Physician Use of Genetic Testing for Cancer Susceptibility: Results of a National Survey

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Abstract

Genetic testing for inherited germ-line mutations associated with cancer susceptibility is an emerging technology in medical practice. Limited information is currently available about physician use of cancer susceptibility tests (CSTs). In 1999–2000, a nationally representative survey was conducted to estimate prevalence of CST use by United States physicians and assess demographic, training, practice setting, and practice patterns associated with use. A stratified random sample of clinicians in eight specialties was selected from a file of all licensed physicians. In total, 1251 physicians, including 820 in primary care and 431 in tertiary care, responded to a 15-min questionnaire by mail, telephone, fax, or Internet (response rate = 71.0%). In the previous 12 months, 31.2% [95% confidence interval (CI), 28.5–33.9] overall, including 30.6% (95% CI, 27.5–33.7) in primary care and 33.4% (95% CI, 27.9–38.9) in tertiary care, had ordered CSTs or referred patients elsewhere for risk assessment or testing. More physicians referred patients elsewhere [26.7% (95% CI, 24.2–29.2)] than directly ordered tests [7.9% (95% CI, 6.3–9.5)]. Factors associated with ordering or referring included practice location in the Northeast [odds ratio (OR), 2.30; 95% CI, 1.46–3.63%], feeling qualified to recommend CSTs (OR, 1.96; 95% CI = 1.41–2.72), receiving CST advertising materials (OR, 1.97; 95% CI, 1.40–2.78%), and most notably, having patients who asked whether they can or should get tested (OR, 5.52; 95% CI, 3.97–7.67%). Lower CST use was associated with not knowing if there were local testing and counseling facilities (OR, 0.39; 95% CI, 0.23–0.66%). These findings underscore the importance of establishing effective clinical approaches to test use and promoting physician education to facilitate communication with patients about cancer genetics.

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Introduction

Genetic testing for inherited germ-line mutations associated with increased cancer risk is an emerging technology in medical practice (1–3). CSTs[2] such as those that detect mutations in the *BRCA1* and *BRCA2* genes associated with familial breast and ovarian cancer (4–6) or in the *MLH1* and *MSH* genes associated with hereditary nonpolyposis colon cancer (7, 8) have been used primarily within research settings. However, increasing awareness of genetic testing, new evidence of risk reduction for some follow-up interventions (9, 10), and the development of commercial tests and clinical guidelines (5, 8, 11–15) may accelerate the diffusion of this technology into routine clinical care.

Patients who consider testing need to have an accurate understanding of inherited cancer risk, the options available for reducing risk, and the benefits and limitations of CSTs to make informed decisions (16). They may also contend with psychosocial issues related to testing that affect quality of life and family relationships (17–23). Thus, healthcare providers must be prepared to address a broad range of patient questions and concerns when conducting cancer risk assessments, making recommendations about testing, interpreting results for patients and their families, and offering follow-up care to carriers of cancer susceptibility mutations (24). Several previous surveys have identified the complex nature of these issues as potential barriers to physician use of CSTs (25–35).

Only limited information exists about the prevalence of CST use by physicians in the United States and the factors that are directly or inversely associated with use. The purpose of this study was to determine the national prevalence of use among nonpediatric PCPs and TCPs in selected specialties and to identify physician characteristics associated with test use. This report provides nationally representative estimates based on self reports from 1251 survey respondents, including 820 PCPs and 431 TCPs in specialties that manage patients with cancer or high cancer risk.

Materials and Methods

Sampling Methods. A nationally representative, stratified random sample of 2079 physicians was selected from the American Medical Association Physician Masterfile, a database containing biographic and current practice information on all licensed physicians in the United States, including both American Medical Association members and nonmembers. Sampling was restricted to the four main primary care specialties providing care for adults (general internal medicine, general practice, family practice, and obstetrics/gynecology) and four of the tertiary care specialties that provide care for cancer patients or

[2] The abbreviations used are: CST, cancer susceptibility test; PCP, primary care physician; TCP, tertiary care physician; OR, odds ratio; CI, confidence interval; ob/gyn, obstetrician/gynecologist.

patients at high risk for cancer (oncology, general surgery, urology, and gastroenterology). The physicians within these eight specialties were considered eligible for the survey if their primary professional activity was patient care (*i.e.*, they devoted more hours to direct patient care than other activities such as administration, medical education, research, or other activities), and they were licensed to practice medicine in the state of their preferred mailing address. Retirees, residents, and physicians not in clinical practice were excluded, leaving a total of 207,266 physicians eligible for sampling.

Eligible physicians were stratified by specialty. The total sample of physicians was allocated to each specialty in proportion to the specialty's representation in the total United States physician population. The one exception to the proportional allocation of the total sample was the oncology stratum, which was oversampled to obtain sufficient numbers for subgroup analyses. Within each specialty, physicians were selected using systematic sampling with a fractional sampling interval after sorting the list by census region (Northeast, North Central, South, and West), urban/rural location, and gender.

Survey Methods. An advance package was mailed to the selected physicians, which contained a letter inviting them to participate, letters from nine medical societies supporting the objectives of the survey, and an optional return card on which respondents could specify their preferred participation mode (*i.e.*, telephone interview, self-administered questionnaire returnable by fax or mail, or encrypted online questionnaire accessible by a password-protected Internet site). Two follow-up mailings of a reminder letter and a paper questionnaire were sent to nonresponders, with concurrent telephone calls made to notify office staff of the mailings. Respondents were sent a $25 honorarium with a thank you letter at time of questionnaire mailing/faxing or with a letter thanking them for their willingness to participate via telephone, fax, or Internet. Data collection commenced with the first mailing on September 27, 1999, and ended March 31, 2000.

The questionnaire, which can be downloaded for public use from the NCI web site,[3] took an average of 15 min to complete. Information was ascertained about test use and physician characteristics possibly associated with the use of tests, including practice arrangement, personal and family history of cancer, race/ethnicity, family history taking, and other practice patterns. Training background and demographic characteristics other than race/ethnicity were obtained from the Physician Masterfile. Socioeconomic data about the physician's county of medical practice were obtained from the February 1999 edition of the Area Resource File, Bureau of Health Professions, Health Resources, and Services Administration.

Statistical Analysis. Weighted proportions were computed to quantify prevalence of CST use by physician characteristics. In bivariate analyses, χ^2 tests were used to explore associations of use with independent variables from the questionnaire, Physician Masterfile, and Area Resource File. Variables which were not significantly associated with CST use at the 0.05 level were not included in multivariate logistic regression models.

ORs and 95% CIs were calculated to model the relationship of various physician characteristics to CST use. The number of independent variables was too large to consider in a single preliminary regression model given the sample sizes of the PCP and TCP groups. Therefore, four preliminary logistic regression models, each containing only a partial set of independent variables, were created to identify potential associations with CST use (*i.e.*, ordering a test or referring patients elsewhere for testing or a testing assessment). The first partial model included demographic characteristics (gender, race/ethnicity, age, census region, and urbanicity of practice location) and family history of cancer (cancer in self, first-degree relatives, or spouse/significant other). The second partial model contained physician training variables, including year of medical school graduation, allopathic *versus* osteopathic degree, foreign *versus* United States medical school, and whether the physician felt qualified to recommend CSTs.

The third preliminary model contained practice arrangement characteristics, including ownership (*i.e.*, owner *versus* employee of a physician practice, health maintenance organization, or hospital/clinic/university), single- *versus* multispecialty practice, percentage of patients covered by managed care ($<$50% *versus* $\geq$50%), number of patients seen/week ($\geq$100, 75–99, or $<$75), and current academic affiliation (yes *versus* no). The fourth preliminary model contained patterns of care factors, including frequency of asking new patients about cancer in second-degree relatives (very frequently *versus* somewhat frequently *versus* infrequently or never); frequency of asking age of relatives' cancer diagnosis; frequency of patient inquiries about cancer risk because of family history; having patients during the past 12 months who asked whether they could or should get tested for an inherited cancer susceptibility gene (yes *versus* no); availability of local counseling and testing facilities in the patient catchment area (yes and not sure *versus* no); and physician exposure to test advertisements (yes *versus* no or not sure).

Using backward logistic regression techniques, statistically significant independent variables were identified in each preliminary model. These variables were then entered into a comprehensive model to determine their relationship to CST use after adjustment for all possible confounders. More variables were subsequently eliminated if not significant until a final reduced model was obtained. Regression analyses were conducted separately for PCPs and TCPs, and because results were generally similar, the two groups were pooled for a combined analysis with increased statistical power.

The following questionnaire variables were excluded from the regression analyses because of highly skewed response distributions (*i.e.*, almost all physicians were in the "very frequently" category): frequency of asking new patients for a medical history; frequency of asking them for a family history of cancer in first-degree relatives; and frequency of performing or referring patients elsewhere for routine cancer screening tests, including fecal occult blood test, pap smear, clinical breast exam, and mammography. Area Resource File variables describing the counties where the physicians practiced were also excluded from the regression analyses because they were not systematically associated with CST use in bivariate analyses. These variables included physician-population ratio (using general practitioners); number of physicians in patient care; number of physicians in medical genetics; number of short-term hospitals with oncology services; number of deaths by malignant neoplasm; percentage of urban; percentage of white, African American, Hispanic; per capita income; percentage of population below federal poverty level; and percentage of population with college education.

Prevalence estimates and ORs were weighted to the United States physician population using SUDAAN software (36). Each respondent was assigned a numerical weight consisting of the basic sampling weight (*i.e.*, the total number of United States physicians in the respondent's specialty divided by the

[3] Internet address: http://riskfactor.cancer.gov/studies/physician/status.html.

number of physicians in the specialty who were selected into the survey) multiplied by a nonresponse factor. Standard errors around the weighted estimates were calculated using SUDAAN.

Results

Response Rates and Characteristics. After an extensive address search, 131 (6.3%) of the 2079 sampled physicians could not be identified by state licensing boards, were therefore assumed to not be providing patient care and thus were considered ineligible. An additional 185 (8.9%), who were originally thought to meet survey eligibility criteria based on Physician Masterfile information, were determined to be ineligible when contacted.

The overall response rate, defined as the number of physicians completing the questionnaire ($n = 1251$) divided by the initial sample minus the ineligibles [$2079 - (131 + 185)$], was 71.0%. Subgroup response rates were 70.4% for PCPs and 72.1% for TCPs. Final numbers of primary care respondents by specialty were: family practice, 280; general practice, 71; obstetrics/gynecology, 150; and internal medicine, 319. Numbers of tertiary care respondents were: gastroenterology, 42; general surgery, 123; oncology, 221; and urology, 45. Of the 1251 total, 84.2% responded by mail, 7.2% by Internet, 6.4% by telephone, and 2.2% by fax. A comparison of demographic factors (age, gender, region, and urbanicity) of responders *versus* nonresponders indicated that physicians ≥60 years had significantly lower response rates, which required nonresponse adjustment in the survey weights. Osteopathic physicians constituted 8.8% of PCPs and 3.0% of TCPs. United States medical school graduates constituted 78.2% of PCPs and 76.8% of TCPs. The mean age was 48.8 years for PCPs and 50.7 years for TCPs.

Prevalence of CST Use. Table 1 shows national estimates of the percentage of PCPs and TCPs who reported using CSTs during the 12 months before completing the questionnaire, by physician characteristics. Unweighted frequencies are also provided. Use was broadly defined as either ordering a test directly or referring a patient elsewhere for testing or a testing assessment. A total of 30.6% (95% CI, 27.5–33.7) of PCPs and 33.4% (95% CI, 27.9–38.9) of TCPs ordered tests or referred patients elsewhere. The combined percentage of users from all selected specialties was 31.2% (95% CI, 28.5–33.9). There was no statistically significant difference between PCPs and TCPs ($P = 0.5$; $\alpha = 0.05$). Fig. 1 shows the national estimates by individual specialty. In the primary care group, use was highest among ob/gyns [51.5% (95% CI, 43.5–59.5)] and lowest among family and general practitioners [24.6% (95% CI, 20.1–29.1)]. In the tertiary care group, use was highest among oncologists [65.4% (95% CI, 59.1–71.7)] and lowest among urologists [15.8% (95% CI, 4.8–26.8)]. Because this survey was designed to assess CST use among two broad subgroups (*i.e.*, PCPs and TCPs), these specialty-specific estimates are based on small numbers and should be interpreted cautiously.

PCP in the 40–59-year age range had somewhat lower use, whereas TCPs in the same age range reported somewhat higher use. Overall, prevalence of CST use was higher among physicians who were female, white, or African American and practiced in the Northeast or in areas with ≥50,000 inhabitants. Prevalence of CST use was also higher among physicians who trained in the United States, felt qualified to recommend tests, saw more patients/week, had ≥50% patients in managed care (for PCPs only), were affiliated with an academic institution, and had received test advertisements.

Interestingly, use was highest among physicians who had local testing and counseling facilities [46.9% (95% CI, 42.6–51.2)], intermediate among those without such facilities [31.8% (95% CI, 24.2–39.4)], and lowest among those who were unsure whether there were local facilities [11.6% (95% CI, 8.3–14.9)]. CST use increased with increasing frequency of asking patients about cancer in second degree relatives, asking patients about age of relatives diagnosis, patient inquiries about increased risk because of family history, and patients asking if they can or should get tested.

Type of CST Use. Table 2 shows prevalence estimates of type of use for the 31.2% of respondents who had ordered tests or referred patients elsewhere. In the first set of prevalence estimates, ordering and referring were not considered to be mutually exclusive so physicians who both ordered and referred were counted twice. For all eight specialties combined, the percentage who directly ordered was relatively low at 7.9% (95% CI, 6.3–9.5), whereas 26.7% (95% CI, 24.2–29.2) had referred patients elsewhere. A total of 7.5% (95% CI, 5.7–9.3) of PCPs and 9.7% (95% CI, 6.4–13.0) of TCPs had ordered tests, whereas 26.4% (95% CI, 23.5–29.3) and 27.9% (95% CI, 22.8–33.0) had referred patients elsewhere, respectively. There were no statistically significant differences between PCPs and TCPs for either ordering ($P = 0.5$) or referring elsewhere ($P = 0.7$).

National estimates of nonmutually exclusive ordering and referring were computed by individual medical specialty, except where numbers were too small to yield statistically meaningful results. The national estimates of ordering CSTs were: family and general practice, 6.0% (95% CI, 3.5–8.5); ob/gyn, 11.1% (95% CI, 6.0–16.2); internal medicine, 7.7% (95% CI, 4.8–10.6), and oncology, 29.2% (95% CI, 23.1–35.3). National estimates for referring patients elsewhere were: family and general practice, 22.6% (95% CI, 18.1–27.1); ob/gyn, 47.7% (95% CI, 39.5–55.9); internal medicine, 22.6% (95% CI, 17.9–27.3); general surgery, 36.5% (95% CI, 27.9–45.1%); and oncology, 55.1% (95% CI, 48.4–61.8).

In the second set of prevalence estimates in Table 2, ordering and referring were considered to be mutually exclusive. The large majority of test users (*i.e.*, 74.4% weighted) had only referred patients elsewhere rather than directly ordered tests. For all eight specialties combined, 4.5% (95% CI, 3.3–5.7) of physicians had only ordered tests, 23.2% (95% CI, 20.7–25.7) had only referred elsewhere, and 3.4% (95% CI, 2.2–4.6) had both ordered and referred. Again, differences between PCPs and TCPs were not statistically significant ($P = 0.8$). Specialty-specific estimates were not computed because of small numbers.

The referring physicians ($n = 390$, unweighted), who included 215 PCPs and 175 TCPs, were asked to describe the type of healthcare facility or provider to which they referred patients for tests or a testing assessment. Their weighted responses to this open-ended question fell into the following categories: 28.1% (95% CI, 23.0–33.2) referred to an oncology provider (*i.e.*, oncologist, oncology clinic, or cancer center); 26.1% (95% CI, 21.2–31.0) to a genetics provider (*i.e.*, medical geneticist, genetic counselor, or genetics clinic or department); 27.2% (95% CI, 22.1–32.3) to a university or tertiary care center with department or specialty not specified; and 8.2% (95% CI, 4.9–11.5) to miscellaneous other providers (*i.e.*, breast surgeon, gynecologist, lab, research study, or community hospital). An additional 4.6% (95% CI, 2.2–7.0) referred to

Table 1 Percentage[a] of United States physicians in primary and selected tertiary care specialties who used CST in 1999–2000, by physician characteristics

	Total			PCP[b]			TCP[c]		
	No. in survey	(%) used	95% CI	No. in survey	(%) used	95% CI	No. in survey	(%) used	95% CI
All combined	1251	31.2	28.5–33.9	820	30.6	28.7–33.7	431	33.4	27.9–38.9
Demographic and personal									
Age (yr)									
30–39	209	35.1	28.4–41.8	68	36.0	28.7–43.3	41	29.7	14.4–45.0
40–49	455	30.6	26.1–35.1	301	29.3	24.2–34.4	154	36.1	26.3–45.9
50–59	379	28.6	23.5–33.7	208	25.9	20.0–31.8	171	36.8	27.2–46.4
60+	206	32.4	25.5–39.3	141	34.5	26.5–42.5	65	NA[d]	NA[d]
Gender									
Male	1022	29.0	26.1–31.9	635	28.1	24.6–31.6	387	32.0	26.3–37.7
Female	229	40.1	33.4–46.8	185	39.1	32.0–46.2	44	54.4	32.4–76.4
Race/ethnicity									
White	910	32.4	29.1–35.7	576	31.2	27.5–34.9	334	36.8	30.3–43.3
African American	42	29.7	15.6–43.8	37	30.1	15.2–45.0	5	NA[d]	NA[d]
Asian/Pacific Islander	150	25.4	18.0–32.8	104	26.5	17.9–35.1	46	20.1	6.2–34.0
Hispanic	65	23.0	12.2–33.8	44	22.4	10.1–34.7	21	25.6	2.9–48.3
Region of United States									
Northeast	279	40.2	33.9–46.5	170	39.0	31.6–46.4	109	44.7	32.4–57.0
North Central	302	26.3	21.0–31.6	205	24.1	18.2–30.0	97	37.3	24.8–49.8
South	410	26.8	22.3–31.3	266	27.8	22.5–33.1	144	23.1	14.9–31.3
West	257	22.5	16.2–28.8	177	33.7	26.6–40.8	80	36.2	22.9–49.5
Urbanicity of practice area									
≥50,000 inhabitants	775	32.5	29.0–36.0	495	32.2	28.1–36.3	280	34.0	26.9–41.1
<50,000 inhabitants	473	29.0	24.7–33.3	323	28.1	23.2–33.0	150	33.0	23.8–42.2
Personal or family history of cancer									
No	659	30.9	27.2–34.6	438	29.9	25.6–34.2	221	35.0	27.2–42.8
Yes	569	31.1	27.0–35.2	367	30.7	26.0–35.4	202	32.6	24.6–40.6
Training									
Degree									
Allopathic	1166	31.2	28.5–33.9	748	31.0	27.7–34.3	418	32.2	26.7–37.7
Osteopathic	85	30.0	20.0–40.0	72	26.2	16.0–36.4	13	NA[d]	NA[d]
Medical school location									
In United States	965	32.7	29.6–35.8	635	31.6	28.1–35.1	330	37.6	30.9–44.3
Outside United States	286	25.9	20.4–31.4	185	27.3	20.8–33.8	101	20.5	11.5–29.5
Feel qualified to recommend CST?									
No or not sure	605	20.5	17.2–23.8	484	20.4	16.9–23.9	121	21.2	13.3–28.9
Yes	640	44.9	40.6–49.2	333	46.0	40.7–51.3	307	41.8	34.4–49.2
Practice setting									
No. of physicians									
1–5	782	28.4	25.1–31.7	528	28.3	24.4–32.2	254	28.8	22.3–35.3
6–49	324	35.6	29.9–41.3	210	33.9	27.4–40.4	114	42.7	30.5–54.9
50+	125	41.3	31.3–51.3	69	40.4	28.8–52.0	56	45.0	26.0–64.0
No. of specialties									
Single	913	30.2	27.1–33.3	594	29.4	25.9–32.9	319	33.0	26.7–39.3
Multiple	310	34.4	28.7–40.1	207	34.2	27.7–40.7	103	35.4	23.2–47.6
Ownership									
Owner	822	30.9	27.6–34.2	495	30.5	26.6–34.4	327	32.0	25.9–38.1
Employee	400	32.1	27.2–37.0	305	30.8	25.7–35.9	95	45.0	30.5–59.5
Percentage of patients in managed care									
<50%	626	28.6	24.7–32.5	381	27.4	22.9–31.9	245	33.2	25.4–41.0
≥50%	588	34.2	30.1–38.3	415	34.3	29.8–38.8	173	33.7	25.3–42.1
No. of patients/week									
100+	435	29.6	25.1–34.1	341	30.1	25.2–35.0	94	35.9	27.5–44.3
75–99	396	34.8	29.7–39.9	243	34.6	28.7–40.5	153	35.4	25.6–45.2
<75	405	29.3	24.4–34.2	225	26.6	20.7–32.5	180	24.5	13.9–35.1
Academic affiliation									
No	724	26.9	23.6–30.2	518	27.1	23.4–30.8	206	26.2	19.1–33.3
Yes	511	38.4	33.7–43.1	290	37.0	31.5–42.5	221	43.0	34.2–51.8
Local counseling and testing services available									
No	167	31.8	24.2–39.4	107	31.5	22.7–40.3	60	32.6	17.9–47.3
Yes	662	46.9	42.6–51.2	398	45.4	40.5–50.3	264	53.4	44.8–62.0
Not sure	393	11.6	8.3–14.9	296	11.9	8.2–15.6	97	10.3	3.8–16.8
In past year, received CST advertising materials									
No or not sure	808	23.8	20.7–26.9	599	23.8	20.3–27.3	209	24.1	17.6–30.6
Yes	426	51.5	45.8–57.2	212	51.3	44.6–58.0	214	52.2	42.2–62.2

Table 1 Continued

	Total			PCP[b]			TCP[c]		
	No. in survey	(%) used	95% CI	No. in survey	(%) used	95% CI	No. in survey	(%) used	95% CI
Family history assessment									
Asks patients about cancer in second-degree relatives									
Infrequently or never	197	19.0	13.5–24.5	155	37.4	32.9–41.9	42	37.1	20.0–54.2
Somewhat frequently	299	29.2	23.7–34.7	205	28.8	22.5–35.1	94	31.0	19.6–42.4
Very frequently	739	36.6	32.7–40.5	446	16.2	10.3–22.1	293	33.9	26.8–41.0
Asks patients about age of relatives' cancer diagnosis									
Infrequently or never	212	18.9	13.4–24.4	153	17.6	11.5–23.7	59	NA[d]	NA[d]
Somewhat frequently	368	29.2	24.3–34.1	259	28.4	22.9–33.9	109	33.9	22.5–45.3
Very frequently	651	38.1	34.0–42.2	393	38.3	33.6–43.0	258	37.2	29.6–44.8
Patients ask about increased risk because of family history									
Infrequently or never	354	22.3	17.8–26.8	254	20.0	15.1–24.9	100	34.1	22.7–45.5
Somewhat frequently	521	30.0	25.7–34.3	351	31.0	26.1–35.9	170	25.5	17.3–33.7
Very frequently	363	44.0	38.3–49.7	207	44.3	37.4–51.2	156	43.0	33.0–53.0
In past year, patients asked if they can or should get tested									
No	676	15.3	12.6–18.0	509	15.9	12.8–19.0	167	12.8	7.1–18.5
Yes	563	57.0	52.3–61.7	303	55.6	49.9–61.3	260	61.7	52.9–70.5

[a] Percentages (and 95% CI) are weighted to the United States population of physicians in the selected specialties and reflect test use during the 12 months before completing a questionnaire. Use is defined as having ordered a test or referred patients elsewhere for testing or a testing assessment.
[b] PCPs (includes internal medicine, general or family practice, ob/gyn).
[c] TCPs (includes oncology, general surgery, urology, gastroenterology).
[d] Insufficient numbers to yield stable estimates. NA, not available.

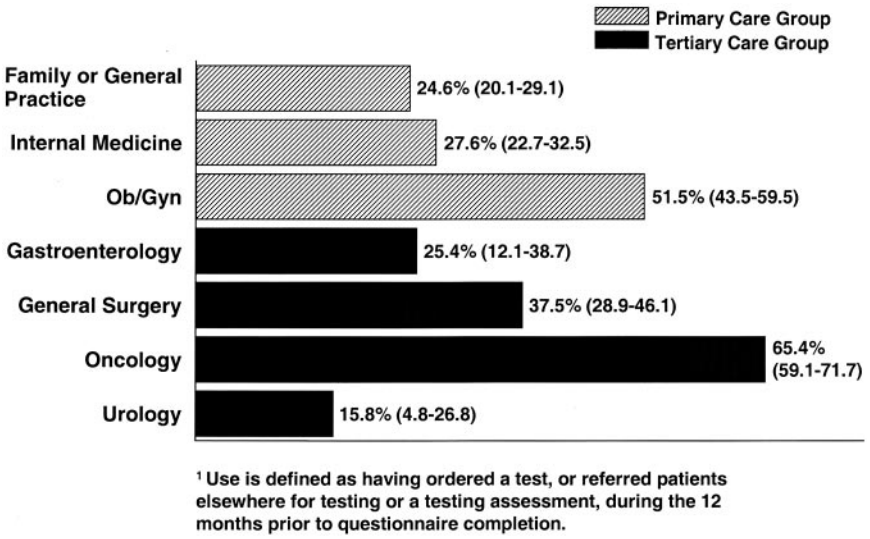

Fig. 1. National estimates of the percentage (and 95% CI) of physicians who used[1] cancer susceptibility tests, by specialty.

more than one type of provider, and 5.8% (95% CI, 3.1–8.5) were unsure or did not specify. There were no statistically significant differences in referral patterns between PCPs and TCPs.

The unweighted number of respondents who directly ordered a CST from a laboratory was 139, including 61 PCPs and 78 TCPs. In both groups, the most commonly reported number of patients tested (*i.e.*, the mode) was 2 per physician, and the median number was 5. Of the 139, 108 had ordered tests for hereditary breast/ovarian susceptibility and 54 for hereditary colon cancer susceptibility.

On the basis of these limited numbers, national estimates of the percentages of PCPs and TCPs who ordered a test for hereditary breast/ovarian cancer susceptibility are 5.8% (95% CI, 4.2–7.4) and 5.4% (95% CI, 3.0–7.8), respectively (P = 0.2). The data suggest significant within-group differences, although 95% CI around the specialty-specific estimates are relatively large. Among the PCPs, 10.5% (95% CI, 5.6–15.4) of ob/gyns ordered a breast/ovarian CST, compared with 3.3% (95% CI, 1.3–5.3) of general or family practitioners, and 6.3% (95% CI, 3.6–9.0) of internists (P = 0.01). Among the TCPs, 24.5% (95% CI, 18.8–30.2) of oncologists ordered this test, whereas numbers in the other specialties were too few to compute meaningful estimates.

National estimates of the percentage who ordered a CST for hereditary colon cancer susceptibility are 3.1% (95% CI, 1.9–4.3) of PCPs and 5.1% (95% CI, 2.4–7.8) of TCPs (P = 0.3). Within the PCP group, 2.1% (95% CI, 0.5–3.7) of family or general practitioners, 3.6% (95% CI, 1.6–5.6) of internists, and 4.5% (95% CI, 1.2–7.8) of ob/gyns had ordered this test (P = 0.4). Within the TCP group, 16.2% (95% CI, 4.8–27.6) of gastroenterologists and 8.8% (95% CI, 5.1–12.5) of oncologists

Table 2 Types of use: percentage[a] of physicians who ordered and/or referred patients elsewhere for CSTs

Ordered a CST or referred patients elsewhere	Total (n = 459)			PCP (n = 250)			TCP (n = 209)		
	Unweighted frequency	(%)	95% CI	Unweighted frequency	(%)	95% CI	Unweighted frequency	(%)	95% CI
Not mutually exclusive									
Referred	390	26.7	24.2–29.2	215	26.4	23.5–29.3	175	27.9	22.8–33.0
Ordered	139	7.9	6.3–9.5	61	7.5	5.7–9.3	78	9.7	6.4–13.0
Mutually exclusive									
Referred only	320	23.2	20.7–25.7	189	23.1	20.2–26.0	131	23.8	19.1–28.5
Ordered only	69	4.5	3.3–5.7	35	4.2	2.8–5.6	34	5.6	2.9–8.3
Both ordered and referred	70	3.4	2.2–4.6	26	3.3	2.1–4.5	44	4.1	2.1–6.1

[a] Percentages (and 95% CI) are weighted to the United States population of physicians in the selected specialties and reflect test use during the 12 months before completing a questionnaire.

Table 3 Factors associated with CST use among physicians: OR[a] and 95% CIs

Factors	Total (n = 1251)		PCP (n = 820)		TCP (n = 209)	
	OR	95% CI	OR	95% CI	OR	95% CI
Region of United States						
South	1.00		1.00		1.00	
Northeast	2.30	1.46–3.63	2.06	1.23–3.48	4.02	1.66–9.74
North Central	1.01	0.65–1.56	0.91	0.55–1.50	1.70	0.66–4.37
West	1.52	0.98–2.37	1.48	0.90–2.42	1.79	0.63–5.06
Medical school location						
In United States	1.00		1.00		1.00	
Outside United States	0.68	0.46–1.00	0.74	0.47–1.15	0.38	0.18–0.80
Feel qualified to recommend CST?						
No or not sure	1.00		1.00		1.00	
Yes	1.96	1.41–2.72	2.03	1.40–2.95	1.90	0.89–4.04
In past year, patients asked if they can or should get tested						
No	1.00		1.00		1.00	
Yes	5.52	3.97–7.67	5.06	3.48–7.35	8.19	3.86–17.36
Local counseling and testing services available						
No	1.00		1.00		1.00	
Yes	1.54	0.99–2.41	1.60	0.97–2.66	0.93	0.36–2.45
Not sure	0.39	0.23–0.66	0.46	0.25–0.82	0.14	0.04–0.45
In past year, received CST advertising materials						
No or not sure	1.00		1.00		1.00	
Yes	1.97	1.40–2.78	1.98	1.33–2.93	1.98	0.95–4.14

[a] ORs and 95% CIs are weighted to the United States population of physicians in the selected specialties and adjusted for all other factors listed in this table.

ordered this test, with numbers in the other specialties too sparse to compute stable estimates.

Multivariate Analyses. Nine variables that were significantly associated with physician use of CSTs (*i.e.*, ordering or referring) in the four partial logistic regression models were entered into a comprehensive model. Three of nine (*i.e.*, female gender, affiliation with an academic institution, and practice size) were simultaneously eliminated from the comprehensive model because they were no longer associated after adjustment for the other six variables. The same results were obtained using backward regression techniques. The final model containing the six significantly associated variables is shown in Table 3.

For PCPs and TCPs combined, the factors that were associated with CST use included practice location in the Northeast [*versus* the South (OR, 2.30; 95% CI, 1.46–3.63%)], feeling very well or somewhat qualified to recommend CSTs [*versus* not very or not at all qualified (OR, 1.96; 95% CI, 1.41–2.72%)], receiving CST advertising materials in the past 12 months [*versus* not receiving or not sure (OR, 1.97; 95% CI, 1.40–2.78%)], and most notably, having patients during the past 12 months who asked whether they could or should get tested for an inherited cancer susceptibility gene [*versus* not having patients who asked (OR, 5.52; 95% CI, 3.97–7.67%)]. Interestingly, physicians who reported having local genetic testing and counseling facilities were not more likely to use CSTs relative to physicians without such facilities. However, uncertainty about the existence of local facilities was inversely associated with CST use when physicians without facilities were the referent group (OR, 0.39; 95% CI, 0.23–0.66%).

Similar results were obtained when the primary care group was analyzed separately. In the tertiary care group, the ORs for feeling qualified to recommend CSTs and for receiving advertising materials were similar to primary care ORs, but the 95% CI included 1.00 perhaps because of limited statistical power for this smaller stratum. Also in contrast to the primary care group, graduation from a medical school outside the United States was inversely associated with CST use (OR, 0.38; 95% CI, 0.18–0.80%). However, there was no statistically significant interaction between medical school location and specialty group (P = 0.3). The results in Table 3 were essentially unaltered after additional adjustment for individual medical specialty.

Discussion

Close to one-third of United States physicians in the represented specialties reported that they ordered a CST or referred patients elsewhere for testing or a testing assessment during a 1-year period in 1999–2000. Most physicians who reported using this technology chose to refer patients elsewhere. Of the ~8% who directly ordered CSTs, the median number of patients tested was 5 per physician, although 2 was the most common number tested. Given the very low estimated prevalence of inherited germ-line mutations associated with adult cancers in the general population (37–39), the early stage of the technology and relative recency of some medical society guidelines published during or after this survey (12–15) limited use of CSTs in most medical specialties should be expected. Nevertheless, several factors were consistently associated with CST use among both PCPs and TCPs.

The factor most strongly related to physicians' use of genetic counseling and testing was patient inquiries. Physicians who reported having patients during the past year who asked if they could or should get tested also reported a 5-fold greater prevalence of use. This finding underscores the importance of physician readiness to respond to patient inquiries about CSTs and requests for testing by providing patients with information about test advantages and limitations, offering genetic counseling and testing when indicated or suggesting other alternatives when not indicated (5, 8, 40–43).

In addition, physicians who felt qualified to recommend testing were twice as likely to have used CSTs, compared with those who felt unqualified or were not sure. This may partly reflect greater confidence among physicians who previously used CSTs. However, it also suggests that educational efforts to increase physician understanding of CSTs could potentially affect the use of tests (25, 26, 30, 31, 35). Availability of local testing and counseling services was not significantly associated with CST use. However, physicians who were unsure about local availability were less than half as likely to use CSTs than those without local services. This suggests that not knowing or perhaps not actively seeking knowledge about how to obtain CST services is a greater barrier to use than geographical distance from such services. Exposure to advertising was associated with a 2-fold higher use of CSTs, although it is not clear whether advertising influenced physician decisions to use CSTs or whether physicians received advertising materials as a consequence of ordering CSTs.

Significantly higher CST use was found in the Northeast *versus* the South after adjusting for other covariates, including local availability of counseling and testing services. Regional variation in test use may reflect geographical concentrations of high-risk populations or differences in physician knowledge of and attitudes toward this technology. Although geographical differences sometimes reflect disparities in access to care, various socioeconomic indicators for respondents' counties of medical practice were not consistently associated with CST use in bivariate analyses. County-level variables, however, may be of limited value in predicting physician practice habits if physicians draw their patients from areas outside their county of practice.

CST use by graduates of medical schools outside the United States approximated use by graduates of United States medical schools in the primary care group and in both groups combined. In the tertiary care group, use by graduates of medical schools outside the United States was relatively lower. This finding may reflect lower tolerance of non-United States graduates for the ambiguities surrounding genetic testing, as previously noted in a study by Geller *et al.* (26). It may also be a reflection of different patient populations served by non-United States graduates (44).

This survey was designed to assess CST use (*i.e.*, ordering or referring) among PCPs and TCPs, and therefore, in-depth analyses of individual medical specialties or of distinct types of CST use were not conducted. Statistically significant differences in prevalence of use between the represented primary and tertiary care specialties were not detected. Nevertheless, the prevalence data suggest that the highest primary care users are ob/gyns (51.5%), and the highest tertiary care users are oncologists (65.4%). These estimates should be interpreted cautiously, taking into account their respective CI width. Cho *et al.* (29) found that physicians ordering *BRCA1/2* tests from a university-based testing service were most likely to be oncologists, pathologists, or ob/gyns. Although this survey did not include pathologists, ordering patterns were otherwise comparable with this previous report.

Higher CST use in these specialties may reflect greater opportunities to discuss family history and genetic testing during routine cancer screening, diagnostic procedures, or clinical management of patients with familial cancer (45, 46). Guidelines established by medical societies, consensus panels, or other groups may also contribute to prevalence of use (5, 8, 11–15). Family and general practitioners may be less frequent CST users because their patient populations include children (47), an age group not tested for inherited susceptibility to adult cancers. Urologists may be less frequent users because the complexities of identifying prostate cancer susceptibility mutations has limited the clinical use of CSTs in this specialty (48).

When compared with earlier state surveys, this national study yielded somewhat higher CST use estimates. In 1997, Friedman *et al.* (27) reported that ~20% of Texas PCPs had made one or more referrals for genetic evaluation and DNA testing for cancer susceptibility. In contrast, our national estimates indicate that 26.4% of PCPs have referred patients for CSTs or evaluation. In 1998, Polednak (30) reported that 16% of physicians involved in follow-up care of Connecticut breast cancer patients had discussed genetic testing with them. Our survey found that 24.5% of oncologists had ordered a breast/ovarian CST. The higher estimates derived from this national survey may be attributable to differences in survey questionnaires and methodology, regional variation, or true increases in CST use over the past few years.

Genetic tests for cancer susceptibility are a potentially useful clinical tool for patients with a strong family history of cancer who are receptive to testing (49). Patients with negative test results can avoid risk reduction interventions of negligible benefit. Asymptomatic patients with positive test results may benefit from intensified cancer screening efforts and from pharmacological, surgical, and/or behavioral interventions aimed at reducing risk.

Numerous issues remain to be addressed to ensure appropriate use of CSTs in clinical care (1, 45, 50–53). Valid, cost-effective tests must be available, patients must understand the benefits and limitations of testing, and testing must be confidential, acceptable, and affordable. Physicians need to understand appropriate indications for risk assessment or testing, how to interpret and communicate test results to patients, and what kinds of follow-up care to recommend (54). The findings of this survey underscore the importance of establishing effective clinical approaches to test use, and of promoting physician education in this area.

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Physician Use of Genetic Testing for Cancer Susceptibility: Results of a National Survey

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