Cancer Survival in Kentucky and Health Insurance Coverage

Kathleen McDavid, PhD, MPH; Thomas C. Tucker, PhD; Andrew Sloggett, MSc; Michel P. Coleman, MD, MSc, MFPHM

Background: Access to health insurance influences the amount and quality of health care received, which in turn is likely to be related to survival. Few studies have systematically examined cancer survival by individual level health insurance data from a state population–based cancer registry for 4 anatomic sites.

Methods: Men and women aged 18 to 99 years who were registered from 1995 to 1998 with the Kentucky Cancer Registry, Lexington, with colorectal, lung, breast, or prostate cancer were followed up through 1999. Three-year crude and relative survival proportion by 7 health insurance categories and by sex for all 4 sites were calculated. Poisson regression was used to model the risk of death (controlling for age group at diagnosis, sex, race, stage at diagnosis, and treatment) relative to expected deaths in the general population from all 4 cancers by health insurance category.

Results: Among patients with prostate cancer, 3-year relative survival proportion was 98% for the privately insured and 83% for the uninsured; comparable figures were 91% and 78% for patients with breast cancer; 71% and 53% for patients with colorectal cancer; and 23% and 13% for patients with lung cancer. For all 4 cancers the uninsured ranked fifth or sixth on survival, above patients with unknown insurance type or Medicaid/welfare.

Conclusion: These findings confirm purported disparities in cancer care and point toward the need to make quality care accessible to all segments of the population.

Arch Intern Med. 2003;163:2135-2144

From the Division of HIV/AIDS Prevention, National Center for HIV, STD, and TB Prevention, Centers for Disease Control and Prevention (work performed while in the Division of Cancer Prevention and Control, Centers for Disease Control and Prevention), Atlanta, Ga (Dr McDavid); Kentucky Cancer Registry, Lexington (Dr Tucker); and London School of Hygiene and Tropical Medicine, London, England (Mr Sloggett and Dr Coleman). *The authors have no relevant financial interest in this article.*

CANCERS OF the colon and rectum (colorectal); of the trachea, bronchus, and lung (lung); and of the breast and prostate impose a substantial burden of disease in the state of Kentucky and in the United States as a whole. In 2002, these 4 highly prevalent cancers are expected to account for approximately 54% of the 21 100 new cases of invasive cancer predicted for Kentucky.[1] This state's cancer registry is distinguished among state cancer registries by being 1 of only 5 to collect insurance status[2] and by actively ascertaining information about vital status on all registered patients. Thus, Kentucky offers a convenient arena for studying population-based survival by health insurance category.

For people with cancer, early diagnosis and the receipt of appropriate treatment may greatly enhance their chances of survival. Correspondingly, survival rates for some cancers may be used as markers of the ability of a health system to work effectively.

Access to health insurance is known to influence the amount and quality of health care received, and thus the insurance status of cancer patients may be important to their survival. We could find no estimates of the proportion of US cancer patients who are uninsured; however, an estimated 16% of all Americans do not have health insurance, and in some states up to 25% of people younger than 65 years

For editorial comment see page 2123

CME course available online at www.archinternmed.com

are uninsured.[3,4] Compared with the insured, people without health insurance receive fewer inpatient and outpatient services,[5-9] undergo fewer cancer screening tests, have different overall treatment patterns,[10-15] and, if they have breast cancer, are less likely to receive appropriate screening and diagnostic workup and to obtain treatment consistent with current standards of care.[16,17] There is also much evidence that the uninsured are diagnosed later and receive different treatment for

cancer than people with insurance,[10-17] but only a few studies have examined differences in cancer survival by health insurance categories on a state population–based level.[10,14,15]

Cancer survival has been shown to differ by socioeconomic status in studies in the United States, Canada, and Europe.[18-35] Most of these were population-based studies that used ecologic measures of socioeconomic status, derived from census data on income, education, or occupation.[18-23,29,30] For most of the cancers studied, patients from deprived economic areas had worse survival than those from advantaged areas.[18,20-23,25-29,31-34]

In addition to socioeconomic status, race and/or ethnicity is often the focus of studies examining disparities in cancer survival. A study of US Department of Defense tumor registry patients in an "equal access system" reported that survival among black men with prostate cancer is similar to that for white men and may be better at more advanced stages.[36] Another study from the same tumor registry system found that black female breast cancer patients had a risk of death 1.45 times greater than white women seen in the same system.[37] Other studies have examined survival by health insurance groups (eg, for breast cancer in Medicaid and Medicare populations[38] and among group/staff health maintenance organization and fee-for-service Medicare populations with prostate cancer[39]). However, most cancer survival studies did not use individual level health insurance data collected by the cancer registry, control for treatment, or examine as many sites as we do here, and the two from the US Department of Defense tumor registry did not report on the quality of the data from the registry.

The present study includes 1- and 3-year relative survival for colorectal, lung, breast, and prostate cancer by health insurance category for patients diagnosed from 1995 to 1998 and followed up through 1999. In addition, the influence of health insurance coverage on relative survival is modeled while controlling for age, sex, race, stage at diagnosis, and summary of first course of treatment.

METHODS

DATA SOURCE

The Kentucky Cancer Registry (KCR), Lexington, established in 1991, is a population-based cancer incidence registry. All health care facilities and physicians in Kentucky are required by state law to report new cancer cases to the KCR within 4 months of diagnosis.

Procedures to ensure data quality, such as eliminating multiple records for the same cancer case and combining information from different sources for one case, take place regularly. Death clearance (matching a registry file with the state's death records), conducted semiannually, identifies cancer patients who have not been identified and registered through the health care system, and it allows the registry to update vital status information on those who have been registered. Vital status is also updated by regular contact with reporting hospitals, private pathology laboratories, freestanding treatment facilities, and physician offices. The KCR maintains follow-up information (active from reporting facilities and passive by KCR linkages with administrative databases) on more than 85% of all cases within 15 months of the date of last contact. For diagnosis years 1995 to 1998, the KCR received from the North American Association of Central Cancer Registries (NAACCR), Springfield, Ill, its highest rating (gold) for completeness, timeliness, and quality of its data.

The KCR provided researchers a file with the following variables: sex, date of birth, race, diagnosis date, date of last known contact, vital status, behavior of neoplasm, clinical and pathologic TNM stage,[40,41] general summary stage, "first-course therapy composite" (defined below), therapy start date, and health insurance. Age at diagnosis in days was calculated from date of birth and diagnosis date. Age at exit from study (in days) was calculated from date of birth and date of last known contact (or death). Age at diagnosis and age at exit from study were used to calculate survival time in days (expressed in years). Only black and white were used for race because other races accounted for less than 1% of cases. Cases were selected on the basis of *International Classification of Diseases for Oncology* (2nd edition) (*ICD-O-2*)[42] topographic codes C18.0 through 18.9, C19.9, C20.9, and C21.0 through C21.8 for colon, rectum, and anus (colorectal); C33.9 and C34.0 through C34.9 for trachea, bronchus, and lung (lung); C50.0 through C50.9 for female breast; and C61.9 for prostate. General summary stage categories included "local" (tumor limited to the primary site), "regional" (disease spread beyond the organ of origin either by direct extension or to regional lymph nodes), "distant" (metastasis to distant site[s]), and "unknown" or "unstaged."[43]

"First-course therapy composite" is a summary of the first course of treatment received during the initial 4 months following diagnosis. Surgery performed at sites other than the primary cancer site is not considered surgical treatment. For colorectal cancer, treatment had 3 categories: surgery at primary site; radiation therapy and/or surgery plus therapy combinations; and no therapy/not curative. Lung cancer had 5 categories: surgery plus therapy combinations; chemotherapy only; radiation therapy only; no surgery, but therapy combinations; and no therapy. The 3 breast cancer categories were surgery at primary site; surgery plus therapy combinations; and no therapy/not curative. Finally, prostate cancer had 5 treatment categories: surgery at primary site; surgery plus therapy combinations; radiation therapy only; no surgery, but therapy combinations; and no therapy/not curative.

The primary payer was defined as the primary payer for services received at the reporting facility. The type of insurer, recorded at diagnosis, was abstracted from the face sheet of the medical record. The abstractor categorized the insurer as one of 20 types. When the specific name of the insurer was not recognized by the abstractor, it was reported as "Insured, not otherwise specified (NOS)," and it was thus used in this analysis. We categorized health insurance into 7 categories: private; Medicare plus supplement; Medicare; other federally funded; Medicaid or welfare; not insured; and unknown.

Private insurance categories included preferred provider organization; health maintenance organization; managed care provider; and private, NOS. Because overall survival for "Insured, NOS" (<3% of the total) was similar to that for those with private insurance, the categories were combined and called "private." People eligible for Medicare,[44] a federally funded health insurance program, were generally 65 years and older. Medicare enrollees with supplemental insurance were categorized as "Medicare plus supplement."

We grouped with "other federally funded" persons insured by the Civilian Health and Medical Program, Uniformed Service (CHAMPUS), which is available to spouses and dependents of military personnel until they are eligible for Medicare, with those insured by the military, the Veterans Administration, and the Public Health Service. Medicaid[45] is a state program jointly funded by states and the federal government to assist low-income persons, and welfare is a state-funded pro-

gram aiding the indigent. These 2 types of insurance were grouped as "Medicaid/welfare."

The "uninsured" included self-pay, charity (patient could not pay and facility wrote off expenses as charity donation), and "uninsured, NOS" and were grouped because they are generally of poorer socioeconomic status. The insurance status was "unknown" for relatively few patients: 3% of colorectal and breast, 6% of lung, and 5% of prostate cancer patients.

SELECTION CRITERIA

All black or white patients diagnosed with a first primary tumor of the colon or rectum, lung, breast, or prostate from 1995 to 1998 with follow-up through December 31, 1999 (n=40 207), were initially included. Patients diagnosed in 1995 and 1996 were followed up for at least 3 years, while those diagnosed in 1997 and 1998 were followed up for at least 1 year. Follow-up involved both active (eg, hospitals contacting physicians and patients) and passive (eg, linkage to Department of Motor Vehicles) methods. Patients with missing or invalid data for sex, race, date of birth, diagnosis, and death (if present), *ICD-O-2* site code, or behavior and those with in situ carcinoma were determined to be ineligible (n=2885) for this study.

In addition, patients were excluded, in the following order, on the basis of age at diagnosis younger than 15 years or 100 years or older, unknown vital status, duplicate registration (records with identical data for site code, sex, race, date of birth, and diagnosis), unknown sex or female sex for prostate cancer, invalid sequence of dates (all combined, n=3), or zero survival (n=1464). We excluded patients for whom the diagnosis date was exactly the same as the date of death because we were unable to distinguish a death certificate–only case from someone who had zero survival. In all, we excluded 2.3%, 5.0%, 1.8%, and 6.3% of colorectal, lung, breast, and prostate cases, respectively. The final data set for analysis included 7661, 12 477, 8758, and 6959 patients with these cancers, respectively. This study was approved by the institutional review boards of the Centers for Disease Control and Prevention, Atlanta, Ga, and the University of Kentucky, Lexington.

STATISTICAL ANALYSES

We used χ^2 tests (significance level, $P<.001$) to assess the difference in age, sex, race, and stage at diagnosis for types of health insurance. The observed (or crude) survival proportion (rate is also commonly used) is commonly used to describe the prognosis of cancer patients. Crude survival is the estimated probability of survival to the end of a period, regardless of cause of death or background mortality of the population. Patients often die of unrelated causes, however, and this becomes more likely with the passage of time. Relative survival proportion is the ratio of the observed survival in the population of interest (cancer patients) to the survival that would have been expected had the patients experienced only the mortality of the general population from which they were drawn.[46,47] The expected probabilities for this analysis were obtained from abridged life tables for the state of Kentucky, smoothed, and extended to provide tabulations by single year of age at death, from 0 to 99 years.[18] Age-, sex-, and race-specific life tables for the years 1995 to 1999 were used for this analysis.[48]

Relative survival analysis is the method most commonly used to describe survival of cancer patients in population-based studies. Because all deaths are included (there is no censoring by cause of death), the death certificate is not required—only the fact and date of death. This approach avoids errors of misclassification (whether the death was "due to" cancer) that can arise with cancer-specific survival.[49] We calculated relative survival proportions using the approach detailed by Estève et al[46] using a maximum likelihood algorithm in STATA software.[18,50] All references to survival are to relative survival proportion unless otherwise stated.

In addition to calculating survival, we modeled the influence of health insurance categories on relative cancer survival while adjusting for age, sex, race, stage at diagnosis, treatment, and year of follow-up. We used 6 age groups for all sites except prostate cancer, for which we combined the 2 youngest groups (15-44 and 45-54 years) because of small numbers.

The underlying model we fitted[51] is identical to that described by both Hakulinen and Tenkanen[52] and Estève et al,[53] the difference being in the method used for estimation. We used regression based on counts (deaths), conditioned by person-years. The result is therefore regression for rates with SEs provided by Poisson distribution rules.[54] The likelihood functions for the approach by Estève et al[53] and the approach used by us[51] are identical, so the parameter estimates are also identical. The advantage of the estimation approach we used is that it is easily implemented using standard software (we used STATA[50]). The estimation approach we used is identical to that described by Breslow and Day.[55] For each relative risk, 95% confidence intervals were calculated.

Interaction terms (for example, effect modification by stage at diagnosis) were assessed in the following order: stage at diagnosis × follow-up, age × follow-up, stage at diagnosis × age, and then all 1-way interactions with health insurance. Stage at diagnosis × follow-up and age × follow-up were assessed first and second based on their importance in previous relative survival analyses (written communication, Paul Dickman, PhD, July 22, 2002). Effect modification was assessed by including then removing the interaction term and assessing improvement in model fit using the likelihood ratio test. The likelihood ratio test was also used to assess improvement in model fit by the addition of health insurance alone. *P* values were used to assess the statistical significance level ($P<.05$) of the likelihood ratio test statistic. For colorectal, lung, and breast cancer, final models included stage at diagnosis × follow-up and age × follow-up interaction terms; for prostate cancer, the final model included stage at diagnosis × age interaction.

RESULTS

For each of the 4 cancers, patients aged 65 to 74 years represented the single largest age group (**Table 1**), but for breast cancer patients there were similar proportions in the 45- to 54-year, 55- to 64-year, and 65- to 74-year age groups. More than half (61.8%) the lung cancer patients were men. A diagnosis at the local stage was made in 34.8% of colorectal and 20.8% of lung cancers, while 60.7% of breast and 67.8% of prostate cancers were diagnosed at that stage. Among lung cancer patients, 40.9% presented with distant disease. "Medicare plus supplement" was the most common insurance category for colorectal (36.8%), lung (31.3%), and prostate (37.1%) cancer patients, but private insurance was most frequent for breast cancer (44.1%). Uninsured persons were in the range of 0.8% to 4.1% (Table 1).

Type of health insurance differed by age, sex, race, and stage at diagnosis (**Table 2**). Most uninsured persons were aged 15 to 64 years. Although they accounted for only about 6.5% of registrants as a whole, black patients accounted for 11.6% of the "other federally funded" and 10.3% of the Medicaid/welfare category. Just over 50% of patients whose insurance category was unknown had unknown/unstaged cancer, but for the other insurance

Table 1. Characteristics by Cancer Site*

Characteristic	Cancer Site			
	Colorectal (n = 7661)	Lung (n = 12 477)	Female Breast (n = 8758)	Prostate (n = 6959)
Age at diagnosis, y				
15-44	417 (5.4)	353 (2.8)	1157 (13.2)	28 (0.4)
45-54	819 (10.7)	1421 (11.4)	1903 (21.7)	394 (5.7)
55-64	1395 (18.2)	3229 (25.9)	1921 (21.9)	1724 (24.8)
65-74	2215 (28.9)	4508 (36.1)	1993 (22.8)	2879 (41.4)
75-84	1981 (25.9)	2499 (20.0)	1375 (15.7)	1530 (22.0)
85-99	834 (10.9)	467 (3.7)	409 (4.7)	404 (5.8)
Sex				
Male	3733 (48.7)	7707 (61.8)	. . .	6959 (100.0)
Female	3928 (51.3)	4770 (38.2)	8758 (100.0)	. . .
Race				
White	7147 (93.3)	11 681 (93.6)	8246 (94.1)	6418 (92.2)
Black	514 (6.7)	796 (6.4)	512 (5.9)	541 (7.8)
Stage at diagnosis				
Localized	2665 (34.8)	2592 (20.8)	5315 (60.7)	4717 (67.8)
Regional	2920 (38.1)	3253 (26.1)	2649 (30.3)	708 (10.2)
Distant	1458 (19.0)	5105 (40.9)	465 (5.3)	562 (8.1)
Unknown/unstaged	618 (8.1)	1527 (12.2)	329 (3.8)	972 (14.0)
Health insurance				
Private†	1912 (25.0)	2678 (21.5)	3866 (44.1)	1754 (25.2)
Medicare + supplement	2821 (36.8)	3904 (31.3)	2206 (25.2)	2584 (37.1)
Medicare	1878 (24.5)	3152 (25.3)	1502 (17.2)	1587 (22.8)
Other federally funded‡	318 (4.2)	705 (5.7)	149 (1.7)	536 (7.7)
Medicaid/welfare§	275 (3.6)	857 (6.9)	412 (4.7)	82 (1.2)
Uninsured‖	196 (2.6)	431 (3.5)	356 (4.1)	53 (0.8)
Unknown	261 (3.4)	750 (6.0)	267 (3.1)	363 (5.2)
Treatment				
No therapy/not curative	1108 (14.5)	. . .	655 (7.5)	1585 (22.8)
Surgery at primary site	4177 (54.5)	. . .	3152 (36.0)	2344 (33.7)
Radiation/surgery + therapy combinations	2376 (31.0)	. . .	. . .	. . .
No definitive therapy	. . .	3782 (30.3)	. . .	. . .
Surgery + therapy combinations	. . .	2728 (21.9)	4951 (56.5)	806 (11.6)
Chemotherapy only	. . .	1353 (10.8)	. . .	. . .
Radiation therapy only	. . .	2369 (19.0)	. . .	743 (10.7)
No surgery, but therapy combinations	. . .	2245 (18.0)	. . .	1481 (21.3)

*Data are number (percentage) of Kentucky patients diagnosed with cancer from 1995 to 1998. Percentages may not add to 100 owing to rounding. Ellipses indicate not applicable.

†Private insurance; managed care provider, not otherwise specified (NOS); health maintenance organization; preferred provider organization.

‡Civilian Health and Medical Program, Uniformed Service; military (active and retired); Veterans Administration; public health service; federally funded, NOS.

§Medicaid; welfare (government assistance other than Medicaid); state funded, NOS.

‖Not insured, NOS; not insured, charity; not insured, self-pay.

classifications the unknown/unstaged group never exceeded 10.3%. Uninsured persons and Medicaid patients had the 2 highest proportions of distant-staged cancers, 31.4% and 31.2% (Table 2). Other analyses showed that almost three fourths (73%) of cancer patients with unknown insurance status received no therapy; this was true for 25% of "other federally funded" patients.

Three-year survival was best for prostate cancer (92.7%) and worst for lung cancer (19.1% for women; 14.5% for men) (**Table 3**). Differences between women and men for colorectal and lung cancer were especially notable for patients younger than 65 years. Patients in the oldest age group had the worst 1- and 3-year relative survival except for breast cancer, in which the youngest group (15-44 years) had the lowest rate (69.4%) of 3-year survival (Table 3).

Three-year relative survival of prostate cancer patients was as high as 97.7% for those with private insurance to as low as 36.6% for those with unknown insurance (**Table 4** and the **Figure**). For breast, colorectal, and lung cancer, we also found that 3-year relative survival was highest for private and lowest for unknown insurance: 90.6% and 57.5% for breast cancer, 70.9% and 24.7% for colorectal cancer, and 23.4% and 4.8% for lung cancer. Uninsured persons ranked sixth of 7 categories for colorectal and lung cancer and fifth of 7 for prostate and breast cancer (Medicaid/welfare and unknown insurance had lower survival for these 2 diseases).

Colorectal, prostate, and breast cancer had similar patterns of survival by insurance category (Table 4). Patients insured privately or by Medicare, Medicare plus supplement, or other federally funded had relatively better survival compared with patients in the other insurance categories. A different pattern was seen for lung cancer, for which Medicaid/welfare, other federally funded, Medicare with supplement, and Medicare all had about

Table 2. Characteristics by Type of Health Insurance*

Characteristic	Health Insurance Type†						
	Private	Medicare + Supplement	Medicare	Other Federally Funded	Medicaid/ welfare	Uninsured	Unknown
Age at diagnosis, y‡							
15-44	1361 (13.3)	15 (0.1)	30 (0.4)	31 (1.8)	269 (16.5)	171 (16.5)	78 (4.8)
45-54	3084 (30.2)	107 (0.9)	193 (2.4)	152 (8.9)	479 (29.5)	349 (33.7)	173 (10.5)
55-64	4925 (48.2)	624 (5.4)	726 (8.9)	441 (25.8)	747 (45.9)	469 (45.3)	337 (20.5)
65-74	634 (6.2)	5732 (49.8)	3909 (48.2)	731 (42.8)	93 (5.7)	28 (2.7)	468 (28.5)
75-84	176 (1.7)	3936 (34.2)	2535 (31.2)	305 (17.9)	27 (1.7)	16 (1.5)	390 (23.8)
85-99	30 (0.3)	1101 (9.6)	726 (8.9)	48 (2.8)	11 (0.7)	3 (0.3)	195 (11.9)
Sex‡							
Male	4398 (43.1)	6130 (53.2)	4394 (54.1)	1430 (83.7)	694 (42.7)	412 (39.7)	941 (57.3)
Female	5812 (56.9)	5385 (46.8)	3725 (45.9)	278 (16.3)	932 (57.3)	624 (60.2)	700 (42.7)
Race‡							
White	9680 (93.8)	10 948 (95.1)	7504 (92.4)	1510 (88.4)	1458 (89.7)	953 (92.0)	1539 (93.8)
Black	630 (6.2)	796 (4.9)	512 (7.6)	198 (11.6)	168 (10.3)	83 (8.0)	102 (6.2)
Stage at diagnosis‡							
Localized	4896 (47.9)	5043 (43.8)	3473 (42.8)	757 (44.3)	480 (29.5)	320 (30.9)	320 (19.5)
Regional	3143 (30.8)	2861 (24.9)	2113 (26.0)	387 (22.7)	508 (31.2)	333 (32.1)	185 (11.3)
Distant	1758 (17.2)	2425 (21.1)	1835 (22.6)	438 (25.6)	508 (31.2)	325 (31.4)	301 (18.3)
Unknown/unstaged	413 (4.1)	1186 (10.3)	698 (8.6)	126 (7.4)	130 (8.0)	58 (5.6)	835 (50.9)

*Data are number (percentage) of Kentucky patients diagnosed with colorectal, lung, female breast, or prostate cancer from 1995 to 1998. Percentages may not add to 100 owing to rounding.
†See footnotes to Table 1 for descriptions of health insurance types.
‡χ^2 Test significant at $P<.001$.

the same 3-year relative survival (13.4%-16.3%). In the Figure, we present insurance categories in the following order: private; Medicare plus supplement; Medicare; other federally funded; Medicaid/welfare; uninsured; and unknown. We chose this order to illustrate what we thought likely to represent the least deprived to most deprived categories of patients.

Among colorectal cancer patients, the differences in survival between those privately insured and those of unknown insurance coverage remained substantial and significant in the statistical models we tested (**Table 5**). Patients with Medicare had a 32% higher risk than those who were privately insured, while those with Medicaid/welfare had a 56% higher risk and those with unknown coverage a 66% greater risk of death. The inclusion of health insurance significantly ($P<.001$) improved the fit of this model as well as the fit of lung, breast, and prostate cancer models (Table 5).

Lung cancer patients of all other insurance types had a significantly higher risk of death within 3 years compared with privately insured patients; for uninsured persons the risk was 19% greater (Table 5). The risk for black patients was lower than that for white patients (relative risk, 0.83; 95% confidence interval, 0.75-0.90). For breast cancer, women insured by Medicaid/welfare were at 66% higher risk of death than women who were privately insured. Black women had a 39% higher risk of death than white women even after controlling for length of follow-up, age, stage, health insurance, and treatment (Table 5).

The modeled results for prostate cancer differed from those for the 3 other sites: men in the Medicaid/welfare and unknown insurance groups had elevated risks of death within 3 years of diagnosis compared with men privately insured (Table 5). There were no differences in risk between the privately insured and men in the other insurance categories.

COMMENT

The present study is one of the few US studies to include all adults and insurance types for a state population–based cancer survival analysis focused on common cancers. It is also the only one to use relative survival, now an accepted technique in such studies, which adjusts for competing causes of mortality without having to rely on death registration data, which can be unreliable. In this study, patients with colorectal, lung, breast, and prostate cancers who had private insurance had the best survival, while those of unknown insurance type always fared worst. Uninsured patients ranked fifth or sixth for all 4 sites. Univariate results were generally confirmed in models that included covariates for age group, sex, race, stage at diagnosis, and treatment. Survival differences were large and consistent across health insurance categories. The fact that patients with unknown insurance coverage fared so poorly could be due to, among other reasons, the differential receipt of screening and/or therapy or to the fact that they were older than cancer patients in other health insurance categories in our population.

Our study supports reported differences between privately insured, Medicaid/welfare, and uninsured persons for colorectal and breast cancers in 2 other states in the United States.[10,14,15,38] Ayanian et al,[10] who studied New Jersey women aged 35 to 64 years with breast cancer, reported that the adjusted (for age, race, marital status, household income, coexisting diagnoses, and disease stage) risk of death was 49% higher for uninsured patients and 40% higher for Medicaid patients than for

Table 3. Relative Survival (1 and 3 Years) Proportion by Age at Diagnosis and Sex*

Diagnosis and Sex	Age Group, y			
	All	15-44	45-54	55-64
Colorectal				
Male	(n = 3733)	(n = 192)	(n = 462)	(n = 797)
1-y Survival	79.3 (77.8-80.7)	84.0 (77.7-88.6)	82.6 (78.7-85.9)	82.1 (79.1-84.7)
3-y Survival	61.3 (59.3-63.3)	58.1 (49.7-65.6)	65.0 (59.8-69.7)	62.5 (58.3-66.4)
Female	(n = 3928)	(n = 225)	(n = 357)	(n = 598)
1-y Survival	78.6 (77.1-80.0)	85.9 (80.4-89.9)	87.5 (83.5-90.6)	85.9 (82.7-88.6)
3-y Survival	63.5 (61.6-65.4)	69.4 (62.1-75.6)	72.2 (66.6-77.0)	69.8 (65.3-73.9)
Lung				
Male	(n = 7707)	(n = 199)	(n = 876)	(n = 2068)
1-y Survival	37.0 (35.9-38.1)	84.0 (77.8-88.6)	40.7 (37.3-44.0)	42.6 (40.4-44.8)
3-y Survival	14.5 (13.6-15.4)	58.2 (49.8-65.6)	14.5 (12.0-17.2)	17.4 (15.6-19.2)
Female	(n = 4770)	(n = 154)	(n = 545)	(n = 1161)
1-y Survival	42.5 (41.0-43.9)	85.8 (80.4-89.9)	54.0 (49.6-58.1)	48.4 (45.4-51.3)
3-y Survival	19.1 (17.8-20.4)	69.4 (62.1-75.6)	25.9 (22.0-30.0)	22.7 (20.1-25.4)
Female breast	(n = 8758)	(n = 1157)	(n = 1903)	(n = 1921)
1-y Survival	96.2 (95.7-96.7)	85.9 (80.4-89.9)	97.6 (96.7-98.2)	95.5 (94.3-96.4)
3-y Survival	87.5 (86.6-88.4)	69.4 (62.1-75.6)	88.4 (86.6-90.0)	87.9 (85.9-89.7)
Prostate†	(n = 6959)		(n = 422)	(n = 1724)
1-y Survival	97.6 (96.8-98.1)		98.7 (96.4-99.5)	98.9 (97.7-99.4)
3-y Survival	92.7 (91.4-93.8)		92.4 (88.3-95.1)	95.8 (93.7-97.2)

	65-74	75-84	85-99
Colorectal			
Male	(n = 1209)	(n = 824)	(n = 249)
1-y Survival	82.1 (79.5-84.4)	73.6 (69.9-76.9)	55.8 (47.9-63.0)
3-y Survival	64.6 (60.9-68.0)	59.6 (54.5-64.3)	38.0 (28.1-47.8)
Female	(n = 1006)	(n = 1157)	(n = 585)
1-y Survival	82.8 (80.1-85.2)	72.1 (69.1-74.9)	61.4 (56.5-65.9)
3-y Survival	67.3 (63.5-70.7)	58.2 (54.3-61.8)	45.1 (38.6-51.3)
Lung			
Male	(n = 2812)	(n = 1499)	(n = 253)
1-y Survival	35.8 (34.0-37.7)	29.4 (26.9-31.8)	23.9 (18.2-30.0)
3-y Survival	14.4 (12.9-15.9)	11.0 (9.1-13.1)	8.6 (4.5-14.4)
Female	(n = 1696)	(n = 1000)	(n = 214)
1-y Survival	40.7 (38.3-43.1)	34.6 (31.5-37.7)	25.3 (19.2-31.9)
3-y Survival	17.7 (15.7-19.8)	14.1 (11.7-16.8)	10.4 (5.7-16.7)
Female breast	(n = 1993)	(n = 1375)	(n = 409)
1-y Survival	96.2 (95.0-97.2)	93.5 (91.5-95.1)	85.8 (80.1-90.0)
3-y Survival	90.3 (88.2-92.1)	84.7 (81.3-87.6)	72.5 (63.1-79.9)
Prostate†	(n = 2879)	(n = 1530)	(n = 404)
1-y Survival	97.7 (96.5-98.5)	95.2 (93.0-96.7)	76.7 (70.4-81.9)
3-y Survival	94.1 (92.0-95.6)	84.7 (80.8-87.8)	49.7 (40.6-58.1)

*Data for survival are relative survival proportion (95% confidence interval), given as percentage, of Kentucky patients. One-year survival is presented for patients diagnosed from 1995 to 1998, and 3-year survival is presented for patients diagnosed in 1995 and 1996. Estimates are based on sex-, race-, and age-specific life tables.

†Youngest age group, 15-54 years.

privately insured patients during the 54 to 89 months after diagnosis. Roetzheim and colleagues,[14,15] who studied Florida residents with colorectal and breast cancers, found that those who were uninsured or insured by Medicaid (colorectal and breast) or commercial health maintenance organizations (breast) had higher mortality rates (adjusted for age, sex, stage at diagnosis, treatment, comorbidity, marital status, smoking status, and community measures of socioeconomic status) than patients with commercial fee-for-service insurance. Bradley et al[38] also found that people 65 years and younger who were receiving Medicaid had a higher risk of death from the disease (breast, cervix, lung, prostate, or colon carcinoma) than did patients older than 65 years and receiving Medicaid or Medicare. None of the 4 studies reported relative survival or used life tables in the estimation of risks, as we did, which would have corrected for the competing causes of mortality. Finally, the overall 3-year survival proportion estimates in our study are lower than those reported from the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) program for roughly the same period for all 4 sites.[56] The fact that Kentucky is a relatively poor state,[57] might have affected the comparatively lower survival proportions reported here.

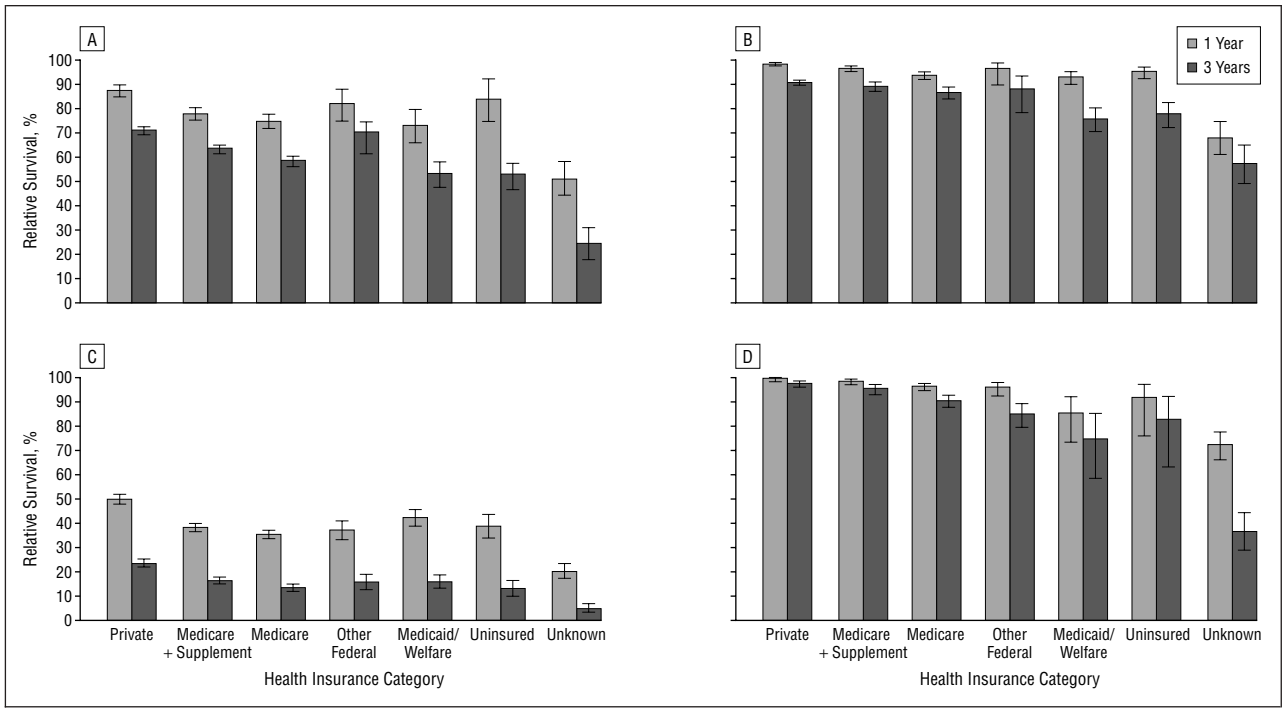
Our uninsured rate of approximately 3% is far below average estimates for the US population as a whole (16%).[58-60] Rates of uninsurance are inversely proportional to age, however, and cancer patients are older than

Table 4. Crude and Relative Survival (1 and 3 Years) Proportion by Type of Insurance*

Health Insurance Type†	Male		Female		All	
	Crude Survival, %	Relative Survival, %	Crude Survival, %	Relative Survival, %	Crude Survival, %	Relative Survival, %
Colorectal Cancer						
Private insurance	(n = 1043)		(n = 869)		(n = 1912)	
1-y Survival	83.3	84.7	89.0	89.9	85.9	87.1
3-y Survival	63.9	67.2	72.9	75.1	68.0	70.9
Medicare with supplement	(n = 1251)		(n = 1570)		(n = 2821)	
1-y Survival	73.6	79.4	71.4	76.4	72.4	77.7
3-y Survival	50.9	63.5	51.9	63.0	51.5	63.2
Medicare	(n = 834)		(n = 1044)		(n = 1878)	
1-y Survival	70.0	75.0	70.5	74.6	70.3	74.8
3-y Survival	46.5	56.8	49.7	59.4	48.2	58.2
Other federally funded	(n = 257)		(n = 61)		(n = 318)	
1-y Survival	79.9	83.6	71.5	75.6	78.2	82.0
3-y Survival	64.6	72.6	52.8	60.1	62.4	70.1
Medicaid/welfare	(n = 119)		(n = 156)		(n = 275)	
1-y Survival	71.0	72.0	72.9	73.8	72.1	73.0
3-y Survival	44.1	46.5	56.1	57.9	50.7	53.0
Not insured	(n = 105)		(n = 91)		(n = 196)	
1-y Survival	83.7	84.4	82.5	83.4	83.1	83.9
3-y Survival	49.8	52.0	50.9	52.9	50.6	52.8
Unknown	(n = 124)		(n = 137)		(n = 261)	
1-y Survival	46.4	49.9	48.4	52.0	47.4	51.0
3-y Survival	13.3	16.2	27.4	31.2	20.9	24.7
Lung Cancer						
Private insurance	(n = 1601)		(n = 1077)		(n = 2678)	
1-y Survival	46.8	47.7	52.0	52.6	48.9	49.7
3-y Survival	20.1	21.3	25.5	26.5	22.3	23.4
Medicare with supplement	(n = 2295)		(n = 1609)		(n = 3904)	
1-y Survival	34.1	36.1	39.1	40.6	36.1	38.0
3-y Survival	12.5	14.8	16.4	18.4	14.1	16.3
Medicare	(n = 1973)		(n = 1179)		(n = 3152)	
1-y Survival	31.7	33.4	37.2	38.4	33.8	35.3
3-y Survival	10.3	11.9	14.1	15.7	11.7	13.4
Other federally funded	(n = 637)		(n = 68)		(n = 705)	
1-y Survival	35.5	36.8	38.3	39.4	35.7	37.0
3-y Survival	14.1	15.9	14.4	15.4	14.1	15.8
Medicaid/welfare	(n = 493)		(n = 364)		(n = 857)	
1-y Survival	36.3	36.9	48.4	48.8	41.5	42.0
3-y Survival	11.7	12.3	20.2	20.8	15.3	16.0
Not insured	(n = 254)		(n = 177)		(n = 431)	
1-y Survival	35.3	35.7	42.5	42.8	38.2	38.6
3-y Survival	8.1	8.4	18.8	19.3	12.5	12.9
Unknown	(n = 454)		(n = 296)		(n = 750)	
1-y Survival	17.7	18.7	21.7	22.6	19.3	20.2
3-y Survival	3.5	4.1	5.3	5.8	4.2	4.8
Prostate Cancer			**Female Breast Cancer**			
Private insurance	(n = 1754)		(n = 3866)			
1-y Survival	98.0	99.6	97.5	98.3		
3-y Survival	92.4	97.7	88.7	90.6		
Medicare with supplement	(n = 2584)		(n = 2206)			
1-y Survival	92.4	98.7	92.1	96.5		
3-y Survival	77.9	95.6	77.1	89.0		
Medicare	(n = 1587)		(n = 1502)			
1-y Survival	89.4	96.6	89.7	93.6		
3-y Survival	72.4	90.5	75.6	86.5		
Other federally funded	(n = 536)		(n = 149)			
1-y Survival	90.6	96.3	94.4	96.6		
3-y Survival	72.5	85.0	81.6	88.0		
Medicaid/welfare	(n = 82)		(n = 412)			
1-y Survival	82.6	85.5	92.6	93.2		
3-y Survival	67.4	74.7	73.8	75.5		
Not insured	(n = 53)		(n = 356)			
1-y Survival	89.3	92.0	94.5	95.5		
3-y Survival	76.4	82.8	75.8	77.7		
Unknown	(n = 363)		(n = 267)			
1-y Survival	66.3	72.3	64.9	68.1		
3-y Survival	28.1	36.6	49.5	57.5		

*One-year survival is presented for Kentucky patients diagnosed from 1995 to 1998, and 3-year survival is presented for Kentucky patients diagnosed in 1995 and 1996. Estimates are based on sex-, race-, and age-specific life tables.

†See footnotes to Table 1 for descriptions of health insurance types.



Relative survival (1 and 3 years) by health insurance category for Kentucky patients with colorectal cancer (A), lung cancer (B), breast cancer (C), and prostate cancer (D) diagnosed from 1995 to 1998. Error bars are 95% confidence intervals. See footnotes to Table 1 for descriptions of health insurance types.

the general US population.[58-60] Programs such as Medicaid may pick up adults who become ill and incur large bills. Therefore, patients coded as Medicaid may have been uninsured at the time of diagnosis.

Possible reasons for the survival disparities we reported include the fact that poor patients frequently have a higher level of comorbidity compared with more affluent persons, which may make a particular cancer more difficult to treat and may lead to increased death from unrelated causes. Kentucky is the sixth poorest state in the United States according to the 2000 census.[57] Additionally, patients with prostate cancer (as well as other patients in our study) with insurance may have been screened at higher rates than those without insurance, which might have affected the relative survival proportion differences noted in the results.

Medicaid patients with any one of the 4 cancers studied here had a higher risk of death (comparable with those without insurance or of unknown insurance status) within 3 years compared with patients privately insured. These results may reflect a scarcity of primary care physicians who are willing to see Medicaid patients for preventive care or screening.

Other studies have used health insurance categories as a proxy for socioeconomic status,[14,15,61-63] but we have used it as a more direct estimate of access to care. To better understand the relationship between patients in the uninsured or underinsured groups and poor survival (and poor health, in general), additional research is necessary. More specifically, are the differences in survival between insurance categories secondary to differences in socioeconomic status or other variables? We need to understand why in one of the richest countries in the world, survival differences between health insurance categories are so large even after adjusting for stage of disease.

Bias in the collection of type of health insurance is likely to be only minimal, since the KCR consistently collects high-quality data,[64] and any bias is likely to be insufficient to explain the survival differences reported here. If treatment differs by health insurance category (as in our data), then factors affecting treatment received, and in turn survival, need to be studied further. Some of these factors include availability of treatment options, access to treatment, the stage of disease at diagnosis (which differs by health insurance category in our data), histologic and subsite differences, comorbidity, referrals to specialists, and treatment quality. The extent to which these characteristics differ by insurance may provide answers as to where health care systems could concentrate their efforts.

Several other limitations may have influenced our findings. First, our analysis used life tables specific to age, year, sex, and race but not health insurance category. Any bias introduced because of this approach is likely to be minimal, however, since health insurance category was included in the Poisson regression models.[54] Second, for this study, health insurance type was taken from the medical record at diagnosis and might have changed during treatment. We have not attempted to assess the change in this variable, but we are aware that patients may become uninsured or uninsurable after a diagnosis of cancer.[65] Another potential limitation is that the KCR may not collect all treatment received by a patient; the extent to which treatment received in outpatient settings or in other states is collected is unknown.

Comorbidity data were not available at the time of this analysis but will be in the future. Hospital treat-

Table 5. Relative Risk of Death Within 3 Years by Type of Cancer*

Characteristic	Colorectal† (49.47§)	Lung† (34.71§)	Female Breast† (46.88§)	Prostate‡ (117.60§)
Sex				
Female	1.00 (Reference)			
Male	1.13 (1.02-1.25)	1.15 (1.10-1.20)		
Race				
White	1.00 (Reference)			
Black	0.99 (0.82-1.20)	0.83 (0.75-0.90)	1.39 (1.05-1.84)	1.12 (0.76-1.67)
Health insurance‖				
Private	1.00 (Reference)			
Medicare plus supplement	1.06 (0.86-1.29)	1.13 (1.04-1.22)	1.07 (0.74-1.56)	0.80 (0.49-1.31)
Medicare	1.32 (1.08-1.62)	1.22 (1.12-1.31)	1.46 (1.03-2.07)	0.76 (0.46-1.24)
Other federally funded	0.74 (0.53-1.03)	1.09 (0.98-1.21)	1.78 (0.94-3.39)	1.24 (0.70-2.21)
Medicaid/welfare	1.56 (1.24-1.96)	1.14 (1.04-1.25)	1.66 (1.22-2.27)	2.49 (1.17-5.29)
Not insured	1.21 (0.91-1.60)	1.19 (1.06-1.34)	1.44 (1.01-2.05)	0.79 (0.33-1.92)
Unknown	1.66 (1.31-2.10)	1.24 (1.12-1.38)	2.89 (2.06-4.06)	5.99 (3.67-9.79)
Treatment¶				
No therapy/not curative	1.00 (Reference)	. . .	1.00 (Reference)	1.00 (Reference)
Surgery at primary site	0.38 (0.34-0.44)	. . .	0.33 (0.24-0.64)	0.58 (0.26-1.26)
Radiation/surgery + therapy combinations	0.30 (0.26-0.34)	. . .	. . .	. . .
No definitive therapy	. . .	1.00 (Reference)		
Surgery + therapy combinations	. . .	0.23 (0.21-0.25)	0.39 (0.31-0.49)	0.38 (0.12-1.13)
Chemotherapy only	. . .	0.58 (0.54-0.62)	. . .	. . .
Radiation therapy only	. . .	0.77 (0.73-0.82)	. . .	0.91 (0.66-1.26)
No surgery, but therapy combinations	. . .	0.50 (0.46-0.53)	. . .	0.79 (0.50-1.25)

*Data are relative risk (95% confidence interval) of Kentucky patients diagnosed with colorectal, lung, female breast, and prostate cancer from 1995 to 1998. Relative risk estimated by Poisson regression in STATA (Stata Corp, College Station, Tex). Ellipses indicate not applicable.

†Colorectal, lung, and breast cancer models control for variables in table plus length of follow-up, age, stage at diagnosis, follow-up × stage at diagnosis, and follow-up × age.

‡Prostate cancer model controls for variables in table plus length of follow-up, age, stage at diagnosis, and age × stage at diagnosis.

§Likelihood ratio test, $P<.001$.

‖See footnotes to Table 1 for descriptions of health insurance types.

¶Treatment categories differ for each site.

ment volume, not studied here, would also be worth examining, since recent reports indicate it influences treatment.[66] In addition, treatment patterns or characteristics could be examined according to whether the standard of care was met for patients in each health insurance category.[67,68] Finally, we reported 1- and 3-year crude and relative survival because this was the longest survival time available at the time of analysis.

The robustness of the health insurance estimates should be noted. We fitted interaction terms in an attempt to improve the fit of the model, but the health insurance terms were unaffected by this procedure and were very similar to those in the main effects models.

While differences in access to care, treatment, and survival continue, some are pushing for universal health care and others for mandatory coverage for serious diseases. The President's Cancer Panel, a 3-member panel established in 1971 under the National Cancer Act that periodically reports to the president, recently recommended immediate cancer care coverage for the uninsured.[4] Our findings confirm reported disparities in cancer care and outcome between patients in different health insurance categories and reinforce the recommendation of the President's Cancer Panel to make quality care available and accessible to all segments of the population.

Accepted for publication March 7, 2003.

We thank Frances Ross, Certified Tumor Registrar, Director, and Eric Durbin, MS, Information Technology Manager, Kentucky Cancer Registry, Lexington, for their invaluable technical assistance.

Corresponding author and reprints: Kathleen McDavid, PhD, MPH, Centers for Disease Control and Prevention/NCHSTP/DHAP, 1600 Clifton Rd, Mailstop E-47, Atlanta, GA 30333 (e-mail: kzm2@cdc.gov).

REFERENCES

1. Jemal A, Thomas A, Murray T, Thun M. Cancer statistics, 2002. *CA Cancer J Clin.* 2002;52:23-47.
2. Krieger N, Chen JT, Ebel G. Can we monitor socioeconomic inequalities in health? a survey of US health departments' data collection and reporting practices. *Public Health Rep.* 1997;112:481-491.
3. Weissman JS, Stern R, Fielding SL, Epstein AM. Delayed access to health care: risk factors, reasons, and consequences. *Ann Intern Med.* 1991;114:325-331.
4. President's Cancer Panel. Report of the chairman 2000-2001. Available at: http://deainfo.nci.nih.gov/ADVISORY/pcp/pcp.htm. Accessed January 12, 2002.
5. Davis K, Rowland D. Uninsured and underserved: inequalities in health care in the United States. *Milbank Mem Fund Q Health Soc.* 1983;61:149-176.
6. Yergan J, Flood AB, Diehr P, LoGerfo JP. Relationship between patient source of payment and the intensity of hospital services. *Med Care.* 1988;26:1111-1114.
7. Weissman J, Epstein AM. Case mix and resource utilization by uninsured hospital patients in the Boston metropolitan area. *JAMA.* 1989;261:3572-3576.
8. Wenneker MB, Weissman JS, Epstein AM. The association of payer with utilization of cardiac procedures in Massachusetts. *JAMA.* 1990;264:1255-1260.
9. Braveman PA, Egerter S, Bennett T, Showstack J. Differences in hospital resource allocation among sick newborns according to insurance coverage. *JAMA.* 1991;266:3300-3308.
10. Ayanian JZ, Kohler BA, Abe T, Epstein AM. The relation between health insurance coverage and clinical outcomes among women with breast cancer. *N Engl J Med.* 1993;329:326-331.
11. Mitchell J, Hadley J. The effect of insurance coverage on breast cancer patients' treatment and hospital choices. *Am Econ Rev Pap Proc.* 1997;87:448-453.

12. Hand R, Sener S, Imperato J, Chmiel JS, Sylvester JA, Fremgen A. Hospital variables associated with quality of care for breast cancer patients. *JAMA*. 1991; 266:3429-3432.
13. Osteen RT, Winchester DP, Hussey DH, et al. Insurance coverage of patients with breast cancer in the 1991 commission on cancer patient care evaluation study. *Ann Surg Oncol*. 1994;1:462-467.
14. Roetzheim RG, Pal N, Gonzalez EC, Ferrante JM, Van Durme DJ, Krischer JP. Effects of health insurance and race on colorectal cancer treatments and outcomes. *Am J Public Health*. 2000;90:1746-1754.
15. Roetzheim RG, Gonzalez EC, Ferrante JM, Pal N, Van Durme DJ, Krischer JP. Effects of health insurance and race on breast carcinoma treatments and outcomes. *Cancer*. 2000;89:2202-2213.
16. Hebert-Croteau N, Brisson J, Pineault R. Review of organizational factors related to care offered to women with breast cancer. *Epidemiol Rev*. 2000;22:228-238.
17. O'Malley MS, Earp JA, Hawley ST, Schell MJ, Mathews HF, Mitchell J. The association of race/ethnicity, socioeconomic status, and physician recommendation for mammography: who gets the message about breast cancer screening? *Am J Public Health*. 2001;91:49-54.
18. Coleman MP, Babb P, Damiecki P, et al. *Cancer and Survival Trends in England and Wales 1971-1995: Deprivation and NHS Region*. London, England: Stationery Office; 1999. Studies in Medical and Population Subjects 61.
19. Sant M, and the Eurocare Working Group. Overview of EUROCARE-2 results on survival of cancer patients diagnosed 1985-1989. In: Berrino F, Capocaccia R, Estève J, et al, eds. *Survival of Cancer Patients in Europe 1985-1989: The Eurocare II Study*. Lyon, France: International Agency for Research on Cancer; 1999: 525-542. IARC Scientific Publication 151.
20. Mackillop WJ, Zhang-Salomons J, Groome PA, Paszat L, Holowaty E. Socioeconomic status and cancer survival in Ontario. *J Clin Oncol*. 1997;15:1680-1689.
21. Schrijvers CT, Mackenbach JP, Lutz JM, Quinn MJ, Coleman MP. Deprivation, stage at diagnosis and cancer survival. *Int J Cancer*. 1995;63:324-329.
22. Schrijvers CT, Coebergh JW, van der Heijden LH, Mackenbach JP. Socioeconomic variation in cancer survival in the southeastern Netherlands, 1980-1989. *Cancer*. 1995;75:2946-2953.
23. Rosso S, Faggiano F, Zanetti F, Costa G. Social class and cancer survival in Turin, Italy. *J Epidemiol Community Health*. 1997;51:30-34.
24. Berg JW, Ross R, Latourette HB. Economic status and survival of cancer patients. *Cancer*. 1977;39:467-477.
25. Morgan MA, Behbakht K, Benjamin I, Berlin M, King SA, Rubin SC. Racial differences in survival from gynecologic cancer. *Obstet Gynecol*. 1996;88:914-918.
26. Auvinen A. Social class and colon cancer survival in Finland. *Cancer*. 1992;70: 402-409.
27. Auvinen A, Karjalainen S, Pukkala E. Social class and cancer patient survival in Finland. *Am J Epidemiol*. 1995;142:1089-1102.
28. Dickman PW, Auvinen A, Voutilainen ET, Hakulinen T. Measuring social class differences in cancer patient survival: is it necessary to control for social class differences in general population mortality? a Finnish population-based study. *J Epidemiol Community Health*. 1998;52:727-734.
29. Gorey KM, Holowaty EJ, Fehringer G, et al. An international comparison of cancer survival: Toronto, Ontario and Detroit, Michigan, metropolitan areas. *Am J Public Health*. 1997;87:1156-1163.
30. Gorey KM, Holowaty EJ, Laukkanen E, Fehringer G, Richter NL. An international comparison of cancer survival: advantage of Toronto's poor over the near poor of Detroit. *Can J Public Health*. 1998;89:102-104.
31. Hakama M, Karjalainen S, Hakulinen T. Outcome-based equity in the treatment of colon cancer patients in Finland. *Int J Technol Assess Health Care*. 1989;5: 619-630.
32. Karjalainen S, Aareleid T, Hakulinen T, Pukkala E, Rahu M, Tekkel M. Survival of female breast cancer patients in Finland and in Estonia: stage at diagnosis important determinant of the difference between countries. *Soc Sci Med*. 1989;28: 233-238.
33. Karjalainen S, Pukkala E. Social class as a prognostic factor in breast cancer survival. *Cancer*. 1990;66:819-826.
34. Karjalainen S. Equity and cancer patient survival. *Acta Univ Tamperensis Ser A*. 1991;316:1-87.
35. Kogevinas M, Porta M. Socioeconomic differences in cancer survival: a review of the evidence. In: Kogevinas M, Pearce N, Susser M, Boffetta P, eds. *Social Inequalities and Cancer*. Lyon, France: International Agency for Research on Cancer; 1997:177-206. IARC Scientific Publication 138.
36. Optenberg SA, Thompson IM, Friedrichs P, Wojcik B, Stein CR, Kramer B. Race, treatment, and long-term survival from prostate cancer in an equal-access medical care delivery system. *JAMA*. 1995;274:1599-1605.
37. Wojcik BE, Spinks MK, Optenberg SA. Breast carcinoma survival analysis for African American and white women in an equal-access health care system. *Cancer*. 1998;82:1310-1318.
38. Bradley CJ, Given CW, Roberts C. Disparities in cancer diagnosis and survival. *Cancer*. 2001;91:178-188.
39. Potosky AL, Merrill RM, Riley GF et al. Prostate cancer treatment and ten-year survival among group/staff HMO and fee-for-service Medicare patients. *Health Serv Res*. 1999;34:525-546.
40. Beahrs OH, Henson DE, Hutter RV, et al, eds. *American Joint Committee on Cancer Manual for Staging of Cancer*. 4th ed. Philadelphia, Pa: JB Lippincott; 1992.
41. Fleming ID, Cooper JS, Henson DE, et al, eds. *American Joint Committee on Cancer Staging Manual*. 5th ed. Philadelphia: Pa: JB Lippincott; 1997.
42. *ICD-O: International Classification of Diseases for Oncology*. 2nd ed. Geneva, Switzerland: World Health Organization; 1990.
43. Young JL Jr, Roffers SD, Ries LAG, Frtiz AG, Hurlbutt AA, eds. *SEER Summary Staging Manual—2000: Codes and Coding Instructions*. Bethesda, Md: National Cancer Institute; 2001.
44. Centers for Medicare and Medicaid Services, Department of Health and Human Services. Available at: http://www.medicare.gov/basics/overview.asp. Accessed January 9, 2002.
45. Centers for Medicare and Medicaid Services, Department of Health and Human Services. NIH Publication 01-4969. Available at: http://cms.hhs.gov/medicaid. Accessed July 21, 2003.
46. Estève J, Benhamou E, Raymond L. *Statistical Methods in Cancer Research, Volume IV: Descriptive Epidemiology*. Lyon, France: International Agency for Research on Cancer; 1994. IARC Scientific Publication 128.
47. Berkson J, Gage RP. Calculation of survival rates for cancer. *Proc Staff Meet Mayo Clin*. 1950;25:270-286.
48. Anderson RN. United States life tables, 1997. *Natl Vital Stat Rep*. 1999;47(28): 1-37.
49. Ederer F, Axtell LM, Cutler SJ. The relative survival: a statistical methodology. *Natl Cancer Inst Monogr*. 1961;6:101-121.
50. StataCorp. *STATA Statistical Software. Release 7.0*. College Station, Tex: Stata Corp; 2000.
51. Dickman PW, Sloggett A, Hills M, Hakulinen T. Regression models for relative survival. *Stat Med*. In press.
52. Hakulinen T, Tenkanen L. Regression analysis of relative survival rates. *Appl Stat*. 1987;36:309-317.
53. Estève J, Benhamou E, Croasdale M, Raymond L. Relative survival and the estimation of net survival: elements for further discussion. *Stat Med*. 1990;9: 529538.
54. Clayton D, Hills M. *Statistical Models in Epidemiology*. New York, NY: Oxford University Press Inc; 1993:227-235.
55. Breslow NE, Day NE. *Statistical Methods in Cancer Research: Volume II—The Design and Analysis of Cohort Studies*. Lyon, France: International Agency for Research on Cancer; 1987;§4.10(e):173-176. IARC Scientific Publication 82.
56. Ries LAG, Eisner MP, Kosary CL, et al, eds. *SEER Cancer Statistics Review, 1973-1999*. Bethesda, Md: National Cancer Institute. Available at: http://seer.cancer.gov/csr/1973_1999/. Accessed 2002.
57. US Census Bureau. *Census 2000 Supplementary Survey*. Washington, DC: US Census Bureau; 2002.
58. US Census Bureau. Current population surveys, March 1998. Available at: http://www.census.gov/hhes/www/hlthins.html. Accessed January 15, 2002.
59. US Census Bureau. Current population surveys, March 1999. Available at: http://www.census.gov/hhes/www/hlthins.html. Accessed January 15, 2002.
60. US Census Bureau. Current population surveys, March 2000. Available at: http://www.census.gov/hhes/www/hlthins.html. Accessed January 15, 2002.
61. Lee-Feldstein A, Feldstein PJ, Buchmueller T, Katterhagen G. The relationship of HMOs, health insurance, and delivery systems to breast cancer outcomes. *Med Care*. 2000;38:705-718.
62. Katz SJ, Zemencuk JK, Hofer TP. Breast cancer screening in the United States and Canada, 1994: socioeconomic gradients persist. *Am J Public Health*. 2000; 90:799-803.
63. Greenberg ER, Chute CG, Stukel T, et al. Social and economic factors in the choice of lung cancer treatment: a population-based study in two rural states. *N Engl J Med*. 1988;318:612-617.
64. North American Association of Central Cancer Registries, certification results. Available at: http://www.naaccr.org/certification. Accessed April 6, 2002.
65. Hewitt M, Breen N, Devesa S. Cancer prevalence and survivorship issues: analyses of the 1992 National Health Interview Survey. *J Natl Cancer Inst*. 1999;91: 1480-1486.
66. Yao S-L, Lu-Yao G. Population-based study of relationships between hospital volume of prostatectomies, patient outcomes, and length of hospital stay. *J Natl Cancer Inst*. 1999;91:1950-1956.
67. Wingo PA, Luke E, O'Brien K, et al. Population-based patterns of care studies: Collaboration among state cancer registries, the American College of Surgeons, and the American Cancer Society. *J Registry Manage*. 2001;28:5-16.
68. Morris CR, Snipes KP, Schlag R, Wright WE. Sociodemographic factors associated with prostatectomy utilization and concordance with the physician data query for prostate cancer (United States). *Cancer Causes Control*. 1999;10:503-511.