article

Genetic testing for susceptibility to breast and ovarian cancer: Evaluating the impact of a direct-to-consumer marketing campaign on physicians' knowledge and practices

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Purpose: To assess the impact of direct-to-consumer marketing of genetic testing for risk of breast and ovarian cancer by a biotechnology company on: 1) physicians' knowledge; 2) reasons given when asking questions about the test; and 3) physicians' practice patterns in two pilot cities where the campaign took place and two control cities. **Methods:** Survey of randomly selected family physicians, internists, obstetrician-gynecologists, and oncologists from May 1–May 21, 2003. **Results:** Physicians' knowledge did not differ between pilot and control cities. Significant differences (pilot versus control cities) were seen in the reasons patients gave for asking questions about testing. More physicians in pilot cities (14%) than control cities (7%) reported an increase in the number of times they ordered genetic testing for breast and ovarian cancer risk in the previous 6 months (adjusted odds ratio 1.9, 95% confidence interval, 1.2–3.1). Awareness of professional guidelines and being in a practice with a policy on genetic testing for risk of breast and ovarian cancer were associated with physicians' behaviors and interest among patients in testing. **Conclusions:** Given the complexity and limitations of genetic testing for risk of breast and ovarian cancer, the development and broad dissemination of clinical guidelines and education of physicians are needed. ***Genet Med* 2006:8(6):361–370.**

Key Words: *direct-to-consumer, advertising, BRCA, breast cancer, ovarian cancer*

In the United States, the probability of a women developing invasive breast cancer from birth to death is estimated at 1 in 7 (13.4%) and 1 in 58 (1.7%) for ovarian cancer.[1,2] An estimated 5–10% of breast cancer cases are associated with an autosomal dominant pattern of inheritance.[3] Mutations in the *BRCA1* and *BRCA2* (BReast CAncer) genes are associated with a predisposition to develop breast and ovarian cancer (BOC). Women identified with *BRCA1* or *BRCA2* (*BRCA*) mutation face lifetime risks of 36–85% for breast cancer and 16–60% for ovarian cancer, depending on the population studied.[2]

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Genetic testing for *BRCA1* and *BRCA2* mutations, which has been available since 1994 and 1995, respectively,[3,4] allows high-risk persons to be identified before they have developed BOC. Test results may predict risk more accurately than family history alone, and may provide additional information on which to base decisions about screening and medical management. Thousands of mutations and variations in *BRCA* have been described,[5] and gene sequencing is often necessary. Because of patent restrictions, full gene sequencing for clinical purposes can only be performed in one laboratory in the U.S.[6] This laboratory offers three options for testing: 1) full DNA sequencing, including detection of five specific large genomic rearrangements of the *BRCA1* gene; 2) targeted DNA sequence analysis for a specified mutation in a *BRCA* gene once a family mutation is known; or 3) DNA sequence analysis of specific portions of the *BRCA* genes designed to detect three mutations that occur more commonly in people of Ashkenazi Jewish descent.[7]

If an unaffected person at increased risk for BOC based on family history wants to pursue testing to learn whether she or he (in the case of breast cancer) carries a *BRCA* mutation, a family member with cancer is generally tested first. If a mutation is identified in that person, unaffected blood relatives can then be tested for the familial mutation to help predict their

risk. Identification of a mutation in an unaffected person does not necessarily mean she or he will develop cancer. Results of testing could also reveal a gene change that is interpreted as a variant of unknown significance. For these mutations, it is unclear whether the variant is a normal polymorphism or is associated with an increased risk for cancer. Such variants may be found in up to 13% of persons tested.[8]

In the United States, guidelines for providers and expert opinions on counseling and testing for genetic susceptibility to BOC have been developed by several professional organizations.[9–12] The guidelines do not have a standard definition of a "positive" family history for BOC, but they agree that testing for *BRCA* mutations is most appropriate for women who have a family history of early-onset BOC, and they do not recommend it for women in the general population. More recently, the U.S. Preventive Services Task Force also recommended against routine testing for women whose family history does not reveal an increased risk for a *BRCA* mutation. The USPSTF also recommended that women whose family history is associated with an increased risk for deleterious mutations in *BRCA* genes be referred for genetic counseling and evaluation for testing.[13] The ultimate goal of testing is to reduce morbidity and mortality associated with inherited BOC through increased surveillance, chemoprevention, or prophylactic mastectomy or oophorectomy.

In September, 2002, the biotechnology company that holds the patent for DNA-based sequencing for inherited susceptibility to BOC (and is thus the major provider in the US) began a pilot campaign for marketing its test (BRACAnalysis®) directly to consumers in Atlanta, GA, and Denver, CO (the pilot cities). Although direct-to-consumer advertising (DTCA) of pharmaceuticals has been employed for over two decades,[14] and advertising of genetic tests is becoming more common on the Internet,[15] this was the first time a biotechnology company marketed a genetic test directly to consumers through mass media. This pilot direct-to-consumer (DTC) campaign targeted women aged 25–54 years and their physicians. The stated intent was to raise awareness among women with a personal or family history of BOC and motivate them to speak to their health care providers about their personal risk for hereditary BOC and how BRACAnalysis® could assess their risk and guide them to effective options for medical management.[16]

Pre-campaign efforts by the company included outreach and education for physicians; in August, 2002, physicians in the pilot cities were sent a launch mailer to inform them about the campaign along with support materials for identifying and managing patients. In addition, the company coordinated the launch of the pilot campaign with clinical programs for assessing cancer risk in Atlanta and Denver by holding meetings with providers of cancer care and community cancer groups to promote awareness of the campaign before it began. The company also created a new website with self-directed patient triage and tools for collecting family history and offered this along with a dedicated, toll-free telephone number. Finally, the company conducted a five-month advertising campaign including TV, radio, and print ads about *BRCA* testing.[16]

To assess the impact of the DTC campaign on the knowledge, attitudes and behaviors of physicians and consumers relative to genetic testing for susceptibility to BOC, two population-based surveys were conducted during the four months post-campaign. Findings from the survey of physicians are presented in this article.

METHODS

At the request of state epidemiologists and public health officials in the two pilot cities as well as two control cities, the Centers for Disease Control and Prevention (CDC) assisted in an investigation to assess the impact of the DTC campaign. The comparison (control) cities (Seattle, WA, and Raleigh-Durham, NC) were selected based on their general proximity to the pilot cities and the presence of public health staff that could be quickly mobilized to participate in the investigation.

Institutional review board approval was obtained from the CDC and the four state health departments involved in the investigation. Office of Management and Budget Clearance was covered under #0920-008 for Epi-Aids. Participation was voluntary and consent was implied if the survey was completed and returned. The objectives of the investigation were to assess: 1) physicians' knowledge regarding genetic testing for susceptibility to BOC; 2) reasons patients give for asking questions about genetic testing for BOC; and 3) physicians' practice patterns and reported interest of their patients in genetic testing for susceptibility to BOC. Providers in both pilot and comparison cities were surveyed.

Study population and design

A sample of 2,000 physicians from three specialties (family medicine, internal medicine, and obstetrics-gynecology) was randomly selected from the American Medical Association (AMA) Physician Masterfile to be proportionally representative of the number of physicians practicing in those specialties within each city. In addition, because of their small numbers, all 262 medical, surgical, and gynecological oncologists who were practicing in the 4 cities were selected. In addition to specialty, selection criteria, as indicated in the Masterfile, included spending more than 20 hours per week in direct patient care. From this sample of 2,262 physicians, confirmation of addresses was attempted by up to three telephone calls. Based on these calls, 469 physicians were deemed ineligible (26 were retired, 205 were not known or no longer at that address, 42 refused to participate, 58 did not treat cancer, 81 were not available during the survey period, and 57 could not receive express mail at a post office box). From the eligible pool of 1,793 physicians, 1,600 were randomly selected to receive the survey. The survey instrument was developed by a nine-member working group that included experts in content, public health officials, and epidemiologists from the four states, ORC Macro (a consulting company), and CDC. The 35 questions in the survey covered the demographics of the physician and the practice, the physician's knowledge about inherited susceptibility to BOC, reports of questions from patients, referral and

practice patterns, and the physician's desire to learn more about genetic testing for susceptibility to BOC. The surveys were pilot tested with a convenience sample of physicians (N = 4) to assess the clarity of the questions.

The survey and a $50 money order were sent to the 1,600 physicians by express mail on May 1, 2003. Reminder postcards were sent a week later, and calls were made and faxes sent to remind non-responding physicians two weeks after the initial mailing. A duplicate express mailing was sent to physicians who had still not returned the survey three weeks after the initial mailing.

Statistical methods

All analyses were performed using SAS® software for Windows, v8.02 (SAS Inc., Cary, NC).

Data on nine characteristics of physicians were compared between pilot and control cities. Chi-square testing at a significance level of 0.05 was used to determine the differences in proportions between groups. Multivariate logistic regression analysis was performed using the hierarchical backwards elimination method.[17,18] Odds ratios (OR) with 95% confidence intervals (CI) were calculated to compare pilot and control cities on the relationship between various physician characteristics and responses to the survey. All covariates (Table 1) and two-factor interaction terms for main effect variables (pilot versus control cities and the primary specialty of the physician) were included in the multivariate analysis. Tests of the contribution of covariates were conducted by dropping the least significant variable in the model based on the Wald χ^2 and maximum likelihood estimation value at $P \leq 0.05$ until all remaining variables were significant.

Characteristics of physicians assessed in the study (Table 1) included specialty (family medicine, internal medicine, obstetrics/gynecology, or oncology) and practice setting (collapsed into four settings: group practice, solo practice, hospital/academic, or managed care. Managed care included respondents who indicated they practiced in a staff model health maintenance organization (HMO), a managed care organization, or other model HMO), sex, and hours worked in direct patient care per week ($<$20, 20–40, and $\geq$40). Although a selection criterion was working 20 hours or more per week, we chose to trichotomize the variable due to the large percentage of respondents who reported working $<$20 hours. The survey also asked about years in practice since residency ($>$20, 11–20, and $\leq$10), a family or personal history of BOC, awareness of national professional guidelines, practice policies on offering the testing, and geographical area of practice ("metro," which included central city and suburban, and "rural," which included small city/town and rural).

The three questions on the physicians' knowledge of genetic testing for BOC (Table 2) were adapted from a previous survey.[19] For χ^2 analysis and logistic regression, the responses to knowledge questions were dichotomized as "correct" or "not correct" ("not sure" was considered "not correct"). To further assess factors associated with the knowledge of physicians in logistic regression analysis, a new knowledge variable was created and responses were dichotomized into 2–3 and 0–1 correct responses (Table 3).

In assessing the interest of patients in genetic testing for susceptibility to BOC (as reported by physicians) and the practice patterns of physicians in this area, responses of "not applicable" (Table 4) were excluded to avoid unstable estimates. For responses on awareness of professional guidelines and having a policy about genetic testing for risk of BOC, "not sure" was combined with "no." Only interaction terms and variables that were significantly associated with being in a pilot city (a proxy for exposure to the campaign) or physician specialty were left in the final models.

RESULTS

In all, 1,070 surveys (67%) were returned. Eighteen were excluded from the analysis because respondents said they did not see patients (16) or were retired (2). A total of 1,052 (66%) questionnaires were analyzed. Although we had selected physicians from the AMA Physician Masterfile who were listed there as spending more than 20 hours per week in direct patient care, 8% of respondents said they worked fewer than 20 hours per week.

Sixty-five percent of respondents were men, 53% were members of a group practice (single- or multi-specialty), and 58% had been in practice more than 10 years. Most physicians worked in a metro area, but in Raleigh-Durham, the majority worked in a rural setting. Overall, 35% of physicians were aware of professional guidelines, and 10% said their practice had a specific policy on genetic testing for BOC risk (Table 1).

Receipt of educational materials

Thirty-two percent of physicians in the pilot cities and 13% in the control cities (results not shown) reported receiving educational materials from a company promoting genetic tests for risk of BOC in the 12 months preceding the survey (N = 221, $P < 0.01$). Most (75%) of those who reported receiving this information said they got it by mail. Fifty-two physicians (24% of those who reported receiving information) said they remembered the name of the company from which they received information, and 45 of these correctly reported the name of the company when requested by the questionnaire. Forty percent of those who received information reported it was useful to their practice.

Knowledge

Although more physicians in the pilot cities reported receiving educational materials, as previously reported,[20] no differences by city status (pilot, control) were seen by χ^2 analysis in the percentage of correct responses to the three questions on knowledge of genetic testing for BOC. Significant differences ($P < 0.01$) were seen by specialty, however, for each of the knowledge questions (Table 2). Logistic regression analysis found interaction between city status (pilot versus control) and specialty; specifically, obstetrician-gynecologists (ob/gyns) in the pilot cities were more likely than ob/gyns in the

Table 1
Characteristics of physicians and variables used in regression models

	Pilot cities (N = 561)		Control cities (N = 491)	
	Denver (N = 270) No. (%)	Atlanta (N = 291) No. (%)	Seattle (N = 328) No. (%)	Raleigh (N = 163) No. (%)
Specialty				
Oncology	34 (13)	24 (8)	41 (13)	14 (9)
Obstetrics and gynecology	55 (20)	98 (34)	53 (16)	35 (21)
Internal medicine	70 (26)	97 (33)	97 (30)	57 (35)
Family medicine	111 (41)	72 (25)	137 (42)	57 (35)
Setting				
Group practice[a]	153 (56)	167 (57)	160 (50)	82 (51)
Solo practice	36 (13)	72 (25)	50 (15)	28 (17)
Hospital/academic[b]	49 (18)	45 (15)	82 (25)	51 (31)
Managed care	32 (12)	7 (2)	31 (10)	1 (1)
Sex				
Female	93 (35)	94 (33)	120 (37)	54 (33)
Male	175 (65)	195 (67)	207 (63)	109 (67)
Hours worked/week				
>40	104 (39)	142 (50)	82 (26)	66 (41)
20–40	145 (55)	125 (44)	199 (63)	76 (47)
<20	17 (6)	17 (6)	36 (11)	19 (12)
Years in practice since residency				
>20	85 (32)	59 (20)	85 (26)	37 (23)
11–20	84 (31)	99 (34)	115 (35)	43 (27)
≤10	100 (37)	132 (46)	126 (39)	82 (51)
Family history of breast or ovarian cancer[c]				
Yes	65 (25)	69 (24)	88 (28)	31 (19)
No	198 (75)	220 (76)	230 (72)	132 (81)
Aware of any national professional guidelines to determine appropriate patients for testing				
Yes	107 (41)	101 (37)	115 (35)	50 (32)
No	84 (32)	115 (42)	119 (37)	65 (41)
Not sure	70 (27)	60 (22)	90 (28)	43 (27)
Practice has a specific policy regarding genetic testing for risk of breast and ovarian cancer				
Yes	43 (16)	26 (9)	31 (9)	8 (5)
No	214 (81)	247 (88)	275 (84)	147 (91)
Not sure	7 (3)	9 (3)	21 (6)	6 (4)
Area of principal practice				
Metro	203 (75)	231 (79)	246 (75)	62 (38)
Rural	67 (25)	60 (21)	80 (25)	100 (62)

Missing values are excluded. Percentages may not add to 100 due to rounding.
[a]Group practice includes single-specialty and multi-specialty group practices.
[b]Hospital/academic includes hospital/medical or community health clinic/public health agency/Veterans Administration or military hospital.
[c]Family history includes a diagnosis of breast or ovarian cancer in an immediate blood relative, a spouse or significant other, or the respondent.

Table 2
Physicians' knowledge of genetic testing for susceptibility to breast and ovarian cancer, by specialty

	Specialty				
	Family medicine (N = 377) No. (%)	Internal medicine (N = 321) No. (%)	Ob/Gyn (N = 241) No. (%)	Oncology (N = 113) No. (%)	*P*-Value[a]
How likely is a woman who gets breast cancer at an early age to have inherited a *BRCA1* or *BRCA2* mutation compared to a woman who gets breast cancer at a much later age?[b]					
More likely	296 (80)	249 (79)	207 (87)	106 (95)	<0.01
Equally likely[c]	11 (3)	16 (5)	6 (3)	5 (4)	
Not sure	63 (17)	49 (16)	21 (9)	1 (1)	
Women can inherit a *BRCA1* or *BRCA2* mutation from:[d]					
Either parent[c]	129 (35)	132 (42)	169 (71)	101 (91)	<0.01
Mother only	80 (22)	52 (17)	28 (12)	5 (5)	
Not sure	160 (43)	129 (41)	40 (17)	5 (5)	
What is the chance that a healthy woman who has a 30-year-old sister with a known *BRCA1* mutation has inherited the same *BRCA1* mutation?[e]					
25%	81 (22)	77 (24)	71 (30)	23 (21)	<0.01
50%[c]	152 (41)	133 (42)	113 (48)	76 (68)	
75%	12 (3)	5 (2)	2 (1)	1 (1)	
Not sure	121 (33)	99 (31)	49 (21)	11 (10)	

Missing values excluded. Percentages may not add to 100 due to rounding.
[a]From 2 × 4 table (specialty × correct or incorrect responses), "Not sure" counted as incorrect.
[b]Data for 5 respondents who replied "less likely" not shown.
[c]Correct response.
[d]Data for 1 respondent who replied "father only" not shown.
[e]Data for 4 respondents who replied "100%" not shown.

control cities to answer knowledge questions correctly (Table 3). We also found that being aware of professional guidelines was associated with getting more knowledge questions correct. Finally, being in solo practice (versus managed care) and being in practice 11 years or more (versus ≤10 years) were inversely associated with getting 2–3 knowledge questions correct (Table 3).

Desire for more knowledge

Sixty-eight percent (N = 707) of physician respondents (71% of family physicians, 64% of internists, 75% of ob/gyns, and 59% of oncologists) reported an increased need or desire to learn more about cancer genetics or genetic testing for risk of BOC in the last six months (versus the same time period a year before). This report (data not shown) contrasted with the 1% of physicians who reported a decrease in their need to learn more (8% responded "not applicable" and 23% responded "remained the same").

Rationales for questions of patients

Physicians were asked the reasons their patients gave for asking questions about genetic testing for risk of BOC during the previous six months. When "not sure" responses were excluded, 31% of physicians in pilot cities and 25% in control cities reported that having had breast or ovarian cancer was a reason patients gave for asking questions about this testing ($P = 0.05$), 62% of physicians in pilot and 55% in control cities reported that having a family member with 1 of these cancers was a reason ($P = 0.02$). In other findings, the results were 27% (pilot) versus 8% (control) for reporting as a reason that patients had seen an ad promoting genetic testing for risk of BOC in the popular media ($P < 0.01$) and 22% versus 14% for saying that patients asked questions because they wanted information about available medical options if a *BRCA* mutation was identified ($P < 0.01$).

These differences remained in logistic regression analyses that adjusted for other variables, but we found interactions with city (pilot versus control) in several of the models. For example, among physicians who practiced in rural areas, those in pilot cities were more likely than those in control cities to report having a family member with BOC as a reason for patients' questions (adjusted OR (AOR), 2.1, 95% CI, 1.2–3.5), but this finding did not hold up for metro physicians (AOR, 0.8, 95% CI, 0.5–1.1). In addition, among female physicians, those in pilot cities were more likely than their counterparts in control cities to report that seeing or hearing an advertisement promoting genetic testing for BOC risk was a reason for patients' questions (AOR, 2.7, 95% CI, 1.2–6.2). The association

Table 3
Characteristics of physicians by odds of answering 2–3 knowledge questions correctly

Variable	Adjusted OR (95% CI)
Specialty × city	
Oncology	
Pilot (vs. control)	0.7 (0.2–2.7)
Ob/Gyn	
Pilot (vs. control)	2.8 (1.4–5.3)
Internal medicine	
Pilot (vs. control)	0.6 (0.4–1.0)
Family medicine	
Pilot (vs. control)	1.0 (0.6–1.5)
Setting	
Group practice[a]	0.9 (0.5–1.6)
Solo practice	0.5 (0.3–0.9)
Hospital/academic[b]	0.9 (0.5–1.6)
Managed care	Reference
Years in practice since residency	
>20	0.6 (0.4–0.9)
11–20	0.7 (0.5–0.9)
≤10	Reference
Aware of professional guidelines	
Yes (vs. no/not sure)	2.4 (1.8–3.4)

CI, confidence interval; OR, odds ratio.
Missing values are excluded. Odds ratios are calculated as the likelihood of getting 2–3 questions right vs. 0 or 1 questions.
[a]Group practice includes single-specialty and multi-specialty group practices.
[b]Hospital/academic includes hospital/medical or community health clinic/public health agency/Veterans Administration or military hospital.

with pilot cities was even stronger in this instance for male physicians (AOR, 6.6, 95% CI, 2.8–15.6). Finally, physicians in pilot cities were more likely than those in control cities to report that wanting information about available medical options if a *BRCA* mutation is identified was a reason patients gave for asking questions (AOR, 1.6, 95% CI, 1.1–2.3).

Change in patient interest and physician practice

We asked five questions to learn more about how patient interest and the practices of physicians had changed over time (Table 4). We previously reported[20] that physicians in pilot cities were more likely than those in control cities to report increased interest among patients in genetic testing for BOC risk (in the six months before the survey versus the same period one year earlier). These increases were in questions asked, requests for referrals to genetic counseling, and requests for testing. In addition, physicians in the pilot cities (14%) were more likely than those in control cities (7%) to report an increase in directly ordering genetic tests for risk of BOC, but there was no statistical difference between cities (pilot versus control) in the number of physicians reporting an increase in referrals to a genetics or oncology center.[20]

In logistic regression, the four variables most consistently associated with increased patient interest (more questions asked, more requests for referrals and testing) and increases in directly ordering the genetic test or referring to genetics or oncology were pilot city, specialty, awareness of professional guidelines, and having a policy on the testing (Table 5). Two variables – awareness of professional guidelines and having a policy – were positively associated with all five increases. Being in a pilot city was positively associated with four of the increases. Being an oncologist or ob/gyn (versus family physician) was also positively associated with four of the increases and interacted with sex in the other model.

DISCUSSION

The public health implications of this DTC campaign are wide-ranging. Although the campaign was piloted in only two cities, it represents population-based marketing of a test that is not considered appropriate for the majority of the population. From the public health perspective, potential benefits of the campaign include increased awareness and knowledge among consumers and physicians about inherited susceptibility to BOC and genetic testing for mutations in the *BRCA* genes. This might, in turn, lead to more appropriate referrals for *BRCA* testing by physicians, more appropriate uptake of genetic testing and cancer screening, possible reduction of anxiety among women who had previously over-estimated their BOC risk, and, depending on medical management decisions, early detection or prevention of BOC among some women with a family history.

Potential risks of the campaign include insufficient knowledge about inherited susceptibility to BOC and testing for *BRCA*, which could lead to inappropriate referrals, uptake, decisions, and interpretation of the test, and increased alarm and anxiety about the risk of developing BOC among consumers. In addition, screening (e.g., with mammography) might be foregone and women falsely reassured if they are tested and found not to carry a mutation in a *BRCA* gene. Finally, physicians and the health care system as a whole might be overtaxed through increased requests for testing, and resources might not be available to provide appropriate education, counseling, and follow-up among those persons who are interested in *BRCA* testing.

Findings from this investigation suggest an association between the DTCA of genetic testing for BOC risk and an increase in patient interest about the test (based on the reports of physicians) as well as an increase in the number of tests ordered by physicians. Our finding that physicians in pilot cities were more likely to report receiving the educational materials presumably reflects their being targeted by the biotechnology company conducting the campaign. We also found that physicians in pilot cities were more likely to report certain reasons that patients gave to explain their asking questions about testing (an affected family member, seeing an ad, wanting infor-

Table 4
Patient interest and physician practices, last six months versus same time period one year earlier

	Pilot cities (N = 561)		Control cities (N = 491)	
	Denver (N = 270) No. (%)	Atlanta (N = 291) No. (%)	Seattle (N = 328) No. (%)	Raleigh (N = 163) No. (%)
The number of patients asking about genetic testing for breast and ovarian cancer risk has				
Increased	96 (36)	96 (34)	63 (19)	30 (19)
Remained the same	128 (48)	143 (51)	207 (64)	102 (64)
Decreased	8 (3)	5 (2)	6 (2)	2 (1)
Not applicable	33 (12)	36 (13)	50 (15)	26 (16)
The number of patients asking directly for a referral for genetic counseling and possible genetic testing for breast and ovarian cancer risk has				
Increased	57 (22)	42 (15)	36 (11)	14 (9)
Remained the same	166 (63)	189 (68)	233 (71)	111 (70)
Decreased	5 (2)	7 (3)	7 (2)	4 (3)
Not applicable	37 (14)	42 (15)	51 (16)	30 (19)
The number of patients asking directly for genetic testing for breast and ovarian cancer risk has				
Increased	72 (27)	59 (21)	40 (12)	18 (11)
Remained the same	151 (57)	173 (62)	230 (70)	108 (68)
Decreased	8 (3)	5 (2)	7 (2)	4 (3)
Not applicable	33 (13)	42 (15)	50 (15)	28 (18)
The number of times you refer patients to a genetics or oncology center for assessment of risk for breast/ovarian cancer and possible genetic testing has				
Increased	75 (28)	66 (23)	77 (24)	31 (20)
Remained the same	148 (56)	170 (61)	200 (61)	97 (61)
Decreased	4 (2)	5 (2)	3 (1)	2 (1)
Not applicable	38 (14)	40 (14)	47 (14)	29 (18)
The number of times you directly order genetic testing for breast and ovarian cancer risk has[a]				
Increased	35 (13)	41 (15)	22 (7)	10 (6)
Remained the same	165 (62)	174 (62)	210 (65)	100 (63)
Decreased	7 (3)	7 (2)	4 (1)	2 (1)
Not applicable	58 (22)	59 (21)	87 (27)	46 (29)

Missing values are excluded.
[a]*Increased* includes responses of "significantly and slightly increased" and *decreased* includes "slightly and significantly decreased."

mation about management options if a *BRCA* mutation was identified). However, the lack of knowledge among physicians about *BRCA* testing (Table 2) raises concerns that many physicians are not prepared to deal with the increased demand that can be generated by DTCA of genetic tests.

A study conducted concurrently by Kaiser Permanente Colorado on the impact of the same campaign within two managed care organizations – one in a city where the campaign occurred and one in a city where it did not – found a significant increase in referrals attributed to the DTC campaign.[21] We did not, however, find physicians in pilot cities reporting a greater increase in referrals to genetics or oncology centers when compared to control cities. Still, we found a trend (albeit statistically insignificant) for female physicians in pilot cities to report a greater increase in referrals made than their counterparts in control cities. We also found that oncologists and ob/gyns were more likely to report an increase in referrals made than family physicians. Regardless of specialty, physicians who were aware of professional guidelines or who had a policy on testing (a setting similar to Kaiser Permanente Colorado) were more likely to report increases in referrals made than those not aware of the guidelines or not having a policy, respectively.

Table 5
Results of regression analyses to predict patient interest and physician practices

	Patients asking about testing increased Adjusted OR (95% CI)
City	
Pilot (vs. control)	2.1 (1.6–2.9)
Specialty	
Oncology	2.9 (1.7–4.8)
Ob/Gyn	2.1 (1.4–3.1)
Internal medicine	1.3 (0.9–2.0)
Family medicine	Reference
Sex	
Female (vs. male)	1.4 (1.0–1.9)
Aware of Professional Guidelines	
Yes (vs. no/not Sure)	1.5 (1.1–2.0)
Practice has a policy	
Yes (vs. no/not sure)	2.0 (1.3–3.3)
	Patients asking for referral increased Adjusted OR (95% CI)
City	
Pilot (vs. control)	1.6 (1.1–2.4)
Specialty	
Oncology	3.5 (1.9–6.4)
Ob/Gyn	2.6 (1.5–4.4)
Internal medicine	1.3 (0.7–2.3)
Family medicine	Reference
Aware of professional guidelines	
Yes (vs. no/not sure)	1.8 (1.2–2.7)
Practice has a policy	
Yes (vs. no/not Sure)	3.3 (2.0–5.5)
	Patients asking directly for testing increased Adjusted OR (95% CI)
City	
Pilot (vs. control)	2.1 (1.5–3.0)
Sex × specialty	
Female	
Oncology	1.5 (0.6–4.2)
Ob/Gyn	0.6 (0.3–1.1)
Internal medicine	0.8 (0.4–1.7)
Family medicine	Reference
Male	
Oncology	3.4 (1.7–7.0)
Ob/Gyn	3.1 (1.6–5.8)
Internal medicine	1.7 (0.9–3.4)
Family medicine	Reference
Aware of professional guidelines	
Yes (vs. no/not sure)	1.5 (1.1–2.2)
Practice has a policy	
Yes (vs. no/not sure)	2.7 (1.6–4.4)
	Physician has increased number of referrals Adjusted OR (95% CI)
Sex × city	
Female	
Pilot (vs. control)	1.6 (0.9–2.6)
Male	
Pilot (vs. control)	0.8 (0.5–1.2)
Specialty	
Oncology	2.8 (1.7–4.7)
Ob/Gyn	2.8 (1.9–4.3)
Internal medicine	1.4 (0.9–2.2)
Family medicine	Reference
Aware of professional guidelines	
Yes (vs. no/not sure)	1.8 (1.3–2.5)
Practice has a policy	
Yes (vs. no/not sure)	1.7 (1.1–2.7)
	Direct orders of test by physician have increased Adjusted OR (95% CI)
City	
Pilot (vs. control)	1.9 (1.2–3.1)
Specialty	
Oncology	6.4 (3.1–13.1)
Ob/Gyn	3.0 (1.6–5.7)
Internal medicine	2.2 (1.1–4.3)
Family medicine	Reference
Aware of professional guidelines	
Yes (vs. no/not sure)	2.4 (1.5–3.8)
Practice has a policy	
Yes (vs. no/not sure)	1.8 (1.0–3.3)

CI, confidence interval; OR, odds ratio.
Missing values and "not applicable" responses are excluded.
"Increased" includes "slightly" and "significantly increased." "Not increased" includes "remained same," "slightly decreased," and "significantly decreased."

Mouchawar et al.[21] also reported (in the Kaiser Permanente Colorado study) a decrease in the proportion of women referred who had a 10% or greater pre-test probability of carrying a *BRCA* mutation during the time the campaign took place but concluded that the majority of these referrals were still appropriate. They did not find an increase in testing among women with less than a 10% pretest probability for a mutation. We found that physicians in the pilot cities were more likely than those in control cities to report an increase in the number of tests they ordered, but we cannot comment on the appropriateness of this testing because this information was not collected. In addition, oncologists, ob/gyns, and internists were all more likely than family physicians to report an increase in tests ordered, as were physicians who were aware of professional guidelines or had a policy on testing (versus those with no guidelines or with no policy).

Our study is not the first to suggest that physicians have limited knowledge about genetic testing for cancer.[19,22,23] As expected, we found that physicians who were aware of professional guidelines were more knowledgeable than those who were not aware of those guidelines. This finding suggests that one of the most effective ways to influence the knowledge and behavior of physicians is to issue and disseminate professional guidelines. The recent publication of the USPSTF guidelines on genetic risk assessment and *BRCA* mutation testing for breast and ovarian cancer susceptibility provide evidence-based recommendations on which professional guidelines can be based.[13] The majority of physicians indicated a desire to learn more about genetic testing for BOC, suggesting that it would be relevant and timely to provide information about inherited susceptibility to cancer. Such education could also help promote adherence to clinical guidelines.

Pharmaceutical companies are spending an increasing amount on DTCA of prescription drugs,[24] a practice that has proven to be an effective way to communicate the availability of treatment to the public while affecting both physician practice and consumer behavior. For example, studies have shown that physicians feel pressure from patients to prescribe name-brand medications and to order prescription drugs despite their ambivalence about the choice of medications.[25,26] Physicians are often required to help patients interpret the information presented by advertisers, resulting in lengthened clinical encounters.[27] Consumer surveys conducted by the Food and Drug Administration and other organizations from 1998–2002 have shown that DTCA of pharmaceuticals increases awareness of medical conditions and disease treatments and influences consumers to ask physicians for particular prescriptions and information about drugs.[28,29]

The impact of DTCA on genetic tests and services on physician practice and consumer behavior may be similar to that seen with pharmaceuticals. For example, physicians may be more likely to make a referral based on a patient's interest in a genetic evaluation, and considerations of appropriateness may become less important.[30,31] Advertisements may also be an important factor in physicians' decisions to recommend genetic testing for inherited susceptibility to cancer.[32]

Although there are many similarities to prescription drug advertising, the implications of DTCA of genetic testing pose additional challenges. Some of these challenges include limited federal oversight of genetic testing as well as advertisements for genetic testing, difficulty in interpreting genetic tests that are probabilistic in nature, possible oversimplification of complex test results, limited awareness and knowledge of available genetic testing and services, lack of evidence that genetic tests ought to be offered routinely to the general public, and many ethical, legal and social issues involved with the use of genetic information for medical use (such as privacy and confidentiality and potential discrimination in insurance).[33,34]

This study is subject to several limitations. All data are self-reported and we were not able to determine the appropriateness of tests ordered by physicians or validate physician practice patterns with medical records. We asked physicians to report on reasons patients gave for asking questions about genetic testing for breast or ovarian cancer risk. However, direct patient report of reasons for asking about testing could differ from those reported by physicians. We do not have information on demographic or practice information of non-responders and thus are unable to determine if any response-biases exist. Finally, the cross-sectional design of this study prohibits drawing causal associations.

Despite these limitations, identified clinical needs based on the findings from our study include the additional development and dissemination of evidence-based professional guidelines and education of physicians to ensure the appropriate use of *BRCA* testing. Once developed, additional efforts are needed to promote adherence to guidelines. From a public health perspective, more tracking and monitoring of utilization rates of genetic tests to understand who is using genetic testing and how, and more outcomes research on the benefits of testing performed in clinical, rather than research settings, are needed.

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