Screening Mammogram Utilization in Women With Diabetes

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OBJECTIVE — To determine whether women with diabetes undergo fewer screening mammograms than matched control subjects.

RESEARCH DESIGN AND METHODS — A total of 424 women with diabetes aged 50–75 years who received their primary care from general internists at a large Midwestern multispecialty group practice were retrospectively studied for frequency of mammography from August 1997 to January 2000. Two control subjects without diabetes ($n = 845$) were matched to each case by age, sex, provider, and date of visit. The main outcome measure was the percentage of subjects undergoing mammography 1 year before and 30 days after an index date, defined as the most recent health care visit after August 1997 and before January 2000.

RESULTS — Analysis by conditional logistic regression demonstrated that women with diabetes had significantly lower rates of mammograms than control subjects (78.1 vs. 84.9%, respectively; odds ratio 0.63, $P = 0.002$). After adjusting for insurance status and race, women with diabetes continued to have significantly lower rates of mammography (odds ratio 0.70, $P = 0.027$).

CONCLUSIONS — Women with diabetes were significantly less likely to undergo screening mammography than control subjects. Considering the increasing incidence of diabetes and the equal incidence of malignancy in women with and without diabetes, it would be beneficial to improve breast cancer screening in this population.

Diabetes Care 24:2049–2053, 2001

The utility of screening in the reduction of cancer mortality has been demonstrated. More than 46,000 women die from breast cancer annually (1), and it is estimated that mammography or mammography plus clinical breast examination in women >50 years of age reduces breast cancer mortality by ≥20% (2,3). The efficacy of screening mammography has also been demonstrated by meta-analysis (4). In addition, the death rate from malignant neoplasms in individuals with diabetes equals that found in individuals without diabetes, and malignancy remains one of the four leading causes of mortality in patients with diabetes (5).

Preventive care is underutilized in women with diabetes and other chronic diseases, possibly due to the added burdens these diseases place on the health care system (6–10). Several studies have demonstrated that physicians caring for patients with diabetes are poor at checking cholesterol and HbA_{1c} levels, examining feet, and screening for diabetic retinopathy and urinary protein (11–13). Considering the difficulty in monitoring clinically relevant end points and complications directly related to diabetes, it is not surprising that preventive services not directly related to diabetes are rendered less often.

A survey of 4,320 subjects by Fontana et al. (8) demonstrated that in women with diabetes, odds ratios for undergoing Pap testing (0.64) or mammography (0.53) were reduced. However, this was a survey study, and potential flaws of survey research, including problems with nonresponse, inaccurate recall, and unrepresentative participants, have been previously described (14,15). Furthermore, it has been shown that self-reporting of screening measures by patients with diabetes is inaccurate (16).

We are unaware of any case-control studies demonstrating whether women with diabetes receive adequate preventive health care compared with women without diabetes. With this in mind, the current study retrospectively compared the utilization of mammograms in women with diabetes and in control subjects without diabetes; subjects were matched for age, sex, provider, and date of visit. Our hypothesis was that women with diabetes undergo fewer screening mammograms.

RESEARCH DESIGN AND METHODS

Identification of subjects

The Disease Management Strategies group of the Mayo Clinic created an electronic registry of all patients with diabetes aged ≥18 years who were seen in a division of internal medicine that provides primary care to residents of Rochester, MN. This database consists of individuals carrying a line item diagnosis of diabetes, documented by *Internal Classification of Diseases, 9th Revision* (ICD-9) codes, with a primary care visit to the clinic during the 3–24 months before being seen and identified for the database. A primary care visit was defined as follows: *1*) a visit to the patient's established physician (excluding first-time, initial contact visits); *2*) an encounter billed at least at U.S. Health Care Financing Administration Code 99212 or higher (Expanded Problem Focused, or

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Received for publication 4 May 2001 and accepted in revised form 21 August 2001.

Abbreviations: DSS, decision support system.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

15-min office visit or greater); or 3) an office visit (excluding urgent care, walk-in clinic, or nursing home visits). This registry excludes subjects residing in nursing homes, subjects who had died, subjects seen only for urgent care visits, or subjects who were misclassified as having diabetes (glucose intolerant, currently on systemic glucocorticoids, gestational diabetes, or nondiabetic range hyperglycemia billed under diabetes ICD-9 code) through a validation process entailing review of the patient's chart by a nurse.

Inclusion criteria for case subjects, who were all derived from the aforementioned diabetes registry, consisted of a diagnosis of type 1 or type 2 diabetes, female sex, and age ranging from 50 to 75 years. Individuals were excluded if they had a history of breast cancer or mastectomy or if they refused research authorization.

Control subjects were identified using Mayo Clinic's Decision Support System (DSS), an electronic repository of health care services provided within the Mayo Clinic and affiliated hospitals in Rochester, MN. Two female control subjects were matched to each case by physician provider. Control subjects were also matched to case subjects by age (within 5 years) and closest primary care visit to the clinic within a 60-day maximum. Inclusion criteria for the control subjects included no diagnosis of diabetes, age ranging from 50 to 75 years, non–nursing home patient, and female sex. Control subjects were excluded if they had a history of breast cancer or mastectomy or if they refused research authorization.

Data collection

Among the patients identified for this study, each episode of care for which mammography was provided at the Mayo Clinic was determined from the billing data contained in the DSS. End points for mammogram utilization were defined as the percentage of women with diabetes and control subjects aged 50–75 years having had a mammogram within the study period. Mammogram utilization was determined by looking forward 30 days and back 1 year from the index visit (defined as the most recent physician visit to the registry after 15 August 1997 and before 1 January 2000). Women who underwent at least one mammogram during this period were recorded as "screened." Women without a documented mammogram were listed as "not screened." Other patient characteristics were abstracted from the medical records using the Mayo Clinic electronic registration data file, as well as the DSS, Disease Management Strategies, and Laboratory Information Service electronic databases, using a standard data abstraction sheet. These characteristics included each patient's sex, birth date, provider, race, insurance status (Medicaid/self pay, Medicare, other), and the number of mammograms within the study time frame. This study was approved by the Mayo Clinic Institutional Review Board before collection of data.

At the initiation of this study, 1,732 case subjects were identified from the diabetes registry. Of these, 1,308 were determined to be ineligible and were not included in the data analysis. Specific reasons for removal of case subjects are as follows: 893 were men, 254 were not aged 50–75 years during the study time frame, 86 refused research authorization, 56 had a history of mastectomies or breast cancer, 13 had no visit found in the DSS database, 5 had been managed by a medical resident, and 1 had been managed by telephone. This left 424 women with diabetes who were included in this study. Two control subjects were successfully matched as described above to all but three case subjects. For each of these three case subjects, one matching control subject was obtained. Therefore, the total number of control subjects was 845. Similar numbers of case (10%) and control (8%) subjects were excluded due to a history of breast cancer or mastectomy.

Statistical analysis

The diabetes database described above contained 424 subjects who were eligible for this study. With an initial estimate of ~380 cases and two matched control subjects per case, we had >90% power to detect odds ratios of 0.53 or less, assuming the rate of mammography in the control subjects was equal to the overall Mayo rate (unpublished data). Notably, this study had sufficient power to duplicate the mammography utilization results obtained in the survey by Fontana et al. (8)

Baseline characteristics were described using simple summary statistics, including means, standard deviations, counts, and percentages. χ^2 tests were used to compare the ethnicity and insurance status categorizations between the case and control subjects. The mammography rates were also summarized as percentages, with odds ratios and corresponding 95% CIs to compare case subjects with control subjects. The frequency of mammography in the interval from 1 year before and 30 days after the index date was obtained for case and control subjects. A 30-day period after the index date was used to capture mammograms that may have been ordered at the end of the annual screening period. The frequency of mammography was compared between case and control subjects using a conditional logistic regression analysis to account for the matched nature of the data. This analysis accounted for the matching variables of age, physician-provider, and date of visit. An additional conditional logistic regression model was used to obtain an adjusted odds ratio for mammography rates, accounting for differences in ethnicity and insurance status between the case and control subjects.

All statistical analyses were performed using SAS statistical software (SAS Institute, Cary, NC). For all comparisons, two-tailed P values ≤ 0.05 were deemed statistically significant. Although it was hypothesized that control subjects would have higher rates of mammography than women with diabetes, two-tailed P values were chosen to allow for the possibility that the observed differences might be opposite of the hypothesis.

RESULTS — The baseline characteristics of the study participants were obtained from the previously described electronic databases. Although these databases were very complete for most of the data of interest, they did not contain information regarding race for 21% of the sample population. The baseline data are summarized in Table 1. Because age was a matching variable, the age distributions were almost identical. The mean age of the cases was 64.1 years, whereas the mean age of the control subjects was 64.0 years. Case and control subjects differed with respect to two variables that did not form a part of the matching algorithm. Women with diabetes were more likely to be insured through Medicaid or Medicare (60.4%) than their matched control subjects (52.0%) ($P = 0.001$, χ^2 test). Also, women with diabetes were more likely to be identified as non-Caucasian (4.9%) than their matched control subjects (1.9%) ($P = 0.009$, χ^2 test).

Mammography rates are summarized

Table 1—*Baseline sample characteristics of the diabetic case subjects and their matched control subjects*

	Total	Case subjects	Control subjects
n	1,269	424	845
Age (years)	64.0 ± 7.6 (50–75)	64.1 ± 7.7 (50–75)	64.0 ± 7.6 (50–75)
Insurance status:			
Medicaid/self pay	35 (2.8)	19 (4.5)	16 (1.9)
Medicare	660 (52.0)	237 (55.9)	423 (50.1)
Other	574 (45.2)	168 (39.6)	406 (48.0)
Race:			
Caucasian	958 (75.5)	314 (74.1)	644 (76.2)
Non-Caucasian	37 (2.9)	21 (4.9)	16 (1.9)
Not available	274 (21.6)	89 (21.0)	185 (21.9)

Data are means ± SD (range) or *n* (%).

in Table 2. The percentage of women undergoing mammography during the period encompassing 30 days after and 1 year before the index date was lower in the women with diabetes (78.1%) than in the control subjects (84.9%). A conditional logistic regression analysis was performed to compare mammography rates between case and control subjects while accounting for the matching variables of age, sex, physician-provider, and date of index visit. This analysis indicated that mammography rates were significantly different between the two groups (P = 0.0024, odds ratio 0.63). In the control subjects, the odds of undergoing mammography were 59% higher than in the subjects with diabetes. This difference was somewhat smaller but remained statistically significant, after adjusting for race and insurance status (P = 0.0266, adjusted odds ratio 0.70). To further assess the burden of diabetes, we looked for decreased rates of mammography among subjects with diabetes who had more complicated disease. To evaluate the severity of disease, we applied the ICD-9 coded version of MEDSTAT's disease staging, developed by Gonnella and colleagues. With disease staging, each disease is classified into three stages: stage 1 (uncomplicated), stage 2 (limited complications), and stage 3 (systemic complications). The mammography rate was lower, but not statistically significant, among the 198 subjects with stage 2 or 3 diabetes (75.8%) as compared with the 209 subjects with only stage 1 diabetes (80.9%). A total of 17 study subjects were not classified into the diabetes category by the disease-staging program.

CONCLUSIONS — Our study demonstrated that women with diabetes were significantly less likely to undergo screening for breast cancer by mammography than control subjects. It has been shown that insurance status and race may be barriers to preventive care (17,18), and our study found that women with diabetes remained significantly less likely to undergo mammography, even after adjusting for insurance status and race. Findings of our study are consistent with previous investigations showing reduced health care delivered to patients with chronic diseases, including diabetes (8–10).

The reasons that women with diabetes receive lower rates of cancer screening are not entirely clear; however, we strongly suspect it is related to the added burdens associated with caring for patients with diabetes. In support of this, we found that, in the current study, over the study time frame, subjects with diabetes expended >$10,000 in medical costs, whereas subjects without diabetes expended <$8,000. Furthermore, subjects with diabetes averaged >9 office visits during the study period, whereas subjects without diabetes averaged <7 office visits. It has been shown that doctors seeing more patients per unit of time are likely to neglect preventive care in patients with diabetes (19). These studies may reflect the fact that physicians are increasingly pressured to see more patients in a given day (20). Indeed, it has been observed that the trend toward shortened office visits may limit physicians to focusing on a single health concern, with a resulting inattention to concomitant illness (21).

Physician and patient attitudes may compromise preventive care in patients with diabetes. Because the cumulative health impacts of diabetes are so great, doctors may believe that the implementation of cancer screening would have comparatively little effect on the life span of a patient with diabetes. It has also been shown that comorbid illnesses influence physicians' decisions not to use screening mammography (22). Additionally, patients with diabetes may find that managing their diabetes demands so much of their attention and resources that they are unwilling to contemplate cancer prevention.

Table 2—*Mammogram rates for case subjects with diabetes and their matched control subjects*

	Total (n = 1,269)	Case subjects (n = 424)	Control subjects (n = 845)	Odds ratio (range)
Individuals screened	1,048 (82.6)	331 (78.1)	717 (84.9)	0.63* (0.47–0.85) 0.70† (0.52–0.96)
Individuals screened by insurance status				
Medicaid/self pay	15 (42.8)	6 (31.6)	9 (56.3)	0.36 (0.09–1.43)
Medicare	531 (80.5)	184 (77.6)	347 (82.0)	0.76 (0.51–1.13)
Other	502 (87.5)	141 (83.9)	361 (88.9)	0.65 (0.39–1.09)
Individuals screened by race				
Caucasian	807 (84.2)	250 (79.6)	557 (86.5)	0.61 (0.43–0.87)
Non-Caucasian	21 (56.8)	11 (52.4)	10 (62.5)	0.66 (0.18–2.49)
Not available	220 (80.3)	70 (78.7)	150 (81.1)	0.86 (0.46–1.61)

Data are *n* (%) unless otherwise indicated. *P = 0.002 (odds ratio accounts for the matching of case and control subjects by age, provider, and time of last medical visit); †P = 0.027 (odds ratio accounts for differences in insurance status and race, in addition to the matching variables).

This study was designed to demonstrate that rates of breast cancer screening by mammography are lower among women with diabetes seen in a primary care practice, and as such mammography has several advantages. One advantage of this study was its design, matching case to control subjects concurrently and by provider, thereby eliminating biases potentially associated with practice patterns that change over time or differ among providers (23). Case subjects were also matched to control subjects by age, reducing a suspected bias associated with lower screening rates at advancing ages (18,22). Another advantage was the diabetes database, wherein all cases of diabetes were carefully validated by chart review, excluding subjects who were misclassified as having diabetes as well as subjects who had died or were residing in nursing homes or who had been seen only for urgent care visits. A final advantage was that all the subjects were derived from a community-based, primary care practice and were included regardless of insurance status. This allowed the investigators to study a stable population that resided exclusively in a community setting and received most of its services from primary care physicians.

Despite these strengths, several limitations must be acknowledged. Although the Mayo Clinic provides most care for the study population described herein, a small minority of these study subjects may have been seen at one other, much smaller, multispecialty group in Rochester, MN, which is not associated with the Mayo Clinic. Although it is unlikely, the possibility remains that a small number of study subjects may have undergone mammography there or possibly elsewhere if the patient spent time away from the Rochester Community. However, there should not be a significant difference in the number of case versus control subjects undergoing screening mammography at alternate sites, so it is unlikely this would be a substantial source of bias. Another limitation of this study was that, although the subjects are derived from a community-based, internal medicine practice, this practice may not typify most community-centered, primary care settings. Specifically, the practice is an integral part of a tertiary referral center. Therefore, this may limit the extent to which the study results can be generalized to nonacademic settings. Additionally, the population of Rochester is ~96% Caucasian, and the demographics of Rochester may not reflect the population of the U.S. as a whole. However, the disparities in mammography rates between individuals with and without diabetes may be even greater within minority populations. A final limitation is that each subject's screening status by mammography was obtained from an electronic database, wherein some of the mammograms may have been obtained for diagnostic purposes. However, we believe that diagnostic mammography would comprise a minority of those obtained. Additionally, excluding patients with mastectomies and breast cancer should reduce the impact of this potential confounder. Also, we would not expect a significant difference in diagnostic mammograms between patients with and without diabetes.

In conclusion, rates of malignancy are similar in women with and without diabetes, and women with diabetes should be expected to enjoy the same benefit in breast cancer reduction by mammography as women without diabetes. This study demonstrated decreased mammography in women with diabetes, which prompts the need for future research. Future studies could be designed to determine specific barriers to health care in women with diabetes. Studies that assess the use of other preventive services in women with diabetes, such as hormone replacement therapy, cervical cytology, immunizations for pneumococcus and influenza, and screening for colon cancer, may be revealing. It would also be interesting to investigate whether patients with diabetes who are managed by a subspecialist have different rates of health care screening as compared with patients who are only managed by a primary care provider. In our study population, 47% of women with diabetes had seen an endocrinologist (average 2.7 visits per individual). Mammography rates were identical in women seen by an endocrinologist (78%) and those women with diabetes seen exclusively by their general internist (78%).

There remains a need for prospective, randomized trials to investigate the effect of physician-, nurse-, and patient-based interventions on outcomes regarding preventive care in postmenopausal women with diabetes. Ultimately, identifying barriers and effective interventions will improve preventive care in women with diabetes. It is likely that these improvements will require use of electronic technology, such as automated reminders to physicians regarding preventive services, and will require innovative collaboration between allied health professionals and physicians. Importantly, the division of internal medicine providing primary care at the Mayo Clinic has recently initiated a pilot study using a computerized tracking system for preventive services in patients with chronic diseases, including diabetes. It is anticipated that this tracking system will allow physicians and allied health professionals to increase the frequency of preventive services provided to patients with chronic diseases. Last, this study should serve as a reminder to health care providers that women with diabetes seem to be underserved with regard to breast cancer screening and that special attention should be given to screening mammography in this population of patients.

Acknowledgments— Results of this study were presented, in part, at the annual meeting of the Society for Endocrinology, London, 13–14 November 2000.

References

1. Wingo PA, Tong T, Bolden S: Cancer statistics, 1995. *CA Cancer J Clin* 45:8–30, 1995
2. Tabar L, Fagerberg G, Duffy SW, Day NE, Gad A, Grontoft O: Update of the Swedish two-country program of mammographic screening for breast cancer. *Radiol Clin North Am* 30:187–210, 1992
3. Shapiro S, Strax P, Venet L: Periodic breast cancer screening in reducing mortality from breast cancer. *JAMA* 215: 1777–1785, 1971
4. Kerlikowske K, Grady D, Rubin SM, Sandrock C, Ernster VL: Efficacy of screening mammography: a meta-analysis. *JAMA* 273:149–154, 1995
5. Geiss LS, Herman WH, Smith PJ: Mortality in non-insulin-dependent diabetes. In *Diabetes in America*. 2nd ed. Harris MI, Bennet PH, Boyko EJ, Eds. Washington, DC, U.S. Govt. Printing Office, 1995, p. 233–257 (NIH publ. no. 95-1468)
6. Selby JV, Ray GT, Zhang D, Colby CJ: Excess costs of medical care for patients with diabetes in a managed care population. *Diabetes Care* 20:1396–1402, 1997
7. Rendell M, Kimmel DB, Bamisedun O, O'Donnell ET, Fulmer J: The health care status of the diabetic population as reflected by physician claims to a major in-

surer. *Arch Intern Med* 153:1360–1366, 1993
8. Fontana SA, Baumann LC, Helberg C, Love RR: The delivery of preventive services in primary care practices according to chronic disease status. *Am J Public Health* 87:1190–1196, 1997
9. Redelmeier DA, Tan SH, Booth GL: The treatment of unrelated disorders in patients with chronic medical diseases. *N Engl J Med* 338:1516–1520, 1998
10. Kiefe CI, Funkhouser E, Fouad MN, May DS: Chronic disease as a barrier to breast and cervical cancer screening. *J Gen Intern Med* 13:357–365, 1998
11. Beckles GL, Engelgau MM, Venkat Narayan KM, Herman WH, Aubert RE, Williamson DF: Population-based assessment of the level of care among adults with diabetes in the U.S. *Diabetes Care* 21: 1432–1438, 1998
12. Weiner JP, Parente ST, Garnick DW, Fowles J, Lawthers AG, Palmer RH: Variation in office-based quality: a claims-based profile of care provided to medicare patients with diabetes. *JAMA* 273:1503–1508, 1995
13. Peters AL, Legorreta AP, Ossorio RC, Davidson MB: Quality of outpatient care provided to diabetic patients: a health maintenance organization experience. *Diabetes Care* 19:601–606, 1996
14. Dawson-Saunders B, Trapp RG: *Basic and Clinical Biostatistics*. 2nd ed. Norwalk, CT, Appleton & Lange, 1994
15. Levy PS, Lemeshow S: *Sampling of Populations: Methods and Applications*. 2nd ed. New York, John Wiley & Sons, 1991
16. Fowles JB, Rosheim K, Fowler EJ, Craft C, Arrichiello L: The validity of self-reported diabetes quality of care measures. *Int J Qual Health Care* 11:407–412, 1999
17. Woolhandler S, Himmelstein DU: Reverse targeting of preventive care due to lack of health insurance. *JAMA* 259: 2872–2874, 1988
18. Marchant D, Sutton S: Use of mammography–United States, 1990. *MMWR Morb Mortal Wkly Rep* 39:621–630, 1990
19. Streja DA, Rabkin SW: Factors associated with implementation of preventive care measures in patients with diabetes mellitus. *Arch Intern Med* 159:294–302, 1999
20. Grumbach K, Osmund D, Vranizan K, Jaffe D, Bindman AB: Primary care physicians' experience of financial incentives in managed-care systems. *N Engl J Med* 339: 1516–1521, 1998
21. Kassirer JP: Doctor discontent (Editorial). *N Engl J Med* 339:1543–1545, 1998
22. Grady KE, Lemkau JP, McVay JM, Carlson S, Lee N, Minchella M, Caddell C: Clinical decision-making and mammography referral. *Prev Med* 25:327–338, 1996
23. Lurie N, Slater J, McGovern P, Ekstrum J, Quam L, Margolis K: Preventive care for women: does the sex of the physician matter? *N Engl J Med* 329:478–82, 1993