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Economic Evaluation Alongside a Clinical Trial of Telephone Versus In-Person Genetic Counseling for *BRCA1/2* Mutations in Geographically Underserved Areas

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QUESTION ASKED: Many individuals at risk for *BRCA1* or *BRCA2* mutations do not have access to trained genetic counselors. This study conducted an economic evaluation alongside a clinical trial of approaches to extending the reach of genetic testing services to geographically underserved populations.

SUMMARY ANSWER: Telephone genetic counseling was less expensive than in-person services delivered in the community per individual counseled, individual tested, or mutation detected. For example, it cost an average of \$120 (range, \$80 to \$200) per person counseled in the telephone counseling arm compared with \$270 (range, \$180 to \$400) for in-person counseling. One-way sensitivity analyses showed that the average cost per participant remained consistently lower in the telephone counseling arm than in the in-person counseling arm across the range values for each cost parameter and for each study outcome.

METHODS: Microcosting was used to enumerate resources for counseling delivered at 14 primary care clinics (nine geographically remote, five urban) in Utah. Staff time and travel, space, overhead, patient time costs, and test costs were calculated on the basis of actual intervention use and valued using national data for wage rates, space, and overhead. We calculated the costs per arm for pretest counseling, uptake of *BRCA1/BRCA2* testing, per mutation detected, and per completion of post-test genetic counseling at 6 months after randomization. Costs and effects were not discounted.

BIAS, CONFOUNDING FACTOR(S), DRAWBACKS: The findings may not be generalizable to women in other geographically underserved regions in terms of socio-demographic characteristics and mutation risk. Next, we included only costs related to genetic counseling and testing. Counseling and testing may affect other costs, such as those related to increased or decreased short-term use of medical care or long-term health behaviors.

REAL-LIFE IMPLICATIONS: Telephone counseling is a cost-efficient method to extend the reach of genetic counseling services in geographically remote areas. **JOP**

ASSOCIATED CONTENT

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Abstract

Purpose

BRCA1/2 counseling and mutation testing is recommended for high-risk women, but geographic barriers exist, and no data on the costs and yields of diverse delivery approaches are available.

Methods

We performed an economic evaluation with a randomized clinical trial comparing telephone versus in-person counseling at 14 locations (nine geographically remote). Costs included fixed overhead, variable staff, and patient time costs; research costs were excluded. Outcomes included average per-person costs for pretest counseling; mutations detected; and overall counseling, testing, and disclosure. Sensitivity analyses were performed to assess the impact of uncertainty.

Results

In-person counseling was more costly per person counseled than was telephone counseling (\$270 [range, \$180 to \$400] v \$120 [range, \$80 to \$200], respectively). Counselors averaged 285 miles round-trip to deliver in-person counseling to the participants (three participants per session). There were no differences by arm in mutation detection rates (approximately 10%); therefore, telephone counseling was less costly per positive mutation detected than was in-person counseling (\$37,160 [range, \$36,080 to \$38,920] v \$40,330 [range, \$38,010 to \$43,870]). In-person counseling would only be less costly than telephone counseling if the most favorable assumptions were applied to in-person counseling and the least favorable assumptions were applied to telephone counseling.

Conclusion

In geographically underserved areas, telephone counseling is less costly than in-person counseling.

ASSOCIATED CONTENT

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INTRODUCTION

Identification of women with *BRCA1* or *BRCA2* (*BRCA1/2*) mutations is important, given their high risk of developing breast cancer and ovarian cancer^{1,2} and the availability of interventions to improve outcomes, including early initiation of breast cancer screening and risk reduction via chemoprevention, mastectomy, and oophorectomy.^{3,4} Thus, genetic risk assessment and counseling services have been widely recommended for those with a high mutation pretest probability.^{4,5}

In-person genetic counseling has been the standard of care approach for provision of these services.^{4,5} However, this approach requires sufficient numbers and wide geographic distribution of trained counselors to ensure access for all at-risk individuals. Alternative delivery approaches, such as provision of telephone counseling, have the potential to increase genetic counseling access to those in geographically underserved areas, while maintaining care standards.^{6,7} Recent research has shown that telephone counseling is noninferior to in-person counseling for psychosocial outcomes.^{8,9} In one study of largely urban women, telephone counseling was estimated to cost less than in-person counseling.⁹ Because distance to services is frequently cited as a structural barrier to using genetic counseling and testing services,¹⁰ telephone and other delivery approaches may be cost-efficient methods to increase access in geographically underserved areas.

In this study, we conducted an economic evaluation alongside a randomized clinical trial comparing methods to increase the geographic reach of services, including telephone and in-person counseling, wherein counselors traveled to remote primary care locations. The results are intended to inform discussions about the most efficient approaches to extend the reach of proven effective methods to identify individuals at risk for cancer susceptibility mutations.

METHODS

Overview

This economic analysis was conducted within the clinical trial entitled Bridging Geographic Barriers: Remote Cancer Genetic Counseling for Rural Women (NCT01346761). The trial was approved by the University of Utah Institutional Review Board and has been described elsewhere.¹¹ Cluster participants were randomly assigned by family unit to in-person or telephone-delivered genetic counseling.

Demographic, psychosocial, and clinical data were collected at baseline using standardized surveys with visual aids. In-person and telephone counseling were delivered by the same five board-certified genetic counselors. In-person counseling took place at 14 primary care clinics (nine geographically remote, five urban; referred to as in-person counseling). Rural or urban residence determination was based on the Rural-Urban Commuting Area codes.¹² Participants in each arm received standardized pretest counseling, followed by another survey. If genetic testing was performed, a final survey was completed 6 months after the standardized post-test counseling.

Participants

Women with cancer at risk for hereditary breast or ovarian cancer were identified via the Utah Cancer Registry based on age at diagnosis. To be eligible, participants or their family members were required to have a personal or family history of breast cancer sufficient to justify genetic evaluation by National Comprehensive Cancer Network criteria during the study period.⁴ Additional eligibility criteria included being English-speaking, being able to provide informed consent, being 25 to 74 years of age, having telephone access, being able to travel to counseling at a community clinic, and not having prior counseling or testing. Participants resided in Utah, where 14% of the population lives in geographically remote zip codes; 24.6% of participants lived outside of the Salt Lake City area.¹³⁻¹⁵

Economic Analysis

The economic analysis was conducted from the societal perspective. The value of all resources used in the clinical trial, such as opportunity costs (eg, time of the participant), variable costs (eg, wages and fringe benefits of the counselors), and fixed costs (eg, overhead), were counted in the calculation of costs, regardless of who pays them. We used a microcosting approach to specifically enumerate the value of each resource used in implementation of the trial. In conducting this economic evaluation, we followed recommendations of the US Panel on Cost-Effectiveness in Health and Medicine.¹⁶ Because we were only interested in the added costs of interventions to increase use of a proven effective test in an at-risk group, we focused on the counseling delivery costs and the immediate 6-month downstream consequences of counseling (eg, uptake of *BRCA1/2* testing and completion of post-test genetic counseling). Given the short time horizon, costs and effects were not discounted.

Economic Data Collection

The economic data were collected from three sources: participant self-report, administrative logs of the research team, and public data sources. First, we used participant-reported data on the time spent on all nonresearch aspects of participation, including reviewing the pretest counseling materials, discussing testing results with family in the post-test session, traveling for testing (for blood draw only), and pretest and post-test counseling. Family discussion time was included because of its central role in hereditary cancer mutation testing. Second, administrative staff and genetic counselors provided data for time spent scheduling appointments, preparing for counseling, traveling to provide counseling (in-person arm only), and preparing letters to insurers and primary care providers related to testing and test results. Counseling time was recorded from audiotapes of actual encounters. Median time was used in the base case analysis and varied across the observed range in sensitivity analyses.

Costs

National data were used, rather than study-specific cost data, to enhance generalizability. Costs were grouped as variable and fixed. Variable costs included participant and staff costs. The average wage and fringe benefit rates for phlebotomists and administrative staff in the United States were \$17 per hour and \$20 per hour, respectively, based on data reported to the Bureau of Labor Statistics.¹⁷ Patient time cost was \$23 per hour, estimated from the earnings of adult women working full time in the United States.¹⁷ The wages and fringe benefits of genetic counselors at the time of the trial were based on the national average of \$83,712 (salary and fringe benefits), as reported in the 2010 National Society of Genetic Counselors report,¹⁸ and then inflated to 2012 projected salary using the consumer price index.¹⁹

Transportation costs (ie, gas, tolls, mileage, and depreciation) were based on allowable rates set by the Internal Revenue Service in 2012; mileage was \$0.23 per mile.²⁰ Given the geography of Utah, we assumed that travel would be by car on highways (60 miles per hour). The average parking fee was assumed to be \$5. We assumed that travel time and costs were the same for pretest and post-test counseling. The average counselor travel distance was calculated as a product of the average number of community clinic sites in geographically remote versus urban areas, multiplied by the average round-trip miles traveled to each area. It was assumed that participants used cellular phones (telephone counseling arm only).

Genetic testing costs at the time of the trial included travel for separate venipuncture visits or the cost of mailing if a buccal kit was used (kit and mailing both ways: \$17), test charges, and miscellaneous materials (\$3 per participant). The cost of *BRCA1/2* testing was based on charges by Myriad Genetic Laboratories (Salt Lake City, UT; \$3,340) because the trial took place before the availability of widespread testing. Participant time to undergo the test was estimated at 15 minutes.

Fixed costs were related to overhead.²¹ Staff office space was based on the national average rate of \$39 per square foot for rental and utilities.²¹ We assumed that telephone counseling required one half the space of in-person counseling (100 sq ft). Staff phone costs were \$33 per month. Per-person overhead was based on 35 participants receiving counseling per month. Because only two participants required childcare in each arm, childcare costs were not included.

Outcomes

We considered three outcomes based on a priori trial specifications: average costs per participant for pretest counseling, average costs per positive *BRCA1/2* case detected, and average costs per participant for pretest counseling and post-test result disclosure and counseling. The costs of pretest counseling were the primary outcomes.

Analysis

We compared the average costs and incremental differences in costs by arm. To test whether conclusions about counseling strategies changed when we varied estimates or assumptions over reasonable ranges, we conducted a series of one-way sensitivity analyses for each outcome. The specific factors that were tested were test prices, travel time, number of participants reached during sessions at remote locations, and mutation yield. For these sensitivity analyses, the primary estimates were varied across the range of values observed in the trial; for other values, estimates were varied over a range of plus or minus one third of the point estimate. Because we were interested in the adoption of counseling within the health care system, we also varied the perspective from societal to the health care system perspective (ie, excluding patient time costs). The sensitivity analyses results are summarized in tornado diagrams (Appendix Figs A1 and A2, online only), where results are arrayed from scenarios showing variables with the largest impact on results to those having the least impact.²² We also conducted a multiway sensitivity analysis of a scenario that

should minimize any cost difference by arm by assuming the least favorable costs in the telephone counseling arm (ie, the upper range) and the most favorable costs in the in-person counseling arm (ie, the lower range); actual test costs were held constant by arm. Finally, we examined how the combination of changes in lower test costs, greater mutation yield with in-person than with telephone counseling, and greater economies of scale for remote counseling (eg, seeing six participants per trip v the base of three participants per trip) affected the incremental difference in costs. Analyses were conducted using STATA software (release 12; STATA, College Station, TX).

RESULTS

The majority of trial participants had breast cancer, were non-Hispanic white, and were of non-Ashkenazi Jewish ancestry; 8% had ovarian cancer (Table 1).

Average Cost per Participant Undergoing Pretest Counseling

The delivery costs of pretest counseling varied by study arm (Appendix Table A1). The largest difference between the arms was in time costs, particularly travel time. Counselors traveled an average of 285 miles round-trip to deliver in-person counseling in geographically underserved areas to an average of three participants per trip. The costs of pretest counseling were lower in the telephone counseling arm than the in-person counseling arm (\$120 [range, \$80 to \$200] v \$270 [range, \$180 to \$400], respectively).

Average Cost per Positive *BRCA1/2* Case Detected

The detection rate of positive *BRCA1/2* mutations was similar across study arms (10.1% for in-person counseling v 9.9% for telephone counseling, $P = .97$), although the in-person counseling arm had a higher uptake rate than did the telephone counseling arm (31.8% v 21.8%, $P = .007$). Because telephone counseling was less costly and test costs were equal, telephone counseling had lower average costs per mutation detected (\$37,160 [range, \$36,080 to \$38,920]) than in-person counseling (\$40,330 [range, \$38,010 to \$43,870]; Appendix Table A1).

Total Average Cost per Participant Counseled and Tested

The average post-test counseling cost per participant was \$383 in the in-person arm and \$160 in the telephone arm. The

content of the genetic counseling was identical in both arms, but the length of the in-person session was slightly longer (approximately 14 minutes) because it promoted more conversation than did telephone counseling. After including genetic test-related costs, the costs per participant counseled and tested was \$3,680 (range, \$3,570 to \$3,850) for telephone counseling versus \$4,060 (range, \$3,830 to \$4,420) for in-person counseling.

Sensitivity Analysis

The one-way sensitivity analyses showed that the average cost per participant remained consistently less expensive in the telephone counseling arm than in the in-person counseling arm (Appendix Tables A2 and A3; Figs A1 and A2). Given the distance traveled to provide remote counseling, the costs of in-person counseling could be decreased if the number of women counseled per trip increased. From the perspective of the health care system, telephone counseling remained the least costly approach. In-person counseling would only be less costly than telephone counseling if the most favorable assumptions were applied to in-person counseling and the least favorable assumptions were applied to telephone counseling (including administration time, travel time, counseling time, and participant time).

DISCUSSION

This study provides important data on the costs of novel structural approaches to extend the reach of genetic counseling and testing in geographically underserved areas. The economic evaluation alongside this randomized trial demonstrates that telephone counseling is less costly than having genetic counselors travel to remote locations to deliver in-person counseling. The results were robust across a variety of scenarios. In-person costs could be decreased by obtaining economies of scale through reaching a larger number of women per trip. Absolute costs could be decreased in both groups as genetic testing costs decline.

This is the first economic evaluation of delivery approaches for genetic testing and counseling for *BRCA* mutations targeting geographically underserved populations. One other study compared the costs of telephone counseling with in-person counseling at central academic centers.⁹ The average cost of telephone counseling and testing in that setting was \$3,660, comparable with our result of \$3,680. Our results are also similar to earlier estimates of genetic counseling, testing, and disclosure (\$3,130 in 2012 dollars).²³

Table 1. Characteristics of Women Participating in a Randomized Trial Comparing Telephone With In-Person Counseling for *BRCA1/2* Testing With Complete Follow-Up Data

Characteristic	Overall (n = 901*)	In-Person (n = 437*)	Telephone (n = 464*)
Age, years, mean (SD)	56.2 (8.2)	56.1 (8.4)	56.2 (8.0)
Race/ethnicity			
Non-Hispanic white	94 (851)	93 (407)	96 (444)
Hispanic	3 (29)	4 (19)	2 (10)
Other	3 (21)	3 (11)	2 (10)
Ashkenazi Jewish ancestry			
Yes	1 (7)	1 (1)	1 (6)
No	97 (878)	97 (426)	98 (452)
Unknown	2 (16)	2 (10)	1 (6)
Marital status			
Married or living as married	78 (703)	78 (342)	78 (361)
Single/widowed/separated/divorced	22 (198)	22 (95)	22 (103)
Educational level			
High school or less	21 (192)	21 (87)	23 (105)
Some college, associate's degree/vocational	37 (331)	39 (174)	34 (157)
Bachelor's degree or higher	42 (378)	40 (176)	43 (202)
Geographically remote/urban residence			
Urban	85 (767)	85 (372)	85 (395)
Geographically remote	15 (134)	15 (65)	15 (69)
Annual household income			
< \$29,999	12 (107)	10 (43)	14 (64)
\$30,000-\$49,999	19 (174)	21 (94)	17 (80)
\$50,000-\$69,999	19 (168)	19 (82)	19 (86)
> \$70,000	47 (420)	47 (207)	45 (213)
Missing	3 (32)	3 (11)	5 (21)
Employment status			
Employed	62 (559)	63 (276)	61 (283)
Not employed	38 (342)	37 (161)	39 (181)
Health care coverage			
Yes	97 (875)	98 (430)	96 (445)
No	3 (26)	2 (7)	4 (19)
Personal history of breast cancer			
Yes	90 (810)	89 (390)	91 (420)
No	10 (91)	11 (47)	9 (44)
Personal history of ovarian cancer			
Yes	8 (71)	8 (33)	8 (38)
No	92 (830)	92 (404)	92 (426)

NOTE. Data are presented as percent (No.) unless otherwise noted.

Abbreviation: SD, standard deviation.

*Nine hundred eighty-eight participants were randomly assigned, and 901 completed both pretest counseling and follow-up; 901 women constituted the study sample for the economic analysis.

Our results indicate that increasing the number of individuals counseled per trip could make the in-person counseling more favorable. Six or more women would need to be

counseled to make costs comparable if travel distances are as extensive as those included in this trial. Given the limited number of trained genetic counselors in the United States,¹⁸

the geographic concentration of these professionals in urban areas,¹⁸ and the possibility that more payers will require patients to undergo counseling with credentialed genetics providers before testing,²⁴ it is increasingly important to continue to develop cost-efficient methods to deliver proven, effective genetic testing to underserved areas.

Targeting relatively scarce genetic counseling resources to those at highest risk can also increase program efficiency and decrease the average counseling cost per participant. The cost of full gene sequencing was a large portion of the total average costs of counseling and testing in both arms of this trial. However, under implementation of the Affordable Care Act, genetic counseling and *BRCA* testing for eligible at-risk women are now considered preventive services, with no charge to the users.^{25,26} Furthermore, the costs of mutation testing have decreased substantially since this trial, with Myriad's loss of patent status.^{27,28} In addition, with advances in sequencing technology, the new generation of tests with the ability to simultaneously evaluate multiple genes could further reduce costs but might increase counseling time because of the detection of variants of uncertain significance.²⁹ Elimination of financial barriers should encourage the use of genetic counseling and testing. The ultimate difference in costs between telephone and in-person counseling will depend on whether changes in technology and market forces lead to a different mix of women deciding to be tested and whether that would differ by care delivery approach.

The costs per quality-adjusted life-years saved downstream from genetic testing and counseling will depend on the population prevalence of mutations,³⁰ as well as the behavior of those detected with mutations, such as uptake of magnetic resonance imaging (MRI) screening³¹ and/or prophylactic surgery.³² In prior economic analyses, *BRCA1/2* testing and counseling seemed cost-effective if at least 50% of those with mutations had prophylactic surgery³³ or used regular MRI screening.³⁴ Although this trial removed geographic barriers to counseling and testing, and the costs were low, especially for telephone counseling, it is possible that women living in geographically remote areas would have nonfinancial barriers to MRI screening or preventive surgery. For example, in remote areas, there may be limited availability of dedicated breast MRI equipment and experienced radiologists, as well as limited access to breast surgeons and gynecologic oncologists. Such barriers could ultimately render testing and counseling less cost-effective than estimated in other settings. As data matures on the long-term health-seeking behaviors of mutation carriers from geographically remote areas, it will be important to extend

the time horizon of our economic analysis to estimate the downstream costs per quality-adjusted life-years saved.

Despite the strong study design alongside a randomized trial and the robust results, this economic analysis has several limitations. First, the generalizability of these study findings may be affected by several factors, including whether study participants are similar to women in other geographically underserved regions in terms of sociodemographic characteristics and mutation risk. The costs observed in this trial may also vary if the intervention is replicated in other settings without high-quality registries, such as the one in Utah. However, electronic records should facilitate identification of individuals with a personal or family history suggestive of hereditary breast or ovarian cancer for practice-based interventions. Second, given that the goal of genetic counseling is to help patients make informed decisions about whether to be tested, significantly higher uptake rates of genetic testing among women receiving in-person counseling might not represent a better outcome or higher likelihood of positive mutation detection. Therefore, the focus of this study was to assess the differences in average cost per pretest counseling for two diverse delivery approaches. Third, we only included costs related to genetic counseling and testing. It is possible that counseling and testing affected other costs, such as those related to increased or decreased short-term use of medical care. We did not have data on these events, nor did we have information on long-term health behaviors, given the time horizon of the trial. If short-term medical care costs were randomly distributed across arms, then this would not affect results. However, if medical care costs were differentially distributed such that they were higher in the telephone than the in-person counseling arm, it is possible that the study conclusions would change. Fourth, we chose to evaluate costs per units related to program efficiency and not years of lives saved. *BRCA1/2* testing and counseling of women with a high prior probability of mutations have been found to be cost-effective.³²⁻³⁸ Thus, we concentrated on the added costs of different interventions to extend the reach of a proven effective and cost-effective service. Finally, this trial was limited to two counseling delivery approaches designed to overcome structural barriers to care in geographically underserved areas. In the future, it will also be important to test other delivery approaches, including computer-based counseling.³⁹⁻⁴²

Telephone genetic counseling has been shown to be as effective as in-person genetic counseling and has comparable

psychosocial and informed decision-making outcomes.⁹ Given its lower costs compared with remote in-person delivery of counseling, telephone genetic counseling could be considered for dissemination as one approach to increasing the reach of genetic testing services to geographically underserved populations. **JOP**

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Authors' Disclosures of Potential Conflicts of Interest

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST**Economic Evaluation Alongside a Clinical Trial of Telephone Versus In-Person Genetic Counseling for BRCA1/2 Mutations in Geographically Underserved Areas**

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APPENDIX

Table A1. Average Costs of Telephone Counseling Versus In-Person Counseling for *BRCA1/2* Mutations

Intervention Activity	In-Person Time, Hours (range) ^a	Cost, Dollars (range)	Telephone Time, Hours (range)	Cost, Dollars (range)
Pretest counseling				
Average staff time and travel cost for counseling one participant				
Administrative staff scheduling and preparing materials at \$20/h ^b	0.8 (0.5-1)	15 (10-20)	0.8 (0.5-1)	15 (10-20)
Genetic counselor preparation time at \$44/h ^c	0.3 (0.2-0.4)	13 (9-17)	0.3 (0.2-0.4)	13 (9-17)
Genetic counselor time providing pretest counseling at \$44/h ^c	0.8 (0.3-2.0)	35 (14-87)	0.8 (0.3-2.0)	33 (14-75)
Genetic counselor's round-trip travel to remote counseling sites per three participants at 284.5 miles; 60 miles/h and \$44/h ^d	1.6 (1.0-2.0)	69 (44-87)	—	—
Round-trip travel-related costs (gas, car usage, parking) ^e	94.8 (60-120) ^f	24 (16-29)	—	—
Average time and travel cost per participant for attending counseling services				
Round-trip travel for pretest counseling at \$23/h ^b ; 35.5 miles ^g	0.59 (0.4-0.8)	14 (9-18)	—	—
Round-trip travel-related costs (gas, car usage, parking) ^{e,g}	35.5 (24-48) ^f	13 (11-16)	—	—
Time in pretest counseling to review study materials at \$23/h	0.7 (0.4-1.1)	17 (9-24)	0.6 (0.5-0.6)	13 (12-14)
Time in pretest counseling at \$23/h ^b	0.8 (0.3-2)	18 (7-46)	0.8 (0.3-1.7)	17 (8-39)
Overhead: 50% of overhead allocated to pretesting				
Office space at \$38.6 per square foot ^h (assumes telephone counseling requires one half the space of in-person counseling)	—	56	—	28
Monthly telephone costs per person, assuming use for 35 participants ⁱ	—	—	—	0.5
Subtotal cost of pretest counseling per participant		270 (180-400)		120 (80-200)
Average genetic testing cost per participant				
Round-trip travel time to obtain test at \$23/h ^b	0.3 (0.2-0.3)	6 (4-8)	0.05 (0.02-0.08)	1 (0-2)
Testing transportation costs (gas, car use, parking) ^e	15.2 (10-20)	9 (7-10)	3.2 (1-5)	6 (5-6)
Time in obtaining laboratory test ^j	0.3 (0.2-0.3)	6 (4-8)	0.3 (0.2-0.3)	6 (4-8)
Gene sequencing charge ^k		3,360		3,360
Blood drawing by phlebotomist at \$17/h ^b	0.2 (0.1-0.2)	3 (2-4)	0.2 (0.1-0.2)	3 (2-4)
Phlebotomy materials ^k		25		25
Subtotal cost of genetic testing per participant		3,410 (3,402-3,413)		3,400 (3,396-3,404)
Post-test counseling				
Average staff time and travel cost for counseling one participant				
Administrative staff scheduling and administrative work at \$20/h ^b	0.8 (0.5-1)	15 (10-20)	0.8 (0.5-1)	15 (10-20)
Genetic counselor preparation time in obtaining and reviewing results at \$44/h	0.2 (0.1-0.2)	7 (5-10)	0.17 (0.1-0.2)	7 (5-10)
Genetic counselor post-test counseling at \$44/h ^c	0.3 (0.03-1.7)	12 (1-75)	0.2 (0.1-0.7)	9 (4-31)
Genetic counselor time in other disclosure activities (ie, physician notification) at \$44/h ^c	1.9 (1.3-2.6)	84 (55-113)	1.9 (1.2-2.1)	82 (51-89)
Genetic counselor's travel time (round trip) at \$44/h ^c ; 284.5 miles ^g (two participants per trip)	2.4 (1.6-3.2)	103	—	—
Genetic counselor's transportation costs; 284.5 miles ^{e,g} (two participants per trip)	142 (96-192) ^f	35 (25-47)	—	—
Average time cost and travel cost per participant for attending counseling services				

(continued on following page)

Table A1. Average Costs of Telephone Counseling Versus In-Person Counseling for *BRCA1/2* Mutations (continued)

Intervention Activity	In-Person Time, Hours (range ^a)	Cost, Dollars (range)	Telephone Time, Hours (range)	Cost, Dollars (range)
Round-trip travel time for post-test counseling at \$23/h ^b ; 35.53 miles for in-person counseling ^g	0.6 (0.4-0.8)	14 (9-18)	—	—
Transportation costs for post-test counseling gasoline and parking; 35.53 miles for in-person counseling ^e	35.5(24-48) ^f	13 (11-16)	—	—
Time in post-test counseling at \$23/h ^b	0.3 (0.03-1.7)	6 (1-39)	0.2 (0.1-0.7)	5 (2-16)
Time to discuss test results with family at \$23/h ^b	1.67 (1.3-2.0)	38 (30-46)	1.45 (0.9-2.0)	33 (21-45)
Overhead: 50% of overhead allocated to post-test counseling				
Office space at \$39 per square foot ^h		55 (28-83)		28 (14-41)
Telephone costs (counseling only) ⁱ		—		0.5 (0.2-0.7)
Subtotal cost of post-test counseling per participant		380 (240-610)		160 (100-250)
Average cost per participant counseled and tested		4,060 (3,830-4,420)		3,680 (3,570-3,850)
Average cost per positive mutation detected (based on detection rates of 10.1% in-person and 9.9% telephone)		40,330 (38,010-43,870)		37,160 (36,080-38,920)

^aThe range is based on observed range or, where not available, is approximately one-third lower or higher than the point estimates.

^bThe median average wage and fringe benefit rates for participants, phlebotomists, and the project coordinator and other REACH staff were \$23, \$17, and \$20 per hour, respectively, based on the earnings of women age 16 and above with a full-time job plus fringe benefit rates in the Current Population Survey in 2012 by the Bureau of Labor Statistics.¹⁹

^cThe hourly rate for the genetic counselor was estimated from the national average of salary plus fringe benefit rate of \$83,712 per annum in the National Society of Genetic Counselors report in 2010.¹⁸ The Consumer Price Index in 2012 was used to inflate the hourly rate to the 2012 dollar value.¹⁷

^dAverage counselor travel distance was calculated as a product of the average number of community clinic sites in geographically remote versus urban areas multiplied by the average round-trip miles traveled to each area.

^eStandard mileage rate is \$0.23 per mile, based on the Internal Revenue Service in 2012 for use of a car driven for medical or moving purposes.²⁰

^fThe numbers in the cell represent miles.

^gWe assumed that travel mileage for participants in post-test genetic counseling was the same as travel mileage for participants in pretest genetic counseling.

^hThe national average office rental rate is \$39 per square foot.²¹ We assumed that the average medical office space was 100 square feet. The average overhead was based on seeing 35 participants per month. We assumed that telephone counseling requires one half of the space of in-person counseling. Space refers to space at the primary center for preparation. Office space rental for in-person counseling in the remote location is excluded.

ⁱMonthly phone rate of \$33 per month used for 35 participants per month.

^jThe time to obtain a laboratory test was assumed to be 15 min.

^kWe assumed that all participants received comprehensive *BRCA* analysis from Myriad Genetic Laboratories. The gene sequencing charge includes a *BRCA* analysis kit from Myriad Genetic Laboratories (\$3,340), postage (\$14), postage for the Myriad kit (\$3 per participant), and miscellaneous materials (\$3 per participant).

Table A2. Average Cost of Telephone Versus In-Person Pretest Counseling Per Participant Under Varying Assumptions

		Average Cost per Participant, Dollars		
Variable Names	Scenario	In-Person Counseling	Telephone Counseling	Incremental Cost of Telephone Versus In-Person Counseling
		270	120	— 150
One-way sensitivity analysis (one variable changed at a time)				
Health care system perspective	Omits patient time costs	210	90	— 120
Travel time	Decrease counselor travel distance to provide services by 50%	22	119	— 107
Multiway sensitivity analysis				
Range of values most favorable to in-person	Highest telephone costs and lowest in-person costs	194	199	5

NOTE. Negative numbers favor telephone counseling.

Table A3. Costs of Telephone Versus In-Person Genetic Counseling and Testing per Positive Mutation Detected Under Varying Assumptions

		Average Cost per Positive <i>BRCA1/2</i> Case Detected, Dollars		
Variable Names	Scenario	Cost of In-Person Counseling	Cost of Telephone Counseling	Incremental Cost of Telephone Versus In-Person Counseling
		40,330	37,160	−3,170
One-way sensitivity analysis (one variable changed at a time)				
Rate of mutation detection	5%, both arms	80,660	74,350	−6,310
	20%, both arms	20,160	18,580	−1,580
Type of test	Buccal swab (v blood draw)	40,050	36,970	−3,080
Test costs	Known mutation at \$250	950	570	−380
Health care system perspective	Omits patient time costs	38,820	36,350	−2,470
Economy of scale	Increase the number counseled per trip from three to six in in-person arm	38,950	37,150	−1,800
Travel time	Decrease counselor travel distance to provide services by 50%	39,200	37,150	−2,050
Multiway sensitivity analysis				
Range of values most favorable to in-person	Highest telephone costs and lowest in-person costs	38,870	38,770	−100
	Mutation test price \$400 in both arms; in-person counseling yields			
Combination of conditions most favorable to in-person	20% mutation positivity and six women are counseled per trip versus 10% positivity in telephone arm	4,780	7,260	2,480

NOTE. Negative numbers favor telephone counseling.

FIG A1. The impact of varying parameters on incremental cost of telephone counseling versus in-person counseling per participant in the pretest session. Differences in the average incremental cost per participant in the pretest session from three one-way and one multiway sensitivity analyses depicted in a tornado diagram format. The specific variable or set of variables being tested is listed to the right of each bar. Each bar represents the incremental costs of telephone counseling versus in-person counseling when the one (or a group of) variable(s) listed is varied from its original value in the base analysis. The end point of the bar indicates the cost under the new condition. The length of the bars provides a visual representation of which factors have the smallest (shortest bars) to the largest (longest bars) impact on the conclusions about the relative costs of telephone counseling versus in-person counseling per participant. Cost values to the left of the zero indicate negative values (ie, telephone counseling is less costly than in-person); values to the right of the zero indicate that in-person counseling would be less costly than telephone counseling. Telephone and in-person would be equivalent at zero incremental difference. As shown in the figure, telephone counseling remains less costly than in-person counseling under all circumstances, except in the one scenario with the most favorable assumptions to in-person counseling and the least favorable assumptions to telephone counseling (including administration time, travel time, counseling time, and participant time).

FIG A2. Impact of varying parameters on incremental cost of telephone counseling versus in-person counseling per positive *BRCA1/2* mutation detected. Differences in the average incremental cost per positive *BRCA1/2* case detected from eight one-way and two multiway sensitivity analyses depicted in a tornado diagram format. The specific variable or set of variables being tested is listed to the side of each bar. Each bar represents the incremental costs of telephone counseling versus in-person counseling when the variable or group of variables listed is varied from its original value in the base analysis. The end point of the bar indicates the cost under the new condition. The length of the bars provides a visual representation of which factors have the smallest (shortest bars) to the largest (longest bars) impact on the conclusions about the relative costs of telephone counseling versus in-person counseling per positive *BRCA1/2* case detected. Cost values in parentheses to the left of the zero indicate negative values (ie, telephone counseling is less costly than in-person); values to the right of the zero point indicate that in-person counseling would be less costly than telephone counseling. Telephone and in-person counseling would be equivalent at zero incremental difference. As shown in the figure, telephone counseling remains less costly than in-person counseling under all circumstances except in the one scenario with the most favorable assumptions (greater economy of scale and double the yield of mutation positivity from the in-person arm v the telephone arm).