

## RESEARCH ARTICLE

# Costs During the First Five Years Following Cancer Diagnosis in Korea

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### Abstract

**Objectives:** We estimated the total medical costs incurred during the 5 years following a cancer diagnosis and annual medical use status for the six most prevalent cancers in Korea. **Methods:** From January 1 to December 31, 2006, new patients registered with the six most prevalent cancers (stomach, liver, lung, breast, colon, and thyroid) were randomly selected from the Korea Central Cancer Registry, with 30% of patients being drawn from each cancer group. For the selected patients, cost data were generated using National Health Insurance claims data from the time of cancer diagnosis in 2006 to December 31, 2010. The total number of patients selected was 28,509. Five-year total medical costs by tumor site and Surveillance, Epidemiology, and End Results (SEER) stage at the time of diagnosis, and annual total medical costs from diagnosis, were estimated. All costs were calculated as per-patient net costs. **Results:** Mean 5-year net costs per patient varied widely, from \$5,647 for thyroid cancer to \$20,217 for lung cancer. Advanced stage at diagnosis was associated with a 1.8–2.5-fold higher total cost, and the total medical cost was highest during the first year following diagnosis and decreased by the third or fourth year. **Conclusions:** The costs of cancer care were substantial and varied by tumor site, annual phase, and stage at diagnosis. This indicates the need for increased prevention, earlier diagnosis, and new therapies that may assist in reducing medical costs.

**Key words:** Prevalent cancers - stomach - lung - liver - breast - colon - thyroid - healthcare cost - Korea

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### Introduction

The overall prevalence and survival rate of cancer is increasing globally due to population aging, early detection of cancer, and the development of innovative therapeutics. However, the use of new, expensive antineoplastics and therapeutic techniques increases the cost of treatment (Jönsson et al., 2007; Meropol et al., 2007; Yabroff et al., 2007; Kimman et al., 2012). Cancer accounts for 13–17% of all disease burden and 4–7% of total global medical expenditure (Jönsson et al., 2007). In Korea, cancer has been the primary cause of death since 1997. The socioeconomic costs of cancer care are likely to increase in the future with expected increases in cancer prevalence and deaths due to cancer (National Cancer Center, 2008; Han et al., 2011).

Disease-specific estimates of direct medical costs are an issue upon which the fields of health care economics and health policy have continuously focused (Brown et al., 2001). They are not only helpful for allocation of resources and financial planning (Yabroff et al., 2008b),

but are also an essential element in calculating national health expenditures, allowing nations to evaluate the productivity of their health care delivery systems (Woodward et al., 2007). To manage health insurance spending efficiently and develop more effective health policies for cancer in the future, evaluating the current costs of cancer is critical.

The cost of cancer changes after the time of diagnosis. Many previous reports have used three time segments: an initial phase, from 6 months to 1 year after diagnosis; a terminal phase, from 6 months to 1 year before death; and a continuing phase, covering the period from the initial phase to the terminal phase. Graphs of cancer costs are U-shaped, with costs being highest in the initial phase, declining in the continuing phase, and increasing again in the terminal phase (Brown et al., 2002; Fireman et al., 1997; Taplin et al., 1995; Yabroff et al., 2007). Phase-specific cost estimates after cancer diagnosis are important because they can be used in the cost-effectiveness analysis of cancer control strategies, and notably, can help in the evaluation of prevention and

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**Table 1. Cost Per Patient (2006–2010) by Cancer Diagnosis (US \$)**

Cancer type	No. of patients (total 28,509)	Total medical cost	Insurer payment	Patient's co-payment	Pharmaceutical cost
Stomach cancer	7,223	12,577	11,253	1,319	1,462
Lung cancer	4,294	20,217	18,035	2,171	1,529
Liver cancer	3,961	19,059	17,120	1,983	1,359
Colorectal cancer	5,377	17,928	16,063	1,859	1,470
Breast cancer	3,055	18,242	16,423	1,819	3,310
Thyroid cancer	4,599	5,647	5,052	594	786

screening methods (Yabroff et al., 2008a).

Costs during the initial 5 years following diagnosis are becoming important because of extended patient survival as a result of better cancer diagnosis and treatment (Yabroff et al., 2008a). In 2006, the 5-year survival rate of patients with cancer was 68%, a 35% increase on 30 years previously (American Cancer Society, 2011). As the survival rate increases, the direct costs of the initial years following cancer diagnosis will also increase. Thus, it is necessary to evaluate the cost of the initial years annually by examining the survival pattern of patients with cancer.

Recently, with the expansion of computerization, health insurance claims data have been widely used globally to analyze treatment costs and as a basic resource for cancer management policy. As many nations continue to recognize the potential of computerization, the movement to use such data keeps spreading (Jung et al., 2011). Korea operates a universal coverage health insurance system that covers all Koreans. Korea's health insurance claims data include medical use data obtained from all hospitals, clinics, Oriental medicine centers, and pharmacies. In 2005, the percentage of computerized claims was 93.9% for inpatient services and 99.3% for outpatient services. The use of computerized data continues to grow (Kim, 2007). Accurate information can be obtained if computerized claims data are used in studies of cost.

This study aimed to estimate total medical costs in the 5 years following the diagnosis of cancer and annual medical use status by establishing a retrospective cohort using Korea Central Cancer Registry (KCCR) and National Health Insurance claims data. The study population consisted of persons who were newly diagnosed in 2006 with the six most prevalent tumors (stomach, liver, lung, colon, breast, and thyroid cancers). Data for each of these cancers were evaluated with the following objectives: to estimate 5-year total medical costs, insurer payments, patients' co-payments, and pharmaceutical costs following diagnosis; to evaluate 5-year total medical costs by cancer stage at the time of diagnosis; and to estimate annual total medical costs by procedure (e.g., surgery, chemotherapy, or radiotherapy).

**Materials and Methods**

This study is a retrospective evaluation of overall costs accrued during the 5 years after diagnosis among patients with cancer in 2006. Registration data on newly diagnosed patients and their data from the KCCR were

used in the study. From January 2006 to December 2006, new patients registered with stomach, liver, lung, breast, colon, and thyroid cancers were randomly selected from the KCCR, with 30% of patients being drawn from each cancer group, excluding patients with cancers of multiple origins. For the selected patients, cost data were generated using cancer-related medical use claims data from the National Health Insurance Corporation (NHIC). Claims data were collected from all health care institutions from the time of cancer diagnosis in 2006 to December 31, 2010. The total number of patients selected was 28,509.

In the present study, "cost" indicates direct medical costs that exclude indirect costs caused by cancer and non-covered out-of-pocket costs, such as patients' co-payments and insurer payments. We calculated all costs after adjusting for the annual variation in health insurance relative value scales during 2010. Total costs were estimated from all medical costs, including pharmaceutical costs, from the initial cancer diagnosis in 2006 to December 31, 2010. Presuming that patients used all prescribed medications, pharmaceutical costs were calculated based on health care institutions' prescription data. Since the health care institutions' prescription data only included medication lists, the previously fixed cost per pharmacy visit (Z1000), the basic dispensing cost (Z2000), the cost of medication counseling, the dispensing cost per prescribed date, and the cost for medication management were also considered.

The total medical cost was calculated from the time of cancer diagnosis in 2006 to December 31, 2010. Total medical costs, patients' co-payments, insurer payments, and pharmaceutical costs were analyzed for the six aforementioned cancers. For a maximum of 5 years during the follow-up evaluation, we used nonparametric Kaplan–Meier sample average estimator modeling techniques to analyze censored cost data (Lang et al., 2009). The Kaplan–Meier sample average estimator is known to minimize the bias associated with censored data by dividing the time period into short intervals (Lang et al., 2009). It is calculated using the following formula:

$$C^t = \sum_{t=1}^{60} P_t C_t$$

Where t is the post-index-date month, Pt is the survival probability, and Ct is the mean actual costs during period t among patients surviving to month t. In addition, we analyzed medical costs according to Surveillance, Epidemiology, and End Results (SEER) summary stage data from the KCCR. Cancer stage was

**Table 2. Cost Per Patient (2006–2010) by Cancer Stage (US \$)**

Cancer type	SEER stage	Total medical cost	Insurer payment	Patient's co-payment	Pharmaceutical cost
Stomach cancer	Total	12,577	11,253	1,319	1,462
	Localized	9,676	8,670	1,004	1,367
	Regional	17,245	15,441	1,799	1,887
	Distant	16,714	14,941	1,773	1,287
	Unknown	8,038	7,103	925	862
Lung cancer	Total	20,217	18,035	2,171	1,529
	Localized	19,234	17,156	2,052	1,565
	Regional	23,045	20,612	2,423	1,934
	Distant	21,522	19,191	2,324	1,650
	Unknown	14,519	12,899	1,618	862
Liver cancer	Total	19,059	17,120	1,983	1,359
	Localized	22,111	19,944	2,277	1,896
	Regional	17,097	15,274	1,825	870
	Distant	12,474	11,109	1,361	328
	Unknown	17,890	16,028	1,854	1,209
Colorectal cancer	Total	17,928	16,063	1,859	1,470
	Localized	10,866	9,732	1,130	1,114
	Regional	21,560	19,320	2,232	1,910
	Distant	27,374	24,548	2,825	1,386
	Unknown	12,068	10,720	1,346	846
Breast cancer	Total	18,242	16,423	1,819	3,310
	Localized	14,775	13,307	1,468	3,620
	Regional	22,649	20,401	2,248	3,133
	Distant	35,557	31,896	3,661	2,063
	Unknown	17,067	15,349	1,718	2,574
Thyroid cancer	Total	5,647	5,052	594	786
	Localized	4,936	4,417	519	780
	Regional	6,260	5,601	658	800
	Distant	11,409	10,194	1,215	1,058
	Unknown	5,763	5,153	610	777

divided into in situ, localized, regional, distant, and unknown. Using these classifications, total medical costs, insurer payments, patients' co-payments, and pharmaceutical costs were analyzed by cancer and stage. Next, annual total costs were analyzed after classifying patients by year of diagnosis. Since cost data consisted of claims data up to December 31, 2010, if a 5-year analysis were applied to new cancer patients as of 2006, the medical costs in the fifth year would be insufficient to analyze and bias would occur in the annual analysis. Therefore, annual cost analysis covered the period from initial diagnosis in 2006 until 2010 (4 years later). Patients who had incurred no cost during the 4-years were excluded from the annual cost analysis.

In addition, we estimated total medical costs and medical costs by procedure type [e.g., surgery, chemotherapy (in hospital or from a pharmacy), and radiotherapy] annually from the first year to the fourth year. Major clinical treatments after diagnosis included surgery, chemotherapy, and radiotherapy. Treatment codes were selected based on previous studies made through clinical consultation (Kim, 2010). In cases of antineoplastics, if the Korean Ministry of Health and Welfare listed the drug as an "antineoplastic," it was considered to be chemotherapy.

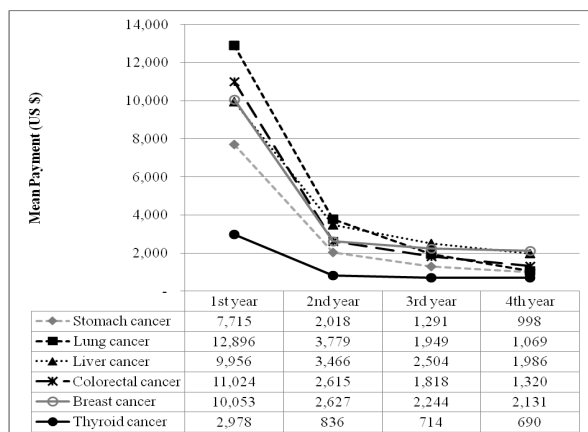
All medical costs were analyzed by type of cancer and cost per patient was calculated. Resulting costs in Korean Won (KRW) were converted into US dollars (\$) for broader comparison (\$1 = 1100 won).

## Results

The study's cohort consisted of 28,509 patients diagnosed with stomach, liver, lung, breast, colon, or thyroid cancer in 2006. Table 1 shows the number of patients selected and total medical costs from diagnosis to 2010 for each cancer group. The mean total medical cost per patient in the lung cancer group (\$20,217) was highest among the six cancer groups, followed by liver cancer (\$19,059), breast cancer (\$18,242), colorectal cancer (\$17,928), stomach cancer (\$12,577), and thyroid cancer (\$5,647). The breast cancer group showed the highest mean pharmaceutical cost per patient (\$3,310) over 5 years.

Table 2 shows medical costs per patient by cancer stage. Colorectal, breast, and thyroid cancer groups accounted for the highest costs for the distant stage. Notably, the thyroid cancer group accounted for \$4,936 in localized stage medical costs and about 2.3 times more in distant stage costs (\$11,409). In the colorectal cancer group, localized stage medical costs were \$10,866 and distant stage costs were 2.5 times higher (\$27,374). In the stomach and lung cancer groups, the costs were highest for the regional stage. In the liver cancer group, the cost was highest for the localized stage.

In an analysis of annual mean medical cost per patient, the lung cancer group showed total medical costs in the first year of \$12,896. Medical costs in the second year decreased to 29.3% of those in the first year and medical



**Figure 1. Annual Total Medical Cost of a Patient Diagnosed with Cancer in 2006**

costs for the fourth year were 8.3% of those in the first year. In the colorectal cancer group, the total medical cost in the first year was \$11,024, with the patient’s payment accounting for 10.5% of this cost. Total medical costs in the second year were 23.7% lower than those in the first year. The medical cost in the fourth year was 12.0% of that in the first year. In the breast cancer group, the first-year medical cost was \$10,053; the second-year medical cost was 26.1% lower than that in the first year. The medical cost in the fourth year (\$2,131) was 21.2% of that in the first year (Figure 1).

Mean medical cost per patient by year and treatment type was analyzed. In the stomach cancer group, the surgery cost for the first year was \$326 (20% of the overall treatment cost). Chemotherapy costs, including inpatient and outpatient costs, accounted for 79% of the treatment costs, with chemotherapy and radiotherapy costs increasing annually. In the lung cancer group, about

\$3000 was spent on chemotherapy during the first year. This represents 72% of the overall treatment cost. Over time, the absolute cost of chemotherapy decreased, but it accounted for an increasing proportion of the overall treatment cost. The proportion of surgery costs was higher in the liver cancer group than in the other cancer groups. The mean surgery cost during the first year in the liver cancer group was \$444. This represents 60% of the overall treatment cost. As with the other cancers, the proportion of the treatment cost that was due to surgery decreased over time. In the breast cancer group, the cost of chemotherapy in the first year was \$2436, the highest cost among the different treatment types. The absolute cost of chemotherapy decreased over time, but it accounted for over 90% of medical costs during the second, third, and fourth years (Table 3).

### Discussion

In the present study, we researched the total, annual, and stage-specific medical costs per patient for the six most prevalent cancers in Korea using representative national data.

During the 5 years following cancer diagnosis, total medical costs differed among cancer types, perhaps because disease prevalence, cancer stage at the time of diagnosis, and survival rate are reflected in the data. Among the six cancers, lung cancer sustained the highest medical costs. In previous studies, lung cancer also incurred high medical costs (Brown et al., 2002; Yabroff et al., 2008a; Tachfouti et al., 2012). This was due to nonspecific screening for lung cancer and its rapid progression, which means that its diagnosis occurs at a more advanced stage compared to other cancers. It thus

**Table 3. Annual Medical Cost by Procedure for a Typical Patient Diagnosed with Cancer in 2006 (US \$)**

Cancer Type		No. of Patients	Surgery (%)	Chemotherapy (%)		Radiotherapy (%)
				Medical Institutions	Pharmacy	
Stomach cancer	1st year	7,028	326 (20.0)	741 (45.3)	551 (33.7)	18 (1.1)
	2nd year	5,057	55 (7.1)	386 (49.5)	319 (40.9)	19 (2.5)
	3rd year	4,249	50 (10.8)	217 (47.2)	166 (36.1)	27 (5.9)
	4th year	3,722	42 (10.7)	160 (40.4)	168 (42.5)	26 (6.5)
Lung cancer	1st year	4,195	464 (11.3)	2,606 (63.6)	368 (9.0)	660 (16.1)
	2nd year	1,763	163 (4.3)	2,393 (63.0)	893 (23.5)	350 (9.2)
	3rd year	1,109	149 (5.0)	1,943 (64.9)	659 (22.0)	244 (8.2)
	4th year	799	111 (5.2)	1,415 (66.0)	409 (19.1)	208 (9.7)
Liver cancer	1st year	3,828	444 (60.5)	71 (9.7)	43 (5.9)	176 (24.0)
	2nd year	1,814	233 (53.2)	50 (11.5)	38 (8.7)	116 (26.6)
	3rd year	1,389	184 (47.9)	42 (10.9)	23 (5.9)	136 (35.4)
	4th year	1,098	226 (54.5)	38 (9.2)	27 (6.5)	124 (29.8)
Colorectal cancer	1st year	5,189	820 (21.9)	1,926 (51.3)	661 (17.6)	345 (9.2)
	2nd year	3,935	98 (8.8)	636 (56.6)	335 (29.8)	55 (4.9)
	3rd year	3,361	90 (12.7)	431 (60.9)	148 (20.9)	39 (5.6)
	4th year	2,916	84 (15.7)	297 (55.7)	120 (22.5)	33 (6.1)
Breast cancer	1st year	2,992	580 (13.4)	1,745 (40.2)	691 (15.9)	1,321 (30.5)
	2nd year	2,789	34 (2.4)	447 (32.4)	841 (60.9)	60 (4.3)
	3rd year	2,712	27 (2.7)	393 (38.9)	538 (53.3)	52 (5.1)
	4th year	2,581	32 (3.1)	345 (33.7)	606 (59.2)	41 (4.0)
Thyroid cancer	1st year	4,503	442 (84.2)	20 (3.8)	12 (2.2)	51 (9.8)
	2nd year	4,358	20 (32.3)	17 (27.3)	11 (17.1)	15 (23.2)
	3rd year	4,304	15 (29.4)	11 (22.8)	10 (19.3)	14 (28.5)
	4th year	4,220	17 (40.7)	7 (17.6)	11 (27.6)	6 (14.1)

incurs higher medical costs, with postoperative intensive care being a necessity (Brown et al., 2002; Bosanquet et al., 2004).

In addition, total medical costs for patients with cancer were highest during the first year following diagnosis and decreased by the third or fourth year. Medical costs for all cancers were higher during the first year compared to subsequent years. This supports previous findings. According to previous reports, medical costs associated with cancer were highest during the initial treatment period (Yabroff et al., 2007; 2008a; 2008b; Mohagheghi et al., 2011).

On the other hand, Brown et al. (2002) reported high costs during the first year, a subsequent decrease, and then an increase during years 3-5 because of metastasis, recurrence, and death. However, the present study showed that total costs continued to decrease after the second year following diagnosis. The difference is likely due to an increase in survival rates caused by the development of new therapeutics.

This study showed that the more advanced the stage was at the time of diagnosis of colorectal, breast, and thyroid cancer, the higher the total cost incurred. The thyroid cancer group showed the smallest cost among the six cancers, but large differences among stages. The stomach and lung cancer groups demonstrated the highest costs in the regional stage. Notably, in the liver cancer group, a higher cost resulted if a cancer was in the localized stage, rather than the advanced stage, at the time of diagnosis. The more advanced the cancer stage is, the higher the cost will be (Fireman et al., 1997; Lang et al., 2009; Yabroff et al., 2008a); however, in cancers that are difficult to diagnose at an early stage or that have relatively low survival rates, such as esophageal, gastric, lung, and pancreatic cancers, cost differences according to cancer stage at the time of diagnosis are small (Yabroff et al., 2008a). This supports the present study results, suggesting that early detection through screening is an important aspect of medical costs. Thus, discreet consideration according to cancer type and stage is needed at the policy-making level with respect to such items as support of medical expenses.

For most cancers, chemotherapy accounted for the largest cost in treatment type analysis. Considering better compliance and the introduction of expensive new chemotherapies, further analysis of the detailed components of the total cost according to cancer type is needed. In addition, given the dynamic nature of cancer therapy, which often includes the introduction of new policies and innovative therapies (Yabroff et al., 2008a), it is critical to monitor time trends in cancer medical costs by procedure (e.g., surgery, chemotherapy, radiotherapy, supportive care, and hospice care).

To date, few studies have reported on medical costs among patients with cancer in Korea. Furthermore, most studies have had several limitations, such as the inability to make comparisons among cancers (most were single-cancer studies), making observations over only a specific period such as a year, and not using national

data, but instead using single- or multiple-institution data. In particular, studies focusing on costs by cancer stage, annual analysis, and treatment procedure are very rare. This study's importance lies in its examination of 5 years of comprehensive cost analysis of the six most prevalent cancers in Korea by identifying a cohort. The present study also has several other advantages. First, it covered subjects of all ages. Previous reports from the United States used Medicare data, which only included patients over 65 years of age (Brown et al., 2002; Lang et al., 2009; Yabroff et al., 2008a). The cost of cancer differs according age (Brown et al., 2001; Warren et al., 2002), with younger patients tending to receive more aggressive therapy (Brown et al., 2002; Smith et al., 1995). The present study included younger patients, which allowed a more realistic cost analysis. Second, the present study used cancer registration data from the KCCR and NHIC claims data. The cancer registration data cover 97.2% of all patients with cancer in Korea (Jung et al., 2012), and the National Health Insurance covers all Korean people. Because the health care system is supported through a single insurance program, the health insurance claims data have high external validity as they cover all patients. In addition, Korea's universal health claims data were originally designed for medical cost reimbursement and include data from all pertinent health institutions, including those on medical treatments, medicines, and materials. These Korean data thus show high reliability in terms of cost data. Finally, this study demonstrated a change in the trend of the annual total cost of treatment over the 4 years following cancer diagnosis. Other studies analyzed only the first year, or a few periods prior to death. Annual analyses using large-scale data are very rare. The present study illustrates costs by stage and treatment procedure for the most prevalent cancers in Korea, and the trend of annual costs through prospective analysis of the cost fluctuation after cancer diagnosis.

In addition to its strength, this study has some limitations. First, total medical costs were calculated from health insurance claims data and excluded non-covered out-of-pocket costs. Additional investigation of medical costs not covered by health insurance is needed. Second, the cost of surgery may have been underestimated in the analysis because while selected treatment codes were applied for surgery, chemotherapy, radiotherapy with professional consultations, some codes such as anesthesia codes for cancer surgery were excluded from the analysis. However, this should not have affected the trend for the change in annual cost by treatment. Third, under a fee-for-service system, health insurance claims data were used as a proxy for medical claim costs. Thus, the low accuracy of diagnosis codes may have limited the analysis.

In 2004, the Korean government introduced a limited personal expense policy, which extended coverage of cancer-related services and decreased the co-payment rate from 20% to 10% beginning in 2005. In addition, the government has tried to reduce medical costs by implementing a rapid decision-making process with the

help of critical illness review committees. Committees are made up of appropriate medical societies and are tasked with reviewing the coverage of medications necessary for cancer treatment, such as antineoplastics (Kim et al., 2009). However, according to a health insurance patient investigation in 2006, the non-covered out-of-pocket costs are still high (21.7%) (Kim et al., 2008), and nonmedical costs of treatment, such as caregivers' costs, are not covered, worsening the economic burden for low-income patients. In the future, studies on out-of-pocket payments, including non-covered costs, are needed. Identifying which sector of the population incurs the highest cost burden will allow appropriate political support to be considered.

In conclusion, this study investigated the medical costs following diagnosis of major cancers in Korea using health claims data, subdivided by cancer stage, annual analysis, and cancer treatment. The economic burden of the six major cancers is considerable, increasing the need for new cost-saving approaches. For efficient medical spending on cancer, additional long-term research on the patterns use of antineoplastics and other medications and treatment outcome data are needed.

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