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Tumor Boards and the Quality of Cancer Care

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- Background** Despite the widespread use of tumor boards, few data on their effects on cancer care exist. We assessed whether the presence of a tumor board, either general or cancer specific, was associated with recommended cancer care, outcomes, or use in the Veterans Affairs (VA) health system.
- Methods** We surveyed 138 VA medical centers about the presence of tumor boards and linked cancer registry and administrative data to assess receipt of stage-specific recommended care, survival, or use for patients with colorectal, lung, prostate, hematologic, and breast cancers diagnosed in the period from 2001 to 2004 and followed through 2005. We used multivariable logistic regression to assess associations of tumor boards with the measures, adjusting for patient sociodemographic and clinical characteristics. All statistical tests were two-sided.
- Results** Most facilities (75%) had at least one tumor board, and many had several cancer-specific tumor boards. Presence of a tumor board was associated with only seven of 27 measures assessed (all $P < .05$), and several associations were not in expected directions. Rates of some recommended care (eg, white blood cell growth factors with cyclophosphamide, adriamycin, vincristine, and prednisone in diffuse large B-cell lymphoma) were lower in centers with hematologic-specialized tumor boards (39.4%) than in centers with general tumor boards (61.3%) or no tumor boards (56.4%; $P = .002$). Only one of 27 measures was statistically significantly associated with tumor boards after applying a Bonferroni correction for multiple comparisons.
- Conclusions** We observed little association of multidisciplinary tumor boards with measures of use, quality, or survival. This may reflect no effect or an effect that varies by structural and functional components and participants' expertise.
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Care for cancer is increasingly complex and often requires specialized expertise from multiple disciplines. Tumor board reviews provide a multidisciplinary approach to treatment planning that involves doctors from different specialties reviewing and discussing the medical condition and treatment of patients (1). They serve to educate providers, to increase shared appreciation of different specialists' perspectives on the approach to specific cancers, and to assist in management decisions for specific patients, although the functions may vary. Tumor boards have been an accepted and established part of the care of cancer patients for decades (2). They are perceived to be so important that the American College of Surgeon's Commission on Cancer Program accreditation requires cancer programs to have a multidisciplinary cancer conference that prospectively reviews cases and discusses management decisions (3).

Despite their widespread use, few data are available about the effects of tumor boards on cancer care (4). We studied cancer care in the Veterans Affairs (VA) health system, the largest integrated delivery system in the United States, to explore the association of tumor boards and measures of cancer care quality and use. Cancer is the second leading cause of morbidity and mortality for veterans, and data suggest that the care delivered to veterans with cancer

is generally similar to or better than care delivered to individuals insured under fee-for-service Medicare (5–7). Specifically, we assessed if the presence of a tumor board, either general or cancer specific, was associated with higher rates of recommended stage-specific cancer care or differences in use of care for veterans with colorectal, lung, prostate, hematologic, and breast cancers.

Methods

Data

The Department of Veterans Affairs Central Cancer Registry (VACCR) collects uniformly reported information on all patients who were diagnosed with and/or received their first course of treatment for invasive cancer at one of the VA medical centers. For all incident cancers, registrars collect information about patient demographics, tumor characteristics, and primary treatment. We linked the registry data with VA administrative data on hospitalizations, outpatient visits, contracted care, laboratory data, inpatient and outpatient pharmacy data, and all Medicare administrative data for Medicare-eligible patients. We obtained National Death Index data to ascertain vital status through

2005. Data were linked using social security numbers. Patients were assigned to the hospital that reported their cancer to the VACCR. We also surveyed 138 VA medical centers in December 2005 (response rate 100%) using a web-based instrument about availability of tumor boards, cancer providers, cancer screening and diagnostic services, chemotherapy, radiotherapy, and palliative care. The survey was supported by VA leadership, and the instrument was directed to veteran integrated service network chief medical officers (and the designated point of contact for each center to complete the survey using the following hierarchy: cancer committee chairpersons (21% of facilities), chief staff oncologist/hematologist (39% of facilities), chief of staff (28% of facilities), or a different physician (eg, surgeon; 12% of facilities). This survey was also presented during two veteran integrated service network chief medical officer conference calls to encourage participation. The study was approved by the Harvard Medical School Committee on Human Studies.

Cancer and Stage-Specific Cohorts

We studied patients with colorectal, lung, prostate, hematologic, and breast cancers. For each cancer type, we identified all patients diagnosed with a first diagnosis of that cancer type during the period from 2001 to 2004. As previously described (5), we excluded small numbers of cases with histology that suggested alternative primary cancers, patients diagnosed at autopsy or by death certificate only, and patients for whom data were incomplete (eg, missing month of diagnosis, no administrative data between 45 days before diagnosis through 195 days after diagnosis). These initial exclusions were to ensure that included patients actually had the cancers of interest and could be treated and that data were complete. Additional inclusion criteria were developed for individual cancer type and stage-specific cohorts, as described below.

Tumor Boards

The facility survey asked each facility to report if they had one or more than one tumor board. If they reported at least one tumor board, they reported whether the tumor board(s) discussed lung cancer, colorectal cancer, prostate cancer, breast cancer, and/or hematologic cancers. They also reported participants at each tumor board, including surgeons, medical oncologists, radiation oncologists, pathologists, social workers, and palliative care specialists.

For each facility and each cancer type with sufficient numbers of patients (lung, colorectal, prostate, hematologic), we characterized if they had no tumor board, a general tumor board, or a cancer-specific tumor board. We also characterized each facility based on the presence or absence of palliative care specialists at the tumor board(s).

Cancer Care Measures

We identified measures of high-quality care and use of care for patients with lung, colorectal, prostate, or hematologic cancers (there were too few breast cancer patients to accurately assess breast cancer measures) (5–7). These process and outcome measures were developed based on national guidelines available during the study period (8–29). Table 1 displays the measures and eligibility criteria.

Control Variables

We also collected information on other patient and tumor factors that might influence receipt of cancer treatments. Information on age, marital status at diagnosis, race/ethnicity, tumor characteristics, and history of previous cancer was included in the registry data, based on medical record abstraction. We characterized comorbid illnesses based on inpatient and outpatient administrative data in the year before diagnosis using the Klabunde modification of the Charlson score (30,31). We linked data with year 2000 Census data for area-level information on the proportion of residents with a college degree. Although there are limitations to the use of area-level measures of socioeconomic status as proxies for individual measures (32), they are nevertheless associated with cancer care and outcomes (33).

Statistical Analyses

We first described the presence and types of tumor boards across the VA facilities. Next, we assessed the association of tumor boards and each indicator using multivariable logistic regression analyses with generalized estimating equations to account for clustering by VA medical center. We used separate models for each indicator. The primary independent variable, availability of tumor boards, was specified with two indicator variables for availability of general tumor boards and availability of cancer-specific tumor boards (with no tumor board as the reference category). We tested for the joint significance of these two variables and present the overall, two-sided *P* value for the effect of tumor board and type of tumor board on the measure of interest, adjusting for all other variables. *P* values less than .05 were considered statistically significant for primary analyses. All analyses were adjusted for patient age, sex, race/ethnicity, marital status, quartiles of the proportion with a college degree in the zip code of residence, history of previous cancer, Charlson comorbidity score, year of diagnosis, tumor grade, and veteran integrated service network. We included stage or cancer type in analyses with patients of more than one stage. We included tumor size in models assessing survival. We included information on availability of services at the reporting facility in relevant models, including radiation in assessing radiation, thoracic surgeons in lung cancer models, urologists in prostate cancer models, and hospice and palliative care services in models assessing palliative care or end-of-life measures. Analyses were conducted using Stata statistical software, version 11 (StataCorp, College Station, TX). For each category of the tumor board variables, we calculated the adjusted rate with each measure using direct standardization (34). We also used a Bonferroni correction to adjust for multiple comparisons ($P < .05/27$) and considered only values less than .00185 to be statistically significant.

Results

Overall, 103 (75%) of the 138 VA medical centers reported having at least one tumor board (Table 2). Sixty-two centers had a single tumor board that discussed cases from multiple cancer sites, and 41 centers had more than one disease-specific tumor board.

Among the 62 centers with a single tumor board, nearly all discussed all of the cancer types we inquired about, including colorectal (92%), lung (97%), prostate (92%), breast (85%), and

Table 1. Measures of cancer care use, recommended processes of care, and outcomes*

Measure	Definition	Cohort	Measure type
Colorectal cancer			
Adjuvant chemotherapy for stage III colon cancer (9)	At least 1 dose of adjuvant 5 fluorouracil or capecitabine administered within 90 days of the date of curative-intent resection of stage III colon cancer	All patients with stage III colon cancer who underwent curative-intent resection. Patients were required to be alive and not in a Medicare HMO through 90 days from surgery.	Quality
Adjuvant chemotherapy and radiation therapy for stage II/III rectal cancer (10)	At least 1 dose of adjuvant chemotherapy with 5 fluorouracil or capecitabine AND at least 1 treatment with radiation therapy before or within 140 days of the date of curative intent resection for stage II, III rectal cancer	All patients with stage II/III rectal cancer who underwent curative-intent resection. Patients were required to be alive and not in a Medicare HMO through 180 days from surgery.	Quality
Three-year all-cause survival for colon cancer patients	Patients alive 3 years after the date of diagnosis	All patients with colon cancer	Outcome
Three-year all-cause survival for rectal cancer patients	Patients alive 3 years after the date of diagnosis	All patients with rectal cancer	Outcome
Lung cancer			
Curative surgery for stage I/II NSCLC (11)	Receipt of pneumonectomy, lobectomy or wedge or segmental resection within 180 days of diagnosis	All patients with stage I/II lung cancer. Patients were required to be alive and not in a Medicare HMO through 180 days from diagnosis. Patients were also included if they died within 180 days but underwent surgery.	Quality
Radiation for unresected stage I/II NSCLC (11)	Receipt of at least 1 treatment with radiation therapy within 180 days of the diagnosis date	All patients with stage I/II lung cancer who did not undergo pneumonectomy, lobectomy, or wedge or segmental resection within 180 days of diagnosis. Patients were required to be alive and not in a Medicare HMO through 180 days from diagnosis.	Quality
Mediastinal evaluation for patients undergoing lobectomy or pneumonectomy for stage I/II NSCLC (11)	Receipt of mediastinal evaluation from 45 days before date of diagnosis through date of lobectomy or pneumonectomy	All patients with stage I/II NSCLC who underwent lobectomy or pneumonectomy. Patients were required to be alive and not in a Medicare HMO through 180 days from surgery.	Quality
Chemotherapy or radiation for stage IIIA NSCLC patients who received surgery (11)	At least 1 dose of adjuvant chemotherapy and/or at least 1 treatment with adjuvant radiation therapy from 30 days before date of diagnosis through 90 days from date of pneumonectomy, lobectomy, or wedge resection for NSCLC	All patients with stage IIIA NSCLC who underwent lobectomy or pneumonectomy or wedge resection. Patients were required to be alive and not in a Medicare HMO through 90 days from surgery.	Quality
Doublet chemotherapy for stage IV NSCLC (11)	Receipt of at least 1 dose of platinum-based doublet chemotherapy, nondoublet chemotherapy, or no chemotherapy within 180 days of diagnosis	All patients with stage IV NSCLC. Patients must survive 45 days from diagnosis and not be enrolled in Medicare HMO through diagnosis through death or 180 days, whichever comes first.	Use
Chemotherapy and radiation for limited-stage small-cell lung cancer (17)	Receipt of at least 1 dose of cisplatin or carboplatin and VP-16 with concurrent radiation therapy within 180 days of diagnosis; chemotherapy must start between the start and end dates of radiation therapy	VA patients were required to be alive through 45 days from diagnosis and not in a Medicare HMO through 180 days from diagnosis.	Quality
One-year all-cause survival for NSCLC	Patients alive 1 year after the date of diagnosis	All patients with NSCLC	Outcome
One-year all-cause survival for small-cell lung cancer	Patients alive 1 year after the date of diagnosis	All patients with small cell lung cancer	Outcome
Prostate cancer			
Primary therapy for local/regional prostate cancer	Radical prostatectomy vs radiation vs neither within 180 days of diagnosis	All patients with local/regional prostate cancer. Patients were required to be alive and not in a Medicare HMO through 180 days from diagnosis.	Use

(Table continues)

Table 1 (Continued).

Measure	Definition	Cohort	Measure type
Androgen ablation within 4 months of diagnosis for stage IV prostate cancer (13,15,16,19)	Androgen deprivation therapy with at least 1 dose of a GnRH agonist or bilateral orchiectomy within 120 days of diagnosis	All patients with stage IV cancer at diagnosis. Patients were required to be alive and not in a Medicare HMO through 120 days from diagnosis.	Quality
Oral antiandrogen before initiating GnRH agonist therapy for metastatic prostate cancer (8)	Among men with metastatic cancer who are started on GnRH agonist, evidence that they also filled a prescription for an oral antiandrogen for at least 2 weeks, with the date of the prescription fill at least 1 week before first dose of GnRH agonist	All patients with stage IV cancer at diagnosis who started a GnRH agonist	Quality
Adjuvant androgen deprivation therapy for high-risk cancers treated with radiation therapy (8)	Proportion of patients with high-risk prostate cancer (Gleason 8–10 or PSA >20 or stage T3 or greater) treated with at least 1 radiation treatment who also get hormonal therapy (adjuvant or neoadjuvant)	All patients with high-risk, nonmetastatic tumors treated with radiation therapy within 180 days of diagnosis. Patients were required to be alive and not in a Medicare HMO through 180 days from diagnosis. Included only cases in 2001–2002 because Gleason 7 tumors could not be distinguished from Gleason 8 in 2003–2004.	Quality
3D-CRT or IMRT if treated with external-beam radiation for local/regional prostate cancer (8,14,18)	Receipt of 3D-CRT or IMRT among men with local-regional prostate cancer who received external beam radiation therapy within 180 days of diagnosis	All patients with local/regional prostate cancer at diagnosis who had evidence for external beam radiation therapy in administrative data. Patients were required to be alive and not in a Medicare HMO through 180 days from diagnosis.	Quality
Hematologic cancers			
CHOP chemotherapy for diffuse large B-cell non-Hodgkins lymphoma (22)	At least 1 dose of each agent of CHO-based chemotherapy from 15 days before date of diagnosis through 60 days after diagnosis	All patients with diffuse large B-cell lymphoma. Patients were required to be alive and not in a Medicare HMO through 60 days from diagnosis.	Quality
Rituximab with CHOP chemotherapy for diffuse large B-cell non-Hodgkins lymphoma (21)	At least 1 dose of rituximab with CHO-based chemotherapy (as defined above) from 15 days before date of diagnosis through 60 days after diagnosis	CHO(P)-treated patients with diffuse-large B cell lymphoma with outpatient claims for chemotherapy in 2002–2004 (patients from measure above)	Quality
White blood cell growth factor with CHOP chemotherapy in diffuse large B-cell non-Hodgkins lymphoma (29)	Receipt of at least 1 dose of white blood cell growth factor from 14 days before date of first CHO-based chemotherapy through 21 days after	CHO(P)-treated patients with diffuse-large B cell lymphoma. Patients could not be in a Medicare HMO during the time of interest.	Quality
Bisphosphonates for myeloma (12,20,23)	At least 1 dose of intravenous pamidronate or zoledraic acid from 15 days before date of diagnosis through 180 days after diagnosis	All patients diagnosed with myeloma. Patients were required to be alive and not in a Medicare HMO through 180 days from diagnosis.	Quality
Palliative care and end-of-life care			
Last dose of chemotherapy within 14 days before death (24,25)	Receipt of last dose of chemotherapy within 14 days of death	All patients diagnosed with stage IV NSCLC or colorectal cancer who died. Patients could not be enrolled in a Medicare HMO in the last 30 days of life.	Use
Admitted to an intensive care unit (ICU) within 30 days before death (24,25)	Admission to the ICU in the last month of life	All patients diagnosed with stage IV NSCLC or colorectal cancer who died. Patients could not be enrolled in a Medicare HMO in the last 30 days of life.	Use
More than 1 emergency room visit within 30 days before death (24,25)	More than 1 emergency room visit in the last month of life	All patients diagnosed with stage IV NSCLC or colorectal cancer who died. Patients could not be enrolled in a Medicare HMO in the last 30 days of life.	Use
Use of potent antiemetics for highly emetogenic chemotherapy (26,28)	Receipt of at least 1 dose of a 5HT blockade among patients treated with highly emetogenic chemotherapy. 5HT blockade assessed from 30 days before date of first dose of a highly emetogenic chemotherapy through 30 days following last dose of the same chemotherapy	All VA patients with any cancer treated with one of the highly emetogenic chemo drugs, including adriamycin, cisplatin, carbo-platin, cyclophosphamide, ifosphamide, idarubicin, epirubicin, daunorubicin. Patients could not be in a Medicare HMO during the time window of interest.	Quality

(Table continues)

Table 1 (Continued).

Measure	Definition	Cohort	Measure type
Prescription of narcotic pain medication for advanced cancer patients in pain (27)	At least 1 opioid prescription filled among stage IV patients with 2 consecutive pain scores ≥ 5 . Script must be filled during the period between the 2 pain scores.	All patients with any cancer diagnosed at stage IV who have 2 consecutive pain scores of ≥ 5 from 3 to 30 days apart with no lower pain score between and no hospitalization. Patients could not be in a Medicare HMO during the time window of interest.	Quality

* 3D CRT = 3-dimensional conformal radiation therapy; 5HT = 5-hydroxytryptamine receptor; CHO = cyclophosphamide, adriamycin, vincristine; CHOP = cyclophosphamide, adriamycin, vincristine, and prednisone; GnRH = gonadotropin-releasing hormone; HMO = health maintenance organization; IMRT = intensity-modulated radiation therapy; NSCLC=non-small-cell lung cancer; PSA = prostate-specific antigen; VA = Veterans Affairs.

Table 2. Tumor boards in Veterans Affairs medical centers

Tumor board features	No.	%
Among all 138 facilities	138	100
Tumor board present		
No tumor board	35	25
Single tumor board	62	45
More than one tumor board	41	30
Among 62 facilities with a single tumor board	62	100
Presentation of patients with these cancer types		
Colorectal cancer	57	92
Lung cancer	60	97
Prostate cancer	57	92
Breast cancer	53	85
Lymphoma/hematologic cancer	52	84
Tumor board participants		
Medical oncologist	59	95
Pathologist	54	97
Surgeon	57	92
Radiation oncologist	50	81
Radiologist	47	76
Social worker	19	31
Palliative care specialist	19	31
Nutritionist	13	21
Among 41 facilities with more than one tumor board	41	100
Has tumor board specifically for		
Colorectal cancer	39	95
Lung cancer	41	100
Prostate cancer	34	83
Breast cancer	27	66
Lymphoma/hematologic cancer	30	73

hematologic cancers (84%). Most of these tumor boards (n = 48 of 62) discussed all five of these cancer types. Participants in these tumor boards nearly always included medical oncologists (95%), pathologists (97%), and surgeons (92%) and typically also included radiation oncologists (81%) and radiologists (76%). Other providers, such as social workers (31%), palliative care specialists (31%), and nutritionists (21%), were less often included (Table 2).

Among the 41 centers with more than one tumor board, all had a lung cancer-specific tumor board, and nearly all (95%) had a colorectal cancer-specific tumor board. Most also had a prostate cancer-specific tumor board (83%), a hematologic cancer-specific tumor board (73%), and a breast cancer-specific tumor board (66%) (Table 2). Most (n = 22 of 41) had tumor boards for all five of the cancer types we discussed. Another eight centers had tumor boards for lung, prostate, colorectal, and hematologic cancers; three had tumor boards for lung, prostate, colorectal, and breast cancers;

two had tumor boards for lung, colorectal, and breast cancers; one had tumor boards for lung, prostate, and colorectal cancers; three had tumor boards for lung and colorectal cancers; and two had a tumor board for lung cancer.

Table 3 presents the adjusted proportion of patients with each indicator by tumor board status. Overall, the presence of a tumor board was associated with only seven of 27 measures assessed (all $P < .05$). Among patients with colorectal cancer, none of the process or outcome measures were associated with the presence or type of tumor board. For patients with lung cancer, three of the nine measures were associated with the presence or type of tumor board. Patients with stage I/II non-small-cell lung cancer who did not undergo curative surgery who were treated at centers with a general tumor board were more likely than patients at a center with no tumor board or a lung cancer-specific tumor board to undergo radiation. Patients with stage IIIA lung cancer who did not undergo resection who were at centers with a general tumor board or a lung cancer-specific tumor board were more likely than those at a center with no tumor board to undergo chemotherapy and radiation therapy. Patients with limited-stage small-cell lung cancer who were at centers with a general tumor board or a lung cancer-specific tumor board were more likely than patients at a center with no tumor board to undergo chemotherapy and radiation.

One of the five measures of prostate cancer care was associated with tumor boards; patients at a center with a prostate cancer-specific or general tumor board were more likely to receive oral antiandrogen therapy before initiating gonadotropin-releasing hormone agonist therapy for metastatic prostate cancer. Two of the four hematologic measures were associated with tumor board status. Receipt of rituximab with cyclophosphamide, adriamycin, vincristine, and prednisone (CHOP) chemotherapy for non-Hodgkins lymphoma was highest among patients at a center with no tumor board or with a hematologic cancer-specific tumor board compared with patients at a center with a general tumor board. Receipt of white blood cell growth factor among patients receiving CHOP chemotherapy was highest among patients treated at a center with a general tumor board (61.3%) or no tumor board (56.4%) compared with a hematologic cancer-specific tumor board (39.4%; $P = .002$) (Table 3).

For the palliative care and end-of-life care measures, we assessed whether the general tumor board or at least one of the cancer-specific tumor boards of interest had a palliative care specialist participating. Only one of these five measures was associated with the presence of a tumor board; patients at a center without a

Table 3. Adjusted proportion of each cancer care process by availability of tumor boards

Colorectal cancer	No. patients	No tumor board, %	General tumor board, %	Colorectal cancer-specific tumor board, %	P*
Measure					
Adjuvant chemotherapy for stage III colon cancer	1738	68.7	69.3	70.4	.83
Adjuvant chemotherapy and radiation for stage II/III rectal cancer	801	74.6	73.9	74.6	.97
3-year (all-cause) survival in colon cancer patients	4995	57.5	58.2	60.2	.24
3-Year (all-cause) survival in rectal cancer patients	1389	52.5	56.2	54.6	.37
Lung cancer	No. patients	No tumor board, %	General tumor board, %	Lung cancer-specific tumor board, %	P
Curative surgery for stage I/II NSCLC	4291	53.2	56.5	61.9	.14
Radiation for unresected stage I and II NSCLC	1666	66.5	70.8	63.8	.04
Mediastinal evaluation for stage I/II NSCLC	2191	85.7	85.6	89.3	.37
Chemotherapy or radiation therapy for stage IIIA NSCLC patients who received surgery	370	79.6	74.8	65.1	.27
Chemotherapy and radiation therapy for unresected NSCLC stage IIIA patients	1305	23.9	39.5	35.6	.02
Doublet chemo for stage IV lung cancer	5853				.15
None		56.0	52.3	50.6	
Doublet chemo		37.3	42.7	42.8	
Nondoublet chemo		6.7	5.0	6.6	
Chemotherapy and radiation therapy for limited-stage small-cell lung cancer	1062	28.4	61.8	62.9	<.001†
1-year (all-cause) survival, NSCLC	21 123	41.3	39.5	41.0	.22
1-year (all-cause) survival, small-cell lung cancer	3493	25.2	26.2	26.6	.88
Prostate cancer	No. patients	No tumor board, %	General tumor board, %	Prostate cancer-specific tumor board, %	P
Primary therapy for local/ regional prostate cancer	32 533				.37
No radiation or surgery		38.9	38.9	37.7	
Radiation		35.4	38.1	36.0	
Surgery		25.6	23.0	26.4	
Androgen ablation for men diagnosed with metastatic prostate cancer	1582	77.2	70.7	76.9	.24
Oral anti-androgen before initiating GnRH agonist for metastatic prostate cancer	1459	71.1	81.7	83.7	.03
Adjuvant androgen deprivation therapy for high-risk cancers treated with radiation therapy (2001–2002)	1537	56.7	63.0	68.6	.25
Use of 3-D CRT/IMRT for men treated with external beam radiation therapy	7898	61.0	59.3	61.0	.94
Lymphoma and multiple myeloma	No. patients	No tumor board, %	General tumor board, %	Hematologic cancer-specific tumor board, %	P
CHOP chemotherapy in diffuse large B-cell NHL patients	766	80.7	75.4	80.6	.31
Rituximab with CHOP in diffuse large B-cell NHL patients	431	89.3	74.6	87.1	.003
White blood cell growth factor with CHOP in diffuse large B-cell NHL patients	350	56.4	61.3	39.4	.002
Bisphosphonate therapy for multiple myeloma patients	899	59.6	66.4	66.2	.18
Palliative care and end-of-life care	No. patients	No tumor board, %	Tumor board without palliative care specialist, %	Tumor board with palliative care specialist, %	P
Receipt of last dose of chemotherapy within 14 days of death	9796	4.8	5.8	5.4	.47
ICU admissions within 30 days of death	9796	15.7	12.8	13.1	.36
More than one ER visit within 30 days of death	9796	9.6	12.0	9.2	.01
Use of potent antiemetics for highly emetogenic chemotherapy	11 256	64.7	75.4	66.4	.10
Prescription of narcotic pain medication for advanced cancer patients in pain	2813	69.6	68.6	67.0	.76

* We assessed the association of tumor boards and each indicator using multivariable logistic regression analyses with generalized estimating equations to account for clustering by Veterans Affairs medical center. We used separate models for each indicator. The primary independent variable, availability of tumor boards, was specified with two indicator variables for availability of general tumor boards and availability of cancer-specific tumor boards (with no tumor board as the reference category). We tested for the joint significance of these two variables, and present the overall two-sided *P* value for the effect of tumor board and type of tumor board on the measure of interest, adjusting for all other variables. 3D CRT = 3-dimensional conformal radiation therapy; CHOP = cyclophosphamide, adriamycin, vincristine, and prednisone; ER = emergency room; GnRH = gonadotropin-releasing hormone; ICU = intensive care unit; IMRT = intensity-modulated radiation therapy; NHL = non-Hodgkin lymphoma; NSCLC = non-small-cell lung cancer.

† This was the only statistically significant association after applying a Bonferroni correction for multiple comparisons ($P < .05/27$ or $P < .00185$).

tumor board or with a tumor board with a palliative care specialist were less likely than those at a center with a tumor board but no palliative care specialist to have more than one emergency room visit within 30 days of death (Table 3).

After applying a Bonferroni correction for multiple comparisons, only one of the 27 indicators was statistically significant ($P < .00185$): patients with limited-stage small-cell lung cancer who were at centers with a general tumor board or a lung cancer-specific tumor board were more likely than patients at a center with no tumor board to undergo chemotherapy and radiation.

Discussion

The VA health system is the largest integrated delivery system in the United States, caring for more than 6.1 million veterans. Cancer is second to cardiovascular disease as a cause of morbidity and mortality for veterans, and data suggest that the care delivered to veterans with cancer is generally similar to or better than care delivered to individuals insured under fee-for-service Medicare (5–7). We surveyed all 138 VA medical centers to learn about the availability of tumor boards to discuss cancer care and assessed whether the presence of general or cancer-specific tumor boards was associated with various measures of use, quality, or outcomes. Most facilities (75%) had at least one tumor board, and many had a number of cancer-specific tumor boards. Yet, we found that only seven of 27 measures we assessed were associated with tumor boards; and if we applied a Bonferroni correction for multiple comparisons, only one of the measures was statistically significantly associated. Moreover, several of the seven associations were not in expected directions, with, for example, rates of some recommended care (eg, white blood cell growth factors with CHOP in diffuse large B-cell non-Hodgkins lymphoma) lower in centers with cancer-specific tumor boards than in centers with general tumor boards or no tumor boards.

Tumor boards are widely seen as serving an important role in physician education and patient care, with the aspiration that care will be better coordinated among specialists and ultimately will be of higher quality. The American College of Surgeon's Commission on Cancer Program accreditation requires all accredited cancer programs to have a multidisciplinary cancer conference that meets at least monthly and prospectively reviews cases and discusses management decisions (3). A national survey of 1700 US hospitals in the late 1980s documented that tumor boards are widely used, with substantial variability in the format, participants, and function of tumor boards (2). This survey also estimated that more than 50 physician hours per month are devoted to tumor board meetings (2). With person-time investments such as this, it is surprising how little data are available about the impact of tumor boards on cancer care.

Some small studies have demonstrated the potential for tumor boards to influence clinical care. One study of eight tumor boards in six hospitals in Oakland assessed care on 97 patients for which 153 specific prospective recommendations were made and found that 84% of the recommendations were followed (35); similar findings were evident for a brain cancer tumor board (36). Another study of a breast cancer tumor board at a single cancer center found that more than half of patients discussed at a tumor board

over a 1-year period had changes in their recommended surgical treatment based on review. Modest evidence from single institutions suggests that presentation of a case at a multidisciplinary tumor board was associated with higher rates of guideline-recommended care for patients with rectal cancer (37), lung cancer (38), or esophageal cancer (39).

We found relatively modest and contradictory associations of tumor boards with care received. With three lung cancer measures (including the one that was statistically significant after the Bonferroni correction for multiple comparisons), we observed higher rates of care that involved consideration of multiple treatment modalities associated with tumor boards: radiation for unresected patients with stage I/II non-small-cell lung cancer, chemotherapy and radiation for unresected stage IIIA non-small-cell lung cancer, and chemotherapy and radiation for limited-stage small-cell lung cancer. Nevertheless, we did not observe effects for other measures of multimodality therapy, including adjuvant chemotherapy for colon cancer, chemotherapy and radiation therapy for rectal cancer, chemotherapy or radiation for resected stage IIIA non-small-cell lung cancer patients, or adjuvant androgen deprivation for high-risk prostate cancers treated with radiation. Moreover, we found high rates of some measures (eg, rituximab with CHOP and white blood cell growth factor with CHOP for lymphoma) among patients at sites with no tumor boards. Information about some types of recommended care may be disseminated effectively without tumor boards. This may be particularly true in an integrated delivery system where care may be better coordinated than in other settings. It is also possible that cancer specialists working at centers without tumor boards may also have appointments at other hospitals where they may have access to tumor boards.

Our study's strengths include the ability to study care within a large, integrated delivery system for patients treated at 138 VA medical centers that varied in their use of tumor boards. We had a 100% response rate to our facility survey, and we studied a variety of indicators for all eligible patients with the cancers of interest over the study period. Nevertheless, some limitations should be noted. First, although we had information on the focus of the tumor board (general or cancer specific) and participants, we did not know the format or frequency of the tumor board or whether individual patients (including patients in our measures) were discussed nor did we have any information about group dynamics or group experiences. We also did not know to what extent each patient's physician(s) participated in the tumor boards or if any medical centers initiated quality improvement initiatives or research network participation during the study period. Second, there may be aspects of care influenced by tumor boards that our measures did not capture. Third, we did not collect information about patients' perceptions of care; some data suggest that breast cancer patients seen at centers with regular multidisciplinary case conferences may have better perceptions of comprehensive cancer care (40). Finally, we asked about tumor boards in late 2005 and studied care in the period from 2001 to 2005; to our knowledge, the presence of tumor boards in the VA was stable in the early 2000s.

In conclusion, we observed little association of multidisciplinary tumor boards with measures of use, quality, or survival. This could mean that tumor boards did not, in fact, influence quality of cancer

care in the VA setting. It might also mean that tumor boards are only as good as their structural and functional components and the expertise of the participants, and because tumor boards likely vary in their efficacy depending on these factors, measuring only the presence of a tumor board may not be sufficient to understand their effects. Additional research is needed to understand the structure and format of tumor boards that lead to the highest quality care.

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