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Are Breast Cancer Navigation Programs Cost-Effective? Evidence from the Chicago Cancer Navigation Project

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Abstract

Objectives—One of the aims of the Chicago Cancer Navigation Project (CCNP) is to reduce the interval of time between abnormal breast cancer screening and definitive diagnosis in patients who are navigated as compared to usual care. In this article, we investigate the extent to which total costs of breast cancer navigation can be off-set by survival benefits and savings in lifetime breast cancer-attributable costs.

Methods—Data sources for the cost-effectiveness analysis include data from published literature, secondary data from the NCI's Surveillance Epidemiology and End Results program, and primary data from the CCNP.

Results—If women enrolled in CCNP receive breast cancer diagnosis earlier by 6-months as compared to usual care, then navigation is borderline cost-effective for $95,625 per life-year saved. Results from sensitivity analyses suggest that the cost-effectiveness of navigation is sensitive to: the interval of time between screening and diagnosis, percent increase in number of women who receive cancer diagnosis and treatment, women's age, and the positive predictive value of a mammogram.

Conclusions—In planning cost-effective navigation programs, special considerations should be made regarding the characteristics of the disease, program participants, and the initial screening test that determines program eligibility.

Keywords

Cost Effectiveness Analysis; breast cancer; healthcare disparities; patient navigation

Introduction

Cancer screening has the potential to significantly reduce cancer morbidity and mortality if it helps to detect cancer at its earliest stages and recommends appropriate treatment options. Lack of adherence to initial screening recommendations and follow-up diagnosis and

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treatment after an abnormal test result limits the effectiveness of screening and contributes to disparities in cancer mortality due to advanced stages at presentation [1–4].

Breast cancer is the most common cancer for women in the US and is second to lung cancer as the leading cause of cancer death among African-American women [5,6]. As compared to white women, the incidence of breast cancer is lower in African-American women but age-adjusted breast cancer mortality rates are higher [7]. Hispanic women diagnosed with breast cancer are 1.5 times more likely to die from the disease within 5 years after diagnosis as compared to non-Hispanic whites [8].

It is documented that about 39 percent of low-income ethnic minority women experience delays of 3-months or more in receiving follow-up cancer care [9]. Patient navigation is a new approach to overcome access barriers that prevent disadvantaged patients from receiving appropriate and timely cancer diagnosis and treatment [10]. The first patient navigation program was implemented in Harlem, New York in the early 1990s. After the reported success of the Harlem project, additional navigation programs were established with support from public and private foundations and through local initiatives [11,12]. In the original navigator model, a navigator is assigned to the patient at the time when the patient receives an abnormal cancer screening. The navigator assists the patient through the intricacies of the health care system until the patient receives definitive diagnostic resolution or if necessary, completes the recommended course of treatment [12,13].

The Chicago Cancer Navigation Project (CCNP) is one of the nine major Patient Navigator Research Programs (PNRP) sponsored by the National Cancer Institute and the American Cancer Society. CCNP tests whether pairing low-income ethnic minority women who have abnormal cancer screening with a patient navigator improves timely diagnostic resolution and treatment initiation [14].

Study Objectives

Patient navigation has become a popular means to organize health and social services for cancer patients. The scientific literature suggests that patient navigation improves the rates of screening and follow-up, cancer detection at earlier stages, and patient satisfaction [12,13]. However, not many of these studies have examined the costs and cost-effectiveness of patient navigation programs [6,11]. The purpose of this analysis is to investigate the extent to which navigating low-income ethnic minority women from the time they receive abnormal breast cancer screening until the time they receive diagnostic resolution has potential of being cost-effective. It tests whether total costs of breast cancer patient navigation can be offset by survival benefits and savings in lifetime breast cancer-attributable costs. It also examines the impact of six factors on the Incremental Cost-Effectiveness Ratio (ICER) of patient navigation versus usual care. These factors are: 1) the interval of time between screening and diagnosis; 2) the percent change in the number of women who receive cancer diagnosis and treatment; 3) the women's age; 4) the positive predictive value of a mammogram; 5) the number of program participants; and 6) the methodological factor of accounting for total medical costs in determining the cost-effectiveness of the program.

Methods

Conceptual Framework

The cost-effectiveness analysis is positioned within the health systems perspective. All costs borne by Chicago sponsors in administering the program are included in the analysis, and all health care expenditures and benefits that stem from the program in diagnosing and treating breast cancer are also included in the analysis [15,16]. Two potential future benefits of breast cancer patient navigation are considered for the analysis. Compared to the usual care (UC), a cancer patient who receives Patient Navigation (PN) has an average increase in her Life-Years (LY) by (LY_{PN}-LY_{UC}) and an average decrease in her Lifetime breast Cancer-attributable Costs (LCC) by (LCC_{UC}-LCC_{PN}). Navigating women who do not have breast cancers have no benefits in LY or LCC. The results of the cost-effectiveness analysis are presented in the form of the Incremental Cost-Effectiveness Ratio (ICER) of administering Patient Navigation (PN) versus keeping the Usual Care (UC). ICER is determined by:

$$\text{ICER}=\frac{\text{Total program costs}-\text{Total savings in LCC (in 2006 dollars)}}{\text{Total potential benefits (in LY)}}$$

In calculating the ICER, costs and effects are discounted by a 3 percent discount rate [16].

Effectiveness of Patient Navigation

Patient navigation's effectiveness is measured by a reduction in the interval of time between an abnormal breast cancer screening and definitive diagnostic resolution in patients who are navigated as compared to usual care. The Chicago Cancer navigation Project (CCNP) serves the example navigation program for the analysis. CCNP navigates women for cancers of the breast and cervix. Women who have Breast Imaging Reporting and Data System (BIRADS) scores of 0, 3, 4, 5 and 6 are eligible for breast cancer patient navigation.

The effectiveness of the CCNP is not yet established. Therefore, in the base-case analysis, we hypothesize that women enrolled in the CCNP receive, on average, diagnostic resolution earlier by 6-months as compared to women who receive usual care. In evaluating the Screening Adherence Follow-up (SAFe) program, which is a patient navigation program administered in a large Los Angeles public sector medical center, the investigators concluded that patients in the intervention group were more likely to adhere to diagnostic resolution when compared to the controls (90% vs. 66%, OR=4.48, p<0.001) and they were also more likely to experience timely adherence (77% vs. 57%, OR=2.5, p=0.01). The investigators assessed timeliness as adherence to diagnostic resolution within 240 days (8-months) for BIRADS score of 3 (72% of the intervention group and controls had BIRADS score of 3) and 60 days (2-months) for BIRADS scores of 4 and 5 [17]. In a Boston hospital-based patient navigation program administered among inner-city minority women, the investigators used pre-intervention and post-intervention data to evaluate the effectiveness of patient navigation. They measured program effectiveness as a dichotomous variable of timely follow-up (yes, no). If patients adhered to diagnostic resolution within 120 days (4-months) from the date of the original appointment, they were considered to have had timely follow-up. During the pre-intervention period, 64% of the patients had timely follow-up compared with 78% of patients during the intervention period (p<0.0001, unadjusted OR=2.0 [95% CI, 1.5–2.6]). In the adjusted model, controlling for age, race, insurance status, reason for referral, and source of referral, the odds of having timely follow-up increased to 39% for patients in the intervention group (OR=1.39 [95% CI, 1.01–1.91]) [18]. Also, the potential effectiveness of patient navigation and the amount of navigation required varies with the characteristics of the target population; women who have a greater number of perceived personal and health systems barriers to follow-up at the beginning of the program have an increased need for navigation services and better potential for having improvement in the timeliness [17].

In a sensitivity analysis, we also examine a navigation program that is effective in increasing by 15% the number of women who will ever return to the health system to receive follow-up cancer care. Using national data, Yabroff et al. [19] found that 13.1 percent of African-

American women and 14.2 percent of Hispanic women do not receive any follow-up diagnosis or treatment for abnormal mammogram results.

Data Sources

Data sources include: (1) data from published literature for breast cancer transition probabilities [20], mean preclinical sojourn time which represents the time breast cancer spends in its preclinical stage [21], lifetime breast cancer-attributable costs [22] and total lifetime medical costs [23]; (2) secondary data from the NCI's Surveillance Epidemiology and End Results program for breast cancer incidence (SEER data years 2000–2004) and survival rates (SEER data years 1990–2004) [24]; and (3) primary data from the Chicago Cancer Navigation Project (CCNP) for the number of program participants, number of women who receive breast cancer diagnosis, and total costs of the program. Primary data from the CCNP were collected from the start date of the project in 2006 until 2008 when the cost-effectiveness analysis was conducted.

Program costs were collected through a structured survey that was administered to the Project Director (PD) of the CCNP. The cost survey represents a customized version of the questionnaire that was developed by the Patient Navigation Research Program (PNRP) Cost-Effectiveness Analysis Committee to collect the costs of administering the program at each of the nine PNRP sites. The survey contained six main sections: (1) background and patient information about the four Community Health Centers (CHC) where the patients for this analysis were being navigated, (2) information about the program startup and training costs, (3) time and salary information of program personnel, including the navigators (4) managerial and other support personnel, (5) associated overhead, and (6) in the final section, it asked the project director to work with the navigators in estimating the time required to navigate breast patients and cervical patients. A detailed description of the cost components has been published in an article by the PNRP group [25]. All costs are inflated to 2006 dollars. Table 2 presents a summary of the key variables that are used in the analysis.

The TreeAge Model

Using the Markov model, the natural history of breast cancer is constructed to simulate the progression of breast cancer in women who do not receive patient navigation. TreeAge Pro 2008 (TreeAge Software, Inc. Williamstown, MA, USA) was used to construct the Markov model. Four assumptions are made in constructing the Markov model: (1) the natural history of breast cancer is progressive; if breast cancer is left undetected, it will progress through the four discrete stages of breast cancer which are Ductal carcinoma in situ (DCIS), Local (L), Regional (R), and Distant (D); (2) the disease progression model is a discrete-time Markov chain; (3) the analysis is a cohort (expected-value) analysis; and (4) the length of a cycle, t, is 1-month. Every month some women shift distributions to more advanced stages of breast cancer according to 1-month age-adjusted transition probabilities. Transition probabilities are adjusted for age by multiplying them with a factor computed from the Mean Sojourn Time (MST) of breast cancer for the various age groups [21]. Tumors, including breast cancer, have more or less constant growth rates and the mean sojourn time is an indicator for tumor growth rate. Tumors that have high growth rates have short sojourn times [26–29].

Input variables in the breast cancer progression model are: function of breast cancer incidence, prognosis, and the characteristics of program participants. Program participants are low-income ethnic minority women age 40 and older and thus the SEER data are selected for African-American women and Latinas who are 40 and older. The initial age-adjusted probability distributions for the four stages of breast cancer are calculated from SEER (2000–2004). The output variables are stage and age-adjusted life expectancy and stage-adjusted lifetime breast cancer-attributable costs.

Results

Project personnel include the program director (1/4 Full time equivalent, FTE) and four full-time (4 FTE) patient navigators. The program director supports and supervises patient navigators; she also provides on the job initial and continuing education training. One of the patient navigators is a licensed clinical social worker who holds a masters degree in social work. The remaining three navigators are lay navigators meaning that they have a high school diploma or less. The social worker navigator provides support for the lay navigators when facing patients with specific needs. There were two PNRP national training sessions. The initial training was held in Atlanta in July 2006 and the second continuing education training was held in Chicago in August 2007.

From the date of program inception to the date at which the evaluation is conducted, there were 252 women who were navigated for a breast or cervical cancer screening abnormalities. Of these women, 97 were navigated for a breast cancer screening abnormalities and 7 were diagnosed with breast cancer. In a qualitative interview, all four navigators were asked to compare the amount of navigator time and resources consumed to navigate a woman with a breast and/or cervical cancer screening abnormalities. All four navigators consistently agreed that, on average, a woman navigated for a breast cancer screening abnormalities and a woman navigated for a cervical cancer screening abnormalities required the same amount of navigator time and resources. The main factor that determined the amount of navigator time and resources consumed consists of the barriers that the women faced in accessing health services.

Table 4 presents total costs of administering the CCNP to 255 women. Fixed costs are multiplied by the factor 0.4 to account for the 2-year period of the entire life of the program. Patient navigation costs, on average, $1,258 per program participant and it costs $122,059 to administer CCNP to 97 women.

When CCNP decrease by 6-months in the time interval in which breast cancer diagnostic resolution is reached in navigated women as compared to usual care; the program leads to an increase in the life expectancy of a woman who has breast cancer and is navigated by 0.219 years (2-months and 19-days). It also leads to a decrease in her lifetime breast cancer-attributable costs by $590. Navigating women who do not have breast cancer has no benefits. When potential future benefits are discounted by a 3 percent discount rate, the increase in a woman's life expectancy diminishes to 0.176 years (2-months and 3.4 days) and a savings in her lifetime breast cancer-attributable costs increase to $607. Discounting makes life years accrued into the future and costs incurred into the future less valuable. In the base-case analysis and considering these two potential benefits of patient navigation, the CCNP costs $95,625 per life-year saved. Table 5 presents the results of the ICER and the sensitivity analyses.

Results from sensitivity analyses suggest that the ICER is sensitive to the interval of time between screening and diagnosis, the percent increase in the number of women who receive cancer diagnosis and treatment, the women's age, and the positive predictive value of a mammogram. The ICER is not sensitive to the number of program participants or accounting for total medical expenditures.

The age of a woman affects the effectiveness of patient navigation in two different manners. First, breast cancer progresses more rapidly in younger women and detecting the cancer at its earlier stages benefits younger women more than it does for older women [29]. However, the positive predictive value (PPV) of the initial screening mammogram is larger in older women as compared to younger women [30]. Larger PPVs usually increase the effectiveness of the screening programs. Therefore, in the sensitivity analysis, the age of women and the

PPV of the initial screening mammography are varied simultaneously. Patient navigation is most cost-effective in women between the ages of 50 and 54 ($47,889 per LY) and least cost-effective in women between the ages of 40 and 49 ($95,346 per LY). Results suggest that the PPV of the initial screening mammogram has a larger impact in determining the cost-effectiveness of patient navigation as compared to the age of women alone. When mammography is the initial screening test, then patient navigation is most cost-effective in women between the ages of 50 and 54.

Patient navigation is not sensitive to 25 percent variations around the number of program participants. This holds when the structure of the program (in terms of the number of program sites and the number of navigators) remains constant. This is mainly because the variable costs of administering patient navigation are small compared to its personnel and fixed costs.

Patient navigation is very cost-effective ($36,052 per LY) when the effectiveness of patient navigation is augmented to include the percent increase in the proportion of women who will ever receive cancer diagnosis and treatment because they were navigated. This analysis is true given the assumption that patient navigation will increase by 15 percent in the number of women who will ever receive cancer diagnosis and treatment [19]. In the remaining 85 percent, the program will function as hypothesized; patient navigation will improve the timeliness between screening and diagnosis by 6 months.

The large decrease in the ICER is due to the large impact that a 15 percent increase in the proportion of women who will ever receive cancer diagnosis and treatment has on breast cancer prognosis and outcomes. The life expectancy of a woman increases by 4.93 years (59-months) when she receives timely diagnosis and treatment compared to not receiving any care or treatment. Her lifetime breast cancer-attributable costs would also increase by $73,308 otherwise not incurred if she did not receive any health care. However, the lifetime breast cancer-attributable costs are offset by the large increases in her life expectancy.

Patient navigation is not sensitive for imputing total medical expenditures instead of breast cancer-attributable costs in calculating the ICER. Unlike breast cancer-attributable costs which decrease when a woman with breast cancer receives patient navigation, total medical costs increase by $1,356. The ICER in this scenario equals $85,815 per LY (not discounted) which is still within the boundaries of cost-effectiveness.

Discussion

A patient navigation program for breast cancer that structurally resembles the CCNP is potentially cost-effective. In the base-case analysis, the patient navigation program costs $95,625 per LY. The threshold of a cost-effectiveness ratio is controversial; different studies suggest different methods. Some studies use the conventional threshold of $50,000 per LY. Programs that cost less than $50,000 per LY or per Quality-Adjusted Life-Year (QALY) are generally viewed as favorable, and programs that cost more than $50,000 are not generally considered cost-effective [31]. Other researchers suggest comparing the cost per life-year saved to per capita income [32–34]. In a recent article, Braithwaite et al. [35] examine the basis of the decision rule of the $50,000 per QALY. Their results suggest that it is highly unlikely that the rule of $50,000 per QALY represents the societal willingness to pay for health care. However, they note that the lower bound of the plausible range that they suggest for the willingness to pay ($109,000 per QALY saved) resembles the inflation-adjusted $50,000 per QALY decision rule ($121,000 per QALY in 2003 dollars). Given these estimates, our results are within the boundaries of cost-effective.

The ICER of patient navigation is also compared to the ICER of other breast cancer screening programs. In one study, offering biennial screening mammography for women between ages 50 and 69 costs $32,638 per LY saved (2006 dollars, discounted costs and effects by 3%). However, extending screening mammography every 18-months to include women between ages of 40 and 49 years comes at a cost of $160,139 per LY. The researchers conclude that the strategy is not cost-effective [36]. Despite these findings, the National Cancer Institute [37] and the American Cancer Society [38] have been recommending annual and biennial screening mammography in women between the ages of 40 and 49. It has been only recently and due to large amounts of evidence that the US Preventive Services Task Force has been recommending against routine screening of women between the ages of 40 and 49 [39].

Results from sensitivity analyses suggest that several factors affect the cost-effectiveness of breast cancer patient navigation. These factors are a function of the target population and the program's eligibility criteria. Under tighter budgetary restrictions, these findings could be translated into practical strategies. Examples are navigating women with more needs for navigation services, who are less self-efficacious, or who have severe BIRADS scores of 4 or 5. Another strategy would be adopting more sensitive and specific screening tests to determine program eligibility.

Mammograms are the most widely used screening test in determining eligibility for patient navigation [12,13,17,18]. Other tests such as ultrasound and Magnetic Resonance Imaging (MRI) might also be candidate screening tests in determining eligibility for patient navigation. Several factors need to be considered before adopting a test to determine eligibility for patient navigation such as the relative cost of the test, whether the test is covered by Medicaid/Medicare or any other public funded program, and finally the sensitivity, specificity, and the positive predictive value of the test.

There are some limitations to this study. The cost-effectiveness analysis is positioned within the health system perspective. Additional factors need to be accounted for in positioning the study within the societal perspective [15,16]. One such factor is costs in productivity losses averted by patient navigation. By extending the lives of women, patient navigation increases the productivity of women who now live longer. Accounting for productivity losses increases the effectiveness of a program.

Another factor that needs to be accounted for in positioning the study within the societal perspective is time costs incurred by women participating in the program's activities. This is the time that women spend in receiving program strategies. Including participant time costs in calculating the ICER makes patient navigation less cost-effective. However, the anticipated effects of participants' time costs on the ICER are relatively small because participating in a patient navigation program does not require large amounts of time investment. A considerable amount of patient-navigator encounters are carried over the phone and most activities that patient navigators do on behalf of patients in coordinating and integrating health care and social services are performed by the navigator in the absence of the patient.

Some end users of cost-effectiveness analysis prefer the ICER being reported in program costs per Quality-Adjusted Life Year (QALY). QALYs are usually preferred over life year(s) in presenting future benefits because QALYs include in them the value that the recipient of the intervention places on health outcomes generated by the program [16]. Measuring potential future benefits in QALYs for patient navigation is a challenging task. The main outcome of patient navigation is detecting and treating cancers at earlier stages and that leads to an increase in the life expectancy of navigated women. The challenge lays in the scarcity of data on the utility that women place on life after breast cancer treatment [36].

It is assumed that once a woman receives breast cancer diagnosis, whether she is navigated or not, will follow the same pattern of breast cancer treatment and prognosis. The data does not allow observing if navigated women will have better chances of receiving timely breast cancer treatment and end up with better health outcomes.

This study uses primary data from the Chicago Cancer Navigation Program in estimating the costs and cost-effectiveness of patient navigation. The results might not be generalizable for other programs in different settings. Also, future research in patient navigation might either support or challenge the hypothesized value of program effectiveness.

Patient navigation might have additional potential benefits that need to be evaluated. Navigated patients might have better satisfaction with the quality of health care services received, have more social and economical needs met, develop increased trust in the health care system, and have established a source for receiving usual source of care. Finally, the incremental value of patient navigation programs as an addition to existing screening programs should be evaluated since both these programs are complementary in targeting morbidity and mortality from cancer.

Conclusions

With expenditures on health care increasing and having limited resources allocated for health and other social welfare programs, the importance of evaluating the relative value of various programs and program strategies is a counting priority. This study is one of the early studies that examines the cost-effectiveness of patient navigation. Our results suggest that the CCNP model for breast cancer patient navigation is within the boundaries of cost-effective. Results from the sensitivity analyses suggest that patient navigation for breast cancer has potential for being more cost-effective. There are several factors within the control of the program planner such as the characteristics of the initial screening test and the characteristics of the target population that affect the effectiveness and cost-effectiveness of patient navigation, with patient navigation for breast cancer being the most cost-effective in women between the ages of 50 and 54.

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Table 1

Input and Output Variables in the Breast Cancer Progression Model

1-month age-adjusted transition probabilities [20,21]	Age	$P_{DCIS\text{-}L}$	$P_{L\text{-}R}$		$P_{R\text{-}D}$
	≤49	0.045	0.025		0.012
	50–54	0.036	0.020		0.010
	55–59	0.023	0.013		0.006
	60–69	0.020	0.011		0.005
	≥70	0.015	0.008		0.004
	All	0.028	0.016		0.007
		DCIS	**Local**	**Regional**	**Distant**
Mean age at diagnosis[a] [24]	Age	58.58	60.21	57.67	61.06
Life expectancy[b][24]	40–49	13.94 yrs	12.85 yrs	10.02 yrs	3.46 yrs
	50–54	13.87 yrs	12.70 yrs	9.62 yrs	2.61 yrs
	55–59	13.19 yrs	12.19 yrs	9.31 yrs	2.69 yrs
	60–69	12.28 yrs	11.36 yrs	8.58 yrs	2.67 yrs
	≥70	9.26 yrs	8.35 yrs	6.21 yrs	1.80 yrs
	All	12.42 yrs	11.13 yrs	8.76 yrs	2.58 yrs
Lifetime breast cancer-attributable costs [22]		$67,598	$67,598	$86,516	$69,449
Total medical costs [23]		$127,596	$111,072	$101,063	$65,940
Stage shift[c]		**DCIS**	**Local**	**Regional**	**Distant**
Initial distribution[a] at time 0		0.183	0.452	0.295	0.07
Distribution at time 3-months		0.168	0.445	0.310	0.076
Distribution at time 6-months		0.154	0.438	0.325	0.083
Distribution at time 9-months		0.142	0.430	0.339	0.090

Data Sources:

[a](SEER, 2000–2004, African-American and Latina women ≥ 40yrs);

[b](SEER, 1990–2004, African American and Latina women ≥ 40yrs);

[c](TreeAge Software, Inc. Williamstown, MA, USA).

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Table 2

Total Costs of Chicago Cancer Navigation Project

Component	Cost driver	Cost per person per month ($)	Component costs ($)	Percent from grand total (%)
Personnel				
Program Director	0.25 FTE	2,449	51,433	
Social Worker Navigator	1 FTE	4,875	102,375	
Lay Navigator	3 FTE	504	31,752	
Total			185,560	58
Variable				
Office supplies	4 Nav[a]	10	840	
Office and cell phone charges	4 Nav[a]	75	6,300	
Transportation and parking fees incurred by navigators	4 Nav[a]	75	6,720	
Transportation fee provided for patients	4 Nav[a]	10	840	
Total			14,700	5
Fixed				
Initial training (personnel and overhead)	4 Nav[a]		19,552 * 0.4	
Setting an office (computer, desk, cabinets, etc.)	4 Nav[a]	$ 1200 per office	4,800 * 0.4	
Associated overhead of the navigator office (renting, taxes, utilities, etc.)	4 Nav[a]	$42.5 per square foot	107,100	
Total			116,841	37
Grand Total (n=252)			317,101	100

[a]Navigator

Table 3

The Incremental Cost-Effectiveness Ratio and Sensitivity Analysis

Variable	Range	$/LY[a]
Base-case		95,625
Interval of time between screening and diagnosis	t=3-months	194,644
	t=9-months	62,657
Number of program participants	n=189 (25% less)	127,118
	n=315 (25% more)	76,728
Age of women and PPV varied simultaneously	Age=40-49/ PPV=0.04	95,346
	Age=50-54/ PPV=0.09	47,889
	Age=55-59/ PPV=0.09	83,323
	Age=60-69/ PPV=0.17	65,376
	Age=70+/ PPV=0.19	89,361
Percent change in number of women who receive cancer diagnosis and treatment	p=15% increase	36,052
The methodological factor of accounting for total medical costs	LC=total medical costs	85,815[b]

[a]2006 dollars, costs and effects are discounted by 3%, and LY stands for life-years.

[b]undiscounted