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Cost-Effectiveness of a Patient Navigation Intervention to Increase Colonoscopy Screening Among Low-Income Adults in New Hampshire

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Abstract

BACKGROUND: Colonoscopy is the most widely used colorectal cancer (CRC) screening test in the United States. Through the detection and removal of potentially precancerous polyps, it can prevent CRC. However, CRC screening remains low among adults who are recommended for screening. The New Hampshire Colorectal Cancer Screening Program implemented a patient navigation (PN) intervention to increase colonoscopy screening among low-income patients in health centers in New Hampshire. In the current study, the authors examined the cost-effectiveness of this intervention.

METHODS: A decision tree model was constructed using Markov state transitions to calculate the costs and effectiveness associated with PN. Costs were calculated for the implementation of

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AUTHOR CONTRIBUTIONS

Ketra Rice: Conceptualization and design, acquisition of the data, methodology, formal analysis and interpretation of the data, investigation, validation, writing–original draft, writing–review and editing, and critical revision of the article for important intellectual content. **Krishna Sharma**: Conceptualization and design, methodology, formal analysis and interpretation of the data, investigation, validation, writing–original draft, writing–review and editing, and critical revision of the article for important intellectual content. **Chunyu Li**: Conceptualization and design, methodology, writing–review and editing, and critical revision of the article for important intellectual content. **Lynn Butterly**: Conceptualization and design, acquisition of the data, writing–original draft, writing–review and editing, resources, supervision, and critical revision of the article for important intellectual content. **Joanne Gersten**: Conceptualization and design, acquisition of the data, writing–review and editing, resources, and critical revision of the article for important intellectual content. **Amy DeGroff**: Conceptualization and design, writing–review and editing, supervision, and critical revision of the article for important intellectual content.

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PN in a statewide public health program and in endoscopy centers. The main study outcome was colonoscopy screening completion. The main decision variable was the incremental cost-effectiveness ratio associated with the PN intervention compared with usual care.

RESULTS: The average cost per screening with PN was $1089 (95% confidence interval, $1075-$1103) compared with $894 with usual care (95% confidence interval, $886-$908). Among patients who were navigated, approximately 96.2% completed colonoscopy screening compared with 69.3% of those receiving usual care (odds ratio, 11.2; $P < .001$). The incremental cost-effectiveness ratio indicated that 1 additional screening completion cost approximately $725 in a public health program and $548 in an endoscopy center with PN compared with usual care, both of which are less than the average Medicare reimbursement of $737 for a colonoscopy procedure.

CONCLUSIONS: PN was found to be cost-effective in increasing colonoscopy screening among low-income adults in the New Hampshire Colorectal Cancer Screening Program, even at the threshold of current Medicare reimbursement rates for colonoscopy. The results of the current study support the implementation of PN in statewide public health programs and endoscopy centers.

Keywords

cancer prevention; colonoscopy; cost-effectiveness; disadvantaged populations; incremental cost-effectiveness ratio (ICER); patient navigation; public health

INTRODUCTION

Colorectal cancer (CRC) is the second leading cause of cancer death in the United States among cancers affecting both men and women.[1] Disparities in CRC exist, with higher rates of incidence and mortality reported among African American individuals compared with white individuals, and higher rates of incidence among lower socioeconomic status groups compared with groups of higher socioeconomic status.[1,2] Screening is effective in reducing CRC incidence and mortality by removing precancerous polyps or detecting cancer early when treatments are more effective. The US Preventive Services Task Force recommends CRC screening for adults aged 50 to 75 years who are at average risk using either stool-based tests (ie, fecal immunochemical test [FIT], fecal occult blood test [FOBT], or multitarget stool DNA test), or tests that directly visualize the colon (ie, colonoscopy, sigmoidoscopy, or computed tomography colonography).[3] Colonoscopy is the most widely used CRC screening test in the United States.[4,5]

Currently, only approximately 65% of Americans are up to date with recommended CRC screening.[6] Research has identified personal and health care system barriers that impede CRC screening. These barriers include inadequate insurance or access to payment resources, a lack of knowledge and misconceptions concerning screening, distrust of the medical system, fear of the procedure, lack of provider recommendation for screening, and language and transportation barriers.[7–14]

Patient navigation (PN) involves individualized assistance to complete CRC screening through educating patients regarding CRC screening and helping them overcome personal and health care system barriers.[15] Initially implemented as an intervention to improve diagnostic follow-up for breast cancer, PN now is used to reduce disparities and improve outcomes across the cancer continuum, including for CRC screening.[16–23]

In 2009, the New Hampshire Colorectal Cancer Screening Program (NHCRCSP), a program funded as part of the Centers for Disease Control and Prevention's Colorectal Cancer Control Program, developed a PN intervention. The NHCRCSP provided colonoscopies to low-income, uninsured, and underinsured patients throughout the state, at no direct cost to patients. Nurse navigators, using a standardized 6-topic protocol, supported patients to complete screening at endoscopy centers with an established partnership with the NHCRCSP. The PN intervention was evaluated and shown to be effective in increasing completion rates for colonoscopy.[24]

The effectiveness results prompted interest in evaluating the cost-effectiveness of the PN intervention. Previous cost-effectiveness studies of PN have demonstrated that navigator programs are cost-effective in increasing rates of colonoscopy completion.[25–28] However, these studies were conducted primarily in urban settings and large hospitals. We believe the current study contributes to the growing literature regarding the cost-effectiveness of PN by evaluating a statewide public health program implementing navigation in both rural and urban settings, and serving patients seen at federally qualified health centers (FQHCs) who were screened with colonoscopy in endoscopy centers. The objective of the current study was to estimate the cost-effectiveness of the NHCRCSP's PN intervention to inform statewide public health program implementation and rural health policy, and to contribute to the body of knowledge regarding the cost-effectiveness of PN for colonoscopy screening.

MATERIALS AND METHODS

To examine the cost-effectiveness of the NHCRCSP's PN intervention, we constructed a decision tree model to evaluate whether implementing PN would be cost-effective compared with the usual care provided to patients scheduled for colonoscopy. We measured the PN program costs under 2 different implementation scenarios: 1) implementing a PN intervention through a statewide public health program; and 2) implementing a PN intervention within individual endoscopy centers. The flow of implementation activities for each scenario are the same. Cost is the only difference because the scale of implementation is smaller for the individual endoscopy centers versus the statewide public health program. For the public health program scenario, we measured the full costs of implementing the statewide PN intervention incurred by the NHCRCSP. For the endoscopy center scenario, we assumed a different cost structure of implementation because the PN intervention for CRC screening would be integrated into the regular workflow of the endoscopy center. The effectiveness of the intervention remained the same under both scenarios. Figure 1 is a simple portrayal of the study design of the PN intervention program.

PN Intervention Versus Usual Care

Intervention—Two registered nurse navigators (totaling 1.2 full-time equivalents) delivered navigation telephonically to all patients at NHCRCSP who were scheduled for CRC screening at endoscopy centers throughout the state. Colonoscopy was selected as the primary test modality for screening. The medical director (an endoscopist) provided clinical oversight/supervision of the navigators, the program director (a registered nurse) provided case management oversight for the navigators, a data manager created and maintained a database of data collected regarding patients, and a secretary provided administrative services. A language translation service for non-English-speaking patients and translated written materials for bowel preparation instruction in the 26 different languages spoken at NHCRCSP were provided. Navigators followed a standardized protocol. The full, detailed protocol is available at www.cdc.gov/cancer/crccp/pn-replication-manual.htm.

Usual Care—Usual care represented existing care provided to all patients scheduled for colonoscopy by the endoscopy center. It typically included scheduling the colonoscopy, determining medical eligibility, mailing the patient bowel preparation and pharmacy instructions, forwarding bowel preparation prescriptions to the patient's pharmacy, educating the patient about bowel preparation, reviewing medical details, reminding the patient about the appointment time, providing instructions for arrival at the clinic, mailing the patient the pathology results, and offering a language translation service for non-English speakers. Similar to PN, usual care also was provided telephonically.

Model Structure

We constructed a decision tree model using Markov state transitions to calculate the costs and effectiveness of PN compared with usual care. The model was developed in TreeAge Pro (TreeAge Software, Williamstown, Massachusetts). The outcomes tracked for the current study included colonoscopy completion, incomplete colonoscopy due to inadequate bowel preparation, cancellations within 48 hours of the scheduled appointment, and missed appointments/no-shows without prior cancellation. The main decision variable was the incremental cost-effectiveness ratio (ICER) associated with the PN intervention compared with usual care.

For Markov state transitions, we determined 5 health states of patients: 1) scheduled appointment round one; 2) scheduled appointment round two; 3) scheduled appointment round three; 4) screened; and 5) unscreened. Figure 2 presents the pathway patients follow in the screening process both in the intervention group and in the usual-care group. Patients enter the screening process by scheduling an appointment for a colonoscopy test (scheduled round 1) and follow the path as shown. For each scheduled appointment, patients who complete the process become screened. Patients who failed to complete screening then reschedule their appointment or drop out of the process and remain unscreened. The goal of the navigation is to minimize the number of incompletes and maximize the number of patients who are rescheduled and screened successfully at the end of the pathway. In the model, we allowed patients up to 3 screening cycles within the total intervention period of 12 months and the complete process lasted for 15 months, which also was the analytical horizon for the current study. Patients who were unscreened by the end of scheduled round 3 remained unscreened in the analysis model.

Model Parameters

Effectiveness parameters—Effectiveness parameters were determined using the data collected for our previously published effectiveness study.[24] To determine effectiveness, we compared clinical outcomes for a subset of NHCRCSP patients at one endoscopy center with those for a subset of patients at the same center who received usual care. Patients in the PN intervention and usual-care groups received medical care at the same clinic, and were referred for colonoscopies at the same endoscopy center. Assignment of patients to the PN intervention or usual care was not randomized. There were no patients in the usual-care group who had been offered NHCRCSP navigation and refused.

To maximize comparability among the 2 patient groups, all patient records met 5 inclusion criteria: 1) aged 50 to 64 years; 2) income <250% of the federal poverty level, with all patients uninsured and having an alternate source of payment for colonoscopy; 3) scheduled for the colonoscopy test date between July 1, 2012 and September 30, 2013; 4) scheduled for a screening or surveillance colonoscopy; and 5) not diagnosed with CRC from the completed test.

Table 1 provides aggregated values of effectiveness parameters. As model inputs, we used disaggregated data (not shown) regarding the percentage of patients who made their appointments, cancelled >48 hours prior to the appointment, cancelled <48 hours prior to the appointment, missed their appointment without prior cancellation, were lost to follow-up, or had incomplete colonoscopy due to inadequate bowel preparation for each of the 3 screening rounds.

Cost parameters—Cost parameters were based on program cost data provided by the NHCRCSP and the average clinical cost for colonoscopy at an endoscopy center, based on New Hampshire's Medicare reimbursement rates.[29] We conducted the analysis from the perspective of an integrated health system and included all direct medically related costs. Intervention costs (start-up and annual operating costs) were calculated for all intervention patients. Start-up costs dedicated to hiring and training navigators were computed for the 4-month time period in 2009 adjusted for 2012 dollars using a 3% rate. Start-up costs were spread over a 5-year period. Annual operating costs included program costs for personnel, training, and supplies. Personnel costs included salary for all personnel dedicated to the PN intervention, including fringe benefits. Training costs included continuing education. Supply costs included printed materials and technology and language resources. We did not apply a discount rate to other intervention costs because of the time horizon of 1 year. Complete and incomplete colonoscopies were set at the same cost based on the average Medicare reimbursement rate reported for all patients during the study time period. We collected data regarding reimbursements for completed screening colonoscopy, which also included colonoscopy with polypectomy or incomplete polypectomy.

We assigned no clinical cost if patients cancelled >48 hours prior to their appointment, assuming any cancellations beyond 48 hours could be filled with another patient. For cancellations occurring <48 hours in advance of the appointment or missed appointments without a prior cancellation, we assigned the same cost as the average reimbursement for screening colonoscopies. The Medicare reimbursement rate was used as a proxy for the clinic's resource cost of providing colonoscopy service. We assumed that incomplete colonoscopy, late cancellations, or missed appointments resulted in pure loss to the clinics (equivalent to full Medicare reimbursement) because clinics have to commit the same resources regardless of whether patients made the appointment and completed their colonoscopy or not. In addition, late cancellations and missed appointments cannot be replaced by other procedures at the last minute, thereby creating a loss of revenue for endoscopy centers. All costs were reported in 2012 US dollars. The cost of screening reported in the current study included the cost of providing colonoscopy with the additional cost of PN for navigated patients.

Under the public health program implementation scenario, a caseload of 443 patients were served statewide during the intervention period. We used 443 as the denominator with which to calculate the average cost of PN per patient for the public health program. Under the endoscopy center implementation scenario, a caseload of 131 patients were served by the endoscopy center during the intervention period. The number of 131 patients served as the denominator for calculating the average cost of PN per patient for the endoscopy center. All costs were prorated based on the number of patients served. The endoscopy center cost was 29.6% of the public health cost for each item with the exception of the following cost items excluded from the endoscopy center scenario: personnel costs for the program medical director, program director, data manager, and clinical secretary and supply and equipment costs for laptops and database management software. Table 2 provides input parameters for all costs. Supporting Table 1 provides detailed disaggregated program costs for each scenario.

Base Case and Sensitivity Analyses

Base case analysis was based on parameter values under no uncertainty. Sensitivity analysis characterized uncertainty. Base case analysis was the main analysis using the mean values of all model parameters and the most plausible assumptions, whereas the sensitivity analysis used a plausible range of values of those parameters and relaxed some assumptions. We conducted sensitivity analyses based on variations in the cost parameters and their distributional assumptions as reported in Table 1. The standard deviation of the cost of colonoscopy was calculated using values from individual reimbursement data obtained from the NHCRCSP. Standard deviations for the cost of PN were based on PN program costs and time spent by navigators for each patient navigated. In 1-way sensitivity analysis, we calculated net monetary benefits by varying the cost of PN from $0 to $600. Zero cost refers to the situation in which there is no patient navigator, whereas the high value in the range is greater than twice the average PN cost. We also calculated the threshold values at which PN and usual care have equal net monetary benefits in 1-way analyses. In 2-way sensitivity analysis, we selected the 2 most critical cost parameters (cost of PN and cost of a late cancellation or missed appointment) to compare the cost-effectiveness of the 2 strategies. The range of cost determined for late cancellations or missed appointments was $0 to $737. The zero value assumes no cost to providers from late cancellations or missed appointments, whereas the high value is the average reimbursement rate for a colonoscopy calculated using actual data. We also selected 2 different willingness-to-pay (WTP) values of $1000 and $1500, informed by prior studies that have reported WTP values ranging from $600 to $1200 based on the level of intensity of the intervention.[28,30]

Probabilistic Sensitivity Analysis

We performed probabilistic sensitivity analysis using Monte Carlo simulations with 10,000 randomly drawn samples. Each draw of the sample mimicked the behavior of a patient moving according to the pathway described in Figure 2. The samples were drawn from the distributions of all cost variables as reported in Table 2 and all probabilities. Event probabilities determined how many times patients took a certain path and had a certain cost outcome. The probabilities varied with the assumption of Dirichlet distribution around the values based on observed proportions.

RESULTS

Under the base case analysis, approximately 96.2% of patients were screened under PN compared with 69.3% under usual care at the end of round 3. Table 3 summarizes ICER results for each scenario. The incremental effectiveness of PN was 0.27, with an incremental cost of $195 under the public health program scenario and $147 under the endoscopy center scenario. The ICER of PN was $548 under the endoscopy center scenario and $725 under the public health program scenario. Under each scenario, the value of the ICER was lower than the $737 average reimbursement for the colonoscopy procedure, indicating that the PN intervention is both a cost-effective and cost-saving intervention under the base case analysis.

Sensitivity Analyses Results

One-way sensitivity analysis results on the cost of PN with different WTP values are shown in Figure 3. The cost of PN with a WTP of $1500, the threshold value above which PN had a higher net monetary benefit than usual care, was $469. Under a WTP of $1000, the same threshold value was $344. Two-way sensitivity analysis results using 2 key variables are shown in Figure 4. Again, we used WTP values of $1500 and $1000 to identify the dominating strategy at all possible combinations of values in the variables used. The PN strategy had a higher net benefit at lower values of navigation cost combined with higher values of cost for a late cancellation or missed appointment (blue area); in contrast, usual care had a higher net benefit at a higher PN cost and a lower cost for a late cancellation or missed appointment (red area). At a WTP of $1500, the PN strategy was more cost-effective for the range of values used than a WTP of $1000. The dotted vertical lines in Figure 4 mark the average navigation cost in the endoscopy center and public health program scenarios. In the endoscopy center scenario, the PN cost of $231 had a higher net benefit over usual care, even at zero cost for late cancellations or missed appointments in both WTP value scenarios. For the public health program scenario (at a PN cost of $275), the PN strategy had a higher net benefit only when the cost for a late cancellation or missed appointment was >$200.

In the probabilistic sensitivity analysis, we varied all the parameters simultaneously and calculated the probability of cost-effectiveness for each combination of parameters forming a strategy. The cost-effectiveness acceptability curve in Figure 5 shows the percentage of times each strategy was cost-effective at different levels of WTP. We used 2 WTP scenarios: a PN cost of $231 from the endoscopy center scenario and a PN cost of $275 from the public health program scenario. The results are from the probabilistic sensitivity analysis based on

5000 draws of parameter samples and WTPs ranging from $0 to $3000. When a PN cost of $231 was used, an equal number of iterations were cost-effective for both PN and usual care at the WTP threshold of $477, whereas approximately 95% of the iterations under the PN strategy were cost-effective at the WTP value of $1475. When a PN cost of $275 was used, an equal number of iterations were cost-effective for both PN and usual care at the threshold value of $644, whereas approximately 95% of the iterations under the PN strategy were cost-effective at a WTP value of $1858.

DISCUSSION

The findings of the current study suggest that PN was not only cost-effective but also cost-saving for increasing the rates of colonoscopy completion among low-income patients screened in endoscopy centers. The current analysis examined cost-effectiveness from the perspective of an integrated health system, which included both the provider and payer perspective of the cost of the intervention. Navigated patients were more likely to complete screening and less likely to cancel on the day of the appointment or to miss their appointment. The incremental cost of a patient completing colonoscopy with PN was $548 under the endoscopy center scenario and $725 under the public health program scenario. The average cost of providing colonoscopy alone was $737, leading to cost savings of $189 and $12, respectively, under the endoscopy center and public health program scenarios. Investing in PN leads to cost savings by reducing the loss of revenue from missed appointments and late cancellations that remain unfilled. In addition, for an individual endoscopy practice, PN also improves the patient experience, which has the potential to reap longer-term financial rewards because patients are more likely to return to the provider or recommend him or her to others.

Prior PN studies typically have evaluated programs in large urban clinic and hospital settings. However, the current study examined PN in local settings in a largely rural state. The cost-saving implementation of PN in local and rural settings helps to support its replication nationally. Although the current study was not a randomized study, the evaluation was conducted for an actual public health program, thereby supporting the feasibility of replication in other communities. The results of the current study demonstrated that whether implementing the intervention statewide or locally within the endoscopy center, savings were incurred.

The current study results support using telephonic navigation to increase the reach of interventions in rural settings. The obstacles faced by patients in rural areas are vastly different from those experienced by patients residing in urban areas. In addition to personal and health care system barriers, individuals in rural areas also face geographic access barriers to needed health services.[31] A telephonic navigation intervention is an appropriate strategy in these settings. For the current study, we examined colonoscopy outcomes and costs for a low-income, FQHC population, a group of patients with traditionally lower screening rates. For example, the average CRC screening rate across all of the FQHCs in New Hampshire in 2013 was 54%.[32] It is important to note that colonoscopy screening is one of many services patients at FQHCs receive; if PN were used to navigate a patient through multiple preventive services, there might be additional cost savings. In addition, the results provide evidence to provide PN services with a good return on investment to providers, while improving access to care for underserved communities.

The current analysis had several limitations. The scope of economic evaluation herein was limited to the endpoint of cost per additional client screened. We did not measure long-term outcomes of the reduced morbidity and mortality associated with screening colonoscopy, and thus the cost savings do not represent the full savings. The current study also did not explicitly examine the use of fecal-based testing as an alternative screening approach. This method of testing often is used for average-risk patients in settings that serve low-income and diverse populations. Although endoscopy centers only perform colonoscopy for CRC screening, a PN program could improve outcomes for individuals who choose FOBT or FIT options; all patients with positive FOBT/FIT results need a colonoscopy to complete their CRC screening process. The favorable results demonstrated with a low-income, uninsured population support the success of PN because this population of patients struggle with greater barriers to health care. In addition, the current study only varied costs in the sensitivity analysis. Other studies of PN demonstrate varied levels of effectiveness; however, to the best of our knowledge, there are no other programs designed similarly to the NHCRCSP, for which we were comfortable varying the effectiveness parameters. There is an effort by other programs to replicate the NHCRCSP and uptake the intervention. Further evaluations of the effectiveness of those programs will be conducted and parameters will be used in future studies. Last, the current study was conducted in 1 state, which could limit the generalizability of the results to other states/populations.

Despite these limitations, the findings of the current study are informative for identifying strategies with which to improve rates of CRC screening among underserved communities. The strength of the current analysis is the evaluation of the effectiveness and costs of an actual program, illustrating the benefits of PN for a statewide public health program and locally operated endoscopy centers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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CONFLICT OF INTEREST DISCLOSURES

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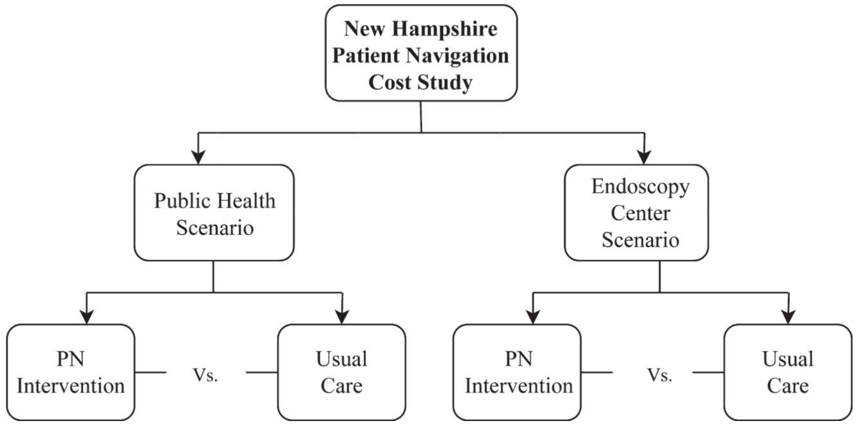

Figure 1.

Study design of the patient navigation (PN) intervention program.

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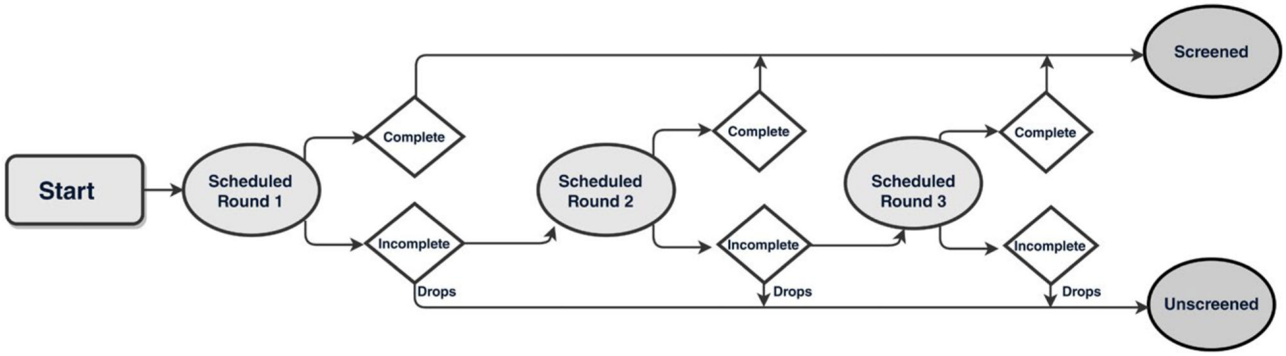

Figure 2.
Patient pathway in the colorectal cancer screening process.

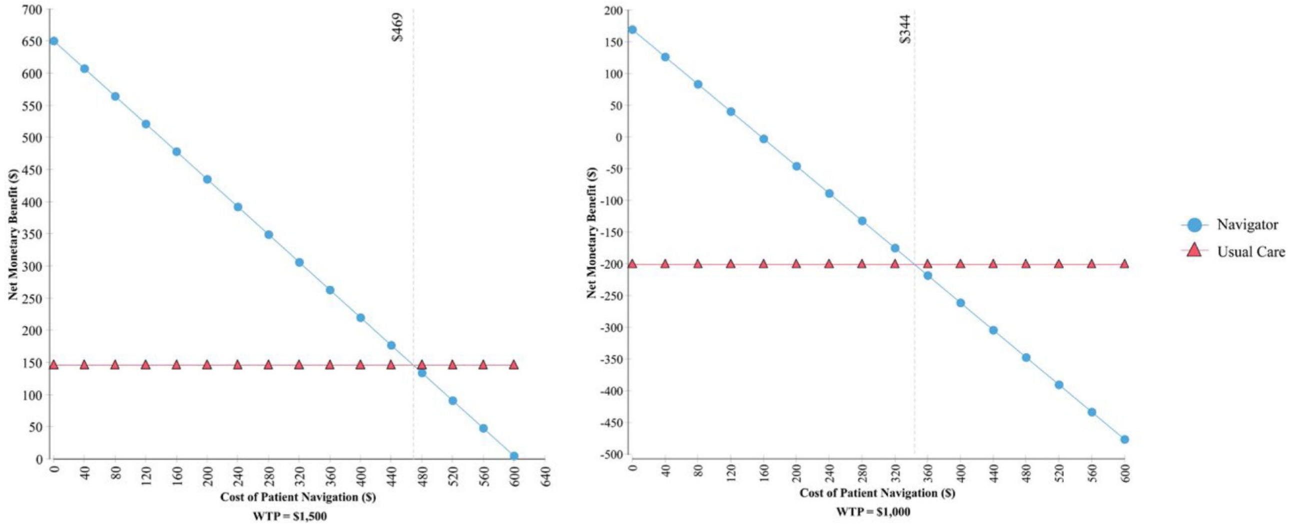

Figure 3.

One-way sensitivity analysis of the cost of patient navigation with different willingness-to-pay (WTP) values.

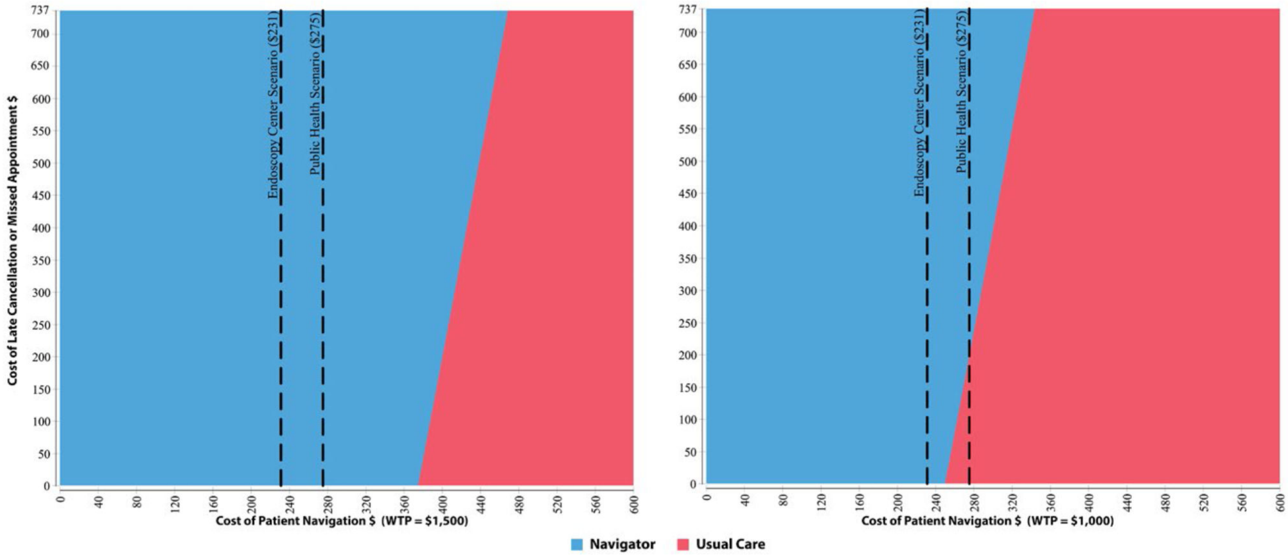

Figure 4.

Two-way sensitivity analysis at different willingness-to-pay (WTP) values. The dotted vertical lines represent the 2 actual costs of patient navigation used in the analysis.

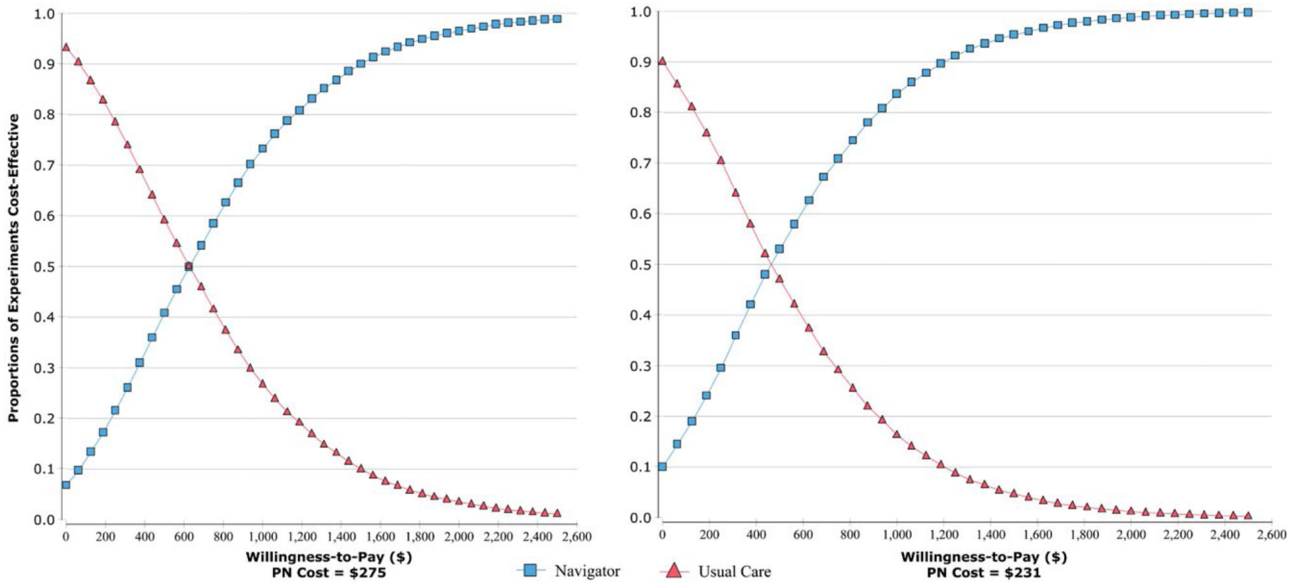

Figure 5.

Cost-effectiveness acceptability curve for different patient navigation (PN) cost scenarios. The results are based on probabilistic sensitivity analysis based on 5000 draws of parameter samples and willingness-to-pay values ranging from $0 to $3000.

TABLE 1.

Effectiveness Measures of Patient Navigation and Usual Care Used as Input Parameters for the Analysis Model[a]

	Values, % of Cohort	
Parameters	**Patient Navigation N = 131**	**Usual Care N = 75**
Screening completion through first encounter Screening completion	90.1	53.3
Screening completion through second encounter Screening completion	94.7	65.3
Screening completion through third encounter	96.2	69.3
Incomplete at end of cycle	3.8	30.6

[a]Data for patient navigation reflect navigated patients at clinic A only and were extracted from the New Hampshire Colorectal Cancer Screening Program database management system, Catalyst, which is a cloud-based software system used to record, track, and manage detailed patient data. Data for patients treated with usual care were abstracted from the electronic medical record, appointment record system, and patient chart records obtained from clinic A.

TABLE 2.

Cost Measures of Patient Navigation and Related Outcomes Used as Input Parameters for the Analysis Model

Parameters	Mean	Standard Deviation	Distributions
Cost of navigation in a public health program implementation scenario	$275	$144	Gamma
Cost of navigation in an endoscopy center implementation scenario	$231	$121	Gamma
Cost of colonoscopy	$737	$143	Gamma
Cost of cancellation (<48 hrs) or missed appointment	$737	$143	Gamma
Cost of incomplete colonoscopy	$737	$143	Gamma

Data source: New Hampshire Colorectal Cancer Screening Program.

TABLE 3.

Results From Cost-Effectiveness Analysis[a]

	Effect, % Screened	Incremental Effectiveness	Average Cost	incremental Cost	ICER
Endoscopy center implementation scenario					
Usual care	69.3		$894		
Patient navigation	96.2	0.27	$1041	$147	$548
Public health program implementation scenario					
Usual care	69.3		$894		
Patient navigation	96.2	0.27	$1089	$195	$725

Abbreviation: icer, incremental cost-ettectiveness ratio.

[a]Average cost per patient.