Influence of Nurses on Compliance with Breast Screening Recommendations in an Organized Breast Screening Program

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Abstract

Background: Evidence from breast screening trials has shown that a significant reduction in breast cancer mortality from screening can be achieved by regular attendance. Few studies have evaluated the influence of nurses on compliance with breast screening recommendations.

Methods: The cohort included 157,788 women ages 50 to 69 years who were screened at 1 of 9 regional cancer centers or 57 affiliated centers with nurses or 26 affiliated centers without nurses between January 1, 2002, and December 31, 2002, within the Ontario Breast Screening Program. These women were followed up prospectively for at least 30 months to compare compliance for annual and biennial screening recommendations among women who attended centers with and without nurses. The associations between type of screening center and the odds of compliance were modeled using mixed-effect logistic regression models. All *P* values are two-sided.

Results: Women attending a regional cancer center [odds ratios (OR), 1.96; 95% confidence interval (95% CI), 1.07-3.58] or affiliated center with nurses (OR, 1.75; 95% CI, 1.38-2.22) were significantly more likely to return within 18 months of their annual screening recommendation than women attending affiliated centers without nurses. In addition, women attending regional cancer centers (OR, 2.28; 95% CI, 1.34-3.89) or affiliated centers with nurses (OR, 2.30; 95% CI, 1.86-2.83) were significantly more likely to make a timely return within the recommended biennial screening interval of between 18 and 30 months.

Conclusions: Breast screening programs should consider methods of integrating educational activities as provided by the nurses to improve compliance with screening. *Cancer Epidemiol Biomarkers Prev; 19(3); 697–706. ©2010 AACR.*

Introduction

Evidence of a reduction in breast cancer mortality rate through screening comes from the results of several randomized controlled trials (1, 2). Long-term follow-up of participants in these trials revealed a statistically significant reduction in mortality on achieving 70% attendance among women in the target age group (3, 4). Therefore, maintaining high levels of regular attendance and timely participation are essential to the success of a screening program.

In countries with population-based screening programs, including Canada, at least 70% of women return

after a biennial screening recommendation (5-10). Fewer studies have examined compliance with an annual screening recommendation and have reported lower rates of reattendance than for biennial screening (5, 11, 12). Although biennial screening is recommended for women ages 50 to 69 years at average risk, annual screening is important particularly for those at a higher risk of breast cancer. Women who have had a prior mammogram are more likely to return to screening and comply with screening recommendations than women undergoing first-time screening (5, 6, 11, 13), and women who have had a clinical breast examination (CBE) are more likely to comply with mammography screening (14-16). Recent studies have also shown that knowledge about screening guidelines may affect compliance as respondents who were unaware of the recommended screening intervals are significantly less likely to comply with screening (12, 14, 15, 17).

Physician recommendation has been identified as one of the most important factors in initial screening behavior as well as in whether a woman reattends and complies with mammography screening (5, 6, 15, 18-20). Fewer studies have examined how screening staff or facility-related

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factors may influence compliance. These studies have shown that a positive experience while having a mammogram or CBE and receiving competent, supportive, and courteous service from screening staff seems to improve rescreening behavior (21-23).

The Ontario Breast Screening Program (OBSP) is conducted under the auspices of Cancer Care Ontario and has operated since July 1, 1990, to deliver a population-based breast screening program. Since the program started, screening has been provided in regional cancer centers that have dedicated breast screening centers that all offer two-view mammography and a CBE by a nurse. In addition to providing a CBE, nurses assist with recruitment, education, and navigation of women with abnormal screens through the assessment process. Beginning in 1995, OBSP began offering screening at affiliated centers located within established mammography facilities in hospitals or independent health facilities. After April 1998, centers that affiliated with OBSP were encouraged, but not required, to offer CBE.

The OBSP provides a unique opportunity to evaluate the influence of nurses on compliance with screening recommendations. Although the usual screening interval in the OBSP is biennial, annual screening is provided to women at a higher risk of breast cancer, and, therefore, compliance with both recommended intervals can be evaluated. This study examined a cohort of women 50 to 69 years of age who attended an organized screening program from January 1, 2002, to December 31, 2002. The purpose of this study was to compare compliance with annual and biennial screening recommendations among women who attend regional cancer centers or affiliated centers with nurses, with women who attend affiliated centers without nurses.

Materials and Methods

Study Population

A cohort of women ages 50 to 69 years who were screened through OBSP between January 1, 2002, and December 31, 2002, was identified from information routinely collected by an integrated client management system and followed up at least 30 months after their screening examination. Women who participate in the OBSP must be residents of Ontario, have no history of breast cancer or augmentation mammoplasty, and have no acute breast symptoms. From the start of the program on July 1, 1990, screening mammography and CBE by a nurse has been provided through nine regional cancer centers. Beginning in 1995, OBSP began offering breast screening within affiliated centers in hospitals or independent health facilities. Although all of the affiliated centers offer screening mammography, as of April 1998, not all provided CBE. Therefore, during the study period, 66 (71.7%) of the 92 OBSP centers had a nurse and 26 (28.3%) did not. A complete description of the details of the operation of the OBSP has been published (24, 25).

Women who attend OBSP for their initial screen are not sent personal invitation letters. The program is promoted to women primarily by their family physicians and through media campaigns, community presentations, and public health units. Therefore, women either self-refer or are referred by their family physicians for their initial screen. After 2 years, recall letters are sent to eligible women 2 months before they are due for their next screening visit. Women who are considered to be at high risk of breast cancer because they have a family history of breast or ovarian cancer or a personal history of ovarian cancer or benign breast conditions such as lobular carcinoma *in situ*, benign phyllodes tumor, radial scar, atypical ductal hyperplasia, or atypical lobular hyperplasia are screened annually. Women are also recommended to be screened at 1-year intervals if their breast density is ≥75% and/or based on their assessment results or if requested by the screening radiologist or referring physician.

There were 143 nurses in the OBSP during the study period. Nurses in the OBSP are awarded certification for the performance of CBE following instructional training and the completion of a written examination. To maintain their OBSP certification, nurses are regularly assessed through an OBSP Quality Assurance Program that consists of practice reviews of documentation of findings and CBE performance and by doing a minimum of 500 CBEs per year. At regional cancer centers and affiliated centers that employ nurses, the primary role of the nurses is to perform CBE at both initial and subsequent screens. The CBE takes 8 to 10 min on average and is done while the woman is in the upright, supine, and lateral oblique positions by using the clock method of examination and includes palpation of nodes in the axillae and the supraclavicular and infraclavicular areas as well as visual observation of the entire breast. In addition, the nurse explains the components of the screening visit to the woman and provides information about the mammography and CBE procedures and breast self-exam if requested; the nurse also advises the woman of the automatic recall system for her next screening visit, of the result letter that will be sent to her and her physician, and of the potential of an assessment referral. The nurse also answers any questions, provides breast health teaching, and brings normal breast findings to the woman's attention. The nurse makes an independent decision about whether the woman has an abnormality that requires further assessment based on standardized referral criteria for visual and palpable findings. The nurse also informs the woman of any clinical abnormality at the time of the visit and refers the woman to her family physician for assessment.

At affiliated centers that do not employ nurses, women do not receive a CBE. At these centers, a medical radiation technologist who has special training and has received accreditation with the Canadian Association of Radiologist's Mammography Accreditation Program does a visual inspection of both breasts with the woman in an upright position and documents any visual findings

as well as physical findings identified by the woman. These findings are available to the radiologist when he or she reads the mammogram. All women who attend affiliated centers without nurses are encouraged to visit their family physician to receive a CBE for routine screening irrespective of the findings documented by the technologist. The technologist also provides information about the screening process to the woman but does not provide any breast health teaching.

Between January 1, 2002, and December 31, 2002, the OBSP provided screens to 162,870 women who were 50 to 69 years of age and monitored follow-up for those with an abnormal screen. We excluded 985 women because they had been seen by a nurse at a center that no longer employed nurses, 4,085 women because they had not been seen by a nurse at a center that employed nurses, and 12 women because they attended a recently affiliated center that had very few screens in the study period. The final sample size for the analyses included 157,788 women. The study was approved by the Health Sciences 1 Research Ethics Board at the University of Toronto.

Definition of Compliance Measures

All women screened between January 1, 2002, and December 31, 2002, were followed up prospectively until their next OBSP screening visit, breast cancer diagnosis, death, or the end of the study (June 30, 2005). For women diagnosed with a screen-detected or interval breast cancer, pathologic confirmation was obtained from regional staff through the recall process and through linkages with the Ontario Cancer Registry. Case ascertainment in the Ontario Cancer Registry was estimated to be 98% complete for breast cancer (26). Identification of vital status of participants was accomplished by a record linkage with the Ontario Registrar General's mortality file. As registration of death is a legal process in Ontario, this ensures that all deaths are registered (27). All of the linkages were accomplished using a computerized probabilistic record linkage system known as Auto Match (28).

Women who were diagnosed with breast cancer or died before their next recommended screening examination were considered ineligible for returning to screening and were excluded from this analysis (Table 1). Compliance with an annual screening recommendation refers to the percentage of eligible women returning for their subsequent screen within 18 months of their 2002 screening examination. Compliance with a biennial screening recommendation refers to the percentage of eligible women returning for their subsequent screen within 30 months of their 2002 screening examination. In addition to identifying late and noncompliers, it is important to determine if women are returning earlier than their recommended 24 months, as this would reflect overscreening of women

Table 1. Comparison of facility characteristics and percentage of women returning for a subsequent screen with an annual or biennial screening recommendation by type of screening center

	Regional cancer centers with nurses	Affiliated centers with nurses	Affiliated centers without nurses
Screening centers, n (%)	9 (9.8)	57 (61.9)	26 (28.3)
No. of years in operation,* mean (SD)†	11.6 (0.55)	3.9 (2.14)	2.2 (1.21)
Annual screening volume,* mean (SD)‡	6,729 (2,549)	1,346 (1,148)	1,179 (1,053)
Annual recommendation			
Women screened (n)	15,750	22,030	9,591
Women eligible to return (n)§	15,595	21,852	9,535
Percentage returned at ≤18 mo, n (%)‖	13,883 (89.0)	18,747 (85.8)	7,594 (79.6)
Biennial recommendation			
Women screened (n)	44,255	49,699	16,462
Women eligible to return (n)§	43,598	49,006	16,259
Percentage returned at ≤30 mo, n (%)‖	37,232 (85.4)	41,037 (83.7)	12,223 (75.2)
Percentage returned at ≥18 to ≤30 mo, n (%)‖	36,797 (84.4)	39,651 (80.9)	10,441 (64.2)

*Total years of operation within the OBSP from July 1, 1990, to December 31, 2002. The annual volume includes screens from January 1, 2002, to December 31, 2002.

†P < 0.001, for regional cancer centers with nurses versus affiliated centers without nurses and for affiliated centers with nurses versus affiliated centers without nurses.

‡P < 0.0001, for regional cancer centers with nurses versus affiliated centers without nurses.

§Women who were diagnosed with breast cancer or died before their next recommended screening examination were excluded.

‖P < 0.0001, for regional cancer centers with nurses versus affiliated centers without nurses and for affiliated centers with nurses versus affiliated centers without nurses.

at average risk. Therefore, we also examined "timely biennial" to determine if women are returning within 6 months either before or after their recommended interval. "Timely biennial" compliance was defined as the percentage of women returning for their subsequent screen at or after 18 months and within 30 months of their 2002 screening examination. "Timely annual" compliance was not examined, as none of the women with an annual screening recommendation returned earlier than 10 months for their subsequent screen.

Definition of Screening Center Characteristics

OBSP screening services were delivered through nine regional cancer centers and 83 affiliated centers. The regional cancer centers provide administration, coordination, education, and training to the affiliated centers in their region. Affiliated centers provide screening mammography services through hospitals or independent health facilities. The total number of years of operation refers to the number of years the center operated as part of the OBSP from July 1, 1990, to December 31, 2002. The volume of screens was calculated as the number of screens done at the center between January 1, 2002, and December 31, 2002.

Definition of Risk Factors

Information on risk factors for breast cancer was based on self-reported data collected during the woman's 2002 screening appointment through a personal interview with the nurse or technologist. Women with one or more first-degree relatives with breast cancer were classified as having a positive family history. Women were defined as current users of hormone therapy if they had taken hormone therapy in 2002. Mammographic density was recorded by the radiologist as either <75% or ≥75% when recording breast findings from the mammogram.

Definition of Screening Visit Characteristics

Age at screen was defined as the age of the woman at her 2002 OBSP screening examination. Screen result was defined as normal for women not referred for further assessment or abnormal for women referred for further assessment. In this study, an abnormal result was considered a false-positive result, as only women referred for further assessment without a breast cancer diagnosis before their next recommended screening examination were included. False-positive results were further classified by modality of referral as mammogram (i.e., referral based on an abnormal mammogram regardless of the CBE result), CBE (i.e., referral based on an abnormal CBE regardless of the mammogram result), and mammogram and CBE (i.e., referral based on an abnormal mammogram and an abnormal CBE). Screen number was defined as the total number of screening examinations a woman had in the OBSP from July 1, 1990, to December 31, 2002. Screening recommendation refers to annual for women who were recommended to return in 1 year and biennial for women who were recommended to return in 2 years in 2002.

Statistical Analysis

Compliance measures were calculated by type of screening center (regional cancer center with nurse, affiliated center with nurse, and affiliated center without nurse). Compliance with an annual or biennial screening recommendation was calculated as the number of women who had returned for a subsequent OBSP screen in the selected time period (≤18 months for annual, ≤30 months for biennial, and ≥18 and ≤30 months for timely biennial) from those eligible (i.e., without breast cancer and alive before their next recommended screening examination) for returning to screening. Compliance measures and characteristics of the women were compared between centers with and without nurses using a Pearson χ^2 test for categorical variables and the Student's t test for continuous, approximately normally distributed variables. Statistical analyses were conducted using SAS version 9.1 (29), and all P values are two-sided. A P value of <0.05 was considered statistically significant.

We used mixed-effect logistic regression models to examine compliance (i.e., the probability of returning for a subsequent screen) among women with an annual or biennial screening recommendation (30). The models included explanatory variables relating to the characteristics of the woman screened and of the screening center she attended. Characteristics of the woman included in the model were her age at screen (50-54, 55-59, 60-64, and 65-69 years), screen number (first, second, third, and greater), screen result (normal, abnormal mammogram, abnormal CBE, abnormal mammogram and CBE), family history of breast cancer (none, one or more first-degree relatives), current hormone therapy use (yes, no), and breast density (<75%, ≥75%). Characteristics of the screening center included the number of years in operation with OBSP (continuous) and the log of the annual volume of screens for 2002 (continuous). To control for clustering of women being screened by the same nurse and of nurses working within the same screening centers, models included random effects for each center and for each nurse. Models including interactions between center type and screen type (first or subsequent) and between center type and screen results (normal or false positive) identified screen type and screen result as potential effect modifiers. Consequently, stratified analyses were also presented. Odds ratios (OR) and 95% confidence intervals (95% CI) were computed for compliance with annual and biennial screening for regional cancer centers and affiliated centers with nurses relative to affiliated centers without nurses. Model fitting and statistical inference was done using penalized quasi-likelihood estimation (31) with the glmmPQL function in the software package R (32).

Results

Compared with the affiliated centers, the regional cancer centers had offered breast screening as part of the OBSP for the longest average number of years and had

a higher annual volume of screens (Table 1). Of the women eligible for annual screening, a significantly greater percentage of women returned within 18 months at regional cancer centers (89.0%) and affiliated centers with nurses (85.8%) compared with affiliated centers without nurses (79.6%). Women with a biennial screening recommendation were also significantly more likely to return within 30 months and within 18 to 30 months if they were screened at regional cancer centers or affiliated centers with nurses compared with affiliated centers without nurses.

Of the 155,845 women screened during the study and eligible to return, 38% were screened at regional cancer centers, 45.5% were screened at affiliated centers with nurses, and 16.5% were screened at affiliated centers

without nurses (Table 2). Compared with women who were screened at affiliated centers without nurses, those screened at regional cancer centers or affiliated centers with nurses were significantly more likely to receive a biennial screening recommendation, to be 60 to 69 years of age at screening, have had a previous screen, have a first-degree relative with breast cancer, be currently using hormone therapy, and have a lower breast density than women attending affiliated centers without nurses. Women screened at affiliated centers with nurses were significantly more likely to have an abnormal screen compared with affiliated centers without nurses.

Using the mixed-effects logistic regression models to account for characteristics of the woman, nurse, and center,

Table 2. Comparison of screening characteristics and risk factors among women by type of screening center

	Regional cancer centers with nurses, n (%)	Affiliated centers with nurses, n (%)	Affiliated centers without nurses, n (%)
Eligible to return*	59,193 (38.0)	70,858 (45.5)	25,794 (16.5)
Screen recommendation[†]			
Annual	15,595 (26.4)	21,852 (30.8)	9,535 (37.0)
Biennial	43,598 (73.6)	49,006 (69.2)	16,259 (63.0)
Screen age (y)[†]			
50-59	32,409 (54.8)	41,870 (59.1)	16,005 (62.1)
60-69	26,784 (45.2)	28,988 (40.9)	9,789 (37.9)
Screen result[‡]			
False positive	4,720 (8.0)	7,905 (11.2)	2,021 (7.8)
Normal	54,473 (92.0)	62,953 (88.8)	23,773 (92.2)
Screen number[†]			
First	10,884 (18.4)	27,744 (39.1)	14,335 (55.6)
Second	10,291 (17.4)	20,527 (29.0)	7,469 (29.0)
≥Third	38,018 (64.2)	22,587 (31.9)	3,990 (15.4)
First-degree relative with breast cancer[§]			
Yes	9,768 (16.5)	11,386 (16.1)	2,984 (11.6)
No	49,425 (83.5)	59,472 (83.9)	22,810 (88.4)
Current use of hormone therapy[‖]			
Yes	22,393 (38.0)	27,376 (38.9)	7,960 (32.1)
No	36,574 (62.0)	42,941 (61.1)	16,853 (67.9)
Unknown	226	541	981
Breast density[†]			
≥75%	3,934 (6.6)	7,394 (10.4)	3,158 (12.2)
<75%	55,259 (93.4)	63,461 (89.6)	22,636 (87.8)
Unknown		3	

*Women who were diagnosed with breast cancer or died before their next screening examination were excluded.

[†]$P < 0.0001$, for regional cancer centers with nurses versus affiliated centers without nurses and for affiliated centers with nurses versus affiliated centers without nurses.

[‡]$P < 0.0001$, for affiliated centers with nurses versus affiliated centers without nurses.

[§]$P < 0.05$, for regional cancer centers with nurses versus affiliated centers without nurses and for affiliated centers with nurses versus affiliated centers without nurses.

[‖]$P < 0.001$, for regional cancer centers with nurses versus affiliated centers without nurses and for affiliated centers with nurses versus affiliated centers without nurses.

Table 3. Adjusted ORs and 95% CIs for compliance with annual and biennial screening recommendations

Variable*	Screening recommendation		
	Annual (≤18 mo) OR (95% CI)	Biennial (≤30 mo) OR (95% CI)	Timely biennial (≥18 to ≤30 mo) OR (95% CI)
Center type			
Affiliated centers without nurses	1.00	1.00	1.00
Affiliated centers with nurses	1.75 (1.38-2.22)[†]	1.66 (1.33-2.06)[†]	2.30 (1.86-2.83)[†]
Regional cancer centers with nurses	1.96 (1.07-3.58)[‡]	1.62 (0.93-2.83)	2.28 (1.34-3.89)[§]
Years of operation	0.96 (0.91-1.02)	0.96 (0.91-1.01)	0.99 (0.94-1.04)
Volume of annual screens	1.04 (0.91-1.19)	1.08 (0.96-1.22)	1.00 (0.89-1.12)
Screen age (y)			
50-54	1.00	1.00	1.00
55-59	1.00 (0.93-1.07)	0.91 (0.87-0.96)[†]	0.95 (0.91-0.99)[‡]
60-64	1.10 (1.01-1.19)[‡]	0.98 (0.93-1.02)	1.02 (0.97-1.07)
65-69	1.11 (1.01-1.21)[‡]	0.97 (0.92-1.03)	1.02 (0.97-1.07)
Screen number			
First	1.00	1.00	1.00
Second	1.51 (1.41-1.63)[†]	1.54 (1.48-1.61)[†]	1.42 (1.36-1.48)[†]
≥Third	2.36 (2.19-2.55)[†]	2.50 (2.38-2.62)[†]	2.09 (2.00-2.19)[†]
Screen result			
Normal	1.00	1.00	1.00
False-positive mammogram	0.52 (0.48-0.56)[†]	0.69 (0.64-0.74)[†]	0.56 (0.52-0.60)[†]
False-positive CBE	0.64 (0.55-0.73)[†]	0.74 (0.66-0.84)[†]	0.60 (0.54-0.67)[†]
False-positive mammogram and CBE	0.64 (0.50-0.80)[†]	0.72 (0.56-0.93)[‡]	0.55 (0.43-0.69)[†]
First-degree relatives with breast cancer			
No	1.00	1.00	1.00
Yes	1.14 (1.08-1.22)[†]	1.18 (1.10-1.27)[†]	0.90 (0.84-0.95)[†]
Hormone therapy use			
No	1.00	1.00	1.00
Yes	1.22 (1.15-1.29)[†]	1.14 (1.10-1.18)[†]	1.05 (1.01-1.08)[§]
Breast density			
<75%	1.00	NA	NA
≥75%	1.19 (1.11-1.27)[†]	NA	NA

Abbreviation: NA, not applicable.

*All variables listed in the table were included in the mixed-effects logistic regression model simultaneously. Models included random effects for each center ($n = 92$) and nurse ($n = 143$). The years of operation were included as a linear variable in the model. The log of annual screens for 2002 was examined to normalize distribution. All P values are two-sided (penalized quasi-likelihood estimation).

[†] $P < 0.001$.

[‡] $P < 0.05$.

[§] $P < 0.01$.

women screened at regional cancer centers (OR, 1.96; 95% CI, 1.07-3.58) or affiliated centers with nurses (OR, 1.75; 95% CI, 1.38-2.22) were significantly more likely to comply with an annual screening recommendation than women screened at affiliated centers without nurses (Table 3). A similar result was found for biennial screening, as women screened at regional cancer centers (OR, 1.62; 95% CI, 0.93-2.83) or affiliated centers (OR, 1.66; 95% CI, 1.33-2.06) with nurses were more likely to return than women attending affiliates without nurses, although the association was significant only for affiliated centers with

nurses. Women screened at regional cancer centers with nurses were also significantly more likely to make a timely return to a biennial screening recommendation (OR, 2.28; 95% CI, 1.34-3.89), as were those screened at affiliated centers with nurses (OR, 2.30; 95% CI, 1.86-2.83) compared with women screened at affiliated centers without nurses.

Risk factors for breast cancer influenced compliance with screening recommendations, as women with a breast density of ≥75% compared with those with a lower breast density were significantly more likely to comply with an annual screening recommendation (Table 3). In

addition, compliance with annual and biennial screening was significantly higher for women with a first-degree relative with breast cancer compared with women without a family history and also for women who were current users of hormone therapy compared with those who were not current users. Screening characteristics also influenced compliance, as women who had three or more screens compared with women with only one screen were significantly more likely to comply with an annual or biennial screening recommendation. Having a false-positive result, especially if the referred abnormality was mammographic, decreased a woman's chance of complying with an annual or biennial screening recommendation.

A stratified analysis by screen type and screen result was conducted (Table 4). Women undergoing an initial or subsequent OBSP screen had a greater chance of complying with their annual (OR, 1.69; 95% CI, 1.31-2.18 and OR, 1.93; 95% CI, 1.49-2.51, respectively) and biennial (OR, 1.59; 95% CI, 1.28-1.98 and OR, 1.93; 95% CI,

1.51-2.45, respectively) screening recommendation if they were screened at affiliated centers with nurses compared with affiliated centers without nurses (Table 4). A similar result was found for women screened at regional cancer centers, although the association was not significant. In addition, compliance was significantly higher for a timely return to a biennial screening recommendation for women who had a first or subsequent screen at regional cancer centers and affiliated centers with nurses compared with affiliated centers without nurses. All women had a greater chance of compliance with their annual screening recommendations if they were screened at affiliated centers with nurses versus centers without nurses, regardless of whether they had a normal screen (OR, 1.82; 95% CI, 1.44-2.31) or a false-positive screen (OR, 1.50; 95% CI, 1.06-2.11). Similar results were found for compliance with a biennial screening recommendation among women with a normal screen (OR, 1.68; 95% CI, 1.34-2.10) and among women with a false-positive screen (OR, 1.43;

Table 4. Adjusted ORs and 95% CIs for compliance with annual and biennial screening recommendations by type of screening center stratified by screen type and screen result

Screening center	Screening recommendation					
	Annual (≤18 mo)		Biennial (≤30 mo)		Timely biennial (≥18 to ≤30 mo)	
	% Return (n)	OR (95% CI)	% Return (n)	OR (95% CI)	% Return (n)	OR (95% CI)
First screen						
Affiliated centers without nurses	75.0 (4,751)	1.00	71.3 (9,584)	1.00	61.6 (9,584)	1.00
Affiliated centers with nurses	79.3 (7,010)	1.69 (1.31-2.18)*	78.9 (20,734)	1.59 (1.28-1.98)*	76.4 (20,734)	2.14 (1.73-2.64)*
Regional cancer centers with nurses	77.8 (1,920)	1.78 (0.93-3.42)	76.3 (8,964)	1.48 (0.84-2.60)	75.0 (8,964)	2.00 (1.17-3.42)†
Subsequent screen						
Affiliated centers without nurses	84.2 (4,784)	1.00	80.7 (6,675)	1.00	68.0 (6,675)	1.00
Affiliated centers with nurses	88.8 (14,842)	1.93 (1.49-2.51)*	87.3 (28,272)	1.93 (1.51-2.45)*	84.2 (28,272)	2.69 (2.12-3.41)*
Regional cancer centers with nurses	90.6 (13,675)	1.46 (0.79-2.70)	87.7 (34,634)	1.45 (0.82-2.58)	86.8 (34,634)	2.12 (1.20-3.75)†
Normal screen result						
Affiliated centers without nurses	81.6 (8,051)	1.00	75.3 (15,722)	1.00	64.8 (15,722)	1.00
Affiliated centers with nurses	87.6 (17,868)	1.82 (1.44-2.31)*	84.1 (45,085)	1.68 (1.34-2.10)*	81.6 (45,085)	2.30 (1.85-2.85)*
Regional cancer centers with nurses	90.6 (13,795)	2.45 (1.35-4.44)‡	85.9 (40,678)	1.68 (0.94-3.00)	85.0 (40,678)	2.28 (1.31-3.97)‡
False-positive result						
Affiliated centers without nurses	69.1 (1,484)	1.00	71.1 (537)	1.00	46.9 (537)	1.00
Affiliated centers with nurses	77.7 (3,984)	1.50 (1.06-2.11)†	79.7 (3,921)	1.43 (1.06-1.94)†	73.0 (3,921)	2.71 (2.02-3.62) *
Regional cancer centers with nurses	77.1 (1,800)	0.79 (0.34-1.83)	78.9 (2,920)	1.11 (0.59-2.07)	75.8 (2,920)	2.62 (1.41-4.87)‡

NOTE: Mixed-effects logistic regression models included random effects for each center (n = 92) and nurse (n = 143). ORs adjusted for years of operation, log of annual screens, age at screen, first-degree family history of breast cancer, and hormone therapy use. Analyses for annual recommendation also adjusted for breast density. Analyses for initial and subsequent screen also adjusted by screen result and analyses for normal and abnormal screen result also adjusted by screen type.

*P < 0.001.
†P < 0.05.
‡P < 0.01.

95% CI, 1.06-1.94). Compliance with timely return for biennial screening was also significantly higher for women seen at regional cancer centers or affiliated centers with nurses compared with women seen at centers without nurses, regardless of screening result.

Discussion

Overall, this study revealed that educational activities provided by the nurses played an important role in influencing women to comply with their screening recommendations, as centers with nurses had statistically significantly higher compliance rates than centers without nurses. Women were nearly twice as likely to comply with an annual screening recommendation if they had attended either a regional cancer center or an affiliated center with nurses compared with affiliated centers without nurses. A similar trend was seen for biennial screening, with women more than twice as likely to comply with the recommended screening interval if they attended centers with nurses compared with centers without nurses.

Although no other screening program has examined the influence of nurses on compliance with screening recommendations, the Canadian National Breast Screening Study, a randomized trial that included nurses providing CBE, examined their influence on compliance by a mailed questionnaire (21). The study found that women who reported receiving "very courteous" or "competent" CBEs were more likely to comply with breast screening than women who did not report receiving "courteous" or "competent" CBEs (21). In addition, studies have shown that women who ever had a CBE or a recent CBE are more likely to comply with mammography screening (14-16).

Our finding of a higher compliance rate in the centers with nurses may be explained by the additional time nurses spend with the women during the screening visit, educating her about the screening process and providing breast health teaching. Previous research has suggested that knowledge about and belief in the benefits of breast screening is positively associated with compliance with screening (14, 19). This finding concurs with our recent study on a random sample of compliers and noncompliers initially screened in 2002 within the OBSP. This study found that knowledge of breast screening recommendations and effectiveness of screening tests and beliefs about breast cancer risk were more likely to influence compliance with screening among women who attended centers with nurses compared with women who attended centers without nurses (33). We hypothesized that nurses may reinforce a woman's knowledge or beliefs about breast cancer and screening and consequently increase the effect this information has on their compliance with biennial breast screening (33).

Many studies have shown that women who have had a prior mammogram are more likely to return to screening within breast screening programs (5, 6, 11, 13). Our study also found that the odds of complying with biennial and annual screening recommendations increases as the number of previous screens increases, being two to two and a half times greater for women on their third screen compared with their initial screen. We also found that regardless of whether the woman was attending the OBSP for her initial or subsequent screen, she was more likely to comply with annual or biennial screening recommendations if seen in centers with nurses compared with centers without nurses. A woman's experience during her initial screen has been found to influence her participation in subsequent screening. Previous research has shown that women who expressed dissatisfaction or negative views about their initial screen were more likely not to reattend (22, 23). It is possible that women have a more positive initial screening experience in centers with nurses as they receive more individualized care and time with the nurses.

Compliance with screening recommendations was decreased by more than half in women with a false-positive result in our study. Other studies have also found a false-positive mammogram to be associated with a lower compliance with rescreening (6, 9, 11, 34), including one conducted within the OBSP (35). However, a recent meta-analysis reported that although Canadian women were less likely to return for routine screening after a false-positive mammogram, women in the United States were more likely and European women were equally likely to return (36). The divergent results may reflect differences in mammography procedures, such as specified screening intervals, use of double reading of mammograms, use of automatic invites for next screening, or whether the country has a national screening program. This meta-analysis also reported that women who received false-positive results have higher anxiety about breast cancer or screening and were generally more likely to conduct breast self-examinations than women without false-positive results, and the authors speculated that the women who receive an abnormal mammogram may therefore have less trust in the accuracy and benefit of mammography (36). This may explain our study result, as we found that women with a false-positive screen attending centers with nurses were significantly more likely to comply with biennial screening compared with centers without nurses. As nurses educate women about the benefits of screening irrespective of their screening result, this may increase a woman's chance of complying if she receives a false-positive result. In addition, nurses in the OBSP assist with the navigation of women with an abnormal mammogram through the assessment process and this would also increase the woman's chance of returning. A recent study from the OBSP found that screening centers with an integrated assessment program improved reattendance of women with a false-positive screen (35).

Compliance with annual screening has not been examined extensively in breast screening programs. One study reported fewer than half of the women initially screened complying within 18 months to the Screening Mammography Program of British Columbia, where annual screening was recommended for all women (11). However, this

study was conducted within 1 year of the start of the screening program and included only women who had an initial screen. Another study of rescreening in low-income women, through a survey in four participating sites of the National Breast and Cervical Cancer Early Detection Program, reported that 72.4% were rescreened within 18 months (5). Our study found a slightly higher proportion of women returning within 18 months with an annual screening recommendation, with the greatest proportion of women returning within regional cancer centers and affiliated centers with nurses compared with centers without nurses (89.0% and 85.8%, respectively, versus 79%). However, our results reflect compliance with annual screening by women who are either at a higher risk of breast cancer or recommended to return within 1 year by their physician. Studies have shown that a physician recommendation has been identified as one of the most important factors in whether a woman reattends and complies with mammography screening (5, 15, 18-20) and women with breast cancer risk factors, such as a family history and current use of hormone therapy, are also more likely to return (5, 14, 15). As has been shown in previous research, our study also found that women with a first-degree relative with breast cancer or currently taking hormone therapy were more likely to comply with screening recommendations.

The present study had several strengths; in particular, it is one of few studies that have examined the influence of nurses on compliance with screening recommendations and have examined compliance with annual screening. In addition, this study used routine data collected on women who were all part of the same screening program, which is an objective measure of behavior about compliance with screening recommendations compared with the use of self-reported screening history. Although self-reported mammography data have been found to be accurate for determining whether a woman has had a mammogram, self-reported data are less accurate in determining the time since last mammogram (37) and women tend to underestimate the time since their last mammogram (38, 39).

This study had several limitations. First, it was not possible to determine whether women who did not comply with their screening recommendation accessed mammography facilities outside of the OBSP. Although this is an important consideration in analyzing factors associated with compliance with screening recommendation, the aim of the present study was to examine compliance within an organized screening program that offers the essential components of recruitment and automatic recall. In addition, a recent study conducted within the OBSP found that only 5.4% of noncompliant women indicated that they returned for a second screen outside of the OBSP, and this percentage did not differ by type of screening center (33). Second, as some of the characteristics of the women, such as family history and hormone therapy use, were based on self-report, misclassification may have occurred. Although accuracy of self-reports of breast cancer in first-degree relatives or hormone therapy use is relatively high and ascertainment of this information was similar between groups, any misclassification would have been nondifferential and would have resulted in attenuating our estimates (40, 41). Finally, the findings of this study may have limited generalizability to other populations. This study examined the influence of nurses on compliance within a population-based screening program, and, thus, the results may not be generalized to clinical practice. In addition, because the study included women ages 50 to 69 years, the results of this study should not be interpreted as supporting the influence of nurses on compliance among women outside this age range.

A high compliance rate for screening recommendations in breast screening programs is important in achieving a reduction in breast cancer mortality. Overall, we found that women screened at centers with nurses were more likely to comply with screening recommendations than women screened at centers without nurses regardless of whether the woman was attending the OBSP for her initial or subsequent screen or whether she had a previous normal or positive screen result. Our finding of a higher compliance rate in the centers with nurses may be explained by the additional time nurses spend educating the women about the screening process and providing breast health teaching. Therefore, breast screening programs should consider methods of integrating educational activities as provided by the nurses to improve compliance with screening.

Disclosure of Potential Conflicts of Interest

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