

ORIGINAL ARTICLE

Cost for treatment and follow-up of thyroid cancer increases according to the severity of disease

Soo Young Kim MD¹  | Seok-Mo Kim MD, PhD¹ | Hojin Chang MD¹ | Bup-Woo Kim MD¹ | Yong Sang Lee MD, PhD¹ | Soon-Sun Kwon PhD² | Hyunjung Shin PhD³ | Hang-Seok Chang MD, PhD¹ | Cheong Soo Park MD, PhD¹

¹Department of Surgery, Thyroid Cancer Center, Gangnam Severance Hospital, Institute of Refractory Thyroid Cancer, Yonsei University College of Medicine, Seoul, Korea

²Department of Mathematics/Data Science, Ajou University, Suwon, Korea

³Department of Industrial Engineering, Ajou University, Suwon, Korea

Correspondence

Hang-Seok Chang, Department of Surgery, Yonsei University College of Medicine, 211 Eonju-ro, Gangnam-gu, Seoul 135-720, Korea.
Email: surghsc@yuhs.ac

Funding information

National Research Foundation of Korea, Grant/Award Number: 2017R1E1A1A03070345; National Research Foundation of Korea (NRF), Grant/Award Number: 2017R1E1A1A03070345

Abstract

Background: The aim of this study was to provide an analysis of thyroid cancer-related health care costs over a 5-year period, according to the extent of thyroid surgery.

Methods: The study included 33 patients from our institutional database who underwent thyroid cancer surgery in 2010. Patients were divided into four groups based on surgical extent: (1) hemithyroidectomy, (2) total thyroidectomy, (3) total thyroidectomy with ipsilateral radical neck dissection, and (4) total thyroidectomy with bilateral radical neck dissection and mediastinal dissection. Costs for admission and outpatient follow-up for 5 years were analyzed.

Results: Costs for outpatient follow-up and admission, and overall cost increased with increasing stage of disease and increasing extent of thyroid surgery. Patients who underwent only hemithyroidectomy had the lowest costs for outpatient follow-up and admission, as well as the lowest overall cost.

Conclusion: Over the 5-year follow-up period, surgery performed at an early disease stage was the most cost-effective.

KEYWORDS

cost effectiveness, differentiated thyroid cancer, extent of surgery, healthcare cost, thyroid cancer

1 | INTRODUCTION

Thyroid cancer is the most prevalent cancer in Korea, and the incidence of thyroid cancer has increased steadily from 2.4% to 9.4% annually over the last three decades,^{1,2} with the increase being more pronounced in younger individuals.³ Similarly, the incidence of thyroid cancer has increased by almost 300% in the United States over the last 34 years.⁴

There are two explanations for this increase. One is that the increase in early detection of small cancers at a preclinical stage because of screening and development of diagnostic tools has resulted in increased rates of diagnosis of thyroid cancer.^{5,6} Another explanation is that the rate of thyroid cancer is truly increasing because of changes in radiation exposure, environment, diet, and lifestyle.^{7,8}

Despite its increasing incidence, the thyroid cancer-related mortality rate remains very low.⁹ Because of its low aggressiveness and mortality rate, the mortality costs are low, but the morbidity and direct costs have been increasing over the last few years. So, thyroid cancer has become a significant contributor to the economic burden of health care in Korea.³ The health care costs of thyroid cancer are substantial not only in Korea but also in the United States. Studies have shown that the societal cost of thyroid cancer could increase to \$3.5 billion by 2030 if the recent trend of increased incidence continues. The majority of the total cost comprises cost of initial treatment, including work-up, surgery, and adjuvant radioactive iodine (RAI) treatment, as well as continuing phases of therapy. With the projected

incidence and survival trends, costs will likely continue to escalate.¹⁰

Because Korea has the highest incidence of thyroid cancer in the world, the abovementioned findings have raised concerns about the potential causes of increased thyroid cancer-related health care costs and the financial burden that they will impose on the national health care system.¹¹ Therefore, in this study, we aimed to analyze the health care costs associated with thyroid cancer, according to the extent of thyroid surgery.

2 | MATERIAL AND METHODS

This study included 33 randomly selected patients from among 2120 patients with a diagnosis of papillary thyroid cancer (TPC) who underwent surgery at the Thyroid Cancer Center at Yonsei University College of Medicine between January 2010 and December 2010. Of the 573 hemithyroidectomy, 1220 total thyroidectomy, 166 total thyroidectomy with ipsilateral radical neck dissection patients, and 10 patients were selected randomly from each group. We included all three patients who underwent total thyroidectomy with bilateral radical neck dissection and mediastinal dissection. Written informed consent was obtained from all the patients. This study was approved by the ethics committee (IRB number 3-2016-0355).

Surgical extent was chosen according to disease severity. On the basis of surgical extent, we divided the 33 patients into four groups: (1) hemithyroidectomy ($n = 10$), (2) total thyroidectomy ($n = 10$), (3) total thyroidectomy with ipsilateral radical neck dissection ($n = 10$), and (4) total thyroidectomy with bilateral RND and mediastinal dissection ($n = 3$).

All patients were followed up postoperatively for 5 years, from 2010 to 2015. Outpatient follow-up was carried out according to our basic routine protocol: (1) an outpatient visit every 6 months for the first year, with an annual follow-up thereafter, (2) a thyroid function test at every visit, (3) annual sonography follow-up, and (4) a positron emission tomography-CT scan after 5 years. Patients were seen more frequently if indicated. Neck CT was performed if clinically indicated. The costs for the clinical examinations and surgery are shown in Table 1.

Patients who underwent total thyroidectomy or more than total thyroidectomy received RAI treatment if indicated. In advanced cases in which laryngeal nerve resection was necessary due to laryngeal nerve invasion of the tumor, patients were concomitantly followed up at the department of otorhinolaryngology.

We analyzed the cost of thyroid cancer treatment and follow-up, starting from the time of surgery.

Descriptive statistics were used to describe the basic characteristics of the five groups. We used Kruskal-Wallis test for continuous variables, and Pearson's chi-square test and Fisher's exact test for categorical variables. SPSS 23.0

TABLE 1 The costs of major clinical examinations and surgery

Item	Cost (Korean Won)
Thyroid U/S	32 160
Neck CT	114 310
PET-CT	334 830
Thyroid function test	54 240
131-Iodine therapy	41 810
I-131 scan	92 180
Hemithyroidectomy c CCND	705 960
Total thyroidectomy c CCND	1 026 220
Total thyroidectomy c CCND and ipsilateral RND	1 271 810
Total thyroidectomy c CCND and bilateral RND and mediastinal dissection	1 909 410

Abbreviations: CCND, central compartment neck dissection; PET, positron emission tomography; RND, radical neck dissection; U/S: ultrasound.

(SPSS, Inc, Chicago, Illinois) was used for the statistical analysis of patient data. All statistics were 2-tailed, and P values <0.05 were considered significant.

3 | RESULTS

THE clinicopathological characteristics of the patients are presented in Table 2. There were no significant differences in sex and age among the patients in the four groups. However, TNM staging was significantly different between groups (Table 2).

Analysis of cost of treatment was carried out in three subgroups: (1) cost of admission when surgery was performed, (2) cost of postoperative outpatient follow-up, including imaging studies and laboratory tests, and (3) cost of admission for reasons other than surgery, such as RAI treatment (Table 3). Significant differences were found between the four groups in the cost of admission for surgery. Cost of outpatient follow-up increased with increasing extent of surgery, with the highest cost incurred by the group of patients that underwent total thyroidectomy with bilateral RND and mediastinal dissection. Readmission for reasons other than initial surgery occurred more frequently in the other treatment groups than in the total thyroidectomy group, with the cost increasing with the extent of surgery.

Relative to the cost of hemithyroidectomy, total thyroidectomy had a 1.7-fold higher cost, total thyroidectomy with ipsilateral RND had a 2.5-fold higher cost, and total thyroidectomy with bilateral RND and mediastinal dissection had an 8.4-fold higher cost.

4 | DISCUSSION

The results of the present study show that costs of initial surgery and outpatient clinic treatment, and overall cost increase with increasing surgical extent and disease severity. Patients who underwent only hemithyroidectomy incurred the lowest costs for outpatient follow-up and admission, as well as overall cost. Patients who underwent total thyroidectomy with

TABLE 2 Clinicopathological characteristics

	Group I (n = 10)	Group II (n = 10)	Group III (n = 10)	Group IV (n = 3)	P value
Sex, females (% of total)	8 (80%)	8 (80%)	8 (80.0%)	1 (33.3%)	ns
Age, y ± SD	48 ± 7.0	46 ± 7.8	46 ± 9.7	58 ± 26.0	ns
TNM					<0.001
Stage I	10 (100%)	4 (40%)	5 (50%)		
Stage II					
Stage III		5 (50%)			
Stage IV		1 (10%)	5 (50%)	3 (100%)	

Abbreviations: Group I, hemithyroidectomy; Group II, total thyroidectomy; Group III, total thyroidectomy with ipsilateral radical neck dissection (RND); Group IV, total thyroidectomy with bilateral RND and mediastinal dissection.

TABLE 3 Analysis of health care costs by extent of surgical treatment

	Group I (n = 10)	Group II (n = 10)	Group III (n = 10)	Group IV (n = 3)	P value
Adm for OP	₩ 2847 ± 706	₩ 3366 ± 468	₩ 5746 ± 1045	₩ 17 382 ± 14 902	<0.001
OPD	₩ 2919 ± 884	₩ 4711 ± 621	₩ 5918 ± 1742	₩ 13 208 ± 6048	<0.001
Adm		₩ 1675 ± 1054	₩ 2668 ± 1342	₩ 18 066 ± 17 246	<0.001
Total	₩ 5766 ± 713	₩ 9753 ± 1395	₩ 14 333 ± 3310	₩ 48 657 ± 16 957	<0.001
Ratio	1:1	1.7:1	2.5:1	8.4:1	

Costs are shown in 1000 ₩ units.

Abbreviations: Adm, cost of admission for reasons other than surgery, for example, radioactive iodine treatment; Adm for OP, cost of admission when surgery was performed; Group I, hemithyroidectomy; Group II, total thyroidectomy; Group III, total thyroidectomy with ipsilateral radical neck dissection (RND); Group IV, total thyroidectomy with bilateral RND and mediastinal dissection; OPD, cost of outpatient follow-up.

bilateral RND, and mediastinal dissection showed highest costs.

In Japan, studies comparing the costs of active surveillance with those of immediate surgery have shown that the total cost of immediate surgery for the management of low-risk papillary microcarcinoma is about 4.1 times the total cost of active surveillance.^{12,13} As we do not perform active surveillance at our center, we were not able to perform a comparison with the cost of active surveillance in the present study. In addition, the study by Oda et al, which investigated the cost of active surveillance, did not include the cost of surgery and only included low-risk papillary microcarcinoma cases, whereas our study also included advanced and recurrent thyroid cancer cases. In advanced and recurrent thyroid cancer cases, which require radical neck dissection or mediastinal dissection, the cost of high-dose RAI therapy should be considered in addition to the cost of surgery and outpatient follow-up. In cases of low-risk cancer, hemithyroidectomy is usually performed; however, if the cancer advances, total thyroidectomy must be performed, which costs about twice as much as hemithyroidectomy, and active surveillance should be reconsidered in terms of cost effectiveness. A recent study showed that the health utility of active surveillance of individual patient and the remaining life expectancy of the patient after diagnosis are the key factors for cost-effectiveness of hemithyroidectomy. If the diagnosis of micro PTC is associated with even a modest decrease in quality of life, patients may benefit from early hemithyroidectomy as the cost-effective strategy.¹⁴

Analysis of post-thyroidectomy surveillance of low-risk, intermediate-risk, and high-risk patients has shown that costs

increase with an increase in risk. Recommended postoperative surveillance differ according to risk level which leads to an increase in cost mainly due to more frequent outpatient visits, laboratory testing, radioiodine treatment, and imaging studies. The surveillance cost of intermediated-risk and high-risk PTC patients was 1.4 and 2.3 times greater than the surveillance cost of a low-risk patient.¹⁵

Health care costs vary between different countries depending on surgical cost, imaging facilities, and hospital costs. A comparative analysis of the cost of thyroid cancer care between the United States and France showed that the cost of care in the United States was threefold greater than that in France, with the majority of the cost being attributable to hospital cost and nuclear medicine costs rather than the cost of the surgery itself.¹⁶ To determine if the rise in cost with increasing surgical extent found in the present study is applicable to the health care costs in the United States, we tried to extrapolate the cost by using reports^{10,16} of cost calculation for thyroid surgery. We found that, compared to the overall cost in Korea, the overall cost in the United States was much higher. The cost of hemithyroidectomy, total thyroidectomy, and total thyroidectomy with ipsilateral RND in the United States showed similar trends to the costs in Korea (data not shown).

The increase in thyroid cancer incidence in recent years has raised concerns regarding the expected increase in the financial burden imposed by the increased use of diagnostic tools to detect small tumors. This has led to consideration of reduction in ultrasound examination with subsequent surgery, unless clinically indicated.¹¹ A previous study found that, since the physician coalition's call to stop ultrasound

screening in March 2014, there has been a marked decrease of 35% in thyroid operations in Korea. Moreover, a 30% reduction in the incidence of thyroid cancer was estimated from insurance claims. The authors of that study concluded that the decrease in thyroid surgeries was not the result of more conservative surgical practices but rather the result of lesser screening, which led to a lower diagnosis rate.¹⁷

Cho et al showed that the incidence of tumors of large size and rates of lymph node involvement decreased significantly from 1962 to 2009. Furthermore, mortality and recurrence rates have decreased compared to those in the prescreening era.¹⁸ If the incidence of small cancers were increasing because of an early detection effect, the proportion of neck dissections would be expected to decrease. Results of a recent study conducted in Korea during 2007-2011 showed that although screening was performed, the proportion as well as the absolute number of neck dissections increased.¹⁹ The findings of these studies suggest that screening helps detect early cancer and decrease recurrence rates. As the numbers of neck dissections and thyroid cancer cases with lymph node metastasis have increased regardless of excessive screening, if screening is not performed, the incidence of advanced thyroid cancer will increase.

In the present study, TNM staging, and the costs of admission and follow-up increased with increasing surgical extent. Surgery at an early stage was most cost-effective approach over the 5-year period. The early diagnosis and treatment of thyroid cancer may have a cost-reducing effect on the overall health care costs of thyroid cancer.

This study has some limitations. Although the patients were selected randomly, the study was retrospective and only included patients from a single hospital. In addition, cost of active surveillance was not compared to surgery-related and treatment-related costs. Finally, because this study only included direct health care cost, societal costs such as costs of rehabilitation, traveling, and caregiving services were not included. Societal costs are likely to increase with increasing disease severity. In the future, a nationwide study should be conducted to investigate the cost of thyroid cancer treatment, including the social cost associated with thyroid cancer.

Our results show that costs for admission and follow-up increased with increasing surgical extent and disease severity. Over the 5-year follow-up period, surgery performed at an early disease stage was the most cost-effective.

ACKNOWLEDGMENTS

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (2017R1E1A1A03070345).

CONFLICTS OF INTEREST

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ORCID

Soo Young Kim  <https://orcid.org/0000-0002-8919-3456>

REFERENCES

- Oh CM, Won YJ, Jung KW, et al. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2013. *Cancer Res Treat*. 2016;48(2):436-450.
- Pellegriti G, Frasca F, Regalbuto C, Squatrito S, Vigneri R. Worldwide increasing incidence of thyroid cancer: update on epidemiology and risk factors. *J Cancer Epidemiol*. 2013;2013:965212.
- Lee KS, Chang HS, Lee SM, Park EC. Economic burden of cancer in Korea during 2000-2010. *Cancer Res Treat*. 2015;47(3):387-398.
- Davies L, Welch HG. Current thyroid cancer trends in the United States. *JAMA Otolaryngol Head Neck Surg*. 2014;140(4):317-322.
- Leenhardt L, Bernier MO, Boin-Pineau MH, et al. Advances in diagnostic practices affect thyroid cancer incidence in France. *Eur J Endocrinol*. 2004;150(2):133-139.
- Ahn HS, Kim HJ, Welch HG. Korea's thyroid-cancer "epidemic"--screening and overdiagnosis. *N Engl J Med*. 2014;371(19):1765-1767.
- Baker SR, Bhatti WA. The thyroid cancer epidemic: is it the dark side of the CT revolution? *Eur J Radiol*. 2006;60(1):67-69.
- Mangano JJ. A post-chernobyl rise in thyroid cancer in Connecticut, USA. *Eur J Cancer Prev*. 1996;5(1):75-81.
- Welch HG, Black WC. Overdiagnosis in cancer. *J Natl Cancer Inst*. 2010;102(9):605-613.
- Lubitz CC, Kong CY, McMahon PM, et al. Annual financial impact of well-differentiated thyroid cancer care in the United States. *Cancer*. 2014;120(9):1345-1352.
- Park S, Oh CM, Cho H, et al. Association between screening and the thyroid cancer "epidemic" in South Korea: evidence from a nationwide study. *BMJ*. 2016;355:i5745.
- Oda H, Miyauchi A, Ito Y, et al. Comparison of the costs of active surveillance and immediate surgery in the management of low-risk papillary microcarcinoma of the thyroid. *Endocr J*. 2017;64(1):59-64.
- Ito Y, Miyauchi A. Nonoperative management of low-risk differentiated thyroid carcinoma. *Curr Opin Oncol*. 2015;27(1):15-20.
- Venkatesh S, Pasternak JD, Beninato T, et al. Cost-effectiveness of active surveillance versus hemithyroidectomy for micropapillary thyroid cancer. *Surgery*. 2017;161(1):116-126.
- Wang LY, Roman BR, Migliacci JC, et al. Cost-effectiveness analysis of papillary thyroid cancer surveillance. *Cancer*. 2015;121(23):4132-4140.
- Finnerty BM, Brunaud L, Mirallie E, et al. Cost disparity between health care systems--it's not the surgeons: a cost analysis of thyroid cancer care between the United States and France. *Surgery*. 2016;159(1):132-140.
- Ahn HS, Welch HG. South Korea's thyroid-cancer "epidemic"--turning the tide. *N Engl J Med*. 2015;373(24):2389-2390.
- Cho BY, Choi HS, Park YJ, et al. Changes in the clinicopathological characteristics and outcomes of thyroid cancer in Korea over the past four decades. *Thyroid*. 2013;23(7):797-804.
- Sung MW, Park B, An SY, Hah JH, Jung YH, Choi HG. Increasing thyroid cancer rate and the extent of thyroid surgery in Korea. *PLoS One*. 2014;9(12):e113464.

How to cite this article: Kim SY, Kim S-M, Chang H, et al. Cost for treatment and follow-up of thyroid cancer increases according to the severity of disease. *Head & Neck*. 2019;41:2376-2379. <https://doi.org/10.1002/hed.25706>