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ADB282838

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AUTHORITY

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AD_____

Award Number: DAMD17-96-1-6262

TITLE: Early Stage Breast Cancer in Older Women: Predictors and Outcomes of Therapy

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REPORT DATE: October 2001

TYPE OF REPORT: Final

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

DISTRIBUTION STATEMENT: Distribution authorized to U.S. Government agencies only (proprietary information, Oct 01). Other requests for this document shall be referred to U.S. Army Medical Research and Materiel Command, 504 Scott Street, Fort Detrick, Maryland 21702-5012.

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20021001 124

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 2001	Final (15 Sep 96 - 14 Sep 01)

4. TITLE AND SUBTITLE
Early Stage Breast Cancer in Older Women: Predictors and Outcomes of Therapy

5. FUNDING NUMBERS
DAMD17-96-1-6262

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution authorized to U.S. Government agencies only (proprietary information, Oct 01). Other requests for this document shall be referred to U.S. Army Medical Research and Materiel Command, 504 Scott Street, Fort Detrick, Maryland 21702-5012.

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 Words)***

The goal of this study was to investigate outcomes associated with different breast cancer treatments in a population-based observational cohort of women aged 65 and older who had undergone surgical treatment for early stage breast cancer. SEER tumor registry records, and linked Medicare claims were used to conduct this work.

We have developed an algorithm for using the Medicare claims data to identify SEER early stage breast cancer subjects who underwent surgical therapy. The sensitivity of the algorithm is about 88%, and the specificity is greater than 99.9%. Additionally, we have explored the relationship between appropriateness of primary therapy for early stage breast cancer, and increased use of breast conserving surgery. We have described additional determinants of the use of breast conserving surgery. We have determined that older women undergoing breast conserving surgery without radiotherapy are at elevated risk for requiring treatment for disease recurrence, as are younger women. Also, older women who received neither axillary lymph node dissection nor radiotherapy were found to be at significantly higher risk of death, after accounting for potential confounders of age, tumor size, and comorbid conditions. The quality of care for older women with breast cancer continues to offer opportunities for improvement.

14. SUBJECT TERMS
Breast Cancer, Mastectomy, Breast Conserving Therapy, Tumor Registry Data, Medicare Data

15. NUMBER OF PAGES
123

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

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INTRODUCTION

Almost half of the incident cases of breast cancer occur in women age 65 and older. However, patients in this age group are infrequently enrolled into randomized clinical trials, and have been seriously under-represented in the randomized trials of breast-conserving surgery (BCS) vs. mastectomy. The randomized trials of younger women suggest that receipt of BCS without radiotherapy is associated with an increased risk of local disease recurrence, but no definite decrease in overall survival.

The goal of this study is to investigate outcomes associated with different breast cancer treatments in a population-based observational cohort of women aged 65 and older who have undergone surgical treatment for early stage breast cancer. The specific aims were:

1. To develop algorithms to utilize Medicare inpatient and outpatient data to define a cohort of older women with early stage breast cancer who received treatment consisting of BCS or mastectomy.

2. To determine predictors of receipt of radiotherapy among older women with early stage breast cancer who have undergone BCS.

3. To determine specific outcomes, especially treatment for local/regional disease recurrence, associated with receipt of BCS with radiotherapy, BCS without radiotherapy, and mastectomy among older women with early stage breast cancer.

To accomplish these aims, we proposed methods for using the National Cancer Institute's Surveillance Epidemiology and End Results (SEER) tumor registry data, as well as Medicare claims files.

BODY

I: Specific Aim #1: Algorithms using Medicare data.

A. Early Algorithm

Our initial work on the development of an algorithm to permit the identification of Medicare patients undergoing surgical treatment for breast cancer focused on the calendar years 1991-1993 (Reference 1). In this paper, we show that 94% of the patients receiving breast cancer surgery according to SEER could be identified using Medicare claims. The sensitivity of the Medicare claims for identifying mastectomy and breast conserving surgery was similar. However, there was a difficulty with the specificity of this very simple algorithm for utilizing claims data. While more than 95% of women having mastectomies according to the Medicare data were confirmed by SEER, only 91% of the women undergoing breast conserving surgery according to the Medicare data were confirmed by SEER. Although not discussed explicitly in the attached manuscript, the

difficulty with specificity of the Medicare claims data was magnified when claims from normal subjects (subjects residing in SEER population areas who had never been entered into the SEER tumor registry data) were included in the analyses. We found that there were a substantial minority of subjects who apparently underwent excision of benign breast masses for which a diagnosis of breast cancer transiently showed up on Medicare claims. This problem would seriously limit the ability of investigators to use solely the Medicare claims data to identify patients undergoing breast-conserving surgery.

Subsequent to the performance of these analyses, the SEER-Medicare data linkage was extended to include breast cancer patients diagnosed as late as 1996, with their associated Medicare claims through 1998. We took advantage of the availability of this data to develop a more complex algorithm, based on 1995 cases, and for which we maximized the positive predictive value of a breast cancer case as determined by the Medicare claims data. We perform this work during a no cost extension year, and details are provided below.

B. Development of a refined algorithm to maximize positive predictive value of breast cancer subjects undergoing surgical therapy, as determined by Medicare claims data.

1.Overview

The goal of this study was to develop an algorithm to identify breast cancer cases from the information contained in Medicare billing records. For such an algorithm to be useful in studying treatment patterns, it must have good statistical properties. The aim was to achieve a positive predictive value (PPV) in the neighborhood of 90%, i.e., among those that are ascertained by the algorithm as breast cancer cases, nearly 90% are to be true cases of the disease. This, in turn, requires a high degree of specificity. In other words, for those that do not have breast cancer, the algorithm must be correct with very high probability since about 99.5% of women in the Medicare population remain free of breast cancer in any given year.

Before turning to the details of the methods employed to construct the algorithm, we give an overview. The data source which made this study feasible from the outset is the SEER-Medicare linked database maintained and made available to us the National Cancer Institute. It contains data with links between cancer cases in the SEER registry and the corresponding Medicare billing records for each case. Since SEER attempts to capture every cancer case in its target areas and is successful with a high degree of reliability, one can construct a cohort of breast cancer cases and their Medicare records. In addition, SEER also makes available the Medicare records of 5% of the entire Medicare population in its areas with all cancer cases marked. This leads to two other cohorts: cancer-free controls and those with cancers other than breast cancer. In the algorithm development phase of the project, we used data on the breast cancer cohort for 1995 (BRCA95), a random sample of the 1995 cancer-free controls and all available cases of other cancers. The last two groups were combined to obtain a control group (CONTROL95). With these data, extensive data investigations were carried out with

closely accompanied discussions of which medical indications in the billing information are likely to differentiate the two groups. Details of diagnosis codes, procedure codes, temporal sequence of events and some physician characteristics were all part of this effort that resulted in the formulation and definition of 20 different variables for each individual. This was followed by a screening step that excluded a large portion of CONTROL95 while retaining a high percentage of BRCA95. The next step consisted of weighted logistic regression model building to attempt to eliminate almost all of CONTROL95. The final model consisted of only four binary variables that successfully discriminated between cases and controls remaining after the screening step.

Since the 1995 data on the training cohorts were used extensively to build variables as well as the algorithm, its success cannot be measured by its performance on these same data. We therefore constructed breast cancer cohorts (BRCA92, BRCA93, BRCA94) for 1992-1994 to evaluate the sensitivity of the algorithm and to study its stability across years. Similarly, we constructed cancer-free cohorts (CAFREE92, CAFREE93, CAFREE94) and other-cancer cohorts (OTHER92, OTHER93, OTHER94) to estimate the algorithm's specificity in for these subgroups of controls. In order to use all available information for estimation, we also constructed CAFREE95 consisting of such controls from 1995 that were not in the random sample used in the construction of the algorithm. The results of applying the algorithm to these cohorts are reported below along with details of data and procedure.

2.Data Sources

The linked Surveillance, Epidemiology and End Results (SEER)-Medicare database used for this analysis consisted of the following components: Patient Entitlement and Diagnosis Summary File (PEDSF) file for selecting cancer patients, Summarized Denominator file (SUMDENOM) for selecting cancer free controls. This latter file includes demographic information for a 5% sample of Medicare beneficiaries residing in the SEER areas who have not been reported to any of the registries as having cancer. It should be mentioned that there is a similar file for cancer patients registered by SEER. This file is called DENOM file and contains information for any Medicare beneficiaries identified as a SEER case. Information from the denominator file has already been appended to the PEDSF file and may be obtained from there. Medicare records were obtained from two files: Medicare Provider Analysis and Review file (MEDPAR) and Physician/Supplier bills file (NCH).

3.Training Cohorts BRCA95 and CONTROL95

Breast cancer patients were selected based on the information provided by SEER (PEDSF file). Patients initially included in BRCA95 were women of age 65 or older diagnosed with breast cancer in 1995 (n=11,380). From these, cases which were reported to SEER based on an autopsy report (n=3) or a death certificate (108) were excluded, leaving 11,269 breast cancer patients. Also excluded were patients not eligible for Medicare

(part A and part B) coverage for the entire year of 1995. However, if an individual died in 1995, the eligibility requirement period was limited to January of 1995 until the month of death. In all, 744 patients were removed because of Medicare ineligibility. Finally, inclusion in BRCA was limited to those not enrolled in an HMO in the year of diagnosis, as Medicare bills from HMOs are incomplete. This last condition eliminated 2,304 breast cancer patients among those satisfying all other requirements, thus leaving a total of 8,221 breast cancer patients in BRCA95.

For training the algorithm, patients having cancer other than breast cancer were included in the cohort CONTROL95. These patients were selected based on the information provided in the PEDSF 5 percent file. This part of CONTROL95 consisted of women of age 65 or older diagnosed with their first (other than breast) cancer in 1995. The total number of such patients in the 5% sample was 1,064. The same Medicare and HMO eligibility criteria were used as for BRCA95. Sixty two patients were not eligible for Medicare coverage, and among those eligible, 196 patients were HMO members. Thus, 258 patients were excluded from the analysis, leaving a total of 806 other-cancer patients in CONTROL95.

Cancer free subjects complemented the selected cancer patients to form the final cohort CONTROL95. These patients were selected based on the SUMDENOM file. A total of 155,173 women, 65 years of age or older were found in the 5% sample. For cancer free patients, age was computed as of January 1, 1995. It was determined that 102,628 of these patients were residing in a SEER area in 1995. Among these, 7,068 were not eligible for Medicare coverage and 20,146 were HMO members. Therefore, we were left with 75,414 cancer-free women, at least 65 years old, residing in a SEER in 1995 and satisfying all the same Medicare coverage and HMO eligibility criteria as cancer patients. Then a random sample of 12,000 cancer free women was selected and added to CONTROL95.

Medicare records could not be found for 36 breast cancer patients, 5 patients diagnosed with other cancers, and 824 cancer free controls. Excluding these patients left a combined of 20,162. Demographic characteristics of these patients are given in Table A.1 in the Appendix.

4.Validation Cohorts

Validation of the algorithm was performed using cohorts which were selected based on the records of the following years: 1992, 1993, 1994. For each year, in addition to the breast cancer cases (BRCA92 etc.), cancer-free controls (CAFREE92 etc.) and other-cancer controls (OTHER92 etc.) were analyzed separately. Their demographic characteristics are in Tables A.2-A.4 in the Appendix. Also, validation was carried out on those cancer-free controls (CAFREE95) which were not in the random sample of 12,000 cancer-free patients. Demographics for this group are in Table A.5. Each cohort was selected according to the same rules as the training cohorts with one exception. Other cancer controls for the training set were such that their first cancer diagnosis occurred in 1995. For the validation cohorts, this first cancer requirement was dropped.

5.Algorithm Development

The first phase in the search for an effective algorithm was to study the cohorts BRCA95 and CONTROL95 with a view toward constructing useful variables. Some definitions and code classifications evolved as part of this phase. The codes are given in Table 1. It should be noted that by "breast cancer dx" we mean breast cancer (ICD-9-CM code 174-174.9) as well as breast carcinoma in situ (ICD-9-CM code 233.0).

Table 1. Codes for Diagnoses and Procedures

Diagnoses	ICD-9-CM codes
Breast cancer	174-1749
Tumor in breast of uncertain nature/behavior	2383, 2393
Carcinoma in situ (breast)	2330
Other cancer	140-1739 (excludes 1735), 175-1958, 196-1962, 1965-1969, 197-1991 (excludes 1982, 19881), 200-20891, 230-2349 (excludes 2330, 2325), 235-2399 (excludes 2383, 2393)
Biopsy	851-8519
Lumpectomy	8520-8521
Partial mastectomy	8522-8523
Nodal Dissection	403
Mastectomy	8533-8548
Radiation therapy	922-9229, V580, V661, V671
Chemotherapy	9925, V581, V662, V672

Procedures	HCPCS codes
Biopsy	19000, 19001, 19100, 19101, 19110, 19112
Lumpectomy	19120, 19125, 19126
Partial mastectomy	19160, 19162
Nodal Dissection	38740, 38745, 38525
Mastectomy	19180-19255
Radiation therapy	77260-77499, 77750-77799
Chemotherapy	96400-96549, J8510-J9999, Q0083-Q0085

The development process is best described as a three-step undertaking.

Step 1 "Screen". Since our goal was to identify incident breast cancer cases who underwent an operation for breast cancer, the first step was to screen out patients who show a small likelihood of satisfying this condition. Thus, only patients having a breast cancer diagnosis and at least one record of a procedure related to breast cancer (biopsy, lumpectomy, partial mastectomy, nodal dissection or mastectomy) anywhere in part A and/or B records were considered to have passed the screen.

Step 2 "Ruled in". Among those who pass the first step, consider everyone who has (i) at least 2 claims on different dates containing breast cancer diagnosis as the primary diagnosis in part B records and (ii) a mastectomy record in Part A and/or B or a lumpectomy or partial mastectomy record in part A and/or B followed by at least one part B claim for radiation therapy along with a breast cancer diagnosis. Such cases clearly have a strong indication of breast cancer treated surgically. We considered these patients "ruled in" as breast cancer cases.

Step 3 "Logistic Regression". For all those who passed the screen (Step 1) but were not ruled in (Step 2), we developed a statistical algorithm to identify breast cancer cases. The technique used to accomplish this was weighted logistic regression variable selection. Here the stepwise method with many variables (along with carefully considered interactions among them) was used iteratively following variable refinement as suggested by the intermediate models. The final result was a model with highly significant variables that have simple interpretations. The variables this final model are:

```
AB_other_cancer = 1 if an "other cancer" code was found as primary dx
                    in part A and/or part B records
                = 0 otherwise

B_brsecond = 1 if a secondary breast cancer code was found somewhere in
                    part B claims
           = 0 otherwise

AB_BCS = 1 if lumpectomy or partial mastectomy code was found in part A
                    and/or part B records
       = 0  otherwise

AB_only_one = 1 if there was no more than one part B claim containing
                    breast cancer dx as primary dx and
                    only one lumpectomy or partial mastectomy record was
                    found in part A and/or B and
                    there was no carcinoma in situ dx detected anywhere,
                    and no record of biopsy or nodal dissection
            = 0 otherwise
```

The final model's parameter estimates and significance levels are in Table 2. It should be noted that estimates themselves are not very meaningful even when converted to odds ratios or to predicted probabilities. This is because the regression was estimated with a heavier weight given to the few remaining controls after the first two steps. However, the

signs of the estimates are meaningful as well as the chi-squares and the corresponding p-values.

Table 2. Logistic Regression Estimates

Parameter	df	Estimate	Standard Error	Chi-Square	Pr >ChiSq
Intercept	1	0.7563	0.1283	34.7690	<0.0001
AB_other_cancer	1	-2.0219	0.1566	166.6770	<0.0001
B_brsecond	1	-2.2432	0.3920	32.7489	<0.0001
AB_BCS	1	4.0221	0.2524	254.0161	<0.0001
AB_only_one	1	-3.5451	0.2655	178.2417	<0.0001

The usual practice in logistic regression based discrimination is to specify a cut-off value for the predicted probability computed from the estimates. In this case, a value of 0.82 showed good properties. To be explicit, if a Step 3 case shows a predicted probability greater than 0.82, it would be classified as positive, negative, otherwise. Once again, one should not interpret the predicted probability or the number 0.82 for reasons given above. Moreover, since all variables in the model are binary, one does not even need to calculate the predicted probability. Table 3 lists the possible variable value combinations that result in declaring a case negative for breast cancer.

Table 3. Possible Profiles to be Declared Negative

Possible Combination	AB_other_cancer	B_brsecond	AB_BCS	AB_only_one
1	1	0	0	0
2	1	1	0	0
3	1	0	1	1
4	1	1	1	1
5	0	1	0	0
6	0	1	1	1
7	0	0	1	1

Although the model and the three-step procedure appears reasonable and resulted in eliminating almost all controls while retaining over 90% of the cases, its performance properties cannot be established by using the same data on which it was trained. We give below the results of using the algorithm on data from other cohorts constructed for validation purposes.

6.Validation

The performance evaluation of the algorithm can be carried out by estimating its sensitivity and specificity. The former is the probability with which a true breast cancer case is detected by the algorithm while the latter equals the probability with which a non-breast-cancer case is correctly classified. Since the intended use of this algorithm is to

study treatment patterns for breast cancer, a third property – the positive predictive value – is perhaps the most important. This is the probability that a case classified as a breast cancer case by the algorithm is indeed a true case. Table 4 below shows how the algorithm fared in the cohorts BRCA95, OTHER95 and CAFREE95. The numbers in each cohort are broken down by the three steps of the algorithm, namely, Screen, Rule and Logistic Regression.

Table 4. Performance of the algorithm on the training cohorts.

	BRCA95	OTHER95	CAFREE95
Number in cohort	8,185	801	11,176
Number after Screen	7,799	8	19
Number Ruled in	6,050	0	8
Number after Step 3, Gold Standard is SEER	7,211	0	8
Number after Step 3, Gold Standard is SEER + Rule	7,211	0	0
Percent remaining, Gold Standard is SEER + Rule	88.10%	0%	0%

Computing from Table 4, we obtain a sensitivity of 88.1%, a specificity of 100.0% and a positive predictive value of 100.0%. This high level of performance, however, is not surprising since the algorithm was constructed using these same cohorts. A more accurate estimation can be obtained by using the algorithm on data available for other years. Table 5 below shows the results of such estimation. Numbers are reported for each of the years 1992, 1993, and 1994 separately to demonstrate the stability of the estimates.

Table 5. Performance of the algorithm on the validation cohorts.

	BRCA92/93/94	OTHER92/93/94	CAFREE92/93/94
Number in cohort	8,480/8,169/8,055	813/802/805	68,797/69,529/69,995
Number after Screen	7,993/7,661/7,618	8/6/4	111/79/83
Number Ruled in	6,246/5,923/5,923	1/0/0	18/14/21
Number after Step 3, Gold Standard is SEER	7,381/7,039/7,075	3/2/2	50/32/36
Number after Step 3, Gold Standard is SEER + Rule	7, 381/7,039/7,075	2/2/2	32/18/15
Percent remaining, Gold Standard is SEER + Rule	87.0%/86.2%/87.8%	0.25%/0.25%/0.25%	0.047%,0.026%,0.021%

It is clear from this table that the performance of the algorithm changes little from year to year. The sensitivity is around 87% while the specificity is about 99.975% for the cancer free group and 99.75% for the other-cancers group. To obtain the most precise estimates possible, it is prudent to pool the data shown in Table 5. Moreover, in CAFREE95 there are additional 58,735 cancer free cases available from 1995 that were not used in constructing the algorithm. Including these along with along with those from Table 5 results in the numbers displayed in Table 6.

Table 6. Performance of the algorithm on pooled validation cohorts.

	BRCA92+93+94	OTHER92+93+94	CAFREE92+93+94+95
Number in cohort	24,704	2,420	267,056
Number after Screen	23,272	18	332
Number Ruled in	18,092	1	63
Number after Step 3, Gold Standard is SEER	21,495	7	143
Number after Step 3, Gold Standard is SEER + Rule	21,495	6	80
Percent remaining, Gold Standard is SEER + Rule	87.0%	0.25%	0.03%

Finally, these estimates of sensitivity and (100 -) specificity can be converted to an estimate of the positive predictive value using Bayes Theorem as

$$PPV = \frac{\pi_B \; Pr(+|B)}{\pi_B Pr(+|B) + \pi_O Pr(+|O) + \pi_N Pr(+|N)}$$

where π_B, π_O and π_N represent the incidence of breast cancer, other cancers and no cancers respectively in the study population. Using SEER data for the period under study these were estimated to be 0.5%, 1.1% and 98.4% respectively. Carrying out this calculation results in PPV=93.1% with a 95% confidence interval of 91.8% to 94.5% constructed using Fieller's method.

II. Specific Aim #2: Determine predictors of radiotherapy.

Our work with respect to determinants of radiotherapy is summarized in three major publications, as well as several of the presentations listed below. As we developed our analyses in this area, it became apparent to us that there is a relationship between receipt of radiotherapy among women who undergo BCS, and receipt of axillary lymph node dissection among these same women. According to the National Institutes of Health's consensus statement on the treatment of early stage breast cancer, both axillary lymph node dissection and postoperative radiotherapy are important components of breast conserving treatment. Therefore, some of the work we performed with respect to determining patterns of care associated with breast conserving surgery was extended to include the concept of "appropriate" therapy, or "complete" vs. "incomplete" breast conserving therapy. This concept is probably more applicable for the analysis of quality of care for women undergoing breast cancer treatment.

A. Relation between appropriateness of primary therapy for early stage breast cancer and increased use of breast conserving surgery.

We performed analyses (detailed in Reference 2) showing that a substantial minority of women undergoing breast conserving surgery had omission of radiotherapy, axillary lymph node dissection, or both. In contrast, women undergoing mastectomy treatment for early stage breast cancer almost always received a total mastectomy with axillary lymph node dissection. Either of these treatments was felt to be appropriate primary therapy, based on the NIH consensus statement regarding the treatment of women with early stage breast cancer. However, as the proportion of women in the U.S. who received BCS rose during the 1990's, the proportion of the breast cancer population undergoing an appropriate primary therapy actually fell, from 88% in 1983-89 to 78% by the end of 1995. Because the proportion of all women who were treated by BCS increased, and because this approach was more likely than was mastectomy to be applied inappropriately, the proportion of all women having inappropriate care actually increased. Details are provided in the reprint provided. This study was published in the *Lancet*, engendered substantial discussion, and was accompanied by an editorial.

B. Relationship of initial breast cancer treatment and distance from a radiotherapy facility.

This paper evaluated distance from a hospital with radiotherapy facilities as a predictor of 1) Receipt of BCS vs. mastectomy and 2) Receipt of radiotherapy among BCS patients. We showed that the odds of receipt of BCS decline when the patient residence is 15 or more miles from the nearest hospital with a radiotherapy facility (detailed in Reference 3). In addition, among those patients undergoing BCS surgery, those residing 40 or more miles from a hospital with radiotherapy facility had decreased odds of undergoing postoperative radiotherapy. Although the effect of distance from a radiotherapy facility was substantial, it applied to only a relatively small percentage of the SEER cohort studied. For example, only 11% of the women in the SEER cohort lived 15 or more

miles away from a radiotherapy facility, and only 3% lived 40 miles or more from a hospital with radiotherapy.

In this paper, we also examined whether the distance from a radiotherapy site accounted for the previously described variation (in the use of breast conserving surgery) by geography, and by urban vs. rural population density in the use of breast conserving surgery. We found that the distance factor did not account for the previously described geographic variation in treatment. It also did not account for the previously demonstrated fact that women residing in more urban areas have greater use of BCS than other women.

C. Persistent differences in determinants of use of breast conserving surgery.

This manuscript was described in the October 2000 annual report for this grant, but has now undergone substantial revision. In this manuscript, which has been accepted for publication in *Medical Care* (Reference 4), we examine how the use of BCS by age group, income, education, and size of metropolitan statistical area has changed over time. In the accepted manuscript, we show not only how the overall use of breast conserving surgery has changed over time, but how the use of complete BCS (defined as BCS accompanied by radiotherapy and axillary lymph node dissection) has changed over time. This manuscript shows that there is substantial use of incomplete BCS (defined as omission of radiotherapy and/or axillary lymph node dissection) in all demographic groups. However, older women are particularly likely to undergo incomplete breast conserving therapy.

III. Specific Aim #3: Outcomes of primary therapies for early stage breast cancer.

A. Survival among BCS patients not undergoing axillary lymph dissection or radiotherapy.

This work, which has been accepted for publication (detailed in Reference 5) shows that women who received neither axillary lymph node dissection nor radiotherapy were at significantly higher risk of death, compared to those undergoing both axillary dissection and radiotherapy. The potential confounders of age, tumor size, and comorbid conditions were adjusted for in the analyses.

B. Intermediate Outcomes After BCS without Radiotherapy.

In the October 2000 report, we showed data showing that women who underwent breast-conserving surgery without radiotherapy had a significantly elevated hazard of disease recurrence, defined as late mastectomy, late radiotherapy, and late chemotherapy. We have now replicated this work on a more contemporary cohort of women who were diagnosed with breast cancer in 1991. The information pertaining to the 1991 cohort is summarized below.

For this analysis, we selected from the SEER data in the SEER-Medicare linked data set women aged 65 and older at the time of diagnosis of a unilateral, stage 1 or 2, first

lifetime invasive breast cancer between July 1, 1991 and December 31, 1992. Subjects were required to have to have microscopic confirmation of disease, and have diagnosis not made at autopsy. Subjects were further required to have undergone breast conserving surgery treatment for their cancer, based on the SEER information, and to have a known status with respect to radiotherapy. Based on the Medicare information in the linked database, the subjects were required to be eligible for both parts A and B of Medicare, and not to be in a Medicare HMO during the entire period of observation, or until death. The characteristics of the women included in this cohort are provided in Table 7 below.

Treatment for disease recurrence was based on Medicare claims data, as SEER does not collect this information. Based on the rationale provided in a previous annual report, treatment for disease recurrence was defined as

- Mastectomy occurring 5 or more months after the month of diagnosis
- Radiotherapy treatment occurring 9 or more months after the month of diagnosis
- Cytotoxic chemotherapy occurring 12 or more months after the month of diagnosis

A Cox proportional hazards model was used to estimate the hazard for development of disease recurrence for women undergoing radiotherapy, compared to those not undergoing initial radiotherapy. Follow up was censored at the time of death, development of a new incident cancer according to the SEER tumor registry data, or no further Medicare claims. For most patients, Medicare claims were available through calendar year 1997. The results are shown in Table 8.

It can be seen in table 8, women initially treated with BCS with radiotherapy had a hazard ratio of about 0.5 for receipt of treatment for disease recurrence, as defined above. This was true even when controlling for important patient and tumor characteristics, such as age, extent of disease status and comorbidity.

We recognize the limitation of this observational data, in that there was undoubtedly selection bias in terms of which patient underwent radiotherapy with their BCS. In order to deal with this problem, we performed a propensity score analysis. We first developed a logistic regression model predicting receipt of radiotherapy among patients in our cohort. The determinants of receipt of radiotherapy in this model included patient age, Charlson comorbidity score, residence in a rural as opposed to urban county, race, having Medicaid insurance in addition to the Medicare insurance, and residence in a zip code of low educational status. These factors were highly predictive of receipt of radiotherapy, with a c-score for the model of 0.84. The subjects were then ordered with respect to propensity for receipt of radiotherapy, and were divided into quintiles, based on the propensity score. The propensity scores were then incorporated into the regression model predicting hazard of disease recurrence, along with all the other factors listed in table 2. In this model, which incorporated the propensity score information, the hazard ratio for receipt of radiotherapy was 0.53, almost exactly the same as the hazard ratio in the model not including the propensity scores.

Table 7.
Characteristics of Study Cohort

Characteristics	Number	%
Total	2268	100
Age Group		
65-74	1144	50.4
75-84	795	35.1
85+	329	14.5
Race		
White	2036	90.4
Black	123	5.5
Other/Unknown	109	4.1
Stage of Disease		
Stage I	1703	75.1
Stage II	565	24.9
Underwent LN Dissection		
Yes	1432	63.1
No	836	36.9
Underwent Radiotherapy		
Yes	1558	68.7
No	710	31.3
Charlson Comorbidity (Inpt)		
0	1949	85.9
1	212	9.3
2	71	3.1
3	36	1.6
Charlson Comorbidity (Outpt)		
0	1410	62.2
1	623	27.5
2	170	7.5
3	65	2.9
Medicaid Insurance		
Yes	158	7
No	2110	93
Proportion 12+ Years Education (in zip code of residence)	mean =74%	sd = 0.12

Table 8.
Risk of Treatment for Disease recurrence Among Women Undergoing BCS

Risk Factor	Hazard Ratio*	P-Value
Received Radiotherapy	0.52	<0.001
Lymph Nodes Positive	2.01	0.01
Lymph Nodes Unknown	1.87	0.01
Tumor Size (square root)	1.23	<0.001
Tumor Grade 3 or more	1.86	<0.001

*Also controlling for age, estrogen receptor positivity, progesterone receptor positivity, and Charlson comorbidity scores.

Our conclusion regarding this work is that older women who undergo radiotherapy as part of initial BCS treatment have a markedly reduced hazard for requiring treatment for disease recurrence. This is true even when incorporating a propensity score analysis to control for the fact that receipt of radiotherapy was not randomly allocated. Previous authors have suggested that women in the Medicare age group may not require radiotherapy after breast conserving surgery, because competing mortality from other diseases make it unlikely that they will live long enough to experience a local disease recurrence, or because the biologic characteristics of their breast cancer may be less aggressive than younger women. Our study provides strong evidence that radiotherapy is indeed important in reducing the future risk of disease recurrence, even among older women.

One important limitation of this work is the fact that we do not have information on tamoxifen treatment. SEER does not collect such information, and Medicare does not pay for tamoxifen therapy. However, one would expect that physicians electing not to provide radiotherapy to older BCS patients would be even to more likely to insure that such patients received tamoxifen therapy. Therefore, it seems unlikely that lack of information on tamoxifen use is accounting for the reported results.

KEY RESEARCH ACCOMPLISHMENTS

- Determination of agreement of SEER and Medicare databased for surgical treatment of breast cancer.
- Determination of relative completeness of different types of Medicare claims for breast cancer operations recorded by SEER.
- Development of predictors of concordance between SEER and Medicare databased.
- Determination of percentage receipt of appropriate care (BCS patients who have undergone radiation and axillary lymph node dissection and total mastectomy patients who have undergone axillary lymph node dissection) over time.
- Determination of predictors of appropriate care, in terms of age, urban vs. rural residence, and type of surgery.
- Determination of predictors of axillary node dissection, relationship of receipt of axillary dissection to receipt of radiotherapy and relationships to survival, among BCS patients.
- Determination of the relationship between breast cancer treatment received and distance a patient resides from a hospital with radiotherapy facilities.
- Finding that distance from patient residence to a hospital with radiotherapy does not account for geographic variation in use of BCS nor the geographic variation in use of radiotherapy after BCS.
- Finding of persistent variation in use of BCS by geography, urban-rural status, and socioeconomic status 10 years after the publication of the first U.S. randomized trial of BCS vs. mastectomy.
- Development of methodology fr partitioning mastectomy, radiotherapy, and chemotherapy claims into initial therapy or therapy for recurrent disease.
- Finding that claims-based methodology for determining breast cancer recurrence has faced validity in terms of predicting breast cancer specific mortality.
- Finding that receipt of BCS without radiotherapy is associated with an elevated hazard of treatment for disease recurrence, among a cohort of breast cancer patients ages 65 and older.
- Determination of demographic determinants of complete BCT (BCS accompanied by radiotherapy and axillary lymph node dissection) vs. incomplete BCT (BCS omitting radiotherapy, axillary lymph node dissection, or both).

- Confirmation of our finding that older women who undergo BCS without radiotherapy have an elevated hazard of treatment for disease recurrence, compared to women who undergo BCS with radiotherapy.

- Development of an algorithm to use solely Medicare claims data to identify women undergoing mastectomy or breast conserving surgery for the initial treatment of early stage breast cancer, and optimization of algorithm to maximize the positive projective value.

REPORTABLE OUTCOMES

Publications:

- Du X, Freeman JL, Warren JL, Nattinger AB, Zhang D, Freeman DH, Goodwin JS. Accuracy and completeness of Medicare claims data for surgical treatment of breast cancer. *Med Care* 2000;38:719-727.

- Nattinger AB, Hoffmann RG, Kneusel RT, Schapira MM. Relationship between appropriateness of primary therapy for early-stage breast carcinoma and increased use of breast-conserving surgery. *Lancet* 2000;356:1148-53.

- Nattinger AB, Kneusel RT, Hoffmann RG, Gilligan MA. Relationship of initial breast cancer treatment and distance from a hospital with radiotherapy facilities. *J Natl Cancer Inst.* 2000;93(17):1344-45.

- Du XL, Freeman JL, Nattinger AB, Goodwin JS. Survival of women after breast conserving surgery for early stage breast cancer. *Breast Cancer Research and Treatment.* Accepted for publication.

- Gilligan MA, Kneusel RT, Hoffmann RG, Greer AL, Nattinger AB. Persistent differences in socio-demographic determinants of use of breast-conserving treatment dispite overall increased use. *Med Care.* Accepted for publication.

Presentations and Abstracts:

- Beam CA, Nattinger AB. Accuracy of inpatient Medicar claims for breast cancer therapy determination. Presented at the Department of Defense U.S. Army Medical Research and Material Command Breast Cancer Research Program Meeting: An Era of Hope. Oct 31-Nov 4, 1997, Washington, DC.

- Beam CA, Guse C, Nattinger AB. Do outpatient records improve the accuracy of medicare breast coancer claims data? *J Gen Intern Med* 1998;13(suppl):41. Presented at the Society of General Internal Medicine National Meeting, April 23-25, 1998, Chicago, IL.

- Nattinger AB, Hoffmann RG, Kneusel RT, Schapira MM. Decrease in appropriateness of breast cancer care associated with increased use of breast-

conserving surgery. *J Gen Intern Med* 1999;14 (suppl 2):58. Presented at the 22nd Annual National SGIM meeting in San Francisco, CA, April 29-May 1, 1999.

- Nattinger AB, Hoffmann RG, Kneusel RT, Schapira MM. Outcomes associated with omission of radiotherapy after breast-conserving surgery, among older women with early stage breast cancer. *JGIM* 2000;15:87-88. Presented at the 23rd Annual SGIM meeting in Boston, MA, May 4-6, 2000.

- Gilligan M, Hoffmann RG, Kneusel RT, Nattinger AB. Determinants of use of breast-conserving surgery: Change over time. *JGIM* 2000;15:117. Presented at the 23rd Annual SGIM meeting in Boston, MA, May 4-6, 2000.

Grants Awarded:

- "Outcomes of Older Women with Early Stage Breast Cancer", PHS, National Cancer Institute R01 CA81379. July 1, 2000-June 30, 2003, based in part on work supported by this award.

CONCLUSIONS

With respect to specific aim #1, we conclude that a simple algorithm using Medicare claims to identify a cohort of older early stage breast cancer patients had sensitivity of greater than 90%, but poor specificity, limiting its practical application. However, it has been possible to develop a more complex algorithm, utilizing logistic regression-based discrimination. This improved algorithm has a positive predictive value of greater than 90% in the target Medicare population. It should be noted that the cases identified by the more complex algorithm are limited to early stage breast cancer cases, for whom an operation was performed.

With respect to specific aim #2, we have identified a number of predictors of radiotherapy, including a novel predictor, distance of patient residence from a radiotherapy facility. We have also show that the increase in use of breast conserving surgery in the treatment of early stage breast cancer has been associated with a decrease in the percentage of the breast cancer population receiving appropriate care, according to the 1990 NIH consensus statement on early stage breast cancer. Furthermore, age, socioeconomic status, and geography remain important determinants of the use of breast conserving surgery, as well as the use of complete (BCS accompanied by radiotherapy and axillary lymph node dissection) breast conserving therapy.

With respect to specific aim #3, we conclude that older women who undergo neither axillary lymph node dissection nor radiotherapy are at significantly higher risk of death, compared to those undergoing both axillary dissection and radiotherapy. Age, tumor size, and comorbid conditions do not appear to account for this effect. In addition, older women undergoing BCS without radiotherapy are at substantial risk for the development of disease recurrence requiring therapy.

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5. Gilligan MA, Kneusel RT, Hoffmann RG, Greer AL, Nattinger AB. Persistent differences in socio-demographic determinants of use of breast-conserving treatment dispite overall increased use. *Med Care.* Accepted for publication.

APPENDICES:

1. Nattinger AB, Hoffmann RG, Kneusel RT, Schapira MM. Relationship between appropriateness of primary therapy for early-stage breast carcinoma and increased use of breast-conserving surgery. *Lancet* 2000;356:1148-53.

2. Nattinger AB, Kneusel RT, Hoffmann RG, Gilligan MA. Relationship of initial breast cancer treatment and distance from a hospital with radiotherapy facilities. *J Natl Cancer Inst.* 2000;93(17):1344-45.

3. Du XL, Freeman JL, Nattinger AB, Goodwin JS. Survival of women after breast conserving surgery for early stage breast cancer. *Breast Cancer Research and Treatment.* Accepted for publication.

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6. Ann B. Nattinger's Curriculum Vitae.

7. Table A.1 Demopgraphic Characteristice of Training cohort: 1995
8. Table A.2 Demographic Characteristics of Validation cohort: 1992
9. Table A.3 Demographic Characteristics of Validation cohort: 1993
10. Table A.4 Demographic Characteristics of Validation cohort: 1994
11. Table A.5 Demographic Characteristics of Validation cohort: unused cancer free controls '95

Relation between appropriateness of primary therapy for early-stage breast carcinoma and increased use of breast-conserving surgery

Ann Butler Nattinger, Raymond G Hoffmann, Ronald T Kneusel, Marilyn M Schapira

Summary

Background Breast-conserving surgery is a more complex treatment than mastectomy, because a separate incision is needed for axillary lymph-node dissection, and postoperative radiotherapy is necessary. We postulated that adoption of this therapy into clinical practice might have led to discrepancies between the care recommended and that received.

Methods We used records of the US national Surveillance, Epidemiology, and End Results tumour registry to study 144 759 women aged 30 years and older who underwent surgery for early-stage breast cancer between 1983 and 1995. We calculated the proportion undergoing at least the minimum appropriate primary treatment (defined, in accordance with the recommendations of a National Institutes of Health Consensus Conference in 1990, as total mastectomy with axillary node dissection or breast-conserving surgery with axillary node dissection and radiotherapy) during each 3-month period.

Findings The proportion of women receiving appropriate primary therapy fell from 88% in 1983–89 to 78% by the end of 1995. This decline was observed in all subgroups of age, race, stage, and population density. Of all women in the cohort, the proportion undergoing an inappropriate form of mastectomy remained stable at about 2·7% throughout the study period. The proportion undergoing an inappropriate form of breast-conserving surgery (omission of radiotherapy, axillary node dissection, or both) increased from 10% in 1989 to 19% at the end of 1995.

Interpretation Although most women undergo appropriate care, the appropriateness of care for early-stage breast cancer in the USA declined from 1990 to 1995. Because the proportion of all women who were treated by breast-conserving surgery increased, and because this approach was more likely than was mastectomy to be applied inappropriately, the proportion of all women having inappropriate care increased.

Lancet 2000; **356:** 1148–53
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Introduction

In June, 1990, a Consensus Development Conference organised by the National Institutes of Health held that either breast-conserving surgery or total mastectomy was appropriate for most women with stage I or II breast cancer. This consensus statement also clarified that either operation should include axillary lymph-node dissection, and that breast-conserving surgery should be accompanied by radiotherapy.[1] Breast conservation was judged preferable to mastectomy[1] but is arguably more complex. Breast conservation requires a separate incision for axillary lymph-node dissection, postoperative radiotherapy, attention to the tumour margins, and attention to the cosmetic result.[2]

The use of breast-conserving surgery increased during the early 1980s,[3] remained generally stable during the late 1980s,[4,5] and increased further from about 1990 onwards.[6–10] Adoption of a more complex therapy into clinical practice might be expected to lead to some discrepancy between the care recommended and that delivered. For example, not all women undergoing breast-conserving surgery receive radiotherapy.[3,10,11]

In this study, we assessed the use of appropriate primary therapy, as recommended by the 1990 consensus conference, over the period 1983–95.

Methods

Patients

The National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) registry[12] was the source of data on breast-cancer patients and their care. The SEER data were collected by nine geographically distinct population-based tumour registries; the registry included information on demographic characteristics, extent of disease, and initial treatment for about 10% of US cancer patients. The nine SEER sites included are the entire states of Connecticut, Hawaii, Iowa, New Mexico, and Utah, and the metropolitan areas of Atlanta, Detroit, Seattle–Puget Sound, and San Francisco–Oakland.

To characterise the study population further, we obtained from the federal Area Resource File[13] information on the urban or rural status of the county of residence of the patient.

We initially selected 147 432 women aged 30 years or older at the time of first diagnosis of an invasive local or regional unilateral breast cancer between 1983 and 1995. We have used similar methods previously.[6,7] We excluded 1887 (1·3%) women who did not undergo primary breast-conserving surgery or mastectomy or whose type of surgery was unknown and 55 women (0·04%) whose date of diagnosis was unknown. These exclusions left a cohort of 145 490 women.

Definitions of analytical variables

Based on SEER convention, the cancer was classified as local if it was confined to the breast tissue and regional if it had extended into surrounding tissue or regional lymph nodes. The more precise American Joint Committee on

Cancer staging was not recorded until 1988, so could not be used for the primary analyses. That staging and tumour size information were used for a subgroup analysis of women treated in 1998 or later.

Patients were classified by SEER as having received breast-conserving surgery if they underwent segmental mastectomy, lumpectomy, quadrantectomy, tylectomy, wedge resection, excisional biopsy, or partial mastectomy. All other women underwent some form of mastectomy. Patients were classified as having had radiotherapy if they received any form of radiotherapy according to SEER and as not having had radiotherapy if SEER recorded them as undergoing no radiotherapy or refusing radiotherapy.

The patients were grouped by age at diagnosis (30–49 years, 50–64 years, 65–79 years, 80 years and older). Race was classified as white, black, or other. The size of metropolitan statistical area (MSA) of the county of residence was classified as fewer than 250 000 individuals or 250 000 or more individuals. For 85 (0·06%) of the patients, no valid code for county of residence was available. Such patients were excluded from analyses of urban versus rural status but were included in other analyses.

On the basis of the 1990 consensus conference,[1] the minimum requirements for appropriate primary therapy were defined as total mastectomy with axillary lymph-node dissection or breast-conserving surgery with axillary lymph-node dissection and radiotherapy. Women who underwent subcutaneous mastectomy, total mastectomy without lymph-node dissection, breast-conserving surgery without radiotherapy, or breast-conserving surgery without lymph-node dissection were classified as not meeting the consensus standard. For 731 (0·5%) of the 145 490 women, we could not assess whether care met the standard, because we could not find out whether they had undergone radiotherapy. The final study cohort consisted of the 144 759 women for whom appropriateness of care could be assessed.

Analysis

The study period was divided into 3-month periods. Each patient was assigned to one of these periods on the basis of her month and year of diagnosis. For each period, the proportion of women who received appropriate therapy was calculated, with the denominator consisting of all cohort patients treated during that time. Unadjusted proportions are plotted in the figures.

A multivariate logistic model was constructed to allow adjustment of the probability of appropriate therapy for differences in age of patient, stage of disease, race, or size of the MSA in which the patient lived. Time for each patient was recorded as month of diagnosis. Trends in treatment over time measured in months were modelled with a logistic spline function,[14] which allowed knots (linear rate changes in the underlying model for appropriateness with time) at the beginning of the year. In addition, knots were allowed every 6 months from 1989 to 1991, around the time of the consensus conference. A forward stepwise regression analysis was used to include only the knots that were significant. This approach produced a piecewise linear logistic fit to the underlying time trend with potential differences for each covariate. Each covariate was fitted separately to allow interactions between the covariates and time.

Using the multivariate model, we calculated the odds ratio for receipt of appropriate care in 1995 compared with 1989, with adjustment for age, race, stage, and size of MSA. Because inappropriate care is not a rare event in this cohort, the odds ratio is a biased estimate of the relative risk. Therefore, we corrected the adjusted odds ratios and CI to estimate the adjusted relative risk more precisely.[15]

Results

65·0% of the patients had local stage disease (table). Most were white and most lived in urban areas. There were increasing numbers of breast-cancer patients over time. Overall, 32·7% of the patients underwent breast-conserving surgery; the remainder had mastectomy. As found previously,[6-9] the use of breast-conserving surgery increased from 1983 to 1985, was stable until mid-1990, then increased steadily until 1995 (figure 1).

The unadjusted proportion of women in the cohort receiving appropriate primary therapy was about 88% until the late 1980s (figure 1); it then decreased to about 78% by the end of 1995. The multivariate model, which adjusted for age, race, stage, and size of MSA, showed a consistent decrease in the proportion receiving appropriate care from the second half of 1990 to 1995. For the cohort overall, the adjusted relative risk of receipt of appropriate therapy in 1995 compared with 1989 (the last year before the decline began) was 0·91 (95% CI 0·90–0·93).

To assess whether this decline in the proportion receiving appropriate care was restricted to certain subgroups of patients, we examined the annual rate of decrease from 1989 to 1995 overall, and for each subgroup of age, race, stage of disease, and size of the MSA in which the patient lived. The adjusted relative risk of receiving appropriate care in each year, compared with the previous year was 0·987 (0·986–0·988). There was a significant annual decrease in the risk of receiving appropriate care for each subgroup, with annual relative risks ranging from 0·980 to 0·994 for the various subgroups. Although each subgroup had a significant decline, the falls were smaller in women aged 80 years and older than in younger women ($p<0·0001$), and in women living in less urban areas than in women living in more urban areas ($p<0·0001$). In addition, each SEER site also had a significant annual decrease in the relative risk of receiving appropriate care.

To assess whether the consensus recommendations were being applied selectively on the basis of prognosis, we calculated the proportion receiving appropriate care

Characteristic	Number of patients	Characteristic	Number of patients
Age (years)		**Stage of disease**	
30–49	34 978 (24·2%)	Local	94 167 (65·0%)
50–64	45 870 (31·7%)	Regional	50 592 (35·0%)
65–79	48 855 (33·7%)	**Year of diagnosis**	
≥80	15 056 (10·4%)	1983	8647 (6·0%)
Race		1984	9179 (6·3%)
White	126 363 (87·3%)	1985	10 037 (6·9%)
Black	10 321 (7·1%)	1986	10 525 (7·3%)
Other	7332 (5·1%)	1987	11 421 (7·9%)
Unknown	743 (0·5%)	1988	11 370 (7·8%)
SEER site		1989	10 996 (7·6%)
San Francisco	24 681 (17·0%)	1990	11 664 (8·1%)
Connecticut	23 657 (16·3%)	1991	12 034 (8·3%)
Detroit	25 042 (17·3%)	1992	12 086 (8·4%)
Hawaii	5830 (4·0%)	1993	11 996 (8·3%)
Iowa	19 350 (13·4%)	1994	12 313 (8·5%)
New Mexico	7180 (5·0%)	1995	12 491 (8·6%)
Seattle	20 832 (14·4%)	**Surgical treatment**	
Utah	7107 (4·9%)	Mastectomy	97 481 (67·3%)
Atlanta	11 080 (7·7%)	Breast-conserving surgery	47 278 (32·7%)
Size of MSA (number of people)			
<250 000	30 115 (20·8%)		
≥250 000	114 599 (79·2%)		

Characteristics of study population

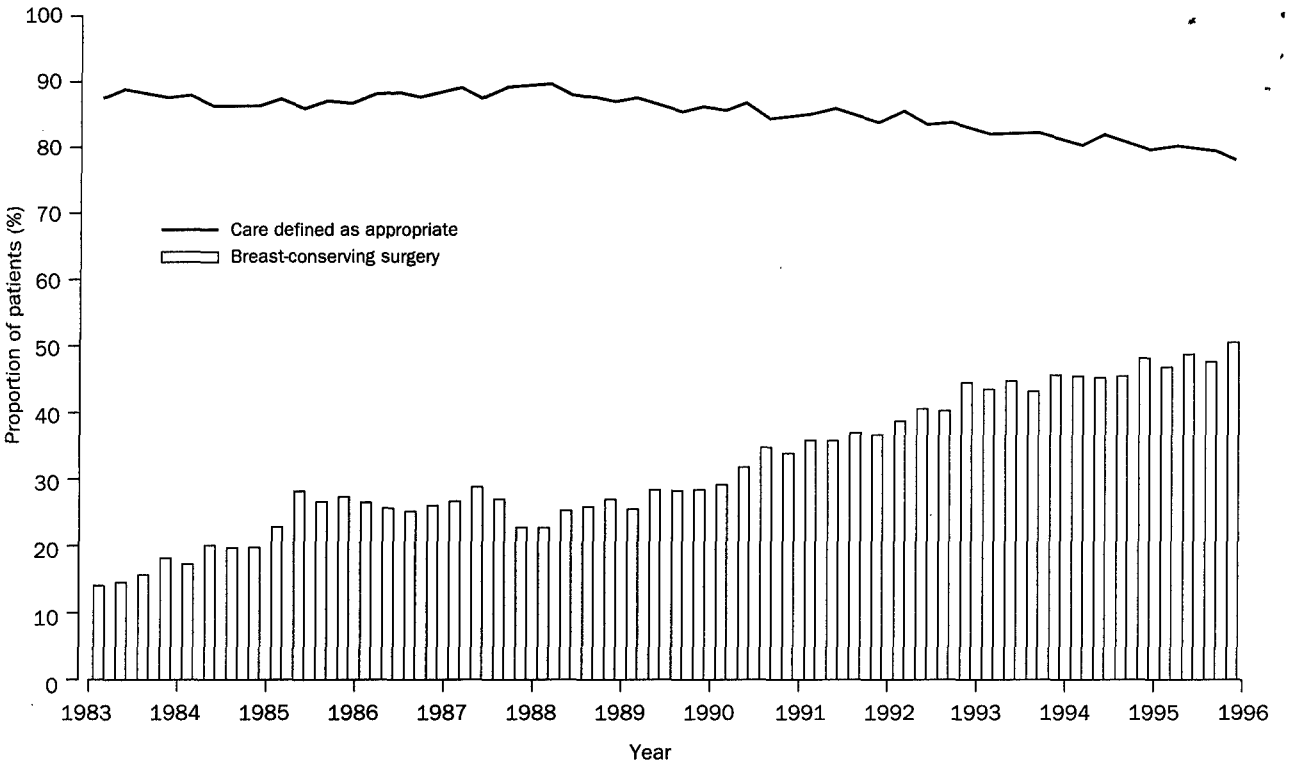

Figure 1: **Use of breast-conserving surgery and use of therapy defined as appropriate in the study population**

based on tumour size. Information on tumour size was available only from 1988, so we restricted these analyses to women diagnosed from 1988 to 1995. Among 45 540 women with stage I disease, those with tumours of 0–10 mm and 11–20 mm in diameter did not differ (p=0·09) in terms of decline in use of appropriate therapy.

We postulated that the decrease in the proportion of patients receiving appropriate therapy was associated with increased use of breast-conserving surgery. Of all patients in the cohort, the proportion of patients undergoing mastectomy treatment that did not meet the standard (total mastectomy without lymph-node dissection or

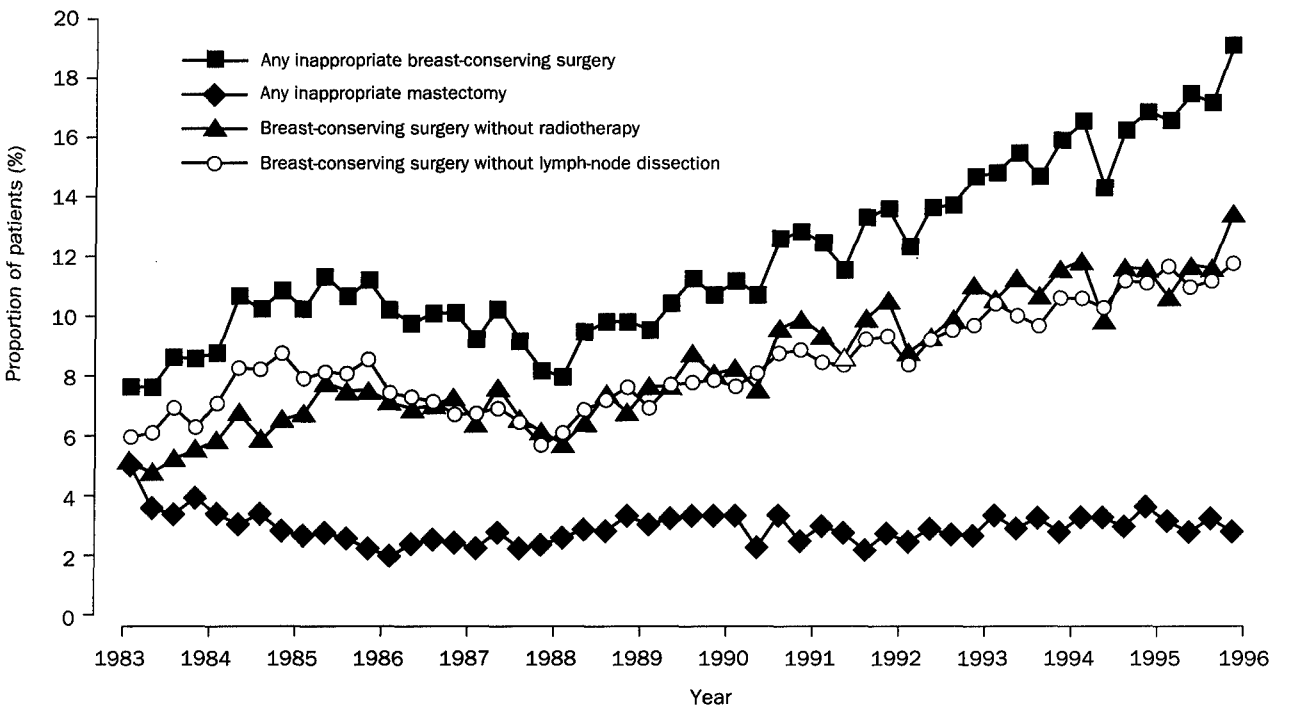

Figure 2: **Proportion of women undergoing care that did not meet the consensus statement standards**
Proportions undergoing breast-conserving surgery without radiotherapy and without axillary lymph-node dissection add to more than the total undergoing any inappropriate breast-conserving surgery because some women underwent neither. The denominator includes 144 759 women diagnosed with local or regional breast cancer from 1983 to 1995, who underwent either mastectomy or breast-conserving surgery.

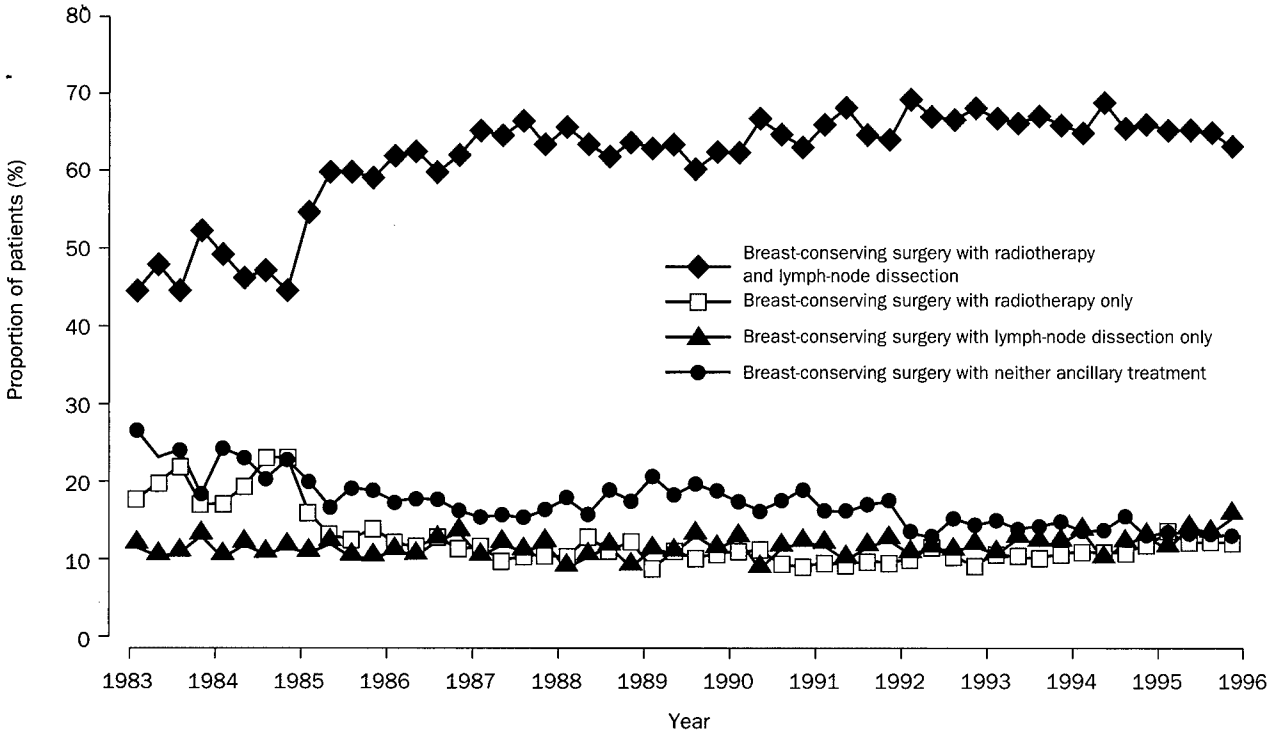

Figure 3: **Proportion of patients undergoing breast-conserving surgery who received both radiotherapy and axillary lymph-node dissection, only one ancillary treatment, or neither**

Denominator is 47 278 women diagnosed with local or regional breast cancer from 1983 to 1995 who underwent breast-conserving surgery as primary therapy.

subcutaneous mastectomy) remained stable at about 2·7% throughout most of the study period (figure 2). By contrast, the proportion of the total cohort undergoing breast-conserving surgery that did not meet the standard (no radiotherapy, no axillary node dissection, or neither) rose from about 10% in 1989 to almost 19% at the end of 1995. About equal proportions of women underwent care that was judged inappropriate because radiotherapy was omitted and because axillary node dissection was omitted.

We further postulated that the decrease in appropriateness of care was related to a decrease over time in the proportion of patients undergoing breast-conserving surgery who received radiotherapy or lymph-node dissection. However, among the women undergoing breast-conserving surgery, the proportion who received radiotherapy and axillary node dissection increased during the mid-1980s and remained stable at about 65% during the 1990s (figure 3). Therefore the decrease in the proportion of patients in the entire cohort undergoing appropriate treatment was related to the overall increase in the use of breast-conserving surgery and was not attributable to a decrease in the proportion of the patients who underwent breast-conserving surgery and received radiotherapy and lymph-node dissection (figure 3). Of the women who underwent breast-conserving surgery, roughly equal proportions did not receive radiotherapy, axillary node dissection, and neither ancillary treatment by 1995.

Although the number of women treated each year for breast cancer in this cohort increased 13·6% from 1989 to 1995 (from 10 996 women in 1989 to 12 491 women in 1994), the number of women each year who received conservative treatment that did not satisfy the consensus guideline nearly doubled over the same period (from 1158 women in 1989 to 2207 women in 1995).

Discussion

We have shown a decrease in the appropriateness of primary therapy for early-stage breast cancer during the period 1990 to 1995, as judged against the 1990 US National Institutes of Health Consensus Statement. The decline occurred in all subgroups based on age, stage of disease, and race. It was more pronounced among women living in more urban areas, probably because such women are more likely to undergo breast-conserving surgery.[4,10,16]

The decrease in the overall proportion of women who received appropriate care is attributable to increased use of breast-conserving surgery during the early 1990s. We emphasise that the proportion of patients treated conservatively who received appropriate care did not change during this time. Rather, there has been a substitution of a newer therapy, breast-conserving surgery for the previously dominant mastectomy therapy. Because breast-conserving surgery is not carried out according to the consensus standards in a substantial minority of patients, and mastectomy therapy is carried out according to consensus standards in the vast majority of cases, there has been a decrease overall in the likelihood that on average patients will receive appropriate therapy.

Some physicians or patients might disagree with the consensus statement recommendations for use of radiotherapy and axillary node dissection in certain subgroups of patients (eg, those at very low risk). However, the decline in appropriateness was found in all subgroups examined, which does not support such disagreement as an explanation for our findings. Patients are diverse, and consensus panel recommendations cannot be expected to be applied rigidly to everyone. Therefore, that 100% of women did not undergo therapy meeting the consensus standard is not surprising. What is surprising, however, is that the proportion of the population meeting the standard declined in the years immediately after the consensus conference. The SEER

sites we studied include about 10% of the US population, so our results suggest that more than 22 000 women each year may be receiving initial care that does not meet the consensus standard.

Women treated with breast-conserving surgery who do not receive radiotherapy have local recurrence rates of about 35% after 5 years.[17-20] Although such recurrences did not influence survival in the randomised trials of breast-conserving surgery, the use of this approach without radiotherapy has been associated with higher mortality in two population-based observational studies.[21,22] In addition, local disease recurrence is psychologically devastating for many women. Some may argue that patients with small tumours and stage I disease who are treated with breast-conserving surgery do not need radiotherapy. However, we are aware of no authorative group that has recommended against the use of postoperative radiotherapy in any subgroup of women treated with breast-conserving surgery.[23]

Some groups of researchers have questioned the need for axillary dissection for patients with small tumours, owing to lower risk of metastatic disease.[24,25] Clinical examination is, however, a poor predictor of axillary lymph-node involvement.[24,26]

In fact, among the 18 837 women in this cohort who had tumours 10 mm or smaller in diameter and underwent axillary lymph-node dissection, 2435 (12·9%) had one or more positive lymph nodes; and among 31 035 with tumours of 11–20 mm in diameter, 8868 (28·6%) had one or more positive nodes. Thus, there is a substantial risk of positive lymph nodes in women with small tumours. These findings are similar to those of others.[24,26,27]

Some researchers have proposed that axillary dissection can be omitted if adjuvant chemotherapy would be given anyway, assuming that axillary radiation would be used to provide local control of axillary disease.[24,25,28] However, of the patients in our cohort who underwent breast-conserving surgery without axillary dissection, only 41% had any radiotherapy, and presumably not all of those received axillary radiotherapy. Although findings of randomised trials suggest that axillary dissection does not improve survival,[29,30] one study in which use of axillary dissection led to greater use of adjuvant chemotherapy found improved survival.[31]

Some women who did not undergo axillary node dissection may have had sentinel lymph-node biopsy.[32] However, this procedure is not accepted as the standard of care;[33] during the years of this study, SEER personnel believe that the use of this procedure among SEER patients was infrequent (personal communication, April Fritz, SEER Quality Assurance).

A limitation of this study is that the SEER registries collect data only on treatments started within 4 months of the initial treatment. Therefore, some women may have undergone radiotherapy that was not included in the registry data because it was delayed until after chemotherapy. However, our finding that the decline in appropriateness was of similar size among the women least likely to undergo chemotherapy (stage I disease with tumours ≤10 cm in diameter) does not support delayed radiotherapy as the major explanation for our findings. The available data suggest that the SEER radiotherapy field is more than 90% accurate,[3,34] and our findings on use of radiotherapy generally accord with those of other investigators.[10,35] The SEER cohort offers the advantages of a large and diverse group of patients for study,[36] a population-based cohort, and recognised high overall quality of data-collection procedures.

Our results raise concern about translation of breast-conserving therapy into clinical practice in the 1990s. Although most women do receive appropriate care, a return to the appropriateness levels of the late 1980s would require a substantial increase in adherence to the consensus standard for use of radiotherapy and axillary node dissection in women undergoing breast-conserving surgery. These findings highlight the need for careful study of the use and outcomes of new therapies as they are adopted into practice.

Contributors

All the investigators contributed to the design of the study and analysis of the results. Raymond Hoffmann was primarily responsible for developing the multivariate analysis, with input from the other investigators. Ann Butler Nattinger drafted the report, and all the investigators contributed to editing.

Acknowledgments

We thank Susan Goodman for assistance with preparation of the report. This study was supported by a grant from the Department of Defense (DAMD17-96-1-6262).

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BRIEF COMMUNICATION

Relationship of Distance From a Radiotherapy Facility and Initial Breast Cancer Treatment

Ann Butler Nattinger, Ronald T. Kneusel, Raymond G. Hoffmann, Mary Ann Gilligan

Substantial variation has been described in the use of breast-conserving surgery (BCS) for early-stage breast cancer *(1–4)* and in the receipt of radiotherapy by patients undergoing BCS *(2,4–6)*. Increased use of BCS is associated with urban residence and with treatment in a hospital with radiotherapy available *(1,3)*.

These findings raise the question of whether the distance that a patient must travel to a radiotherapy facility affects the likelihood that BCS will be used or that the patient will receive radiotherapy in conjunction with BCS *(4,5,7)*. According to current guidelines, women undergoing BCS should receive postoperative radiotherapy to decrease the likelihood of local disease recurrence *(8)*. Radiotherapy is typically provided in treatments that are given 5 days per week for 5–6 weeks *(9,10)*.

To address these issues, we studied patients from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER)[1] registry national public-use database, by using methods similar to those that we described previously *(6)*. Patients from Hawaii were excluded because of the unusual geographic characteristics of this state.

A cohort was selected of 21 135 women who were aged 30 years or older at the time of first diagnosis of a stage I or II unilateral breast cancer during the period from 1991 through 1992 and who underwent BCS or mastectomy. The 1990 U.S. Census tract of residence for each patient was determined from SEER records, and the latitude and longitude of the census tract were determined from the ZIP Code Equivalency file of the U.S. Bureau of the Census *(11)*. Census tracts were unavailable from SEER for years of diagnosis after 1992. The size of the metropolitan statistical area (MSA) of residence of each patient was determined from the 1990 U.S. Census, as was the percent of adults living in the patient's census tract who had a college education (a proxy indicator of socioeconomic status) *(12)*. Information on census tract or socioeconomic status was unavailable for 3406 women, leaving a final study cohort of 17 729 women.

Hospitals offering radiotherapy services were determined from the 1990 American Hospital Association (AHA) Annual Survey of Hospitals *(13)*. Of the 1257 such hospitals, the latitude and longitude of 87% were determined from the 1997 AHA Survey *(14)*. (The 1997 AHA Survey was the first year to include hospital latitude and longitude.) For those hospitals not included in the 1997 AHA Survey, we determined the latitude and longitude of the centroid of the hospital's ZIP code from the U.S. Bureau of the Census *(15)*. For each patient in the cohort, the hospital with the shortest distance from the census tract of residence of that patient was determined by a standard formula for computing the distance between two coordinates of latitude and longitude *(16)*.

Of the 17 729 women in the study cohort, 88.0% were white, 54.9% had stage I disease, and almost 58.3% underwent mastectomy therapy. Of the 7384 patients who underwent BCS, 74.8% underwent radiotherapy, and 2.7% had an unknown status with respect to radiotherapy. The median distance from a hospital with a radiotherapy facility was 4.1 miles, and 89.2% of the patients lived within 15 miles of such a hospital.

Women residing an increased distance from a hospital with a radiotherapy facility had a decreased likelihood of undergoing BCS (Table 1). The lower probability of undergoing BCS was statistically significant for women residing 15 miles or more from the nearest hospital with a radiotherapy facility (odds ratio [OR] = 0.52; 95% confidence interval [CI] = 0.46 to 0.58). We had postulated that any relationship of distance to radiotherapy site and therapy undergone might be more prominent among older women because older women may have more difficulties with transportation *(17)*. However, when the analysis was limited to the 8095 (45.7%) women in the cohort aged 65 years and older, the results were virtually the same as for the entire cohort (Table 1).

Among the 7187 women who underwent BCS and for whom receipt of radiotherapy was known, a statistically significant decrease in the probability of receipt of radiotherapy (OR = 0.55; 95% CI = 0.37 to 0.82) was observed for women living 40 miles or more from a radiotherapy site (Table 1). However, only 1.7% of the patients who received BCS lived this far from a hospital providing radiotherapy.

We were further interested in whether the distance from a radiotherapy facility explained the differential use of BCS previously observed in relation to geographic region and population density. Thus, we assessed the fit of incremental logistic regression models. The likelihood ratio test for a logistic model using the patient covariates plus distance from radiotherapy site was statistically significantly different from a model including only the patient covariates as predictors of receipt of BCS ($P<.001$, Table 2). When the size of the MSA in which the patient resides was added to the model including distance, the likelihood ratio test was again statistically significant for the difference between the two models ($P<.001$, Table 2), which implies that MSA size contributes explanatory power incremental to that of the distance from the radiotherapy site and the patient characteristics. Similarly, when the SEER site was added to the model with radiotherapy distance, the likelihood ratio test was statistically significantly different between the two models ($P<.001$, Table 2), suggesting that geographic region also adds predictive value incremental to that of distance and the patient characteristics.

Using an analogous set of comparisons, we found that the size of the MSA and the SEER geographic site also each

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See "Notes" following "References."

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Table 1. Effect of distance of patient residence to nearest hospital with a radiotherapy facility on the receipt of breast-conserving surgery (BCS) and on radiotherapy after BCS

Distance from hospital with radiotherapy facility, miles	Overall OR* (95% CI)	OR* if ≥65 y old (95% CI)
Receipt of BCS versus mastectomy		
<5	Referent	Referent
5 to <10	1.08 (1.00 to 1.06)	1.07 (0.95 to 1.20)
10 to <15	1.07 (0.95 to 1.19)	0.98 (0.82 to 1.18)
15 to <20	0.76 (0.62 to 0.92)	0.72 (0.52 to 0.99)
20 to <30	0.61 (0.50 to 0.75)	0.49 (0.37 to 0.66)
30 to <40	0.44 (0.34 to 0.58)	0.32 (0.22 to 0.45)
≥40	0.43 (0.35 to 0.53)	0.42 (0.31 to 0.56)
Receipt of radiotherapy among BCS patients		
0 to <10	Referent	Referent
10 to <20	0.79 (0.65 to 0.94)	0.76 (0.57 to 1.01)
20 to <30	1.03 (0.68 to 1.55)	0.81 (0.46 to 1.40)
30 to <40	0.91 (0.55 to 1.51)	0.97 (0.47 to 2.01)
≥40	0.55 (0.37 to 0.82)	0.56 (0.32 to 0.97)

*Adjusted for age, stage of disease, race, educational status [which have previously been shown to be determinants of use of BCS *(1,2,18)*] with a logistic regression model. There was no substantive difference between adjusted and unadjusted results (not shown). The analyses of receipt of radiotherapy among patients undergoing BCS had a substantially smaller sample size. Therefore, larger categories of distance were required for analysis. OR = odds ratio; CI = confidence interval.

Table 2. Incremental explanatory effect of distance from RT site, size of MSA, and SEER site on breast cancer treatment*

Model components†	LR test	P	R^2
Use of BCS vs. mastectomy			
1) Covariates	—	—	—
2) Covariates + distance	151.9 with 6 *df* (vs. model 1)	<.001	.275
3) Covariates + distance + MSA size	79.7 with 2 *df* (vs. model 2)	<.001	.282
4) Covariates + distance + SEER site	389.3 with 7 *df* (vs. model 2)	<.001	.311
Use of RT among BCS patients			
5) Covariates	—	—	—
6) Covariates + distance	13.8 with 4 *df* (vs. model 5)	.008	.368
7) Covariates + distance + MSA size	56.4 with 2 *df* (vs. model 6)	<.001	.377
8) Covariates + distance + SEER site	237.3 with 8 *df* (vs. model 6)	<.001	.405

*MSA = metropolitan statistical area; SEER = Surveillance, Epidemiology, and End Results Registry; LR = likelihood ratio; RT = radiotherapy.

†For these analyses, logistic regression models were constructed, incrementally including the distance factor and then the population density or SEER site (geographic region) factors. The incremental fit of these models was assessed with the LR test *(18)*. An R^2 statistic was used as a measure of the predictive power of the different models *(18)*. Covariates refer to the patient characteristics of age, race, stage of disease, and educational status. All statistical tests are two-sided.

have incremental explanatory power in a model including patient characteristics and distance as predictors of receipt of radiotherapy after undergoing BCS (Table 2).

In summary, we found a statistically significant decrease in the likelihood of undergoing BCS among women residing 15 miles or more from a hospital with radiotherapy facilities. Among women who underwent BCS, a lower probability of undergoing radiotherapy was observed consistently only among those residing 40 miles or more from a hospital with radiotherapy facilities. However, distance did not account for all of the previously described *(1–3,19)* geographic variation in treatment or for the previously demonstrated *(1,3)* fact that women residing in more urban areas have greater use of BCS than other women.

Some unmeasured factor, such as a health systems factor, could account for the observed association between distance from a radiotherapy facility and treatment. However, our results regarding distance and receipt of radiotherapy after BCS are similar to those obtained in a study of patients in New Mexico *(20)*. Although that study did not find an association between receipt of BCS and the distance to a radiotherapy site, our larger sample size gave us better power to detect this association.

The decreased use of BCS among breast cancer patients living 15 miles or more from a radiotherapy site does not necessarily mean that these women undergo inappropriate care. Modified radical mastectomy is an appropriate treatment option for women with early-stage breast cancer *(8)*. Nonetheless, these women may not perceive access to BCS as a realistic treatment option. The finding of a lower use of radiotherapy among BCS recipients living 40 miles or more from a hospital with a radiotherapy facility, however, does raise an issue of appropriateness of care *(6)*. Radiotherapy is clearly recommended for women who undergo breast conservation as primary therapy *(8)*, and women who undergo BCS without radiotherapy have local recurrence rates of about 35% over a 5-year period *(21–24)*.

Although the distance of more than 15 miles from a radiotherapy site had a moderate effect on the receipt of BCS, only 11% of the women in this cohort lived 15 miles or more away from a radiotherapy facility. Similarly, only 3.1% of the entire study cohort and 1.7% of the BCS patients lived 40 miles or more away from a hospital with radiotherapy. Although the SEER population is somewhat more urban than the population in the rest of the United States *(25)*, only a reassuringly small percentage of the U.S. population is likely to be affected by the findings of this study.

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Notes

[1]*Editor's note:* SEER is a set of geographically defined, population-based, central cancer registries in the United States, operated by local nonprofit organizations under contract to the National Cancer Institute (NCI). Registry data are submitted electronically without personal identifiers to the NCI on a biannual basis, and the NCI makes the data available to the public for scientific research.

Supported by grant DAMD17-96-1-6262 from the Department of the Army and by Career Development Award CCCDA-99-291-01 from the American Cancer Society.

Received January 31, 2001; revised June 27, 2001; accepted July 6, 2001.

Running Head: Survival of Women with Breast Cancer

Article Type: Original Report

Title: Survival of Women After Breast Conserving Surgery for Early Stage Breast Cancer

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Word count: 3,102 words of text, excluding **abstract (245 words)**, acknowledgements, references, 3 tables and 1 figure.

Abstract (245 words)

Background. Increasing numbers of older women with breast cancer are receiving breast-conserving surgery (BCS). However, substantial numbers of them are not receiving either axillary dissection or adjuvant irradiation.

Objective. To determine whether failure to perform axillary dissection or irradiation is associated with decreased survival in women with early-stage breast cancer.

Method. We studied 26,290 women aged ≥25 in 1988-1993 from the Surveillance, Epidemiology and End Results (SEER) data and 5,328 women aged ≥65 in 1991-1993 from SEER-Medicare linked data, who had early-stage breast cancer and received BCS.

Results. Twenty seven percent of women aged ≥25 receiving BCS did not receive axillary dissection, most of whom (74%) were age ≥65. Women receiving BCS with axillary dissection had lower 7-year breast cancer-specific mortality than did those without dissection (hazard ratio=0.53, 95% confidence interval: 0.44-0.63). We found an interaction between receipt of axillary dissection and radiotherapy on survival of older women after BCS. Women who received either axillary dissection or radiotherapy experienced similar survivals to those who received both axillary dissection and radiation, while women who received neither treatment experienced poorer survival (hazard ratio=1.76, 1.23-2.52), after controlling for demographics, tumor size and comorbidity.

Conclusions. Women who receive neither axillary dissection nor radiation therapy after BCS experience an increased risk of death from breast cancer. The lack of improvement in the past two decades in survival of older women with breast cancer may be explained in part by the increasing use of treatments that do not address potential tumor in axillary nodes.

Key words: axillary node dissection; breast cancer; breast-conserving surgery; survival.

Introduction

Axillary node dissection is a component of modified radical mastectomy, and also is commonly used in breast conserving surgery. There are two major rationales for axillary dissection [1-3]. First, it physically removes potentially cancerous tissue in the axilla. Second, it allows for adequate staging information as a guide to more appropriate therapy. It could be argued that these two rationales are less compelling today than in the 1980's and before. For example, radiotherapy to the axillary nodes would accomplish a similar goal to physical removal of cancerous tissue [4]. Also, increased use of adjuvant chemotherapy in early stage breast cancer means that the distinction between local and regional cancer may have less impact on choice of therapy now than it did before.

The reasons outlined above have led some authorities to question the wisdom of routine axillary dissection [5-8], and this is reflected in an increasing percentage of women with early stage breast cancer who do not receive axillary dissection as part of initial treatment [1, 9-11].

On the other hand, there are serious concerns raised by the omission of axillary dissection. It would appear that substantial numbers of older women who do not receive axillary dissection also are not receiving radiation therapy or chemotherapy [1, 10-13]. Approximately 20-50% of women with early stage breast cancer will have positive axillary nodes found on axillary dissection [1, 14-16]. In most women with axillary node metastases there is no indication of metastases on clinical palpation of the axilla [14-20]. Even women with very small primary tumors of 0.5 to 1.0 cm in size have a greater than 10% incidence of axillary node metastases [1,

15-21]. It would appear that many of these women are receiving no therapy directed against the axillary node tumor [1, 10-13, 15].

Therefore, we hypothesize that the failure to perform axillary dissection is associated with decreased survival in women diagnosed with early stage breast cancer. To test this hypothesis we examined the survival difference between older breast cancer patients receiving axillary dissection and those without axillary dissection, and examined the role of radiation therapy, chemotherapy and comorbidity. We used a data base in which information from the Surveillance, Epidemiology and End Results (SEER) registry was linked to Medicare Part A and B files [22-25]. This allows us to better consider factors such as adjuvant radiation therapy and chemotherapy, as well as control for comorbidity, in survival analyses.

MATERIALS AND METHODS

Data Sources

We used two data sources: (1) the Surveillance, Epidemiology and End Results (SEER) 1973-96 Public Use Data Set, and (2) the merged SEER-Medicare database. The SEER program supports population-based tumor registries in four metropolitan areas (San Francisco/Oakland, Detroit, Atlanta, and Seattle) and five states (Connecticut, Iowa, New Mexico, Utah, and Hawaii), covering approximately 10% of the U.S. population [26]. Since 1992 SEER registries included 11 areas, accounting for about 14% of the U.S. population [26]. Information includes tumor location, size and histologic type; demographic characteristics such as age, gender, race and marital status; and types of treatment provided within four months after the date of diagnosis

[27]. The SEER data set does not contain information on comorbidity, and information on chemotherapy and radiation therapy is considered incomplete [22, 23, 25, 28].

The Medicare claims data used in the study included inpatient hospital claims; claims for outpatient facility services, including ambulatory surgery; and claims for physicians' and other medical services. Cases reported by the SEER registries from 1991 to 1996 have been matched against the Medicare master enrollment file. The method of linking these data has been described elsewhere [22]. This study was approved by the Institution's Review Board.

Study Population

Two study populations were analyzed separately. From the SEER Public Use Data Set, 26,290 female patients aged 25 and older women diagnosed with breast cancer between 1988 and 1993, who were diagnosed with early stage breast cancer, i.e. the American Joint Committee on Cancer (AJCC) stages I or II, and who received breast-conserving surgery, were selected for the analysis. Cases diagnosed before 1988 were not selected because information on tumor size was only available after 1988. Since the last date of follow-up was December 31, 1996, it allows the 3-year survival rate to be calculated in cases diagnosed in 1988-1993 and the 7-year survival rate for 6,318 cases diagnosed in 1988-89.

The SEER-Medicare linked database was used to examine the use of radiation therapy and chemotherapy and to determine comorbidity levels for cases diagnosed between 1991 and 1993. These years were studied because Medicare claims were available for all incident cases diagnosed beginning in 1991. In the SEER-Medicare linked data, after excluding those without

both Medicare Part A and Part B in the year of diagnosis, the study population were 14,089 women diagnosed with early stage (AJCC stage I or stage II) breast cancer at age 65 and older in 1991-1993. After excluding those who received mastectomy, or received no cancer directed surgery, or had missing information on the months of diagnosis, 5,328 who received breast-conserving surgery were included in the analysis.

Treatment and survival

Surgery and axillary dissection. In SEER, breast-conserving surgery (BCS) was defined as segmental mastectomy, lumpectomy, quadrantectomy, tylectomy, wedge resection, nipple resection, excisional biopsy, or partial mastectomy unspecified, with or without dissection of axillary lymph nodes [27].

Radiation therapy. We have previously shown that combining data from SEER and Medicare provided more complete information on radiation therapy [23]. As previously described, receipt of radiation therapy was determined from SEER, supplemented by review of Medicare claims for radiation therapy within 4 months after diagnosis.

Chemotherapy. Chemotherapy was ascertained from the Medicare data through procedure and revenue center codes on at least one claim for chemotherapy made within 12 months after diagnosis of breast cancer [25]. These codes included the ICD-9-CM procedure code of 9925 for a hospital inpatient or outpatient facility claim of chemotherapy (injection or infusion of cancer chemotherapeutic substance) [29], the Common Procedure Terminology codes of 96400-96549, J9000-J9999, and Q0083-Q0085 for a physician or outpatient claim of chemotherapy

administration [30, 31], and revenue center codes of 0331 (chemotherapy injected), 0332 (chemotherapy oral) and 0335 (chemotherapy intravenous) for an outpatient claim of chemotherapy [32]. The ICD-9-CM V codes [29] of V58.1, V66.2, or V67.2 for follow-up examination or care after chemotherapy was also used, that generated 3 additional cases in the category of receiving chemotherapy within 12 months of diagnosis.

Comorbidity index. Comorbidity was ascertained from the Medicare data through ICD-9-CM diagnoses or procedures on claims made 2 years prior to the diagnosis of breast cancer. We used the comorbidity index created by Charlson [33] and later validated by Romano and colleagues using the ICD-9-CM diagnosis and procedure codes [34]. Comorbidity scores were calculated for each patient. Both the Medicare inpatient and outpatient claims were searched for comorbid conditions, but not including breast cancer diagnosis codes (ICD-9-CM codes of 174x). Patients who had no inpatient or outpatient Medicare claims during this period were coded as a separate category.

Mortality and Survival Time. Breast cancer-specific death was defined similar to the method of the Early Breast Cancer Trialists' Collaborative Group [4]: if patients died of breast cancer as an underlying cause of death, or if patients with breast cancer died of unknown causes. Information on months of survival from the date of diagnosis was provided in SEER. The last date of the follow-up for this cohort was December 31, 1996. This would allow analyses on the 7-year survival in women diagnosed with breast cancer in 1988-1989 from SEER Public Use Data, and 3-year survival among women diagnosed in 1991-1993 from the SEER-Medicare linked data.

Analysis

After patients who were lost to follow-up or died of other diseases were censored, a 7-year Kaplan-Meier survival curve was produced using the LIFETEST procedure for women diagnosed with breast cancer in 1988-1989 [35]. In a separate analysis, all deaths in the first four years were censored and a survival curve from 4 to 7 years was constructed, in order to reduce any effect of comorbidity which might be expected to differentially affect early deaths. The log rank test was used to assess differences among the survival curves. In addition, the Cox proportional hazard model was used in the survival analyses using the PHREG procedure available in the SAS statistical package [35]. These analyses took into account possible confounding factors such as age, race, marital status, cancer stage, tumor size, SEER area, and comorbidity level. The analyses also adjusted for other breast cancer therapies such as adjuvant radiation therapy and chemotherapy.

RESULTS

Table 1 presents the percentages of women receiving breast-conserving surgery (BCS) with or without axillary dissection by patient and tumor characteristics. Overall, 27% of all women with early stage breast cancer who underwent BCS did not receive axillary dissection as part of initial surgical treatment. Older women, unmarried women and those with very small (<0.5 cm) or very large tumors (>=4.0 cm) were less likely to receive axillary dissection. Overall, 74% of women who received BCS without axillary dissection were aged 65 or older. The data on the percentages receiving axillary dissection by stage are misleading, because the

major means of distinguishing regional from local stage is by axillary dissection. Thus there is a misclassification bias of underreporting regional stage tumor in women without axillary dissection. Because of this, in the survival analyses we control for tumor size rather than stage.

Figure 1 presents Kaplan-Meier survival curves of the 7–year breast cancer specific survival for women receiving BCS with or without axillary dissection. Survival was significantly greater for women with axillary dissection as compared to those without axillary dissection ($P<0.0001$). The hazard ratio for mortality at seven years was 0.53 (0.44-0.63) for women with axillary dissection as compared with those without, after adjusting for age, marital status, race, tumor size and SEER area. There was also a significant difference in the survival curves between years 4 and 7 ($P<0.0001$) after deaths in the first 3 years were censored as a crude control for comorbidity.

As discussed in the Introduction, axillary dissection may be less important if patients not receiving axillary dissection receive adjuvant radiation therapy or chemotherapy. We investigated this issue in women aged 65 and over diagnosed with early stage breast cancer between 1991 and 1993 using the SEER-Medicare linked data, which provides information on radiation therapy, chemotherapy, and comorbid conditions [22-25]. Table 2 presents the percentage of women receiving radiation and chemotherapy as a function of receipt of axillary node dissection. Only 38% women who underwent BCS without axillary dissection received radiotherapy, compared to 86% of women who underwent BCS with axillary dissection. Very few of these older women received chemotherapy after BCS. Women who underwent BCS with axillary dissection were somewhat more likely to receive chemotherapy than women who

underwent BCS without dissection (8.0% vs 3.1%). Use of radiotherapy did not vary greatly by whether the axillary nodes were positive or negative or by estrogen receptor status, while use of chemotherapy was greater in women with axillary node metastases or with estrogen receptor negative tumors.

Table 3 presents the relationship between axillary dissection and receipt of radiation therapy on mortality of women aged 65 and older with early stage breast cancer. Women receiving neither axillary dissection nor radiotherapy were at a significantly higher risk for death, compared to those who received both axillary dissection and radiation therapy. Women receiving either radiation alone without axillary dissection, or axillary dissection without radiation were not at significantly higher risk for death, after adjusting for tumor size, estrogen receptor status, comorbidity scores, and other patient characteristics.

DISCUSSION

The findings of this study can be summarized as follows. First, substantial numbers of older women receiving breast-conserving surgery do not receive axillary dissection. Second, of those women not receiving axillary dissection, most also do not receive either adjuvant radiation therapy or chemotherapy. In other words, they receive no therapy directed at occult cancer in the axillary nodes. The percentage of older women who receive no therapy to their axillary nodes has been steadily increasing over the past decade [1, 22, 36, 37]. Third, patients receiving breast-conserving surgery without axillary dissection experience significantly worse survivals than those who do, after controlling for other factors known to affect survival. Finally, there is an interaction between receipt of axillary dissection and radiation therapy on survival, such that

women who receive either axillary dissection or radiation therapy experience similar survivals to those who receive both axillary dissection and radiation, while women who receive neither treatment experience substantially poorer survivals.

In randomized controlled trials of women receiving breast-conserving surgery for early stage breast cancer, axillary dissection has no impact on survival, while the present study and another recent report[9] found a strong effect of axillary dissection on survival in women treated in the community. We will discuss several possible reasons for this difference.

First, in the randomized trials showing no survival advantage associated with axillary node dissection, all other therapies (e.g., radiation, chemotherapy) were held constant. In actual community practice, a major theoretical benefit of axillary dissection would be that the results would influence choice of other treatments. At least one RCT has results that directly support that interpretation. Cabanes and colleagues [38] randomized 658 patients with breast cancers < 3 cm in diameter to receive lumpectomy alone or lumpectomy plus axillary dissection. All patients received radiotherapy to the breast and axilla, but choice of chemotherapy and tamoxifen was left to the discretion of the treating physicians. Not surprisingly, the group receiving axillary dissection had a much higher percentage of patients classified as regional stage; these patients in turn were more likely to receive adjuvant therapies; and they experienced substantially lower overall five year mortality (relative risk of death for the group not receiving axillary dissection = 2.4, $P<0.01$). A recent clinical trial, presented at the 2001 American Society of Clinical Oncology meeting, showed that women aged 70 and older with clinical stage I and estrogen

receptor positive breast cancers may not require routine axillary dissection, and excision and tamoxifen alone is a reasonable alternative [39].

Second, follow-up of patients would be expected to be better in a randomized controlled trial than in the community. Local or regional recurrence of disease would be picked up early, and appropriate therapy initiated, thus minimizing the impact of axillary dissection on survival. In the community, surveillance after initial treatment for breast cancer is sporadic. For example, 22% of women who underwent breast-conserving surgery without adjuvant radiotherapy did not receive any mammography in the 2 years after initial treatment [40].

A third potential explanation for the discrepancy between randomized controlled trials and population-based observational studies on the impact of axillary dissection on survival is possible selection bias in the community; that is, women with underlying comorbidity might be less likely to receive axillary dissection and also be at higher risk for death. However, it is important to note that we were assessing only breast cancer-specific mortality, not total mortality. In addition, controlling for underlying comorbidity did not appreciably affect the increased breast cancer-specific mortality associated with axillary dissection. Finally, eliminating all deaths in the first four years after diagnosis, as an additional control for comorbidity, did not eliminate the impact of axillary dissection on breast cancer-specific survival.

We found no difference in survival among those who received axillary dissection plus radiation versus radiation therapy alone. This was unexpected, because those receiving axillary

dissection would be more likely to be correctly staged and therefore more likely to receive chemotherapy and other treatments (Table 2 and reference 21). One reason for this may be that too few women received chemotherapy for there to be a noticeable effect on survival (Table 2).

We should point out the limitations of this study. First, there is no information on why women did not have an axillary dissection. Second, information on chemotherapy from Medicare has not been well validated externally, and its completeness is unknown. However, our study on patterns of chemotherapy use would suggest that Medicare claims data are relatively complete and accurate in identifying chemotherapy use [25]. In addition, as we previously demonstrated, the fact that Medicare data demonstrates good validity in other aspects of breast cancer care (radiation therapy and type of surgery) provides indirect support for the validity of information for chemotherapy in Medicare [23, 24]. The information on radiation therapy from the combined sources of SEER and Medicare would appear to be complete [23]. Third, there was no information on the use of sentinel node biopsy in SEER, although this procedure may have potential to be a replacement for routine axillary dissection. However, it has still not been confirmed for routine use [41], and it was unlikely to have been widely used during the study period.

Perhaps the major limitation of the study is that there was no information on whether the patients were taking hormone therapy. Because hormone therapy have been shown to improve survival from breast cancer [42], it is possible that women who underwent BCS without either axillary dissection or irradiation were also less likely to be prescribed hormone therapy, which in turn was responsible for the worse survival of these women. In other words, lack of axillary

dissection and radiation therapy associated with BCS may be a marker for other less than adequate care, such as hormone therapy. Recent studies by us support such a possibility. For example, women with breast cancer who received breast-conserving surgery without radiation were also less likely to receive chemotherapy than did women who received this surgery with radiation [25, 43]. The clinical trails have documented that tamoxifen therapy provides substantial survival benefit [42]. In unpublished analyses of women with breast cancer in the New Mexico Tumor Registry, we found that patients receiving breast-conserving surgery without radiation were also less likely to receive hormone therapy (data not shown). Whether the decreased survival of women who received breast-conserving surgery without treatment of the axillary nodes would be completely eliminated by tamoxifen treatment cannot be answered at this time.

In conclusion, a substantial number of older women with early stage breast cancer in the United States receive BCS without axillary dissection, and most of those women also do not receive adjuvant radiation. This combination of no axillary dissection plus no radiation after BCS is associated with an increased risk of deaths from breast cancer. Breast cancer survival has improved steadily over the past 25 years, except for older women [44, 45]. The lack of improvement in the past two decades in survival of older women may be explained in part by the increasing numbers of older women who receive treatments that do not address potential tumor in the axillary nodes [1, 9].

ACKNOWLEDGMENTS

This study was supported by grants from the Department of Defense (DAMD17-99-1-9397 and DAMD17-96-1-6262) and the National Cancer Institute (CA871773). We thank Dong Zhang, Ph.D., for his data management and analytical support. This study used the Linked SEER-Medicare Database. The interpretation and reporting of these data are the sole responsibilities of the authors. The authors acknowledge the efforts of the Applied Research Branch, Division of Cancer Prevention and Population Science, NCI; the Office of Information Services, and the Office of Strategic Planning, HCFA; Information Management Services (IMS), Inc.; and the SEER Program tumor registries in the creation of the SEER-Medicare Database.

Presented in part at the Society for Epidemiologic Research Annual Scientific Meeting, Seattle, WA, June 15-17, 2000.

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Table 1. Receipt of axillary dissection by women with breast cancer who received breast conserving surgery (BCS) between 1988 and 1993 in 9 SEER areas, by patient and tumor characteristics

Patient and tumor characteristics	Number (%) of women receiving BCS* without axillary dissection	Number (%) of women receiving BCS* with axillary dissection	Total
Age (years)			
25-54	931 (10.2)	8173 (89.8)	9104
55-64	835 (15.2)	4674 (84.8)	5509
65-74	1604 (26.0)	4573 (74.0)	6177
75+	3421 (62.2)	2079 (37.8)	5500
Race			
White	6021 (26.0)	17145 (74.0)	23166
Black	463 (26.1)	1313 (73.9)	1776
Other	252 (20.9)	955 (79.1)	1207
Unknown	55 (39.0)	86 (61.0)	141
Marital status			
Married	2588 (17.4)	12276 (82.6)	14864
Unmarried	3866 (36.0)	6876 (64.0)	10742
Unknown	337 (49.3)	347 (50.7)	684
Cancer stage			
Stage I	5143 (28.7)	12750 (71.3)	17893
Stage IIA	1442 (22.4)	4998 (77.6)	6440
Stage IIB	190 (10.8)	1564 (89.2)	1754
Stage II,NOS †	16 (7.9)	187 (92.1)	203
Tumor size (cm)			
<0.5	472 (38.9)	743 (61.1)	1225
0.5-<1.0	1294 (25.0)	3883 (75.0)	5177
1.0-<2.0	2857 (23.9)	9089 (76.1)	11946
2.0-<3.0	1362 (25.2)	4053 (74.8)	5415
3.0-<4.0	466 (30.4)	1066 (69.6)	1532
4.0+	324 (40.4)	478 (59.6)	802
Unknown size	16 (7.9)	187 (92.1)	203
Total	**6791 (25.8)**	**19499 (74.2)**	**26290**

* BCS denotes breast-conserving surgery.
† NOS - not specified.

Table 2. Receipt of radiation therapy and chemotherapy in women aged 65 and older who underwent breast conserving surgery in 1991 through 1993, with or without axillary node dissection*

Surgical treatment categories	Number of patients	Percent of women receiving radiation therapy †	Percent of women receiving chemotherapy ‡
breast conserving surgery **without** axillary dissection	**2215**	**38.5**	**3.1**
ER § positive	1439	39.0	2.0
ER negative	197	44.2	6.1
ER unknown	579	35.4	1.9
Breast conserving surgery **with** axillary dissection	**3113**	**85.9**	**8.0**
Node positive, and ER § positive	368	85.3	13.6
Node positive, and ER negative	72	79.2	34.7
Node positive, and ER unknown	87	81.6	16.1
Node negative, and ER positive	1680	88.0	1.8
Node negative, and ER negative	306	86.6	9.8
Node negative, and ER unknown	534	83.5	2.1
Node not examined	66	62.1	4.6

* For women with early stage (local or regional) breast cancer diagnosed between 1991 and 1993 from the SEER-Medicare linked database.

† Radiation therapy was defined if SEER data indicated so or if there were Medicare claims for radiation therapy within 4 months after diagnosis of breast cancer.

‡ Chemotherapy was defined if patients had at least one Medicare claim for chemotherapy within 12 months after diagnosis.

§ ER denotes estrogen receptor status.

Table 3. Interaction between receipt of axillary dissection and radiation therapy on breast cancer survival in women aged 65 and older with early stage breast cancer, 1991-1993

Variables	Number of patients (n=5328)	Hazard ratio for 3-year breast cancer specific mortality (95% CI) †
Patients receiving BCS, by receipt of axillary dissection (Ax) and radiation (XRT)*		
No Ax + no XRT	1362	1.80 (1.26-2.58)
No Ax + XRT	853	1.13 (0.74-1.73)
Ax + no XRT	440	1.01 (0.59-1.71)
Ax + XRT	2673	1.00
Other key risk factors in the model		
Age (years)		
65-69	1287	1.00
70-74	1415	1.04 (0.69-1.56)
75-79	1189	1.04 (0.68-1.60)
80+	1437	1.21 (0.79-1.86)
Tumor size (cm)		
<0.5	264	1.00
0.5-<1.0	1252	1.17 (0.44-3.10)
1.0-<2.0	2419	2.21 (0.89-5.51)
2.0-<3.0	968	3.51 (1.39-8.86)
3.0-<4.0	255	6.99 (2.69-18.17)
4.0+	138	5.84 (2.11-16.19)
Unknown size	32	6.60 (1.54-28.28)
Comorbidity index scores ‡		
No Medicare claims	344	0.86 (0.46-1.60)
0	3616	1.00
1	637	1.55 (1.07-2.24)
2	323	1.77 (1.11-2.81)
3+	408	1.95 (1.30-2.91)

* BCS (breast-conserving surgery), No Ax (no axillary dissection); no XRT (no radiation therapy); Ax (axillary dissection); XRT (radiation therapy).

† Hazard ratios (95% confidence interval), adjusted for the variables listed in the table and also adjusted for marital status (married, unmarried and unknown), race (white, black, and other), 9 SEER areas, and estrogen receptor status (positive, negative, unknown).

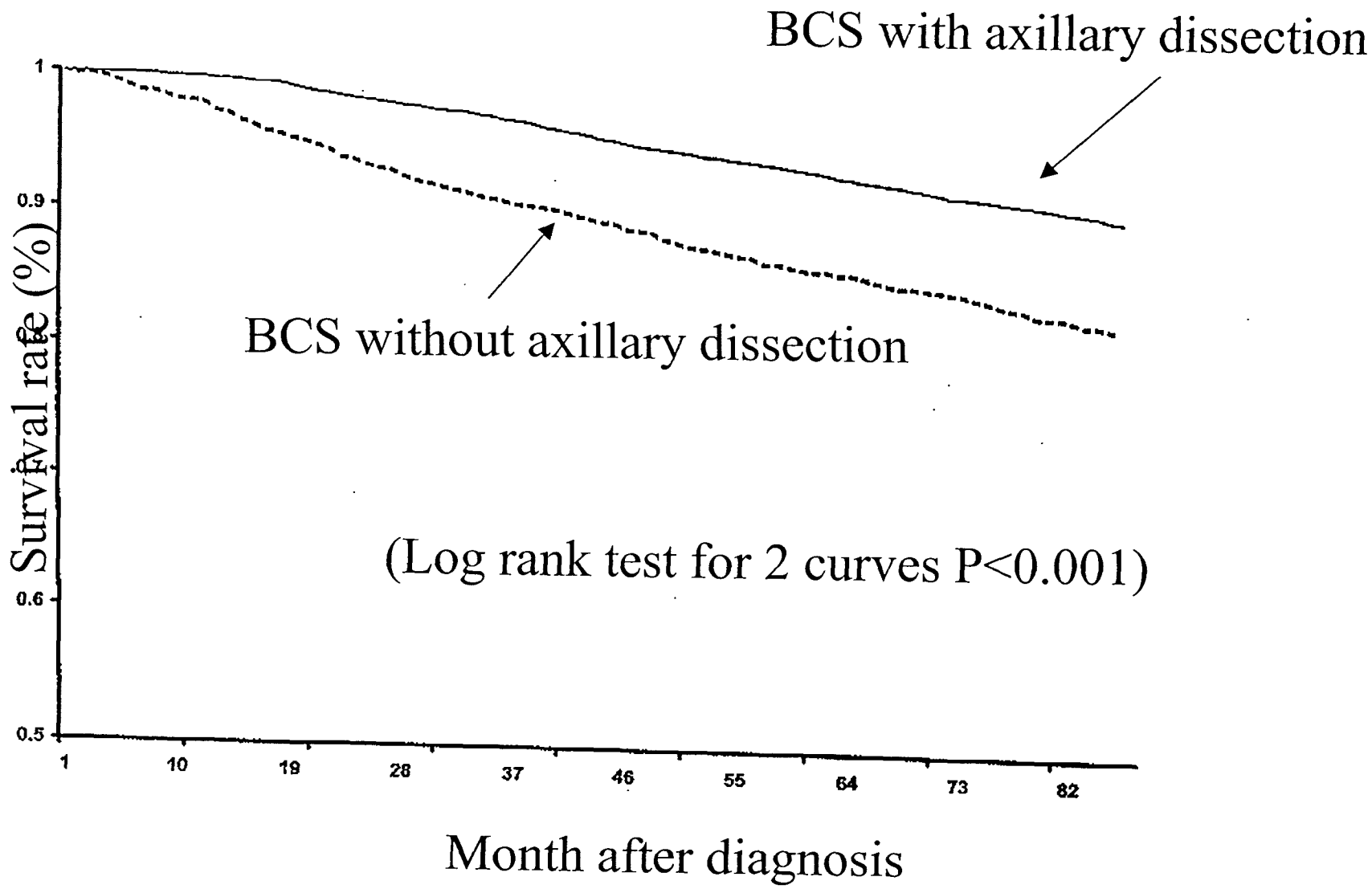
‡ Comorbidity was assessed by a validated algorithm[33,34] using Medicare claims.

Legend for Figure 1.

Figure 1. Kaplan-Meier breast cancer specific survival curve for women with early stage breast cancer, stratified by breast-conserving surgery (BCS) with and without axillary dissection.

The 7-year breast cancer specific survival curves are shown for women diagnosed with breast cancer diagnosed in 1988-1989. The log rank test for survival curves between BCS without axillary dissection and BCS with axillary dissection was statistically significant for two groups ($P<0.0001$). Data are for all women aged 25 and older diagnosed with early stage breast cancer in one of the 9 SEER areas in 1988 and 1989 (n=6,318), and followed though 1996 from SEER Public Use Data Set.

The 7-year Breast Cancer Specific Survival Curve



Persistent Differences in Socio-demographic Determinants of Breast Conserving Treatment Despite Overall Increased Adoption

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Running head: Persistent Differences in Socio-demographic Determinants

Text word count 3,637

Grant support from Department of Defense, Grant #DAMD 17-96-1-6262; American Cancer Society CCCDA-99-291-01; and MCW General Clinical Research Center, Grant Number 5 M01 RR00058.

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Word count 250

ABSTRACT

Background. Use of breast-conserving treatment (BCT) has previously demonstrated variability by socio-demographic factors.

Objective. To determine whether variation in use of BCT by age, race, county income, county education, and population density declined between 1983 and 1996.

Design. Trends in use of BCT over time were modeled with logistic regression.

Setting. Surveillance, Epidemiology, and End Results national tumor registry data.

Patients. Population-based cohort of 158,496 women with local or regional stage breast cancer.

Main Outcome Measure. Receipt of BCT.

Results. Use of BCT increased overall, and among all subgroups of age, county income, county education, population density, and race. There was no decline in age-related variation in use of BCT over time. However, older women were less likely to undergo BCT including radiotherapy (RT) and lymph node dissection (LND), and were more likely to undergo BCT omitting RT and/or LND. Variation in use of BCT by county income persisted, with women residing in poorer counties less likely to undergo BCT, whether or not accompanied by RT and LND. Variation in overall use of BCT by county education also persisted. While women residing in better-educated counties were more likely to undergo BCT accompanied by RT and LND, they were not more likely to undergo BCT omitting RT and/or LND. No decline in variation by population density occurred, with women residing in urban areas more likely to use BCT whether or not accompanied by RT and LND.

Conclusions. Socio-demographic differences in BCT use have persisted over time. The increased overall adoption of BCT has not led to consistency in use of this treatment.

Key Words: breast neoplasms; mastectomy, segmental; SEER program; health services research

INTRODUCTION

Although randomized clinical trials are generally regarded as the highest level of evidence guiding clinical care, [1] studies have shown substantial lag time before the results of such trials are incorporated into clinical practice. [2-5] In the case of breast-conserving surgery (BCS) as therapy for early stage breast cancer, the first U.S. randomized trial showing equal 5-year survival with BCS and mastectomy was published in 1985. [6] Although the use of BCS rose moderately from 1983 to 1985, the use of BCS was virtually unchanged over the first several years after the 1985 randomized trial publication [4, 7-9] and did not rise further until after1990. This was the year of an NIH consensus conference which recommended BCS as "preferable" for the majority of women with early stage breast cancer. [10]

BCS has been characterized by variation in level of use by patient demographic factors. Specifically, greater use of BCS has been found in more urban areas compared to rural areas [5, 9, 11], in patients residing in the northeastern U.S. compared to those residing in central and southern states [5, 12] and among women of higher socioeconomic status compared to women of lower socioeconomic status [13]. There have been conflicting results with respect to use of BCS by age, with some investigators finding greater use among older women, [11, 14] and others finding greater use among younger women. [4, 15-17]

In addition to the variation in use of BCS, it has not been uniformly accompanied by axillary lymph node dissection (LND) and radiotherapy (RT) as was recommended in

the 1990 NIH consensus statement. [10] In fact, omissions of both axillary LND and RT have been documented [18]. Omission of these aspects of complete breast conserving treatment (complete BCT defined as BCS accompanied by axillary LND and RT) has also been subject to variation. [19-23] For example, older patients or those with substantial co-morbidity have been less likely to undergo complete BCT, while younger, healthier patients have been more likely to undergo complete BCT [22, 23].

The purpose of this study was to examine the variation of demographic predictors of BCT during the years preceding and following the 1990 NIH Consensus Conference. One would expect some variation in the use of a new therapy shortly after its introduction to clinical care. However, we hypothesized that the variation in use of BCT by age, socioeconomic status, and urban vs. rural residence would have declined over time, particularly after the 1990 NIH conference.

METHODS

Databases

SEER National Tumor Registry Files. The National Cancer Institute's SEER program consists of a group of population-based tumor registries, each of which provides data to the national program. The nine sites analyzed in this study include five whole states (CT, HI, IA, NM, UT), and four metropolitan areas (Atlanta, Detroit, San Francisco-Oakland, and Seattle-Puget Sound). [24]

The SEER registries function according to a standardized set of procedures. Incident cancers in persons residing within the coverage areas are determined from hospitals, offices, and some freestanding centers. For each subject with an incident breast cancer, information is abstracted regarding demographics, stage of disease, and initial therapy administered or planned within 4 months.

United States Census Data. We used the U.S. 1990 Census files to provide estimates of socioeconomic data for patients in the study cohort. [25] For each patient, we determined the mean per capita income, percentage of the population that had completed high school, and size of the metropolitan statistical area for the county in which the patient resided at the time of diagnosis. Use of census data is a validated method for estimating socioeconomic status when individual level data is not available. [25, 26] County-level data was used since SEER does not release census tract or zip code information.

Study Subjects

A cohort of 158,496 women was selected from 238,005 women diagnosed with breast cancer between 1983 and 1996. Women were excluded for the following reasons:

the cancer was *in situ* (n=28,005), distant (n=12,393), or unstaged (8,932); breast cancer was not the patient's first cancer (n=25,294); there was no microscopic confirmation of disease (n=3,573); the patient did not receive either a mastectomy or BCS (n=1,902); the age at diagnosis was less than 30 (n=1,368); or breast cancer was bilateral (n=220). Some women were in more than one exclusion category. We excluded women with carcinoma *in situ* because the effectiveness of BCS for this condition did not become established until much later than for invasive breast cancer, which would have lead to different historic patterns of use. [27, 28]

Women were considered to have received BCS if they underwent segmental mastectomy, lumpectomy, quadrantectomy, tylectomy, wedge resection, excisional biopsy, or partial mastectomy. All other women underwent mastectomy treatment. Women underwent complete BCT if they underwent BCS plus LND and RT; they underwent incomplete BCT if they underwent BCS omitting LND or RT, or both. Total BCT refers to the sum of complete and incomplete BCT. The size of the metropolitan statistical area (MSA) of the county of residence of the patient was categorized as less than or equal to100,000 persons (rural), or greater than100,000 persons (urban). The per capita income (PCI) of the county of residence of the patient based on 1990 census data was categorized into quartiles (<$13,017; $13,017-17,114; $17,115-18,982; >$18,983). Educational status was based on the percent of high school graduates among adults residing in the county of residence of the patient, categorized as <80% graduates, 80-85% graduates and >85% graduates.

Age at diagnosis was categorized as 30-49, 50-64, 65-79, and 80 and older. Of the 158,496 patients, 24.3% were aged 30-49, 31.8% were 50-64 years, 33.6% were 65-79

years, and 10.4% were 80 and older. Race was categorized as white-non-Hispanic, black-non-Hispanic, Hispanic, and other or unknown. Eighty-four percent were white-non-Hispanic, 7.2% were black-non-Hispanic, 3.1% were Hispanic, and 5.9%were other or unknown. Stage was categorized as local or regional based on the SEER historic stage. Approximately 66% had local stage disease and 34% had regional disease at presentation. (The more precise AJCC staging was not available in SEER until 1988.)

Statistical Analysis

BCT use for each of the variables used in the model (age, race, stage of disease, income, education, MSA, and SEER site) was calculated for each quarter based on month and year of breast cancer diagnosis. Trends in treatment over time were modeled with polytomous logistic regression incorporating a linear spline function. [29] The model was built in two steps. The first step modeled the trends in use over time with linear regression. Time was decomposed into 5 distinct linear segments: 1) an "early" phase from 1983-84, 2) a 6-month period of rapid "rise" in BCT use during the first 2 quarters of 1985, 3) a period of "stable" use from the 3rd quarter of 1985 through the 4th quarter of 1989, 4) a 6-month period of decline, or "dip," in BCT use within the stable period previously shown to be attributable to a celebrity role model, [8] and 5) a "late" phase gradual increase beginning in the 1st quarter of 1990 and continuing through 1996. Each segment was described by a linear regression equation.

The second step involved polytomous logistic regression to simultaneously predict the probability of receipt of 1) complete BCT, 2) incomplete BCT and 3) mastectomy for each woman in the cohort. The model included terms for the time trend

described by the five linear segments (early, rise, stable, dip, late) as well as the covariates (age, race, stage of disease, income, education, MSA, SEER site). The results of the model were plotted and p-values determined separately for each subgroup of a given socio-demographic factor, e.g., age categories, quartiles of income. The Hosmer-Lemeshow test [30] was performed to assess goodness-of-fit.

Two aspects of variation were assessed for each determinant of BCT use. First, the spread was calculated as the difference between the adjusted means of the highest and lowest use subgroup between 1983 and 1996. Wald Z-tests [30] were performed to determine significant differences in the change in spread. Second, the slopes of the curve for each subgroup were compared for the late phase (1990-1996). Tukey's HSD (Honestly Significant Difference) [30] was used for multiple comparison adjustment of the individual p-value. The overall p-value was set to 0.05.

RESULTS

Change in Use of BCT by Age

Figure 1 shows by age group the percentage of the total cohort (mastectomy and BCT) that underwent total BCT, complete BCT, and incomplete BCT during each calendar quarter from 1983 through 1996. An increase in total, complete, and incomplete BCT use occurred among all age groups. We had hypothesized that the variation in use by age group would decrease over time. However, this was not seen. For total BCT, the spread between the highest and lowest use age groups did not change significantly between 1983 and 1996 ($p = 0.055$) (Figure 1, bottom). The results for complete BCT and incomplete BCT use help to explain the pattern of use seen for total BCT. For complete BCT, the oldest age group was the lowest use group throughout the time period studied (Figure 1, top) and the spread between the highest and the lowest use group increased significantly between 1983 and 1996 ($p < 0.001$). With respect to slope, or rate of change in complete BCT use, women aged 30-49 had a significantly smaller slope than women in the other age groups ($p < 0.001$) suggesting a possible increase in variation in use of complete BCT in the near future. For incomplete BCT, the oldest age group was the highest use group throughout the time period studied (Figure 1, middle) and the spread between the highest and lowest use groups increased significantly between 1983 and 1996 ($p < 0.001$). The slope for women in the oldest age group was significantly less than the slopes of the other three groups suggesting a possible decrease in variation of use of incomplete BCT in the near future.

Change in Use of BCS by County Per Capita Income

An increase in use occurred in every quartile of income for total BCT as well as for complete BCT and incomplete BCT. Similar to previous reports, we found a direct relationship between residence in a wealthier county and increased total use of BCT (Figure 2, bottom). Interestingly, this relationship was true for both complete BCT (Figure 2, top) and incomplete BCT (Figure 2, middle); that is, women residing in the wealthiest counties were more likely to receive complete BCT and they were more likely to receive incomplete BCT. A significant increase in spread occurred between 1983 and 1996 for total BCT ($p < 0.001$), complete BCT ($p < 0.001$), and incomplete BCT ($p < 0.001$). For complete BCT, the slope of the highest quartile of income was significantly greater than that of the middle two quartiles ($p = 0.006$), and approaching significance compared to the lowest quartile ($p = 0.046$), suggesting an increase in variation in use of complete BCT in the near future. For incomplete BCT, the slope of the lowest quartile of income was significantly less than that of the other three quartiles ($p = 0.0012$), suggesting an increase in variation in incomplete BCT in the immediate future.

Change in Use of BCS by County Education

Total use of BCT increased substantially with increasing educational status (Figure 3, bottom). Women residing in the least educated areas had the lowest use of BCT throughout the period of study. Counter to our hypothesis, there was no significant change in the spread between the highest and lowest categories of county educational status from1983 to 1996. The results for complete BCT show a persistent direct relationship between better county educational status and greater use of BCT (Figure 3, top). The spread between the highest and lowest use groups did not change significantly

from 1983 to 1996. However, the slope of the highest educational group is significantly less than that of the other two groups ($p < 0.001$) suggesting a decrease in the variation in use of complete BCT in the near future. In contrast to the pattern of use for incomplete BCT seen for PCI, there was no direct relationship between higher educational status and receipt of incomplete BCT (Figure 3, middle). The slopes of the 3 educational groups were not significantly different from one another, suggesting no immediate change in use of incomplete BCT.

Change in Use of BCS by Population Density

An increase in overall use of BCT (Figure 4, bottom) was seen for both urban and rural areas, which remained true for both complete (Figure 4, top) and incomplete BCT (Figure 4, middle). The spread between urban and rural use groups did not change significantly between 1983 and 1996 for total, complete, or incomplete BCT. For complete BCT, the slope for the rural group was significantly greater than the slope for the urban group ($p = 0.001$) suggesting a possible decrease in variation between the two groups in the near future. In contrast, for incomplete BCT, the slope for the rural group was significantly less than the slope for the urban group ($p = 0.001$), suggesting a future increase in variation between the two groups for incomplete BCT.

Change in Use of BCS by Race

Use of total BCT went up in all racial groups, and this increase was seen in both complete BCT and incomplete BCT (data not shown). Similar to previously published work [13], when controlling for county income and education we found no consistent variation in use by racial subgroups, and no change in spread over time.

DISCUSSION

In this paper, we show that the use of BCT has increased over time among all subgroups of age, county-level income, county-level education, population density, and race. However, we did not find the expected decreased variation in use of BCT by 1996. For all the factors studied, the spread between the highest and lowest use groups over time either remained the same or increased. Patterns of use varied by complete and incomplete BCT. This was especially striking for age for which women in the oldest age group had the lowest use of complete BCT and the highest use of incomplete BCT. The differential use in the adoption of BCT based on county-level socioeconomic status and population density persisted over the entire 14-year period of observation. Patterns of use for complete and incomplete BCT were similar for county-level income with women residing in higher income areas being more likely to receive both complete and incomplete BCT. Patterns of use for complete and incomplete BCT were different for county-level education. Women residing in the better-educated counties were more likely to receive complete BCT while educational status was not a determinant for receipt of incomplete BCT.

The changing pattern of relative use of total BCT by age, and the striking differences in use of complete and incomplete BCT by the oldest age group, may explain disagreement among previous authors regarding use of BCT by age. Some previous studies have shown higher BCT use among older women [11, 14, 19] and some have shown lower use.[4, 15-17] In two studies which found that women aged 80 and older had greater use of BCT, the time period analyzed was 1983-1986, [11, 14] a time during which the current study also finds high use of total BCT among women aged 80 and older. By

about 1986, the use of total BCT among women under 50 years exceeded the use by women aged 80 and older, explaining the fact that studies of years after 1985 found lower use among women aged 80 and older. [4, 15-17] The breakdown into use of complete and incomplete BCT helps explain the overall pattern of use. In future studies of BCT use by age, it will be important for investigators to consider the changing use of BCT by age over time, and specify whether analysis was for total, complete, or incomplete BCT.

The persistent differences in use of BCT by county-level socioeconomic status are particularly compelling. Early in the diffusion of a new treatment, physician factors such as knowledge of the treatment options can be assumed to play a critical role in the variation in use. However, the persistently higher use of BCT among women of higher socioeconomic status over time suggests other factors at play. Factors contributing to lower rates of BCT have been examined by many authors and include societal factors such as organization of the medical community, [20, 21] as well as physician- and patient-level factors. Patient factors include access to radiation therapy facilities,[31] economic problems and "different life concepts" [32] and body image. [22]

Whether variation in BCT use by different groups is acceptable as a matter of social policy will depends to a large degree whether the differences in use are motivated by patient preferences or forces external to the patient. The literature of technology diffusion has established that early adopters of new technology have more years of formal education, superior ability to deal with abstractions, and greater financial capability than later adopters [33] consistent with our findings of greater use of complete BCT among women residing in wealthier and better educated areas. The final level of

diffusion in a community of potential adopters is not necessarily 100% but depends on assessment of costs and benefits in relation to patients' circumstances and values.

In the case of complete BCT for early stage breast cancer, better-educated women may be more likely to be aware of and seek out treatment options even if not initially offered by their physician. Better-educated women may be more willing to accept the rather abstract notion that an irradiated cancer is just as "gone" as a cancer that has been surgically removed. Higher income patients may be able to absorb costs and risks of implementation of breast conserving treatment, from the more immediate logistical problems associated with transportation to and from radiation therapy and the time off from work required to attend radiation sessions, to the more remote increased chances of cancer recurrence. Persistent lesser use of complete BCT by women residing in less educated and less wealthy areas may be a reflection of women opting for a treatment that requires the least time away from work or the least time away from daily tasks and obligations. A substantial effort has been made toward studying the decision making process of women regarding treatment for early stage breast cancer, and toward developing educational tools which incorporate patient preferences into the decision. [34-37] Benefits of such efforts will be to improve patient satisfaction with their decision. The fact that use of incomplete BCT was higher among women from higher income areas but that this pattern of use was not seen for women from higher education areas suggests that these factors are measuring distinct characteristics in the population. Further research into patient decision making at the patient level is needed to better understand the treatment patterns for complete and incomplete BCT.

Our findings on population density confirm previous studies that have found an association between decreased use of BCT and rural residence. [5, 11] Other studies have found an association between greater use of BCT and large hospital size [7, 38] and also the presence of radiation facilities,[4, 5, 7, 17] both of which are also related to urban location of the hospital. However, we have previously found that distance from a radiation therapy facility site did not entirely explain the lesser use of BCT among rural women. [39] The fact that the differential use of BCT by population density has increased over time supports the view that the urban-rural discrepancy in use of BCT is more likely attributable to access issues or differences in patient preference than to lack of knowledge about the newer therapy.

A limitation of our study is that the population residing within the SEER areas is more affluent and more urban than the remainder of the United States. [40] However, given that rates of breast conserving treatment are higher in more affluent and urban women, we would anticipate an even greater discrepancy between groups if we could study the general population. Our measures of socioeconomic status are ecologic, and based on county level data. The national SEER database does not include census tract or zip code information that would allow a more accurate estimate of income and educational status. However, any resulting misclassification should be non-differential, which would make it harder to detect differences between subgroups. This makes our positive findings all that much more significant.

Conclusion

Our analysis confirms that socio-demographic differences in BCT use have persisted for more than 10 years after the publication of the first U.S. randomized trial of

this therapy. The fact that these differences have persisted for so long suggests that they are not due simply to lack of physician knowledge about treatment options for early stage breast cancer but are due to enduring factors such as organization of the medical community and patient preferences. To the extent that the differences in use represent differential access to care, programs to improve access need to be developed. Likewise, the use of incomplete BCT in any group is in conflict with the NIH Consensus Statement[10] and raises quality of care concerns. However, inasmuch as differences are a reflection of patients choosing between two equally effective treatments based on their own life circumstances, differences may be acceptable. Just as the optimal rate for BCT use is not necessarily 100%, the optimal rate may vary by age, income, education and location of the patient, as well as other variables not evaluated in this study. In the case of treatment for early stage breast cancer, it is even conceivable that practice variation is a marker of success in terms of physicians listening to patients and incorporating their beliefs and values into treatment decisions. Further research at the level of the patient needs to be performed to further explore the reasons for variation in treatments.

Acknowledgements

Grant support from Department of Defense, Grant #DAMD 17-96-1-6262; American Cancer Society CCCDA-99-291-01; and MCW General Clinical Research Center, Grant Number 5 M01 RR00058.

Presented in part at the 23rd Annual Meeting of the Society for General Internal Medicine, May 4-6, 2000, Boston, MA.

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Legend

Figure 1

Use of breast-conserving treatment (BCT) for early stage breast cancer by subgroups of age, over the time period 1983-1996. Figures shown are for complete BCT (top), incomplete BCT (middle), and total BCT (bottom). Plotted points are based on a logistic regression model that simultaneously adjusts for age, race, county-level income, county-level education, population density and SEER site.

Legend

Figure 2

Use of complete (top), incomplete (middle), and total (bottom) BCT for early stage breast cancer by per capita income of the county in which each woman lived at the time of breast cancer diagnosis, 1983-1996, based on a logistic regression model simultaneously adjusting for age, stage, race, county-level education, population density and SEER site.

Legend

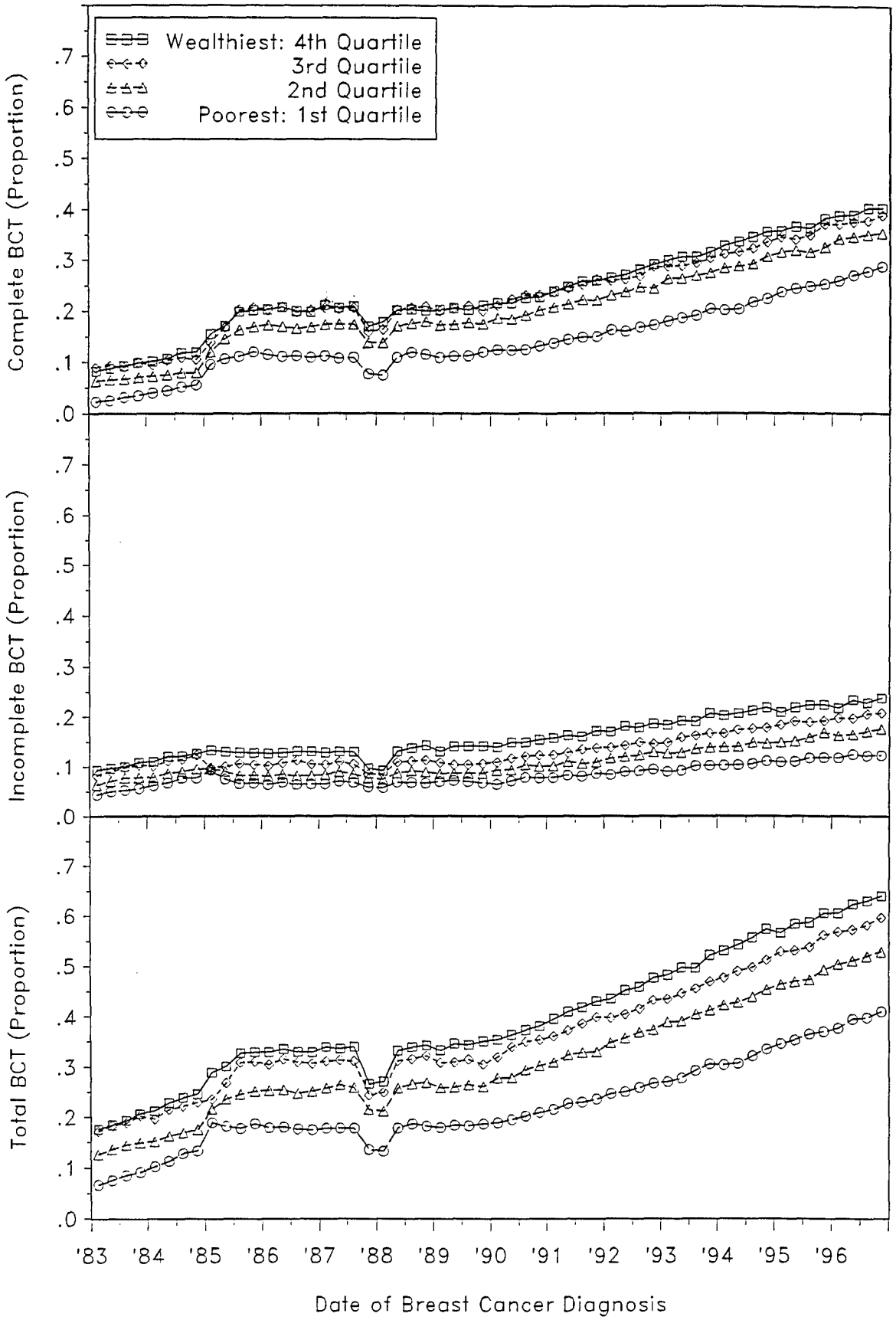
Figure 3

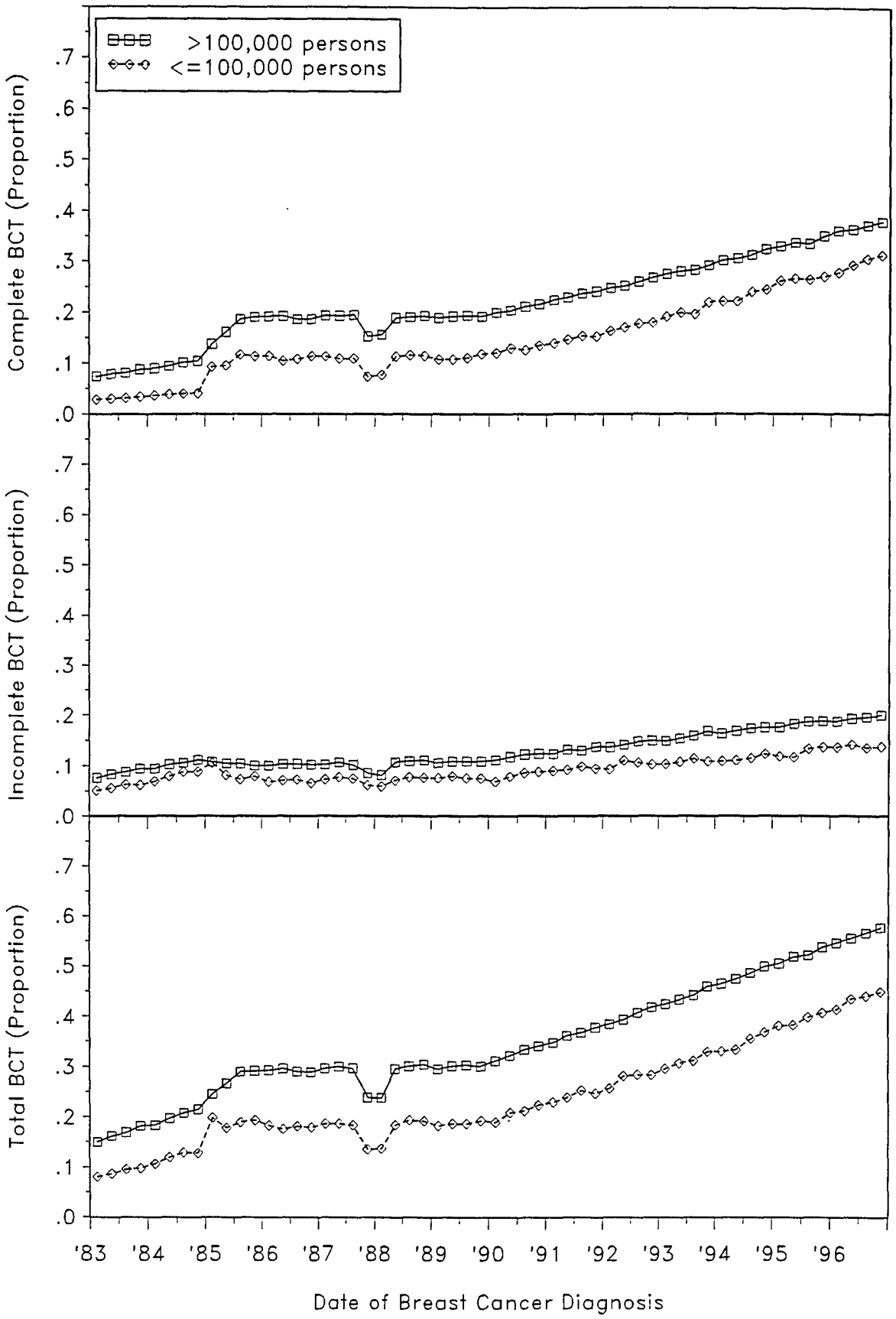
Use of complete (top), incomplete (middle), and total (bottom) BCT for early stage breast cancer by educational status of the county in which each woman lived at the time of breast cancer diagnosis, 1983-1996, based on a logistic regression model simultaneously adjusting for age, stage, race, county-level income, population density, and SEER site.

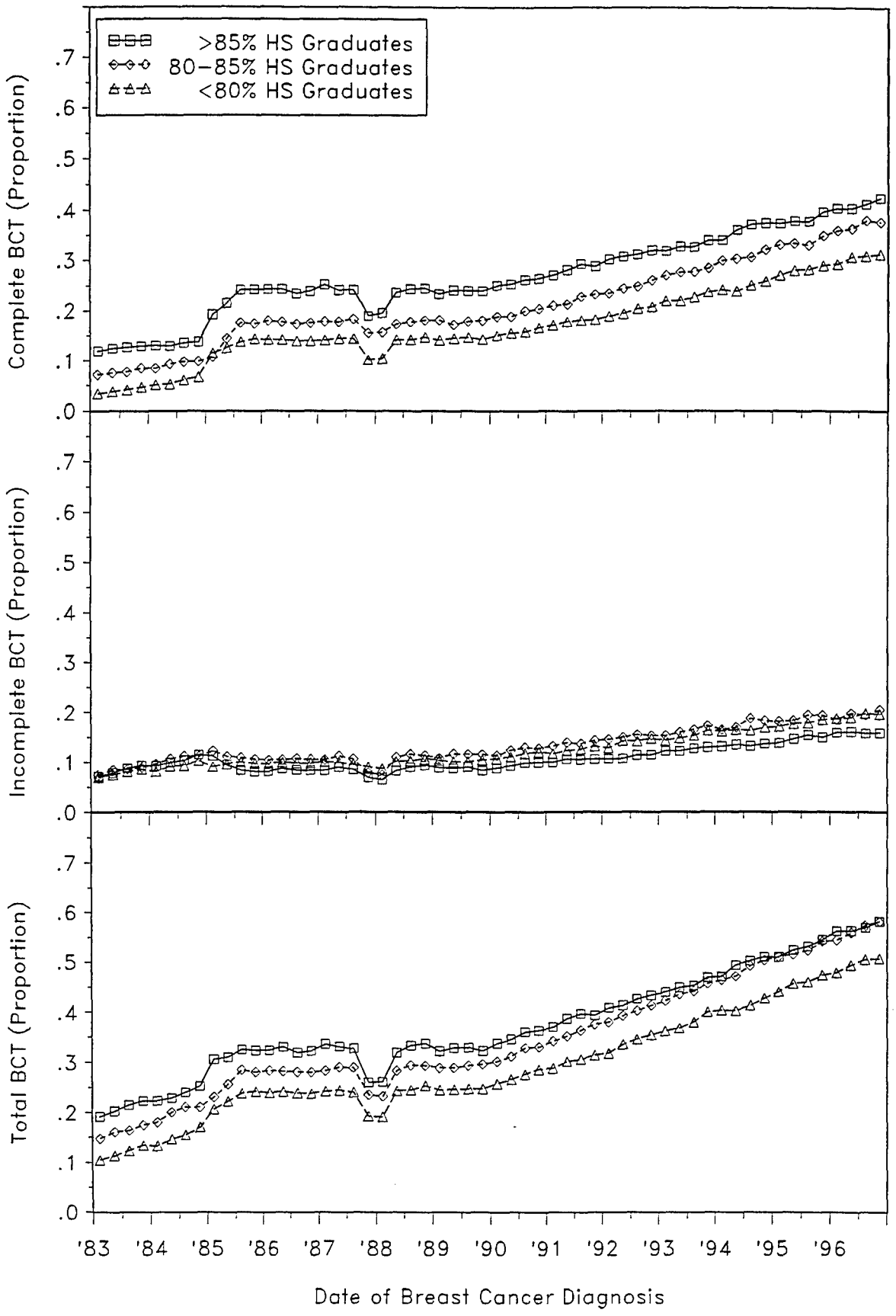
Legend

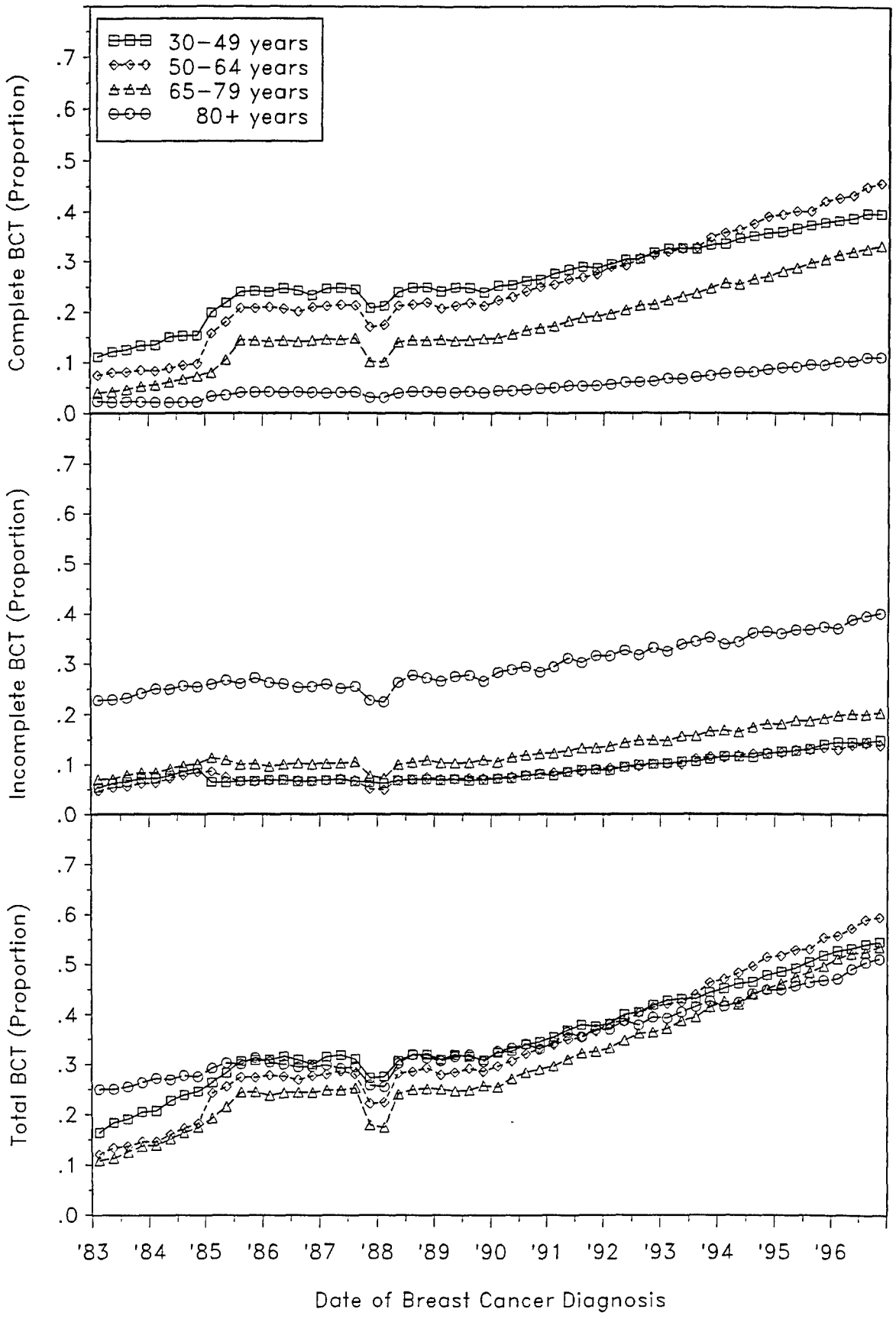
Figure 4

Use of complete (top), incomplete (middle) , and total (bottom) BCT for early stage breast cancer by population density, 1983-1996, based on a logistic regression model simultaneously adjusting for age, stage, race, county-level income, county-level education, and SEER site.


Wealthiest: 4th Quartile
3rd Quartile
2nd Quartile
Poorest: 1st Quartile
Complete BCT (Proportion)
Incomplete BCT (Proportion)
Total BCT (Proportion)
.0
.1
.2
.3
.4
.5
.6
.7
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
Date of Breast Cancer Diagnosis


>100,000 persons
<=100,000 persons
Complete BCT (Proportion)
Incomplete BCT (Proportion)
Total BCT (Proportion)
.0
.1
.2
.3
.4
.5
.6
.7
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
Date of Breast Cancer Diagnosis


>85% HS Graduates
80-85% HS Graduates
<80% HS Graduates
Complete BCT (Proportion)
Incomplete BCT (Proportion)
Total BCT (Proportion)
.0
.1
.2
.3
.4
.5
.6
.7
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
'95
'96
Date of Breast Cancer Diagnosis


30–49 years
50–64 years
65–79 years
80+ years
Complete BCT (Proportion)
Incomplete BCT (Proportion)
Total BCT (Proportion)
.0
.1
.2
.3
.4
.5
.6
.7
'83
'84
'85
'86
'87
'88
'89
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Date of Breast Cancer Diagnosis

MEDICAL CARE
Volume 38, Number 7, pp 719–727
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Accuracy and Completeness of Medicare Claims Data for Surgical Treatment of Breast Cancer

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BACKGROUND. Although a number of studies have used Medicare claims data to study trends and variations in breast cancer treatment, the accuracy and completeness of information on surgical treatment for breast cancer in the Medicare data have not been validated.

OBJECTIVES. This study assessed the accuracy and completeness of Medicare claims data for breast cancer surgery to determine whether Medicare claims can serve as a source of data to augment information collected by cancer registries.

METHODS. We used the Surveillance, Epidemiology and End Results (SEER) Cancer Registry–Medicare data and compared Medicare claims on surgery with the surgery recorded by the SEER registries for 23,709 women diagnosed with breast cancer at ≥65 years of age from 1991 through 1993.

RESULTS. More than 95% of women having mastectomies according to the Medicare data were confirmed by SEER. For breast-conserving surgery, 91% of cases were confirmed by SEER. The Medicare physician services claims and inpatient claims were approximately equal in accuracy on type of surgery. The Medicare outpatient claims were less accurate for breast-conserving surgery. In terms of completeness, when the 3 claims sources were combined, 94% of patients receiving breast cancer surgery according to SEER were identified by Medicare.

CONCLUSIONS. The combined Medicare claims database, which includes the inpatient, outpatient, and physician service claims, provides valid information on surgical treatment among women known to have breast cancer. The claims are a rich source of data to augment the information collected by tumor registries and provide information that can be used to follow long-term outcomes of Medicare beneficiaries.

Key words: breast cancer; mastectomy; breast conserving surgery; SEER; Medicare. (Med Care 2000;38:719–727)

Administrative databases have been increasingly utilized in studies of health care outcomes over the past decade.[1–8] For example, Medicare claims data have been used to estimate the incidence of breast cancer,[4–7] to examine treatment patterns for breast cancer,[8,9] and to study clinical surveillance of breast cancer, such as postoperative use of radiotherapy.[10,11] Although Medicare claims data have been found to

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This study was supported by grants from the Department of Defense (DAMD17-97-1-709-5, DAMD17-96-6262, and DAMD17-99-1-9397), the National Cancer Institute (CA72076), and the Sealy & Smith Foundation.

Presented in part at the Association for Health Services Research Annual Meeting, Los Angeles, California, June 25–27, 2000.

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Received July 13, 1999; initial review completed October 8, 1999; accepted February 8, 2000.

be useful for research, there are some concerns, including the accuracy of the diagnostic and procedure coding,[1-6,12] demographic coding errors,[2,11] incomplete coverage of all Medicare beneficiaries,[2,12] and completeness of the claims.[2,11,13] Recently, Cooper and colleagues[14] found that the sensitivity of Medicare data for detection of breast cancer was reasonably high, especially if Medicare parts A and B are combined and surgical procedure codes were used. On the other hand, Warren et al[7,15] determined that the diagnostic codes from Medicare hospital claims had high predictive value for breast cancer incidence but that the diagnoses from the physician claims had low predictive value. Medicare data also have limited utility for measuring cancer stage.[16]

The accuracy and completeness of information on surgical treatment for breast cancer in Medicare data, however, have not been validated, even though a number of studies have used Medicare claims data to study trends and variations in breast cancer treatment.[8-11,17] Although the coding and completeness of mastectomies in the inpatient claims appear to be very good,[12,18] the accuracy and completeness of information on breast-conserving surgery (BCS) are not known. In particular, the increasing use of BCS[8,19] and the shift to more outpatient treatment[20] have raised questions about the completeness and accuracy of claims for surgery performed outside the hospital.

This study was conducted to assess the accuracy and completeness of Medicare data for breast cancer surgery through the use of all available Medicare claims sources: hospital inpatient, hospital outpatient, and physician services data. Of interest is the extent to which the claims provide information on breast cancer–related surgery in the first course of therapy and whether the type of surgery is confirmed by an external source of data. The overall goal is to determine, with the use of a cohort of women reported by cancer registries as having breast cancer, whether Medicare claims can serve as a source of data to augment information collected by cancer registries and be used to describe surgical treatment patterns in older women with breast cancer.

Methods

Data Sources

We used the merged Surveillance, Epidemiology and End Results (SEER)–Medicare database for this analysis. The SEER program, supported by the National Cancer Institute, includes population-based tumor registries in selected geographic areas. In 1992, these areas included the metropolitan areas of San Francisco–Oakland, Detroit, Atlanta, and Seattle; Los Angeles County; the San Jose–Monterey area; and the states of Connecticut, Iowa, New Mexico, Utah, and Hawaii.[21] These areas cover ~14% of the US population.[21] The registries ascertain all newly diagnosed (incident) breast cancer cases from multiple reporting sources, such as hospitals, outpatient clinics, laboratories, private medical practitioners, nursing/convalescent homes/hospices, autopsy reports, and death certificates.[13,22,23] Information includes tumor location, size, and histological type; such demographic characteristics as age, gender, race, and marital status; and types of treatment provided within 4 months of the date of diagnosis.[22] In the case of surgery, SEER records the most invasive surgery.

The Medicare program is administered by the Health Care Financing Administration (HCFA). It covers hospital, physician, and other medical services for >97% of persons ≥65 years of age.[13,23] The Medicare claims data used in the study included the following 3 files: (1) Medicare Provider Analysis and Review File, which contains inpatient hospital claims; (2) the Hospital Outpatient Standard Analytic File, which contains the claims for outpatient facility services; and (3) the 100% Physician/Supplier File, which contains the claims for physicians' and other medical services. These data were available for all beneficiaries starting in 1991. Therefore, we used all cases diagnosed between January 1, 1991, and December 31, 1993.

Cases reported by the SEER registries from 1973 to 1993 have been matched against Medicare's master enrollment file. Of persons ≥65 of age appearing in the SEER records, Medicare eligibility could be identified for 94%. The method of linking these data has been described elsewhere.[13,20] For SEER cases found to be Medicare eligible, their claims are available through 1994.

Study Population

The study population consisted of all female patients diagnosed with breast cancer at ≥65 years of age between 1991 and 1993. Excluded were women who did not have full coverage of both Medicare parts A and B or who were members of

HMOs in the year of diagnosis because claims from these organizations may not be included in the HCFA databases. Also excluded were 61 patients whose month of diagnosis was unknown and 126 patients with no information from SEER on surgical treatment. This left 23,709 patients for analysis (8,022 in 1991, 8,056 in 1992, and 7,631 in 1993).

Variable Definitions

Breast Cancer–Directed Surgery In SEER, BCS was defined as segmental mastectomy, lumpectomy, quadrantectomy, tylectomy, wedge resection, nipple resection, excisional biopsy, or partial mastectomy unspecified, with or without dissection of axillary lymph nodes. Mastectomy was defined as subcutaneous, total (simple), modified radical, radical, or extended radical mastectomy.

In Medicare, BCS was defined with the following codes: ICD-9-CM[24] procedure codes 8521 (local excision), 8522 (quadrantectomy), or 8523 (subtotal mastectomy) or common procedure terminology[25] codes 19120 (local excision), 19160 (partial mastectomy), or 19162 (partial mastectomy with axillary dissection). Mastectomy was defined with the following codes: ICD-9-CM procedure codes 8541 to 8542 (simple mastectomy), 8543 to 8544 (modified radical), or 8545 to 8548 (radical) or a common procedure terminology code on a physician or outpatient claim of 19240 (modified radical), 19220 (radical), or 19180 (simple mastectomy).

Analyses

Medicare claims for surgical treatment were categorized into 3 groups: mastectomy, BCS, and no cancer-directed surgery. Women were considered to have received mastectomy if any of 3 Medicare claim sources (inpatient, outpatient, or physician/supplier claims) indicated so, regardless of whether or not they had any claims for BCS. If they had claims for BCS only, they were defined as having received BCS. If they had neither claims for mastectomy nor for BCS, they were considered to have no cancer-directed surgery.

Because SEER collects only information on treatment within 4 months of the date of diagnosis,[23] we examined all Medicare claims from 1991 to 1994 for surgery that were made within 4 months (122 days) of the date of diagnosis. Because SEER reported only the month and year of diagnosis, we therefore arbitrarily defined the day of diagnosis in SEER as the 15th of the month. Date of surgery was determined from the claims source that first identified the type of surgery (mastectomy or BCS). For inpatient claims, it was defined as the date of admission. For outpatient and physician claims, it was defined as the earliest date of service.

Patient and tumor characteristics, such as age, race, tumor stage, and geographic areas, are available from the SEER data. The simple κ statistic was calculated to quantify the degree of agreement in surgical treatment categories between the 2 databases.[26] The odds ratios of concordance on surgical treatment between the 2 databases were generated from multivariate logistic regression analyses. These analyses adjusted for age, race, tumor stage, and geographic area because previous studies have found that the degree of agreement of information on treatment is affected by these factors.[8,9,11,12,20] Four metropolitan areas (San Francisco–Oakland was combined with Los Angeles County and the San Jose–Monterey area in California) and 5 states, forming 9 areas, were adjusted in the analysis. All computer programming and analyses were completed with the SAS system.[27]

Results

Table 1 presents comparisons of surgical treatment between the SEER and Medicare databases in women with breast cancer diagnosed from 1991 through 1993. Of 13,431 women having mastectomies according to the Medicare data, 95% were confirmed by SEER. For BCS, 88% of cases were confirmed by SEER. The simple κ statistic for overall agreement on surgery between SEER and Medicare was 0.75 (95% confidence interval [CI] 0.74 to 0.76). From Table 1, of the 23,709 total patients with breast cancer, in 21,299 (90%) there was information regarding surgical treatment in both SEER and Medicare. Among these patients, concordance between the 2 databases was 94%, and the κ statistic was 0.86 (95% CI 0.85 to 0.87). There was no statistically significant difference for the concordance rates between SEER and Medicare for cases diagnosed in 1991 compared with 1992 (χ^2 test, $P > 0.2$) or 1993 ($P > 0.09$).

TABLE 1. Comparison of Surgical Treatment Between SEER and Medicare Claims Made Within 4 Months of Date of Diagnosis for Women With Breast Cancer Diagnosed From 1991 to 1993

	Medicare*			
SEER	No Cancer-Directed Surgery, n (%)	BCS, n (%)	Mastectomy, n (%)	Total Row, n (%)
No cancer-directed surgery	674 (66.1)	258 (25.3)	87 (8.5)	1,019 (100.0)
	(32.6)	(3.1)	(0.7)	
BCS	477 (5.7)	7,231 (86.4)	658 (7.9)	8,366 (100.0)
	(23.1)	(88.0)	(4.9)	
Mastectomy	914 (6.4)	724 (5.1)	12,686 (88.6)	14,324 (100.0)
	(44.3)	(8.8)	(94.5)	
Total column, n (%)	2,065 (100.0)	8,213 (100.0)	13,431 (100.0)	23,709

*Claims for surgical treatment were identified from the hospital inpatient, hospital outpatient, or physician services files in the Medicare database, and only those claims for surgery made within 4 months of the date of diagnosis of breast cancer were counted here. Women were considered to have received mastectomies if any of the 3 Medicare claim sources (inpatient, outpatient, or physician claims) indicated so, regardless of whether or not they had any claims for BCS. If they had claims for BCS only, they were defined as having received BCS. If they had no claims for mastectomy or BCS, they were considered to have no cancer-directed surgery. Values are n (row %) followed by column percent.

Table 2 presents data on the accuracy of information on type of surgery in each of the 3 Medicare claims sources compared with SEER. In these analyses, we limited the analyses to cases in which information about type of surgery was available both in the particular Medicare claims source examined and in SEER. Approximately 96% of patients with mastectomy claims either in Medicare physician files or in Medicare inpatient files were confirmed by SEER. As for BCS, 91% and 88%, respectively, were confirmed by SEER. Of patients with mastectomies in Medicare outpatient files, 83% were confirmed by SEER, but only 50% of patients with BCS claims in outpatient files were confirmed by SEER. Overall agreement between Medicare and SEER was 95% for mastectomy and 91% for BCS (Table 2).

Table 3 presents the completeness of information on surgery from the different sources of Medicare claims compared with SEER. The Medicare physician services claims identified >91% of patients who received breast cancer surgery according to SEER. The Medicare inpatient claims identified 68%; the outpatient claims identified only 33%. As might be expected, the 3 sources of the Medicare claims data differed in their completeness, depending on the type of breast cancer surgery performed. The outpatient claims had data on surgery for 44% of those receiving BCS according to SEER but for only 27% of those receiving mastectomies (Table 3). The inpatient claims had data on 86% of those receiving mastectomies and only 34% of those receiving BCS. The physician claims showed similar degrees of completeness of information on surgery for patients receiving mastectomies (91%) and BCS (91%). Of 13,341 patients with mastectomies and 8,213 with BCS, 54 (0.4%) of patients with mastectomies and 166 (2.0%) patients with BCS were identified by the outpatient claims and were not identified in either the inpatient or physician claims. When the 3 claims sources were combined, 94% of surgeries according to SEER were identified by Medicare.

Table 4 presents 3 different comparisons of information on receipt of surgery between the 2 databases. The percentage of patients in whom there is agreement on receipt of surgery is given, as is the κ statistic, as a function of patient and tumor characteristics. The last column was a multivariate analysis, showing the odds of a patient having concordant information regarding receipt of surgery between the 2 databases. Concordance between the 2 data sets was significantly greater in older women and in whites. Agreement on receipt of surgery was significantly better in those with local or regional stage but much lower in those with distant or unstaged compared to those with in situ cancer. There was variation among the 9 SEER areas in the extent of concordance on type of surgery between SEER and Medicare, ranging from 81% to 90% (data not shown). When the region variables were excluded from the logistic model, the magnitude of the odds ratios for other variables changed slightly, but the direction and

TABLE 2. Accuracy of Information on Type of Surgery in the Medicare Claims Database Compared With SEER

Source of Medicare Claims	Cases With Claims for Mastectomy in Medicare Files Confirmed by SEER, % (No. Identified by SEER/No. in Medicare)*	Cases With Claims for BCS in Medicare Files Confirmed by SEER, % (No. Identified by SEER/No. in Medicare)*
Medicare physician claims	96.2 (12,096/12,580)	87.9 (7,105/8,087)
Medicare inpatient claims	96.0 (12,087/12,586)	91.3 (2,369/2,596)
Medicare outpatient claims	82.8 (231/279)	49.7 (3,612/7,269)
Three Medicare claims combined†	95.1 (12,686/13,344)	90.9 (7,231/7,955)

*The analyses are restricted to those cases in which a surgical therapy is coded in both SEER and the particular Medicare database being assessed for accuracy. As a result, denominators varied by paired comparisons (including the combined numbers at the bottom of the table).

†If there was a claim for mastectomy in any of the 3 Medicare claims sources (hospital inpatient, hospital outpatient, or physician claims files), the case was categorized as mastectomy. Otherwise, the case was categorized as BCS. Only claims for surgery made within 4 months of the date of diagnosis of breast cancer were examined to ascertain surgery status.

significance of the odds ratios remained unchanged.

Discussion

The question addressed by this study is whether the Medicare claims data provide valid information on surgical treatment for patients known to have breast cancer. This question has 2 components: one involves accuracy and the other is completeness. We examined these issues for each of the 3 sources of Medicare claims and for the combined data from all 3 sources. When we were addressing these issues, we used the SEER data as the reference group because the SEER program of the National Cancer Institute is the most authoritative source of data on cancer incidence, mortality, and treatment.[28,29] SEER was designed primarily to provide such information,[21] whereas the Medicare claims data are administrative in nature and not designed for research purposes.[1-6,11-13] In addition, the validation study showed that the results on breast cancer surgery were similar in SEER compared with the National Cancer Database of the American College of Surgeons Commission on Cancer and the American Cancer

TABLE 3. Completeness of Medicare Claims on Surgery (Mastectomy or BCS) for Women With Breast Cancer Diagnosed From 1991 Through 1993

Source of Medicare Claims	Patients With Mastectomy According to SEER Who Were Identified by Medicare Claims as Having Any Surgery* (n = 14,324), n (%)	Patients With BCS According to SEER Who Were Identified by Medicare Claims as Having Any Surgery* (n = 8,366), n (%)	Patients With Either Mastectomy or BCS According to SEER Who Were Identified by Medicare Claims as Having Any Surgery (n = 22,690), n (%)
Physician claims	13,078 (91.3)	7,589 (90.7)	20,667 (91.1)
Inpatient claims	12,314 (86.0)	2,868 (34.3)	15,182 (67.9)
Outpatient claims	3,888 (27.1)	3,660 (43.7)	7,548 (33.2)
3 Claims combined†	13,410 (93.6)	7,889 (94.3)	21,299 (93.9)

*Surgery includes either mastectomy or BCS.

†Medicare claims for surgery were identified from the hospital inpatient, hospital outpatient, or physician services files. Only claims for surgery made within 4 months of the date of diagnosis of breast cancer were examined to ascertain breast cancer surgery. If there was a claim for mastectomy in any of the claims sources, the case was categorized as mastectomy. Otherwise, the case was categorized as BCS.

TABLE 4. Comparison of Surgical Treatment Between SEER and Medicare in Women With Breast Cancer Diagnosed From 1991 Through 1993

Characteristics From SEER Registry	Medicare Versus SEER			
	Number of Patients	Simple κ (95% CI)	Concordant Cases, %	Adjusted Odds Ratio of Being Concordant (95% CI)*
All patients	23,709	0.75 (0.74–0.76)	86.8	...
Age, y				
65–74	12,902	0.71 (0.70–0.72)	84.8	1
75–84	8,408	0.79 (0.78–0.80)	88.9	1.39 (1.27–1.52)
85+	2,399	0.84 (0.82–0.86)	90.5	1.51 (1.30–1.76)
Race				
White	21,534	0.75 (0.74–0.76)	87.0	1
Black	1,342	0.73 (0.70–0.76)	84.1	0.79 (0.67–0.94)
Other	833	0.77 (0.73–0.81)	87.2	1.17 (0.90–1.53)
Cancer stage				
In situ	2,176	0.74 (0.71–0.76)	86.0	1
Local	13,546	0.77 (0.76–0.78)	88.3	1.26 (1.09–1.45)
Regional	5,051	0.70 (0.68–0.73)	88.8	1.44 (1.23–1.69)
Distant	914	0.58 (0.53–0.62)	71.8	0.39 (0.32–0.48)
Unstaged	2,022	0.68 (0.65–0.70)	79.6	0.56 (0.47–0.68)

*Odds ratios were derived from the logistic regression model, adjusted for the variables listed in the table and 9 SEER areas.

Society.[30] They found that 53.4% of women with breast cancer had mastectomies and 37.7% had BCS in SEER compared with 54.1% and 40.7%, respectively, in the National Cancer Database.[30]

In terms of accuracy, among patients for whom information on type of surgery was available from both Medicare and SEER, 95% of patients who received mastectomies according to the combined Medicare claims were confirmed by SEER. Of those who received BCS, 91% were confirmed by SEER. The Medicare physician services claims and inpatient claims were approximately equal in accuracy for type of surgery. The Medicare outpatient claims were less accurate for BCS. The concordance is greater in older women (≥75 years) and in patients with local or regional stage cancer but varies among the SEER areas.

The accuracy of Medicare data on breast cancer surgery has also been studied with different reference groups, such as reabstracted records or local cancer registry data. Fisher et al[12] compared Medicare inpatient hospitalization codes for mastectomy with that identified from the reabstracted hospital record. Of those mastectomies identified by the reabstracted record, 97% were found to have a code for mastectomy in Medicare data. However, only 33 cases were reviewed. In another study, discharge data from one hospital in New York City were compared with hospital cancer registry data. The study found a high concordance rate for mastectomy between the 2 databases.[18] Warren et al[20] described a comparison of mastectomy between Medicare and SEER in patients who underwent mastectomies only in 1992–1993. The agreement rate was 95% for inpatients and 89% for outpatients.[20] These previous studies on breast cancer surgery depended on the Medicare inpatient or outpatient claims data but did not use the physician claims data. We found in this study that information on surgery identified from the physician service claims was similar in accuracy compared with that from the inpatient claims. Only 50% of BCS from the outpatient claims could be identified by SEER. This may largely reflect clinical practice patterns because many women who had BCS in the outpatient settings for diagnostic purposes may end up with a mastectomy in hospitals. Therefore, the combined data from all 3 sources of Medicare claims should generate the most accurate information on surgery.

We also found that any single Medicare claims source did not provide complete information on surgery (Table 3), although Medicare physician claims seemed the most complete among the 3 Medicare claims sources. Medicare outpatient claims, although least complete, still identified 0.4% of patients with mastectomies and 2.0% of cases with BCS that otherwise were not identified

by either inpatient or physician claims. When the 3 claims sources were combined, 94% of patients receiving breast cancer surgery according to SEER were identified by Medicare.

A number of factors might have contributed to reduce the completeness of the Medicare data on surgery. First, information on surgery from Medicare was restricted to those who had claims within 4 months of the date of diagnosis. This made it compatible with SEER data because SEER collects information only within this period.[23] However, this might have excluded those who had late claims for surgery and thus underestimate the degree of agreement between 2 data sets. We did additional analyses extending the time frame from 4 to 12 months after diagnosis. As a result, the overall agreement between SEER and Medicare on type of surgery improved ($\kappa=0.78$ compared with 0.75 in Table 1). Second, younger patients who recently became eligible for Medicare coverage might have less complete information in Medicare claims records. Indeed, younger age was a risk factor for lack of concordance between Medicare and SEER (Table 4). Third, if patients switched their care to HMOs or received care in Veterans Affairs hospitals, they may have missing information in the Medicare claims. Finally, it may be possible that a very small proportion of patients in SEER were mismatched with the Medicare data. If this happened, those patients would not have had Medicare claims for breast cancer surgery.

As previous studies also showed, Medicare claims data on the validity of mastectomy[12] have been found to have a high level of accuracy. In this study, we demonstrated that information on mastectomy and BCS is reasonably accurate and complete for women known to have breast cancer. Hence, using Medicare claims data may overcome the limitations in ascertaining treatment from cancer registries.

This study has some limitations. First, this analysis used only the Medicare claims for women identified from the SEER data as having cancer. The accuracy and completeness of breast cancer–related procedures for non-SEER cases are unknown. It is important to note that the presence of a Medicare claim with a breast cancer–related procedure does not confirm that the woman had cancer because some procedures, such as BCS, may be used for diagnostic as well as therapeutic purposes. Second, we used the SEER data as the reference group. Although SEER provides valid information on breast cancer surgical treatment,[30] we found a number of women with breast cancer who received cancer-directed surgery according to the Medicare claims data that were not recorded in the SEER data. For example, of 1,019 patients who did not have surgery according to SEER, 345 (34%) had claims for such a surgery in Medicare (Table 1). As previous investigators[11,23,31] also demonstrated, SEER might not provide complete information on treatment because it might sometimes miss information from outpatient settings and might not record those who moved immediately after diagnosis or underwent treatment in an out-of-state facility.[32] Furthermore, this study was performed in a cohort of women who were diagnosed with breast cancer and were successfully linked with Medicare data (94% match rate).[13] Also excluded were patients enrolled in HMOs and those without coverage of both Medicare parts A and B in 1991–1993. It is unknown whether the 2 databases would agree on type of surgery for those cases excluded, particularly those that were not ascertained by SEER as breast cancer but identified by Medicare data alone. Nevertheless, there was no external validation of the information on receipt of surgical treatment to assess the accuracy of the Medicare and SEER data sources and to determine which data source is "correct." This may be achieved by reviewing the medical records for a sample of patients with breast cancer. However, all patient identifiers were removed from the final SEER-Medicare linked database for confidentiality reasons, precluding these analyses.

In conclusion, the combined Medicare claims database, which includes the inpatient, outpatient, and physician service claims, provides valid information on surgical treatment among women known to have breast cancer. The claims are a rich source of data to augment the information routinely collected by tumor registries. In particular, it provides information on receipt of medical services that can be used to examine patterns of care and follow long-term outcomes of Medicare beneficiaries.

Acknowledgments

This study used the Linked SEER-Medicare Database. The interpretation and reporting of these data are the sole responsibilities of the authors. We acknowledge the efforts of the Applied Research Branch, Division of Cancer Prevention and Population Science, National Cancer Institute; the Office of Information Services and the Office of Strategic Planning, HCFA; Information Management Services, Inc; and the SEER

program tumor registries in the creation of the SEER-Medicare Database.

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4. **McBean AM, Warren JL, Babish JD.** Measuring the incidence of cancer in elderly Americans using Medicare claims data. Cancer 1994;73:2417–2425.

5. **McClish DK, Penberthy L, Whittemore M, Newschaffer C, Woolard D, Desch CE, et al.** Ability of Medicare claims data and cancer registries to identify cancer cases and treatment. Am J Epidemiol 1997;145:227–233.

6. **Whittle J, Steinberg EP, Anderson GF, Herbert R.** Accuracy of Medicare claims data for estimation of cancer incidence and resection rates among elderly Americans. Med Care 1991;29:1226–1236.

7. **Warren JL, Riley GF, McBean AM, Hakim R.** Use of Medicare data to identify incident breast cancer cases. Health Care Financing Rev 1996;18:237–246.

8. **Nattinger AB, Gottlieb MS, Hoffman RG, Walker AP, Goodwin JS.** Minimal increase in use of breast-conserving surgery from 1986 to 1990. Med Care 1996;34:479–489.

9. **Nattinger AB, Gottlieb MS, Veum J, Yahnke D, Goodwin JS.** Geographic variation in the use of breast-conserving treatment for breast cancer. N Engl J Med 1992;326:1102–1107.

10. **Simon MS, Stano M, Severson RK, Hoff MS, Smith DW.** Clinical surveillance for early stage breast cancer: An analysis of claims data. Breast Cancer Res Treat 1996;40:119–128.

11. **Du XL, Freeman JL, Goodwin JS.** Information on radiation treatment in patients with breast cancer: The advantages of the linked Medicare and SEER data. J Clin Epidemiol 1999;52:463–470.

12. **Fisher ES, Whaley FS, Krushat WM, Malenka DJ, Fleming C, Baron JA, et al.** The accuracy of Medicare's hospital claims data: Progress has been made, but problems remain. Am J Public Health 1992;82:243–248.

13. **Potosky AL, Riley GF, Lubitz JD, Mentnech RM, Kessler LG.** Potential for cancer related health services research using a linked Medicare-tumor registry database. Med Care 1993;31:732–748.

14. **Cooper GS, Yuan Z, Stange KC, Dennis LK, Amini SB, Rimm AA.** The sensitivity of Medicare claims data for case ascertainment of six common cancers. Med Care 1999;37:436–444.

15. **Warren JL, Feuer E, Potosky AL, Riley GF, Lynch CF.** Use of Medicare hospital and physician data to assess breast cancer incidence. Med Care 1999;37:445–456.

16. **Cooper GS, Yuan Z, Stange KC, Amini SB, Dennis LK, Rimm AA.** The utility of Medicare claims data for measuring cancer stage. Med Care 1999;37:706–711.

17. **Nattinger AB, Hoffmann RG, Howell-Pelz A, Goodwin JS.** Effect of Nancy Reagan's mastectomy on choice of surgery for breast cancer by US women. JAMA 1998;279:762–766.

18. **Kahn LH, Blustein J, Arons RR, Yee R, Shea S.** The validity of hospital administrative data in monitoring variations in breast cancer surgery. Am J Public Health 1996;86:243–245.

19. **Du XL, Freeman JL, Freeman DH, Syblik DA, Goodwin JS.** Temporal and regional variation in the use of breast conserving surgery and radiotherapy for older women with early stage breast cancer from 1983 to 1995. J Gerontol Med Sci 1999;54A:474–478.

20. **Warren JL, Riley GF, Potosky AL, Klabunde CN, Richter E, Ballard-Barbash R.** Trends and outcomes of outpatient mastectomy in elderly women. J Natl Cancer Inst 1998;90:833–840.

21. **Ries LAG, Kosary CL, Hankey BF, Miller BA, Harras A, Edwards BK, eds.** SEER cancer statistics review, 1973–1994. Bethesda, Md: National Cancer Institute; 1997. NIH publication No. 97-2789.

22. National Cancer Institute. The SEER program code manual. Revised ed. Bethesda, Md: National Cancer Institute; 1994. NIH publication No. 94-1999.

23. **Ballard-Barbash R, Potosky AL, Harlan LC, Nayfield SG, Kessler LG.** Factors associated with surgical and radiation therapy for early stage breast cancer in older women. J Natl Cancer Inst 1996;88:716–726.

24. US Public Health Services. International classification of diseases, 9th revision: Clinical modification. 5th ed. Los Angeles, Calif: PMIC; 1996.

25. American Medical Association. Physicians' current procedural terminology: CPT 94. Chicago, Ill: American Medical Association; 1993.

26. **Fleiss JL.** Statistical methods for rates and proportions. 2nd ed. New York, NY: John Wiley & Sons; 1981.

27. **Stokes ME, Davis CS, Koch GG.** Categorical data analysis using the SAS system. Cary, Ind: SAS Institute Inc; 1997.

28. **Wingo PA, Ries LA, Giovino GA, Miller DS, Rosenberg HM, Shopland DR, et al.** Annual report to

the nation on the status of cancer, 1973–1996, with a special section on lung cancer and tobacco smoking. J Natl Cancer Inst 1999;91:675–690.

29. **Wingo PA, Ries LA, Rosenberg HM, Miller DS, Edwards BK.** Cancer incidence and mortality, 1973–1995: A report card for the US. Cancer 1998;82:1197–1207.

30. **Mettlin CJ, Menck HR, Winchester DP, Murphy GP.** A comparison of breast, colorectal, lung, and prostate cancers reported to the National Cancer Data Base and the Surveillance, Epidemiology, and End Results Program. Cancer 1997;79:2052–2061.

31. **Farrow DC, Hunt WC, Samet JM.** Geographic variation in the treatment of localized breast cancer. N Engl J Med 1992;326:1097–1101.

32. **Mann BA, Samet JM, Hunt WC, Key CR, Goodwin JM, Goodwin JS.** Changing treatment of breast cancer in New Mexico from 1969 through 1985. JAMA 1988;259:3413–3417.

CURRICULUM VITAE

11/01

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Date of Birth: October 9, 1957

Marital Status: Married Bruce Nattinger, 1979
Children Kevin John, born 1986
Kinsey Ann, born 1990
Michael Bruce, born 1996

EDUCATION

1979 B.S., University of Illinois at Urbana-Champaign
1983 M.D., University of Illinois College of Medicine, Chicago
1988 M.P.H. University of Rochester School of Med & Dentistry

POSTGRADUATE TRAINING AND FELLOWSHIP APPOINTMENTS

1983-1986 Resident in Medicine,
Primary Care Program in Internal Medicine
Strong Memorial Hospital, University of Rochester
1986-1988 Fellow, General Medicine Unit, Strong Memorial Hospital, University of Rochester

FACULTY APPOINTMENTS

1983-1986 Assistant in Internal Medicine
School of Medicine and Dentistry,
Strong Memorial Hospital, University of Rochester
1986-1987 Instructor and Fellow in Internal Medicine,
School of Medicine and Dentistry, Strong Memorial Hospital, University of Rochester
1988-95 Assistant Professor of Medicine,
Medical College of Wisconsin
1989-99 Director of Health Services Research, Div. of General Internal Medicine, Medical College of Wisconsin

1993-95	Assistant Professor of Health Services Research, Health Policy Institute, Medical College of Wisconsin
1995-2000	Associate Professor of Medicine and Health Services Research, General Internal Medicine, Medical College of WI
1997-99	Associate Chief of General Internal Medicine
1999-	Chief of General Internal Medicine
2000-	Professor of Medicine and of Health Services Research, Medical College of Wisconsin
2000-	Director, Center for Patient Care and Outcomes Research
2001-	Award of Tenure, Medical College of Wisconsin

SPECIALTY CERTIFICATION

1984	National Board of Medical Examiners
1986	American Board of Internal Medicine

LICENSURE

New York and Wisconsin (WI#29279)

HONORS, AWARDS

1979	Summer Fellowship, The Chicago Heart Association
1980	Summer Fellowship, The Research Scholars Program University of Illinois, School of Basic Medical Sciences
1986	Lawrence E. Young Book Award, University of Rochester (Best Third Year Resident)
1990	Excellence in Attending Award, Dept. of Med., MCW
1994	Central Society for Clinical Research
1996	Division of GIM awarded "Best Teaching Service", by Medicine Housestaff
1997	Division of GIM awarded "Best Teaching Service", by Medicine Housestaff
1998	Fellow, American College of Physicians
1999	Division of GIM awarded "Best Teaching Service", by Medicine Housestaff
1999	Recipient of "The Learning Resources Innovative Educational Project Award", MCW
2000	Excellence in Attending Award, Dept. of Med., MCW

MEMBERSHIPS IN PROFESSIONAL AND HONORARY SOCIETIES

1986-present American College of Physicians

1986-present Society of General Internal Medicine

Offices held

1990-92 Coordinator, National Women's Caucus

1991-92 Counsellor, Midwest Region
1992-93 Chairperson-Elect, Midwest Region
1993-94 Chairperson, Midwest Region
1993-94 Co-Chair, Annual National Meeting
1994-97 National Council Member
2000-03 Secretary, National SGIM

Committees

1989 Workshop Selection Committee, National Meeting
1989 Abstract Selection Committee, Regional Meeting
1990 Fellow's Award Committee, Midwest Region
1992 Trainee Award Committee, National Meeting
1992 Trainee Award Committee, Midwest Meeting
1994 Continuing Medical Education Committee
1995 Abstract Selection Committee, National Meeting
1995-97 Education Committee
1995-97 Membership Committee
1996 Chair, Clin Epi Abstract Committee, National Mtg
1996- Development Task Force
1997 HSR abstract Committee, National Mtg
1998 HSR abstract Committee, National Mtg
2000 Chair, Glaser Award Selection Committee
2000- Communications Committee
(oversees the Journal of General Internal Medicine)
2000 Work and Family Balance Task Force
2000- Chair, Ad Hoc Awards Committee

1987 American Public Health Association
1988 Society for Medical Decision Making
1992 American Geriatrics Society
1994 Central Society for Clinical Research (invited)
1995-98 Council Member
1995 Association for Health Services Research
1999 Milwaukee Academy of Medicine

EDITORIAL BOARDS

1996-99 Editorial Board, *Journal of General Internal Medicine*
1996- Editorial Board, *American Journal of Medical Sciences*

Manuscript Reviewer for the *Journal of General Internal Medicine, American Journal of Medicine, Annals of Internal Medicine, Journal of the National Cancer Institute, Medical Care*, Journal of the American Medical Association, Cancer, American Journal of Public Health*

*2001 Citation from *Medical Care* for being in the top 5% of reviewers in the past 5 years.

NATIONAL ADVISORY COMMITTEES AND/OR ACTIVITIES

1990-92	Coordinator, National Society of General Internal Medicine Women's Caucus
1993	Agency for Health Care Policy and Research. Invited participant for the program "Medical Effectiveness Research: Strategies for the Future", a discussion of the future of the PORT program. February 17-18, 1993
1993-94	Co-Chair, Society of General Internal Medicine National Annual Meeting Co-Responsible for entire scientific program, including abstracts, workshops, precourses, mentoring program.
1993-01	American Cancer Society, national office. Member, Medical Affairs Advisory Group on Primary Care Physicians Awards. (Study section to select recipients of ACS Primary Care Physicians Career Development Awards). - 1998-2001 Chair
1994-97	Elected to National Council of the Society of General Internal Medicine. Two persons per year nationally are elected as councilors.
1997	American Cancer Society – national office. Member, Peer Review Group to conduct site visit of ACS Intramural Epidemiology & Surveillance Programs. Committee Chair: Jonathon Samet, MD.
1998	Ad Hoc Reviewer, Agency for Health Care Policy and Research small grants program.
2000-03	Secretary, National Society of General Internal Medicine
2000	Reviewer for Institute of Medicine, for report: Hewitt M, Simone JV (Eds) *Enhancing Data Systems to Improve the Quality of Cancer Care,* Washington, DC: National Academy Press, 2000.
2000-present	Reviewer for NIH Study Section SNEM-4 (Health Services Research).
2001-	Primary Care Advisory Committee, American Cancer Society
2001-present	Electronic Task Force Committee, Society of General Internal Medicine

COMMUNITY ADVISORY COMMITTEES AND/OR ACTIVITIES

1989-93	American Cancer Society, Wisconsin Physician Education Subcommittee
1990-95	American Cancer Society, Wisconsin Cancer Prevention and Early Detection - 1994 Co-Chair
1995-98	American Cancer Society, Wisconsin - Detection Policy Task Force Committee.
1995-99	American Cancer Society, Wisconsin - Research and Clinical Issues Committee

MEDICAL COLLEGE COMMITTEES

1988-	Member, Cancer Center
1993-97	Women's Faculty Council
	1994-96 Chair, Program Planning Committee
	1995-96 Chair-elect
	1996-97 Chair
1993-97	Faculty Welfare Committee
1994	Search Committee for Chair of Preventive Medicine

1994 Chair, Outcomes Measurement Work Group
1995 Clinical Task Force for Strategic Planning
1997-98 Board Member, Clinical Practice Group
1998-99 Chair, Medical Effectiveness Task Force
2000- General Clinical Research Center Advisory Board
2000- Rank and Tenure Committee
2000 MCW Strategic Planning Group: Research Directions

DEPT. OF MEDICINE COMMITTEES

1992-98 Advisory Committee on Rank & Tenure
1992- Residency Curriculum Committee
1992-93 Advisory Committee on Search for GIM Div. Chief
1996-97 Research Committee
1998-01 Faculty Development Committee

DIVISION OF GIM COMMITTEES

1988-93 General Medical Clinic Team Leader
1989-93 Research Committee, Co-director
1989-93 Executive Committee
1993-98 Chair, Research Strategic Planning Committee
1994-97 Chair, Inpatient Education Subcommittee
1995- Management Team
1998- Research Committee

HOSPITAL COMMITTEES

1998-0 Clinical Management Committee, FMLH
2000- Hospital Advisory Committee, FMLH

INVITED PRESENTATIONS, WORKSHOPS

"Lifestyle Issues Impacting the Faculty Development of Academic Internists." Coordinator and moderator of panel discussion at the Society of General Internal Medicine National meeting, Washington, D.C., April 29, 1988.

"Prevention of Postmenopausal Osteoporosis: Are Two Hormones Better Than One?" Moderator of debate at Society of General Internal Medicine National meeting, Washington, D.C., May 1990.

"Faculty Development and Mentorship in General Internal Medicine." Panel Discussion at SGIM Midwest Regional meeting, Chicago, IL, Nov. 1990.

"Screening for Breast Cancer", presented at the Wisconsin State ACP meeting, Madison, WI, Sept. 1990.

"Breast Cancer Screening in the Elderly Woman", Lecture at the Annual Fall Conference on Geriatrics, Midwest Geriatric Education Center, Milwaukee, WI, Sept. 7, 1990.

"Mentoring in Academic General Internal Medicine: Finding and Becoming a good Academic Parent." Panel Discussion at SGIM National Meeting, Seattle, WA, May, 1991.

"Breast Cancer in the Older Woman: Barriers to Care", Medical Grand Rounds and Visiting Professor, Henry Ford Hospital, Detroit, MI, Dec, 1991.

"Working Part-time in the Academic Setting: A Viable Option?" Panel discussion at SGIM National Meeting, Washington, DC, May, 1992.

"Variation in Breast Cancer Treatment", Plenary presentation at Central Society for Clinical Research, Chicago, IL, Nov. 6, 1992.

"Women in Academic Medicine", invited presentation to Regional AMWA Student-Doctor Annual Meeting, Milwaukee, WI, Feb. 1993.

"Community Variation in Breast Cancer Treatment", Plenary presentation at University of Wisconsin Meeting:Providing Health Care to the Local Community: What Do We Need and How Do We Know It? Milwaukee, WI April 3, 1993.

"Promotion of Women in Academic Medicine", Plenary presentation, A Clinical Symposium Honoring Rudolph J. Napodano, M.D., Rochester Academy of Medicine, Rochester, NY, April 24, 1993.

"Linkage of AHA and Medpar Databases", Plenary presentation, "Linkage of Central Cancer Registries with Secondary Databases." Sponsored by National Cancer Institute and Medical College of Virginia, Richmond, VA, November 12, 1993.

"Variations in Breast Cancer Treatment", invited presentation to Regional AMWA Student-Doctor Annual Meeting, Milwaukee, WI, March 19, 1994.

"Cancer Screening in Primary Care Practice" and "Variation in the Use of Breast Conserving Surgery", 18th Annual Solomon Papper Humane Scholarship Lectures, University of Oklahoma Health Services Center, Oklahoma City, OK, March 23, 1994.

"Variations in Breast Cancer Treatment", Medical Grand Rounds, St. Luke's Hospital, Milwaukee, WI, June 9, 1994.

"Issues of Detection and Etiology", Northern Illinois Medical Center-Symposium" Cancer Challenges 1994-Breast & Prostate", McHenry, Illinois, June, 1994.

"Breast Cancer Screening and the Clinical Breast Exam", workshop presentation at SGIM National Meeting, San Diego, CA, May, 1995.

"Exploring Career and Family Dilemmas", workshop presentation at SGIM National Meeting, San Diego, CA, May, 1995.

"Breast Cancer Screening in the Older Woman", plenary presentation "Cancer in Older People", at Lake Geneva, WI, June 9, 1995.

"Breast Cancer Screening:Standards and Strategies", invited lecture at The University of Michigan Medical School, Ann Arbor, MI, April 29, 1996.

"Colorectal Cancer Screening: The Latest Poop", workshop presentation at the Midwest SGIM meeting, Chicago, IL, Sept 27, 1997.

"Update on Women's Health-1997". Invited speaker at The American College of Physicians National meeting. San Diego, CA. April 2-5, 1998.

"Career Development Awards: How To Get One", workshop presentation at the Society of General Internal Medicine National Meeting. April 23-25, 1998, Chicago, IL.

"Colorectal Cancer Screening: Clinical Update and Controversies", workshop presentation at the National Society of General Internal Medicine meetings in Chicago IL, April 23-25, 1998.

"Breast and Cervical Cancer: Where Are We Going? How Might We Get There", plenary talk at a conference Sponsored by Wisconsin Cancer Council, June 25, 1998, Oconomowoc, WI.

"How Do We Treat Women with Breast Cancer? Studies in Variation in Care", lecture at University of Chicago, Chicago, IL, July 15, 1998.

"Breast Cancer in Older Women", lecture at Wisconsin Board Review Course in Geriatric Medicine. Delavan, WI, September 23-26, 1998.

"How Do We Treat Women with Breast Cancer? Observations from Studies of Variation in Care", lecture at University of California at San Francisco, San Francisco, CA, October 26, 1998.

"Update in Women's Health – 1998". Invited speaker at the American College of Physicians national meeting. New Orleans, LA, April 22, 23, 1999.

"Breast Cancer Screening", Plenary speaker at the New York Downstate Scientific meeting of the New York ACP-ASIM Chapter. New York, NY, May 15, 1999.

"Promotion of Women in Academic Medicine," invited presentation at the Regional American Medical Women's Association meeting. Milwaukee, WI, August 21, 1999.

"Rekindling Career Passion in Mid-Life", workshop presentation at the Society of General Internal Medicine Midwest Regional Meeting. September 16-18, 1999, Chicago, IL.

"Primary Care Internal Medicine", presentation at the American College of Physicians-American Society of Internal Medicine "Preparation for Recertification in Internal Medicine" meeting, Milwaukee, WI, September 15-17, 2000.

"Methodologic Issues in Surveillance: Using Medicare Claims After Cancer Treatment", presentation at invitation-only conference: Methodologic Issues for SEER-Medicare Data, National Cancer Institute, Bethesda, MD, November 16-17, 2000.

"Cancer Issues for Women." Meet the professor and eat lunch with the professor sessions for American College of Physicians-American Society of Internal Medicine National Meeting. Atlanta, GA, March 29-April 1, 2001.

"Current Issues in Breast Cancer Prevention and Screening" and "Lessons from the Adoption of a Cancer Treatment into Clinical Practice: The Case of Breast-Conserving Surgery." Visiting Professor, The University of Alabama at Birmingham, June 5-6, 2001.

RESEARCH GRANTS, CONTRACT, AWARDS

Innovation in Patient Care Program, Strong Memorial Hospital. Co-principal Investigator. Total Direct Costs: $10,200 1987-1988. "Holter Monitoring in the Patient with Focal Neurologic Deficit."

American Cancer Society Institutional Grant. Principal Investigator of Seed Grant. Total Direct Costs: $7,200 Jan. 1, 1989-Dec. 21, 1989. "Relation of Age and Ethnicity to Patterns of Treatment for Breast Cancer".

Public Health Service Grant, National Cancer Institute R01-CA54676. Principal Investigator at 40% effort. Total Direct Costs: $49,099, April 1, 1991-June 1992. "Use of Breast-Conserving Surgery in the Elderly."

Public Health Service Grant, National Cancer Institute R01-CA54676. Principal Investigator at 35% effort. Total Direct Costs: $286,271, May 24,1993-April 30, 1997. "Use of Breast-Conserving Surgery in the Elderly."

VA HSR&D #92-609. Co-Investigator at 10% effort. Total Direct Costs: $508,000, July 1, 1993-June 30, 1996. "Clinical Decision Making and Prostate Cancer." PI: Marilyn Schapira, M.D.

Department of Defense, DAMD17-94-J4043. Principal Investigator at 25% effort. Total Direct Costs $525, 667. September 1994-August 1999. "Surveillance After Initial Treatment for Breast Cancer: A Population-Based Study of Variation and Outcomes of Care".

Department of Defense DAMD17-96-6262. Principal Investigator at 25% effort. Total Direct Costs: $540,000, Sept 1996-Aug 2001. "Early Stage Breast Cancer in Older Women: Predictors and Outcomes of Therapy".

National American Cancer Society, Cancer Control Career Development Award for Primary Care Physicians. Mentor at 5% effort (donated) for award to Marilyn M. Schapira, M.D. Total Direct Costs: $140,000. July 1, 1997-June 30, 2000.

National American Cancer Society, Cancer Control Career Development Award for Primary Care Physicians. Mentor at 5% effort (donated) for award to Mary Ann Gilligan, M.D. Total Direct Costs: $165,000. July 1, 1999-June 30, 2002.

HRSA, National Research Service Award T32-PE10030. Co-Program Director at 10% effort. PI: Linda Meurer, MD. Total direct costs $1,308,420, July 1, 1998-June 30, 2003. "Academic Fellowship in Primary Care Research."

PHS, National Cancer Institute 1U01CA/E581773. Site Principal Investigator at 15% effort. PI: James S. Goodwin, MD. Total Direct Costs for site: $283,969, June 1, 1999 – March 31, 2003. "Regional Variation in Breast Cancer Rates in the U.S.".

PHS, National Cancer Institute RO1CA081379. Principal Investigator at 25% effort. Total Direct Costs: $525,000, July 1, 2000-June 30, 2003. "Outcomes of Older Women with Early Stage Breast Cancer."

-BIBLIOGRAPHY-

ORIGINAL PAPERS

1. Nattinger AB, Panzer RJ, Janus J. Improving the utilization of screening mammography in primary care practices. *Arch Intern Med* 1989;149:2087-2092.

2. Jablonski DF, Mosley GM, Byrd JC, Schwallie DL, and Nattinger AB. Informed consent for patient transfers to a VA Medical Center. *J Gen Intern Med* 1991;6:229-232.

3. Nattinger AB, Gottlieb MS, Veum J, Yahnke D, Goodwin JS. Geographic variation in the use of breast-conserving treatment for breast cancer. *N Engl J Med* 1992;326:1102-07.

4. Nattinger AB, Goodwin JS. Screening mammography for older women: A case of mixed messages. *Arch of Intern Med* 1992;152:922-925.

5. Janjan NA, Nattinger AB, Young MJ, Wilson JF. First year initial treatment charges for early stage vs. locally advanced breast cancer. *Breast Dis* 1993;6:27-37.

6. Wood H, Wang-Cheng R, Nattinger AB. Postmenopausal hormone replacement: Are two hormones better than one? *J Gen Intern Med* 1993;8:451-458.

7. Nattinger AB, Goodwin JS. Regional and hospital-based variation in treatment of early breast cancer. *Cancer Control* 1994;1:334-338.

8. MacKinney TG, Walters D, Bird GL, Nattinger AB. Improvements in preventive care and communication of deaf patients: Outcomes associated with a novel health care program. *J Gen Intern Med* 1995;10:133-137.

9. Tesch BJ, Wood HM, Helwig AL, Nattinger AB. Promotion of women physicians in academic medicine: Glass ceiling or a sticky floor? *JAMA* 1995;273:1022-1025.

10. Goodwin JS, Nattinger AB. Effect of season and climate on choice of therapy for breast cancer in older women. *J Amer Geriatrics Soc* 1995;43:962-966.

11. Schapira MM, McAuliffe TL, Nattinger AB. Treatment of localized prostate cancer in African-American compared to white men: Less use of aggressive therapy for comparable disease. *Med Care* 1995;33:1079-1089.

12. Nattinger AB, Gottlieb MS, Hoffmann RG, Walker AP, Goodwin JS. Minimal increase in use of breast-conserving surgery from 1986-1990. *Med Care* 1996;34:479-489.

13. Nattinger AB, Hoffmann RG, Shapiro R, Gottlieb MS, Goodwin JS. The effect of legislative requirements on the use of breast-conserving surgery. *N Engl J Med* 1996;335:1035-1040.

14. Nattinger AB, Wang-Cheng R, Sonnenberg G, Kotchen TA. Recent advances in internal medicine. *Wisconsin Medical Journal* 1996;95:871-874.

15. Michalski TA, Nattinger AB. The influence of black race and socioeconomic status on the use of breast-conserving surgery in Medicare beneficiaries. *Cancer* 1997;79:314-319.

16. Schapira MM, Meade C, Nattinger, AB. Enhanced Decision-Making: The use of a videotape decision-aid for patients with prostate cancer. *J Patient Ed Counsel* 1997;30:119-127.

17. Tesch B, Nattinger, AB. Career advancement and gender in academic medicine. *J Irish Colleges of Physicians and Surgeons* 1997;26:172-176.

18. Nattinger AB, McAuliffe TL, Schapira MM. Generalizability of the surveillance, epidemiology, and end results registry population: Factors relevant to epidemiology and health care research. *J Clin Epidemiol* 1997;50:939-945.

19. Nattinger AB, Hoffmann RG, Howell-Pelz A, Goodwin JS. The Effect of Nancy Reagan's Mastectomy on Choice of Surgery for Breast Cancer by US Women. *JAMA* 1998;279:762-766.

20. Goodwin JS, Freeman J, Freeman D, Nattinger AB. Geographic variations in breast cancer mortality: Do higher rates imply elevated incidence or poorer survival? *Am J Public Health* 1998;88:458-460.

21. Charney P, Walsh J, Nattinger AB. Update in Women's Health:1997. *Ann Intern Med* 1998;129:551-558.

22. Schapira MM, Meade C, McAuliffe TL, Nattinger AB. Information sources and professional consultations sought by men newly diagnosed with prostate cancer. *J Ca Educ* 1999;14:243-247.

23. Charney P, Walsh J, Nattinger AB. Update in Women's Health:1998. *Ann Intern Med* 1999;131:952-958.

24. Schapira MM, McAuliffe TL, Nattinger, AB. Underutilization of Mammography in Older Breast Cancer Survivors, *Med Care* 2000;38:281-289.

25. Du X, Freeman JL, Warren JL, Nattinger AB, Zhang D, Freeman DH, Goodwin JS. Accuracy and Completeness of Medicare Claims Data for surgical Treatment of Breast Cancer. *Med Care* 2000;38:719-727.

26. Nattinger AB. Older Women, Mammography, and Mortality from Breast Cancer. (Editorial) *Amer J Med* 2000;108:174-175.

27. Nattinger, AB. Care for Breast Cancer: The Adoption of Newer Clinical Paradigms. (Editorial) *Med Care* 2000;38:693-695.

28. Nattinger AB, Hoffmann RG, Kneusel RT, Schapira MM. Relationship between appropriateness of primary therapy for early-stage breast carcinoma and increased use of breast-conserving surgery. *Lancet* 2000;356:1148-53.

29. Schapira MM, Lawrence WF, Katz DA, McAuliffe TL, Nattinger AB. The Effect of Treatment on Quality of Life Among Men with Clinically Localized Prostate Cancer. *Med Care* 2001;39:243-253.

30. Nattinger AB, Kneusel RT, Hoffmann RG, Gilligan MA. Relationship of Distance From a Radiotherapy Facility and Initial Breast Cancer Treatment. JNCI, 2001;93;1344-1346.

31. Schapira MM, Nattinger AB, McHorney CA. Frequency or Probability? A Qualitative Study of Risk Communication Formats Used in Health Care. *Med Decis Mak*, in press, 2001.

32. Ketteler E, Brasel K, Eastwood D, Laud P, Nattinger A, Ahrendt G. Fear, Not Evidence, Impacts Physicians' Personal Choices for Treatment of Early Stage Breast Cancer. Am J Surg, in press, 2001.

33. Du X, Freeman J, Nattinger AB, Goodwin JS. Survival of women after breast conserving surgery for early stage breast cancer. Breast Cancer Res Treat In press, 2001.

34. Goodwin JS, Shiva S, Anderson ET, Nattinger AB, Freeman J. Nurse Case Managers Improve the Care of Older Women with Breast Cancer. Submitted, 2000.

35. Goodwin JS, Freeman JL, Mahnken JD, Freeman DH, Nattinger AB. Both Differences in Incidence and in Survival Contribute to Geographic Variation in Breast Cancer Mortality. Accepted, Jrnl of Gerontology: Med Sciences, 2001.

36. Gilligan MA, Kneusel RT, Hoffman RG, Greer AL, Nattinger AB. Persistent Differences in Socio-demographic Determinants of Use of Breast Conserving Surgery Despite Overall Increased Adoption. Med Care 2001, in press.

37. Gilligan MA, Nattinger AB. Risk Assessment and Decision-Making Regarding Genetic Susceptibility Testing for Breast Cancer: A Case Study. J Lab Clin Med, 2001, submitted.

38. Nattinger AB, Schapira MM, Warren JL, Earle CC. Methodologic Issues in the Use of Administrative Claims Data to Study Surveillance After Cancer Treatment. Submitted, 2001.

39. Earle CC, Nattinger AB, Potosky AL, Mallick R, Berger M, Warren JL. Identifying Cancer Recurrence Using SEER-Medicare Data. Submitted, 2001.

LETTERS TO THE EDITOR

Tesch BJ, Nattinger AB. Creative part-time faculty arrangements. *Ann Intern Med* 1994; 120:346.

Nattinger, AB. Communicating with deaf patients. *JAMA* 1995;274:794-795.

Nattinger AB, Schapira MM, Hoffman RG. Breast-conserving surgery. *Lancet* 2001;357:305.

BOOK REVIEW

Nattinger, AB. Current Therapy in Adult Medicine. (4th Edition). Kassirer JP, Greene HL; eds. 1512 pages. St. Louis MO: Mosby-Year Book; 1997. *Ann Intern Med* 1998;128:611.

BOOK CHAPTERS

Nattinger AB. Colon Cancer Screening and Detection. In: Black ER, Panzer RJ and Griner P. (ed.). Diagnostic Strategies for Common Medical Problems, Philadelphia: *American College of Physicians*, 1991.

Nattinger, AB. Colon Cancer. In: Black ER, Bordley DR, Tape TG, and Panzer RJ (eds) . Diagnostic Strategies for Common Medical Problems , Philadelphia: *American College of Physicians*, 1999.

Wang-Cheng R, Nattinger AB. Postmenopausal hormone replacement therapy. In: Gynecology for the Internist. *American College of Physicians*, 2001, in press.

ABSTRACTS

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Appendix

Table A.1 Demographic Characteristics of Training cohort: 1995

	Group			
	Br. c. cases (n=8,185)	Cancer contr. (n=801)	Cancer free contr. (n=11,176)	Total (n=20,162)
Age				
65-69	1,853 (22.64%)	188 (23.47%)	2,827 (25.29%)	4,868 (24.14%)
70-74	2,222 (27.15%)	190 (23.72%)	2,795 (25.01%)	5,207 (25.83%)
75-79	1,789 (21.86%)	162 (20.23%)	2,186 (19.56%)	4,137 (20.52%)
80+	2,321 (28.35%)	261 (32.58%)	3,368 (30.14%)	5,950 (29.51%)
Range	65-107	65-101	65-108	65-108
Median	75	76	74	75
Mean (sd.)	75.53 (7.00)	76.38 (7.69)	75.77 (7.69)	75.70 (7.42)
Race				
White	7,237 (88.42%)	697 (87.02%)	9,529 (85.26%)	17,463 (86.61%)
Black	517 (6.31%)	58 (7.24%)	809 (7.24%)	1,384 (6.87%)
Other	396 (4.84%)	43 (5.37%)	737 (6.59%)	1,176 (5.83%)
Unknown	35 (0.43%)	3 (0.37%)	101 (0.91%)	139 (0.69%)
State				
California	2,235 (27.31%)	221 (27.59%)	2,939 (26.30%)	5,395 (26.76%)
Connecticut	1,217 (14.87%)	90 (11.23%)	1,592 (14.24%)	2,899 (14.38%)
Georgia	455 (5.56%)	50 (6.24%)	719 (6.43%)	1,224 (6.07%)
Hawaii	178 (2.17%)	20 (2.50%)	284 (2.54%)	482 (2.39%)
Iowa	1,159 (14.16%)	125 (15.60%)	1,619 (14.49%)	2,903 (14.40%)
Michigan	1,345 (16.43%)	130 (16.23%)	1,795 (16.06%)	3,270 (16.22%)
New Mexico	291 (3.55%)	28 (3.50%)	521 (4.66%)	840 (4.17%)
Utah	341 (4.17%)	32 (4.00%)	543 (4.86%)	916 (4.54%)
Washington	964 (11.78%)	105 (13.11%)	1,164 (10.42%)	2,233 (11.07%)

Table A.2 Demographic Characteristics of Validation cohort: 1992

	Group			
	Br. c. cases (n=8,480)	Cancer contr. (n=813)	Cancer free contr. (n=68,797)	Total (n=78,090)
Age				
65-69	2,030 (23.94%)	183 (22.51%)	18,390 (26.73%)	20,603(26.38%)
70-74	2,231 (26.31%)	184 (22.63%)	16,809 (24.43%)	19,224(24.62%)
75-79	1,907 (22.49%)	169 (20.79%)	13,769 (20.02%)	15,845(20.29%)
80+	2,312 (27.26%)	277 (34.07%)	19,829 (28.82%)	22,418(28.71%)
Range	65-104	65-100	65-107	65-107
Median	74	76	74	74
Mean (sd.)	75.47 (7.08)	76.53 (7.70)	75.53 (7.71)	75.53 (7.64)
Race				
White	7,545 (88.97%)	711 (87.46%)	59,105 (85.91%)	67,361(86.26%)
Black	534 (6.30%)	44 (5.41%)	4,626 (6.72%)	5,204(6.66%)
Other	348 (4.10%)	48 (5.90%)	3,850 (5.60%)	4,246(5.44%)
Unknown	53 (0.63%)	10 (1.23%)	1,216 (1.77%)	1,279(1.64%)
State				
California	2,539 (29.94%)	251 (30.88%)	20,876 (30.34%)	23,666(30.31%)
Connecticut	1,244 (14.67%)	121 (14.88%)	9,533 (13.86%)	10,898(13.96%)
Georgia	462 (5.45%)	44 (5.41%)	4,016 (5.84%)	4,522(5.79%)
Hawaii	154 (1.82%)	11 (1.35%)	1,481 (2.15%)	1,646(2.11%)
Iowa	1,174 (13.84%)	111 (13.66%)	9,213 (13.39%)	10,498(13.44%)
Michigan	1,352 (15.94%)	128 (15.74%)	10,483 (15.24%)	11,963(15.32%)
New Mexico	316 (3.73%)	33 (4.06%)	3,102 (4.51%)	3,451(4.42%)
Utah	326 (3.84%)	36 (4.43%)	3,076 (4.47%)	3,438(4.40%)
Washington	913 (10.77%)	78 (9.59%)	7,017 (10.20%)	8,008(10.25%)

Table A.3 Demographic Characteristics of Validation cohort: 1993

	Group			
	Br. c. cases (n=8,169)	Cancer contr. (n=802)	Cancer free contr. (n=69,529)	Total (n=78,500)
Age				
65-69	1,852 (22.67%)	149 (18.58%)	18,119 (26.06%)	20,120(25.63%)
70-74	2,224 (27.22%)	202 (25.19%)	17,152 (24.67%)	19,578(24.94%)
75-79	1,828 (22.38%)	175 (21.82%)	13,887 (19.97%)	15,890(20.24%)
80+	2,265 (27.73%)	276 (34.41%)	20,371 (29.30%)	22,912(29.19%)
Range	65-106	65-99	65-108	65-108
Median	75	76	74	74
Mean (sd.)	75.57 (7.04)	76.83 (7.66)	75.63 (7.71)	75.64 (7.64)
Race				
White	7,309 (89.47%)	712 (88.77%)	60,370 (86.83%)	68,391(87.12%)
Black	483 (5.91%)	42 (5.24%)	4,898 (7.04%)	5,423(6.91%)
Other	339 (4.15%)	42 (5.24%)	3,817 (5.49%)	4,198(5.35%)
Unknown	38 (0.47%)	6 (0.75%)	444 (0.64%)	488(0.62%)
State				
California	2,343 (28.68%)	264 (32.92%)	20,283 (29.17%)	22,890(29.16%)
Connecticut	1,234 (15.11%)	104 (12.97%)	9,756 (14.03%)	11,094(14.13%)
Georgia	467 (5.72%)	42 (5.24%)	4,173 (6.00%)	4,682(5.96%)
Hawaii	167 (2.04%)	17 (2.12%)	1,578 (2.27%)	1,762(2.25%)
Iowa	1,114 (13.64%)	119 (14.84%)	9,438 (13.57%)	10,671(13.59%)
Michigan	1,276 (15.62%)	133 (16.58%)	10,805 (15.54%)	12,214(15.56%)
New Mexico	295 (3.61%)	22 (2.74%)	3,222 (4.64%)	3,539(4.51%)
Utah	336 (4.11%)	23 (2.87%)	3,092 (4.45%)	3,451(4.40%)
Washington	937 (11.47%)	78 (9.72%)	7,182 (10.33%)	8,197(10.44%)

Table A.4 Demographic Characteristics of Validation cohort: 1994

	Group			
	Br. c. cases (n=8,055)	Cancer contr. (n=805)	Cancer free contr. (n=69,995)	Total (n=78,855)
Age				
65-69	1,892 (23.49%)	172 (21.37%)	17,991 (25.70%)	20,055(25.43%)
70-74	2,130 (26.44%)	191 (23.73%)	17,258 (24.66%)	19,579(24.83%)
75-79	1,767 (21.94%)	192 (23.85%)	14,143 (20.21%)	16,102(20.42%)
80+	2,266 (28.13%)	250 (31.05%)	20,603 (29.43%)	23,119(29.32%)
Range	65-105	65-101	65-109	65-109
Median	75	75	74	74
Mean (sd.)	75.51 (7.03)	76.43 (7.56)	75.67 (7.69)	75.66 (7.62)
Race				
White	7,203 (89.42%)	688 (85.47%)	60,201 (86.01%)	68,092(86.35%)
Black	496 (6.16%)	75 (9.32%)	4,964 (7.09%)	5,535(7.02%)
Other	325 (4.04%)	39 (4.84%)	4,362 (6.23%)	4,726(5.99%)
Unknown	31 (0.38%)	3 (0.37%)	468 (0.67%)	502(0.64%)
State				
California	2,226 (27.63%)	227 (28.20%)	19,688 (28.13%)	22,141(28.08%)
Connecticut	1,213 (15.06%)	113 (14.04%)	10,032 (14.33%)	11,358(14.40%)
Georgia	472 (5.86%)	51 (6.33%)	4,355 (6.22%)	4,878(6.19%)
Hawaii	159 (1.97%)	14 (1.74%)	1,635 (2.34%)	1,808(2.29%)
Iowa	1,100 (13.66%)	110 (13.66%)	9,650 (13.79%)	10,860(13.77%)
Michigan	1,292 (16.04%)	144 (17.89%)	11,063 (15.80%)	12,499(15.85%)
New Mexico	291 (3.61%)	29 (3.60%)	3,185 (4.55%)	3,505(4.44%)
Utah	355 (4.41%)	23 (2.86%)	3,175 (4.54%)	3,553(4.51%)
Washington	947 (11.76%)	94 (11.68%)	7,212 (10.30%)	8,253(10.47%)

DEPARTMENT OF THE ARMY
US ARMY MEDICAL RESEARCH AND MATERIEL COMMAND
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REPLY TO
ATTENTION OF:

MCMR-RMI-S (70-1y) 21 Feb 03

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2. Point of contact for this request is Ms. Kristin Morrow at DSN 343-7327 or by e-mail at Kristin.Morrow@det.amedd.army.mil.

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