

Medical Home Transformation and Breast Cancer Screening

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Among women in the United States, breast cancer is the most common cancer and is the second most common cause of cancer-related death.¹ Primary care plays a critical role in breast cancer screening and detection. One primary care model that may improve the use of screening is the patient-centered medical home (PCMH), which advocates believe can achieve the “triple aim” of improving health, decreasing cost, and enhancing patient experiences.²⁻⁴ Core components of the PCMH model include: patient-centered access, team-based care, population health management, care management and support, care coordination and care transitions, and performance measurement and quality improvement.⁵

National initiatives in PCMH adoption have expanded rapidly; the number of patients cared for in medical homes increased from approximately 5 million in 2009 to 21 million in 2013.³ The model has received widespread support from policy makers and industry stakeholders, including all major US primary care physician organizations²; however, research on the effect of the medical home model overall has been mixed,^{4,6-9} underscoring the need for additional research given the rapid uptake of this care model.

Understanding how the PCMH model can impact care quality and processes early on, as well as in the long term, is critical for policy planning, primary care design, and resource allocation. Medical home transformation is a dynamic and complex transition that may take several years and may be implemented differently in different settings.⁹⁻¹¹ Additionally, exploring how processes are impacted during this early period can help optimize and standardize future initiatives. Our study focuses on this implementation period and examines in depth how 1 strategy of implementation and assessment may impact an important indicator of primary care: the delivery of breast cancer screening. Importantly, to our knowledge, there are no validated measures of the process of primary care transformation to a PCMH, so settings interested in assessing progress toward PCMH recognition may define their own measures.

Breast cancer screening may be an important indicator of successful PCMH transformation, as several of the required PCMH

ABSTRACT

OBJECTIVES: The patient-centered medical home (PCMH) continues to gain momentum as a primary care delivery system. We evaluated whether medical home transformation of primary care practices is associated with the use of breast cancer screening, a broadly endorsed preventive service.

STUDY DESIGN: Retrospective cohort study evaluating 12 Brigham and Women’s Hospital (BWH)-affiliated primary care clinics in greater Boston, Massachusetts.

METHODS: Practice transformation was measured quarterly using a continuous PCMH transformation score (range = 0-100) modeled after National Committee for Quality Assurance recognition requirements. We included women aged 50 to 74 years who had at least 1 primary care visit at a participating clinic between April 2012 and December 2013 (n = 20,349)—a period of medical home transformation. The main measures included: a) whether screening was up-to-date at the time of the visit (mammography completion within 24 months prior to the visit); and b) if screening was overdue at the visit (ie, it had been more than 24 months since the last mammogram), and whether timely screening was completed within 3 months after the visit.

RESULTS: In adjusted analyses, PCMH transformation scores were negatively associated with up-to-date screening status [odds ratio [OR] for a 20-point change, 0.93; 95% confidence interval [CI], 0.89-0.96] and with timely screening of women who were overdue [OR, 0.94; 95% CI, 0.87-1.02].

CONCLUSIONS: Preventative care, such as breast cancer screening, may not improve in early PCMH implementation.

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components (patient-centered access to scheduling and convenient appointment times, team-based care with integration with specialty providers in obstetrics/gynecology and radiology, population health management, and performance measurement and quality improvement) may facilitate completion. Evaluating whether the PCMH can improve the use of breast cancer screening is also important, as it is strongly recommended for women aged 50 to 74 years by the US Preventive Services Task Force, the American Cancer Society, and other specialty societies.^{12,13} Yet, PCMH also places significant emphasis on chronic disease management, utilization, and the prevention of readmission.^{4,14} This emphasis may divert focus from cancer screening and other preventive care. We evaluated whether medical home transformation of primary care practices is associated with the use of breast cancer screening—a broadly endorsed preventative service.

METHODS

Study Design and Data Source

We conducted a retrospective cohort study evaluating 12 participating Brigham and Women's Hospital (BWH)-affiliated primary care clinics. Clinical data were extracted from the BWH Population-based Research Optimizing Screening through Personalized Regimens (PROSPR) Registry supplemented with additional data elements from the electronic health record (EHR). This study was conducted as part of the National Cancer Institute (NCI)-funded consortium PROSPR.¹⁵ The overall aim of PROSPR is to conduct multi-site, coordinated, trans-disciplinary research to evaluate and improve cancer-screening processes. This study was approved by the Partners Healthcare Institutional Review Board.

Study Population

We included women aged 50 to 74 years who had at least 1 primary care visit to 1 of 12 participating BWH-affiliated primary care clinics between April 2012 and December 2013 (n = 20,349), a period when the institution was undertaking medical home transformation. Women were excluded if they had a prior history of breast cancer (n = 2085) or died during the follow-up period (n = 279).

Exposure: Practice Transformation

In 2012, BWH began measuring PCMH transformation using a framework called "Primed Status" that was modeled on the National Committee for Quality Assurance (NCQA) requirements for medical home recognition. Primed Status was developed by Partners Healthcare Population Health Management as a metric for progress

TAKE-AWAY POINTS

- ▶ The patient-centered medical home (PCMH) model has received widespread support, yet to our knowledge, there are no validated measures to track this complex care transition or with which to examine the impact of this transition on well-accepted quality measures, like breast cancer screening.
- ▶ Using a locally developed measure of PCMH transformation over a 2-year period, we found that transformation scores were negatively associated with up-to-date, timely breast cancer screening.
- ▶ Care redesign should include the development of valid measures so that unexpected effects of care transformation on important quality metrics can be examined.

toward PCMH implementation (ie, it is intended to indicate whether a practice is "primed" for PCMH recognition). Although other studies have used NCQA audit data following PCMH recognition, this measure was developed to help guide practices before recognition status was achieved. This measure of PCMH transformation is the exposure variable for this analysis. This score was assessed quarterly for each practice based on achieving targets for the following elements: use of EHR, patient access to a Web-based portal, team-based care, practice redesign and process improvement, and care management of high-risk patients (Table 1). Several of these features could positively influence the use of cancer screening (eg, EHR use could facilitate use of provider reminders or panel management to identify overdue screening, patient portals could be used for patient reminders, quality improvement initiatives could focus on cancer screening); however, several of the measures could be negatively associated with cancer screening if resources were more focused on high-risk patients (ie, the care management criteria). The measure was developed to reflect the institutional need for practice transformation to achieve NCQA recognition. Partners Healthcare supported practices both by providing quarterly financial incentives for reaching these targets and by providing practice change support, such as consultants and increased staffing.¹⁶

We evaluated an aggregate 0-to-100 "PCMH Transformation Score" based on the percentage of elements achieved. The most recent quarter's score was assigned to a woman's primary care visit. If there were multiple visits within a quarter, the first visit score was used for analysis.

Outcome Measures

We examined 2 outcome measures using data from the EHR and our PROSPR data repository: a) whether screening was up-to-date at the visit (defined as mammography completion within 24 months prior to the visit); and b) if screening was overdue at the visit (ie, it had been >24 months since the last mammography), and whether timely screening was completed within 3 months after the visit. We included uses of screening both observed in the EHR or noted in the EHR to have occurred elsewhere. These outcome definitions follow from Healthcare Effectiveness Data and Information Set measures for breast cancer screening.¹⁷

TABLE 1. Elements of the Patient-Centered Medical Home Transformation Score

Element	Description	NCQA Requirement(s) Addressed
Electronic health record	Every physician in each practice has met Stage 1 Meaningful Use criteria	Population health management; care management and support; care coordination and care transitions; performance measurement and quality improvement
Patient portal	For each practice, average member portal enrollment per physician has been met: full-time provider = 400 patients, intermediate-time provider = 300 patients, part-time provider = 200 patients	Patient-centered access
Team-based care	Dedicated clinical staff (ie, medical assistants, licensed practical nurses, RNs) with 1:1 physician ratio; standardized workflow documentation; Agency for Healthcare Research and Quality Culture Survey completion by 60% of staff	Team-based care
Practice redesign: provider	30% of physicians trained in process improvement methodology (eg, Lean Six Sigma Training)	Performance measurement and quality improvement
Practice redesign: staff	30% of staff trained in process improvement methodology (eg, Lean Six Sigma Training)	Performance measurement and quality improvement
Care management staffing	Achieve CM staffing ratio of 1:200 for high-risk patients	Team-based care; CM and support; care coordination and care transitions
Case manager assignment	95% of high-risk patients assigned to RN case manager in each practice	Team-based care approach; CM and support; care coordination and care transitions
High-risk patient prioritization	95% of high-risk patients identified and prioritized as high, medium, and low	Population health management; CM and support; care coordination and care transitions

CM indicates care management; NCQA, National Committee for Quality Assurance; RN, registered nurse.

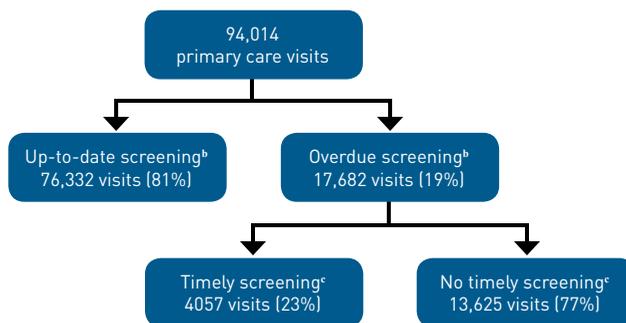
Data Analysis

The primary care visit was the unit of analysis. The continuous 0-to-100 PCMH Transformation Score was used as the exposure variable. Covariates included patient age, race/ethnicity, education level, insurance status, known family history of breast cancer, Charlson Comorbidity Index score,¹⁸ smoking history, number of primary care visits in the prior year, marital status, body mass index, and a linear time trend to account for secular changes in screening.

Adjusting for the above covariates, we used 2-level hierarchical logistic regression with PROC GLIMMIX version 9.2 (SAS Institute, Cary, North Carolina) to examine the impact of medical home transformation on status indicators of breast cancer screening. The regression coefficients for the PCMH Transformation Score were used to calculate the odds ratio for a 20-point change on the screening status indicators. A 20-point change was chosen to reflect a meaningful amount of transformation change. Regression analyses were clustered at the level of the patient and primary care practice. If there were missing data for a given variable, it was included in the model as a dummy variable.

years and these women made an average of 2.8 primary care visits in the prior year (Table 2). A majority of women had Charlson Comorbidity Index scores of 0 (67%). A majority of patients were white (72%), with similar reported percentages of Hispanics (12%) and blacks (13%). Nearly all women had insurance (99%), with a majority having commercial (60%) or Medicare (27%) and the remainder having Medicaid or another federal program (12%). The

FIGURE. Flow Diagram of Primary Care Visits and Screening Status^a



^aA total of 20,349 women had at least 1 primary care visit during the study period.

^bScreening was considered up-to-date if mammography was completed within preceding 24 months of visit, and overdue if there was no mammography in preceding 24 months.

^cScreening was considered timely if completed within 3 months of visit, if overdue at the time of the visit.

RESULTS

Study Sample and Practice Characteristics

The cohort included 20,349 women who made 94,014 primary care visits (Figure). The average age of women in the cohort was 60

TABLE 2. Patient Characteristics^a

Characteristic	Mean	Range
Age, years	60	50-74
Number of primary care visits in prior year	2.8	0-27
	N	%
Number of patients	20,349	-
Marital status		
Married	11,540	57
CCI score		
0	12,909	67
1	3580	19
2	1597	8
≥3	1143	6
Race/ethnicity		
White	13,763	72
Hispanic	2313	12
Black	2440	13
Asian	499	3
Insurance		
Commercial	12,131	60
Medicare	5493	27
Medicaid/other federal insurance program	2421	12
Uninsured	205	1
Education		
Less than high school	1604	9
High school graduate/GED	3243	17
Some college	3226	17
College or beyond	10,750	57
Smoking status		
Current	1124	6
Never or former	17,283	94
First-degree family history of breast cancer	840	4
Body mass index		
Normal or underweight	7294	37
Overweight	6210	31
Obese	6612	33

CCI indicates Charlson Comorbidity Index; GED, General Educational Development.

^aData were missing for: CCI score (n = 1143), race (n = 1034), insurance status (n = 9), educational status (n = 1526), smoking history (n = 1942), and body mass index (n = 233).

majority of women had at least a college education. Four percent of women had a family history of breast cancer noted in the EHR. One-third of women were obese, and nearly one-third were overweight.

All 12 practices had improvements in their PCMH Transformation Scores over the study period; the average practice score increased from 26% in the first quarter to 81% in the final quarter

TABLE 3. Average Quarterly Patient-Centered Medical Home Transformation Score by Primary Care Practice

Practice	2012			2013				Color Key
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
1	56	22	67	56	78	78	89	0%-20% 21%-40% 41%-60% 61%-80% 81%-100%
2	11	11	44	56	67	67	100	
3	22	22	44	100	100	78	89	
4	44	22	44	56	56	78	100	
5	22	22	44	67	89	67	78	
6	44	22	56	67	89	89	100	
7	33	33	56	44	56	89	89	
8	11	11	33	44	44	56	67	
9	22	11	44	67	78	78	100	
10	22	33	56	67	67	89	100	
11	22	22	33	44	78	56	67	
12	0	22	44	56	67	67	78	
Mean score	28	21	47	61	73	75	89	

(Table 3). The first practice to achieve a score in the highest quintile did so in the first quarter of 2013 and the last practices achieved this goal in the final quarter of 2013.

Use of Breast Cancer Screening and Practice Transformation

Women were up-to-date with screening at a majority of visits (81%) and were overdue at only 18% (Figure). At visits when a woman was overdue for screening, timely screening was not completed within 3 months for a majority of the visits (77%).

In adjusted analyses, PCMH Transformation Scores had a slightly negative correlation with up-to-date screening status (odds ratio [OR] for a 20-point change, 0.93; 95% confidence interval [CI], 0.89-0.96) and for timely screening of women who were overdue (OR, 0.94; 95% CI, 0.87-1.02) (Table 4).

Increasing age (up until age 70), Hispanic (OR, 1.82; 95% CI, 1.69-1.97) and black (OR, 1.11; 95% CI 1.05-1.18) race/ethnicity, greater number of primary care visits, and having higher levels of education were all positively correlated with up-to-date screening. Negatively correlated predictors of current screening included being unmarried, having a comorbid condition, Asian race, having insurance other than Medicare or commercial, or being a smoker. Up-to-date screenings in 2012 and the first quarter of 2013 were lower than those observed in the last quarter of 2013.

Positively correlated predictors of timely completion of screening when overdue at the time of the visit were Hispanic (OR, 1.46; 95% CI, 1.25-1.70) and black (OR, 1.15; 95% CI, 1.02-1.30) race/ethnicity and having a known family history of breast cancer (OR, 1.37; 95% CI, 1.15-1.63). Negatively correlated predictors were being in the oldest age category, being unmarried, having a comorbid condition,

TABLE 4. Correlates of Breast Cancer Screening Completion^{a,b}

Variable	Screening Up-to-Date (n = 94,014) OR (95% CI)	Timely Screening if Overdue (n = 17,682) OR (95% CI)
PCMH transformation score (20-point change)	0.93 (0.89-0.96)	0.94 (0.87-1.02)
Age, years		
50-54	1.00	1.00
55-59	1.08 (1.03-1.13)	1.00 (0.90-1.10)
60-64	1.19 (1.13-1.25)	1.01 (0.91-1.12)
65-69	1.23 (1.16-1.30)	0.94 (0.84-1.06)
70-74	0.95 (0.89-1.01)	0.70 (0.61-0.80)
Marital status		
Married	1.00	1.00
Not married or unknown	0.91 (0.88-0.94)	0.86 (0.80-0.93)
CCI score		
0	1.00	1.00
1	0.95 (0.90-0.99)	0.84 (0.76-0.93)
2	0.89 (0.84-0.95)	0.74 (0.65-0.85)
≥3	0.79 (0.73-0.87)	0.59 (0.47-0.73)
Race		
White	1.00	1.00
Hispanic	1.82 (1.69-1.97)	1.46 (1.25-1.70)
Black	1.11 (1.05-1.18)	1.15 (1.02-1.30)
Asian	0.88 (0.79-0.99)	1.16 (0.93-1.45)
Insurance status		
Commercial or Medicare	1.00	1.00
Medicaid, other government program, uninsured, or unknown	0.86 (0.85-0.77)	1.02 (0.92-1.14)

(continued)

greater number of visits, and being a smoker. Timely completion of screening when overdue at the time of the visit was highest in the last quarter of 2012 and the first half of 2013.

DISCUSSION

We evaluated whether medical home transformation was associated with breast cancer screening among women seen in a network of primary care practices during a period of PCMH transformation from 2012 to 2013. We found that the process of PCMH transformation, as assessed by the institutional metric modeled after NCQA requirements, was not associated with higher rates of screening; in fact, we found a statistically significant negative relationship, with higher scores being associated with lower rates of up-to-date screening and a trend toward a negative association between higher

scores and lower completion of timely screening among women who were overdue at the time of the visit. Of note, overall use of screening mammography was somewhat lower earlier in the study period at these sites at a time when national estimates of mammography use were unchanged.¹⁹

Despite the rapid expansion of PCMH initiatives, to our knowledge, there are no validated measures for institutions to use to guide their transformation toward NCQA recognition. Paustian and colleagues developed a measure using practice metrics available to Blue Cross Blue Shield of Michigan.²⁰ Although some of the domains that they assessed were similar (components of meaningful use of an EHR), others were quite different (eg, linkage to community services). We used metrics developed by our institution to assess progress toward PCMH recognition; they were locally relevant and used to guide a complex process, but may not be generalizable to other institutions. The elements of the PCMH Transformation Score do address specific NCQA standards for recognition.⁵ Several practices made considerable changes, as assessed by this metric over a 2-year period. These rapid changes may have contributed to the lack of improvement in quality metrics of breast cancer screening. Alternately, because baseline rates of use were high, it may have been difficult to achieve improvements, as patients who were unscreened at baseline may not be candidates for screening because of comorbidity, or they may be particularly difficult to engage in screening. Future work should examine whether the use of screening stabilizes or improves over time as care redesign become more stable.

The need to understand the impact of medical home care models requires the development of specific measures to more clearly understand the changes undertaken and the diversity of findings on the changes associated with medical home transformation.⁹ Kern and colleagues examined use of breast cancer screening and several other measures of utilization and quality following NCQA recognition.⁴ In general, they found that medical home recognition was associated with modest declines in utilization (eg, hospitalization), but was not associated with changes in quality. Specifically, they found no association between achieving NCQA recognition status and use of breast cancer screening. A study that evaluated PCMH model adoption in Federally Qualified Health Centers using Commonwealth Fund national survey data and clinical data from HRSA's 2009 Uniform Data System also found mixed results: some PCMH domains (access and communication, care management, and external coordination) showed slight improvements in various clinical domains, while patient tracking/registry was associated with lower performance in childhood immunization, Pap testing, and diabetes control.²¹ Breast cancer screening was not included as a process measure in this study. Our findings contrast with several other PCMH studies that have showed improved rates of breast cancer screening in established medical home practices.²¹⁻²³ In a single private-payer demonstration project in New Jersey with 8 medical home practices, the use of annual mammography screening by women aged 42 to 64 years

TABLE 4. Correlates of Breast Cancer Screening Completion^{a,b}
(continued)

Variable	Screening Up-to-Date (n = 94,014) OR (95% CI)	Timely Screening if Overdue (n = 17,682) OR (95% CI)
Number of PCP visits in prior year		
0 visits	1.00	1.00
1-2 visits	1.34 (1.28-1.40)	0.64 (0.59-0.70)
3-4 visits	1.54 (1.46-1.64)	0.54 (0.48-0.61)
5-10 visits	1.54 (1.44-1.64)	0.45 (0.40-0.52)
≥11 visits	1.33 (1.18-1.50)	0.22 (0.15-0.31)
Education		
<High school	1.00	1.00
High school graduate/GED	1.09 (1.02-1.17)	0.97 (0.83-1.13)
Some college	1.06 (0.98-1.14)	0.96 (0.81-1.13)
≥College graduate	1.20 (1.11-1.29)	1.00 (0.85-1.17)
Smoking status		
Never or former	1.00	1.00
Current	0.63 (0.60-0.68)	0.76 (0.66-0.87)
Family history of breast cancer		
No	1.00	1.00
Yes	1.00 (0.92-1.09)	1.37 (1.15-1.63)
Time (quarter)		
2012 Q2	0.56 (0.49-0.65)	0.87 (0.64-1.20)
2012 Q3	0.64 (0.55-0.74)	1.00 (0.73-1.37)
2012 Q4	0.74 (0.67-0.82)	1.39 (1.11-1.74)
2013 Q1	0.82 (0.75-0.89)	1.49 (1.23-1.80)
2013 Q2	0.98 (0.91-1.06)	1.36 (1.15-1.61)
2013 Q3	0.93 (0.87-1.01)	1.11 (0.93-1.33)
2013 Q4	1.00	1.00

CCI indicates Charlson Comorbidity Index; CI, confidence interval; GED, General Educational Development; OR, odds ratio; PCMH, patient-centered medical home; PCP, primary care provider.

^aAdjusted for age, Patient-Centered Medical Home Transformation score, marital status, Charlson Comorbidity Index score, race, insurance status, number of primary care visits in the prior year, education level, smoking status, family history of breast cancer, body mass index, time (quarter), and clinic.

^bBold indicates findings that was statistically significant $P < .05$.

increased by 2.2% over 1 year from a base of 69.5%.²¹ A randomized controlled trial in New York evaluating PCMH transformation among 32 practices (18 intervention practices) also found an increase in annual breast cancer screening of 3.5% in PCMH practices, versus only 0.4% in control practices, over a 2-year period.²³ Finally, a recent study in Michigan found higher rates of breast cancer screening as PCMH scores increased, interestingly with larger improvements as socioeconomic categories decreased.²²

One explanation for our negative findings is that transformation may not have specifically targeted disease prevention, including

breast cancer screening, but was directed more toward chronic disease management and decreasing utilization.⁹ In addition, transformation efforts required practice redesign and the establishment of team-based care, which may require complex shifts in culture and roles that may dominate efforts early on. Timely use of breast cancer screening in these clinics was also higher at baseline than in prior studies that have examined this issue, making it challenging to detect improvements.

Our study also examined other predictors of screening, including sociodemographic factors, comorbidity, and measures of healthcare utilization (based on number of primary care visits). Our findings were consistent with prior literature showing that improved screening is associated with higher educational status, insurance status, being married, having fewer comorbidities, being a nonsmoker, and increased primary care utilization.²⁴⁻²⁷ Interestingly, our results showed that Hispanic and black women had higher rates of screening than white women. This is in contrast to data from the CDC in 2010 showing similar national rates of screening for black and white women, but slightly lower rates for Hispanic women.²⁴

Limitations

This study has several limitations. Because of the observational design, our findings do not establish causality. Overall trends for mammography use in the United States were stable during this time period,¹⁹ and we do not know of other contemporaneous institutional or local policy changes that would have affected mammography use; however, we did see an overall increase in mammography over this time period in the study population. The measure of medical home transformation, the PCMH Transformation score, is not a validated metric. It was, however, based on NCQA medical home recognition requirements, was uniformly deployed across several hundred Partners Healthcare primary care practices, and was collected by a centralized population health management team (our study had access to clinical mammography data only for the BWH practices). PCMH transformation is a heterogeneous process that will vary based on each healthcare system's unique needs.⁹ Thus, standardizing an approach to measurement has been challenging, and currently a well-established gold-standard measurement of transformation does not exist. The baseline rates of breast cancer screening were high; our findings may therefore not be generalizable to settings with lower levels of screening. Although important, breast cancer screening is only 1 of several recommended prevention metrics.

CONCLUSIONS

PCMH adoption is at the center of a rapid transformation of primary care to improve quality and lower cost; however, it is critical to understand how it may shift priorities with unintended consequences. Our study suggests that 1 preventative measure may have worsened during transformation, as assessed using an institution-

ally developed metric. Each practice and healthcare system must carefully weigh these competing priorities and recognize that while ideally transformation will improve care across a system, initiatives outcomes may be mixed during early stages of improvement.

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