5-Year Mammography Rates and Associated Factors for Older Women

R. Van Harrison, Ph.D.[1]
Nancy K. Janz, Ph.D.[2]
Robert A. Wolfe, Ph.D.[3]
Philip J. Tedeschi, Ph.D.[3]
Xuelin Huang, Ph.D.[4]
Laurence F. McMahon, Jr., M.D., M.P.H.[5]

[1] Department of Medical Education, University of Michigan, Ann Arbor, Michigan.

[2] Department of Health Behavior and Health Education, University of Michigan, Ann Arbor, Michigan.

[3] Deparment of Biostatistics, University of Michigan, Ann Arbor, Michigan.

[4] Department of Biostatistics, University of Michigan, Ann Arbor, Michigan.

[5] Departments of Health Management and Policy and Internal Medicine, University of Michigan, Ann Arbor, Michigan.

Supported by Grant RO1 CA62246 from the National Cancer Institute.

Approved by the University of Michigan Medical School Institutional Review Board for Human Subject Research (#1995-0343).

Barbara Threatt, M.D., was a consultant regarding mammography practice and interactions with older women.

Dr. Huang's current address: Department of Biostatistics, M.D. Anderson Cancer Center, Houston, Texas.

Address for reprints: R. Van Harrison, Ph.D., Department of Medical Education, University of Michigan, G-1105 Towsley Center, Ann Arbor, MI 48109-0201; Fax: (734) 936-1641; E-mail: rvh@umich.edu.

Received July 8, 2002; revision received October 4, 2002; accepted October 10, 2002.

BACKGROUND. Major national interventions occurred in the early and mid-1990s to increase mammography screening rates among older women. The current study examined mammography utilization by older women during this period. Relation between mammography utilization and demographic measures and health care-related factors also were examined.

METHODS. A cross-sectional design examined variations in mammography during the 5 years between 1993 to 1997 in a representative sample of 10,000 female Medicare beneficiaries in Michigan age ≥ 65 years in 1993. Medicare and census data were used. Separate analyses were performed for having undergone any mammogram and, for the 5680 women who had undergone a mammogram, the number of mammograms. Relations were examined between mammography utilization and 15 demographic variables (e.g., age and African-American race) and health care-related variables (e.g., inpatient admissions and number of physicians involved in care).

RESULTS. In the 5 years 43% of older women had no evidence of having undergone a mammogram. Those with any mammogram averaged 2.8 mammograms. Meaningful independent predictors of both having undergone a mammogram and having more than one mammogram were more physicians involved in care, fewer inpatient admissions, and younger age. Having undergone a mammogram also was found to be associated with seeing an obstetrician/gynecologist.

CONCLUSIONS. Even with screening mammography as a covered benefit and after several national informational campaigns, the current study found that in 5 years, 60% of older women either had not undergone a mammogram or had undergone only 1. Intervention efforts should emphasize screening based on functional status, not age. This message should be targeted to physicians as well as to older women without claims for recent mammograms and who are likely to be in good health.
***Cancer* 2003;97:1147–55.** *© 2003 American Cancer Society.*
DOI 10.1002/cncr.11172

KEYWORDS: breast carcinoma screening, Medicare, older/aged women, patient compliance, guideline adherence, demographic factors.

Breast carcinoma is the second most frequently occurring cancer in women and the second leading cause of their death due to cancer.[1,2] Incidence increases with age;[1] approximately 59% of breast carcinoma deaths are reported to occur among women age ≥ 65 years.[3] The most effective approach to reducing breast carcinoma mortality is early detection and treatment through routine mammography. Although questions have been raised concerning the methodologic rigor of some studies of breast carcinoma screening,[4] the U.S. Preventive Services Task Force (USPSTF) recently reaffirmed its recommendation for screening mammography every 1–2 years for women ages 50–69 years. The USPSTF also expanded the age ranges

to include women ages 40–49 years and women age ≥ 70 years (a group that reportedly faces a higher absolute risk of breast carcinoma) whose life expectancy is not compromised by comorbid disease.[5]

Major national efforts have been underway since the early 1990s to increase screening mammography among older women. Medicare made screening mammography every 2 years a covered benefit in 1991 and annual screening a covered benefit in 1999. During the first years of Medicare coverage, the majority of older women were unaware that screening was a benefit.[6] By 1995, the Health Care Financing Administration (HCFA) was working with approximately 50 major organizations to publicize mammography and its coverage.[7] Self-reported 2-year mammography screening rates for women age ≥ 65 years increased from 43% in 1990 to 64% in 1998.[1] Although this increase is appreciable, the rate still is below national recommendations for screening older women.[5,8,9]

The reported increase in mammography among older women raises several methodologic and substantive questions:

1) What is the actual mammography rate among older women? The majority of large studies of older women depend on self-reported mammography behavior.
2) What are the rates for older women having undergone any mammogram compared with the rates for older women undergoing mammograms on a routine basis? Although this difference has been addressed in some studies, to our knowledge, little attention has focused on older women.[10,11]
3) What factors currently are associated with older women having mammograms? Factors previously found to be related to lower mammography rates in some studies include: age,[7] being African American,[1,7] living in rural areas,[12,13] having less education,[12,14] lower income,[12] poorer health,[14,15] and lack of a specific recommendation from a physician.[12,13,16–18] Many of the interventions in the early to mid-1990s tried to address several of these factors, for example, Medicare coverage to make screening affordable for most women and information campaigns to address the lack of knowledge. The extent to which these factors continue to be important is unclear.

The current study had 3 interrelated aims to address these questions: 1) to determine actual mammography utilization in a representative sample of older women across the 5 years between 1993 to 1997; 2) to examine separately a) having undergone any mammogram and b) having undergone > 1 mammogram; and 3) to examine the relation between mammography utilization during this period and demographic and selected health-related factors previously found to be associated with mammography use.

MATERIALS AND METHODS

Design and Sample

The study utilized a cross-sectional design to examine relations between mammography and other factors in a representative sample of older women. The annual Medicare beneficiary files for Michigan for each of the years 1993 through 1997 were merged to identify a population of approximately 550,000 women who were age ≥ 65 years in 1993 and living continuously in Michigan from 1993 to 1997. An initial sample frame of 40,000 Medicare identification numbers was selected randomly. A Medicare cross-reference file identified individuals with more than one identification number across years to link their files. The few individuals enrolled in Medicare managed programs during this period were identified and excluded. From the remaining 38,347 women, a random sample of 10,000 women was identified for analysis.

Measures

Outcome measures

Two mammography measures were created: whether a woman (age ≥ 70 years by 1997) ever had "any mammogram" in the preceding 5-year period (no or yes), and if yes, "the number of mammograms." Medicare claims identified screening mammograms (Healthcare Common Procedure Coding System [HCPCS] code 76092) and diagnostic mammograms (HCPCS codes 76090 and 76091). Like other investigators,[7] we included both screening (two-view) and diagnostic (typically six-view) mammograms because providers did not uniformly apply the codes for mammography in the early 1990s.

Predictors

Fifteen measures were used to predict mammography behavior. Medicare beneficiary files provided individual's demographic characteristics of "age," "race" (recoded as African American or non-African American), and zip code, which was recoded as "urban or rural county" in Michigan based on Medicare's classification. Some additional demographic characteristics of individuals were approximated using census data at the zip code level. Census data from 1990 were obtained.[19] An individual's zip code was used to link the mean values for a zip code to an individual. From the various census measures available, we selected "mean education level" for adults of the individual's race, "mean household income" for the same race and age ≥ 65 years, and "mean percent of individuals below

poverty level" for women of the same race and age ≥ 65 years. This use of population-based mean values has been shown to provide results similar to person-specific results for aggregate analyses.[20]

Medicare claim files for Michigan were used to create measures regarding the individual's health. Three types of medical conditions were identified that were likely to affect mammography use: "significant malignancies," "severe mental problems," and "specified physical conditions" (e.g., breast removal) The International Classification of Diseases—Clinical Modification (9th revision) (ICD-9-CM) codes and HCPCS codes used to classify women as having these conditions are available from the authors.

Medicare claim files also were used to create measures of the individual's interaction with the health care system. "Number of inpatient admissions" was calculated using claims for inpatient services, with claims ≥ 3 days apart counted as different admissions. "Number of visits to physicians" was calculated using both 1) claims for inpatient care (claims ≥ 3 days apart counted as different visits) and 2) claims for outpatient care (claims ≥ 2 days apart counted as different visits). "Number of physicians involved in care" was calculated as the number of different physician billing numbers on the individual's claims. "Number of visits to primary care physicians" (PCPs) and "number of PCPs involved in care" were similarly calculated when the specialty code on the claim was for a PCP. PCPs include general practitioners, family physicians, general internists, obstetrician/gynecologists (Ob/Gyn), and geriatricians. Specialty codes on claims also were used to construct a measure of "types of physicians seen" with the categories of no PCP seen, PCPs other than Ob/Gyn seen, and an Ob/Gyn seen.

Analyses

Standard descriptive statistics (e.g., means and distributions) were used to characterize the population. Pearson product-moment correlations examined the strength of associations between variables. Multiple linear regression models examined the independent and combined effects of predictors on mammography rates in physician's practices. For a regression model we report both the unstandardized coefficient ("b") for the original scale of a predictor and the standardized transformation of that coefficient ("beta").[21] Beta weights estimate the effect on the dependent variable for a change of one standard deviation on a predictor while holding the other predictors constant. Beta weights allow direct comparison of the magnitude of relations that different predictors have with the dependent variable. The correlation coefficient equals the beta weight for linear regressions having only one predictor.

Log transformations were used for measures with skewed distributions (e.g., average income across zip codes and number of visits to physicians). For the measure "if any mammogram, the number of mammograms," the relatively few instances of more than six mammograms were recoded to six. The results note when transformed measures were used in analyses.

Logistic regression typically would be performed for a dicotomous dependent variable such as "any mammogram (no or yes)." Multiple linear regression is reported herein to provide results that can be directly compared with results for the continuous measure "if mammogram, the number of mammograms." Logistic regression and multiple regression produce similar results for the range of mammography rates observed in the current study. We performed parallel logistic regression analyses for "any mammogram" to confirm that the results are consistent with the reported multiple linear regression results.

A sample size of 10,000 has the power to detect extremely weak relationships (e.g., 90% power to detect a correlation of 0.04 as significant at the 0.05 level). A correlation of 0.04 reflects a 0.16% shared variance, which is too small to be of practical consequence for most purposes. Although we report significance levels, we considered results of meaningful magnitude to be correlations ≥0.20 (≥4% shared variance) and for multiple regressions, beta values ≥ 0.15 (variance of approximately ≥2% in the dependent variable is associated with a predictor, independent of the effects of all other predictors).

RESULTS

Sample Characteristics

Characteristics of the sample are presented in Table 1 for all the measures in the study. As shown in the last row, 43% of women age ≥ 65 years in 1993 did not undergo a mammogram within the subsequent 5-year study period. Of these women, 9% had a condition that would affect mammography directly (e.g., cancer, major mental problem, or physical problem), leaving 34% with no mammogram and no claim for a condition likely to make screening less appropriate. Among the 57% of women who had undergone ≥ 1 mammograms, the mean was 2.8 mammograms (standard deviation [SD] = 1.6)

Relations between Predictors and Mammography Measures

Table 2 presents the correlations and multiple linear regression coefficients for each of the characteristics

TABLE 1
Women's Demographic Characteristics, Health-Related Status, and Mammography Status (n = 10,000)

Measure	Distribution					Mean or %	SD
Demographic characteristics							
Age in 1993 (yrs)	65–69	70–74	75–79	80–84	≥ 85		
	54%	21%	14%	8%	3%	69.9	6.7
African American	No	Yes					
	91%	9%				9%	—[a]
Urban	Rural	Urban					
	21%	79%				79%	—[a]
Mean education in zip code[b]	≤ 2.4	2.5–3.4	3.5–4.4	≥ 4.5			
	1%	50%	42%	7%		3.6	0.6
Mean household income in zip code[c]	< $15,000	$15,000–19,999	$20,000–29,999	$30,000–39,000	≥ $40,000		
	10%	29%	45%	11%	5%	$23,600	$8,960
Mean percent below poverty level in zip code[d]	≤ 4%	5–9%	10–14%	15–19%	≥ 20%		
	21%	35%	22%	10%	12%	11%	0.1
Health-related status							
Any cancer diagnosis 1993–1997	No	Yes					
	81%	19%				19%	—[a]
Any psychiatric diagnosis 1993–1997	No	Yes					
	92%	8%				8%	—[a]
Any physical diagnosis affecting mammography 1993–1997	No	Yes					
	98%	2%				2%	—[a]
No. of inpatient admissions 1993–1997	0	1–2	3–4	5–8	≥ 9		
	48%	29%	11%	8%	4%	1.8	3.2
No. of visits to physicians 1993–1997	0–9	10–29	30–59	60–99	≥ 100		
	10%	25%	32%	21%	12%	52	41
No. of physicians involved in care 1993–1997	0–4	5–14	15–29	30–59	≥ 60		
	7%	20%	32%	32%	9%	30	22
No. of visits to PCPs	0	1–4	5–14	15–29	≥ 30		
	6%	12%	27%	29%	25%	21	20
No. of PCPs involved in care 1993–1997	0	1–4	5–9	10–14	≥ 15		
	6%	30%	43%	15%	6%	6.5	4.7
Type of physicians seen 1993–1997	No PCP		PCPs other than Ob/Gyn		Ob/Gyn		
	6%		78%		16%	—[a]	—[a]
Mammography status							
No. of mammograms 1993–1997	0	1	2–3	4–5	≥ 6		
	43%	16%	23%	13%	5%	1.7	2.0

SD: standard deviation; PCP: primary care physician; Ob/Gyn: obstetrician/gynecologist.

[a] For categoric variables see distribution at left.

[b] Education of adults of the individual's race. Mean of 3.6 = a little more than high school. (3 = high school graduate, 4 = some college but no degree).

[c] Household income of the same race and age ≥ 65 years.

[d] Percent below poverty level for women of the same race and age ≥ 65 years.

of women in predicting having undergone any mammogram and, if any, the number of mammograms. A correlation shows the magnitude of association between an individual predictor and the mammography measures without taking into account associations between predictors. A regression coefficient reflects a predictor's independent association with mammography when other predictors are held constant.

First examining general associations, 6 predictors were correlated ≥ 0.20 with 1 or both of the mammography measures. Both having undergone any mammogram and the number of mammograms were higher for women who had a higher number of visits to physicians, had a higher number of physicians involved in care, and a had a higher number of PCPs involved in care. In addition, having undergone any mammogram was more likely for women who were younger, those who had a higher number of visits to PCPs, and those who had seen a PCP (particularly an Ob/Gyn).

TABLE 2
Correlation and Multiple Regression of Predictors with Mammography Measures

	Mammogram? (No/Yes) (n = 10,000)				If yes, no. of mammograms[a] (n = 5680)			
		Regression coefficient				Regression coefficient		
Predictor	Correlation Coefficient r[b]	Beta[c,d] (standardized)	B (unstandardized)	$P <$	Correlation Coefficient r[e]	Beta[c] (standardized)	B (unstandardized)	$P <$
Demographic characteristics								
Age	**−0.29**	**−0.29**	**−0.03**	0.001	−0.17	**−0.18**	**−0.05**	0.001
African American	−0.02	0.01	0.01	N/S	−0.07	−0.03	−0.19	0.05
Urban	0.00	−0.05	−0.06	0.001	−0.01	−0.07	−0.28	0.001
Mean education, zip code	0.07	0.08	0.08	0.001	0.10	0.09	0.25	0.001
Mean household income, zip code (log)	0.17	−0.08	−0.11	0.001	0.15	−0.04	−0.20	N/S
Mean % below poverty, zip code	−0.13	−0.03	−0.19	N/S	−0.14	−0.03	−0.72	N/S
Health-related status								
Any cancer diagnosis	0.14	0.05	0.06	0.001	0.08	0.02	0.06	N/S
Any psychiatric diagnosis	−0.07	−0.07	−0.13	0.001	−0.03	−0.05	−0.32	0.001
Any physical dx affect mamm.	0.10	0.06	0.24	0.001	0.06	0.05	0.52	0.001
No. of inpatient admissions (log)	−0.04	**−0.29**	**−0.18**	0.001	−0.04	**−0.32**	**−0.72**	0.001
No. of visits to physicians (log)	**0.28**	−0.11	−0.05	0.001	**0.25**	0.00	0.00	N/S
No. of physicians in care (log)	**0.31**	**0.57**	**0.32**	0.001	**0.29**	**0.48**	**1.24**	0.001
No. of visits to PCPs (log)	**0.21**	0.07	0.03	0.01	0.17	0.01	−0.01	N/S
No. of PCPs in care (log)	**0.25**	−0.06	−0.04	0.01	**0.22**	0.03	−0.08	N/S
Type physician seen (ref: no PCP)	−0.20	—	—		−0.06	—	—	N/S
PCPs other than Ob/Gyn	−0.11	0.03	0.03	N/S	−0.14	−0.06	−0.24	N/S
An Ob/Gyn seen	**0.25**	**0.15**	**0.19**	0.001	0.16	−0.02	−0.06	N/S
Regression intercept			2.43	(NA)			4.64	(NA)
R-square		0.29		0.001		0.21		0.001

dx: diagnosis; affect mamm: affecting mammogram; PCP: primary care physician; Ob/Gyn: obstetrician/gynecologist; N/S: not significant; NA: not applicable.

r values ≥ 0.20 and beta values ≥ 0.15 are set in bold face.

[a] More than 6 mammograms were recoded to 6.

[b] For $r \geq 0.02$, $P < 0.05$; for $r \geq 0.03$, $P < 0.01$; and for $r \geq 0.04$, $P < 0.001$.

[c] A multiple linear regression model including the 15 predictors in this table.

[d] Logistic regression typically would be performed for a dicotomous dependent variable. Multiple linear regression was performed here to provide results that could be compared with those for the two continuous mammography measures. Logistic regression also was performed to confirm that the results were similar.

[e] For $r \geq 0.03$, $P < 0.05$; for $r \geq 0.04$, $P < 0.01$; and for $r \geq 0.05$, $P < 0.001$. $P < 0.001$

Examining the regression coefficients to determine independent predictors of mammography behavior, 4 measures were found to have beta weights ≥ 0.15. Both measures of mammography had independently higher rates for younger women, a lower number of inpatient admissions, and a higher number of physicians involved in care. In addition, having any mammogram was more likely for women who saw an Ob/Gyn. The unstandardized coefficients and the original scales for the predictors demonstrated the change in the dependent variables per unit change in the predictor. For example, the unstandardized coefficients for age demonstrated that, overall, the likelihood of having any mammogram decreased by 3 percentage points per year increase in age. For those women having undergone mammograms, the number of mammograms decreased by 0.05 per year increase in age.

The effect of colinearity among predictors is evident when the correlations and beta weights for predictors are compared. For two predictors, controlling for other predictors results in the predictor's beta values for the two mammography measures having a greater magnitude than the predictor's correlations with the mammography measures. The predictors were: number of inpatient admissions and number of physicians involved in care. The two predictors were correlated with each other (correlation coefficient [r] = 0.60), but they had opposite independent associations with the mammography measures. When the simultaneous effects of these two predictors on mammography were examined in correlations, their oppos-

TABLE 3
Unadjusted and Adjusted Mammogram Measures by Predictor Values[a]

	% with any mammogram (n = 10,000)		If any, no. of mammograms[b] (n = 5680)	
Predictor	Percent	Adjusted percent[c]	Mean	Adjusted mean[c]
Age (yrs)				
70–74	68	68	3.0	3.0
75–79	57	55	2.7	2.6
80–84	41	40	2.4	2.4
85–89	28	30	2.0	2.1
≥ 90	12	15	1.9	1.9
No. of inpatient admissions				
0	57	67	2.8	3.2
1–2	60	53	2.9	2.8
3–4	56	45	2.8	2.4
5–8	52	39	2.5	2.0
≥ 9	45	29	2.5	1.7
No. of physicians involved in care				
0–4	7	10	1.4	1.6
5–14	41	36	1.9	2.0
15–29	63	59	2.7	2.6
30–59	68	71	3.2	3.2
≥ 60	66	80	3.2	3.6
Type of physicians seen				
No PCP	19	55	2.2	2.9
PCPs other than Ob/Gyn	54	54	2.7	2.8
Ob/Gyn	85	71	3.3	3.0

PCP: primary care physician; Ob/Gyn: obstetrician/gynecologist. Only values for predictors with a beta value ≥ 0.15 for either mammography measure (Table 3) are presented.

[a] $P < 0.001$ for all of the regressions and multiple regressions except for the regression of "No. of inpatient admissions" on "If any, no. of mammograms," for which $P < 0.01$.

[b] More than 6 mammograms were recoded to 6.

[c] A multiple linear regression model included all 15 predictors (values categorized as indicated in the table). The model adjusts the mammography percent/mean associated with a predictor value by holding all other predictors constant at the mean value for each predictor.

ing independent effects were counterbalanced. Controlling other predictors did not appear to affect the magnitude of association between age and mammography behavior. Controlling other predictors resulted in beta values that were lower than correlations for four predictors: number of visits to physicians, number of visits to PCPs, number of PCPs involved in care, and type of physician seen.

Unadjusted and Adjusted Mammography Levels by Predictor

Table 3 includes only predictors with beta weights of ≥ 0.15 for either mammography measure. For specific levels of a predictor, Table 3 presents the associated unadjusted values for both mammography measures and those values adjusted (i.e., statistically controlled) to the mean levels of other predictors. This display illustrates the change in relation between a predictor and the mammography measures when the effects of other predictors are controlled. For example, as the number of physicians involved in care over 5 years increased from 0–4 to ≥ 60, the unadjusted percent of women with any mammogram increased by 59 percentage points, from 7% to 66% (reflecting the correlation of 0.31 in Table 2). When the percent with any mammogram was adjusted for the effects of other predictors, as the number of physicians involved in care increased from 0–4 to ≥ 60, the percent with any mammogram increased by 70 percentage points, from 10% to 80% (reflecting the beta weight of 0.57 in Table 2).

Variation in Mammography Rates

The R-square values at the end of Table 2 indicate the percent of observed variation in the outcome measures that is associated with the predictors. When the 15 predictors were included in a linear regression model, they were found to jointly account for 29% of the variation in having undergone any mammogram and 21% of the variation in the number of mammograms for women with at least 1 previous mammogram. We ran additional linear regression models to determine the extent to which the stronger predictors accounted for this variance in mammography. The 4 predictors with beta weights ≥0.15 accounted for most of the explained variation: 27% of the variation in having any mammogram and 19% of the variation in the number of mammograms.

DISCUSSION

Previous studies have used Medicare claims to identify annual mammography screening rates among older women.[7] The current study examines mammography utilization by older women over an extended period (5 years) that began 2 years after the introduction of the Medicare mammography benefit. For this population and time period, the study is also unique in: 1) examining the component behaviors of "ever having a mammogram" and of "having more than one mammogram" and 2) examining factors associated with those behaviors.

Main Findings

5-year mammography rate

Efforts to increase screening through national media campaigns and Medicare financial coverage have increased mammography rates over time, but to our knowledge have had little impact on many older women. In the 5 years from 1993 to 1997, 43% of women age ≥ 65 years in 1993 had never undergone a mammogram and an additional 16% had undergone

only 1 mammogram. Therefore, nearly 60% of older women were not taking advantage of the Medicare benefit for mammography every 2 years. It is unlikely that the expansion of the Medicare benefit in 1999 to cover a mammogram every year will change mammography use by the majority of older women.

Predictors of mammography

The number of physicians involved in care (i.e., billing for services) is the single strongest predictor, both in "raw" association and even more strongly as an independent predictor when measures related to health (e.g., number of inpatient admissions) are held constant. A likely mechanism is that in being exposed to more physicians, a woman is more likely to encounter a physician who recommends having a mammogram and having mammograms on a routine basis.

When other predictors are controlled, the number of inpatient admissions appears to have a strong independent negative relation with ever having undergone a mammogram and with having repeated mammograms. Patients with more inpatient admissions are likely to be in poor health. Physician encounters would likely focus on acute illness rather than preventive care.

Increasing age appears to have a relatively strong independent negative relation with ever having undergone a mammogram and a lower, but meaningful negative independent relation with having repeated mammograms. Many previous studies have found a negative relation between age and mammography for older women.[7,13,14] This relation most likely reflects perceptions of both older women and their physicians that as people age, preventive health care is less important-that increasing age, independent of health status, is a reason not to be screened. The effect of age independent of health status has been reported by others.[15]

The type of physician seen appears initially to be strong predictor. When other characteristics of women are controlled, the independent relation between the type of physician seen and ever having undergone a mammogram is lower but still meaningful. The rate for ever having undergone a mammogram was 71% for women who saw an Ob/Gyn and approximately 55% for women who did not see an Ob/Gyn (Table 3). Ob/Gyns may be more likely than other physicians to recommend a mammogram. Older women who continue to see Ob/Gyns may be more interested in preventive care, such as mammography. Whatever the process, it applies only to getting one mammogram, having repeated mammograms does not appear to differ by type of physician seen.

Other than age, demographic characteristics did not appear to have any meaningful independent association with mammography utilization in this population and time period. Race and urban or rural location were found to have little effect. Education, income, and being below poverty level also were found to have little effect, at least when they were represented by the zip code in which the individual lived. The lack of relation between these measures most likely reflects the success of previous efforts to address demographic disparities in mammography use. Making mammography a covered Medicare benefit reduced the importance of income as a barrier to obtaining a mammogram. Major information campaigns have reduced the importance of education level. To the extent that racial differences were the result of underlying differences in income and education, efforts addressing those issues addressed racial differences as well. In Michigan, access was addressed by locating mammography facilities in every county so that women in both urban and rural locations have access to mammography services.

Limitations

The study necessarily has the strengths and limitations of the database it utilizes. A major strength is the ability to measure actual mammography behavior and interactions with the health care system. Medicare enrolls approximately 96% of U.S. women age $\geq$ 65 years.[7] Data in Medicare beneficiary and claims files contain inaccuracies because of errors in the information submitted and in information processing. Although error rates for reimbursable procedures such as mammography are low, to the extent they occur they are more likely to be the omission of provided mammography services than the inclusion of services not provided.[14] This would underestimate the number of mammograms slightly. Because of potential inconsistency in the coding of mammography procedures in the early 1990s, we included both screening mammograms and diagnostic mammograms in our measures of mammography use. Because the two types of mammography are not differentiated in the current study, the results reflect total mammography use. Overall, the data are sufficiently accurate for aggregate analyses. No better data for the measures in the current study are likely to be available for statewide and national studies of mammography use.

Medicare claims do not provide important data regarding individual women relevant to mammography, (e.g., family history of breast carcinoma or severity of comorbid disease). We used claims data to examine some categories of diagnoses (cancer, psychiatric, and physical) likely to affect preventive screening. The number of hospital admissions is a

general measure of health, but does not classify the health status of individual women precisely. However, the current study focused on averages across all women. The measures may function reasonably in characterizing average health status in aggregate analyses.

The results of the current study directly reflect the population of Michigan. The results also are likely to reflect national trends because Michigan approximates the entire U.S. in its composition by age, racial distribution, and distribution across urban, suburban, and rural communities.

Implications

Priorities for intervention

The results of the current study suggest priorities for interventions to increase mammography among older women.

Message: focus on risk and life expectancy, not age. Messages to both older women and to physicians should be strongly worded to correct the misperception that mammography screening is less important as women age. The results of the current study indicate that women and their physicians use age, independent of health status, as a reason not to undergo mammography. To the contrary, the balance of benefits and harms grows more favorable as women age.[5] The incidence of breast carcinoma increases with age so that more tumors are likely to be detected,[1] and the sensitivity and positive predictive value of mammography in diagnosing breast carcinoma increases with age.[22] Although overall life expectancy decreases with age, screening is moderately cost-effective for women ages 70–79 years, who are at a higher risk for breast carcinoma.[23] The cost-effectiveness of screening will be greater for women who do not have comorbid conditions that shorten their life expectancy.

Target older women not undergoing mammograms. Resources to increase mammography can be targeted to older women who most need it: those who have not undergone a recent mammogram. The methods of the current study demonstrate that Medicare claims data can identify these women for specific interventions by Medicare. The time period for defining "no recent mammogram" could be based on the USPSTF recommendation of at least every 2 years.[5] The recommendation applies to older women whose life expectancies are not compromised. Medicare claims can identify women without recent mammography who have a reasonable probability of being in good health (e.g., no or few inpatient admissions and no major mental conditions).

Target physicians. The number of physicians involved in care appears to be the single strongest independent predictor of mammography. In other studies, older women consistently report that a physician's recommendation is one of the most important factors in their obtaining a mammogram.[12,13,16–18,24,25] A strong message to increase screening in older women can be accompanied by supporting information that addresses the operational steps. For example, a clinical framework is available for physicians to use that ignores age and helps determine the appropriateness of screening based on an older woman's health status and preferences.[26] Supporting information also can address office systems to monitor preventive care and approaches that enhance older women's acceptance of recommendations for mammography.[27–30]

Priorities for research

The methods of the current study also can be used to measure mammography use by older women in other states and nationally, and to monitor changes across time. The methods and findings of the current study can guide the development of demonstration projects to increase appropriate mammography among older women, particularly in identifying and targeting older women without a recent mammogram. Going beyond mammography, future research can explore the use of Medicare data to measure older individuals' use of other preventive services, such as colorectal carcinoma screening or immunizations, and factors associated with the use of those services.

REFERENCES

1. National Center for Health Statistics. Health, United States, 2000 with Adolescent Health Chartbook. Hyattsville, MD: National Center for Health Statistics, 2000.
2. American Cancer Society. Cancer facts and figures. Atlanta, GA: American Cancer Society, 1999.
3. National Center for Health Statistics. General Mortality Worktable (GMWK) 250A: total number of deaths for 72 selected causes, 1998. Hyattsville, MD: National Center for Health Statistics, 2000. Available from URL: www.cdc.gov/nchs/datawh/statab/unpubd/mortabs.htm [accessed 30 Aug 2001]
4. Olsen O, Gotzsche PC. Screening for breast cancer with mammography. *Cochrane Database of Systematic Reviews.* 2002; Issue 2.
5. U.S. Preventive Services Task Force. Screening for breast cancer. Washington, DC: Agency for Healthcare Research and Quality, 2002.
6. American Association of Retired Person. Older women and the Medicare mammography benefit: 1992 awareness and usage levels. Washington, DC: American Association of Retired Persons, 1993.
7. Trontell AE. Use of mammography services by women aged ≥ 65 years enrolled in Medicare-United States, 1991-1993. *MMWR Morb Mortal Wkly Rev* 1995;44:777–781.

8. Leitch AM, Dodd GD, Costanza M, et al. American Cancer Society guidelines for the early detection of breast cancer: update 1997. *CA Cancer J Clin.* 1997;47:150–153.
9. American Geriatrics Society Clinical Practice Committee. AGS position statement: breast cancer screening in older women. *J Am Geriatr Soc.* 2000;48:842–844.
10. Zapka JG, Stoddard A, Maul L, Costanza ME. Interval adherence to mammography screening guidelines. *Med Care.* 1991;29:697–707.
11. Ulcickas Yood M, McCarthy BD, Lee NC, Jacobsen G, Johnson CC. Patterns and characteristics of repeat mammography among women 50 years and older. *Cancer Epidemiol Biomarkers Prev.* 1999;8:595–599.
12. Pearlman DN, Rakowski W, Ehrich B, Clark MA. Breast cancer screening practices among black, Hispanic, and white women: reassessing differences. *Am J Prev Med.* 1996;12: 327–337.
13. Ruchlin HS. Prevalence and correlates of breast and cervical cancer screening among older women. *Obstet Gynecol.* 1997; 90:16–21.
14. Ives DG, Lave JR, Traven ND, Schulz R, Kuller LH. Mammography and pap smear use by older rural women. *Public Health Rep.* 1996;111:244–250.
15. Burack RC, Gurney JG, McDaniel AM. Health status and mammography use among older women [see comments]. *J Gen Intern Med* 1998;13:366–372. Comment in: *J Gen Intern Med.* 1998;13:424–425.
16. Bastani R, Marcus AC, Maxwell AE, Das IP, Yan KX. Evaluation of an intervention to increase mammography screening in Los Angeles. *Prev Med.* 1994;23:83–90.
17. Caplan LS, Wells BL, Haynes S. Breast cancer screening among older racial/ethnic minorities and whites: barriers to early detection. *J Gerontol.* 1992;47:101–110.
18. Rimer BK. Improving the use of cancer screening for older women. *Cancer.* 1993;72:1084–1087.
19. U.S. Department of Commerce, Bureau of the Census. Census of population and housing, 1990: summary Table File 3B [Computer file]. Washington, DC: U.S. Department of Commerce, Bureau of the Census, 1993.
20. Hofer TP, Wolfe RA, Tedeschi PJ, McMahon LF, Griffith JR. Use of community versus individual socioeconomic data in predicting variation in hospital use. *Health Serv Resea.* 1998; 33:219–235.
21. Nunnally JC. Paychometric theory, 1st ed. New York: McGraw-Hill, 1967.
22. Kerlikowske K, Grady D, Barclay J, Sickles EA, Ernster V. Effect of age, breast density, and family history on the sensitivity of first screening mammography. *JAMA.* 1996;276: 33–38.
23. Kerlikowske K, Salzmann P, Phillips KA, Cauley JA, Cummings SR. Continuing screening mammography in women aged 70 to 79 years: impact on life expectancy and cost-effectiveness. *JAMA.* 1999;282:2156–2163.
24. Fox SA, Murata PJ, Stein JA. The impact of physician compliance on screening mammography for older women. *Arch Intern Med.* 1991;151:50–56.
25. Grady KE, Lemkau JP, McVay JM, Reisine ST. The importance of physician encouragement in breast cancer screening of older women. *Prev Med.* 1992;21:766–780.
26. Walter LC, Covinsky KE. Cancer screening in elderly patients: a framework for individualized decision making. *JAMA.* 2001;285:2750–2756.
27. Agency for Healthcare Research and Quality. Put prevention into practice, a step-by step guide to delivering clinical preventive services: a systems approach. Washington, DC: Agency for Healthcare Research and Quality; 2001 AHRQ Pub. No. APPIP01-0001.
28. Weinberger M, Saunders AF, Bearon LB, et al. Physician-related barriers to breast cancer screening in older women. *J Gerontol.* 1992;47:111–117.
29. Frame PS. Breast cancer screening in older women: the family practice perspective. *J Gerontol.* 1992;47:131–133.
30. Preston JA, Scinto JD, Grady JN, Schulz AF, Petrillo MK. The effect of a multifaceted physician office-based intervention on older women's mammography use. *J. Am Geriatr Soc.* 2000;48:1–7.