Breast and ovarian cancer screening behaviors and health outcomes after genetic testing

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Introduction

Access to genetic testing has rapidly expanded as the cost of DNA sequencing decreases. As traditional delivery models of genetic testing are often time consuming for patients and providers, the use of alternative models to deliver genetic testing are being explored. Color has implemented one such model, integrating newer elements of the genetic testing process such as online ordering, telephone genetic counseling sessions, and reports tailored for both providers and patients. All testing is provider ordered and can either be ordered by a patient's own provider (traditional model) or by a third-party network of ordering providers (non-traditional model).

Previous research on outcomes after genetic testing are scarce due to the new and unique nature of many genetic tests[1]. Although past literature is limited, some research[2] revealed the rate of colonoscopies decreased from 59% to 8% before and after genetic testing among negatives, while others[3] found as many as 32% of *BRCA1* and *BRCA2* carriers are not compliant with annual mammography recommendations.

The purpose of this study is to explore and compare cancer screening behavior in individuals who received a genetic test for hereditary cancer through traditional and non-traditional models of testing. Specific aims of the study include: 1) Compare self-reported screening behavior to recommended guidelines, and 2) assess differences in behavior between models of testing.

Methods

In this study, a quantitative retrospective computer administered survey was used to analyze the outcomes of Color clients who have negative results (no mutations identified), increased risk (no mutations identified, increased risk of breast cancer according to the Gail or Claus model), and positive results (pathogenic mutation identified) in only the *BRCA1*, *BRCA2*, and Lynch syndrome genes *MLH1*, *MSH2*, *MSH6*, *PMS2*, and *EPCAM*. Individuals aged 18-90 who have had a negative, increased risk, or pathogenic mutation report one year or more prior to the start of data collection were eligible for this study. An email invitation to participate in the study was sent to a total of 3,436 individuals and 249 individuals responded. Participants had the option to enter into a raffle to win one of ten $75 gift cards upon completion of the survey.

Survey responses were collected in an anonymized manner. Demographic information previously provided by the individual was attached to the survey responses including age, gender, and result type. However, no personal identifying information was collected. All individuals consented to have their de-identified information used in this anonymized study. All information was reported by the individuals who participated.

The survey data was analyzed in aggregate with difference in proportions hypothesis testing to explore differences between the traditional and non-traditional models. Cancer screening actions were compared to screening recommendations by the National Comprehensive Cancer Network for Genetic/Familial High-Risk Assessment Breast and Ovarian[4] (*BRCA1* and *BRCA2*), Genetic/Familial High-Risk Assessment Colorectal[5] (Lynch syndrome genes), and Breast Cancer Screening and Diagnosis[6] (Negative and Negative with increased risk). Specific screening actions assessed by the survey and used for analysis are detailed in Table 1. Participants were asked "One year before you took this genetic test, which of the following had you done?" and "Since taking this genetic test, which of the following screening actions have you taken?" and given the option to select all answer choices that applied. The answer choices included but were not limited to: "Mammogram", "Breast exam by a healthcare provider", "Breast imaging using MRI", and "Colonoscopy". Timing of these actions post-testing was collected and analyzed.

Table 1. Guidelines

Cancer screening actions derived from NCCN guidelines used to gauge client compliance levels. Breast cancer screening actions are recommended until age 75 unless otherwise indicated, upon which screening becomes individualized.

Population	Screening Action			
	Mammogram	**Breast exam by a healthcare provider**	**Breast imaging using MRI**	**Colonoscopy**
Negative Female	Every year from age 40	Every 1-3 years from age of 25-40, Every year from age 40		
Negative Male				
Negative Female, increased risk (Claus)	Every year from age 30	Every 6-12 months from age 25	Every year from age 25	
Negative Female, increased risk (Gail)	Every year from age 35	Every 6-12 months from age 35		
BRCA1 positives Female	Every year from age 30	Every 6-12 months from age 25	Every year from age 25	
BRCA1 positives Male		Every year over age 35		
BRCA2 positives Female	Every year from age 30	Every 6-12 months from age 25	Every year from age 25	
BRCA2 positives Male		Every year from age 35		
Lynch positives Female				Every 1-2 years from age 25
Lynch positives Male				Every 1-2 years from age 25

Results

Table 2. Participant Characteristics

Self-reported demographic information of participants. Study participants were similar to previous genetic testing cohorts[7] and the overall population who received a Color test, (80% female, median age 48 years, 72% Caucasian), however, there is possible ascertainment bias due to the online survey methodology. Color testing was either ordered by a patient's own provider (traditional model) or by a third-party network of ordering physicians connected to the patient (non-traditional model).

		Nontraditional n (%)	Traditional n (%)
Gender	Female	132 (88.6)	87 (87.0)
	Male	17 (11.4)	13 (13.0)
Age (Years)	18-25	3 (2.0)	0 (0.0)
	26-30	10 (6.7)	3 (3.0)
	31-40	26 (17.4)	16 (16.0)
	41+	110 (73.8)	81 (81.0)
Ethnicity	Caucasian	125 (83.9)	84 (84.0)
	Asian	11 (7.4)	6 (6.0)
	Hispanic	5 (3.4)	3 (3.0)
	Multiple Ethnicities	5 (3.4)	2 (2.0)
	Other	3 (2.0)	5 (5.0)
Personal Cancer History	No high school diploma	2 (1.3)	1(1.0)
	High school diploma	6 (4.0)	4 (4.0)
	Technical, trade or vocational training	3 (2.0)	4 (4.0)
	Some college	17 (11.4)	14 (14.0)
	Associate degree	10 (6.7)	9 (9.0)
	Bachelor's degree	58 (38.9)	33 (33.0)
	Graduate degree	53 (35.6)	33 (33.0)
	No Answer	0 (0.0)	2 (2.0)
Genetic Test Result	Positive	49 (32.9)	35 (35.0)
	Negative with increased risk	55 (36.9)	33 (33.0)
	Negative	45 (30.2)	32 (32.0)

Figure 1. Compliance to baseline guidelines before genetic testing

Proportion of respondents in each cohort who were completing all baseline screening in the year before genetic testing. Traditional n = 100, Non-Traditional n = 149, 95% confidence interval error bars shown. The proportion of compliant individuals in both cohorts were not significantly different before testing (z-test, p = 0.061).

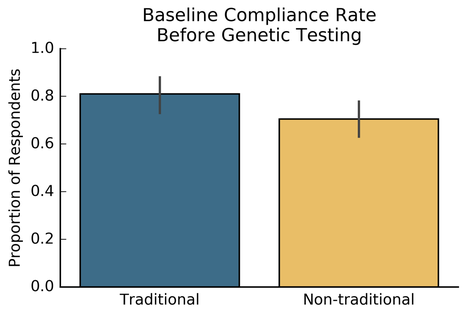


Figure 2. Actions before and after genetic testing by positives

Performance of gene-specific screening actions by respondents with positive results. Actions were assessed before and after testing. Panels (A) and (B) show proportion of participants that completed all of result-specific recommended screening actions. Panels (C) and (D) show proportion of participants who completed no recommended screening actions (None), one or more, but not all screening actions (Partial), and all of the screening actions (All). Traditional n = 35, Non-Traditional n = 49, 95% confidence interval error bars shown. While not statistically significant, a slightly higher proportion of participants in the traditional cohort were completing the gene-specific screening actions before testing than in the non-traditional cohort (z-test, p = 0.083). There was no difference in proportions of participants completing gene-specific actions after testing (z-test, p = 1.000).

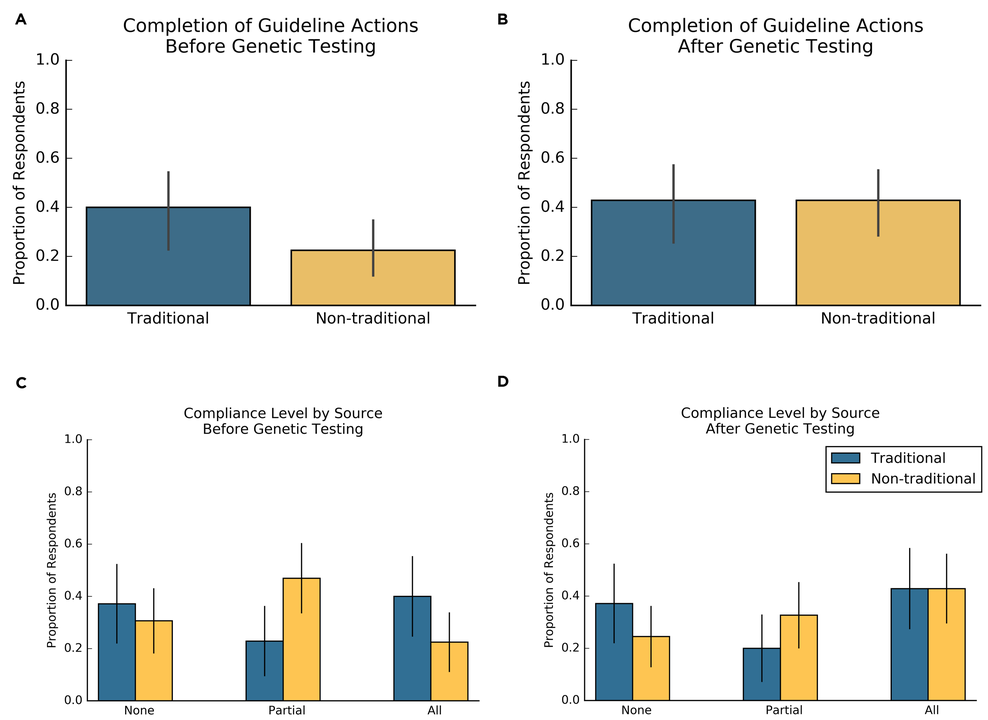
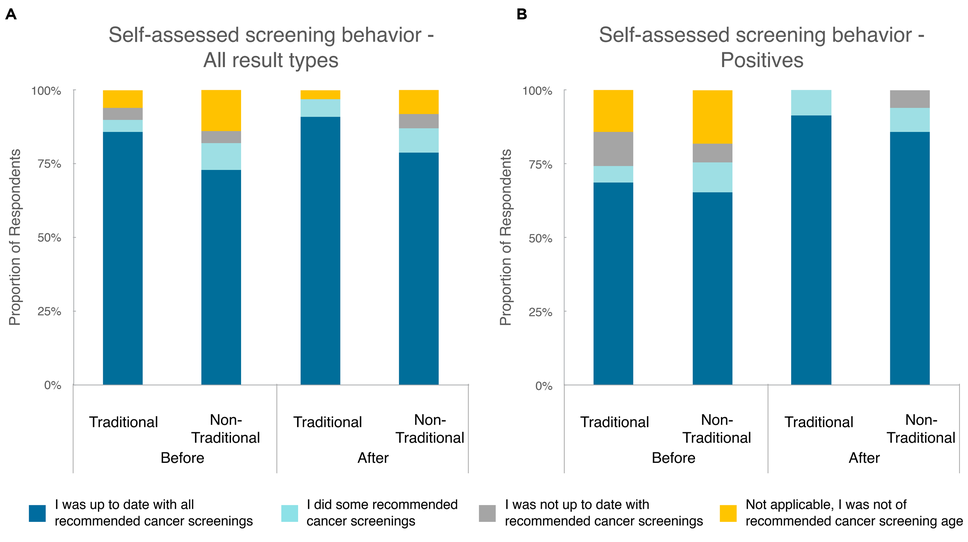


Figure 3. Self-assessed up to date with screening

In addition to analyzing screening actions, we asked participants to self-assess how up to date they were with their cancer screening using the following question about their actions before and after genetic testing: "Are you up to date with your doctor's recommended cancer screenings (for example, mammograms every year, or a colonoscopy every 10 years)?". Participants of all result types (A) had a higher self-assessment of their screening behavior than we measured by specific actions. Interestingly, participants with a positive testing result (B) recognized there were screening behaviors appropriate at their current age after learning their genetic testing result.



Conclusions

- Participants in the traditional model may have done slightly more screening actions before testing due to increased provider contact.
- However, genetic testing through this non-traditional model can educate about screening guidelines and spur knowledge and compliance to the same degree as a traditional model post-testing.
- Based on the data presented, the non-traditional model of genetic testing is not inferior to the model of traditional genetic testing with respect to compliance with gene-specific recommendations.

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