Cancer Causes & Control (2019) 30:923–929
https://doi.org/10.1007/s10552-019-01200-3

ORIGINAL PAPER

Cost-effectiveness of patient navigation for breast cancer screening in the National Breast and Cervical Cancer Early Detection Program

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Received: 8 November 2018 / Accepted: 20 June 2019 / Published online: 11 July 2019

Abstract

Objectives Patient navigation (PN) services have been shown to improve cancer screening in disparate populations. This study estimates the cost-effectiveness of implementing PN services within the National Breast and Cervical Cancer Early Detection Program (NBCCEDP).

Methods We adapted a breast cancer simulation model to estimate a population cohort of women aged 40–64 years from the NBCCEDP through their lifetime. We incorporated their screening frequency and screening and diagnostic costs.

Results Within the NBCCEDP, Program with PN (vs. No PN) resulted in a greater number of mammograms per woman (4.23 vs. 4.14), lower lifetime mortality from breast cancer (3.53% vs. 3.61%), and fewer missed diagnostic resolution per woman (0.017 vs. 0.025). The estimated incremental cost-effectiveness ratios for a Program with PN was $32,531 per quality-adjusted life-years relative to Program with No PN.

Conclusions Incorporating PN services within the NBCCEDP may be a cost-effective way of improving adherence to screening and diagnostic resolution for women who have abnormal results from screening mammography. Our study highlights the value of supportive services such as PN in improving the quality of care offered within the NBCCEDP.

Keywords Breast cancer · Screening · Mammography · Cost-effectiveness

Introduction

About one in four cancers diagnosed in women are breast cancers [1]. Breast cancer is the most commonly diagnosed cancer and the second leading cause of death among women in the U.S [1]. Each year, about 220,000 diagnoses and about 40,000 breast cancer deaths occur [1]. The U.S. Preventive Services Task Force (USPSTF), the American Cancer Society, and several medical societies all recommend screening for breast cancer using either annual or biennial mammograms; [2, 3] however, data from the 2015 National Health Interview Survey show that mammography rates have remained relatively stable from 2000 to 2015, 71.5% of women aged 50–74 years reporting having had a mammogram in the past 2 years [4]. Despite the known benefits of regular breast cancer screening in reducing morbidity and mortality through early detection and follow-up care, mammography use varies by subpopulations and is lowest among those who report being uninsured or without a usual source of healthcare [4].

The Centers for Disease Control and Prevention's (CDC) National Breast and Cervical Cancer Early Detection Program (NBCCEDP), which currently operates in all 50 states, the District of Columbia, 6 U.S. territories, and 13 American Indian and Alaska Native tribal jurisdictions, was established by the U.S. Congress in 1990 to provide breast and cervical cancer screening to uninsured and underinsured low-income women. The program also gives awardees resources to educate the public and healthcare providers about screening for breast and cervical cancer and to conduct outreach activities that identify underserved women who are in need of screening services. Since its inception, the NBCCEDP has provided more than 12.7 million breast and cervical cancer screening tests to more than 5.3 million low-income women [5]. Even with adequate health insurance and coverage of

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clinical services, studies suggest that many women still face significant barriers in obtaining breast cancer screening due to language barriers, low health literacy, geographic isolation, transportation cost to provider office, inconvenient appointment times to access services, lack of paid sick leave, lack of education about cancer screening and screening tests, and fear, mistrust of the medical system [6–10].

Implementation of patient navigation (PN) services has been shown to reduce some of the barriers experienced by women and improve compliance with breast cancer screening [11, 12]. Navigation provided to patients in the form of education, language translation services, reimbursement for transportation, guidance in interpreting doctor recommendations, emotional support, and help completing required documents have been used by NBCCEDP programs to reduce barriers related to undergoing screening and diagnostic testing [13]. Systematic establishment of PN services could also help increase screening compliance among insured women by eliminating barriers [13].

To date, there have been limited economic assessments of the NBCCEDP [14–17] and no systematic studies conducted on the cost and effectiveness of the program's PN activities. In an accompanying article, we estimate the overall cost-effectiveness of breast cancer screening in the NBCCEDP [18]. In this study, we expand upon the prior analysis to assess the cost-effectiveness of PN services within the NBCCEDP using a hybrid decision analytic-simulation model. We expect that these findings will enable the NBCCEDP awardees to assess the cost and effectiveness of implementing PN to reduce barriers faced by women when undergoing breast cancer screening and diagnostic testing.

Methods

Model description

A detailed description of the cost-effectiveness model for this paper is described in the accompanying article and in Hoerger et al. [15]. Briefly, we modified a validated breast cancer screening simulation model developed by the Cancer Intervention and Surveillance Modeling Network (CISNET) [19–21]. We added data from the NBCCEDP on patient cohorts, screening frequency, and program costs, and calculated life-time costs and quality-adjusted life-years (QALYs). We calculated the costs and QALYs for four scenarios: (1) breast cancer screening in the NBCCEDP; (2) less frequent screening of low-income, non-insured women that would take place in the absence of the program [i.e. "No Program"]; (3) breast cancer outcomes that would occur if no screening took place within the program since clinical detection would still occur under this scenario [i.e. "No Screening"]; and (4) PN services that would occur within the NBCCEDP [i.e. "Program with PN"]. The NBCCEDP scenarios (Program with PN and No PN scenarios) includes costs associated with breast cancer screening and program delivery. More details on the costs included in the Program with PN and No PN scenarios are available in Rim et al. [18]. We estimated the incremental costs and QALYs for each scenario and calculated incremental cost-effectiveness ratios (ICERs) for the NBCCEDP relative to the other scenarios. The model takes a societal perspective.

Impact of PN on cancer screening

We reviewed published studies on PN in breast cancer screening and identified three areas where navigation is likely to improve patient care: adherence to screening, completion of diagnostic resolution, and timeliness of diagnostic follow-up. Table 1 shows our model assumptions in these areas. Wells et al. found that the rate of adherence to screening increased between 10.8% and 17.1% when patients in a navigation group were compared with a control group [22]. We modelled this effect as a reduction of 14% (the midpoint of the estimated range in Wells et al. in the share of irregular screeners in the NBCCEDP in our analysis. Our model contained three screening types: annual, biennial, and irregular. Annual and biennial screeners were considered those who

Table 1 Model parameters for the cost-effectiveness analysis

Parameter	With patient navigation	No patient navigation	Sources
Impact			
Adherence to screening: reduction in percentage of irregular screeners	14%	–	Wells et al. [22]
Diagnostic follow-up	92%	77%	Raich et al. [12]
Time to diagnostic resolution (days)	25	42	Hoffman et al. [29]
Costs			
Patient navigation	$8.52 per screen	–	Colorado Connect to Care Program (2013)
Case management: patient navigation after abnormal screening result	$30.53 per abnormal screen result	–	Colorado Connect to Care Program (2013)

adhered to screening recommendations. In the NBCCEDP, the percentage of irregular screeners ranged from 9% (age 60–65) to 28% (age 40) (see Hoerger et al. for details on this calculation) [15]. For comparison, in low-income, uninsured women not covered by the program, the percentage of irregular screeners ranged from 47% (age 60–65) to 64% (age 40) [15].

For diagnostic resolution, the evidence on PN is mixed. Battaglia et al. found a slight increase in complete diagnostic follow-up in their unadjusted results and a statistically significant hazard ratio for diagnostic resolution after 60 days [23]. Although Clark et al. found an increase in diagnostic follow-up, this could not be attributed to the intervention [24]. Markossian et al. reported high unadjusted rates for diagnostic adherence (98.7% for the PN arm versus 81% for the control group) [25], but the results were not significantly associated with improved odds of diagnostic resolution after adjusting for covariates.

In contrast, several studies have shown PN to be effective in improving diagnostic resolution [12, 26, 27]. For example, Raich and colleagues found 92% of the navigated patients reached diagnostic resolution of the initial abnormal test, as compared with 77% for the control patients ($P < 0.001$) [12]. In addition, Battaglia et al. found statistically significant improvements in diagnostic adherence: 65% of pre-intervention versus 76% of intervention subjects had timely follow-up ($P = 0.008$) [26]. Further, Ferrantes et al. showed, in a small group, that 94% of patients with navigation completed diagnostic follow-up versus 78% in the control [27]. In the present study, we assumed a baseline rate of 65% diagnostic adherence [26] for those not in the program and an improvement to 90% diagnostic adherence within the program based on expert opinion of NBCCEDP data and the results from Miller et al. [28]. This is a substantial improvement that is probably not solely due to PN services. Therefore, we assumed a more modest increase in diagnostic follow-up (from 77 to 92%) based on a study by Raich et al. [12].

Several studies also have demonstrated that PN reduces time to diagnostic follow-up [22, 27, 29]. Based on prior studies, we introduced a time delay for navigated and non-navigated women in the program of 25 and 43 days, respectively [22, 27].

Costs of PN

PN costs were obtained from a survey of the subcontractors participating in Colorado's "Connect-to-Care" component of the state's NBCCEDP-funded program in 2011 (Personal Communication, Christen Lara 2013; Connect to Health 2014). Forty-two of the state's 45 subcontractors participated in the survey, which measured the time spent for a patient navigator for screening and also the time spent for navigation after an abnormal screening result. The survey found that PN was conducted by non-clinical staff typically for screening and clinical staff after an abnormal screening result. Respondents indicated that half of patients received navigation for screening and that about 95% of the time navigation took less than an hour. Navigating for diagnostic resolution after an abnormal screen result, however, typically took between 30 and 90 min to complete. We estimated a cost of PN to be $8.52 per screen and $30.53 per abnormal screen result. Using the hourly rate provided by the state of Colorado and inflated to 2018 costs we calculated the following hourly rates– nonclinical ($14.80) and clinical staff ($26.50). We assume 30-mins of a patient navigator for screening and an hour for diagnostic resolution.

Outcomes

The main outcomes for each scenario were: estimates of screening history, breast cancer incidence, screening or clinical detection, stage at detection, costs, life-years, and QALYs. Costs and QALYs were summed for each scenario. The effect of PN in the NBCCEDP was estimated as the difference in costs and the difference in QALYs between the Program with PN and No PN scenarios. The ICERs were then estimated by dividing the difference in costs by the difference in QALYs. We also compared the Program with PN and No PN (also within the NBCCEDP) to the No Program and No Screening scenarios described in the accompanying article. The model was developed and analyzed in TreeAge Pro 2009 (TreeAge Software Inc, Williamstown, MA). Costs are reported in 2018 U.S. dollars; costs and QALYs were discounted at a 3% annual rate.

Sensitivity analyses

Sensitivity analyses for the model involved running deterministic and probabilistic sensitivity analyses (PSA). The results of all parameters are presented in Rim et al. of the sensitivity analyses for the model [18]. For this study, we ran an additional sensitivity analyses varying the total costs of PN by ± 50%.

Results

Results from the four simulations estimated breast cancer mortality as 3.53%, 3.61%, 3.93%, and 4.97% under the respective scenarios of Program with PN, No PN, No Program, and No Screening scenarios (Table 2). In terms of screen-detected cancers, the model estimated a modest increase for Program with PN compared to Program without PN (8.55% vs. 8.25%). Existence of the program, as demonstrated in both scenarios, resulted in estimated 1.69 to 1.99 percentage point increases in screen-detected cancers

Table 2 Results of the four scenarios modeled for women receiving breast cancer screening in the NBCCEDP (n = 2000,000 in each scenario)

Parameter	Program with PN	Program with No PN	No program	No screening
Mammograms (per woman), lifetime	17.61	17.37	12.34	0.00
Mammograms (per woman) (age 40–64, 1991–2005)	4.23	4.14	2.41	0.00
Breast cancer mortality	3.53%	3.61%	3.93%	4.97%
Clinically detected rate	5.27%	5.56%	7.17%	13.30%
Screen detected rate	8.55%	8.25%	6.56%	0.00%
Overall detected rate	13.82%	13.81%	13.73%	13.30%
Clinically detected				
Localized	52.0%	51.9%	50.8%	48.0%
Regional	41.7%	41.7%	42.7%	44.7%
Distant	6.3%	6.4%	6.5%	7.3%
Screen detected				
Localized	81.1%	80.0%	78.8%	
Regional	17.5%	18.5%	19.6%	
Distant	1.4%	1.6%	1.6%	
Missed diagnostic resolution (per woman)	0.017	0.025	0.020	0.000
Costing information (per woman)				
Treatment costs	$5,689	$5,669	$5,560	$5,258
Screening costs	$2,635	$2,594	$1,771	$0
Diagnostic costs	$342	$328	$233	$0
Patient navigation costs	$126	$0	$0	$0
Total costs	$8,791	$8,589	$7,564	$5,258
Life-years (per woman)	21.990	21.984	21.965	21.915
QALYs (per woman)	21.969	21.963	21.945	21.898
Incremental cost-effectiveness ratios (ICERs)				
$ Per life-year				
Versus no screening	$47,109	$48,284	$46,126	
Versus no program	$49,075	$53,962		
Versus no patient navigation	$33,600			
$ per QALY				
Versus no screening	$49,763	$51,255	$49,070	
Versus no program	$51,120	$56,960		
Versus no patient navigation	$33,600			

Note: NBCCEDP = National Breast and Cervical Cancer Early Detection Program; PN = patient navigation; QALYs = quality-adjusted life-years

relative to the No Program scenario (6.56%). Women were estimated to have fewer missed diagnostic follow-ups with PN (0.017/woman) compared to the No PN scenario (0.025/woman).

Overall costs per woman in the modeled cohort were higher in the Program with PN, No PN, and No Program scenarios than in the No Screening scenario. Screening costs accounted for the largest share of the differences between scenarios; treatment costs were also higher in the Program with PN, No PN, and No Program scenarios compared to the No Screening scenario. Diagnostic costs were higher in the Program with PN scenario than in the No PN scenario, reflecting the decrease in missed follow-ups. Navigation costs were $126 per woman in the Program with PN scenario.

We estimated that including navigation in the Program would lead to an increase of 0.006, 0.024 and 0.071 QALYs relative to the No PN, No Program, and No Screening scenarios, respectively. Incremental (discounted) life-years were slightly higher. The Program with PN had an ICER of $33,600 per QALY and $51,120 per QALY relative to the No PN and No Program scenarios, respectively. Relative to either the No Program or No Screening scenarios, the Program with PN had lower ICERs than the No PN scenarios (Table 2). In cost-effectiveness terms, the Program with PN scenario has extended dominance over the No PN scenario, because the former scenario provided more QALYs with a lower ICER.

We also calculated ICERs based on discounted life-years gained. Estimates of life-years gained do not take into account the quality-of-life decrements included in the QALY estimates. Therefore, because estimated life-years gained exceeded QALYs gained, the life-year ICERs were slightly lower than the QALY ICERs.

PN costs have a significant impact on the ICER. When we decrease patient navigation costs by 50%, we find the Program with PN ICER drops to $23,136 per QALY relative to the No PN scenario. Increasing costs increases the Program with PN ICER to $44,064. (Results available on request.)

Discussion

Based on our simulations, PN within the NBCCEDP-improved outcomes but also raised costs. The estimated ICER is considered cost-effective by some thresholds at $33,600 per QALY relative to No PN. In the accompanying paper, we report that the ICER for the NBCCEDP as a whole (including PN) was $51,120 and $49,596 per QALY relative to scenarios with less frequent or no screening, respectively. If incorporating PN into NBCCEDP improves screening frequency for irregular screeners and increases diagnostic resolution rates for women who have abnormal screening results, our results suggest that the program may be cost-effective.

The PN became a required NBCCEDP activity in 1999 when Congress appropriated specific funds to support it. For low income, un- and under-insured women who face multiple personal and health system barriers, PN provides the necessary support and resources to help them complete screening and diagnostic follow-up. Navigation has also been shown to decrease disparities in breast cancer outcomes [30–33] and increase patient satisfaction [34]. The CDC continues to recognize the value of PN and has expanded the service beyond traditionally program-eligible women to include low-income women who have other resources for mammography, including those recently insured through expanded health care under the Affordable Care Act. Data suggest that among age-appropriate women with public insurance, 23–29% remain unscreened or not up to date with screening [4]. CDC encouraged awardees to use PN to link those women in the community who have never been screened or do not have a medical home to cancer screening. Without reaching these populations, breast cancer screening rates are likely to continue at current levels, which is below the Healthy People 2020 target [4].

Our analysis is subject to certain limitations. First, PN is one part of a more comprehensive NBCCEDP health promotional activity, so it is difficult to precisely estimate the impact of the navigation services within the program. We use assumptions about the impact of PN from studies of NBCCEDP non-participants; as such, results may not be generalizable to the NBCCEDP. On the other hand, these studies have focused on vulnerable populations, including low-income, uninsured women who are the target population for the NBCCEDP. Second, while using data from an actual NBCCEDP awardees (i.e., Colorado) is a strength of this study, we recognize that PN costs likely vary across NBCCEDP awardee in different states. Third, long-term breast cancer treatment outcomes are based on a simulation model that relates PN to screening and diagnostic follow-up, and then relates the screening and diagnostic follow-up to breast cancer outcomes. Although a study directly linking observed PN services to observed breast cancer outcomes would provide more compelling evidence on the impact of PN, such a study is not likely to be feasible because it would require a long follow-up period and a large sample size. As a more feasible alternative approach, simulation models link an intervention's short-term outcomes to long-term impact. Fourth, our cost estimates reflect the direct costs of PN and do not take into account overhead costs when sourcing the costs for the PN program. Sensitivity analysis results around this estimate by increasing by 50% found that PN is still cost-effective relative to No PN.

Our study has potential implications for breast cancer screening among low-income women. The Affordable Care Act (ACA) expanded health insurance coverage to previously uninsured low-income women (through health insurance exchanges or Medicaid coverage in states that expand their programs), improving access to preventive services, including breast cancer screening. This expanded coverage, particularly to low-income populations, may not be enough to ensure that beneficiaries actually receive cancer screening. Therefore, PN may be essential to ensure that these women get appropriate and complete screening and diagnostic services as reported in this paper and in other studies [22, 25, 35, 36]. As our results suggest, providing PN may be cost-effective if it can be provided at costs that are similar to those in the NBCCEDP. Even with the availability of health insurance, some low-income women will still remain uninsured [35]. The estimates reported in this paper indicate that incorporating PN activities in the NBCCEDP breast cancer screening and diagnostic services could be a cost-effective way of improving adherence to cancer screening in medically underserved low-income women.

Acknowledgments We would like to thank Christen Lara from the Colorado Department of Public Health and the Environment for her assistance in compiling Colorado NBCCEDP cost data for this manuscript.

Funding This research was supported by Contract No. 200-2008-27958 TO 27 from the Centers for Disease Control and Prevention (CDC). The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

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