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Prevalence and characteristics of cancer patients receiving care from single vs. multiple institutions

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Abstract

Introduction—Patients may receive cancer care from multiple institutions. However, at the population level, such patterns of cancer care are poorly described, complicating clinical research. To determine the population-based prevalence and characteristics of patients seen by multiple institutions, we used operations data from a state-mandated cancer registry.

Methods and materials—59,672 invasive cancers diagnosed in 1/1/2010-12/31/2011 in the Greater Bay Area of northern California were categorized as having been reported to the cancer registry within 365 days of diagnosis by: 1) ≥1 institution within an integrated health system (IHS); 2) IHS institution(s) and ≥1 non-IHS institution (e.g., private hospital); 3) 1 non-IHS institution; or 4) ≥2 non-IHS institutions. Multivariable logistic regression was used to characterize patients reported by multiple vs. single institutions.

Results—Overall in this region, 17% of cancers were reported by multiple institutions. Of the 33% reported by an IHS, 8% were also reported by a non-IHS. Of non-IHS patients, 21% were reported by multiple institutions, with 28% for breast and 27% for pancreatic cancer, but 19%% for lung and 18% for prostate cancer. Generally, patients more likely to be seen by multiple institutions were younger or had more severe disease at diagnosis.

Conclusions—Population-based data show that one in six newly diagnosed cancer patients received care from multiple institutions, and differed from patients seen only at a single institution. Cancer care data from single institutions may be incomplete and possibly biased.

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Conflicts of interest

None. Since completing this work, Dr. Clarke has taken a position with GRAIL, Inc, a life sciences company.

Contributions

CC, SLG, THK, KDA, and ScLG designed and conducted the research, prepared the manuscript and have responsibility for content; RL analyzed data. All authors read and approved the final manuscript.

1. Background

In the United States, patients may receive care for a given cancer from multiple institutions. When care is provided across multiple, non-integrated institutions, single institution medical record- based research, quality monitoring, or clinical learning systems [1–4] could be missing relevant tests, procedures or treatments [5]. Such research could thus be biased if it includes care only from a single institution [6]. Relatedly, research databases that aggregate de-identified records across institutions may double count the same patient seen at two institutions. Despite the importance of multi-institutional cancer care to clinical and health services research, little has been published describing the patterns of cancer care received across multiple institutions.

Cancer is unique among chronic diseases in the United States because all 50 states mandate that hospitals and private physicians report information to a central cancer registry about every patient newly diagnosed or seen for cancer [7]. Central cancer registries consolidate this information (abstracted per international standards) from all clinical reports in the population, including those from different institutions, into a single record for that cancer. However, the resulting research databases generally do not include details about the number and types of reporting institutions for each tumor. Thus, central cancer registry operations data, containing the unconsolidated records, provide a unique and underutilized opportunity to characterize cancer patients at the population-level according to the number of institutions at which they received care for a given cancer. Using such data from California, we quantified the number of institutions from which cancer patients were reported and determined whether patients seen only at one institution for their cancer differed in their sociodemographic and tumor characteristics from those seen at more than one institution. We evaluated patients newly diagnosed with any invasive cancer, with specific focus on those sites representing a range of care patterns (breast, prostate, lung, and pancreatic cancers).

2. Methods

From the Greater Bay Area Cancer Registry (GBACR), funded by the California Cancer Registry and the National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) program, we obtained reports from all medical facilities for patients newly diagnosed with an invasive cancer during a two-year period (1/1/2010-12/31/2011) while resident in one of the GBACR's nine Northern California catchment counties (Alameda, Contra Costa, Marin, Monterey, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz). We examined all cancers combined and four site- specific cancers representing a spectrum of care – breast and prostate cancers have detailed clinical practice guidelines and generally favorable survival, while lung and pancreatic cancers are rapidly fatal and require more complex care. We defined these specific cancers as follows, using International Classification of Diseases-Oncology 3rd edition site and histology codes: breast C500–509, prostate C619, lung C340–349, pancreas C250–259, including all histologies except 9050–9055, 9140, and 9590–9992.

For analysis, we obtained patient and tumor characteristics from the GBACR (routinely abstracted from the medical record), including age at diagnosis, sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic Asian/Pacific Islander, hereafter referred to as white, African-American, Hispanic, and Asian/PI, and other/unknown), AJCC stage at diagnosis, primary source of payment at the time of initial diagnosis or treatment (health insurance status), and a composite measure of neighborhood socioeconomic status (nSES) based on census block group of residence at diagnosis [8]. Patients were assigned an nSES quintile based on the distribution of nSES across all census block groups in California.

From the GBACR patient "admissions-level" database (i.e., data reflecting each institutional report per patient for a specific tumor rather than institutional-level data consolidated to the tumor level, as is reported to SEER and the CCR, and available for research), we obtained the names of all medical facilities (public and private hospitals; freestanding surgery, radiation, or pathology centers; private physician offices) reporting that they had diagnosed or treated a given cancer within 365 days of the first report. Over the study time period, 59,672 invasive tumors were reported to the GBACR from 205 facilities, including at least 85 located outside the registry's catchment area. We grouped facilities into two types: those that were part of an integrated health system (IHS) (n = 35) known to share medical record systems and for which access is based on specific insurance coverage (i.e., Kaiser Permanente, Veterans Affairs systems), and those that were not (called non-IHS institutions) (n = 170). Private physician offices were counted as a single entity. We then grouped patients into four mutually exclusive categories: 1) reported from an IHS only; 2) reported from an IHS and at least one non-IHS institution; 3) reported from a single, non-IHS institution only; 4) and reported from two or more non-IHS institutions. For patients with any invasive cancer and for those with any of the four specific cancer types described above, we calculated frequencies and percentages of patients in these four categories. To describe whether diagnostic or therapeutic care was reported by each hospital, we utilized the Commission on Cancer definitions of "class of case" [9]. Unfortunately, cancer registry data items do not distinguish whether care was inpatient or outpatient or whether it was coordinated among different non-IHS institutions.

2.1. Statistical analysis

To understand independent patient and tumor characteristics associated with numbers of institutions from which patients were reported, we used multivariable logistic regression analyses to calculate adjusted odds ratios (OR) and 95% confidence intervals (CI) associated with being reported by multiple institutions as compared to a single institution (in groups stratified by any report by IHS). All *P* values reported are two-sided, and those <0.05 are considered statistically significant.

3. Results

In this region, 17% of cancers newly diagnosed in the study period were reported by multiple institutions. Among the 33% of cancers ever reported by an IHS, 8% were additionally reported by an institution outside the IHS, with higher proportions among

patients with breast cancer (11%) than pancreatic cancer (6%) (Table 1). Among the 66% of patients reported only by non-IHS institutions, a much higher proportion (21%) was reported by multiple institutions; these proportions varied by cancer site, with higher proportions among patients with breast (28%) and pancreatic (27%) cancer than lung (19%) and prostate (18%) cancer.

Table 2 shows that, for patients reported for cancer care by multiple institutions, the most common pattern involved one institution reporting the diagnosis and treatment and additional institution(s) also reporting treatment; this situation occurred for approximately three-quarters of all cancer patients reported by at least one IHS, and about half of all cancer patients never reported by any IHS. Smaller proportions of patients were diagnosed at one institution and then treated at another institution(s). In general, patients reported by an IHS were more likely to have received some or all treatment at another institution than patients never reported by an IHS, who were more likely to have received diagnostic services from multiple institutions. Reasons for multiple institution reports varied for the specific cancer sites, with higher proportions of pancreatic cancer than breast cancer patients receiving diagnostic services from multiple institutions, irrespective of IHS report.

Table 3 shows patient and tumor characteristics of the non-IHS patients reported by multiple vs. single institutions. For all invasive cancers combined, the most important independent predictor of being reported by non-IHS multiple institutions was younger age at diagnosis; patients under age 65 at diagnosis were more than two times as likely, and patients under age 44 were more than three times as likely, as those 75 years of age or older to be seen at multiple institutions. Patients with later stage of disease at diagnosis (stage II, III or IV) were more than one and one-half times as likely as patients with stage I disease to be reported by multiple institutions. Females were somewhat more likely than males to be seen at multiple institutions. Compared to white patients, Asians/PIs were more likely to be reported by multiple institutions. For most cancer sites, unknown status of variables (stage, race, health insurance) were inversely associated with being reported by multiple institutions, albeit based on small numbers of patients. For breast, prostate and lung cancers, patterns of association were generally similar to those seen for all invasive cancers, although associations with being reported at multiple institutions were particularly marked for prostate cancer patients with later AJCC stage II–IV disease (vs stage I) and for breast cancer patients with public insurance (vs. private/military insurance). However, for pancreatic cancer, patients with AJCC stage II disease at diagnosis (vs stage I) or without health insurance were more likely to be reported by multiple institutions, while pancreatic cancer patients who lived in the lowest SES neighborhoods were less likely to be reported by multiple institutions.

Table 4, which shows similar analyses for patients reported by at least one IHS, suggests generally similar associations across the cancer site categories, with younger age and later stage at diagnosis representing the most important and consistent indicators of being seen by institution(s) outside the IHS. However, for pancreatic cancer patients, none of the factors assessed was associated with outside facility use; and black breast cancer patients, and Hispanic and Asian/PI patients with any cancer, were less likely than whites to have been seen by outside institution(s).

4. Discussion

Population-based data from a large urban region of California showed that nearly one quarter of all non-IHS patients overall, and nearly one-tenth of all IHS patients (comprising more than one- third of all cancer patients), received some care from at least two institutions within 365 days of their cancer diagnosis. Most such patients were diagnosed and received some treatment at one institution and additional treatment at another institution(s). Patients reported by multiple institutions were more likely to have been younger and have had more advanced stage disease at diagnosis than those seen at single institutions. However, they generally were not more likely to have certain kinds of insurance or to live in more affluent neighborhoods. Among patients with one of the four specific cancer types investigated, additional patient characteristics, such as having no health insurance, were associated with multiple institution use; this was particularly true for pancreatic cancer. Patients reported from an IHS also were seen at additional institutions, although, as expected, in smaller proportions, likely due to insurance coverage and the need to pay out-of-pocket for care received outside of the IHS. Despite this, however, the proportion was meaningful for breast and lung cancer, for which more than one in ten patients was also seen outside the IHS.

Our findings indicate that the prevalence of multiple institution use for cancer care is substantial at the population level, at least in this urban California region. Our data further show that most patients receive care from multiple institutions to obtain additional treatment after being diagnosed and receiving some treatment at the first institution. Lower proportions of patients were reported as having been diagnosed at the first institution and then treated at the second. While we considered cancer registry data as an important resource for estimating the prevalence of multi-institutional care, our cancer registry data were limited in the detail needed to comprehensively assess the specific kinds of services (i.e., scans, surgery, chemotherapy) being provided in what sequence by what institution. Patients might seek initial treatment or additional treatment from a second facility for many reasons, including referral by their first physician, out-sourcing of treatment by the patient’s primary facility, changes in health insurance or residence during treatment, or dissatisfaction with care or geographic proximity of the first institution. They might receive treatment first from inpatient and later from outpatient facilities. Unfortunately, other than being able to separate reports from IHS from non-IHS, our cancer registry resource does not collect the information that might enlighten these reasons further. However, in cancer registry data covering larger geographic areas, it would be important to carry out further assessments of detailed hospital characteristics (e.g. number of beds, cancer center status, volume of cancer-specific patients, and geographic proximity to higher volume hospitals) associated with referral and multiple facility use.

Population-based patterns of cancer care involving multiple institutions are not well described in the literature. To our knowledge, only two prior studies have quantified the percentage of cancer patients seen at two or more institutions, and these also suggest a substantial prevalence of this phenomenon [10,11]. When the records of breast cancer patients seen at a community hospital were linked with those of a nearby academic institution, 16% of patients were found to have been seen at both institutions [10]. Those patients were significantly more likely than the patients seen at one institution to be under

age 40 at diagnosis, to be Asian/PI, to live in the highest SES neighborhoods, and to have prognostic factors (including stage, grade, subtype) that were intermediate to patients singularly seen at the two facilities [10]. For breast cancer patients, our population-based results confirm associations of multiple facility use with younger age and stage II/III, but not with race or neighborhood SES. Among Medicare recipients with stage III colorectal cancer, 37% received surgery and oncology services from different hospitals [11]. Rural patients were more likely to be seen at multiple hospitals, and although there were no associations with cancer specific survival, costs were noted to be higher for patients seen at multiple hospitals [11]. In non-oncology settings, a study of Massachusetts patients seeking acute care found that 31% visited at least two hospitals over a five-year period [12] and a team building electronic medical record-based algorithms to identify patients with type 2 diabetes reported substantial data fragmentation across institutions, such that using data from two institutions greatly improved the predictive value of their search over using data from only one institution [13].

Patterns of cancer care involving multiple institutions are difficult to study, as most institutions do not have systematic access to records from other institutions, and multi-institution data resources may pool together de-identified records instead of formally linking identified records. Central cancer registries receive reports of any first admission to a facility for a given cancer occurring among residents of defined geographic areas. For public health surveillance and research use of their data, registries consolidate this admissions information into a single tumor record; thus, data users do not have ready access to information regarding the full complement of physicians and/or institutions reporting the same patient for the same cancer. A strength of our approach included leveraging these detailed, unconsolidated registry data to provide a first assessment of the population- based prevalence of care from multiple institutions. Unfortunately, our data also have a number of limitations, most importantly not including the detailed items needed to assess the full spectrum of care received from specific types of institutions nor to the reasons why patients changed institutions. In addition, although our registry receives reports from some facilities outside our catchment region, our assessment may not have captured care provided by smaller, out-of-state hospitals without reporting relationships with the California registry. Thus, our estimates likely underestimate the true extent to which patients obtain care at multiple facilities. In addition, although we characterized patients seen at multiple facilities for both cancer overall and for selected site-specific cancers, we did not examine characteristics for all individual cancer types. Lastly, it documents multiple facility use in one large urban region in California, but may not be representative of other populations, especially those with a lower geographic concentration of hospitals.

Others have noted that data are likely to be missing from the electronic health records of patients who interact with multiple, nonintegrated healthcare providers [5,6]. To our knowledge, ours is the first study quantifying and describing basic patterns of cancer care involving multiple institutions at the population-level. As the prevalence of patients receiving care from more than one institution in this region was high, especially outside the IHS setting, future studies should characterize reasons for and details of care being received by patients across institutions to inform the types of clinical data most likely to be missing from a single institutional record. In particular, work should be carried out to understand the

implications of this missing data on quality indicators. Our findings underscore the value of population-based data resources, including cancer registries and linked registry- claims data (e.g., SEER-Medicare [14]), to broadly informative future health services studies. These include studies addressing comparative effectiveness, quality of care, and clinical learning systems, as they highlight the crucial benefit of including systematically reported information from all institutions involved in patient care. Researchers planning quality assessment or comparative effectiveness research projects based on medical records from a single institution or IHS should be attentive to the possibility of missing data or other bias.

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Disclaimer

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Table 1

Patterns of institutional reporting by type of invasive cancer, Greater Bay Area of California, 2010–11.

Cancer site	Integrated health system (IHS) institutions				non-IHS institutions			
	Only		IHS plus other(s)		Single		Multiple	
	n	%	n	%	n	%	n	%
Breast cancer	2651	89.3%	318	10.7%	4681	72.1%	1815	27.9%
Prostate cancer	3386	92.5%	275	7.5%	4578	82.0%	1002	18.0%
Lung cancer	1774	90.1%	195	9.9%	3307	80.7%	793	19.3%
Pancreatic cancer	500	94.0%	32	6.0%	845	73.2%	309	26.8%
All invasive cancers	18171	92.5%	1481	7.5%	31554	78.8%	8466	21.2%

Table 2

Factors associated with reporting of patients by multiple institutions, by cancer site, Greater Bay Area of California, 2010–11.

Primary invasive cancer site	Reported by integrated health system plus other institution(s)		Not reported by integrated health system but reported by two or more other institutions	
	n	%	N	%
Breast				
Diagnosed at one institution, treated at another	28	8.8	446	24.5
Diagnosed at one institution, treated there and at other(s)	277	87.1	1147	63.2
Multiple institutions reporting diagnosis and treatment	11	3.5	147	8.1
Diagnosed at multiple institutions, treated at one	<5	0.6	75	1.1
Total	318		1815	
Prostate				
Diagnosed at one institution, treated at another	63	22.9	297	29.6
Diagnosed at one institution, treated there and at other(s)	193	70.2	427	42.6
Multiple institutions reporting diagnosis and treatment	8	2.9	132	13.2
Diagnosed at multiple institutions, treated at one	11	4.0	146	14.6
Total	275		1002	
Lung				
Diagnosed at one institution, treated at another	32	16.4	162	20.4
Diagnosed at one institution, treated there and at other(s)	147	75.4	420	53.0
Multiple institutions reporting diagnosis and treatment	5	2.6	107	13.5
Diagnosed at multiple institutions, treated at one	11	5.6	104	13.1
Total	195		793	
Pancreas				
Diagnosed at one institution, treated at another	7	21.9	81	26.2
Diagnosed at one institution, treated there and at other(s)	15	46.9	87	28.2
Multiple institutions reporting diagnosis and treatment	<5	12.5	56	18.1
Diagnosed at multiple institutions, treated at one	6	18.8	85	27.5
Total	32		309	
All invasive cancers				
Diagnosed at one institution, treated at another	223	15.0	1857	22.9
Diagnosed at one institution, treated there and at other(s)	1121	75.7	4635	54.8
Multiple institutions reporting diagnosis and treatment	69	4.7	1005	11.9
Diagnosed at multiple institutions, treated at one	68	4.6	969	11.4
Total	1481		8466	

Table 3

Socio-demographic and tumor-related factors associated with being reported by multiple (mult) vs. single institutions for patients not reported to any integrated health system (IHS), by invasive cancer site, Greater Bay Area of California, 2010–11.

	Breast cancer		Prostate cancer		Lung cancer		Pancreatic cancer		All invasive cancers	
	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)
Age at diagnosis										
75+	172/1046	Reference	119/1123	Reference	238/1517	Reference	84/404	Reference	1433/9728	Reference
65–74	321/1015	**1.9 (1.5–2.2)**	337/1733	**1.9 (1.5–2.4)**	221/960	**1.5 (1.2–1.8)**	98/201	**2.1 (1.5–3.1)**	1909/7661	**1.8 (1.6–1.9)**
55–64	480/1148	**2.5 (2.1–2.9)**	408/1336	**3.0 (2.3–3.9)**	207/566	**2.3 (1.9–2.9)**	79/137	**2.5 (1.6–3.8)**	2331/7064	**2.3 (2.1–2.5)**
45–54	545/984	**3.4 (3.0–3.8)**	134/363	**3.5 (2.6–4.8)**	99/202	**3.0 (2.2–4.0)**	38/78	**1.9 (1.2–3.1)**	1650/4265	**2.7 (2.5–2.9)**
0–44	297/485	**3.7 (3.2–4.2)**	4/21		28/47	**3.7 (2.2–6.1)**	10/23		1161/2788	**3.2 (2.9–3.5)**
Sex										
Male		N/A	1002/4576	N/A	416/1577	Reference	159/404	Reference	3747/15694	Reference
Female	1815/4678				377/1715	0.9 (0.8–1.0)	150/439	1.0 (0.8–1.4)	4719/15812	**1.2 (1.2–1.3)**
Race/ethnicity										
NH White	1061/2893	Reference	684/2670	Reference	419/2016	Reference	176/475	Reference	4825/18921	Reference
NH Black	97/282	0.8 (0.6–1.1)	65/306	0.8 (0.6–1.1)	71/282	1.0 (0.8–1.4)	34/60	1.7 (1.0–2.9)	532/1944	1.0 (0.9–1.1)
Hispanic	240/519	1.0 (0.8–1.2)	88/585	**0.7 (0.6–0.9)**	61/262	1.1 (0.8–1.5)	36/102	1.1 (0.7–1.8)	1114/3892	1.0 (1.0–1.1)
NH Asian/PI	411/922	1.0 (0.9–1.2)	153/663	1.1 (0.9–1.3)	240/713	**1.6 (1.3–1.9)**	62/194	0.9 (0.7–1.3)	1953/5999	**1.2 (1.1–1.3)**
Other/Unknown	6/62	**0.2 (0.1–0.5)**	12/352	**0.2 (0.1–0.3)**	2/15	0.4 (0.1–2.0)	1/12	0.2 (0.0–1.3)	42/750	**0.2 (0.2–0.3)**
AJCC stage at diagnosis										
I	809/2491	Reference	177/1444	Reference	145/638	Reference	29/103	Reference	2367/11025	Reference
II	627/1353	**1.3 (1.2–1.5)**	609/2207	**2.4 (2.0–2.9)**	54/231	1.0 (0.7–1.5)	113/168	**2.3 (1.4–3.7)**	2077/6148	**1.8 (1.6–1.9)**
III	286/447	**1.7 (1.5–2.1)**	131/279	**3.3 (2.5–4.3)**	165/542	1.3 (1.0–1.7)	35/81	1.3 (0.7–2.4)	1556/3774	**2.0 (1.9–2.2)**
IV	77/231	1.0 (0.7–1.3)	75/296	**2.5 (1.8–3.4)**	419/1666	1.0 (0.8–1.3)	129/417	1.1 (0.7–1.7)	1678/5276	**1.7 (1.6–1.8)**
Unknown	16/156	**0.4 (0.2–0.6)**	10/350	**0.3 (0.2–0.5)**	10/215	**0.2 (0.1–0.4)**	3/74	**0.2 (0.0–0.6)**	788/5823	**0.8 (0.7–0.9)**
Neighborhood socioeconomic status	(quintiles)									
5, highest	850/2185	Reference	581/2273	Reference	309/1240	Reference	143/331	Reference	3866/14022	Reference
4	426/1157	0.9 (0.8–1.1)	210/1021	0.8 (0.7 1.0)	180/785	0.9 (0.7–1.1)	76/212	0.8 (0.6–1.1)	1950/7354	0.9 (0.9–1.0)
3	282/708	1.0 (0.8–1.2)	114/607	0.8 (0.6 1.0)	135/576	0.8 (0.7–1.1)	45/143	0.7 (0.4–1.0)	1303/4888	0.9 (0.8–1.0)
2	148/396	0.9 (0.7–1.1)	61/406	**0.7 (0.5 0.9)**	87/405	0.8 (0.6–1.0)	27/100	**0.5 (0.3–0.9)**	802/3188	**0.8 (0.8–0.9)**

	Breast cancer		Prostate cancer		Lung cancer		Pancreatic cancer		All invasive cancers	
	n (mult/single)	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**
1, lowest	109/232	1.0 (0.8–1.4)	36/269	0.7 (0.4 1.0)	82/286	1.0 (0.8–1.4)	18/57		545/2054	0.9 (0.8–1.0)
Insurance[a]										
Private/military insurance	1018/2408	Reference	577/2125	Reference	249/840	Reference	119/250	Reference	4107/12954	Reference
Public insurance	756/2181	**1.4 (1.2–1.6)**	402/2274	1.0 (0.8 1.2)	502/2335	1.0 (0.8–1.2)	171/543	0.9 (0.7–1.3)	4059/17476	1.0 (1.0–1.1)
No insurance	12/37	0.9 (0.5–1.8)	11/32	1.2 (0.6 2.4)	11/36	0.9 (0.5–1.9)	13/9	**4.9 (1.8–12.8)**	109/350	1.0 (0.8–1.3)
Unknown	29/52	1.6 (1.0–2.7)	12/145	**0.5 (0.3 0.9)**	31/81	**2.3 (1.4–3.6)**	6/41	1.1 (0.4–2.9)	191/726	1.2 (1.0–1.4)

NH = non-Hispanic; PI – Pacific Islander.

Logistic regression models were adjusted for all variables presented on table. Categories were combined as needed and as shown to facilitate regression model convergence. Patients included were not seen at any integrated health system such as Kaiser Permanente or the Veterans Affairs Administration.

Bold values indicate $p < 0.05$.

[a]Public insurance included Medicaid and other government-assisted programs; private insurance included health maintenance organizations, preferred provider organizations, managed care not otherwise specified, and military care.

Table 4

Socio-demographic and cancer-related factors associated with being reported by multiple (mult) vs. single institutions for patients reported to an integrated health system, by invasive cancer site, Greater Bay Area of California, 2010–11.

	Breast cancer		Prostate cancer		Lung cancer		Pancreatic cancer		All invasive cancers	
	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)	n (mult/single)	OR (95% CI)
Age at diagnosis										
75+	64/468	Reference	47/466	Reference	61/747	Reference	9/177	Reference	282/4714	Reference
65–74	65/599	1.1 (0.7–1.6)	101/1249	0.9 (0.6–1.3)	57/569	1.3 (0.9–1.8)	8/153	1.0 (0.4–2.9)	387/4883	**1.4 (1.2–1.6)**
55–64	96/738	1.0 (0.8–1.3)	102/1308	0.9 (0.6–1.2)	55/339	**2.0 (1.3–3.0)**	11/99	1.9 (0.7–4.9)	474/4836	**1.8 (1.5–2.1)**
45–54	65/563	1.0 (0.8–1.3)	24/344	0.7 (0.4–1.2)	21/92	**3.1 (1.8–5.5)**	4/38	1.6 (0.4–5.9)	215/2340	**1.8 (1.5–2.1)**
0–44	28/282	0.9 (0.7–1.3)	1/15		1/20	0.7 (0.1–5.0)	0/2		123/1357	**2.0 (1.6–2.4)**
Sex										
Male		N/A	275/3382	N/A	149/917	Reference	23/266	Reference	925/9679	Reference
Female	318/2650				46/850	0.3 (0.2–0.5)	9/203	0.5 (0.2–1.0)	556/8451	**0.7 (0.6–0.8)**
Race/ethnicity										
NH White	223/1480	Reference	181/1999	Reference	140/1155	Reference	20/308	Reference	975/11199	Reference
NH Black	13/235	**0.4 (0.2–0.7)**	43/419	1.2 (0.9–1.8)	23/178	0.8 (0.5–1.4)	3/42	1.3 (0.3–4.8)	129/1619	0.8 (0.7–1.0)
Hispanic	24/332	**0.5 (0.3–0.7)**	29/480	0.7 (0.5–1.1)	6/128	**0.4 (0.2–0.9)**	1/59	0.2 (0.0–1.6)	155/2238	**0.8 (0.6–0.9)**
NH Asian/PI	54/586	**0.6 (0.5–0.9)**	21/378	**0.6 (0.4–0.9)**	26/294	0.6 (0.4–1.0)	8/68	2.1 (0.9–5.3)	213/2796	0.8 (0.7–1.0)
Other/Unk	4/17	1.7 (0.6–5.1)	1/106	**0.1 (0.0–0.8)**	0/12	–	0/0		9/278	**0.4 (0.2–0.7)**
AJCC stage at diagnosis										
I	179/1407	Reference	49/1223	Reference	23/371	Reference	5/44	Reference	357/6758	Reference
II	96/870	0.9 (0.7–1.2)	182/1764	**2.6 (1.9–3.6)**	15/141	1.9 (0.9–3.8)	6/114	0.5 (0.1–1.7)	396/4139	**1.8 (1.5–2.1)**
III	34/216	1.3 (0.9–1.9)	24/154	**3.9 (2.3–6.5)**	45/328	**2.3 (1.3–3.9)**	7/33	1.9 (0.5–6.9)	223/2025	**2.1 (1.8–2.5)**
IV	7/113	0.5 (0.2–1.1)	17/188	**2.1 (1.2–3.9)**	110/868	**2.1 (1.3–3.4)**	14/278	0.5 (0.2–1.4)	334/3020	**2.2 (1.9–2.6)**
Unknown	2/44	0.3 (0.1–1.4)	3/53	1.3 (0.4–4.3)	2/59	0.7 (0.2–3.2)	N/A		171/2188	**1.6 (1.3–1.9)**
Neighborhood socioeconomic status (quintiles)										
5, highest	143/1093	Reference	134/1469	Reference	70/642	Reference	11/203	Reference	635/7463	Reference
4	85/763	0.9 (0.7–1.2)	62/848	0.8 (0.6–1.1)	59/520	1.0 (0.7–1.5)	10/113	1.5 (0.6–3.8)	378/4928	0.9 (0.8–1.0)
3	49/442	1.0 (0.7–1.4)	46/596	0.9 (0.6–1.2)	33/332	0.9 (0.6–1.4)	10/83	2.4 (0.9–6.1)	243/3199	0.9 (0.8–1.0)

	Breast cancer		Prostate cancer		Lung cancer		Pancreatic cancer		All invasive cancers	
	n (mult/single)	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**	**n (mult/single)**	**OR (95% CI)**
2	35/235	1.4 (0.9–2.1)	21/310	0.7 (0.4–1.2)	24/199	1.1 (0.7–1.8)	0/50	0.3 (0.0–2.2)	158/1694	1.1 (0.9–1.4)
1, lowest	6/117	0.6 (0.3–1.4)	12/159	0.8 (0.4–1.6)	9/74	1.1 (0.5–2.4)	1/20		67/846	1.0 (0.7–1.3)

NH = non-Hispanic; PI Pacific Islander.

Logistic regression models were adjusted for all variables presented on table. Categories were combined as needed and as shown to facilitate regression model convergence. Patients included were not seen at any integrated health system such as Kaiser Permanente or the Veterans Affairs Administration.

Bold values indicate $p < 0.05$.