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# Cost of Care for Cancer in a Health Maintenance Organization

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*The direct costs of medical care for cancer are examined at Kaiser Permanente (KP) in Northern California. Use data from July 1987 through June 1991 were obtained from KP automated files for all 21,977 KP patients in the Bay Area SEER registry with cancer at one of seven cancer sites. Medical charts were reviewed for a stratified sample of 886 patients. Costs were estimated for initial, continuing, and terminal care, and for all person time within 15 years of diagnosis, by stage at diagnosis. From diagnosis until death or 15 years, long-term costs attributable to cancer were as follows: breast, \$35,000; colon, \$42,000; rectum, \$51,000; lung, \$33,000; ovarian, \$64,000; prostate, \$29,000; and Non-Hodgkin's Lymphoma (NHL), \$48,000. The utilization and cost results reported here may be useful in assessing the cost-effectiveness of cancer prevention and control programs, in adjusting capitation rates and budgets, and in estimating the aggregate medical care costs attributable to cancer.*

## INTRODUCTION

The estimation of direct medical costs for specific diseases is, increasingly, an important area of health services research.

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Policymakers need cost estimates to rationally allocate health care resources at a time when the main objectives in U.S. health care policy are to contain costs as well as to improve quality and expand access. The rigorous estimation of direct medical costs can inform consideration of the cost effectiveness of alternative policies and interventions.

Until fairly recently, most estimates of direct medical costs fell within the genre of "cost-of-illness" studies, which aggregate expenditures (of health-care resources or dollars) per annum per disease category. There has been an increasing demand for more detailed disease-specific estimates of direct medical costs derived from patient-level longitudinal expenditures that occur over the entire course of disease. Such data can be used to construct several policy-relevant measures—including the long-term cost from diagnosis until death, the cost per person year lived with cancer, and the costs for the initial, continuing (i.e., the phase beginning after initial and continuing until terminal phase) and terminal phases of cancer care. These phase-specific costs can be used to assess the efficiency and cost-effectiveness of alternative treatments and disease management programs. Long-term costs are useful in assessing the cost effectiveness of preventive services. Costs per person-year can be used to risk-adjust capitation rates, insurance premiums, and budgets and also to assess the "burden" of a disease when setting broad priorities for research and public health programs.

In this article, we report cost estimates based on data from the KP Medical Care Program, Northern California Region, for cancers of the breast, colon, rectum, lung, ovary, prostate and for NHL for the years 1987-91. Measures are presented of the use of health care services, the costs of health care services attributable to cancer diagnosis and treatment, and the total costs of all health care services received.

## METHODS

### Case Selection

KP is a not-for-profit health maintenance organization (HMO) that currently provides medical and hospital services to 8.5 million members nationwide and 2.5 million members in Northern California. By the end of the study period (1991) it served approximately 1.6 million members in six Bay Area counties covered by the SEER registry.<sup>1</sup> Across these counties, KP's share of the population ranged from 23 percent to 35 percent. The racial and demographic composition of the KP membership is generally similar to that of the rest of the population in Northern California (Krieger, 1992). Medicare patients diagnosed with cancer at KP have been shown to have a more favorable stage-at-diagnosis for screen-detectable cancers compared with non-HMO patients in the San Francisco SEER area (Riley, 1994). Among patients with cancer, disenrollment from HMOs is very low (Riley, 1996).

KP provides comprehensive outpatient and inpatient services, covering the first 100 days per calendar year of care at skilled nursing facilities (SNFs). Custodial nursing home care is not covered. Outpatient drugs and medications are covered

for most patients with some cost sharing. Hospice and home health visits are covered, including medications and injectables administered during house calls. All members who have Medicare Part B are covered for durable medical equipment for everything on the Durable Medical Equipment Screening List. Radiation oncology and bone marrow transplants are done by outside providers on a contractual basis. Data on utilization and charges of these services are available in KP data bases.

### Study Population, Study Period, and Data Sources

From the San Francisco Bay Area SEER registry, we selected all 21,977 patients diagnosed at KP since 1973, and prevalent at KP for any of the period from June 1987 through June 1991, with cancer of the following sites: breast, colon, rectum, prostate, lung, ovary and non-Hodgkin's lymphoma. These KP-SEER cases were linked, by their unique medical record numbers, to automated KP utilization files. The age, sex, and race distributions of the study population, by cancer site and stage, are shown in Table 1. Mortality, all-cause as well as cancer-specific, was ascertained from SEER data.

The KP automated utilization data bases available for the study period included: (1) inpatient discharges, diagnoses and procedures (including inpatient hospice), (2) inpatient length of stay, including length of stay in intensive care and intermediate care, (3) minutes in the operating room for inpatient and ambulatory surgery, (4) outpatient visits to physicians and non-physician providers, by department, (including outpatient hospice and home health), (5) outside referrals and claims including radiation oncology, stays at SNFs, and some durable medical equipment.

<sup>1</sup>SEER is a set of geographically-defined, population-based, central tumor registries in the United States, operated by local non-profit organizations under contract to the NCI.

## The Chart Review Sample

For more complete ascertainment of the use of outpatient chemotherapy, home health services, durable medical equipment and clinical lab tests than was permitted by automated files, medical charts were abstracted for a stratified random sample of 886 patients. Utilization abstracted from charts was combined with unit costs described below and analyzed in relation to cost estimates derived from automated data. The purpose of the chart review sample is to obtain an algorithm—from a regression of chart-based data on automated data—to adjust the computer-based estimates for the use of medical services not captured by KP's automated data bases. Because cancer care is generally most intensive during the months near diagnosis or death, incident and terminal cases were oversampled so that at least 50 percent of patients chart reviewed at each site were incident during the study period and at least 25 percent were fatal during the study period.

For each phase of care, regression (weighted least squares—weighted according to the sampling fractions) was used to examine patients' chart-based costs in relation to data available in automated files. The resulting regression coefficients were used to obtain predicted costs for each patient in the entire study population. The variance in the chart based costs that is "explained" with the fitted models is very high, ( $r$ -squared  $>0.95$ ) for all three phases of care. Stage and demographic effects are not very significant beyond what is explained by automated costs, indicating that ancillary costs within phase of care are underestimated, more or less similarly, across stage and demographic categories. Cost estimates are obtained using the results of the same phase-specific models fit to each cancer site separately. Because

clinic visits by cancer patients, as compared with average patients, were associated with more intensive use of services unmeasured by our automated data bases, chart review yielded estimates of cancer attributable costs that were higher than would have been permitted by the automated data alone: by 7 percent for prostate cancer, 7 percent for NHL, 8 percent for lung, 9 percent for colon, 11 percent for rectum, 15 percent for breast, and 25 percent for cancer of the ovary.

## Unit Costs

For services provided by KP, cost of care estimates are obtained by multiplying amounts of utilization (e.g., visits, inpatient bed days, minutes in the operating room) by unit costs. Costs are given in 1992 dollars. This was done not by inflating earlier costs according to any index, but rather by using 1992 unit costs. For example, a visit to an oncologist in 1990 contributed to our cost estimates an amount based on KP clinic costs during 1992, the most recent year available when the data were collected. Unit costs were derived by "step-down" accounting methods from cost data available in KP's general ledger and in cost reports obtained from its department of governmental reimbursement. They are "fully loaded" to include all building and administrative overhead as well as costs of all utilization not explicitly measured. In other words, the costs of administration, building maintenance and unmeasured utilization are included in the costs of measured utilization. We used the fully loaded costs (to the provider) of providing the service, regardless of whether any costs were offset by Medicare or by copayments. We used average unit costs across KP's Northern California region rather than unit costs specific to the clinic or hospital delivering the service. For the costs of the

services that were paid for—but not provided by—KP, we used the charges (often negotiated rates) of the non-Kaiser providers.

### Utilization and Cost Statistics for Treatment Phases

Utilization and costs for each patient during the study period) were cumulated during four phases, defined as:

Pre-diagnosis: 30 days prior to the diagnosis date.

Initial care: 6 months following the diagnosis date.

Terminal care: 6 months prior to the date of a death due to cancer.

Continuing care: all time following initial care that is not within 6 months of a death due to cancer.

For patients who died within a year of diagnosis, their follow-up was divided in half between initial and terminal care; for a patient who died 6 months after diagnosis, the initial phase included the first 3 months, the terminal phase included the last three months and there was no continuing care. If a hospital stay overlapped two phases, costs were prorated by days.

Costs for the continuing care phase are summarized, by site and stage, as costs per person year. The numerator is the sum of the costs of patients in the stratum; the denominator is the sum of their follow-up time. Patients contributed to the numerators and denominators of these cost rates only when they were alive and in the health plan. For the initial and terminal phases, however, we present mean costs for the 6-month phase, regardless of length of follow-up during the phase, rather than cost rates. This is appropriate because members rarely drop out of the health plan during initial or terminal care, and phases shorter than 6 months are unusual and due

to short lifetimes rather than incomplete data.

The costs per person-year (of all phases) are summarized as cost rates. Shown in the third columns of Tables 4 and 5, they amount to the total costs of all care—for all patients with cancer of the given site—divided by the total person-years of follow-up.

Long-term (15 year) costs were calculated for site and for site-stage strata using the distribution of survival times estimated for the Bay Area SEER region together with the KP utilization and costs summarized in the phases described earlier. We begin with the cost of the pre-diagnosis month and the cost of initial care received by all incident cases. Then, we assembled costs for five time intervals following diagnosis: the year following diagnosis, the 2nd and 3rd years following diagnosis, the 4th and 5th years, years 6-10, and years 11-15. The cost for each interval is the likelihood of surviving to the beginning of the interval times the cost expected during the interval. The latter has two components: (a) the likelihood of dying in the interval times terminal costs, and (b) the likelihood of surviving the interval times continuing costs.

This approach is elaborated to account for the length of continuing care expected during each interval, as follows:

$$15 \text{ yr cost} = C^p + C^i + \sum_{t=1}^5 S_t [ q_t ( C^t + C^c \times pmth_t + (1 - q_t) ( C^c \times mth_t ) ) ],$$

where:

$C^p$  = mean cost of pre-diagnosis care;

$C^i$  = mean cost of initial care;

$C^t$  = mean cost of terminal care;

$C^c$  = mean cost of continuing care;

$S_t$  = likelihood of survival until  $t$ ;

$q_t$  = likelihood of death during  $t$ ;

$t$  = time periods after diagnosis, as follows:

1 = 1 year following diagnosis

2 = the 2nd and 3rd year following diagnosis

3 = the 4th and 5th year following diagnosis

4 = the 6th through 10th year following diagnosis

5 = the 11th through 15th year following diagnosis

$pmt h_t$  = the number of preterminal months in interval  $t$

$mth_t$  = number of months in interval  $t$

Standard errors were obtained for such 15-year cost estimates, given that each is a linear function of the initial, continuing, and terminal cost estimates, and that the variance of a linear combination of random variables is equal to the sum of the associated variances and covariances. We treat the survival distribution estimates as constants, and, therefore, our estimates of variance are conditional on the survival estimates (not unreasonable given our focus on cost rather than survival and our use of rather stable survival estimates from the entire Bay Area SEER population). Standard errors for the continuing care cost rate, and for the overall cost rate per person year, are estimated using a Taylor series linearization approach (see Riley and Lubitz, 1989). Standard errors for the mean costs of initial and terminal care are the usual estimates associated with a sample mean.

Long-term costs are not considered beyond 15 years for two reasons: (1) we lack SEER data on patients who survived more than 15 years after diagnosis because the registry only includes cases diagnosed since 1973, and (2) there is unlikely to be much medical care attributable to cancer more than 15 years after diagnosis.

Initial, continuing and terminal costs were examined in relation to site, stage at diagnosis, age, sex, race, and interactions of site, stage and demographics, using or-

dinary least squares regression. Separate models were fit to each cancer site and aggregate models were fit to data from all sites combined.

Fifteen-year costs were discounted at a constant proportional rate of 3 percent per year for the length of time from when the cost was incurred back to the diagnosis date. Discounting was done by dividing the costs for each of the five intervals in equation 1 by  $1.03^y$ , where  $y$  is the number of years from diagnosis until the midpoint of the given interval. Discounting is done to take into account opportunity costs and "time preferences" (Gold, 1996). Visits and hospital days are discounted similarly and for the same reason; there are opportunity costs and time preferences for the resources they consume. We also conducted sensitivity analysis on the discount rate by discounting summary results at 5 percent as recommended by Gold (1996).

### Use of "Controls" to Ascertain Utilization and Costs Attributable to Cancer

Cancer patients receive some care for diseases and conditions unrelated to their cancer. We assumed that were it not for their cancer, patients would be receiving the same amount of medical care as average health plan members of the same age and gender. Therefore, we obtained "attributable" costs by subtracting from each cancer patient's costs for a given interval, the cost rate among health plan members of the same age (in 5-year intervals) and sex, multiplied by the number of months in the given interval. These age specific cost rates were obtained by multiplying unit costs by age-sex specific utilization rates available from KP automated files.

Although charts were not reviewed for any controls, the costs of all ancillary services (and overhead) were included in the

unit costs of clinic visits and hospital days so that the total costs of for all health plan members amounted to the total expenditures of the health plan, excluding only costs for marketing and for other functions related to providing insurance rather than medical care. (Therefore, unit costs for visits and hospital days were somewhat higher for controls than for chart-reviewed cases, for whom the costs of most ancillary services were assessed separately rather than stepped into visits and hospital days.) The costs of cancer care at the seven cancer sites were not removed from these "control" costs—to do so appropriately would have required separate controls for each cancer site and the costs for cancer at any single site comprise only a small portion the controls' costs for the site.

To estimate a cancer patient's long-term costs attributable to cancer, we subtracted from the estimate obtained by equation number 1 the cost of care that an average patient (of the same age and sex) would receive during the lifetime (up to 15 years) of the cancer patient. This was done as in equation number 1 above—by combining survival likelihoods with cost rates for intervals following diagnosis—after subtracting controls' costs from the cases' costs, using cost rates for controls that increase with age during the time intervals following diagnosis.

## RESULTS

First, we present data on hospital days and outpatient visits (Tables 2 and 3). Then, we present data on inpatient costs (Table 4), the cost component that has been most widely considered in other reports. Finally, we present data on total costs (Table 5).

Tables 2 through 5 are formatted similarly. Results are shown by stage-at-diagnosis, for each cancer organ site. Each entry

in the table gives a mean value and standard error. The third column of the table gives average annual costs or resource use for cancer patients averaged across all treatment phases. The fourth column gives the comparable value for control (non-cancer) patients. The next four columns show mean resource use or cost for the pre-diagnosis, initial, continuing and terminal phases, respectively. The final three columns show, respectively, long-term resource use or cost for cancer patients, long-term resource use or cost attributable to cancer, and discounted attributable long-term resource use or cost.

### Inpatient Days and Outpatient Visits

A large proportion of total medical resource use for cancer treatment is accounted for by inpatient hospital days and outpatient visits. Data on these "cost drivers" is given in Tables 2 and 3. Cancer patients differ from their controls by much more for hospital days than for visits. Site and stage effects are also more apparent for hospital days than for visits during all intervals. Site and stage effects for hospital days are greatest during initial care, less during terminal care. Long-term attributable hospital days are highest for ovarian cancer (32 days) and cancer of the rectum and colon (26 and 24 days), lower for breast cancer (12 days). Overall, there are about 12-13 visits per person year among prevalent cancer cases—all stages combined—at six of the seven sites, and 15.6 visits per person-year for NHL. Mean visits for controls were six to eight per person-year. Visits were most frequent during initial care for breast cancer, less frequent for NHL and cancer of the colon and rectum, and even less frequent for the other three cancers. Subtraction of control visits from case visits cut "attributable" long-term visits to half or less of the level of all long-term

visits at each site (all stages combined). Long-term attributable visits are highest (relative to the other cancer sites) for breast cancer (52 visits) and NHL (54 visits). They are lowest for lung cancer (21 visits).

### Cost of Care

The estimated costs of care incurred during inpatient stays, including physician services during inpatient stays, are shown in Table 4. For all seven of the cancer sites inpatient costs comprise more than 74 percent of terminal costs and more than 50 percent of initial costs. Inpatient cost as a proportion of total adjusted long-term cost (attributable to cancer after discounting) is 0.44 for breast, 0.57 for prostate, 0.69 for rectum, 0.71 for NHL, 0.72 for lung, and 0.75 for colon.

Table 5 gives estimates of costs from all sources, including adjustments made from chart data to account for underestimation of chemotherapy, home health and ancillary costs in the automated data base. Costs per person-year are highest for ovarian and lung cancer. The estimated cost for all ovarian cancer stages combined is \$15,390 per year; for lung cancer it is \$15,127. For lung this high cost rate is not surprising given that the percent of person time that is in the initial or terminal phase is highest for lung cancer and given that relatively few lung cancer patients are in remission while they are in the continuing phase. At none of the other six cancer sites is more than 5 percent of follow-up time in the terminal phase (as compared with 14 percent for lung cancer). For cancer of the ovary the high costs are explained by the relatively high mean hospital days for ovarian cancer patients during all treatment phases as shown in Table 2. Breast cancer costs are the lowest per person year (\$7,196) of the seven sites—not surprising

since breast cancer had the highest proportion of follow-up in the continuing phase—nevertheless breast cancer costs per person year are 2.9 times higher than the “controls”. The difference in cost per person year between cases and controls is relatively high for lung and ovarian cancer and low for breast cancer and prostate cancer.

Initial care was the most costly for cancers of the colon, rectum, and ovary, ranging from \$24,000-\$30,000. Initial care at these sites generally involves rather long surgery followed by more than a few days in the hospital. Although initial care for invasive breast cancer almost always involves surgery, breast cancer surgery takes less time in the operating room and is followed by shorter inpatient stays.

Costs varied less across sites for terminal care than for initial care. Terminal costs were highest for ovarian cancer and NHL—over \$20,000—associated in part with relatively young ages at death. The costs of terminal care were higher than the costs of initial care for cancer of the breast, prostate and NHL.

The three columns on the right of Table 5 show all long-term costs, then costs attributable to cancer (after subtracting costs for “controls”), and finally, discounted costs attributable to cancer. The most costly sites in the final column of Table 5—long-term costs after subtracting controls and discounting by 3 percent per year—are cancer of the ovary (\$64,000), rectum (\$51,000), NHL (\$48,000), and colon (\$42,000). Least costly are cancer of the prostate (\$29,000), lung (\$33,000), and breast (\$35,000). Subtracting the cost of controls and discounting reduces long-term costs by 46 percent for breast and 54 percent for prostate, sites for which mortality is relatively low. For lung cancer, on the other hand, the discounted attributable cost is 79 percent of all long-term costs.

## Costs of Care in Relation to Stage at Diagnosis

Care is substantially less expensive for cases diagnosed in situ (not shown in the tables) than for the invasive cases. About 12 percent of incident cases of breast cancer, 7 percent of rectal cancer and 3 percent of colon cancer were diagnosed in situ (at the remaining four sites the numbers of non-invasive cancers were less than 1 percent). Initial care for in situ breast cancer averaged about \$11,000, 77 percent as costly as initial care for local breast cancer. For cancer of the colon initial care of in situ disease averaged about \$13,000, and about \$5,700 for rectum, 57 percent and 25 percent of the costs of initial care for local cases at these two sites, respectively.

Initial care is less expensive for cases diagnosed at the local stage than the regional stage at six of the seven cancer sites shown in Table 5—all except lung where initial surgery is done most for local cases. Initial care for remote cases is less costly than for regional cases for all sites with the exceptions of colon cancer and NHL. Continuing care is markedly stage related because less favorably staged cases are less likely to be in remission. If cases known to be fatal are omitted, the impact of stage on continuing care is attenuated but still significant. Terminal costs are not significantly related to stage at diagnosis; but note that stage specific cost estimates for the terminal phase are relatively unstable, especially for the local cases that are not often terminal. After subtracting the costs of “controls” and discounting, long-term costs of locally staged invasive cancers of the ovary, colon, and rectum are substantially less than long-term costs for unfavorably staged cases. For breast cancer, local cases were significantly less expensive but the stage effect was smaller. For lung cancer the stage ef-

fect was in the opposite direction—long-term costs were higher for more favorably staged cases. Stage effects on long-term costs were modest and insignificant for cancer of the prostate and NHL.

## Costs of Care in Relation to Demographic Variables

The associations of age, race, and sex with initial, continuing and terminal costs are shown in Table 6. Also shown are race and sex effects. These effects are adjusted. Initial costs were age related for cancer of the lung and breast such that younger patients cost more and older patients cost less than middle-aged patients. Also, for NHL initial care is more costly among younger patients, and for prostate cancer initial care is less costly among older patients. For cancer of the rectum and colon, on the other hand, initial costs were higher among patients aged 75 and over, associated with initial hospitalizations that were more lengthy and complicated. For all cancer sites terminal costs were higher for patients younger than 50, significantly so for all sites but rectum and NHL. For all sites but NHL, terminal costs were relatively low among patients aged 75 and over. Costs for the continuing phase were less age-related than were costs for the initial or terminal phase, though continuing care for NHL was notably higher among younger patients.

Sex effects were rather small, for the four cancer sites which include both genders. For five of the seven cancer sites, cancer care for African Americans appears less costly during the initial phase and more costly during the terminal phase, though these effects could be due to chance alone. Other non-whites, primarily patients of Asian and Hispanic origins, appear to incur fewer costs, significantly fewer for all phases of breast cancer.

## Discounting

Table 7 shows the sensitivity of adjusted estimates of long-term costs for each of the seven sites (all stages combined) to discount rates of 4 percent and 5 percent compared with the 3 percent shown in Table 5: The impact of the choice of discount rate—3, 4 or 5 percent—appears to be neither trivial nor large. Discounting makes more of a difference to breast cancer than lung cancer because survival is longer. Long-term costs are truncated here at 15 years—discounting would have a larger impact if the costs of continuing care, such as for tamoxifen, continue for longer than 15 years.

## DISCUSSION

### Comparison with Other Studies

Rice, Hodgson, and Capell (1989) reported that direct costs of medical care for cancer (all cancer sites) in California and nationwide amounted to about 5 percent of total spending for medical care. Brown (1990) estimated that direct medical care costs for cancer were about \$35 billion—about 4.8 percent of the \$717 billion in national health care spending. The 21,977 KP-SEER patients with cancer of the seven sites under consideration contributed only 1.3 percent of the person-time yet consumed 7.4 percent of the medical costs incurred by the KP population. After subtracting non-cancer costs, cancer care for these seven cancer sites comprises 4.9 percent of all KP costs. The burden of cancer care at KP appears to be similar to what has been estimated for California and the United States.

Scotto and Chiazze (1976), studying patients diagnosed in 1969-70, found the following average length of stay (LOS) for the first hospital admission of incident cancer

cases; breast—13 days, colon—23 days, rectum—23.5 days, lung—19.6 days, prostate—16.4 days. This is same rank order as found for hospital LOS for initial care in this study. However, current lengths-of-stay are, overall, drastically shorter in the current study compared with those reported by Scotto and Chiazze, ranging from 3.4 - 11.4 days as compared with 13 - 23.5 days. Whereas average LOS in this study are approximately half those reported by Scotto and Chiazze., for colon, rectum, and lung cancer, for breast and prostate cancer LOS are only about a quarter of those reported for the 1969-70 cases. Reductions in average LOS during the 1980s have been reported for cancer by Scheffler and Phillips (1989). They also reported the same rank order of LOS for breast, lung, prostate and colon cancer as reported here. In 1986 the average LOS reported by Scheffler and Phillips ranges from 6.75 days for breast cancer to 14.44 days for colon cancer.

Recently Riley et al. (1995), extending earlier work by Baker et al. (1991) and Baker, Kessler, and Smucker (1989) have examined cancer care costs in the Medicare population, using Medicare data linked to SEER for cancer of the breast, colorectal, lung and prostate for the years 1984-90. Compared with our SEER-KP long-term totals as reported in column nine of Table 5, the SEER-Medicare long-term totals in 1992 dollars (adjusted from 1990 dollars using the medical care component of the Consumer Price Index) are somewhat lower: by 10 percent for breast, 9 percent for prostate, 14 percent for colorectal (compared with combined results for colon and rectum above), and 19 percent for lung. Furthermore, Riley et al. found that cancer diagnosed at the local stage involves higher long-term costs than unfavorably staged cases for breast and colorectal cancer, while we find costs to be highest at

the regional stage at these sites. Our results agree with the SEER-Medicare results that for prostate cancer the regional stage has the highest long-term costs and for lung cancer the local stage is the most costly. The U-shaped pattern across phases of care was generally similar to that reported here with initial care more expensive than terminal care for colorectal and lung, and initial care relatively less expensive for cancers of the breast and prostate. Continuing costs were substantially lower than reported here, due in part to their use of a "pre-final" phase while we included "pre-final" costs with continuing care.

Etzioni, Urban, and Baker (1996) estimate long-term costs for ovarian cancer among SEER-Medicare patients, 1984-1990, to be \$69,172 in 1990 dollars amounting to \$80,771 in 1992 dollars. The latter figure is close to the \$82,344 among SEER-KP patients reported here. The estimated long-term attributable costs among SEER-Medicare patients were \$64,899 as compared with \$63,696 for our SEER-KP patients. Costs for "controls" were somewhat higher in the KP population than in the Medicare population, but not enough to account for all of this difference.

The SEER-Medicare estimates are based on Medicare reimbursements while our SEER-KP estimates are based on KP accounting costs; the SEER-Medicare estimates are for cancer patients over the age of 64 while the SEER-KP estimates cover all age groups; the SEER-Medicare estimates exclude certain costs that are covered by KP. Given these differences the general level of agreement between the two types of estimates is quite close.

Taplin et al. (1995) used a very similar methodology as in this study to produce estimates of cancer costs for patients at Group Health Cooperative (GHC) of Puget Sound. For continuing care, the GHC estimates are similar to those reported here.

For prostate cancer the estimates are also roughly similar for initial care cost but the GHC estimates are lower for regional and distant prostate cancer. For breast cancer, GHC terminal costs estimates are similar but the initial care cost estimates are lower than reported here. For colon cancer the GHC estimates of both initial and terminal costs are markedly lower than reported here. There are a number of possible sources of the differences between these estimates. Two such sources are differences in underlying resource use and differences in unit costs assigned to resources. An evaluation of the differences between these two studies is beyond the scope of this article, but it is clear that, when cost estimates from different institutional settings are compared it is important to examine both patterns of resource use and unit costs as well as the determinants of each of these variables such as patterns of care and relevant characteristics of the served population.

### **Relevance of Data from Kaiser Permanente**

These results from KP in Northern California from 1987-91 are relevant to other settings for several reasons. First, as cost issues become increasingly important in health policy and management, large mature HMOs are one among the few candidate sources for data which may approximate efficient costs, not contaminated by cross-subsidies or monopoly rents. Second, the HMO market share of U.S. health care has increased considerably in recent years. According to the National Center for Health Statistics (NCHS), 52.5 million individuals, 19.9 percent of the U.S. population, were enrolled in traditional prepaid forms of HMOs in 1996 compared with 13 percent in 1989. An additional 6 million people were enrolled in "open-ended" plans in

1996 (National Center for Health Statistics, 1997).

### **Limitations of Data for Current Analysis**

Data on resource use for this study dates from 1987-91 and unit costs were for 1992. In the intervening period there has been inflation in medical care costs and patterns of cancer care have also changed to some extent. For cancer care, as for medical care in general, hospitalizations have become shorter. However, the shift of much oncologic care from the inpatient to the outpatient setting was already well underway at KP during the study period. More recently there has been some increase in the use of certain cancer-related procedures and services, such as adjuvant therapy for breast and colorectal cancers. The data reported here can be adjusted for inflation by using a price index such as the Medical Care component of the Consumer Price Index which increased by 23.8 percent 1992-97. More recent utilization and cost data would be more useful. An effort is currently underway at KP to annually update estimates of cancer care costs, linking cancer registry and automated resource utilization data, by the methods used here.

### **Uses of Cost of Care Data**

Long-term cost statistics can be used in studies of the cost effectiveness of screening programs. It is sometimes suggested—with only anecdotal evidence—that screening programs would “more than pay for themselves” by saving the costs of care for patients whose cancer would otherwise have been detected when it was at a more advanced stage (Brown and Fintor, 1993). For five of the six sites for which screening tests are available—all except lung—attributable long-term costs (after discounting) were lower for cases diagnosed at the local

stage than for cases diagnosed at the regional stage or distant stage. These stage effects amounted to about \$3,600 per case for prostate, \$9,400 for breast, \$11,300 for colon, \$21,900 for rectum, and \$41,700 for ovary. For breast, colon and rectum—the only sites with appreciable numbers of non-invasive cancers—in situ cases were less expensive for initial care than local invasive cases by amounts of \$2893, \$8121, and \$14,656 respectively, and continuing care was less for in situ cases by amounts of \$237, \$144, and \$754 per year, respectively. These effects of stage at diagnosis are substantial enough to be worth considering in studies of the cost effectiveness of screening but they would not be dominant factors. In order to achieve costs savings in screening costs for favorably staged cancers must be approximately \$100,000 less than for unfavorably staged cancers. (Brown, 1992) The modest stage effects shown in Table 5 suggest that the argument for the cost effectiveness of cancer screening must be framed in terms of the costs to society per life year saved—not primarily in terms of savings from future treatments averted with the possible exception of screening for colorectal cancer where invasive disease and the entire cost associated with invasive disease may be prevented.

In this illustration using discounted attributable costs from Table 5, the consequences of screening for future unrelated costs have not been considered. That is, we have not counted the medical care costs unrelated to cancer but associated with the longer life enjoyed as a result of early cancer detection. Whether or not to include future unrelated cost is an issue of longstanding controversy. For example, Russell has argued that such costs should not be counted because they are akin to any other type of unrelated cost or benefit associated with longer life span (e.g., more

economic productivity; more consumption of Social Security benefits). Unrelated costs and benefits can be counted in a cost-benefit analysis but are beyond the boundaries of a cost-effectiveness analysis. On the other hand, Garber and Phelps have argued that counting future unrelated costs is optional, but only if this practice is consistent when cost effectiveness analyses of different programs are compared and only if annual future unrelated costs are unrelated to age. (Gold et al.,1996).

In the screening illustration above, future unrelated costs can be taken into account by comparing total costs, rather than attributable costs, for favorable compared with unfavorable stages. The general effect of doing this is to further reduce treatment costs savings attributable to more favorable stages. For example, for breast cancer the undiscounted long-term savings in costs attributable to cancer treatment is over \$10,000 for local compared with regional stage breast cancer, (column 10; Table 5) but the undiscounted long-term cost savings is only about \$2,000 (column nine, Table 5).

The attributable long-term costs shown in Table 5 also give some idea of the resources saved by health care interventions which prevent the occurrence of cancer, such as the prevention of tobacco use for lung cancer. The average cost avoided per lung cancer case is \$33,000 (the discounted attributable long-term cost for lung cancer, all stages combined, Table 5). This tells health policymakers that any tobacco preventive program costing less than \$33,000 per lung cancer case avoided will save money, for society, perhaps up to \$100,000 per lung cancer case avoided. More expensive programs could be more cost-effective than alternative uses of available resources.

Again, it could be argued that future unrelated costs should be taken into account

by subtracting them from the long-term attributable costs of lung cancer. In this example, future unrelated costs could be estimated by the expected annual health care costs of non-cancer patients times the increased life expectancy. For example, if smoking cessation postpones a person's death by 5 years, then the additional unrelated future cost would be approximately \$2,852 per year (Table 5, column 4) times 5 years.

The phase-specific costs in Tables 4 and 5 can be useful in assessing an intervention which advances or delays diagnosis and medical care without affecting survival. Such an intervention, arguably, would affect the length of continuing care and the amounts by which all phases of care should be discounted. Yearly discounted costs attributable to cancer for the continuing phase, for example, can be roughly estimated from Table 5 with (or without) the intervention by subtracting controls' yearly costs for the relevant time period from twice the cases' 6-month costs (note that the tables give yearly costs for controls and 6-month costs for each of the phases), adjusting (or not adjusting) for the changed length of the continuing phase, and then discounting back to the time of the intervention. This rough estimate could be improved slightly by using the formula given in the notes to Table 5 to adjust controls' costs—which are given in Table 5 for the cases age distribution at diagnosis—for aging during any number of years following diagnosis.

The third column of Table 5 shows the costs per person-year for prevalent cases in any phase of care. These results could be helpful in the risk adjustment of budgets (within an HMO) or capitation payments (to an HMO). They could help to determine appropriate levels of prospective per capita payments to providers for patients with cancer. For example, the mean cost

rate for colon cancer (all stages combined) is \$10,434 per year (column 1, Table 5). A payor could use such an estimate, in addition to demographic and other predictors of cost, to determine an appropriate amount to pay annually for patients with colon cancer. Currently, HCFA risk adjusts capitation payments to HMOs according to age, sex, and geographic region; it could also risk adjust according to whether or not a patient has a serious chronic disease such as colon cancer. The purpose of such risk adjustment is to eliminate perverse incentives to avoid enrollment of sick patients. (Jones, 1996).

## CONCLUSION

This article presents estimates of the cost of medical care for seven major types of cancer. Long-term cost, costs for initial, continuing and terminal care, and cost per person year lived after cancer diagnosis, have been estimated by cancer site and stage-at-diagnosis. Possible uses of these various cost estimates have been illustrated. This is one of several ongoing efforts to obtain more current and detailed data on costs of cancer care than has been possible in the past. As data systems and analytical methods mature it should become possible to periodically update and cross-validate these cost estimates.

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## TECHNNICAL NOTE

The following technical notes apply to Tables 2-5:

- All Costs are in 1992 dollars and are for medical services utilized from July 1987 through November 1990.
- The “all stages” row for each site includes cases that were in situ and unstaged at diagnosis in addition to those shown separately that were local, regional and remote.
- The “all phases” column shows costs or utilization per person year, including all initial, continuing and terminal care after diagnosis, but not including the month before diagnosis.
- The “controls” column shows the cost or utilization rates per person year that would be expected for cancer patients—with cancer of the given site and stage—if they utilized at the rate of all Kaiser

Permanente members during the study period who were the same sex and age as the cases were at diagnosis. To permit estimation of how controls’ costs increase with age, control cost rates above age 35 were regressed on age and age-squared, yielding for women:  $5400 - 180 \cdot \text{age} + 56 \cdot \text{age-squared}$ , and for men:  $5048 - 200 \cdot \text{age} + 68 \cdot \text{age-squared}$ .

- The “pre-dx” column includes the 30 days preceding the date of diagnosis.
- The “initial care” column includes the 6 months following diagnosis of half of the time from diagnosis until death—which ever is the lesser amount of time.
- The “terminal care” column includes the 6 months prior to death due to the given cancer or half of the time from diagnosis until death—whichever is the lesser amount of time.
- The “continuing care” column shows cost rates per 6 months of follow-up.
- The “all long-term” column estimates costs or utilization from the prediagnosis month until death or 15 years following diagnosis.
- The “attributable long-term” column estimates costs or utilization due to cancer by subtracting the costs or utilization of “controls” during the lifetime of the cancer patient. Not considered are the costs or utilization associated with controls’ longer life expectancy.
- The “attributable long-term discounted” column shows the net present value of the attributable costs at the time of diagnosis after discounting all future cost at the rate of 4 percent.

**Table 1**  
**Study Population: Demographic Characteristics and the Number of Patients Who Receive**  
**Each Phase of Care, by Cancer Site and Stage at Diagnosis**

Cancer Site and Stage at Diagnosis	Total Number	Mean Age at Diagnosis	Age at Diagnosis, Percent Distribution				Percent Male	Percent Non-White	Number With Initial Care	Number With Continuing Care	Number With Terminal Care
			Under 50	50-59	60-74	75 or Over					
<b>Breast, Female</b>											
In Situ	807	55.7	35.3	26.6	31.1	6.9	0.0	20.6	476	670	4
Local	4,584	58.4	26.9	23.8	38.9	10.4	0.0	17.3	2,120	4,036	209
Regional	2,375	55.1	36.2	25.7	31.5	6.5	0.0	18.9	1,041	2,044	383
Remote	225	58.4	26.2	24.4	40.9	8.4	0.0	20.0	162	148	106
Unspecified	161	55.8	34.8	28.0	26.7	10.6	0.0	26.1	25	154	22
All Stages	8,152	57.1	30.6	24.7	35.8	8.9	0.0	18.3	3,824	7,052	724
<b>Colon</b>											
In Situ	141	63.8	9.2	25.5	47.5	17.7	57.4	22.7	58	125	2
Local	1,142	65.2	7.1	20.8	53.6	18.6	55.6	18.8	560	989	35
Regional	1,543	65.6	10.4	15.9	51.1	22.7	49.8	18.7	763	1,302	205
Remote	424	65.9	10.1	18.6	44.6	26.7	47.4	21.2	338	178	243
Unspecified	71	65.2	14.1	18.3	39.4	28.2	57.7	23.9	19	56	18
All Stages	3,321	65.4	9.2	18.4	50.7	21.7	52.0	19.3	1,738	2,650	503
<b>Rectum</b>											
In Situ	119	59.7	18.5	23.5	50.4	7.6	65.5	20.2	56	111	1
Local	662	62.3	13.1	23.3	49.4	14.2	57.1	14.2	327	584	30
Regional	484	62.2	12.4	23.3	51.0	13.2	60.7	20.7	252	408	58
Remote	149	62.6	15.4	20.1	48.3	16.1	53.0	16.8	127	73	45
Unspecified	54	66.4	13.0	14.8	40.7	31.5	50.0	25.9	28	43	8
All Stages	1,468	62.2	13.6	22.7	49.6	14.2	58.3	17.5	790	1,219	142
<b>Lung</b>											
In Situ	2	69.5	0.0	0.0	100.0	0.0	50.0	0.0	1	1	2
Local	765	62.3	11.8	23.5	53.7	11	54.2	17.9	388	600	174
Regional	781	62.7	8.6	27.8	54.0	9.6	60.3	17.0	556	448	413
Remote	1,486	63.6	9.8	23.4	51.4	15.3	58.0	17.6	1,336	304	1,049
Unspecified	317	66.9	7.3	13.9	54.3	24.6	58.4	17.4	224	162	196
All Stages	3,351	63.4	9.7	23.5	52.8	13.9	57.7	17.5	2,505	1,515	1,834
<b>Ovarian</b>											
In Situ	2	46.0	50.0	0.0	50.0	0.0	0.0	0.0	0.0	2	0
Local	286	48.9	49.3	22.0	25.2	3.5	0.0	16.4	146	247	10
Regional	67	53.6	31.3	29.9	32.8	6.0	0.0	17.9	34	54	7
Remote	435	58.4	26.2	23.7	38.9	11.3	0.0	14.0	291	282	164
Unspecified	26	55.8	26.9	30.8	15.4	26.9	0.0	3.8	16	17	6
All Stages	816	54.6	34.8	23.8	32.8	8.6	0.0	14.8	487	602	187

See Notes at end of table.

**Table 1—Continued**  
**Study Population: Demographic Characteristics and the Number of Patients Who Receive**  
**Each Phase of Care, by Cancer Site and Stage at Diagnosis**

Cancer Site and Stage at Diagnosis	Total Number	Mean Age at Diagnosis	Age at Diagnosis, Percent Distribution				Percent Male	Percent Non-White	Number With Initial Care	Number With Continuing Care	Number With Terminal Care
			Under 50	50-59	60-74	75 or Over					
<b>Prostate</b>											
In Situ	3	65.0	0.0	0.0	100	0.0	100.0	33.3	2	3	0
Local	2,109	69.3	0.9	9.2	64.0	25.9	100.0	18.1	1,244	1,709	151
Regional	523	67.3	0.4	13.0	70.2	16.4	100.0	19.3	351	387	65
Remote	600	70.7	1.0	8.3	55.5	35.2	100.0	22.0	427	419	232
Unspecified	248	72.6	0.8	8.5	47.2	43.5	100.0	21.8	135	189	39
All Stages	3,483	69.4	0.9	9.5	62.3	27.3	100.0	19.2	2,159	2,707	487
<b>Non-Hodgkin's Lymphoma</b>											
Local	379	55.8	34.6	20.6	34.8	10.0	55.7	16.9	250	289	60
Regional	239	56.7	30.1	20.1	36.4	13.4	63.6	13.0	143	173	36
Remote	665	55.1	34.0	20.0	35.9	10.1	58.5	12.8	431	445	166
Unspecified	103	59.9	26.2	18.4	34.0	21.4	47.6	12.6	50	75	20
All Stages	1,386	55.9	32.9	20.1	35.6	11.5	57.8	13.9	874	982	282
<b>All Seven Sites</b>											
In Situ	1,074	57.3	29.9	26.0	35.8	8.4	15.2	20.8	593	912	9
Local	9,927	61.7	18.0	20.1	47.2	14.7	37.8	17.4	5,035	8,454	669
Regional	6,012	60.5	20.7	22.0	44.6	12.7	36.7	18.5	3,140	4,816	1,167
Remote	3,984	62.6	15.5	20.0	46.6	17.8	53.5	17.5	3,112	1,849	2,005
Unspecified	980	65.3	13.5	16.1	43.0	27.4	56.1	20.0	497	696	309
All Stages	21,977	61.5	18.6	20.7	45.6	15.0	40.0	18.0	12,377	16,727	4,159

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Center - SEER Registry, 1993.

**Table 2**  
**Mean Hospital Days (With Standard Errors), Long-Term Resource Use Per Person-Year and Treatment Phase for Cancer Patients and Controls, by Cancer Site and Stage at Diagnosis**

Cancer Site and Stage of Diagnosis	Cases All Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (1 Month)	Initial Care (6 Months)	Continuing Care		Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
					(Per 6 Months)	(Per 6 Months)				
<b>Breast, Female</b>										
Local	1.8 (0.06)	0.77 (0.01)	0.01 (0.00)	3.28 (0.07)	0.58 (0.03)		11.61 (0.83)	20.46 (0.76)	11.37 (0.76)	9.83 (0.62)
Regional	2.6 (0.15)	0.66 (0.01)	0.03 (0.01)	4.02 (0.12)	0.72 (0.08)		10.75 (0.61)	21.55 (1.39)	15.27 (1.39)	13.47 (1.16)
Remote	6.27 (0.50)	0.89 (0.03)	0.3 (0.13)	4.85 (0.57)	1.19 (0.25)		10.47 (1.15)	18.18 (1.61)	15.77 (1.62)	14.96 (1.47)
All Stages	2.03 (0.06)	0.73 (0.01)	0.04 (0.01)	3.4 (0.06)	0.6 (0.03)		10.97 (0.46)	19.69 (0.60)	12.17 (0.60)	10.72 (0.49)
<b>Colon</b>										
Local	3.52 (0.23)	1.16 (0.02)	0.36 (0.06)	9.32 (0.32)	0.97 (0.12)		9.49 (1.97)	32.05 (2.49)	20.43 (2.50)	18.49 (2.08)
Regional	5.35 (0.19)	1.21 (0.02)	0.73 (0.08)	12.75 (0.42)	1.22 (0.09)		13.77 (1.07)	37.31 (1.41)	28.2 (1.41)	26.08 (1.22)
Remote	12.58 (0.59)	1.11 (0.04)	0.89 (0.13)	13.09 (0.68)	2.1 (0.32)		9.98 (0.85)	27.15 (1.29)	25.04 (1.30)	24.28 (1.22)
All Stages	4.88 (0.14)	1.18 (0.01)	0.63 (0.05)	11.46 (0.26)	1.14 (0.07)		11.44 (0.63)	32.14 (0.95)	24.12 (0.95)	22.5 (0.82)
<b>Rectum</b>										
Local	3.61 (0.19)	1.02 (0.03)	0.15 (0.03)	9.28 (0.54)	0.96 (0.09)		10.5 (2.06)	31.28 (1.92)	21.66 (1.91)	19.58 (1.63)
Regional	6.99 (0.40)	0.99 (0.03)	0.19 (0.07)	14.96 (0.92)	1.75 (0.19)		12.86 (2.01)	43.3 (2.67)	36.55 (2.67)	33.45 (2.33)
Remote	15.43 (1.30)	0.92 (0.05)	0.46 (0.13)	13.02 (0.83)	4.65 (0.97)		9.53 (1.54)	33.53 (3.09)	31.64 (3.13)	30.16 (2.86)
All Stages	5.06 (0.18)	1.01 (0.02)	0.23 (0.04)	11.22 (0.43)	1.3 (0.08)		10.85 (1.07)	32.98 (1.24)	26.2 (1.24)	24.11 (1.09)
<b>Lung</b>										
Local	5.4 (0.28)	0.99 (0.02)	0.54 (0.09)	11.52 (0.86)	1.12 (0.12)		11.99 (0.89)	33.15 (1.81)	26.12 (1.79)	24.1 (1.58)
Regional	7.99 (0.34)	0.89 (0.02)	0.51 (0.09)	7.67 (0.43)	1.53 (0.19)		9.8 (0.54)	22.31 (1.08)	19.44 (1.08)	18.46 (0.97)
Remote	11.69 (0.34)	0.91 (0.02)	0.62 (0.05)	7.04 (0.24)	2.42 (0.35)		8.04 (0.29)	17.54 (0.57)	16.56 (0.57)	16.15 (0.53)

See Notes at end of table.

**Table 2 —Continued**  
**Mean Hospital Days (With Standard Errors), Long-Term Resource Use Per Person-Year and Treatment Phase for Cancer Patients and Controls, by Cancer Site and Stage at Diagnosis**

Cancer Site and Stage of Diagnosis	Cases All Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (1 Month)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Ovarian</b>									
Local	2.53 (0.17)	0.56 (0.03)	0.47 (0.09)	8.19 (0.40)	0.39 (0.07)	20.4 (6.43)	24.27 (2.73)	17.18 (2.71)	15.75 (2.29)
Regional	4.75 (0.72)	0.66 (0.05)	1.76 (0.95)	14.03 (2.05)	0.81 (0.29)	15.43 (8.02)	36.03 (6.39)	30.13 (6.37)	28.03 (5.58)
Remote	11.92 (0.61)	0.71 (0.02)	0.64 (0.08)	16.9 (0.69)	2.39 (0.35)	15.13 (1.23)	42.19 (2.43)	39.54 (2.43)	37.17 (2.13)
All Stages	6.86 (0.29)	0.66 (0.02)	0.67 (0.09)	13.81 (0.49)	1.22 (0.14)	15.41 (1.19)	36.0 (1.73)	32.09 (1.73)	29.97 (1.49)
<b>Prostate</b>									
Local	3.57 (0.20)	1.48 (0.02)	0.16 (0.03)	3.95 (0.25)	1.25 (0.11)	13.12 (1.05)	31.2 (1.82)	17.8 (1.82)	15.57 (1.53)
Regional	4.6 (1.07)	1.26 (0.03)	0.03 (0.02)	3.87 (0.27)	1.55 (0.66)	13.48 (1.76)	33.87 (9.47)	23.17 (9.45)	20.21 (7.95)
Remote	6.56 (0.34)	1.51 (0.03)	0.32 (0.07)	4.02 (0.38)	1.66 (0.17)	12.54 (0.84)	22.75 (1.28)	16.52 (1.29)	15.44 (1.16)
All Stages	4.13 (0.21)	1.48 (0.01)	0.2 (0.03)	3.89 (0.17)	1.35 (0.12)	12.72 (0.59)	29.32 (1.64)	17.91 (1.64)	15.9 (1.38)
<b>Non-Hodgkin's Lymphoma</b>									
Local	5.08 (0.43)	0.74 (0.03)	0.64 (0.16)	8.13 (0.84)	1.14 (0.19)	14.37 (2.78)	32.41 (3.13)	26.65 (3.15)	24.05 (2.71)
Regional	5.38 (0.45)	0.83 (0.04)	0.64 (0.17)	10.17 (1.14)	0.95 (0.15)	21.97 (4.04)	35.04 (3.19)	29.21 (3.18)	27.02 (2.86)
Remote	7.35 (0.35)	0.75 (0.03)	0.84 (0.12)	10.76 (0.72)	1.47 (0.16)	16.57 (1.10)	34.48 (1.69)	30.69 (1.69)	28.62 (1.50)
All Stages	5.99 (0.22)	0.79 (0.02)	0.74 (0.08)	9.67 (0.48)	1.2 (0.09)	16.63 (1.07)	32.91 (1.28)	28.11 (1.28)	26.03 (1.13)

NOTES: Numbers in parentheses are standard errors. For notes that apply generally to Tables 2-5, see Technical Note.

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Cancer Center - SEER Registry, 1993.

**Table 3**  
**Mean Outpatient Visits (With Standard Errors), Long-Term Resource Use Per Person-Year**  
**and Treatment Phase for Cancer Patients and Controls, by Cancer Site and Stage at**  
**Diagnosis**

Cancer Site and Stage at Diagnosis	Cases All Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (6 Months)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Breast, Female</b>									
Local	12.38 (0.12)	7.05 (0.02)	1.64 (0.03)	15.81 (0.15)	5.25 (0.07)	12.56 (0.51)	135.07 (1.45)	53.1 (1.44)	45.8 (1.18)
Regional	13.92 (0.18)	6.77 (0.03)	1.53 (0.04)	19.73 (0.26)	5.57 (0.10)	12.3 (0.39)	120.47 (1.64)	57.37 (1.66)	50.6 (1.39)
Remote	18.5 (0.72)	6.86 (0.08)	1.73 (0.13)	15.82 (0.75)	7.11 (0.47)	9.76 (0.77)	61.03 (2.61)	37.69 (2.69)	35.1 (2.39)
All Stages	12.84 (0.09)	6.98 (0.01)	1.64 (0.02)	16.5 (0.13)	5.35 (0.05)	11.98 (0.29)	122.08 (0.95)	51.7 (0.95)	45.15 (0.79)
<b>Colon</b>									
Local	10.54 (0.23)	7.37 (0.05)	1.95 (0.06)	10.09 (0.29)	4.77 (0.12)	9.14 (1.22)	103.44 (2.37)	29.8 (2.35)	25.98 (1.94)
Regional	12.65 (0.24)	7.46 (0.04)	1.99 (0.06)	14.04 (0.37)	5.36 (0.13)	9.84 (0.50)	93.15 (1.78)	36.67 (1.78)	32.7 (1.50)
Remote	17.65 (0.75)	7.29 (0.08)	2.28 (0.09)	11.88 (0.54)	7.64 (0.59)	8.14 (0.48)	41.22 (1.75)	26.58 (1.77)	25.12 (1.59)
All Stages	11.88 (0.16)	7.41 (0.03)	2.01 (0.04)	12.02 (0.22)	5.15 (0.09)	8.88 (0.33)	80.89 (1.07)	30.45 (1.06)	27.27 (0.89)
<b>Rectum</b>									
Local	11.65 (0.32)	7.01 (0.06)	1.8 (0.09)	12.1 (0.40)	5.13 (0.17)	11.9 (1.99)	108.84 (3.17)	41.34 (3.19)	35.99 (2.65)
Regional	15.27 (0.45)	6.93 (0.08)	1.47 (0.08)	18.07 (0.61)	6.22 (0.25)	9.79 (0.95)	99.55 (3.08)	51.63 (3.11)	46.01 (2.64)
Remote	23.38 (1.73)	6.77 (0.15)	1.99 (0.15)	15.65 (0.98)	10.08 (1.34)	8.42 (0.95)	52.32 (4.01)	37.93 (4.17)	35.8 (3.78)
All Stages	13.14 (0.24)	6.95 (0.04)	1.72 (0.05)	14.3 (0.33)	5.56 (0.13)	9.62 (0.66)	87.82 (1.66)	40.12 (1.68)	35.76 (1.42)
<b>Lung</b>									
Local	11.62 (0.30)	7.1 (0.06)	2.61 (0.10)	10.51 (0.29)	5.08 (0.17)	8.68 (0.48)	83.45 (2.25)	32.21 (2.24)	28.57 (1.88)
Regional	14.65 (0.37)	6.74 (0.06)	2.33 (0.08)	11.23 (0.27)	5.85 (0.27)	8.46 (0.28)	48.11 (1.35)	26.23 (1.36)	24.4 (1.19)
Remote	14.13 (0.27)	6.78 (0.04)	2.45 (0.06)	8.88 (0.19)	6.33 (0.33)	5.35 (0.16)	23.93 (0.49)	16.04 (0.48)	15.55 (0.44)
All Stages	12.97 (0.18)	6.9 (0.03)	2.43 (0.04)	9.66 (0.13)	5.5 (0.13)	6.52 (0.13)	39.51 (0.56)	20.74 (0.56)	19.43 (0.49)

See Notes at end of table.

**Table 3—Continued**  
**Mean Outpatient Visits (With Standard Errors), Long-Term Resource Use Per Person-Year**  
**and Treatment Phase for Cancer Patients and Controls, by Cancer Site and Stage at**  
**Diagnosis**

Cancer Site and Stage at Diagnosis	Cases All Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (6 Months)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Ovarian</b>									
Local	9.56 (0.46)	6.47 (0.07)	3.03 (0.14)	8.66 (0.50)	4.33 (0.25)	10.1 (1.81)	109.07 (5.53)	32.29 (5.39)	27.82 (4.40)
Regional	10.97 (0.96)	6.86 (0.16)	3.56 (0.46)	9.15 (0.88)	5.04 (0.53)	7.77 (1.60)	95.88 (8.52)	35.74 (8.12)	31.13 (6.71)
Remote	15.19 (0.54)	6.96 (0.06)	3.11 (0.12)	11.23 (0.41)	6.58 (0.34)	9.18 (0.56)	61.31 (2.22)	34.46 (2.23)	31.34 (1.91)
All Stages	12.13 (0.33)	6.78 (0.05)	3.1 (0.09)	10.19 (0.30)	5.28 (0.19)	9.07 (0.51)	73.57 (2.06)	32.97 (2.03)	29.38 (1.70)
<b>Prostate</b>									
Local	12.78 (0.18)	7.81 (0.03)	2.04 (0.05)	9.56 (0.14)	5.83 (0.1)	10.88 (0.60)	109.66 (1.68)	40.57 (1.66)	35.12 (1.39)
Regional	13.92 (0.38)	7.36 (0.06)	1.81 (0.09)	10.6 (0.31)	6.02 (0.23)	12.14 (0.86)	105.19 (3.29)	44.62 (3.32)	38.95 (2.80)
Remote	15.32 (0.38)	7.83 (0.06)	2.47 (0.11)	11.33 (0.30)	6.19 (0.25)	10.26 (0.45)	59.33 (1.62)	27.76 (1.65)	25.77 (1.46)
All Stages	13.27 (0.15)	7.78 (0.03)	2.07 (0.04)	10.02 (0.12)	5.89 (0.09)	10.63 (0.32)	96.68 (1.16)	37.54 (1.15)	32.94 (0.97)
<b>Non-Hodgkin's Lymphoma</b>									
Local	14.58 (0.55)	6.09 (0.10)	2.53 (0.13)	14.28 (0.56)	5.96 (0.31)	10.64 (1.13)	106.31 (4.50)	57.66 (4.42)	50.3 (3.67)
Regional	14.49 (0.76)	6.28 (0.13)	2.95 (0.15)	16.87 (0.69)	5.61 (0.43)	13.51 (1.61)	100.11 (5.75)	54.89 (5.81)	48.67 (4.83)
Remote	17.42 (0.49)	6.04 (0.08)	3.08 (0.11)	16.06 (0.49)	7.03 (0.29)	13.09 (0.74)	88.06 (2.58)	56.65 (2.60)	50.79 (2.20)
All Stages	15.55 (0.31)	6.16 (0.05)	2.9 (0.07)	15.31 (0.32)	6.29 (0.18)	12.15 (0.56)	92.53 (1.98)	54.28 (1.98)	48.25 (1.66)

NOTES: Numbers in parentheses are standard errors. For notes that apply generally to Tables 2-5, see Technical Note.

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Cancer Center - SEER Registry, 1993.

**Table 4**  
**Mean Inpatient Costs (With Standard Errors), Long-Term Costs and Costs per Person-Year**  
**and Treatment Phase**

Cancer Site and Stage at Diagnosis	Cases All Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (1 Month)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Breast, Female</b>									
Local	\$3,005 (72)	\$1,353 (14)	\$28 (9)	\$7,349 (112)	\$849 (37)	\$14,419 (1,058)	\$31,408 (904)	\$15,421 (904)	\$13,816 (744)
Regional	4,095 (112)	1,159 (18)	51 (22)	9,057 (168)	1,001 (55)	13,233 (780)	32,582 (1,009)	21,537 (1,015)	19,504 (852)
Remote	8,677 (628)	1,211 (59)	538 (198)	7,881 (754)	1,560 (303)	13,096 (1,436)	25,058 (1,996)	20,824 (2,018)	19,881 (1,844)
All Stages	3,327 (56)	1,275 (10)	63 (15)	7,549 (94)	879 (28)	13,670 (604)	30,175 (591)	16,964 (592)	15,368 (495)
<b>Colon</b>									
Local	5,327 (197)	2,037 (35)	1,207 (139)	16,467 (538)	1,238 (92)	14,721 (4,272)	47,472 (2,745)	27,056 (2,763)	25,290 (2,344)
Regional	7,915 (230)	2,120 (33)	2,390 (167)	20,865 (574)	1,664 (106)	17,709 (1,473)	55,130 (1,733)	39,123 (1,740)	36,819 (1,511)
Remote	17,954 (803)	1,948 (62)	2,720 (287)	20,240 (1013)	2,736 (416)	12,704 (1,114)	39,923 (1,760)	36,218 (1,767)	35,291 (1,668)
All Stages	7,212 (150)	2,074 (22)	2,019 (105)	18,889 (382)	1,515 (69)	14,873 (872)	47,375 (1,043)	33,289 (1,048)	31,648 (919)
<b>Rectum</b>									
Local	5,762 (296)	1,793 (44)	569 (114)	16,107 (882)	1,414 (134)	16,018 (4,062)	49,007 (3,178)	32,111 (3,185)	29,462 (2,729)
Regional	10,820 (547)	1,746 (53)	407 (115)	25,882 (1313)	2,421 (254)	17,393 (2,872)	65,077 (3,689)	53,206 (3,695)	49,254 (3,233)
Remote	22,442 (1,672)	1,618 (94)	1,271 (297)	21,329 (1319)	5,780 (1,180)	11,917 (1,964)	47,571 (3,880)	44,248 (3,951)	42,445 (3,633)
All Stages	7,837 (256)	1,771 (31)	623 (85)	19,058 (653)	1,844 (118)	14,707 (1,608)	49,870 (1,790)	37,961 (1,794)	35,348 (1,578)
<b>Lung</b>									
Local	8,290 (411)	1,731 (38)	1,440 (166)	20,493 (1,508)	1,562 (141)	14,870 (1,179)	50,299 (2,453)	37,950 (2,436)	35,589 (2,203)
Regional	11,508 (440)	1,559 (34)	949 (136)	13,219 (682)	1,966 (195)	12,159 (776)	32,012 (1,297)	26,976 (1,293)	25,855 (1,190)
Remote	15,373 (479)	1,595 (27)	1,041 (83)	9,668 (355)	3,287 (479)	9,876 (417)	23,249 (794)	21,527 (798)	21,005 (749)
All Stages	10,533 (237)	1,659 (18)	1,126 (66)	12,197 (370)	1,934 (120)	11,006 (336)	29,193 (668)	24,749 (666)	23,841 (612)

See Notes at end of table.

**Table 4—Continued**  
**Mean Inpatient Costs (With Standard Errors), Long-Term Costs and Costs per Person-Year**  
**and Treatment Phase**

Cancer Site and Stage at Diagnosis	Cases All Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (1 Month)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Ovarian</b>									
Local	4,063 (234)	992 (44)	3,098 (362)	14,405 (614)	550 (97)	25,275 (7,876)	38,240 (3,533)	25,798 (3,518)	24,385 (2,972)
Regional	7,221 (1,257)	1,155 (94)	7,807 (3,313)	22,640 (4,959)	1,207 (413)	18,470 (9,347)	58,346 (9,905)	47,973 (9,880)	45,318 (8,949)
Remote	16,380 (757)	1,246 (41)	2,568 (285)	25,352 (974)	3,039 (418)	18,790 (1,587)	58,942 (2,980)	54,290 (2,996)	51,424 (2,642)
All Stages	9,744 (373)	1,159 (29)	3,074 (313)	21,430 (741)	1,601 (177)	19,170 (1,529)	52,069 (2,193)	45,223 (2,199)	42,714 (1,919)
<b>Prostate</b>									
Local	4,887 (165)	2,605 (27)	492 (52)	6,817 (274)	1,546 (84)	15,420 (1,162)	40,322 (1,509)	16,775 (1,513)	15,150 (1,280)
Regional	6,012 (375)	2,220 (47)	78 (38)	8,135 (495)	1,448 (190)	16,411 (2,332)	38,356 (3,071)	19,552 (3,065)	17,795 (2,627)
Remote	9,172 (480)	2,660 (52)	747 (145)	6,359 (551)	2,351 (259)	15,898 (1,083)	32,017 (1,859)	21,071 (1,870)	19,814 (1,680)
All Stages	5,610 (141)	2,600 (21)	490 (46)	6,774 (213)	1,634 (72)	15,603 (727)	37,945 (1,068)	17,888 (1,071)	16,349 (916)
<b>Non-Hodgkin's Lymphoma</b>									
Local	6,638 (522)	1,308 (59)	1,268 (274)	11,485 (1,099)	1,411 (223)	16,804 (3,168)	41,504 (3,738)	31,371 (3,789)	28,674 (3,258)
Regional	7,659 (649)	1,457 (75)	1,449 (308)	14,814 (1,612)	1,372 (239)	29,064 (5,518)	49,862 (4,614)	39,629 (4,613)	36,843 (4,110)
Remote	9,710 (522)	1,314 (44)	1,567 (195)	14,110 (1,017)	2,096 (249)	20,007 (1,387)	46,055 (2,538)	39,388 (2,539)	36,737 (2,234)
All Stages	8,168 (376)	1,385 (32)	1,472 (141)	13,820 (1,021)	1,652 (136)	20,324 (1,334)	44,729 (1,942)	36,290 (1,950)	33,799 (7,50)

NOTES: Numbers in parentheses are standard errors. For notes that apply generally to Tables 2-5, see Technical Note.

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Cancer Center - SEER Registry, 1993.

**Table 5**  
**Adjusted Mean Total Costs (With Standard Errors), Long-Term Cost and Costs per Person-Year and Treatment Phase for Cancer Patients and Controls, by Cancer Site and Stage at Diagnosis**

Cancer Site and Stage of Diagnosis	Cases Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (1 Month)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Breast, Female</b>									
Local	\$6,622 (91)	\$2,570 (17)	\$353 (12)	\$14,470 (130)	\$2,133 (48)	\$19,269 (1137)	\$68,331 (1126)	\$38,191 (1124)	\$33,628 (923)
Regional	8,707 (146)	2,331 (22)	350 (24)	17,791 (220)	2,606 (74)	18,020 (834)	70,843 (1,330)	48,879 (1,341)	43,622 (1,124)
Remote	15,847 (783)	2,398 (71)	867 (202)	14,892 (822)	3,937 (437)	17,303 (1,578)	47,544 (2,640)	39,237 (2,671)	37,021 (-,241)0
All Stages	7,196 (72)	2,473 (12)	387 (16)	14,737 (117)	2,245 (37)	18,406 (643)	65,036 (749)	39,670 (750)	35,282 (625)
<b>Colon</b>									
Local	8,195 (333)	3,308 (41)	1,561 (142)	22,121 (1,453)	2,218 (110)	17,308 (4,522)	72,598 (3,333)	39,550 (3,331)	36,507 (2,903)
Regional	11,136 (266)	3,405 (38)	2,763 (170)	25,929 (664)	2,814 (124)	20,388 (1,485)	77,417 (1,973)	51,681 (1,956)	48,115 (1,695)
Remote	24,713 (1,099)	3,205 (73)	3,141 (292)	27,323 (1,627)	4,660 (499)	14,896 (1,161)	54,345 (2,315)	48,089 (2,315)	46,668 (2,208)
All Stages	10,443 (200)	3,350 (26)	2,391 (107)	24,489 (648)	2,607 (82)	17,282 (898)	67,806 (1,284)	45,045 (1,276)	42,378 (1,137)
<b>Rectum</b>									
Local	9,304 (344)	3,004 (53)	916 (120)	22,710 (1,002)	2,588 (155)	19,986 (4,087)	78,300 (3,491)	49,795 (3,424)	45,180 (2,932)
Regional	16,227 (650)	2,944 (64)	676 (120)	35,471 (1,467)	4,023 (309)	21,090 (3,132)	96,196 (4,352)	75,988 (4,235)	69,914 (3,695)
Remote	31,517 (1,946)	2,789 (115)	1,632 (306)	29,184 (1,539)	8,507 (1,384)	15,602 (2,074)	66,180 (4,487)	60,344 (4,530)	57,810 (4,160)
All Stages	12,096 (303)	2,972 (37)	943 (88)	26,369 (758)	3,187 (140)	18,310 (1,695)	75,554 (2,064)	55,389 (2,017)	51,148 (1,772)
<b>Lung</b>									
Local	11,499 (427)	2,956 (46)	1,936 (170)	26,335 (1,526)	2,538 (151)	18,356 (1,265)	71,156 (2,579)	49,963 (2,555)	46,634 (2,299)
Regional	17,036 (488)	2,725 (42)	1,420 (140)	19,379 (724)	3,526 (234)	15,536 (829)	48,608 (1,479)	39,786 (1,478)	37,912 (1,350)
Remote	21,853 (506)	2,767 (33)	1,501 (86)	14,776 (380)	4,797 (498)	12,438 (446)	32,908 (835)	29,822 (836)	29,115 (785)
All Stages	15,127 (253)	2,852 (22)	1,593 (68)	17,583 (385)	3,154 (131)	13,851 (360)	42,130 (716)	34,442 (713)	33,093 (653)

See Notes at end of table.

**Table 5 —Continued**  
**Adjusted Mean Total Costs (With Standard Errors), Long-Term Cost and Costs per Person-  
 Year and Treatment Phase for Cancer Patients and Controls, by Cancer Site and Stage at  
 Diagnosis**

Cancer Site and Stage of Diagnosis	Cases Phases (Per Year)	Controls (Per Year)	Pre-Diagnosis Care (1 Month)	Initial Care (6 Months)	Continuing Care (Per 6 Months)	Terminal Care (6 Months)	Long-Term	Attributable Long-Term	Attributable Long-Term Discounted
<b>Ovarian</b>									
Local	6,577 (327)	2,114 (55)	3,766 (367)	18,404 (741)	1,462 (152)	28,594 (8,030)	63,835 (4,409)	38,117 (4,318)	35,164 (3,613)
Regional	13,963 (2,453)	2,341 (120)	8,868 (3,317)	41,358 (11,303)	2,867 (580)	21,180 (9,783)	105,598 (15,637)	84,833 (15,473)	78,981 (14,428)
Remote	25,146 (1,021)	2,449 (50)	3,311 (314)	36,154 (1,139)	5,958 (604)	22,333 (1,686)	90,975 (4,097)	81,694 (4,049)	76,517 (3,531)
All Stages	15,390 (539)	2,332 (36)	3,813 (324)	30,480 (1,134)	3,372 (260)	22,612 (1,617)	82,344 (3,099)	68,468 (3,060)	63,696 (2,652)
<b>Prostate</b>									
Local	8,242 (190)	3,946 (31)	878 (55)	10,958 (310)	2,812 (98)	18,883 (1,235)	66,772 (1,724)	31,363 (1,718)	27,969 (1,452)
Regional	10,118 (429)	3,488 (57)	417 (42)	13,028 (584)	2,892 (222)	19,752 (2,400)	66,112 (3,501)	36,905 (3,529)	33,127 (3,002)
Remote	13,809 (532)	4,006 (62)	1,218 (150)	10,908 (814)	3,835 (291)	19,440 (1,153)	48,643 (2,075)	32,266 (2,089)	30,266 (1,874)
All Stages	9,222 (161)	3,938 (25)	883 (48)	11,074 (242)	2,944 (83)	19,070 (767)	62,068 (1,216)	31,855 (1,216)	28,771 (1,038)
<b>Non-Hodgkin's Lymphoma</b>									
Local	10,235 (579)	2,367 (73)	1,736 (280)	16,576 (1,206)	2,566 (253)	19,955 (3,266)	64,982 (4,146)	46,445 (4,180)	42,089 (3,584)
Regional	11,127 (711)	2,547 (95)	2,000 (313)	19,798 (1,698)	2,493 (276)	33,816 (5,741)	72,556 (5,056)	54,460 (5,045)	50,150 (4,468)
Remote	14,378 (575)	2,365 (56)	2,133 (197)	19,956 (1,112)	3,627 (276)	23,859 (1,474)	68,082 (2,791)	55,968 (2,776)	51,799 (2,441)
All Stages	12,215 (472)	2,456 (40)	2,007 (143)	19,517 (1,374)	2,940 (152)	24,057 (1,401)	66,905 (2,284)	51,838 (2,285)	47,868 (2,075)

NOTES: Numbers in parentheses are standard errors. For notes that apply generally to Tables 2-5, see Technical Note.

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Cancer Center - SEER Registry, 1993.

**Table 6**  
**Effects of Age, Race and Sex on Costs in 1992 Dollars for**  
**Initial, Continuing and Terminal Care, by Site: Regression Coefficients**  
**(\* if p< .05) Adjusted for Date and Stage at Diagnosis**

Organ Site Variable	Initial Cost	Continuing Cost	Terminal Cost
<b>Breast</b>			
Under 50 Years	\$902*	\$204	\$4,582*
75 Years or Over	-2,207*	1,058*	-9,328*
Black	49	56	-2,228
Other Non-White	-1,148*	-846*	-6,295*
<b>Colon</b>			
Under 50 Years	383	-397	8,229*
75 Years or Over	4,960*	-1,137*	-962
Black	736	944	2,522
Other Non-White	-119	-860	4,999
Male	1,570*	-464	1,788
<b>Rectum</b>			
Under 50 Years	-296	707	3,898
75 Years or Over	1,689	1,180	-6,371
Black	-3,512	-1,124	1,206
Other Non-White	-4,686*	-2,450	861
Male	1,942	-436	2,256
<b>Lung</b>			
Under 50 Years	3,805*	-55	4,335*
75 Years or Over	-3,030*	-1,661	-3,354*
Black	-2,036	-1,731	2,029
Other Non-White	198	-1,201	2,765
Male	-717	459	-1,496*
<b>Ovary</b>			
Under 50 Years	1,904	137	11,657*
75 Years or Over	-1,069	-151	339
Black	-3,069	-1,763	8,870
Other Non-White	1,466	287	-7,979
<b>Prostate</b>			
Under 50 Years	2,572	-191	19,875*
75 Years or Over	-3,768*	702	-6,687*
Black	-828	989	1,087
Other Non-White	2	-1,098	-4,526
<b>Non-Hodgkin's Lymphoma</b>			
Under 50 Years	5,202*	4,986*	11,219*
75 Years or Over	-730	-626	-9,115*
Black	-4,067	365	-3,932
Other Non-White	-1,408	-1,085	-2,619
Male	1,263	403	-891

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Cancer Center

-- SEER Registry, 1993.

**Table 7**  
**Discounted Long-Term Costs As a Function of the Discount Rate**

Discount Rate (Percent)	Breast	Colon	Rectum	Lung	Ovary	Prostate	Non-Hodgkin's Lymphoma
3	\$35,282	\$42,378	\$51,148	\$33,093	\$63,696	\$28,771	\$47,868
4	34,070	41,627	49,960	32,704	62,362	27,902	46,755
5	32,960	40,934	48,864	32,339	61,134	27,100	45,729

SOURCE: Kaiser Permanente, Northern California Region, and Northern California Cancer Center - SEER Registry, 1993.