Missed or Delayed Diagnosis

Identifying Women at Risk of Delayed Breast Cancer Diagnosis

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Relatively little is known about the nature of missed and delayed diagnoses.[1,2] Such cases are difficult for clinicians and researchers to identify in the course of medical care and become apparent only when the true diagnosis presents. Of particular concern are delays related to the diagnosis of breast cancer, which account for many malpractice claims.[3,4] Moreover, patient-related delays in the diagnosis of breast cancer may contribute to increased morbidity and mortality because of the presence of more advanced disease at diagnosis and postponed treatment.[5–8]

The literature offers conflicting information about the factors that increase a woman's risk of experiencing a delayed breast cancer diagnosis. In a study of closed malpractice claims, no patient characteristics were associated with a diagnostic error.[9] In other studies, researchers found that racial and socioeconomic disparities may contribute to delays in breast cancer diagnosis and treatment.[8,10–13] In a chart review study of 102 cases drawn from breast cancer patients referred to a Boston-based cancer center, we found that process of care failures were common among women at increased risk of a delayed diagnosis and that patients from racial and language minorities, with lower educational attainment, and on Medicaid were more likely to experience process failures.[14] In the present study, we used the larger cohort of women treated at the same cancer center to explore further the relationship between delayed breast cancer diagnosis and patient-specific factors that may affect women's receipt of timely breast care.

Methods

STUDY SUBJECTS

The study population was drawn from women who obtained care at a Boston-based comprehensive cancer center. Subjects were identified using the Clinical Research Information System (CRIS). CRIS was created in 1997 as a longitudinal registry of breast cancer patients at Dana-Farber Cancer Institute. The CRIS data repository represents up to 90% of all patients with an initial oncology consultation at this cancer center. The data-

Article-at-a-Glance

Background: Delays in breast cancer diagnosis contribute to increased morbidity and mortality. Factors related to the occurrence of delayed diagnosis have not been well studied.

Methods: A retrospective cohort study of 5,464 women newly diagnosed with breast cancer from 1999 through 2006 was conducted at a comprehensive cancer center in Boston. A delayed diagnosis was defined as an interval greater than 90 days between the patient's first breast-related problem that prompted seeking of medical care and the breast cancer diagnosis based on biopsy.

Results: 938 (17%) patients had a delayed breast cancer diagnosis. Non-white race or Hispanic ethnicity (adjusted odds ratio [OR] = 1.46, 95% confidence interval [CI] = 1.13–1.90), living more than 26 miles from Boston (OR 1.46, 95% CI = 1.25–1.71), and initial presentation with a lump found by the patient herself (OR = 2.89, 95% CI = 2.36–3.55) or another breast symptom (OR = 0.25, 95% CI = 1.79–2.82) compared to an abnormal mammogram were significantly associated with a delay in diagnosis. In contrast, the odds of a delay were lower for women who were older than 18–39 years of age and for women living with two or more household members (OR = 0.72, 95% CI = 0.59–0.87). The likelihood of experiencing a delayed breast cancer diagnosis increased markedly if a woman had multiple risk factors, with a nearly 12-fold increase among women with five or more risk factors (OR = 11.96, 95% CI = 6.32–22.61).

Conclusions: Younger age, minority race, and self-identification of breast symptom affect the likelihood of delayed breast cancer diagnosis. Awareness of these issues could help focus efforts to develop algorithms that identify women at risk for a delay and build programs that facilitate their timely access to care.

base contains information on presenting breast problem derived from a self-administered questionnaire, as well as demographic data obtained from registration records and clinical information abstracted from medical records.

Between January 1, 1999, and December 31, 2006, 5,834 female breast cancer patients were enrolled in the CRIS database after providing written informed consent. We excluded patients from the present analysis if their reported date of initial breast problem was missing (n = 258) or was more than seven days after the date of breast cancer diagnosis (n = 111), which we assumed was an error of recall; one additional subject did not have a recorded date of birth and was not included. Thus, the final sample consisted of 5,464 patients. The study protocol was approved in advanced by the Institutional Review Board of Dana-Farber/Harvard Cancer Center.

Data Collection

The CRIS new patient questionnaire asked patients to identify the first event that prompted them to seek medical attention for a breast problem related to their diagnosis of breast cancer, including an abnormal mammogram, a lump found by a clinician, a lump found by oneself, or some other breast symptom (that is, axillary mass, inverted nipple, bloody discharge from nipple, breast pain or discomfort, or other symptom), and the date of the first event. Additional details concerning type of breast cancer—invasive versus in situ, date of diagnosis, and stage at pathological diagnosis—also were recorded on the basis of pathology results obtained at the time of diagnosis (regardless of whether the diagnosis was made at the cancer center or elsewhere) and nurse case abstraction. The date of diagnosis was the date of the surgery or biopsy that confirmed the diagnosis of cancer.

In addition to factors that were shown to be related to delayed breast cancer diagnoses in previous studies, we examined novel factors that we hypothesized to pose practical obstacles to care, such as geographic location and living alone. Basic demographic, as well as primary insurance data, were drawn from the hospital registration system. We relied on responses to the CRIS questionnaire to create a race/ethnicity variable, grouped as non-Hispanic white and non-white or Hispanic. Primary language was categorized as English and non-English. Zip code of residence was used to calculate proximity to Boston; the distance was dichotomized at 26 miles to approximate residence within or beyond a major interstate that bounds the city.

Health insurance status was assessed at the time the patient completed the new patient questionnaire (that is, when she became a patient at the cancer center and enrolled in the CRIS

longitudinal study). Although a patient's health insurance status could have changed since the diagnosis date, close to 60% of patients were surveyed within one month of diagnosis. We combined medical insurance type into private/Medicare or self-pay/Medicaid. Insurance status was included as an indicator of socioeconomic status, with patients who were on Medicaid, received free care, or paid for their own health care costs representing a disadvantaged group. Patients with private or Medicare insurance were used as the reference group. The frequency of diagnostic delay was similar for patients with either private insurance or Medicare (data not shown).

Other patient information was obtained from the CRIS new patient questionnaire. We treated number of household members as a categorical variable (0, 1, $\geq$ 2). Educational level was grouped as college/graduate school and vocational/high/grade school. Women who were employed full or part time or were retired comprised one group; those who were homemakers, disabled, or unemployed comprised the other group. We classified smoking status as current, past, or never smoker and categorized current alcohol use as none, < 1, 1–4, or $\geq$ 5 drinks per week. Functional status was based on five options (fully active, restricted in strenuous activity, can walk and care for self, needs some help caring for self, cannot care for self); in the analysis, the latter three levels were combined into one "limited activity" category. We calculated the Charlson comorbidity index[15] and evaluated it as a categorical variable (0, 1, 2, $\geq$ 3).

Data Analysis

The outcome of interest was the time interval between the patient's reported date of the first breast-related problem that prompted the seeking of medical care and the date of breast cancer diagnosis based on biopsy. We defined a delayed diagnosis as a period of more than 90 days between initial breast problem and disease diagnosis. The 90-day cutoff is a standard approach that has been used in most of the published studies, including our previous research on this topic,[14] that have examined delayed breast cancer diagnosis.[5,6,8,9,16–19] In bivariate analysis, we compared demographic and clinical characteristics of patients with and without a delayed breast cancer diagnosis, using the chi-square statistic.

Variables that were associated at a two-sided p < .20 level in the bivariate analysis were entered into a multivariable logistic regression model. Because education level was found to be associated with process of care failures in our previous study,[14] education was included in the multivariable model, even though it did not meet the inclusion criterion in the bivariate analysis. Stepwise backward elimination was employed to identify factors

that were independently related to a delayed breast cancer diagnosis in the multivariable regression analysis; covariates with a *p* < .20 were retained in the final model. We did not include two-way interactions in the multivariable model because our interest was in the main effects of the variables evaluated in the study. In addition, we had no a priori expectation of a multiplicative interaction between any two variables. Moreover, despite the large sample size, there was insufficient power to detect statistically significant two-way interactions in the final multivariable regression model.

We also analyzed the relationship between diagnostic delay and number of risk factors present, hypothesizing that this relationship was nonlinear. We used those variables that were included in the final multivariable logistic regression model to create a new categorical variable with mutually exclusive levels on the basis of the number of risk factors a patient had. No other variables were included in this logistic regression model.

Finally, we stratified analyses by initial presentation (that is, self-identified lump/other breast symptom versus abnormal mammogram/clinician-detected lump) to assess whether the impact of the identified risk factors was more pronounced for those patients who recognized the first sign of cancer themselves and needed to initiate care. All analyses used SAS software version 9.1 (SAS, Cary, North Carolina).

Results

PATIENT CHARACTERISTICS

Patients' characteristics are shown in Table 1 (pages 571–572). The mean age of subjects at first breast problem presentation was 52.5 (standard deviation [SD], ± 11.8) years. More than 90% of the patients were non-Hispanic white; 3% of the patients were black, and 2% were Asian. In addition, nearly all the patients spoke English as their primary language. The study population was of relatively high socioeconomic status; 76.2% had at least some college education. In addition, 96.2% had private medical insurance or Medicare. About half of the subjects (53.8%) lived within 26 miles of Boston.

DISEASE PRESENTATION AND STAGE

Among the patients whose presenting breast problem was known, an abnormal mammogram (35.8%) or a lump found by the patient herself (33.2%) were the most common reasons for initially seeking medical care; about 10% of the women had a clinician-identified lump, and about 20% experienced some other type of breast symptom (Table 1). The interval between the presenting breast problem and the diagnosis of breast cancer ranged from 0 to 1,095 days, with a median of 27 days (in-terquartile range, 12–61 days). Some 938 patients (17.2%) experienced a delay of more than 90 days between first reported breast problem and disease diagnosis (Figure 1, page 573). For 504 patients (9.2%), the interval was more than six months, and for 268 (4.9%) it was more than one year. Among the 4,254 patients for whom information on stage at diagnosis was available, the women whose diagnosis was delayed by more than 90 days had a statistically significant greater frequency of stage III or IV disease (22.7%) than those whose diagnosis was not delayed (12.8%; *p* < .001, Table 1). There was no difference between the two groups with respect to the type of breast cancer (data not shown).

FACTORS ASSOCIATED WITH DELAYED DIAGNOSIS

As shown in Table 1, women with a delayed breast cancer diagnosis were more likely than those who did not experience a delay to be younger (mean age, 49.2 versus 53.2 years, respectively), non-white or Hispanic (10.5% versus 8.2%), self-pay or have Medicaid (5.4% versus 3.4%), live alone (50.0% versus 44.3%), and live more than 26 miles from Boston (55.1% versus 44.4%). In addition, a greater proportion of women with a delay initially presented with a lump they found themselves (49.2%) or with another breast symptom (25.2%) than did women without a delay (29.7% and 20.3%, respectively). There was no statistically significant difference with respect to primary language or education level (Table 1).

Because language is a potential barrier to care among Hispanics, the effect of primary language was examined among the 174 patients of Hispanic ethnicity in the study population. However, primary language was not associated with delay in these patients (data not shown).

On the basis of the bivariate analysis (Table 1), the following variables were associated with a delayed diagnosis with a *p* < .20 and were entered into a multivariable logistic regression model: age group, race/ethnicity, insurance type, household members, distance from Boston, and initial presentation. Education level also was included in the multivariable analysis because education was associated with process of care failures in our previous study.[14] The results from the final multivariable model of those variables that remained associated with delay, at a *p* < .20, are presented in Table 2 (page 573); the sample size for the final multivariable model was 4,693. A delayed breast cancer diagnosis of more than 90 days was associated with non-white race or Hispanic ethnicity (odds ratio [OR] = 1.46, 95% confidence interval [CI] = 1.13–1.90), living more than 26 miles from Boston (OR = 1.46, 95% CI = 1.25–1.71), and initial presentation with a lump found by the patient herself (OR = 2.89, 95% CI =

Table 1. Patient Characteristics, by Absence or Presence of Delay in Breast Cancer Diagnosis

Characteristics	Total (*N* = 5,464) No. (%)	No Delay (*n* = 4,526) No. (%)	Delay (*n* = 938) No. (%)	*P* Value*
Age Group (years)				< .001
18–39	718 (13.1)	509 (11.2)	209 (22.3)	
40–49	1,742 (31.9)	1,413 (31.2)	329 (35.1)	
50–59	1,670 (30.6)	1,433 (31.7)	237 (25.3)	
60–69	844 (15.4)	737 (16.3)	107 (11.4)	
70–95	490 (9.0)	434 (9.6)	56 (6.0)	
Race/Ethnicity				.03
White and non-Hispanic	4,984 (91.4)	4,146 (91.8)	838 (89.5)	
Non-white or Hispanic	470 (8.6)	372 (8.2)	98 (10.5)	
Missing	10	8	2	
Primary Language				.36
English	4,278 (97.1)	3,564 (97.2)	714 (96.6)	
Non-English	126 (2.9)	101 (2.8)	25 (3.4)	
Missing	1,060	861	199	
Insurance Type				.008
Private/Medicare	4,843 (96.2)	3,999 (96.6)	844 (94.6)	
Self-pay/Medicaid	190 (3.8)	142 (3.4)	48 (5.4)	
Missing	431	385	46	
Education Level				.58
College/graduate school	3,595 (76.1)	2,951 (76.3)	644 (75.4)	
Vocational/high/grade school	1,126 (23.9)	916 (23.7)	210 (24.6)	
Missing	743	659	84	
Current Employment Status				.35
Employed/retired	3,692 (77.4)	3,035 (77.6)	657 (76.1)	
Homemaker/disabled/unemployed	1,081 (22.6)	875 (22.4)	206 (23.9)	
Missing	691	616	75	
Household Members				.006
0	2,476 (45.3)	2,007 (44.3)	469 (50.0)	
1	1,494 (27.3)	1,266 (28.0)	228 (24.3)	
≥ 2	1,494 (27.3)	1,253 (27.7)	241 (25.7)	
Distance from Boston				< .001
< 26 miles	2,888 (53.8)	2,472 (55.6)	416 (44.9)	
> 26 miles	2,483 (46.2)	1,972 (44.4)	511 (55.1)	
Missing	93	82	11	
Current Alcohol Use (drinks/week)				.21
None	1,468 (28.7)	1,193 (28.3)	275 (30.4)	
< 1	1,556 (30.4)	1,269 (30.1)	287 (31.7)	
1–4	1,283 (25.0)	1,073 (25.4)	210 (23.2)	
≥ 5	816 (15.9)	684 (16.2)	132 (14.6)	
Missing	341	307	34	
Smoking Status				.75
Never smoker	2,532 (49.1)	2,095 (49.3)	437 (48.1)	
Past smoker	2,209 (42.8)	1,816 (42.7)	393 (43.3)	
Current smoker	418 (8.1)	340 (8.0)	78 (8.6)	
Missing	305	275	30	
Functional Status				.70
Fully active	3,558 (74.9)	2,923 (75.1)	635 (73.8)	
Restricted activity	935 (19.7)	758 (19.5)	177 (20.6)	
Limited activity	258 (5.4)	209 (5.4)	49 (5.7)	
Missing	713	636	77	
Previous Cancer				.88
None	5,028 (92.0)	4,161 (91.9)	867 (92.4)	
Breast cancer	152 (2.8)	127 (2.8)	25 (2.7)	
Other cancer	284 (5.2)	238 (5.3)	46 (4.9)	
Charlson Comorbidity Score				.45
0	3,702 (70.3)	3,046 (70.1)	656 (71.4)	
1	800 (15.2)	672 (15.5)	128 (13.9)	
2	395 (7.5)	331 (7.6)	64 (7.0)	
≥ 3	368 (7.0)	297 (6.8)	71 (7.7)	
Missing	199	180	19	

Table 1. Patient Characteristics, by Absence or Presence of Delay in Breast Cancer Diagnosis (continued)			
Characteristics	Total (*N* = 5,464) No. (%)	No Delay (*n* = 4,526) No. (%)	Delay (*n* = 938) No. (%)	*P* Value*
Initial presentation				< .001
Abnormal mammogram	1,760 (35.8)	1,591 (39.5)	169 (19.2)	
Lump found by clinician	483 (9.8)	426 (10.6)	57 (6.5)	
Lump found by self	1,631 (33.2)	1,197 (29.7)	434 (49.2)	
Other symptom	1,039 (21.1)	817 (20.3)	222 (25.2)	
Missing	551	495	56	
Stage at Diagnosis				< .001
0	438 (10.3)	360 (10.3)	78 (10.2)	
I	1,560 (36.7)	1,328 (36.1)	232 (30.3)	
II	1,634 (38.4)	1,353 (38.1)	281 (36.7)	
III	455 (10.7)	335 (9.6)	120 (15.7)	
IV	167 (3.9)	113 (3.2)	54 (7.1)	
Missing	1,210	1,037	173	

* *P* values based on chi-square tests.

2.36–3.55) or with another symptom (OR = 2.25, 95% CI = 1.79–2.82) compared to an abnormal mammogram.

The odds of a delayed diagnosis were lower for women who were older at symptom presentation, with the inverse association increasing from OR = 0.68 (95% CI = 0.55–0.85) for those 40–49 years of age to OR = 0.47 (95% CI = 0.33–0.68) for those 70–95 years of age, compared with women 18–39 years of age and for those who lived with two or more household members (OR = 0.72, 95% CI = 0.59–0.87). Education level was included in the logistic regression model, but it had a weak effect on delayed diagnosis (OR = 1.16, 95% CI = 0.96–1.39). Although insurance status was associated with a delayed diagnosis in the unadjusted, bivariate analysis (Table 1), it was no longer significantly associated after we adjusted for other factors (OR = 1.20, 95% CI = 0.82–1.76, *p* = .34). None of the OR estimates for the other variables was affected by the inclusion of insurance status in the model, so we did not retain this variable in the final model.

MULTIPLE RISK FACTORS

To examine the relationship between diagnostic delay and number of factors present, we dichotomized each of the independent risk factors identified in the final multivariable model on the basis of the effect estimates obtained (Table 2): age < 40 years of age (versus 40+), non-white or Hispanic race/ethnicity (versus white and non-Hispanic), vocational/high/grade school education (versus college/graduate school), no household members (versus 1+), distance > 26 miles from Boston (versus < 26 miles), and initial presentation with a lump found by self or other breast symptom (versus abnormal mammogram or lump found by clinician). An age of 40 years and older was selected as the risk factor level for the multiple risk factor analysis based on

the odds ratio estimates in the multivariable regression model (Table 2). The odds of a delayed diagnosis for women in each age category of 40 years and older (40–49, 50–59, 60–69, 70–95) were consistent and significantly higher than for women who were younger than 40, supporting our decision to include these patients in a single group.

The odds of experiencing a delayed breast cancer diagnosis increased markedly if a woman had multiple risk factors for delay (Appendix 1, available in online article). Compared with patients with no risk factor, those with any three factors were three times as likely to have more than a 90-day delay (OR = 3.04, 95% CI = 2.17–4.27). A nearly 12-fold increased risk of a delay was found among women with five or more risk factors (OR = 11.96, 95% CI = 6.32–22.61).

PATIENT-IDENTIFIED BREAST SYMPTOMS

In a subgroup analysis (Appendix 2, available in online article), the effects of distance from Boston and of education level were evident only in the multivariable model for women with a self-identified lump or other breast symptom (OR = 1.66 and OR = 1.24, respectively) in contrast to women with an abnormal mammogram or clinician-detected lump as their presenting event (OR = 1.08 and OR = 1.02, respectively). The inverse association with older age was stronger in the former group. In addition, the number of risk factors had a stronger relationship with delayed diagnoses in the subgroup of women with self-identified breast lumps or other breast symptoms (OR = 5.45, 95% CI = 2.94–10.10, for four or more factors) than in the subgroup of women with abnormal mammograms or clinician-detected lumps (OR = 1.25, 95% CI = 0.28–5.66, for four or more factors). Of note, the median interval between initial breast prob-

Distribution of Diagnostic Delay Interval
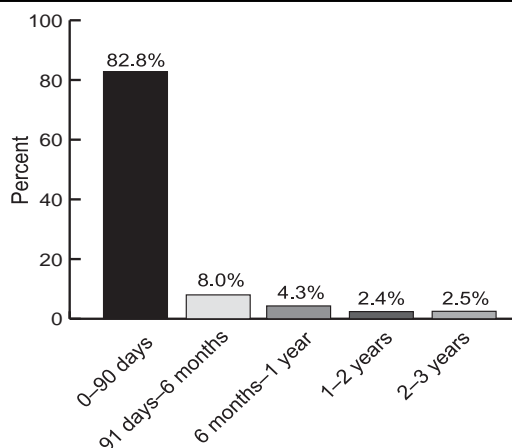
Figure 1. *The percentage of breast cancer patients in the study population is shown by length of delay between reported date of first breast problem and date of breast cancer diagnosis.*

lem and diagnosis was 34 days (interquartile range, 14–89 days) among women whose breast problem was self-identified, compared with a median interval of 22 days (interquartile range, 9–43 days) among women with medically detected disease (*p* < .001, Wilcoxon test).

Discussion

In this study of 5,464 breast cancer patients seen at a Boston-based comprehensive cancer center, we found that 17% of women had a delay of at least 90 days between identification of a breast problem and cancer diagnosis. Those at greater risk of a delay were women under 40 years old, non-white or Hispanic women, women who lived alone, and those who resided more than 26 miles outside the city of Boston. Compared with women who presented initially with an abnormal mammogram or a clinician-detected breast lump, women who found a lump themselves or who had another breast symptom such as an axillary mass, an inverted nipple, bloody discharge, or breast pain also were at increased risk. Importantly, the risk of a delayed diagnosis increased dramatically with the number of risk factors present. Women with three of these risk factors were 3 times as likely to experience a delay, and those with at least five factors were almost 12 times as likely. Taken together, these findings highlight the increased likelihood of delayed breast cancer diagnosis among at-risk women.

Our research corroborates previous studies that found delays in the identification and diagnosis of breast cancer more often among non-white women,[8,10–13,20,21] even after adjustment for sociodemographic factors such as social class and education.[13,20]

Table 2. Multivariable Logistic Regression Model of Factors Associated with Delayed Diagnosis*		
Variables	**OR (95% CI)**	***P* Value**
Age Group (years)		
18–39	1.0	—
40–49	0.68 (0.55–0.85)	.001
50–59	0.51 (0.40–0.65)	< .001
60–69	0.49 (0.37–0.66)	< .001
70–95	0.47 (0.33–0.68)	< .001
Race/Ethnicity		
White and non-Hispanic	1.0	—
Non-white or Hispanic	1.46 (1.13–1.90)	.004
Education Level		
College/graduate school	1.0	—
Vocational/high/grade school	1.16 (0.96–1.39)	.13
Household Members		
0	1.0	—
1	0.88 (0.72–1.06)	.18
≥ 2	0.72 (0.59–0.87)	.001
Distance from Boston		
< 26 miles	1.0	—
> 26 miles	1.46 (1.25–1.71)	< .001
Initial Presentation		
Abnormal mammogram	1.0	—
Lump found by clinician	1.18 (0.85–1.64)	.32
Lump found by self	2.89 (2.36–3.55)	< .001
Other symptom	2.25 (1.79–2.82)	< .001

* Final multivariable model, based on stepwise backward elimination, of those covariates with a *p* < .20. OR, odds ratio; CI, confidence interval.

Fewer years of education also has been identified as a potential risk factor for delayed diagnosis,[8,10,16] presumably related to health literacy.[14] In addition, our finding that increasing age at symptom presentation was associated with decreasing risk of delayed breast cancer diagnosis is consistent with other studies.[8,10,16,22]

The present study adds to our previous understanding of delayed breast cancer diagnosis in several ways. First, in contrast to previous studies that distinguished "patient delay" (time from symptom discovery to first medical consultation) or "medical delay" (time from initial medical consultation to diagnosis or start of treatment), the present study examined the entire interval from initial presentation to diagnosis among women with either self-identified symptoms or medically detected disease. The studies of patient delay were conducted among women with symptomatic disease and excluded women with tumors detected on screening.[6,10,16,17,19,20] Although investigations of medical delays may have included screen-detected as well as symptomatic breast cancer cases, those studies were primarily record-based.[8–10,13,22] To our knowledge, this cohort is the largest sample of patients reported to date for investigation of delayed breast cancer diagno-

sis. Although the study population was ascertained across a seven-year period, there were no major changes in the way that health care was delivered in the community. In the late 1990s, radiology departments took more responsibility for notifying patients of abnormal results and arranging follow-up testing. Practices have been relatively stable since that time and unlikely to affect our results.

Second, our study investigated a wider range of risk factors than previous research, which in general focused on patient attributes alone such as race, language, ethnicity, and literacy. We identified other obstacles to care that adversely affected time to diagnosis, including distance to a major city and living alone. Although both factors might reflect ability to access a comprehensive cancer center, living farther from a tertiary center could represent patients with more advanced disease being willing to travel farther for care; that the association was evident only among women with self-detected disease would support such an alternative explanation. Third, we discovered that having multiple risk factors dramatically increased the likelihood of delay. Finally, the impact of the identified risk factors was stronger among women with a self-identified breast lump or other breast symptom, further underlining the magnified risk among those who identify their disease independently of their health care providers.[18,21]

Thus far, improvements in care have focused largely on accurate communication and follow-up of abnormal test results, education of providers about the need to pursue findings on exam that are not corroborated on mammography, and greater awareness of breast cancer. Novel, targeted strategies may be needed to reduce patient-related delays following initial symptom presentation, which may be associated with worse clinical outcomes.[5–7] Patient navigator programs have been shown to be effective in increasing access by disadvantaged and underserved groups to mammography screening and follow-up of abnormal findings.[23–26] Through the Patient Navigation Research Program, the National Cancer Institute is supporting the development and testing of patient navigation programs for cancer patients in underserved populations.[27] Implementation of community-based interventions and development of racially and culturally appropriate messaging also could work toward reducing barriers to medical care.[28–30] Addressing the practical and financial burdens related to travel from distant locations may be warranted.

Our research also indicates a need to create tools that can alert providers to patients who are at greatest risk for a delayed breast cancer diagnosis following initial detection. Given the observed cumulative nature of the risk, identification and counseling of at-risk women should be incorporated into standard clinical prac-

tice by primary care clinicians. Most of the identified risk factors are readily available in administrative systems and could be used to flag high-risk patients.[31] Outreach strategies should emphasize the importance of obtaining the results of completed mammograms, completing follow-up studies at recommended intervals,[29,32,33] and, in particular, initiating care for self-identified breast symptoms.[34] In addition, more efficient and effective care coordination between primary care and specialty providers would increase ease of scheduling and timely availability of new patient referrals. At our own institution, we have reached out to primary care groups to discuss these issues and are considering mechanisms to identify vulnerable patients using electronic systems.

LIMITATIONS

Several limitations of this study should be noted. First, information on initial presentation was based on patient self-report. Although those data were collected in a more systematic and complete way than could be achieved on the basis of abstraction of medical records, some misclassification in time to diagnosis and symptom discovery may have occurred. We would, however, expect such misclassification to be nondifferential with respect to the factors examined, which would have led to an underestimate of their associations with delayed diagnosis. Second, we did not have information concerning the process leading up to the patient's breast cancer diagnosis. Thus, we do not know at which specific point the delay occurred. In our chart-review study of this study population,[14] patient-related and provider-related process failures both figured prominently. Finally, the study patients were drawn from a single referral-based cancer center and likely are not representative of women with breast cancer in the general population in the United States, particularly with respect to the low number of patients from racial minorities.

Conclusion

We found that factors related to age, race, and self-identification of symptoms, as well as residential proximity and household members, affected the likelihood of delayed breast cancer diagnosis in this population of patients seen at a comprehensive cancer center. Women with multiple factors were at highest risk of a delay. These findings underscore the role of racial disparities, care-seeking behavior, and access to care in the timely diagnosis of breast cancer. Tools that would enable primary care providers to identify the high-risk patients could help providers to counsel these patients during office visits and to manage high-risk members of providers' panels between appointments. Targeted

education, outreach, and follow-up interventions could serve to ensure that these vulnerable patients receive timely breast cancer screening, facilitated access for breast-related symptoms, and "safety net" interventions designed to assist patients with breast symptoms or abnormal mammograms to complete recommended tests, consultations, and treatments. **J**

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Appendix 1. Association Between Number of Factors from Multivariable Logistic Regression Model and Delayed Diagnosis

Appendix 2. Multivariable Logistic Regression Model of Factors Associated with Delayed Diagnosis, by Initial Presentation

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Appendix 1. Association Between Number of Factors from Multivariable Logistic Regression Model* and Delayed Diagnosis			
	No. Delay/No Delay	**OR (95% CI)**	**_P_ Value**
No factors[†]	45/423	1.0	—
Any 1 factor	134/1,081	1.17 (0.82–1.66)	.40
Any 2 factors	279/1,338	1.96 (1.40–2.74)	< .001
Any 3 factors	247/763	3.04 (2.17–4.27)	< .001
Any 4 factors	114/219	4.89 (3.34–7.17)	< .001
Any 5 or all 6 factors	28/22	11.96 (6.32–22.61)	< .001

* Risk factors were based on the variables included in the final multivariable logistic regression model (Table 2): age (< 40 versus 40+), race/ethnicity (non-white or Hispanic versus white and non-Hispanic), education level (vocational/high/grade school versus college/graduate school), household members (0 versus 1+), distance from Boston (> 26 versus < 26 miles), and initial presentation (lump found by self or other breast symptom versus abnormal mammogram or lump found by clinician). OR, odds ratio; CI, confidence interval.

[†] A categorical variable was created with six mutually exclusive levels on the basis of the number of risk factors present; those with none of the six risk factors were defined as the reference category.

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Appendix 2. Multivariable Logistic Regression Model of Factors Associated with Delayed Diagnosis, by Initial Presentation*				
	Abnormal Mammogram/ Clinician-Detected Lump		**Self-Detected Lump/ Other Breast Symptom**	
Variables	**OR (95% CI)**	***P* Value**	**OR (95% CI)**	***P* Value**
Age Group (years)				
18–39	1.0	—	1.0	—
40–49	0.77 (0.44–1.36)	.37	0.65 (0.51–0.83)	< .001
50–59	0.47 (0.27–0.85)	.01	0.52 (0.40–0.68)	< .001
60–69	0.68 (0.37–1.25)	.22	0.38 (0.26–0.55)	< .001
70–95	0.63 (0.32–1.24)	.18	0.38 (0.24–0.61)	< .001
Race/Ethnicity				
White and non-Hispanic	1.0	—	1.0	—
Non-white or Hispanic	1.67 (1.03–2.69)	.04	1.44 (1.06–1.97)	.02
Education Level				
College/graduate school	1.0	—	1.0	—
Vocational/high/grade school	1.02 (0.73–1.43)	.91	1.24 (0.99–1.55)	.06
Household Members				
0	1.0	—	1.0	—
1	0.69 (0.49–0.98)	.04	1.00 (0.79–1.27)	.97
≥ 2	0.68 (0.47–0.98)	.04	0.75 (0.60–0.94)	.01
Distance from Boston				
< 26 miles	1.0	—	1.0	—
> 26 miles	1.08 (0.81–1.44)	.61	1.66 (1.37–2.00)	< .001

* All variables in the table were included in the respective multivariable models. OR, odds ratio; CI, confidence interval.