The Cost of Cancer in Texas

2007

Texas Cancer Registry

UTMB The University of Texas Medical Branch

TEXAS Department of State Health Services

Texas Department of State Health Services
Texas Cancer Registry

March 2009
Publication No. 10-13121

The Cost of Cancer in Texas, 2007

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Suggested Citation: Tan, A., Freeman, D.H., Freeman, J.L., Zhang, D.D., Dayal, H., and Philips, B.U. (March 2009). *The Cost of Cancer in Texas, 2007.* Texas Cancer Registry, Texas Department of State Health Services, Publication No. 10-13121.

Preface

Health promotion for improved cancer prevention, diagnosis, treatment, and survival remains a top public health and health care priority that often needs legislative action and other significant policy decisions. Cancer cost estimates are critical for legislators, other policy makers, and stakeholders to make informed decisions in the formulation of state cancer programs and policies. However, there is no updated estimate of costs of cancer in Texas since 1998. To address this need, the Texas Cancer Registry (TCR), Texas Department of State Health Services initiated and funded this study to estimate the cost of cancer in Texas for the year 2007, evaluate its data for use in measuring the economic burden of cancer, and provide additional insight for further enhancing TCR data to support this important area of research.

In this study, the TCR incidence data were used for the first time in estimating Texas cancer costs. The TCR data currently meet Centers for Disease Control and Prevention national high quality data standards, as well as gold certification from the North American Association of Central Cancer Registries. We believe the current TCR data completeness and quality enabled us to build our estimates based on both incident and prevalent cancer cases, which should greatly improve the quality of the cost estimates. This study was conducted by a team of researchers, led by Dr. Billy U. Philips, of the Department of Preventive Medicine and Community Health, University of Texas Medical Branch at Galveston. This report is the result of a lot of hard work by UTMB research team together with input, support and advice from the Texas Cancer Registry, Texas Department of State Health Services, Texas Comprehensive Cancer Coalition, and other agencies and organizations. We hope that you will find the report a valuable resource.

For more information regarding the Texas Cancer Registry, Texas Department of State Health Services, and the Department of Preventive Medicine and Community Health, University of Texas Medical Branch at Galveston, please visit: http://www.dshs.state.tx.us/tcr/default.shtm and http://www.utmb.edu/pmch/Departmental_Information.htm.

Acknowledgements

We acknowledge Dr. K. Robin Yabroff, Health Services and Economics Branch, Division of Cancer Control and Population Sciences, National Cancer Institute (NCI), for contributing data on estimates of monthly cost of care for elderly cancer patients.

We also acknowledge Paul Betts and Dr. Melanie Williams, Texas Cancer Registry, Cancer Epidemiology and Surveillance, Texas Department of State Health Services, for providing essential Texas Cancer Registry data to this study (for additional information about the Texas Cancer Registry, see Appendix A). Special thanks for the investment, dedication, and hard work of Texas's cancer registrars, health care facilities, cancer treatment centers, ambulatory surgery centers, pathology laboratories, and physicians responsible for cancer data collection across the state. We also acknowledge members of the Advisory Committee to the Texas Cancer Registry and Texas Comprehensive Cancer Control Coalition for their ongoing support and leadership. For a list of members and to learn more about these Committees visit: http://www.dshs.state.tx.us/tcr/actcr-portal.shtm and http://www.texascancercoalition.org.

We also want to express our heartfelt appreciation to those who had greatly support our study by providing important data elements or information. These include Dr. Eric A. Miller and Dr. David R. Risser from the Texas Cancer Registry, Karen Torges from the American Cancer Society (ACS) High Plains Division, Carol DeSantis from the ACS, Michelle Huddleston from the Cancer Prevention and Research Institute of Texas, Robert Snipes from the Texas Department of Transportation, Brenda Salisbery from the Texas Health and Human Services Commission, and Adam M. Clark and Amy Nunn from Lance Armstrong Foundation.

Lastly, we wish to thank the American Cancer Society (ACS) High Plains Division for the Texas cover art of this report.

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Executive Summary

Introduction

Cancer is a growing health concern in the United States. The financial burden of cancer affects not only cancer patients and their families, but also the society as a whole.

The cancer cost estimates are critical for legislators and stakeholders in the formulation of state cancer programs and policies. However, there has not been an estimate of the cost of cancer in Texas since 1998. The objective of this study was to estimate the economic impact of cancer in Texas for the year 2007. The study was initiated and funded by the Texas Cancer Registry (TCR) and conducted by a team of researchers, led by Dr. Billy U. Phillips, of the Department of Preventive Medicine and Community Health, University of Texas Medical Branch at Galveston.

Methods

We used recently published National Cancer Institute (NCI) methodology for costs of cancer care, in combination with standard methods for cost-of-illness evaluation for other cost component estimations. The TCR incidence data were used for the first time in estimating Texas cancer costs, since these data now meet national high quality data standards.

Results

Our estimates indicate that the total cost of cancer in Texas in 2007 was $21.9 billion. The direct cost was $10.0 billion, with $7.7 billion for cancer health care. The indirect cost of cancer due to morbidity and mortality was estimated at $11.8 billion. Cost of cancer-related programs in Texas from State Agencies, non-profits and foundations was approximately $78.5 million. This report also provides estimates of cost of cancer care for eighteen common cancers, as well as estimates of other cost components for the four most common cancers (colorectal, lung, breast and prostate cancer). When possible, costs are presented by Texas Health Service Regions.

Future Directions

Potential future directions for the cost of cancer project have multiple aspects that encourage collaborative contributions. First, the cost of cancer report can be updated annually or in a timely fashion to match emerging factors such as inflation, changes in mortality, and availability of more accurate data sources. Second, it is important to model the costs and benefits of screening and other cancer prevention. These include but are not limited to the estimates of efficacy, efficiency and effectiveness of cancer prevention and categorical estimates for specific diseases, such as breast cancer. Third, it is possible to link the cost estimation with Medicare claims and other data systems to maximize the research value of these data systems. If Texas statute is amended to allow for linkage of TCR data and Texas Health Care Information Collection (THCIC) data, further improvement in the cost estimation method can also occur. Finally, comparison studies are needed to investigate the economic impact and relative value of public, private and voluntary cancer control programs as well as the cost estimates of the Texas Cancer Plan.

Introduction

Dr. David C. Warner, of the University of Texas LBJ School of Public Affairs, led a research team in 2000 to estimate the costs cancer in Texas in 1998. They estimated the total cost in 1998 to be $14.0 billion, with $4.9 billion in direct costs and $9.1 billion in indirect costs due to lost productivity from cancer morbidity and mortality [1].

Costs have been increasing since 1998. Factors that contribute to the increased costs of cancer include (a) population growth, (b) aging of the population, (c) medical price inflation, and (d) the development of more advanced and more expensive treatments. As the growth of national health expenditures outpaces inflation and the growth in Gross Domestic Product [2, 3], cancer costs are expected to increase at a faster rate than overall medical expenditures [4].

National efforts to evaluate costs of cancer in recent years have been documented. For example, the National Institute of Health estimated the overall costs of cancer in the U.S. for 2007 at $219.2 billion, with $89.0 billion for direct costs of all health expenditures, $18.2 billion for indirect morbidity costs and $112.0 billion for indirect mortality costs [5]. In Texas, updated cost estimates are critical for the formulation of state cancer programs and policies. It is more reliable to evaluate cancer costs in Texas on the basis of state-level information, rather than simply calculated as a proportion of national costs because of the unique demographic structure (with a younger and large Hispanic population) of Texas [1].

In this study, we employed an approach adapted from recently published National Cancer Institute (NCI) methodology [6, 7] in combination with methods used by Warner et al. [1] to estimate the economic impact of cancer in Texas for the year 2007.

Background

Cancer is a growing health concern in the United States. An estimated 11.9 million Americans were alive with a history of cancer as of January 2007 [8]. Cancer has surpassed heart disease as the leading cause of death for the population under 85 years [9]. The financial burden of cancer affects not only cancer patients and their families, but also the society as a whole.

The total cost of cancer in Texas in 1998 was estimated to be $14.0 billion, with $4.9 billion in direct costs and $9.1 billion in indirect costs due to lost productivity from cancer morbidity and mortality [1]. Cancer treatment costs have increased dramatically in the past 10 years [10]. Therefore, updated cost estimates are needed in the formulation of state cancer programs and policies in Texas.

Costs of cancer include various components for both direct and indirect costs. The cost of medical care is the most important component of direct cost. Various methods can be used to produce cost estimates for cancer care [11]. For the 1998 cost estimates, Dr. Warner's team built a cost estimate for cancer care on the basis of best available information of various

medical care expenditures, including inpatient care, outpatient care, emergency services, home health care, hospice care and retail pharmaceuticals [1]. Alternatively, the cost of cancer care can be estimated using the methodology adapted from the recently published study from the National Cancer Institute (NCI) [6, 7]. That is, the cost of care in any given year can be determined by multiplying the cancer registry prevalence data by unit cost, specific to cancer site, stage and phase-of-care as described in Yabroff et al. [7]. In 2000, when Dr. Warner's team conducted the costs of cancer study, the Texas Cancer Registry (TCR) data were not complete or of sufficient quality for such estimation. The Texas Cancer Registry data currently meet Centers for Disease Control and Prevention national high quality data standards, as well as gold certification from the North American Association of Central Cancer Registries. Subsequently, these improved data can now be employed in the NCI methodology for estimating the cost of cancer care. The UTMB team evaluated the cost of cancer care based on the approach adapted from NCI methodology using Texas Cancer Registry data and retained the methodology of the Warner report for other components of cost.

Methods

Consistent with the Warner report [1], we estimated the costs of cancer in Texas in 2007 in a "bottom-up" fashion by estimating various cost components. For direct costs, we estimated costs of cancer care (including hospital care, outpatient care, physician billing, home health care, hospice care, and durable medical equipment), cancer screening and retail pharmaceuticals. For indirect costs, we estimated current year costs of lost productivity due to cancer morbidity, and present value of lost future productivity due to cancer mortality in 2007. Other related costs include the expenditures of state agencies, large non-profit associations and foundations.

Direct Costs

We employed various methods to estimate three facets of direct cost of cancer: (1) costs of cancer care; (2) costs of cancer screening; and (3) costs of retail pharmaceuticals.

Costs of Cancer Care: We adapted recently published NCI methodology from Yabroff et al. [7] to estimate the costs of cancer care. To summarize, it is a three step approach. First, we estimated the number of cancer cases in 2007 using Texas Cancer Registry (TCR) incidence data from 1997-2006. Then, the number of patients needing cancer related care in the year 2007 was determined by applying the survival probabilities to 2007 cancer cases of pertinent years. We also estimated to what extent each phase of care (initial, continuing and final phase) was utilized. The initial phase of care is defined as the first 12 months following diagnosis. The final phase is the final 12 months of life. And the continuing phase is the months between the initial and the final phases. Lastly, we applied a cost-per-unit matrix provided by Dr. Yabroff to the estimated cancer care utilization. All the calculations were stratified by Health Service Region (HSR), year of diagnosis, age of diagnosis, primary cancer site and stage. The total cost of cancer care was then estimated by recursively summing up costs across strata and sub-strata.

Step 1. To estimate the cancer cases in Texas in 2007

We obtained 1997 to 2006 data for incident cancer cases for Texas residents from the Texas Cancer Registry. Each record contains information on patient demographics (age at diagnosis, sex, race/ethnicity, HSR), cancer diagnosis (year of diagnosis, primary cancer site and stage) and vital status (vital status, cause of death, and date of death). There were 490,452 out of 867,701 (56.5%) cancer cases diagnosed in 1997 to 2006 alive as of December 31, 2006. The 2007 TCR incidence data have not been finalized. Therefore, we estimated 2007 cancer incidence using a linear trend method based on TCR 2001-2006 incidence data. By combining estimated 2007 cancer incident and prevalent cases, we estimated the number of cancer cases in Texas in 2007, stratified by HSR, year of diagnosis, age of diagnosis, primary cancer site and stage. The estimated number of cancer cases is conservative since it is known that under-reporting occurs for early stage cancers such as melanoma, prostate, and breast cancers.

Step 2. To estimate cancer care utilization in Texas in 2007

We employed the phase-of-care approach [7, 12, 13] to estimate cancer care utilization. Basically, the care for each cancer patient is divided into three phases: the initial phase (the first 12 months after diagnosis), the final phase (the final 12 months before death), and the continuing phase (all months between the initial and final phase). We obtained ten-year cancer survival probabilities by primary cancer site and stage from the American Cancer Society (ACS). Then, the months of care by phase in the year 2007 were determined by applying the survival probabilities to 2007 cancer cases diagnosed in pertinent years.

As an example, for cancer cases diagnosed in 1997, a number A_{1997} were alive as of December 31, 2006 based on vital status in TCR data. We estimated B_{1997} out of A_{1997} survived the year of 2007. This was calculated by $B_{1997} = A_{1997} \times (P_{10}/P_9)$, where P_{10} denotes the 10-year survival probability, P_9 denotes the 9-year survival probability, and (P_{10}/P_9) is the conditional probability that A_{1997} survived the year of 2007. Therefore, C_{1997} out of A_{1997} died during 2007, where $C_{1997} = A_{1997} - B_{1997}$. Assuming the deaths were evenly distributed in the year of 2007, the months of final phase of care equal $C_{1997} \times 6$, and the months of continuing phase of care equal $B_{1997} \times 12$. In the same manner, we calculated the months for continuing and final phases of care for cancers diagnosed in 1998 – 2006. Cancers diagnosed in 2007 only received initial or final phase of care. A_{2007} of cancers were diagnosed in 2007. B_{2007} survived the year of 2007. $B_{2007} = A_{2007} \times P_1$, where P_1 is the 1-year survival probability. C_{2007} out of A_{2007} died during 2007, where $C_{2007} = A_{2007} - B_{2007}$. Assuming both months of diagnosis and death were equally distributed in 2007, the months of final phase of care are equal $C_{2007} \times 6$, and the months of initial phase of care are equal $B_{2007} \times 6$.

Again, the estimations of months of cancer care by phase in 2007 were stratified by HSR, year of diagnosis, age of diagnosis, primary cancer site and stage.

Step 3. To estimate the cost of cancer care in Texas in 2007

We obtained a cost matrix that contains monthly cost of care estimates by primary cancer site, stage, and phase of care (see Appendix B for details). These cost estimates were compiled for the cost of cancer in Texas project by Dr. K. Robin Yabroff in the Health Services and Economics Branch at the National Cancer Institute, based on her published research [7]. Briefly, Yabroff et al. used SEER-Medicare data from 1999 through 2003 to estimate mean costs of cancer care by phase of care for 18 primary cancer sites and all remaining tumor sites combined. The costs included costs of inpatient hospital stays, outpatient visits, physician, hospice, home health care and durable medical equipment.

We applied the cost matrix to the estimated cancer care utilization from step 2, stratified by HSR, year of diagnosis, age at diagnosis, primary cancer site and stage. The total cost of cancer care was then estimated by summing up costs across all strata.

The TCR data were not complete enough in terms of case ascertainment and follow-up in 2002 when Warner et al. conducted the 1998 cost estimates. Therefore, they employed an approach which basically built a cost estimate for cancer care from the best available data for each cancer care component [Texas Health Care Information Council (THCIC) hospital discharge data for inpatient care, Medical Expenditure Panel Survey data for outpatient care and emergency services, National Association for Home Care data for home health care and Hospice care [1]]. The current TCR data completeness and quality enabled us to build our estimates based on both incident and prevalent cancer cases, which should greatly improve the quality of the cost estimates.

Another highlight of our methodology is the use of unit cost estimates from Yabroff et al. [7]. There are several advantages of these unit cost estimates. First, they were estimated from **actual payments** instead of charges. Second, they represent unit cost estimates of **all components** of cancer care, including inpatient hospital stays, outpatient visits, physician, hospice, home health care, and durable medical equipment.

Since the Yabroff et al. cost estimates were based on Medicare cancer patients, there is a concern that they might not be accurate for younger patients. On the one hand, younger cancer patients tend to seek more aggressive surgical and adjuvant treatments than older cancer patients [14-16], which increase the costs. On the other hand, younger cancer patients might have fewer comorbidities and complications than older cancer patients. Thus, the costs associated with management of comorbidities and complications will be lower. To evaluate the effect of age of cancer patients on cost of cancer care, we analyzed 2006 Medical Expenditure Panel Survey (MEPS) data and found that the average annual cost for younger (<65 years old) and older (65+ years old) cancer patients were very close ($10,583 for younger and $11,477 for older cancer patients). Hence, we used Yabroff et al. unit cost estimates for all cancer patients.

Costs of Cancer Screening:

We employed the same methodology used in Warner's report [1] to estimate the costs of cancer screening in Texas for 2007. Specifically, we used 2006 survey data from the Behavior Risk Factor Surveillance System (BRFSS) [17] to estimate the utilization rates of common cancer screening procedures in Texas. The included screening procedures are mammography for breast cancer, Pap smear for cervical cancer, prostate-specific antigen (PSA) test for prostate cancer, fecal occult blood test (FOBT), sigmoidoscopy and colonoscopy for colorectal cancer. The 2006 Texas BRFSS survey only contained questions on sigmoidoscopy and colonoscopy together ("Have you ever had sigmoidoscopy/colonoscopy?" and "What was the time since your last sigmoidoscopy/colonoscopy?"). To obtain separate screening rates for sigmoidoscopy and colonoscopy, the Warner et al.'s report employed a ratio of 6:1 in the estimation of cancer screening cost [1]. The colonoscopy rate has increased significantly since Medicare began to cover screening colonoscopies in 1998. Our analysis of 2005 National Health Interview Survey (NHIS) data showed that the ratio of sigmoidoscopy to colonoscopy was 1:4.5. We employed the ratio of 1:4.5 from 2005 NHIS data in our estimation because this is the latest available figure of colorectal cancer screening from either NHIS or BRFSS.

We then estimated the number of screening procedures performed in Texas in 2007 by multiplying the estimated screening rates from BRFSS by corresponding subgroups of 2007 Texas population estimates from the US Census [18] (mammography for females aged 40 and above, Pap smear for females 18 and above, PSA for males aged 40 and above, and FOBT, sigmoidoscopy and colonoscopy for both males and females aged 50 and above). We updated the 1998 unit procedure cost to 2007 unit cost using medical price inflation factors during 1998 – 2007 [19]. Lastly, we multiplied the estimated number of people who received each screening procedure by 2007 unit cost of the procedure. The overall costs of cancer screening were estimated by summing up the costs for all procedures.

Several methodological limitations need to be noted. First, the screening rates were estimated from a survey sample of health-related behaviors, and thus subject to recall bias. Studies have found that the self-reported screening rates tend to overestimate the actually screening rates [20]. Second, our cost estimates of cancer screening do not include costs of follow-ups after positive screening results, nor costs associated with complications following screening procedures. Third, some of the procedures might be performed for diagnostic purposes. This will result in double counting the costs for both costs of care and costs of screening. Moreover, it is difficult to determine the unit cost of clinical breast exam and digital rectal exam, thus the associated costs are not included in our cost estimates. Lastly, we did not include the cost of screening for skin cancer and other type of cancer for certain high risk groups.

Cost of Retail Pharmaceuticals:

We updated Warner et al.'s estimates on retail pharmaceuticals to the year of 2007. He estimated that the average per capita cost of retail pharmaceuticals was $693.34 in Texas in 1998 using data from Texas Vendor Drug Program. It also estimated that approximately 200,000 people received cancer treatments in Texas in 1998 using THCIC data. The increasing cost on pharmaceuticals is driven by the increase of both price and utilization [21]. The annual percent growth for prescription prices ranged from 1.7 to 4.3 percent during 1998-2007. And the annual percent growth for prescription utilization ranged from 2.6% to 9% during 1998-2007 [21]. Based on the annual percent growth rate for prescription price and utilization, we updated Warner et al.'s estimates of average per capita cost and the number of cancer patients who had cancer prescriptions. By multiplying the updated 2007 average per capital cost by updated 2007 utilization, we obtained the total cost estimates of retail pharmaceuticals.

Warner et al. [1] enlisted drugs that were used to obtain the 1998 retail pharmaceutical estimates, including oncology drugs and drugs to treat side effects. We acknowledge that new drugs have been developed and widely used since 1998. However, our methodology does not rely on a detailed list of cancer medications since cost increases associated with newly developed drugs have been embraced in the annual percent growth rate of prescription price.

Indirect Costs

For indirect costs, we estimated current year costs of lost productivity due to cancer morbidity, and present value of lost future productivity due to cancer mortality in 2007.

Cost of Morbidity: We previously estimated the number of prevalent and incident cancers in Texas in 2007 using TCR data when we estimated the direct costs associated with cancer care. To estimate the cost of morbidity, we need to estimate how many these cancers had employment or housekeeping disability. We first used 2007 data from the National Health Interview Survey (NHIS) to estimate the following rates for people aged 18-69 years and with a history of cancer: (1) unemployment rate due to cancer, (2) rate of employment but with work loss days in the past week due to cancer, and (3) rate of subjects engaged in housekeeping and not otherwise in the labor force. We then applied these rates to our estimated number of cancer cancers in Texas in 2007 to obtain the estimated number of people with a history of cancer and employment or housekeeping disability.

For people who had a history of cancer and were unemployed because of cancer in 2007, the associated costs were valued according to national average wage or salary income [22] plus an adjustment of 23 percent for fringe benefits, with further adjustment for labor participation rates. The 23 percent adjustment for fringe benefits was based on 2007 national income estimates from the U.S. Bureau of Economic Analysis [23]. We obtained labor participation rates in Texas from the US Census [24].

For individuals who had a history of cancer and employed but with work loss days because of cancer, the associated costs were valued similarly by 2007 national average income and 23% adjustment for fringe benefits (except no adjustment was made for labor participation rates).

For those who had a history of cancer and engaged in housekeeping and were not otherwise in the labor force, the associated costs were valued according to estimated values for housekeeping services, with adjustment for housekeeping rates in the general population from our analysis of 2007 NHIS data. The values for housekeeping services were estimated from a previous study [25] and inflated to 2007 dollar value by the Consumer Price Index [19].

The national cost values were adjusted downward with a factor of 0.94 to Texas on the basis of median household income [24]. All calculations were age and sex specific.

Cost of Mortality: We obtained 2001-2005 Texas population cancer mortality rates from the TCR. These were the most current mortality data available. We then estimated the number of cancer deaths in 2007 by applying the mortality rates to 2007 Texas population estimates from the U.S. Census [18]. Based on life tables for Texas [26], we estimated years of life lost due to 2007 cancer deaths. Each cancer death was assumed to incur lost wages, fringe benefits, and value of housekeeping from year of death to average life expectancy in Texas [26]. As was done for estimates for costs of morbidity, the costs of mortality were valued based on national average wage income and housekeeping value with a 0.94 downwardly adjustment to Texas values. Various other adjustments were also employed, including adjustment for (1) labor force and housekeeping participation rates, (2) 3% discount rate, and (3) 1% annual productivity increase rate. All calculations were age and sex specific.

Related Costs

We include the expenditures of state agencies, large non-profit associations and foundations in the category of related costs in contrast to the direct and indirect costs.

State Agency Budgets: We searched online and found the following Texas state agency cancer-related programs: the Texas Cancer Registry, the Breast and Cervical Cancer Service Program, the Texas Comprehensive Cancer Control Program, and the Tobacco Prevention and Control Program at the Texas Department of State Health Services (TDSHS); the Indigent Cancer Transportation Program at the Texas Department of Transportation; the Medical Transportation Program at the Texas Health and Human Services Commission for paid patient trips to oncologists; and the former Texas Cancer Council. We contacted related personnel of the programs to obtain the budget for fiscal year 2007 for each of these programs. Total state agency budget for FY2007 was obtained by adding up budgets of all cancer-related programs.

Nonprofits and Foundations: Similar to Warner et al.'s report [1], we also included non-profits and foundations with large expense in Texas whose identification and information was readily

available, and whose funding is not provided by another state agency or other non-profit or foundation. These include the Lance Armstrong Foundation (LAF), the Susan G. Komen Foundation, and the High Plains Division of the American Cancer Society. We contacted related personnel in each of these organizations and requested their 2007 expenses in Texas.

Items Not Included

For direct cost, we did not include the cost estimates for (1) cost of care for non-melanoma skin cancers and in situ cervical cancers, since they are not required to be reported to the TCR; and (2) costs of rehabilitation that were provided in settings other than inpatient and outpatient care. For indirect cost, we did not include (1) costs associated with pain and suffering to the patient and mental anguish to the family that need treatment; (2) costs of lost work by family members, relatives, and friends who provided care for cancer patients; and (3) costs of home modifications to accommodate disability. For related costs, we did not include municipal and county level agency budgets for cancer-related activities.

Results: Direct Costs

Cost of Cancer Care

We estimated that there were 490,452 prevalent cancer cases and 95,458 incident cancer cases in Texas in 2007. These cancer cases were associated with 814,224 months of initial phase, 5,147,100 months of continuing phase, and 314,754 months of final phase of cancer care in 2007. The estimated cost of cancer care in Texas in 2007 was $7.7 billion, with $2.1 billion for initial phase of care, $3.9 billion for continuing phase of care and $1.7 billion for final phase of care. The cost by primary cancer site indicates that approximately $1.0 billion were for lung/bronchus cancer, $1.1 billion for colorectal cancer, $955.5 million for prostate cancer, and $923.7 million for breast cancer (Table 1). Table 2 breaks down these costs by phase of care and Health Service Regions (HSR). Table 3 summarizes the cost of cancer care by primary cancer site and HSR. Map 1 shows the distribution of cost of cancer care by HSR. The health service region 3 and 6 had the highest cost in cancer care ($1.9 and $1.7 billion, respectively).

Table 1. Cost of Cancer Care in Texas, 2007

Cancer Site	Cost (unit = $1,000,000), by Phase of Care[$]			
	Initial	Continuing	Final	All Phases
Brain CNS	60.1	48.8	56.7	165.6
Breast female	272.9	548.8	101.9	923.7
Cervix uteri	30.2	35.2	12.1	77.4
Colorectal	296.1	590.4	170.9	1,057.3
Corpus uteri	50.5	59.6	16.9	127.1
Esophagus	23.2	23.0	34.8	81.0
Gastric	40.8	42.6	53.0	136.5
Head and neck	85.7	170.5	57.3	313.4
Leukemia	58.5	112.9	61.8	233.2
Liver and bile duct	32.8	34.8	62.3	129.9
Lung and bronchus	222.2	299.1	488.9	1,010.2
Lymphoma	128.8	222.5	64.2	415.4
Melanoma of skin	40.2	186.3	16.1	242.6
Ovary	58.6	50.9	30.0	139.4
Pancreas	34.7	28.1	105.3	168.1
Prostate	208.3	636.8	110.3	955.5
Renal	107.6	248.3	52.3	408.1
Urinary bladder	48.0	151.6	28.9	228.5
Other sites	304.2	443.4	138.8	886.4
All Cancer	**2,103.3**	**3,933.6**	**1,662.5**	**7,699.4**

[$] The initial phase of care is the first 12 months following diagnosis; the final phase is the final 12 months of life, and the continuing phase is all the months between the initial and the last year of life phases.

Table 2. Cost of Cancer Care in Texas by Phase of Care and Health Service Region (HSR), 2007

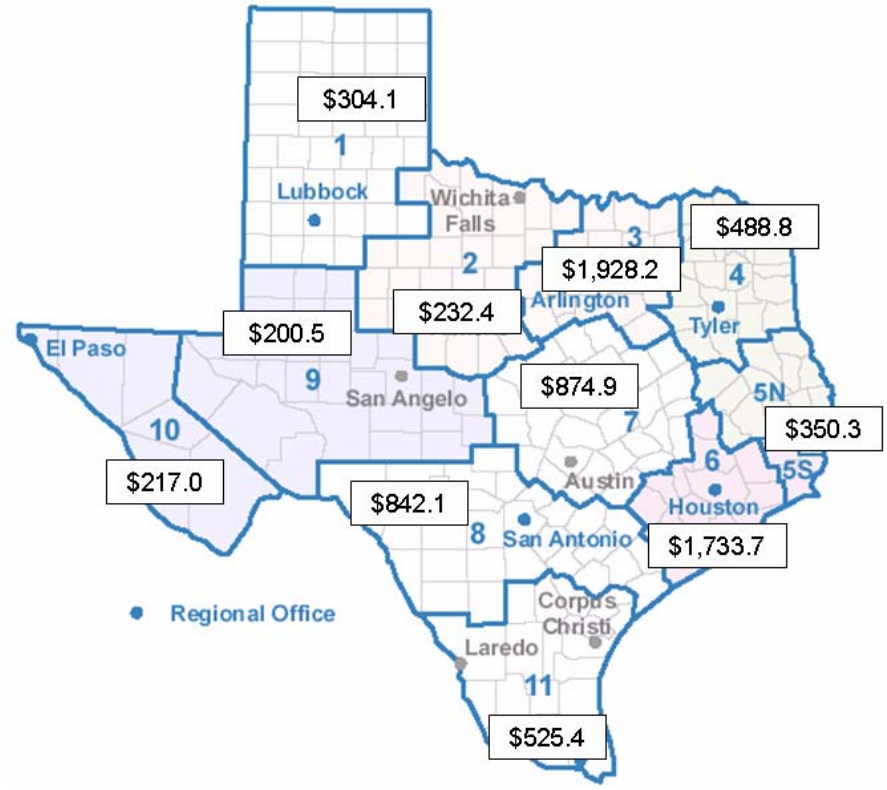
HSR	Cost (unit = $1,000,000), by Phase of Care[$]			
	Initial	Continuing	Final	All Phases
1	82.0	159.0	63.1	304.1
2	62.3	120.8	49.3	232.4
3	532.8	972.1	423.3	1,928.2
4	133.0	246.4	109.4	488.8
5	96.3	177.4	76.6	350.3
6	463.2	894.3	376.2	1,733.7
7	241.4	448.8	184.7	874.9
8	232.9	429.9	179.3	842.1
9	54.3	104.0	42.2	200.5
10	59.3	114.3	43.4	217.0
11	145.1	265.5	114.9	525.4

[$] The initial phase of care is the first 12 months following diagnosis; the final phase is the final 12 months of life, and the continuing phase includes all the months between the initial and the last year of life phases.

Table 3. Cost of Cancer Care in Texas by Primary Cancer Site and HSR, 2007

HSR	Cost (unit = $1,000,000), by Primary Cancer Site				
	All	Breast	Colorectal	Lung/Bronchus	Prostate
1	304.1	33.9	40.0	38.8	38.8
2	232.4	27.3	35.4	35.5	25.8
3	1,928.2	247.1	258.6	262.0	224.2
4	488.8	54.5	71.2	81.9	63.8
5	350.3	34.1	50.5	56.9	48.8
6	1,733.7	216.4	234.3	219.8	218.3
7	874.9	104.3	114.8	109.9	110.2
8	842.1	100.0	118.1	98.4	107.5
9	200.5	21.5	29.6	27.3	21.8
10	217.0	25.7	29.1	19.1	33.8
11	525.4	58.6	75.6	60.2	62.2

Map 1. Cost of Cancer Care in Texas by HSR, 2007 (all figures are in million dollars)



Cost of Cancer Screening

We estimated the rates of cancer screening procedures using Texas 2006 Behavior Risk Factor Surveillance Survey data. Among females aged 40 years and older, 55.4% reported having a mammogram in the past year. Applying this rate to the estimated Texas population size of females aged 40 years and older (5,014,973), we estimated that there were 2,778,295 women aged 40 years and older who had a screening mammogram during 2007. At an average cost of $152 [1, 19], the estimated cost of breast cancer screening was $422.3 million in Texas in 2007 (Table 4).

Three procedures are associated with colorectal cancer screening: fecal-occult blood test (FOBT), sigmoidoscopy and colonoscopy. Among persons aged 50 years and older, 13.2% reported having a FOBT in the past year and 15.7% reported having a signoidoscopy or colonoscopy in the past year. Approximately 815,876 persons aged 50 years and older had a FOBT in 2007, resulting in an estimated cost of $13.1 million using an average cost of $16 [1, 19]. Approximately 179,245 persons aged 50 years and older had a signoidoscopy in 2007, resulting in an estimated cost of $60.9 million using an average cost of $340 [1, 19]. Approximately 791,152 persons had a colonoscopy in 2007, resulting in an estimated cost of $1.1 billion using an average cost of $1,433 [1, 19]. The total cost of colorectal cancer screening is estimated to be $1.2 billion (Table 4).

Similarly, we estimated about $268.2 million for cervical cancer screening, $65.3 million for prostate cancer screening. Table 3 presents the details about these estimates. There is no routine screening for lung cancer for the general population. The total cost of cancer screening was estimated to be $2.0 billion in Texas in 2007 (Table 4).

Table 4. Cost of Cancer Screening in Texas, 2007

Screening in the past year	Screening Rate (%)	Population Estimate, 2007	Number Screened	Unit Cost ($)	Total Cost[§] (Unit = $1,000,000)
Mammogram (Female 40+)	55.4	5,014,973	2,778,295	152	422.3
PAP (Female 18+)	55.9	8,418,612	4,706,004	57	268.2
PSA (Men 40+)	39.7	4,568,027	1,813,507	36	65.3
FOBT (M&F 50+)	13.2	6,180,878	815,876	16	13.1
Colonoscopy (M&F 50+)	12.8	6,180,878	791,152	1433	1,133.7
Sigmoidoscopy (M&F 50+)	2.9	6,180,878	179,245	340	60.9
All Cancer Screening					**1,963.5**

[§]The total cost may not be equal to the number screened multiplying by unit cost due to rounding errors.

Cost of Retail Pharmaceuticals

Warner et al. had estimated that approximately 200,000 people received cancer treatments and the per capital cost of retail pharmaceuticals was $693.34, resulting in an estimated cost of $138.7 million of retail pharmaceuticals in Texas in 1998 [1]. The increasing cost of pharmaceuticals is driven by the increase of both price and utilization [21]. The annual percent growth for prescription price ranged from 1.7 to 4.3 percent during 1998 – 2007. And the annual percent growth for prescription utilization ranged from 2.6% to 9% during 1998 – 2007 [21]. The total annual percent growth rates were 12.7% in 1998-2003, 8.5% in 2003-04, 5.8% in 2004-05, 6.5% in 2005-06, and 7.4% in 2006-07 [21]. Applying these annual percent growth rates to cost estimates in 1998, we estimated that the cost of retail pharmaceuticals in Texas in 2007 was $334.5 million.

Summary of Direct Costs of Cancer in Texas, 2007

The estimates of various components of direct costs of cancer are summarized in Table 5. We estimate that the total direct cost of cancer in Texas in 2007 was approximately $10.0 billion, with $2.3 billion for colorectal cancer, $1.0 billion for lung cancer, $1.3 billion for breast cancer, and $1.2 billion for prostate cancer (Table 5).

Table 5. Summary of Direct Costs of Cancer in Texas, 2007

Cost Component	Cost (Unit = $1,000,000)				
	All Cancer	Colorectal	Lung	Breast	Prostate
Cancer care	7,699.4	1,057.3	1,010.2	923.7	955.5
Cancer screening	1,963.5	1,207.7	[§]-	422.3	268.2
Retail pharmaceuticals	334.5	-	-	-	-
Total	**9,997.4**	**2,265.0**	**1,010.2**	**1,346.0**	**1,223.7**

[§] There is no effect screening for lung cancer.

Results: Indirect Costs

Cost of Morbidity

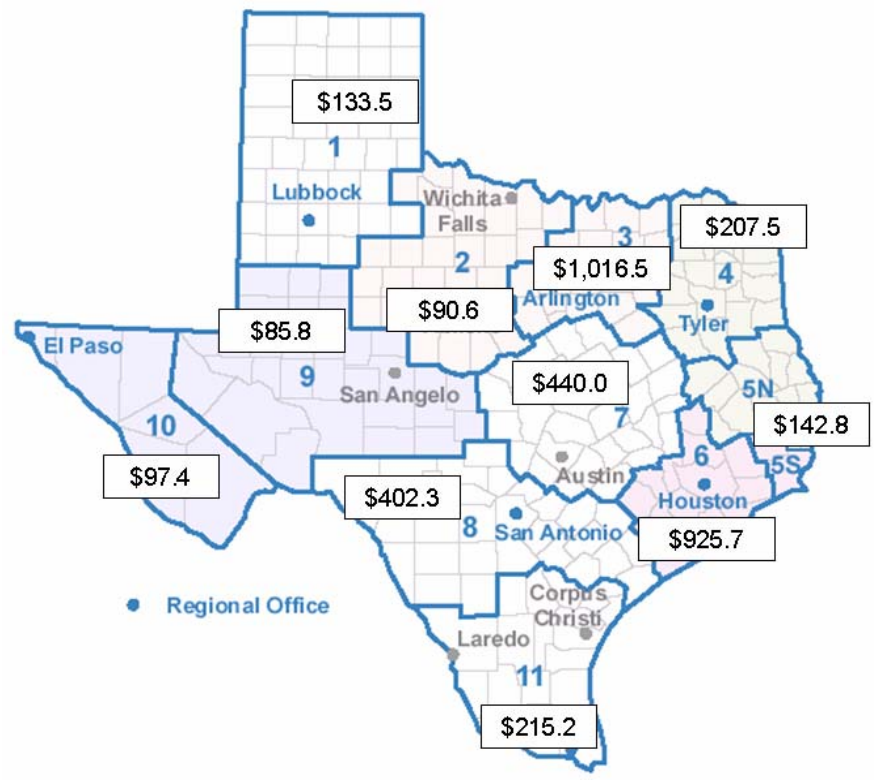
We estimated that the total cost of morbidity due to cancer was about $3.8 billion in loss of productivity, with $1.1 billion due to female breast cancer, $509.4 million due to colorectal cancer, $141.5 million due to lung/bronchus cancer and $823.7 million due to prostate cancer (Table 6). Map 2 shows the distribution of cost of cancer morbidity by HSR. HSR 3 had the highest cost of morbidity ($1.0 billion), followed by HSR 6 ($925.7 million).

Table 6. Costs of Cancer Morbidity in Texas by HSR, 2007

HSR	Unit = $1,000,000				
	All Cancers	**Breast**	**Colorectal**	**Lung/Bronchus**	**Prostate**
1	133.5	36.5	18.1	4.7	27.9
2	90.6	25.5	15.1	4.6	15.6
3	1,016.5	317.5	132.9	38.5	218.4
4	207.5	55.0	31.1	12.2	49.7
5	142.8	33.9	22.3	7.4	36.1
6	925.7	277.7	121.7	32.0	211.8
7	440.0	125.3	55.0	15.0	97.9
8	402.3	115.6	54.9	13.3	93.3
9	85.8	21.9	13.5	3.6	15.0
10	97.4	31.0	11.8	2.2	21.7
11	215.2	65.7	33.1	7.9	36.1
Texas (Total)[§]	**3,757.5**	**1,105.6**	**509.4**	**141.5**	**823.7**

[§] The total cost of cancer morbidity may not be equal to the sum of costs across HSRs due to rounding errors.

Map 2. Cost of Cancer Morbidity in Texas by HSR, 2007 (all figures are in million dollars)



Cost of Mortality

Using Texas 2001-2005 cancer population mortality rates and the 2007 estimated population size, we estimated that there were 36,588 cancer deaths in 2007. Among them, approximately 2,750 died of female breast cancer, 3,577 died of colorectal cancer, 10,684 died of lung/bronchus cancer, and 1,881 died of prostate cancer (Table 7). Table 7 also presents the detailed estimates of cancer deaths by age groups in Texas in 2007.

The total cost associated with the above cancer deaths were estimated to be $8.0 billion, with $997.9 million from breast cancer deaths, $794.7 million from colorectal cancer deaths, $2.2 billion from lung/bronchus cancer deaths, and $114.9 million from prostate cancer deaths (Table 7). Map 3 shows the distribution of cost of cancer mortality by HSR. HSR 3 and 6 had the highest cost of cancer mortality (approximately $2.0 billion for both HSR 3 and 6).

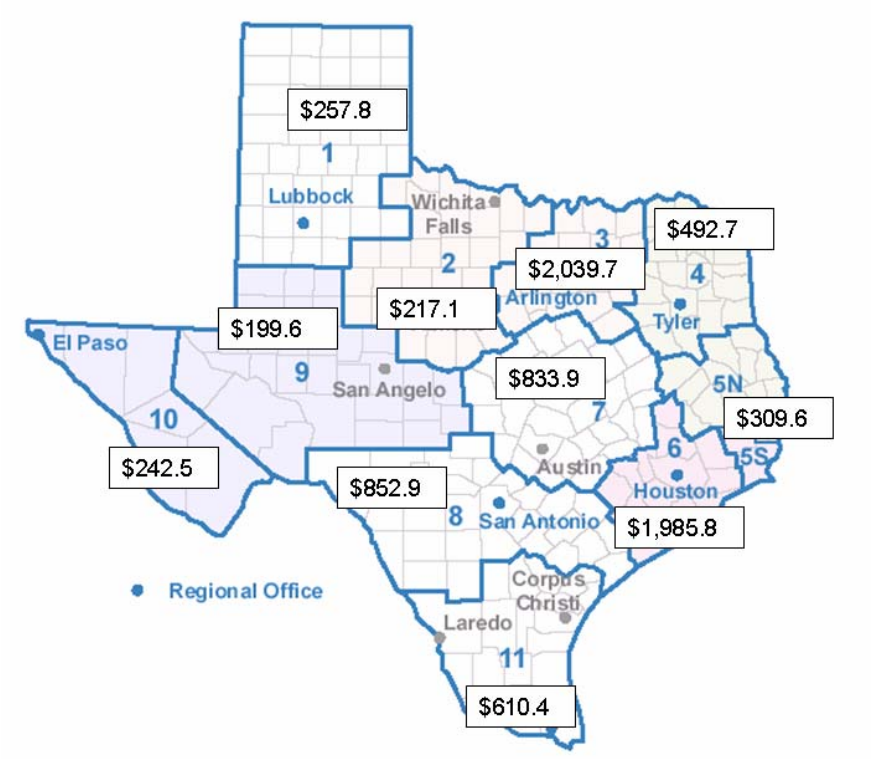
Table 7. Estimated Cancer Deaths in Texas by 5-Year Age Groups, 2007

Age Group	All Cancer Deaths	Breast	Colorectal	Lung/Bronchus	Prostate
0-4	38	0	0	0	0
5-9	44	0	0	0	0
10-14	51	0	0	0	0
15-19	73	0	1	1	0
20-24	95	1	3	1	0
25-29	123	8	8	4	0
30-34	197	28	15	7	0
35-39	379	63	38	29	0
40-44	793	131	72	134	2
45-49	1,497	204	142	319	7
50-54	2,369	282	227	564	23
55-59	3,361	337	303	960	57
60-64	4,220	315	369	1,414	103
65-69	4,500	270	383	1,623	158
70-74	5,069	270	430	1,793	258
75-79	5,289	273	494	1,719	349
80-84	4,634	245	492	1,265	388
85+	4,637	323	601	854	535
Total	**36,588**	**2,750**	**3,577**	**10,684**	**1,881**

Table 8. Cost of Cancer Mortality in Texas by HSR, 2007

HSR	Unit = $1,000,000				
	All Cancer	Breast	Colorectal	Lung/Bronchus	Prostate
1	257.8	26.1	28.9	66.8	3.7
2	217.1	19.9	21.6	73.2	2.6
3	2,039.7	236.7	198.4	582.6	26.5
4	492.7	41.1	53.4	168.6	7.0
5	309.6	30.4	29.6	107.4	5.9
6	1,985.8	262.3	198.7	545.0	31.6
7	833.9	91.3	81.5	243.6	12.3
8	852.9	117.6	85.5	198.6	11.8
9	199.6	22.4	19.9	59.4	2.6
10	242.5	54.5	21.8	37.7	4.0
11	610.4	95.6	55.8	135.3	6.8
Texas (total)	**8,042.0**	**997.9**	**794.7**	**2,223.2**	**114.9**

Map 3. Cost of Cancer Mortality in Texas by HSR, 2007 (all figures are in million dollars)



Results: Related Costs

There was $78.5 million in cancer-related expenses by identified State Agency, Non-Profits and Foundations.

State Agency Expenses

The expenses by identified cancer-related programs in several Texas state agencies were approximately $26.1 million in 2007. These include the Texas Cancer Registry with an FY07 expenditure of $5,470,212 [27], Breast and Cervical Cancer Service Program with FY07 budget of $7,536,000 [27, 28], Texas Comprehensive Cancer Control Program with FY07 expenditure of $500,000 [27, 29], Tobacco Prevention and Control Program with FY07 expenditure of $5.2 million [27, 30], Indigent Cancer Transportation Program with FY07 expenditure of $105,723 [31], Texas Cancer Council with FY07 expenditure of $3,255,350 [32], and the Medical Transportation Program at the Texas Health and Human Services Commission reported $3,997,930 in FY07 for paid patient trips to oncologists [33] (Table 8). Since most cancer-related programs address multiple or all cancers, the estimated state agency budgets cannot be reliably allocated to specific cancer sites (Table 9).

Non-Profits and Foundations

Although there are hundreds of non-profit organizations and foundations in Texas that fund cancer research and serve cancer patients and survivors in some capacity, it is difficult to calculate their associated financial costs.

In this study, we estimated a total of $52,419,534 from a few of the large non-profits and foundations in Texas (Table 9). These include (1) the Lance Armstrong Foundation (LAF), with 2007 expenses of $204,660 in Texas [34-36], (2) the Susan G. Komen Foundation, with 2007 expenses of $17,522,408 in Texas [37], and (3) the American Cancer Society, with $34,692,466 expenses in Texas in 2007 [38]. These costs could not be broken down by specific cancer types because most of the organizations are not specific to a particular type of cancer.

It needs mentioning that the reported $204,660 of LAF 2007 expenses in Texas contains only expenses on research funds and community programs in Texas. The other support services that LAF provides were not accounted for in our estimate because its administrative system made it difficult to get a monetary allocation for just Texas. These support services range from educational materials to clinical trial matching to direct personal services such as insurance assistance [34].

The reported $17,522,408 of Susan G. Komen Foundation 2007 expenses in Texas were program service expenses including research, public health education, health screening services and treatment services from its 13 affiliates in Texas (Austin, Central Texas, Dallas County, El Paso, Greater Amarillo, Houston, Lubbock, North Texas, San Antonio, Tarrant County, Texarkana, Tyler and Wichita Falls). Expenses in fund-raising and administration were not included [37].

Table 9. Summary of Related Costs of Cancer in Texas, 2007

Related Costs	FY07 Budgets/Expenses
State Agency Cancer-related programs	**26,065,215**
Texas Cancer Registry, Texas Dept. of State Health Services (TDSHS)	5,470,212
Breast and Cervical Cancer Service Program, TDSHS	7,536,000
Texas Comprehensive Cancer Control program, TDSHS	500,000
Tobacco Prevention and Control Program, TDSHS	5,200,000
Texas Cancer Council	3,255,350
Medical Transportation Program, Texas Health and Human Services Commission	3,997,930
Indigent Cancer Transportation Program, Texas Dept. of Transportation	105,723
Non-Profits and Foundations	**52,419,534**
LAF	204,660
Susan G. Komen Foundation	17,522,408
American Cancer Society	34,692,466
Total	**78,484,749**

Summary of Results: Total Costs of Cancer in Texas in 2007

The total estimated cost of cancer in Texas in 2007 was $21.9 billion, including direct costs of $10.0 billion, indirect costs of $11.8 billion, and $78.5 million related costs. Among the direct costs, $2.3 billion were for colorectal cancer, $1.0 billion for lung/bronchus cancer, $1.3 billion for breast cancer, and $1.2 billion for prostate cancer. Among the indirect costs, $1.3 billion were from colorectal cancer, $2.4 billion from lung cancer, $2.1 billion from breast cancer, and $938.6 million from prostate cancer (Table 10).

Table 10. Summary of the Cost of Cancer in Texas, 2007

Cost Component	Cost (Unit = $1,000,000)				
	All Cancer	Colorectal	Lung	Breast	Prostate
Direct Costs	**9,997.4**	**2,265.0**	**1,010.2**	**1,346.0**	**1,223.7**
Cancer Care	7,699.4	1,057.3	1,010.2	923.7	955.5
Cancer screening	1,963.5	1,207.7	-	422.3	268.2
Retail pharmaceuticals	334.5	-	-	-	-
Indirect Costs	**11,799.5**	**1,304.1**	**2,364.7**	**2,103.5**	**938.6**
Morbidity	3,757.5	509.4	141.5	1,105.6	823.7
Mortality	8,042.0	794.7	2,223.2	997.9	114.9
Related Costs	**78.5**	-	-	-	-
State agency budgets	26.1	-	-	-	-
Nonprofits and foundations	52.4	-	-	-	-
Total	**21,875.4**	**3,569.1**	**3,374.9**	**3,449.5**	**2,162.3**

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Appendix A: About the Texas Cancer Registry

The Texas Cancer Registry (TCR) is a statewide population-based registry that serves as the foundation for measuring the Texas cancer burden, health disparities, comprehensive cancer control efforts, progress in prevention, diagnosis, treatment, and survivorship, as well as supports a wide variety of cancer-related research. These priorities cannot be adequately addressed in public health, academic institutions, or the private sector without timely, complete, and accurate cancer data.

The TCR is the 4th largest cancer registry in the United States, and currently meets the National Program of Central Cancer Registries, Centers for Disease Control and Prevention high quality data standards and is Gold Certified by the North American Association of Central Cancer Registries. The long-term vision of the TCR is to collect and provide data that are equivalent in timeliness, completeness, and quality as those of the National Cancer Institute, Surveillance and Epidemiology End Results Program registries.

The ultimate goal and purpose of the TCR is to collect the highest quality cancer data that will contribute towards cancer prevention and control, improving diagnoses, treatment, survival, and quality of life for cancer patients.

The Texas Cancer Registry collects information such as the types of cancers that occur and their locations within the body, the extent of cancer at the time of diagnosis (disease stage), the kinds of first course treatment that patients receive, length of survival, and patient characteristics. These data are reported from various sources, including hospitals, cancer treatment centers, ambulatory surgery centers, pathology laboratories, and physician's offices, as well as supplemented through various data sharing efforts with other government data collection systems, such as vital statistics.

TCR data are available in a variety of publications and formats at the state, regional, and local community levels. To review or request TCR data, visit http://www.dshs.state.tx.us/tcr/, call 1-800-252-8059, 512-458-7523, or e-mail CancerData@dshs.state.tx.us.

Recognition of Texas Cancer Registry Funding Sources

Maintaining a statewide cancer registry that meets Centers for Disease Control and Prevention high quality data standards and North American Association of Central Cancer Registries gold certification is accomplished through collaborative funding efforts.

The Texas Cancer Registry recognizes the following whose financial support is essential to accomplishing the Texas Cancer Registry mission for our State, and maintaining the 4th largest cancer registry in the Nation.

Federal Grant Funding

- We acknowledge the Centers for Disease Control and Prevention for its financial support under Cooperative Agreement #U58/DP000824-02.

State Agency Funding

- Texas Department of State Health Services
- Texas Health and Human Services Commission

Academic Institutions

Through the Texas Higher Education Coordinating Board:

- University of Texas M.D. Anderson Cancer Center
- Baylor College of Medicine
- University of Texas Southwestern Medical Center at Dallas

Appreciation is also extended to the following academic institutions that provide funding and collaboration with the Texas Cancer Registry in support of regional registry operations:

- Texas A&M University
- University of Texas Health Science Center at Tyler
- University of Texas Health Science Center at San Antonio

Additional financial support is provided by:

- University of Texas Medical Branch at Galveston
- University of Texas Health Science Center at Houston
- Texas A&M University System Health Science Center
- Texas Tech University Health Sciences Center
- University of Texas at Austin
- University of Houston
- University of North Texas Health Science Center at Fort Worth
- Texas Tech University
- University of Texas at Arlington
- Texas State University - San Marcos
- University of Texas at Brownsville
- Texas Woman's University
- Texas Southern University
- University of Texas - Pan American
- University of Texas at El Paso
- Stephen F. Austin State University
- University of Houston - Clear Lake
- University of Texas at Dallas

Appendix B. Monthly cost of care by primary site, stage at diagnosis, and phase of care

Primary Site	Initial Phase of Care ($)				Continuing Phase of Care ($)				Final Phase of Care ($)			
	Local	Regional	Distant	Unstaged	Local	Regional	Distant	Unstaged	Local	Regional	Distant	Unstaged
Brain/ONS	—	—	—	6,042	—	—	—	819	—	—	—	7,035
Female Breast	1,240	1,960	2,783	1,994	326	516	733	525	2,867	3,164	4,101	3,377
Cervix	2,077	3,146	3,840	3,021	324	490	599	471	3,485	4,133	5,409	4,342
Colorectal	2,475	3,451	4,699	3,542	827	1,154	1,571	1,184	3,320	3,544	5,284	4,049
Corpus uteri	1,570	2,557	3,938	2,688	293	477	735	502	2,887	3,566	4,244	3,566
Esophagus	4,291	5,412	4,193	4,632	1,326	1,672	1,295	1,431	4,999	5,713	6,114	5,609
Gastric	3,745	5,206	4,846	4,599	1,008	1,401	1,304	1,238	4,697	4,995	7,030	5,574
Head and Neck	1,353	3,687	4,742	3,261	524	1,428	1,837	1,263	3,304	4,297	5,203	4,268
Leukemia	—	—	—	2,391	—	—	—	841	5,817	5,817	5,817	5,817
Liver	3,825	3,626	5,422	4,291	1,616	1,532	2,291	1,813	4,742	5,147	6,329	5,406
Lung	2,985	3,676	3,974	3,545	1,277	1,573	1,701	1,517	4,045	4,957	6,048	5,017
Lymphoma	—	—	—	2,805	—	—	—	789	4,829	4,829	4,829	4,829
Melanoma	701	1,356	2,302	1,453	470	910	1,545	975	2,855	2,990	4,368	3,404
Ovary	2,962	3,881	5,265	4,036	548	718	974	747	3,021	3,935	5,294	4,083
Pancreas	4,924	5,723	5,309	5,319	1,449	1,684	1,562	1,565	5,267	5,694	6,754	5,905
Prostate	1,297	1,297	1,527	1,374	568	568	669	602	3,281	3,281	3,566	3,376
Renal	2,517	2,762	4,095	3,125	1,165	1,278	1,895	1,446	3,774	3,900	5,066	4,247
Urinary/ Bladder	1,277	3,107	4,674	3,019	548	1,333	2,005	1,295	3,334	4,224	6,165	4,574
All Other	2,433	2,433	2,433	2,433	668	668	668	668	4,406	4,406	4,406	4,406

Notes:

1. These cost estimates have been compiled for the Cost of Cancer in Texas project from estimates obtained from Dr. K. Robin Yabroff, Health Services and Economics Branch, Division of Cancer Control and Population Sciences, National Cancer Institute (NCI).
2. Dr. Yabroff provided the cost estimates on the basis of the figures published in Yabroff et al, Cost of Cancer Patients in the United States, J Natl Cancer Inst, 2008; 100: 630-641.
3. Cost of care for "unstaged" is the average of cost for local, regional, and distant stages at diagnosis.
4. Cost estimates reflect Medicare payments in 2004 dollars.