 (1.19–1.46)	< 0.001	—	
Inpatient radiation	0.80 (0.68–0.93)	0.005	0.60 (0.48–0.75)	< 0.001
Inpatient chemotherapy	0.56 (0.44–0.71)	< 0.001	0.27 (0.19–0.39)	< 0.001
Inpatient brain surgery	0.24 (0.22–0.26)	< 0.001	0.31 (0.28–0.34)	< 0.001
Blood transfusion	—		1.71 (1.53–1.92)	< 0.001
Tracheostomy	0.51 (0.35–0.74)	< 0.001	0.31 (0.21–0.46)	< 0.001
Non-invasive mechanical ventilation	1.67 (1.36–2.05)	< 0.001	2.80 (2.13–3.69)	< 0.001
Invasive mechanical ventilation	2.87 (2.61–3.16)	< 0.001	9.30 (7.86–11.01)	< 0.001
CPR	0.62 (0.39–0.98)	0.040	24.07 (15.67–36.97)	< 0.001
Intubation	—		1.59 (1.33–1.91)	< 0.001
Hospital region (reference Northeast)			—	
Midwest	1.08 (0.96–1.22)	0.183	—	
South	1.27 (1.14–1.42)	< 0.001	—	
West	1.34 (1.18–1.51)	< 0.001	—	
Hospital type (reference rural)	—			
Urban non-teaching	—		0.54 (0.47–0.61)	< 0.001
Urban teaching	—		0.43 (0.38–0.49)	< 0.001
Constant	0.01 (0.01–0.01)	< 0.001	0.04 (0.03–0.05)	< 0.001

[a] Variable was not included in this model as it did not contribute significantly to the dependent variable

cell lung cancer (NSCLC) was associated with significantly improve quality of life and survival [18]. Palliative care that is delayed until treatment no longer benefits the patient may not be associated with significant cost reduction or improvement in quality of life for patients or families [5, 7, 17].

Early referral to palliative care is an important standard for PBM patients in particular due to the natural history of this illness with or without advanced therapies. Tumor resection can have mixed effects on cognitive function, and radiation therapy and chemotherapy can have associated neurotoxicities, leading to seizures or cognitive impairment [1]. These symptoms can affect over 60% of PBM patients at the end of life, making it difficult for patients to have complex discussions or to communicate their desired medical plans [1, 2]. Early palliative care referral, ideally at time of diagnosis, may enable a patient to participate in advance care planning to ensure that they receive desired care even if they lose their ability to communicate effectively [1, 2]. Patients' wishes can be honored and burden on family or other surrogate decision-makers can be lessened as they face difficult decision points later in the disease process.

Our study reveals that palliative care is associated with a 7% savings in hospitalization costs despite a 2-day increase in length of stay. This may reflect the established association between palliative care and less aggressive care at end of life, including decreased chemotherapy at end of life, lower rates of hospital and emergency department utilization, and increased use of hospice [7, 9, 18]. Palliative care consults are also associated with discharge disposition to home health care and nursing facilities which may represent increased use of hospice and further societal cost savings not represented in this analysis [7].

The NIS dataset provides a large sample size in a geographically diverse area over a 10-year period, thus increasing the generalizability of its results. However, the NIS dataset also has some limitations. The dataset is structured to represent hospitalizations and not unique patients, preventing examination of patients over time or differentiation of pre-existing conditions from complications of treatment. One barrier to palliative care referral is with respect to the patient's survival and identifying causal evidence for the effect of palliative care can only be done in a prospective manner. This dataset cannot determine the intensity of use of palliative care or when in the hospital course palliative care was engaged. All provided therapies, including identification of PBM or palliative care, are determined by ICD coding, which can be miscategorized or be underutilized. For example, patients with benign meningiomas or secondary neoplasms of the brain (brain metastases) may have been mis-coded as PBM. However, the use of ICD coding and the use of NIS to assess palliative care has been well validated across other types of malignancies [5, 9, 10, 19]. While the NIS lacks data specific to patients' cancer grade and histology and prevents determination of where a patient is in their disease course, our results still provide novel information to support the continued growth and availability of palliative services for patient and families hospitalized with PBM.

Future research on this topic can provide further insight into the barriers and effects of various palliative care strategies in patients with PBM. Longitudinal research is needed to better understand the drivers and effects of palliative care on individual patients, especially research examining patient-centered outcomes such as care satisfaction and quality of life indicators. Other opportunities for research include more specific investigation into efficacy of different venues, such as outpatient care, provider types, and palliative care interventions for patients with PBM.

Conclusion

Inpatient palliative care utilization for patients hospitalized with PBM significantly increased between 2007 and 2016, though the service is still underutilized in the context of the typical severe symptom burden and poor prognosis of PBM. Factors associated with palliative care consults indicate that palliative care may be more often used later in the disease course, instead of early on when it can have the most benefits in terms of improving quality of life and improving patient and caregiver satisfaction.

Author contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Sindhu Kubendran and Sharad Goyal. The first draft of the manuscript was written by Sindhu Kubendran and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability This National Inpatient Sample (NIS) dataset is available through the Healthcare Cost and Utilization Project from the Agency for Healthcare Research and Quality.

Code availability The code generated during the current study is available from the corresponding author upon reasonable request.

Declarations

Ethics approval The NIS dataset is a de-identified database and does not directly involve "human subjects" per federal regulations and guidance. The NIS dataset does not require Institutional Review Board (IRB) approval or exempt determination. All procedures performed in the study were in accordance with the ethical standards of the institutional and national research committee as well as with the 1964 Helsinki declaration and its later amendments.

Consent to participate Not applicable.

Consent to publication All authors consent for publication.

Conflict of interest The authors declare no competing interests.

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