



Survival of Breast Cancer Patients in Connecticut in Relation to Socioeconomic and Health Care Access Indicators

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ABSTRACT *The purpose of this study of 16,931 black and white Connecticut women diagnosed with invasive breast cancer in 1988–1995 was to examine survival in relation to surrogate or proxy indicators of both socioeconomic status (SES) and access to primary care. Patients were followed through 1998, and the risk of death was elevated for the lowest (vs. highest) SES category independent of stage at diagnosis and other characteristics, especially among patients diagnosed before age 65 years. The health care access indicator was not associated with risk of death when other patient characteristics (including the SES variable and stage at diagnosis) were taken into account. Unexplained elevations, relative to the rest of the state, in risk of death were found for patients diagnosed while living in two of the state's four largest cities.*

KEYWORDS *Breast Cancer, Medically Underserved, Poverty, Survival.*

INTRODUCTION

The survival of patients with certain types of cancer (including breast cancer) has been shown to be related to socioeconomic status (SES) indicators,^{1,2} even when stage at diagnosis was considered.^{3,4} Population-based cancer registries do not obtain information on SES for individual patients, so surrogate or proxy indicators must be used.⁵ After the diagnosis of breast cancer, access to and quality of primary care could influence the risk of death from breast cancer or other causes.⁶ Residence in a medically underserved area (MUA) is one indicator of potentially poor access to health care for individual patients. Criteria for MUAs include the ratio of primary care physicians per 1,000 population (also used to define health professional shortage areas, or HPSAs, for primary care), infant mortality rate, poverty rate, and proportion of elderly persons in the area.^{7,8}

The present study used data from a population-based cancer registry to examine the hypothesis that surrogate indicators of an individual patient's SES and health care access may both be independent predictors of overall risk of death after diagnosis of breast cancer.

METHODS

The population-based Connecticut Tumor Registry (CTR), located in the Connecticut Department of Public Health, is part of the National Cancer Institute's Surveil-

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lance, Epidemiology, and End Results (SEER) Program. SEER registries provide high-quality data, with high rates of completeness of reporting of data from three hospitals.⁹ In Connecticut, state public health legislation requires reporting of cancers to the CTR by all hospitals and clinical laboratories in the state. Reciprocal reporting agreements with cancer registries in adjacent states improves the ascertainment of cancers diagnosed among Connecticut residents.

The original sample included all 17,462 patients diagnosed in 1988–1995 with invasive breast cancer (International Classification of Diseases for Oncology [ICD-O-2] codes C500–509) as the first or only diagnosed cancer; we excluded patients with diagnoses ascertained solely by autopsy or death certificate (for whom survival analyses are not relevant). After excluding 114 patients with race coded as other than white or black, 342 with unknown census tract of residence (used to estimate SES), and 71 with unknown month of diagnosis, the final sample was 16,931 (16,063 white and 868 black).

The CTR ascertains vital status and date of last “contact” from hospital tumor registries and through linkages with the Connecticut Department of Motor Vehicles, Connecticut death records, and records of the Health Care Finance Administration. For this study, follow-up was until death or last contact, through the end of 1998; all patients had a chance to survive for at least 3 years after diagnosis. Of the 16,931 patients, 5,097 (30.1%) had died of any cause by the end of 1998. Follow-up was rather complete; of 11,834 patients not known to have died, year of last contact was 1998 or later for 87% and 1997 or later for 92%.

Patient characteristics examined included age (recoded as 45–54, 55–64, 65–74, and 75+ years) and marital status (recoded as married, not married, and unknown). Stage at diagnosis was recoded as local (confined to the breast, with high 5-year relative survival rates)¹⁰ or other (regional, distant, or unknown); unknown stage cancers are probably disproportionately later (i.e., nonlocal) stage in view of the survival rates of these patients.¹⁰ In the absence of SES indicators for individual patients in cancer registries, the proportion of persons with income below the federal poverty threshold (1990 census) of the census tract of residence at the time of diagnosis was used as an ecologic indicator of each patient’s SES.¹¹ Poverty rate was selected because (unlike household income) household size is taken into account. Residence in a tract with a rate of 20% or greater (“federal poverty area”) was selected for analysis, comprising 914 patients or about 5% of all 16,931; another 1,290 (8%) lived in tracts with a 10%–19.4% poverty rate, while the remaining 14,727 (87%) lived in tracts with poverty rates of less than 10% (Table 1). Other analyses used quintiles and deciles of poverty rate.

Connecticut census tracts that were MUAs were identified from a report provided by the Department of Health and Human Services Bureau of Primary Health Care, Division of Shortage Designation (P. Salladay, personal communication, June 2000). The original list of MUAs was published in the *Federal Register* in 1976, but deletions made in 1982 and additions or changes (through 1994) were taken into account. The criteria for designation of MUAs involve application of the Index of Medical Underservice (IMU) to a geographic area; values for four variables (primary care physicians per 1,000 population, poverty rate, percentage of population aged 65 years or older, and infant mortality rate) are converted to a weighted value, according to established criteria, and the four values are summed for an area to obtain the IMU score (0 or “completely underserved” through 100 or “best served,” with those areas with a value of 62.0 or less being defined as an MUA).⁸ Thus, MUA status of each patient is a dichotomous variable. HPSAs were not analyzed

TABLE 1. Distributions of characteristics of 16,931 Connecticut women diagnosed with invasive breast cancer in 1988–1995, in three groups defined by poverty rate of census tract (1990 census)

Characteristic	Poverty rate of census tract						<i>P</i> (<i>df</i>)*
	<10.0% (N = 14,727)		10.0%–19.4% (N = 1,290)		19.5%+ (N = 914)		
	No.	%	No.	%	No.	%	
Distribution of characteristics							
Age at diagnosis, years							
<45	1,869	12.6	191	14.8	145	15.9	
45–54	2,800	19.0	202	15.7	161	17.6	
55–64	3,044	20.7	235	18.2	198	21.7	
65–74	3,588	24.4	327	25.3	183	20.0	
75+	3,435	23.3	335	26.0	227	24.8	<.001 (8)†
Race							
White	14,342	97.4	1,095	84.9	626	68.5	
Black	385	2.6	195	15.1	288	31.5	<.001 (2)†
Stage							
Local	8,049	54.7	621	48.1	443	48.5	
Regional, distant	6,678	45.3	669	51.9	471	51.5	<.001 (2)†
Marital status							
Married	8,298	56.3	529	41.0	253	27.7	
Not married	5,811	39.5	712	55.2	618	67.6	
Unknown	618	4.2	49	3.8	43	4.7	<.001 (4)†
MUA census tract							
No	14,674	99.6	1,145	88.8	306	33.5	
Yes	53	0.4	145	11.2	608	66.5	<.001 (2)†
City of residence							
Bridgeport	368	2.5	136	10.5	126	13.8	
Hartford	109	0.7	116	9.0	239	26.1	
New Haven	145	1.0	172	13.3	243	26.6	
Waterbury	356	2.4	59	4.6	127	13.9	
Rest of state	13,749	93.4	807	62.6	179	19.6	<.001 (8)†
Proportion known dead‡							
	%		%		%		<i>P</i> (<i>df</i>)
Total state	28.8		36.6		41.6		<.001 (2)†
Residence in MUA census tract							
No	28.8		36.2		38.2		<.001 (2)†
Yes	24.5		39.3		43.3		<.001 (2)†
City							
Bridgeport	35.6		36.8		43.7		.268 (2)
Hartford	35.8		32.8		41.8		.216 (2)
New Haven	25.5		40.1		42.8		.002 (2)†
Waterbury	39.0		39.0		48.0		.197 (2)
Rest of state	28.4		36.2		33.5		<.001 (2)†

MUA, medically underserved area.

**P* value from chi-square test (*df*, degrees of freedom).

†*P* < .05.

‡As of the end of 1998; numbers known dead versus not known dead were included in each chi-square test.

separately because the census tracts involved changed over time, and small samples were involved for the tracts that were consistently HPSAs (e.g., both in 1990 and in 1995).

The state's four largest cities (Bridgeport, Hartford, New Haven, and Waterbury) accounted for 66 (88.0%) of all 75 MUA tracts and 714 (88.6%) of all 806 patients residing in MUAs.

Cox proportional hazards regression¹² was used to analyze risk of mortality per unit of time (i.e., months after diagnosis). The regression models included categorical ("indicator" or "dummy") variables for age at diagnosis, stage at diagnosis, the three SES groups, race (black or white), marital status (married, not married, or unknown), residence versus nonresidence in an MUA census tract, and (in some models) residence in each of the four largest cities versus the rest of the state.

RESULTS

With increasing poverty rate of census tract (using the three categories defined above), the distribution of age at diagnosis differed little (albeit statistically significantly for these large samples), while the proportions of patients who were black, had a late stage at diagnosis, and were unmarried increased (Table 1). As would be expected from the definition of MUAs (which is based in part on poverty rate), the proportion living in an MUA increased greatly from the first (i.e., lowest) to the third (i.e., highest) poverty rate group; within the group with the highest poverty, 34% lived in tracts not defined as MUAs. Patients residing in the four largest cities (especially Hartford and New Haven) comprised considerable proportions of all patients in the group with the highest poverty rate.

Within each poverty rate group, the proportion dead differed little between patients in MUA and non-MUA census tracts (Table 1), and associations were not statistically significant (not shown). The proportion dead increased across the poverty rate groups within each of the four largest cities and for patients in the rest of the state.

The simplest Cox proportional hazards models (not shown) included only age at diagnosis (five categories) and either MUA (vs. non-MUA) or the three SES categories. The risk ratio for MUA was statistically significant (1.51, $P < .001$). For the poverty rate groups, risk ratios were 1.25 ($P < .001$) for 10%–19.4% (vs. <10%, the reference category) and 1.53 ($P < .001$) for the group with more than 19.5%.

Findings were similar when stage at diagnosis (local vs. all other) was added to the models. In a model (Table 2) that included all independent variables, the adjusted risk ratios were statistically significant for the highest (vs. lowest) poverty rate group, for black versus white race, unmarried versus married marital status, and for later or unknown versus local stage at diagnosis; the risk ratio for MUA residence was not statistically significant. In models (not shown) similar to those in Table 2 but using either quintile or decile of poverty rate (instead of the three categories in Table 2), the only statistically significant risk ratios were for either the highest quintile (6.8% or more of the poverty rate) or the highest decile (12.5% or more of the poverty rate).

Separate models (including age, race, marital status, stage, SES, and MUA status) were done for age less than 65 years and 65 years and older at diagnosis (data not shown). For age less than 65 years, the risk ratio for the second (vs. first) poverty rate group reached statistical significance (i.e., 1.20, 95% confidence limits 1.01 and 1.42); risk ratios for the SES variable were lower in the older age group.

TABLE 2. Risk ratios from a Cox proportional hazards regression model for mortality among 16,931 Connecticut women diagnosed with invasive breast cancer in 1988–1995

Characteristic	Total	Adjusted risk ratio	95% Confidence limits
Age, years			
<45	2,196	1.00	Reference category
45–54	3,163	0.94	0.82, 1.06
55–64	3,477	1.19	1.06, 1.34*
65–74	4,098	1.65	1.47, 1.84*
75+	3,887	3.29	2.96, 3.67*
Stage			
Local	9,113	1.00	Reference category
Other	7,818	2.96	2.79, 3.14*
Race			
White	16,063	1.00	Reference category
Black	868	1.44	1.28, 1.62*
Poverty rate of tract			
<10%	14,727	1.00	Reference category
10%–19.4%	1,290	1.09	0.99, 1.21
19.5%+	914	1.25	1.08, 1.46*
MUA status of tract			
Not MUA	16,125	1.00	Reference category
MUA	806	1.05	0.89, 1.23
Marital status			
Married	9,080	1.00	Reference category
Not married	7,141	1.30	1.22, 1.38*
Unknown	719	1.04	0.90, 3.14

Note: All risk ratios are from the full models. *Tract* refers to census tract of residence at diagnosis. Poverty rate and MUA status of tract were used as surrogate or proxy indicators of individual socioeconomic status and access to health care (see text for explanation).

MUA, medically underserved area.

* $P < .05$.

Only when stage at diagnosis was omitted from the model for patients less than 65 years old did the risk ratio for MUA residence reach statistical significance (i.e., 1.31, $P = .045$).

In a Cox proportional hazards model that had age at diagnosis (five categories) as the only other variable, risk ratios were elevated for each of the four largest cities (using the rest of the state as the reference category) (Table 3). After including age, SES, race, stage, and marital status, the risk ratio was elevated for two of the cities (i.e., Bridgeport and Waterbury; Table 3); adding MUA residence to the model (not shown) had no effect on the results.

DISCUSSION

Study limitations include the use of an ecologic indicator of the SES of individual patients. However, the ecologic indicator was available for almost all patients, whereas missing data are often a problem in studies attempting to obtain SES data

for individuals; in one study, poverty index was unknown for 40% of patients.¹³ Only a single SES indicator (i.e., poverty rate of census tract) was used for each patient, and use of units smaller than census tracts (such as census block groups)^{11,14} was not feasible in this study. Part of the association attributed to a surrogate or proxy indicator of patient SES could conceivably be due to “neighborhood” or “contextual” effects.¹⁵ In the absence of actual data on patient SES (income and/or education) obtained directly from patients, it is not possible to examine the association between mortality and neighborhood characteristics, independent of the SES of individuals, as was done in the Alameda County study, in which SES data were obtained from questionnaires.¹⁵

While marital status was not of primary interest in this study, the association between risk of death and marital status (Table 2) may reflect residual confounding between marital status and SES and/or other mechanisms (e.g., related to social support) independent of stage at diagnosis.¹⁶

With regard to the SES variable, risk ratios for death reached statistical significance for patients in census tracts with poverty rates of 20% or higher among all patients (Table 2) and with poverty rates of 10%–19% (vs. <10%) among patients diagnosed before 65 years of age. SES differences in survival among breast cancer patients have been reported in several US studies, and the stronger association among nonelderly (age less than 65 years) than elderly patients could involve the impact of Medicare coverage for the elderly and/or the greater importance of breast cancer as the underlying cause of death among nonelderly than elderly patients.¹⁷

The association between black versus white race and risk of death (Table 2), independent of the SES indicator, is consistent with the results of another study using SEER registry data.¹⁸

Both SES and racial differences have been reported in studies of various cancer treatments,¹⁹ but reporting of nonsurgical treatments (i.e., radiotherapy, chemotherapy, and hormone therapy) to the CTR is too incomplete for meaningful analysis. The potential roles of quality of specialist care (i.e., breast cancer treatment) versus primary care (i.e., for noncancer conditions) in explaining SES differences in survival could be illuminated by examination of causes of death, but there are problems in using information solely from death certificates^{16,20}; review of medical

TABLE 3. Risk ratios from Cox proportional hazards regression models including city of residence at diagnosis

City	n	Model with age	Model with other variables*	
		Risk ratio	Risk ratio	95% CL
Bridgeport	630	1.25*	1.19	1.04, 1.37†
Hartford	464	1.29*	1.00	0.84, 1.18
New Haven	560	1.31*	1.01	0.87, 1.19
Waterbury	542	1.33*	1.22	1.06, 1.40†
Rest of state	14,735	1.00	1.00	Reference

CL, confidence limits (95%) on risk ratio.

*Includes age, marital status, stage at diagnosis, race, and poverty rate of census tract (as in Table 2); risk ratios for these variables are not shown.

† $P < .05$.

records would be needed to assess the contribution of breast cancer to the death for each patient.

Although there is some overlap in the definition of SES and MUA status and some collinearity between the two independent variables, 34% of the lowest SES group did not live in an MUA.

Residence in an MUA, a surrogate indicator of a patient's access to health care, was associated with risk of death only when stage at diagnosis was omitted from the Cox proportional hazards model for patients under 65 years of age at diagnosis. This suggests a role for medical care factors related to early detection of cancer.²¹ Studies of health care quality in HPSAs (a variable involved in the definition of MUAs) have shown that adjustment for other factors associated with living in an HPSA (e.g., high poverty, lack of health insurance status, and minority group status) explained much or all of the differences between HPSA and non-HPSA areas in access to primary care²² and risk of preventable hospitalization among Medicare beneficiaries.²³

The risk ratio for MUA status was not statistically significantly elevated in a model that included stage at diagnosis (Table 2), although future studies should include larger samples of MUA residents. In the absence of information on access to health care for individual cancer patients, other characteristics of area of residence that might be predictive of an individual patient's access to health care should be examined, including numbers of primary care physicians working in community health centers or other safety net facilities, number of minority physicians, and cultural competency among all physicians.^{21,24}

About 80% of patients residing in census tracts with high (20% or above) poverty rates lived in the state's four largest cities (Bridgeport, Hartford, New Haven, and Waterbury; Table 1), which also included about 90% of all breast cancer patients who lived in an MUA. Reduced survival rates among lower SES patients with breast and other cancers living in a group of US counties in metropolitan areas (Hartford, CT; San Francisco, CA; Detroit, MI; and Seattle, WA) combined,^{25,26} along with small SES gradients in survival in Hawaii and no clear gradient in Toronto (Canada),¹⁶ have suggested a role for differences in health care systems (i.e., health insurance coverage).^{16,25,26} For each of the four largest cities in Connecticut, the present study shows an SES gradient (albeit not always statistically significant) in the proportion of patients known to have died (Table 1). There was also unexplained variation in the risk ratio for the four cities (relative to the rest of the state) after adjustment for certain patient characteristics (including the SES variable) (Table 3). Studies are needed that use individual indicators of SES, health insurance coverage, cause of death, and cancer treatments received by patients in these four cities; studies are also needed in other states.

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