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Estimating the Cost of Cancer Care for a State

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ABSTRACT
The National Cancer Institute (NCI) has developed a framework for estimating the cost of cancer care using linked data from Surveillance Epidemiology and End Results (SEER)-Medicare databases. However, for states that are outside of SEER areas and for those lacking cancer registry-claims linked data, using the NCI framework presents a challenge. We illustrate an adaptive use of the NCI method with Texas as an exemplar. We estimated that for 2007 the cost of cancer care in Texas was $7.7 billion; approximately $1.0 billion for lung/bronchus cancer, $1.1 billion for colorectal cancer, $955.5 million for prostate cancer, and $923.7 million for breast cancer. Our estimates include the cost of care associated with eighteen common cancer sites as well as costs for each Health Service Region (HSR) in the state. This study is the first to estimate cancer care costs using Texas Cancer Registry (TCR) incidence data, which currently meet national high quality data standards. The study demonstrates that it is feasible for a state to estimate the cost of cancer care using an adapted NCI method and state cancer registry data. This method can be used to examine issues related to cancer costs, including regional disparities in the cost of care.

INTRODUCTION
As the growth of national health expenditures outpaces inflation and the growth in Gross Domestic Product,[1] cancer costs are expected to increase at a faster rate than overall medical expenditures.[2] According to a National Institutes of Health analysis, national costs for cancer care was estimated to be 125 billion in 2010 and are projected to reach at least $158 billion (in 2010 dollars) – an increase of 27 percent over 2010.[3] Factors contributing to the increased cost of cancer care include: (a) population growth, (b) aging of the population, (c) medical price inflation, and (d) the development of more advanced and more expensive treatments.[2, 3]

In recent years, national efforts to evaluate the costs of cancer have been documented. For example, the National Institutes of Health estimated the overall costs of cancer in the U.S. for 2007 at $219.2 billion, $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.[4] Accurate cost estimates are critical at the state-level for the formulation of state cancer programs and policies. It is more reliable to evaluate cancer costs for a state based on state-level information, rather than a proportion of national costs because each state has a unique demographic structure (e.g. a younger population and a large Hispanic population in Texas).[5]

A variety of data sources and methods can be used to produce cost estimates for cancer care.[6] In 2000, at the request of the Texas Comprehensive Cancer Control Coalition, Dr. David C. Warner led a research team to estimate the cost of cancer in Texas for 1998. They built a cost estimate for cancer care based on the best available information related to various medical care expenditures. The data sources they used included: Texas Hospital Discharge data for inpatient care, Medical Expenditure Panel Survey data for outpatient care and emergency services, and Health Care Financing Administration and National Association for Home Care data for home health and hospice care.[5]

Newer methodologies developed by the National Cancer Institute (NCI) use cancer registry-claims linked data and should allow more precise estimates of the cost of cancer care.[7,8] That is, the cost of care in any given year can be determined by multiplying cancer prevalence by unit cost (or monthly net cost), specific to cancer site, stage and phase-of-care.[7, 8] 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. Currently, The TCR data meet the national high quality data standards of the Centers for Disease Control and Prevention, as well as the standards for gold certification from the North American Association of Central Cancer Registries.[9] Therefore, these data can now be employed in the NCI methodology for estimating the cost of cancer care.

Using Texas as an exemplar, the present study applied and evaluated the NCI method[7, 8] in combination with state-level cancer registry data to estimate the cost of cancer care for a state.

METHODS
Using a three-step approach, we adapted the NCI methodology[7, 8, 10] to estimate the costs of cancer care. First, we used TCR incidence data from 1997-2006 to estimate the number of prevalent and incident cancer cases in 2007. At the time of the study, vital statuses in the TCR data were complete to 12/31/2006. Prevalent cases were those who were diagnosed with cancer and were still alive as of 12/31/2006. The 2007 incident cases were estimated from the 2001-2006 TCR incidence data. The monthly vital statuses of these patients for 2007 and 2008 were estimated by applying conditional survival probabilities to all 2007 cancer cases according to their date of diagnosis.

In the second step, we estimated the extent to which 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 and the final phase is the last 12 months of life. The continuing phase includes the months between the initial and the final phases.[7, 8, 10 ,11] Figure 1 illustrates how we determined the months of care received for each phase for all cancer patients in the year 2007. For example, cancer cases diagnosed before 12/31/05 (A, B and C) only received continuing and/or final phase of care. Specifically, case A was predicted to be alive as of 12/31/08. We determined that case A received 12 months of continuing care during the study period (year 2007) since the study period began after the initial phase (first 12 months after diagnosis) and ended before the final phase (last 12 months before death). Case B was predicted to die of cancer in the middle of year 2008. We determined that case B received Bx months of continuing phase and By months of final phase of care, where Bx + By =12. Case C was predicted to die of cancer in 2007. We then determined that Case C received only Cx months final phase of care, where Cx<=12. Cancer cases diagnosed in the year 2006 (D, E and F) would have received initial+continuing phases of care (for case D, who was alive as of 12/31/08), initial+continuing+final phases of care (for case E, who died of cancer during 2008), and final phase of care only (for case F, who died of cancer in the year 2007). The incident cancer cases diagnosed in the year 2007 (G, H and I) would have received initial phase of care only (for case G, who was alive as of 12/31/08), initial+final phases of care (for case H, who died of cancer during 2008), and final phase of care only (for case I, who died of cancer during 2007) during the study period (Figure 1).

In the third step, we applied a matrix of monthly, phase-specific NCI estimates of net cost of care[8] to the estimated cancer care utilization. All computations were stratified by age, primary cancer site, cancer

stage, phase of care and Health Service Region (HSR). The total cost of cancer care was then estimated by summing up costs across strata.

RESULTS

Using 1996-2006 cancer incidence data from the TCR, 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 cancer care in 2007. The estimated cost of cancer care in Texas in 2007 was $7.7 billion: $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. Estimates of cost by primary cancer site indicate 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 1. Cost of Cancer Care in Texas by Primary Cancer Site, 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 final phases.

Figure 1. Months of Cancer Care Needed in the Year 2007, by Phase of Care

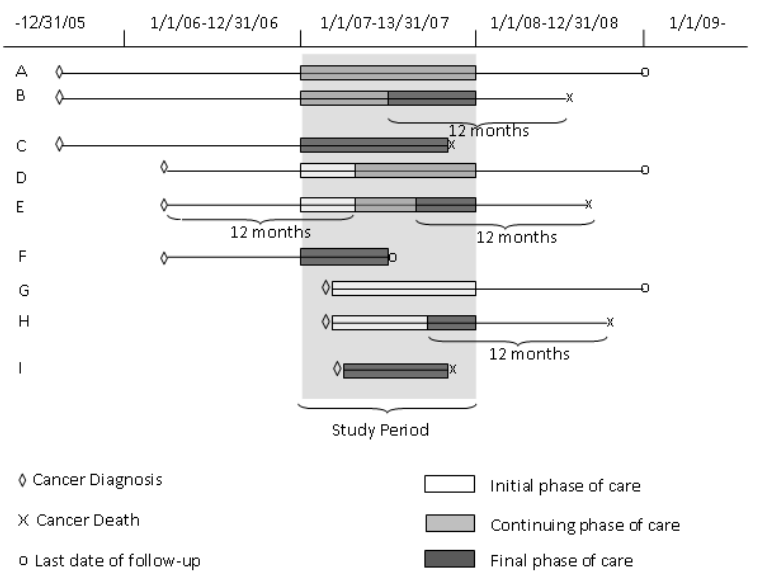
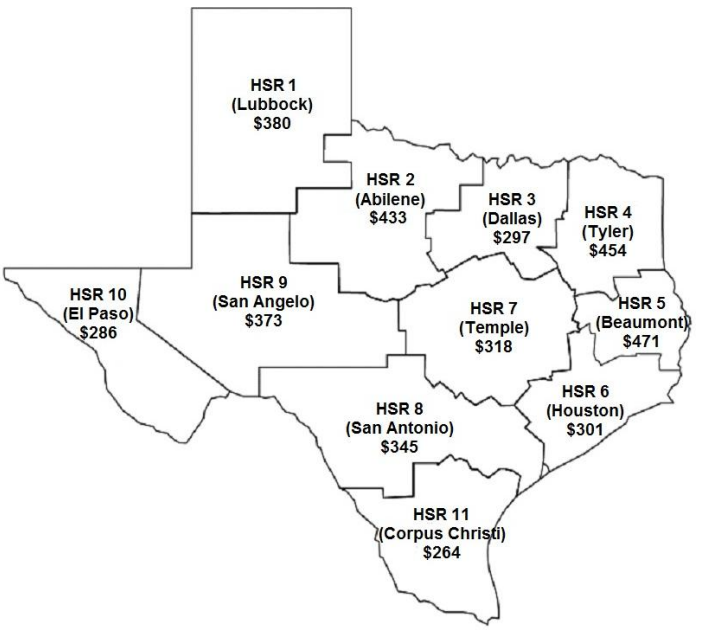


Table 2 breaks down these costs by the four most prevalent primary cancer sites (female breast, colorectal, lung and prostate cancer) and Health Service Region (HSR). There were significant variations in the cost of cancer care among HSRs. HSRs 3 and 6, which include Dallas and Houston, respectively, had the highest costs in cancer care ($1.9 and $1.7 billion, respectively). Figure 2 shows the distribution of per capita cost of cancer care by HSR. Each Texan spent between $264 (HSR 11) to $471 (HSR 5) for cancer health care during 2007. HSRs 4 and 5, which include Tyler and Beaumont, had the highest per capita cost of cancer care ($454 and $471, respectively).

Table 2. 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

Figure 2. Per Capita Cost of Cancer Care in Texas by HSR, 2007.



Note: We label each Health Service Region (HSR) with a well-known city name to make the figure more informative and user friendly.

DISCUSSION

The present study is the first to estimate the cost of cancer care using Texas Cancer Registry (TCR) incidence data, which currently meets national high quality data standards.[9] The study demonstrates that it is feasible for a state to estimate the cost of cancer care by using an adapted NCI method and state cancer registry data.

In 2002, when Warner et al. conducted the 1998 cost estimates, TCR data were not complete enough in terms of case ascertainment and follow-up. Therefore, they employed an approach which built a cost estimate for cancer care from the best available data for each cancer care component, including 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.[5] Current completeness and quality of the TCR data enabled us to build our estimates based on both incident and prevalent cancer cases. This should greatly improve the quality of the cost estimates.

There are several advantages to using NCI unit cost estimates[8] in estimating the cost of cancer care. First, the estimates were based on the Surveillance, Epidemiology and End Results (SEER)-Medicare linked data, which provide a longitudinal profile of cost across the whole trajectory of cancer treatment and are considered to be the best source regarding the cost of cancer care.[6, 11-15] Additionally, estimates

were based on actual payments rather than charges. Lastly, estimates represent all components of cancer care, including inpatient hospital stays, outpatient visits, physician, hospice, home health care, and durable medical equipment.

Several methodological limitations need to be noted for these estimates of the cost of cancer care. First, the NCI cost estimates were based on data for Medicare cancer patients and there is some concern that they might not be accurate for younger patients. On one hand, younger cancer patients tend to seek more aggressive surgical and adjuvant treatments than older cancer patients,[16-18] which increases costs. On the other hand, younger cancer patients might have fewer comorbidities and complications than older cancer patients, thereby reducing costs associated with management of comorbidities and complications. To evaluate the effect of patient age on the 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). This justifies our use of NCI unit cost estimates for all cancer patients. The second limitation is that the cost matrix is estimated from cancer cases in SEER areas, which might not be the same for cases in Texas.[15, 19] Future study to develop a Texas-specific cost matrix and compare it to the SEER-area cost matrix is needed. Lastly, we note that non-melanoma skin cancers and in-situ cervical cancers are not required to be reported to the Texas Cancer Registry. Thus, the corresponding costs for these cancers were not included in our estimates.

Cancer registry and claims data are among the best data resources for studies of the cost of cancer care.[11, 15] Adaptive use of the NCI method can address a variety of cancer related issues at both the state and national level. For example, cost of cancer reports can be updated regularly and in a timely fashion to in light of such emerging factors as inflation, changes in mortality, and availability of more accurate data. It is also possible and worthwhile to explore the extent of and reasons for geographic variations in the cost of cancer care. Additionally, the costs and benefits of screening and cancer prevention can and should be modeled. Applications 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. Finally, this method can be used in comparative studies to investigate the economic impact and relative value of public, private and voluntary cancer control programs as well as to estimate the cost of the Texas Cancer Plan.[20]

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