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The effect of the Life-sustaining Treatment Plan
on healthcare expenditure and healthcare
utilization among cancer patients

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The effect of the Life-sustaining Treatment Plan on healthcare expenditure and healthcare utilization among cancer patients

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ABSTRACT

The effect of the Life-sustaining Treatment Plan on healthcare expenditure and healthcare utilization among cancer patients

Background: The medical costs of cancer treatment increase rapidly before diagnosis, decrease after diagnosis, following which they increase again rapidly, towards the end of life. Healthcare utilization also increases in the last months of life. The rights of patients to refuse life-sustaining treatment have been discussed, and the law to opt for our life-sustaining treatment have also been established. Terminally ill patients at the final stage of life choose to have in writing their Life-sustaining Treatment Plan (LSTP) to determine their end-of-life care process. This study investigated the effects of the Life-sustaining Treatment Plan on healthcare expenditure and utilization among patients who died from cancer.

Methods: The data for this study were obtained from the National Health Information DB, collected by the National Health Insurance Service of Korea, between 2018 and 2020. We included 23,494 participants who died from cancer after their propensity score matched a 1:1 ratio. Between the LSTP and control groups, healthcare expenditure and utilization were analyzed for the following three spans of time: 30 days, 60 days, and 90 days before death. The effect of LSTP on healthcare expenditure and utilization was examined by a regression analysis with

a generalized linear model. Subgroup analyses were conducted according to the cancer type.

Results: Among the 23,494 participants, 11,747 were in the LSTP group and 11,747 were in the control group. 11,301 (LSTP group: 5,740, control: 5,561), 5,173 (LSTP group: 2,680, control: 2,493), 3,005 (LSTP group: 1,567, control: 1,438) were alive for more than 30 days, 60 days, and 90 days, respectively. Compared to the control group, the LSTP group had a lower EXP(β) of 0.81 and 0.94 of total cost in the last 30 days of life (95% CI: 0.78-0.85) and in the last 60 days of life (95% CI: 0.90-0.99). Among the four life-sustaining treatments, CPR and chemotherapy cost and utilization were lower in the LSTP group than in the control group. However, the LSTP group had a higher EXP(β) of hospice cost and use in the last 30, 60, and 90 days of life.

Conclusions: This study found that the LSTP reduced healthcare expenditure and utilization in the last 30 days of life. However, we found an increase in the cost and use of hospice. As LSTP can reduce some healthcare expenditures and utilization, it is necessary to educate and promote the medical staff, patients, and their caregivers to prepare relevant LSTPs.

Key words: Life-Sustaining Treatment Plan (LSTP), Withdraw life-sustaining treatment, Healthcare expenditure, Healthcare utilization

I. Introduction

1. Background

In 2015, the average monthly medical expense paid for one year before the death of an adult aged 40 years or older in South Korea was ₩1,329,000, compared to ₩391,000 in 2005; this reveals an increase by approximately 3.4 times in the span of 10 years¹. A dying person's medical expenses increase towards the end of their life. As of 2015, the average monthly medical expense was ₩1,758,000 for six months prior to death, was ₩2,227,000 for three months before death, and ₩2,417,000 for one month before death. As death approaches, the higher pre-death medical expenditure is due to the development of medical technology, which increases the number of services, or due to the continuous service to patients provided by medical institutions².

The top ten causes of death, in descending order, were malignant neoplasms (cancer), heart diseases, cerebrovascular diseases, pneumonia, intentional self-harm, diabetes mellitus, chronic lower respiratory diseases, liver diseases, hypertensive diseases, and transport accidents in Korea, in 2016. The percentage of deaths caused by cancer was 27.8%. The number of deaths caused by cancer was 153 per 100,000 people³.

The medical cost of cancer patients has increased rapidly prior to diagnosis, declined after diagnosis, and then once again increased rapidly with approaching

death⁴. About half of all medical expenses in the last 6 months of the patients were incurred in the last 60 days of life, and about 30% of it in the last 30 days⁵.

The majority of cancer patients admitted to the ICU die before discharge, and if they survive hospital admission, they spend minimal time at home before their death. This limited survival is achieved at a considerable cost⁶. In addition, cancer patients who received palliative chemotherapy, visited the ER and were admitted to the ICU more frequently in their last month of life⁷. Patients and their family reported that the cost of care was a major financial burden, and some of them used most or all of their savings on medical expenses⁸.

The rights of patients to refuse various forms of medical care have been discussed with regard to end-of-life treatment⁹. In Korea, the National Assembly passed a legislation termed ‘The Law on the Hospice and Palliative Care and the Determination of Life-Sustaining Treatment for Terminally Ill Patients’ (Act No. 14013) (henceforth, ‘Determination of Life-Sustaining Treatment Act’) in January 2016, which allowed terminally ill patients to opt out of life-sustaining treatment. The Determination of Life-Sustaining Treatment Act came into effect in February 2018.

Although there were expectations that the Determination of Life-Sustaining Treatment Act would diffuse control in patients’ determination of treatment and results in terms of changes in the culture and practice of treatment at the end of life, there is insufficient discussion or research on the actual efficacy of the law.

It has been more than two years since the Determination of Life-Sustaining Treatment Act was enforced; we examined the differences in healthcare expenditure and healthcare utilization between the patient group that planned to withdraw life-sustaining treatment and the patient group that did not. Through this examination, we intended to provide evidence for the policy of withdrawing life-sustaining treatment.

2. Study objectives

The aim of this study was to investigate the effect of the Life-sustaining Treatment Plan (LSTP) on healthcare expenditure and healthcare utilization among patients who died from cancer. The detailed study objectives were as follows:

- (1) To investigate the differences in healthcare expenditure and healthcare utilization between patients who provided in writing their LSTP and those who did not.
- (2) To investigate the differences in healthcare expenditure and healthcare utilization between patients who implemented the LSTP and those who did not.
- (3) To investigate the differences in healthcare expenditure and healthcare utilization between patients who provided in writing their LSTP and patients who did not, stratified by cancer type.

II. Literature Review

1. Introduction to withdrawal of life-sustaining treatment

Life-sustaining treatment is any treatment that serves to prolong life without reversing the underlying medical condition, and includes CPR, mechanical ventilation, hemodialysis, antibiotics, palliative chemotherapy, etc. The appropriate use of life-sustaining treatment in patients nearing end-of-life is a controversial topic that continues to generate intense debate among the general population and experts ¹⁰.

The word ‘withholding’ appears to be used interchangeably with the word ‘withdrawing.’ There is no ethical or legal distinction between withholding and withdrawing treatment; on the other hand, caregivers experience a disturbing difference between the two practice ¹¹⁻¹³. Another perspective of clinical medicine suggests that withdrawing life-sustaining treatment is an act of commission irrespective of whether withholding life-sustaining treatment is an act of omission; additionally, death usually occurs more quickly from withholding life-sustaining treatment ¹⁴. Therefore, for many patients, family members and medical staff’s withdrawal of life-sustaining treatment results in a greater psychological burden ^{15,16}.

2. Legal and ethical considerations of withdrawing life-sustaining treatment

The legal and ethical issues associated with withdrawing life-sustaining treatment have been the subject of intense discussion. Proper and requisite care practices are based on an understanding of the concerned legal and ethical issues, as well as familiarity with the practical aspects of implementation ¹⁷.

The legality of withdrawing life-sustaining treatment differs among countries. In the United States and England, withdrawing life-sustaining treatment is legal, although each country has different approaches for the same ¹⁸. On the other hand, the legality of withdrawing life-sustaining treatment in developing countries, is uncertain ¹⁹. In Korea, the law related to the withdrawing of life-sustaining treatment was legislated in January 2016 and came into effect in February 2018. Even in countries where withdrawing life-sustaining treatment is legal, it has been found that clinicians' poor knowledge of the law is negatively associated with aggressive and unwarranted end-of-life treatment ²⁰.

The guidelines on who can decide to withdraw life-sustaining treatment in England accept the right of a mentally-competent patient to refuse treatment; however, both emphasize the physician's role as a decision-maker, especially in the case of an unconscious or otherwise mentally-incompetent patient ²¹. Other countries, such as North America, accept that the decision lies with a competent patient, or a family member in case of an incompetent patient ²².

The criteria for withdrawal of life-sustaining treatment also differ among countries. The central criterion for withdrawal of treatment is clinical futility. Futility can be defined as the relationship among effectiveness, benefit, and burden of the treatment question. Effectiveness, benefit, and cost are morally valid reasons for withdrawing treatment if the patient invokes treatment ²³. However, withdrawal of treatment for patients unable to make decisions, is questionable. In case of incapacity, current bioethical reflection favors the idea that physicians should liaise with a surrogate decision maker of the patient ²⁴. Legally recognized decision makers vary according to country.

Religious and cultural considerations also influence decisions to withdraw life-sustaining treatment. If patients or caregivers are uncertain, they adhere to the tenets of the patient's religion, and they may need to consult a religious representative within that tradition ²⁵.

Overall, it is important that both official policy and the existing practice of the healthcare system are consistent with the values of the people in the community ²⁶.

3. Withdrawing life-sustaining treatment directives overseas

1) United States

Advance directives (ADs) were developed to equip patients with control over their medical decisions by outlining their choices regarding end-of-life treatments. However, the usefulness of ADs was questionable, as AD alone has not been as effective as originally intended, in providing patients with control over their end-of-life treatment ²⁷. Therefore, in 1994, Oregon developed a form called Physician Orders for Life-Sustaining Treatment (POLST), which converts the patient's end-of-life care preferences into a medical order written by a physician with the concurrence of the patients' instructions for other healthcare providers—such as emergency personnel—on how to treat the patient under specific circumstances ²⁸. The differences between AD and POLST are outlined in Table 1.

Table 1. Differences between AD and POLST

Characteristics	AD	POLST
Target Population	All adults	For the seriously ill
Time frame	Current care	Future care
Responsibility of completing form	Patients	Health care professionals
Meaning	Living will	Medical order
Health care agent or surrogate decision-maker	Cannot complete	Can engage in discussion, if patient lacks capacity
Portability	Patient/family's responsibility	Provider's responsibility

The POLST specifies what a physician is expected to do in the following four categories of medical treatment: CPR, the level of medical intervention (comfort measures only, limited additional interventions, full treatment), antibiotic use, feeding tubes, and IV fluids (long-term or short-term).

Studies on AD and POLST mainly focus on the consistency of treatments given with POLST orders. In a study with 57 participants who completed POLST, in the last 2 weeks of their lives, care followed POLST instructions for CPR for 91% of participants, antibiotics for 86%, IV fluids for 84%, and feeding tubes for 94%. However, only 46% of cases were matched with POLST instructions regarding the level of medical intervention in severe illness²⁹. Another study suggests that consistency rates between treatments and POLST orders were high for resuscitation (98%), medical interventions (91.1%), and antibiotics (92.9%), and modest for feeding tubes (63.6%) in nursing homes³⁰. Other outcome variables such as cost, location of death, and ICU admission were also conducted.

The study of AD and the cost of terminal hospitalization suggests that patients without AD incurred total costs 1.35 times higher than those with AD [95% CI, 1.08 -1.73]³¹. A previous study indicates that individuals with POLST orders are more likely to die in a nursing home than in a hospital³². Among patients who were hospitalized six months before death, treatment-limiting POLST was associated with lower rates of ICU admission, compared with full-treatment POLST (aRR, 0.79 [95% CI, 0.71-0.87]). However, 38% of patients with treatment-limiting POLST received intensive care that was discordant with their POLST³³. For patients who were readmitted to the same hospital less than a month later, POLST forms were associated with a decrease in time to a DNR/I order being entered into the EMR. However, this reduction was only statistically significant among patients who were both unable to communicate and were not accompanied by a family member or proxy at the time of readmission³⁴. Table 2 delineates a summary of previous literature on withdrawing life-sustaining treatment in the United States.

Table 2. Summary of previous literature on withdrawing life-sustaining treatment in the United States

Year	Source	Summary	Outcome Variable
1994	Weeks WB, Kofoed LL, Wallace AE, Welch HG. Advance directives and the cost of terminal hospitalization. <i>Archives of internal medicine</i> 1994;154:2077-83.	Patients without ADs have significantly higher terminal hospitalization charges than those with ADs.	Healthcare expenditure
2000	Lee MA, Brummel-Smith K, Meyer J, Drew N, London MR. Physician orders for life-sustaining treatment (POLST): Outcomes in a PACE Program. <i>Journal of the American Geriatrics Society</i> 2000;48:1219-25.	Care-matched POLST instructions for CPR, antibiotics, IV fluids, and feeding tubes were more consistent than those previously reported for AD instructions but not matched for medical intervention.	Healthcare utilization
2011	Hickman SE, Nelson CA, Moss AH, Tolle SW, Perrin NA, Hammes BJ. The consistency between treatments provided to nursing facility residents and orders on the physician orders for life-sustaining treatment form. <i>Journal of the American Geriatrics Society</i> 2011;59:2091-9.	With the exception of feeding tubes and antibiotic use in residents with orders for no antibiotics, the use of medical treatments was nearly always consistent with POLST orders.	Healthcare utilization

2012	Hammes BJ, Rooney BL, Gundrum JD, Hickman SE, Hager N. The POLST program: a retrospective review of the demographics of use and outcomes in one community where advance directives are prevalent. <i>Journal of palliative medicine</i> 2012;15:77-85.	Individuals with POLST orders are more likely to die in a nursing home than in a hospital.	Healthcare utilization
2019	Turnbull AE, Ning X, Rao A, Tao JJ, Needham DM. Demonstrating the impact of POLST forms on hospital care requires information not contained in state registries. <i>PloS one</i> 2019;14:e0217113.	Among patients who wanted to avoid intubation and/or CPR, POLST forms were protective when the patient was unaccompanied and could not communicate.	Healthcare utilization
2020	Lee RY, Brumback LC, Sathitratanaheewin S, Lober WB, Modes ME, Lynch YT, et al. Association of physician orders for life-sustaining treatment with ICU admission among patients hospitalized near the end of life. <i>JAMA</i> 2020;323:950-60.	Treatment-limiting POLTS were associated with lower rates of ICU admission.	Healthcare utilization

2) England

Living wills have been replaced by the Advance Decision to Refuse Treatment (ADRT), which carries the legal force of the Mental Capacity Act (MCA) of 2005. ADRT enables someone aged 18 and over, while still capable, to refuse specific types of treatment at some time in the future, when they lack the capacity to make the decision themselves³⁵. The treatment that replaces or supports bodily functions are ventilation, CPR, and antibiotics. ADRT may also include assigning proxy decision-making powers through the lasting power of attorney (LPA).

A study, conducted before the MCA was enforced, suggests that a high percentage of patients admitted to the ICU had withdrawn life-sustaining treatment. Interestingly, there was considerable variation between units regarding the percentage of ICU deaths that occurred after the decision to withdraw treatment³⁶. Another study suggests that patients who withdrew life-sustaining treatment, experienced a longer length of stay in the ICU³⁷. However, these studies included 21 European countries, which indicates that patients with ADRT or LPA were partially involved. Table 3 shows a summary of previous literature on withdrawing life-sustaining treatment in England.

Table 3. Summary of previous literature on withdrawing life-sustaining treatment in England

Year	Source	Summary	Outcome Variable
2005	Wunsch H, Harrison DA, Harvey S, Rowan K. End-of-life decisions: a cohort study of the withdrawal of all active treatment in intensive care units in the United Kingdom. <i>Intensive care medicine</i> 2005;31:823-31.	High percentage of patients admitted to ICU withdrew life-sustaining treatment.	Healthcare utilization
2018	Guidet B, Flaatten H, Boumendil A, Morandi A, Andersen FH, Artigas A, et al. Withholding or withdrawing of life-sustaining therapy in older adults (≥ 80 years) admitted to the intensive care unit. <i>Intensive care medicine</i> 2018;44:1027-38.	Length of stay in the ICU by the patients with life-sustaining treatment withheld was a little longer than the other patients; however, it was still under three days, suggesting an early decision to limit life-sustaining treatment.	Healthcare utilization

3) Other countries

A retrospective study in Taiwan performed a comparative analysis of patients with and without life-sustaining treatment who died in the ICU. The results show that participants who decided to withdraw life-sustaining treatment experienced a longer stay in the ICU, than those who did not withdraw life-sustaining treatment (2.9 ± 7.1 vs. 8.4 ± 9.6 days; $p < 0.001$). The reduction in healthcare costs for patients who decided to withdraw life-sustaining treatment was \$3,467 [95% CI, 915–6019] ($p < 0.001$)³⁸. Another study of DNR in Taiwan suggests that DNR patients had significantly lower expenditure one year before death (\$67,553), compared to non-DNR patients³⁹.

A French observational study indicates that there was an association between withdrawing life-sustaining treatment and the final 30 days of mortality (hazard ratio (HR) 20.05 [95% CI, 15.58–25.79]). However, there was no association between withdrawing life-sustaining treatment and escalation of treatment (HR 1.14 [95% CI, 0.91–1.44])⁴⁰.

A summary of withdrawing life-sustaining treatment in other countries is shown in Table 4.

Table 4. Summary of previous literature on withdrawing life-sustaining treatment in other countries

Year	Source	Summary	Outcome Variable
2015	Lautrette A, Garrouste-Orgeas M, Bertrand P-M, Goldgran-Toledano D, Jamali S, Laurent V, et al. Respective impact of no escalation of treatment, withholding and withdrawal of life-sustaining treatment on ICU patients' prognosis: a multicenter study of the Outcomerea Research Group. <i>Intensive care medicine</i> 2015;41:1763-72.	No association between withdrawing life-sustaining treatment and escalation of treatment.	Healthcare utilization
2019	Cheng M-T, Shih F-Y, Tsai C-L, Tsai H-B, Tsai DF-C, Fang C-C. Impact of major illnesses and geographic regions on do-not-resuscitate rate and its potential cost savings in Taiwan. <i>Plos one</i> 2019;14:e0222320.	DNR associated with lower costs, one year before death.	Healthcare expenditure
2020	Chang H-T, Jerng J-S, Chen D-R. Reduction of healthcare costs by implementing palliative family conference with the decision to withdraw life-sustaining treatments. <i>Journal of the Formosan Medical Association</i> 2020;119:34-41.	Decisions to withdraw life-sustaining treatments significantly lowered healthcare costs.	Healthcare expenditure

4. Withdrawing life-sustaining treatment directives in Korea

1) Background

While confusion continued due to the lack of a clear law on terminating and suspending life-sustaining treatment of terminally ill patients, the ‘Madam Kim’ case came under scrutiny. Madam Kim, a patient suspected of having lung cancer, suffered internal bleeding while being examined for diagnosis. She suffered a cardiac arrest due to a blockage in breathing and suffered brain damage during resuscitation. The patient’s caregivers requested to remove the ventilator, but the hospital refused, and the patient’s caregivers filed a lawsuit. The Supreme Court ruled that discontinuation of life-sustaining treatment could be permitted based on the patient’s right to pursue human dignity, value, and happiness. Accordingly, the need to lay the groundwork for patients, their families, and medical staff to make rational decisions on withdrawing life-sustaining treatment was highlighted^{41,42}. In 2013, the Presidential Committee on Bioethics formed a special committee to discuss specific procedures and methods for withdrawing life-sustaining treatment and recommended the need to enact a special law on life-sustaining treatment, because social consensus refusing meaningless life-sustaining medical care had gradually been reached, since Madam Kim’s case.

Under the Determination of Life-Sustaining Treatment Act, withdrawing life-sustaining treatment began in February 2018, for institutions that set up an Ethics Committee, and were capable of providing all four life-sustaining treatments. Originally life-sustaining treatment included CPR, hemodialysis, chemotherapy administration, provision of a ventilator; since March 28, 2019, blood transfusion, extracorporeal circulation, and vasopressor were also included. The purpose of the act was to respect the patient’s right to self-determination, such as discontinuing meaningless life-sustaining treatment, especially if they were terminally ill and/or at the end stage of life, to establish the role of the medical staff, and come up with appropriate compensation plans. The terms of the Life-Sustaining Treatment Act are provided in Table 5 ⁴³.

Table 5. Terms of the Life-Sustaining Treatment Act

Terms	Description
Terminally ill patients	Patients who have been diagnosed as likely to die within a few months by the physician in charge and a physician specializing in the relevant field, as there are no possibilities of fundamental cure, and whose symptoms gradually worsen despite proactive treatment.
Patients at the end stage of life	Patients who have received a medical evaluation from the physician in charge and a physician specializing in the relevant field as being in a state approaching imminent death; there is no possibility of revitalization or recovery despite treatment, and patients’ symptoms worsen rapidly.
Life-sustaining treatment	Medical treatment by cardiopulmonary resuscitation, hemodialysis, administration of anticancer drugs, mechanical ventilation, and other medical treatments prescribed by the presidential decree, to a patient at the end of life, which only prolongs the duration of the end of life without curative effects.

Anyone aged 19 years or older can prepare an AD on life-sustaining treatments even if they are in good health. However, people are required to go to the registration agencies of ADs designated by the Ministry of Health and Welfare and complete the form after receiving sufficient explanations to make it legally valid. The Life-sustaining Treatment Plan (LSTP) is a written form of AD for people who have been diagnosed or assessed as terminally ill or at the end stage of life by the concerned physician and a specialist physician at a medical facility where an ethics committee has been established. The differences between AD and LSTP are shown in Table 6 ⁴⁴.

Characteristics	AD	LSTP
Target Population	Adults aged 19 or older	Terminally ill patients or patients at the end stage of life.
Prepared by	Patient himself or herself	Prepared by the physician in charge upon request of the patient
Explained by	Counselor	Physician in charge
Registration	Registry Agencies designated by the Ministry of Health and Welfare	Medical Institution with registered Ethics Committee

2) Life-Sustaining Treatment Plan

The target population consists of patients diagnosed as terminally ill patients or those at the end stage of life by the physician in charge and a specialist of the concerned field. Therefore, the patient should first consult a physician to see if they are eligible for the preparation of the LSTP. A detailed description of the target population of the LSTP is described in Table 7 ⁴⁵.

	Terminally ill patient	Patient at the end stage of life
Disease	<ul style="list-style-type: none"> • Cancer • AIDS • Chronic obstructive respiratory disease • Chronic hepatic cirrhosis 	No restrictions
Condition	The patient is expected to die within a few months as there is no possibility of fundamental recovery, and patient's symptoms gradually worsen despite proactive treatment.	The patient is in a state of near death, in which there is no possibility of revitalization or recovery despite treatment, and symptoms rapidly worsen.
Confirmation	<ul style="list-style-type: none"> • Clinical symptoms • Existence of other diseases or illnesses • Degree of improvement per drug administration or procedure • Progression of previous medical treatment • Diagnosed by the concerned physician and a specialist of the relevant field, taking into account the overall possibility of other treatments. 	Assessed by the physician in charge and one medical specialist of the relevant field.

3) Withdrawing life-sustaining treatment

There are three necessary steps for withdrawing life-sustaining treatment. The first step is to ascertain whether the patient is at the end stage of life. The physician in charge and a specialist physician in a medical institution with an ethics committee should assess the patient in a state of near death, in which there is no possibility of revitalization or recovery despite treatment, and patient's symptoms are worsening rapidly. The second step is to verify the decisions of the patient or the patient's family. The patients or their family members must express their opinion on withdrawing life-sustaining treatment, which must be verified by the physician in charge and/or a specialist doctor. Third, the withdrawal of life-sustaining treatment is executed. The procedure of withdrawing life-sustaining treatment is shown in Figure 1 ⁴⁶.

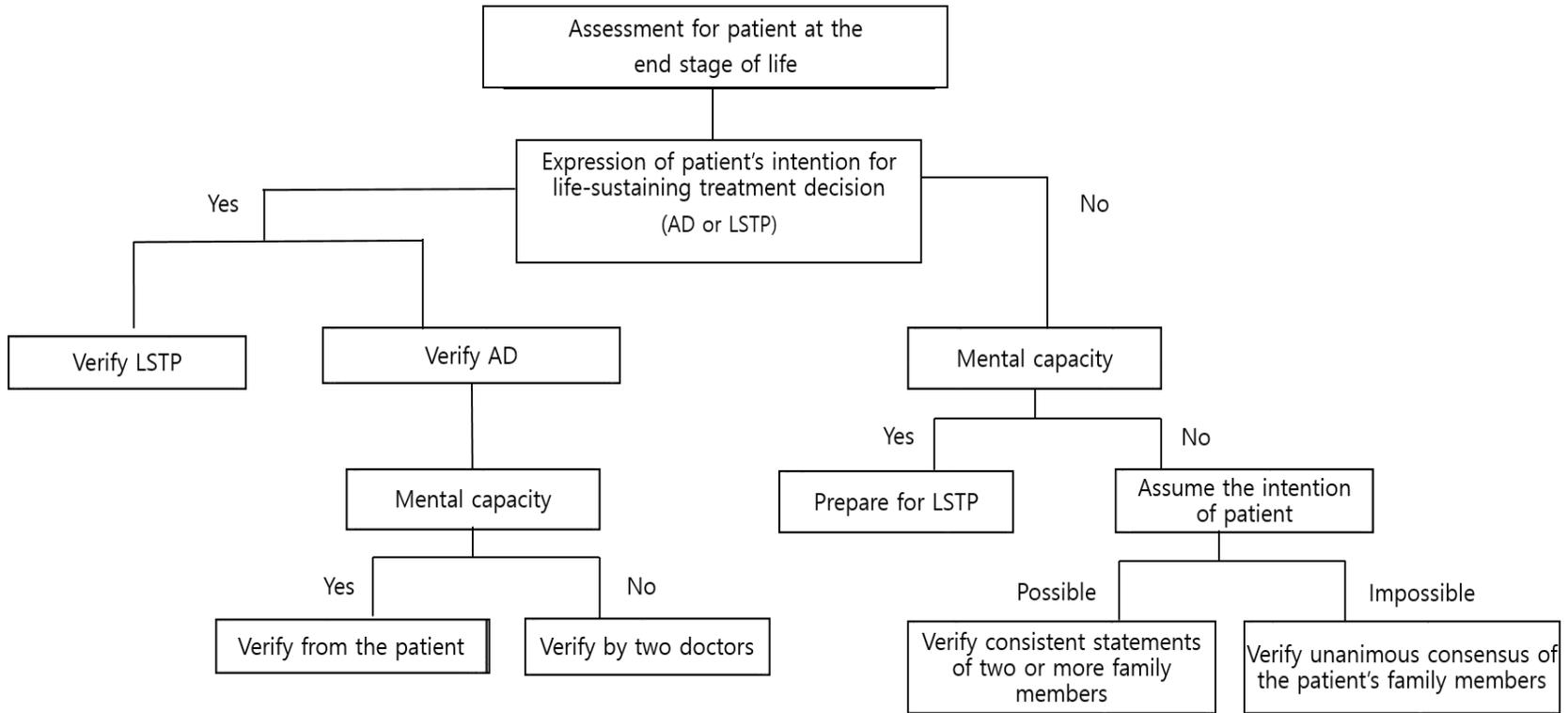


Figure 1. Procedure of withdrawing life-sustaining treatment

III. Material and Methods

1. Framework of the Study Design

This study is a case-control study that compares healthcare expenditure and utilization of cancer patients (C01-C97, ICD-10 codes) who have LSTP (case) and those who do not (control).

2. Data and Study Population

The data used in this study were the obtained National Health Information DB and collected by the National Health Insurance Service of Korea between 2018 and 2020. These comprehensive data were compiled for the sole purpose of providing public health researchers and policy makers with representative and useful information on Korean citizens' use of health insurance and health examinations.

From this data, 1,337,156 participants were included as cancer patients. We extracted 29,848 cases in which patients provided in writing their LSTP (claim codes "IA71, IA72, IA73"), between January and December 2018. A total of 13,409 participants were excluded based on the following criteria: still alive during the follow-up period (2018.01–2020.06.) and aged over 40 years. The

remaining 16,439 participants were included in the case group. We employed 1:1 propensity score matching (matching variables: sex, age, medical coverage type, cancer type, cancer diagnosis date, duration until death, hospital type) with 171,839 individuals in the control group. Finally, 23,494 participants (case: 11,747, control: 11,747) were included in this study (figure 2).

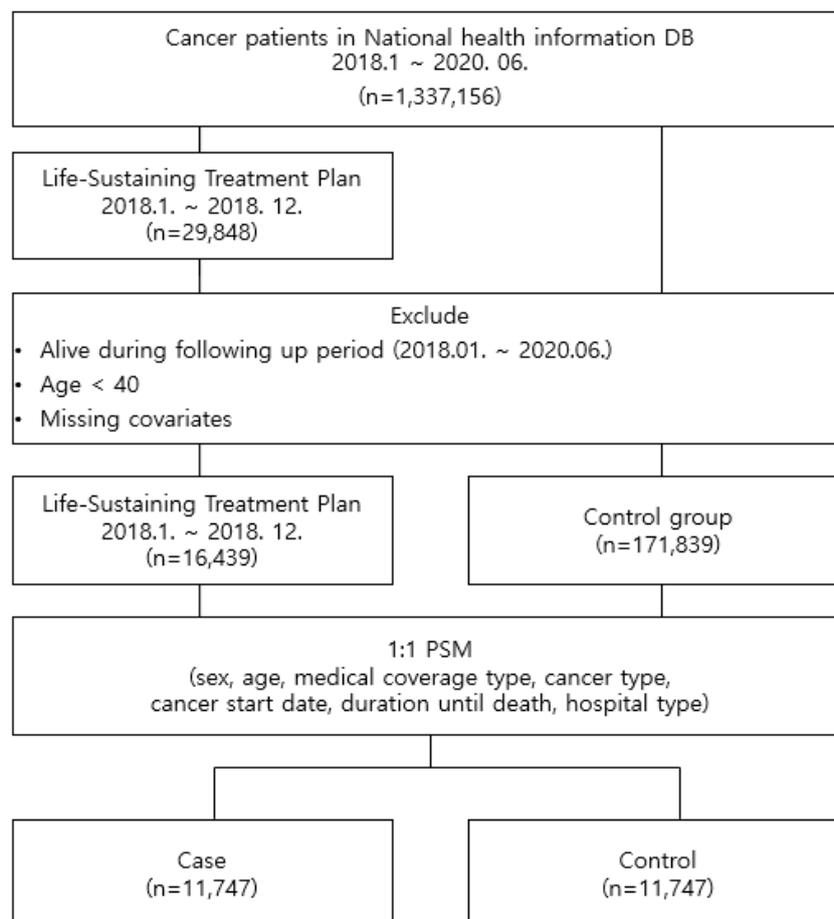


Figure 2. Flowchart of the participant selection

3. Variables

1) Dependent variables

The dependent variables of this study were healthcare expenditure and healthcare utilization. Healthcare expenditure includes total cost, hospitalization cost, outpatient cost, medication cost, ICU cost, narcotic painkillers cost, hospice cost, and the cost of the four life-sustaining treatments (CPR, hemodialysis, mechanical ventilation cost, and chemotherapy). Healthcare utilization includes days of hospitalization, outpatient visits, ICU use, narcotic painkillers use, hospice use, and the four categories of life-sustaining treatment use.

2) Main independent variables

The primary independent variable in this study is the withdrawal of life-sustaining treatment, among patients who wrote their LSTP, from January to December 2018, defined by claims code “IA71, IA72, IA73”

3) Other independent variables

Covariates controlled for, while investigating the association between withdrawing life-sustaining treatment and healthcare cost and expenditure, included sex, age, medical coverage type, insurance premium (percentile), cancer type, duration until death (days), hospital type, surgery, radiation therapy, and chemotherapy.

Table 8. Controlled variables

Variables	Description
Sex	Male, Female
Age	<50, 50-59, 60-69, 70-79, ≥ 80
Medical coverage type	Insurance Coverage (Regional), Insurance Coverage (Workplace), and Medical Aid
Insurance premium	0-5
Cancer (type) of	Digestive organs, Respiratory and intrathoracic organs, Lymphoid, hematopoietic and related tissue, and Others.
Duration until death	Continuous
Hospital type	Advance general hospital, General hospital, and Others
Surgery	Yes, No
Radiation therapy	Yes, No
Chemotherapy	Yes, No

4. Statistical Methods

To compare participants who provided in writing their LSTP and those who did not, we employed a 1:1 propensity score matching, and the matching variables were sex, age, medical coverage type, cancer type, cancer diagnosis date, duration until death, and hospital type.

General characteristics were reported as frequencies and percentages. A t-test and analysis of variance (ANOVA) were conducted to examine the distribution of the general characteristics of the study population according to healthcare expenditure and utilization.

We used a generalized linear model (GLM) to calculate the association between withdrawing life-sustaining treatment and healthcare expenditure and utilization. To analyze the association between withdrawing life-sustaining treatment and healthcare expenditure, we used log for the link function and Gamma for distribution. We use log for the link function and negative binomial for distribution to analyze healthcare utilization.

For all values calculated in our study, a p value of $<.05$ was considered statistically significant. All statistical analyses were conducted using SAS software (version 9.4).

IV. Results

1. General Characteristics of the Study Population

Table 9 shows the general characteristics and distribution of the LSTP case group and matched controls. The case group included 11,747 individuals, and the control group included 11,747 individuals.

In the case group, 63.7% were male and 36.3% were female. About 32.1% of participants were aged between 70 and 79 years. Approximately 22.5% of participants had cancers of the digestive organs. The average day until death after the date of implementation of the LSTP was 52.6 days. Nearly, 63.1% of the LSTP case group used the services of an advanced general hospital.

Table 9. General characteristics of the study population

Variables	Life-Sustaining Treatment Plan (LSTP)			
	Total (N=23,494)			
	Yes		No	
	N	(%)	N	(%)
Gender				
Male	7,487	(63.7)	7,376	(62.8)
Female	4,260	(36.3)	4,371	(37.2)
Age (years)				
< 50	618	(5.3)	615	(5.2)
50-59	1,819	(15.5)	1,833	(15.6)
60-69	2,902	(24.7)	2,871	(24.4)
70-79	3,772	(32.1)	3,710	(31.6)
≥ 80	2,636	(22.4)	2,718	(23.1)
Medical coverage type				
Regionally-insured	3,656	(31.1)	3,858	(32.8)
Workplace-insured	7,124	(60.6)	6,851	(58.3)
Medical aid	967	(8.2)	1,038	(8.8)
Insurance premium (percentile)				
0	967	(8.2)	1,038	(8.8)
1	1,657	(14.1)	1,659	(14.1)
2	1,396	(11.9)	1,370	(11.7)
3	1,764	(15.0)	1,779	(15.1)
4	2,385	(20.3)	2,316	(19.7)
5	3,578	(30.5)	3,585	(30.5)
Cancer type				
Digestive organs	2,648	(22.5)	2,653	(22.6)
Respiratory and intrathoracic organs	1,679	(14.3)	1,652	(14.1)
Lymphoid, hematopoietic and related tissue	1,090	(9.3)	1,039	(8.8)
Others	6,330	(53.9)	6,403	(54.5)
Duration until death (days)†				
	52.6	± 91.3	51.7	± 78.5
Hospital type				
Advance general hospital	7,407	(63.1)	7,182	(61.1)
General hospital	4,329	(36.9)	4,311	(36.7)
Others	11	(0.1)	254	(2.2)

**Before date of plan
(or matched date in non-plan
patients)**
Surgery

Yes	8,999	(76.6)	7,202	(61.3)
No	2,748	(23.4)	4,545	(38.7)

Radiation therapy

Yes	3,705	(31.5)	2,469	(21.0)
No	8,042	(68.5)	9,278	(79.0)

Chemotherapy

Yes	2,076	(17.7)	1,218	(10.4)
No	9,671	(82.3)	10,529	(89.6)

**After date of plan
(or matched date in non-plan
patients)**
ICU

Yes	1,707	(14.5)	2,547	(21.7)
No	10,040	(85.5)	9,200	(78.3)

Narcotic painkillers

Yes	776	(6.6)	1,454	(12.4)
No	10,971	(93.4)	10,293	(87.6)

Hospice care

Yes	4,272	(36.4)	1,868	(15.9)
No	7,475	(63.6)	9,879	(84.1)

CPR

Yes	85	(0.7)	571	(4.9)
No	11,662	(99.3)	11,176	(95.1)

Hemodialysis

Yes	496	(4.2)	865	(7.4)
No	11,251	(95.8)	10,882	(92.6)

Mechanical ventilation

Yes	990	(8.4)	1,825	(15.5)
No	10,757	(91.6)	9,922	(84.5)

Chemotherapy

Yes	83	(0.7)	303	(2.6)
No	11,664	(99.3)	11,444	(97.4)

TOTAL	11,747	(100.0)	11,747	(100.0)
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[†]Mean and SD of the continuous independent variables in this study

2. General characteristics of the study population categorized by days alive

Table 10 shows the general characteristics of the study population, categorized by days alive.

The number of participants of the LSTP case group, who survived for more than 30 days after the implementation date of the plan, was 5,740 while the number of participants of the control group who survived for more than 30 days was 5,561. The average number of days until death after the implementation date of the LSTP for the case group, when more than 30 days was 91.0 days while that of the control group was 94.7 days.

The number of participants of the LSTP group who survived for more than 60 days after the implementation date of the plan was 2,680; the participants of the control group who survived for more than 60 days was 2,493. The average number of days until death, after the implementation date of the LSTP, for the case group which survived for more than 60 days, was 147.1 days while that for the control group was 160.1 days.

Participants who survived for more than 90 days after the implementation date of plan, or matched date in non-plan patients were 1,567 and 1,438, respectively. The average number of days until death, after the implementation date of LSTP, for the participants of the case group who survived for more than 90 days was 200.5 days while for that of the control group was 224.9 days.

Table 10. General characteristics of the study population categorized by days alive

Variables	Life-Sustaining Treatment Plan (LSTP)											
	Alive ≥ 30 days (N=11,301)				Alive ≥ 60 days (N=5,173)				Alive ≥ 90 days (N=3,005)			
	Yes		No		Yes		No		Yes		No	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Gender												
Male	3,402	(59.3)	3,430	(61.7)	1,505	(56.2)	1,500	(60.2)	862	(55.0)	835	(58.1)
Female	2,338	(40.7)	2,131	(38.3)	1,175	(43.8)	993	(39.8)	705	(45.0)	603	(41.9)
Age (years)												
< 50	352	(6.1)	333	(6.0)	166	(6.2)	173	(6.9)	87	(5.6)	111	(7.7)
50-59	973	(17.0)	938	(16.9)	446	(16.6)	456	(18.3)	249	(15.9)	261	(18.2)
60-69	1,441	(25.1)	1,471	(26.5)	632	(23.6)	701	(28.1)	362	(23.1)	444	(30.9)
70-79	1,755	(30.6)	1,732	(31.1)	837	(31.2)	767	(30.8)	502	(32.0)	415	(28.9)
≥ 80	1,219	(21.2)	1,087	(19.5)	599	(22.4)	396	(15.9)	367	(23.4)	207	(14.4)
Medical coverage type												
Regionally-insured	1,781	(31.0)	1,855	(33.4)	811	(30.3)	843	(33.8)	442	(28.2)	471	(32.8)
Workplace-insured	3,442	(60.0)	3,254	(58.5)	1,583	(59.1)	1,461	(58.6)	947	(60.4)	856	(59.5)
Medical aid	517	(9.0)	452	(8.1)	286	(10.7)	189	(7.6)	178	(11.4)	111	(7.7)
Insurance premium (percentile)												
0	517	(9.0)	452	(8.1)	286	(10.7)	189	(7.6)	178	(11.4)	111	(7.7)
1	808	(14.1)	799	(14.4)	377	(14.1)	362	(14.5)	242	(15.4)	207	(14.4)
2	685	(11.9)	651	(11.7)	297	(11.1)	290	(11.6)	175	(11.2)	161	(11.2)

3	835	(14.5)	853	(15.3)	377	(14.1)	386	(15.5)	190	(12.1)	232	(16.1)
4	1,140	(19.9)	1,088	(19.6)	510	(19.0)	502	(20.1)	290	(18.5)	295	(20.5)
5	1,755	(30.6)	1,718	(30.9)	833	(31.1)	764	(30.6)	492	(31.4)	432	(30.0)
Cancer type (affecting)												
Digestive organs	1,234	(21.5)	1,260	(22.7)	590	(22.0)	547	(21.9)	363	(23.2)	312	(21.7)
Respiratory and intrathoracic organs	626	(10.9)	701	(12.6)	244	(9.1)	267	(10.7)	136	(8.7)	141	(9.8)
Lymphoid, hematopoietic and related tissue	534	(9.3)	476	(8.6)	232	(8.7)	201	(8.1)	130	(8.3)	110	(7.6)
Others	3,346	(58.3)	3,124	(56.2)	1,614	(60.2)	1,478	(59.3)	938	(59.9)	875	(60.8)
Duration until death (days)†												
	91.0	± 97.6	94.7	± 94.7	147.1	± 120.1	160.1	± 153.9	200.5	± 133.2	224.9	± 176.3
Hospital type												
Advance general hospital	3,613	(62.9)	3,731	(67.1)	1,697	(63.3)	1,748	(70.1)	994	(63.4)	1,034	(71.9)
General hospital	2,118	(36.9)	1,751	(31.5)	979	(36.5)	712	(28.6)	570	(36.4)	389	(27.1)
Others	9	(0.2)	79	(1.4)	4	(0.1)	33	(1.3)	3	(0.2)	15	(1.0)
Before date of plan (or matched date in non-plan patients)												
Surgery												
Yes	4,768	(83.1)	3,958	(71.2)	2,306	(86.0)	1,990	(79.8)	1,359	(86.7)	1,215	(84.5)
No	972	(16.9)	1,603	(28.8)	374	(14.0)	503	(20.2)	208	(13.3)	223	(15.5)
Radiation therapy												
Yes	2,012	(35.1)	1,446	(26.0)	1,016	(37.9)	813	(32.6)	597	(38.1)	533	(37.1)

No	3,728	(64.9)	4,115	(74.0)	1,664	(62.1)	1,680	(67.4)	970	(61.9)	905	(62.9)
Chemotherapy												
Yes	992	(17.3)	606	(10.9)	467	(17.4)	298	(12.0)	266	(17.0)	176	(12.2)
No	4,748	(82.7)	4,955	(89.1)	2,213	(82.6)	2,195	(88.0)	1,301	(83.0)	1,262	(87.8)
After date of plan (or matched date in non-plan patients)												
ICU												
Yes	172	(3.0)	825	(14.8)	125	(4.7)	465	(18.7)	102	(6.5)	292	(20.3)
No	5,568	(97.0)	4,736	(85.2)	2,555	(95.3)	2,028	(81.3)	1,465	(93.5)	1,146	(79.7)
Narcotic painkillers												
Yes	272	(4.7)	550	(9.9)	343	(12.8)	466	(18.7)	293	(18.7)	373	(25.9)
No	5,468	(95.3)	5,011	(90.1)	2,337	(87.2)	2,027	(81.3)	1,274	(81.3)	1,065	(74.1)
Hospice care												
Yes	2,076	(36.2)	1,197	(21.5)	1,324	(49.4)	777	(31.2)	820	(52.3)	529	(36.8)
No	3,664	(63.8)	4,364	(78.5)	1,356	(50.6)	1,716	(68.8)	747	(47.7)	909	(63.2)
CPR												
Yes	15	(0.3)	178	(3.2)	9	(0.3)	75	(3.0)	7	(0.4)	176	(12.2)
No	5,725	(99.7)	5,383	(96.8)	2,671	(99.7)	2,418	(97.0)	1,560	(99.6)	1,262	(87.8)
Hemodialysis												
Yes	63	(1.1)	301	(5.4)	45	(1.7)	144	(5.8)	26	(1.7)	38	(2.6)
No	5,677	(98.9)	5,260	(94.6)	2,635	(98.3)	2,349	(94.2)	1,541	(98.3)	1,400	(97.4)
Mechanical ventilation												

Yes	107	(1.9)	623	(11.2)	74	(2.8)	320	(12.8)	52	(3.3)	85	(5.9)
No	5,633	(98.1)	4,938	(88.8)	2,606	(97.2)	2,173	(87.2)	1,515	(96.7)	1,353	(94.1)
Chemotherapy												
Yes	15	(0.3)	79	(1.4)	25	(0.9)	83	(3.3)	30	(1.9)	196	(13.6)
No	5,725	(99.7)	5,482	(98.6)	2,655	(99.1)	2,410	(96.7)	1,537	(98.1)	1,242	(86.4)
TOTAL	5,740	(100.0)	5,561	(100.0)	2,680	(100.0)	2,493	(100.0)	1,567	(100.0)	1,438	(100.0)

†Mean and SD of the continuous independent variables in this study

3. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients, in the last 30, 60, 90 days of life

Table 11 shows the general characteristics of the study population's healthcare expenditure and utilization in the last 30, 60, and 90 days of life.

The mean total cost incurred by the LSTP group was ₩4,172,175, ₩11,182,681, and ₩17,044,6899 in the last 30, 60, and 90 days of life, respectively. The mean total cost of control group was ₩6,189,690, ₩12,567,891, and ₩17,063,578 for the last 30, 60, and 90 days of life, respectively.

The mean number of days of hospitalization of the LSTP case group was 12.25 days, 33.57 days, 52.19 days for the last 30, 60, and 90 days of life, respectively. The mean number of days of hospitalization of the control group was 14.82 days, 31.77 days, 42.55 days in the last 30, 60, and 90 days of life, respectively.

Table 11. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients, in the last 30, 60, 90 days of life

Variables	Life-Sustaining Treatment Plan (LSTP)														
	Last 30 days of life				P-value	Last 60 days of life				P-value	Last 90 days of life				P-value
	Yes		No			Yes		No			Yes		No		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
Expenditure (in ₩)															
Total cost	4,172,175	5,142,325	6,189,690	7,675,425	<.0001	11,182,681	9,087,496	12,567,891	12,305,079	<.0001	17,044,689	12,841,831	17,063,578	16,011,299	0.9714
Hospitalization cost	4,009,719	5,108,726	5,824,644	7,648,186	<.0001	10,615,630	9,165,519	11,502,433	12,263,526	0.0031	15,866,295	13,052,923	15,091,611	15,863,920	0.1426
Outpatient cost	122,281	459,473	268,469	701,436	<.0001	415,222	995,307	761,132	1,560,621	<.0001	851,914	1,796,947	1,410,787	2,697,506	<.0001
Medication cost	40,175	236,053	96,577	507,861	<.0001	151,829	709,635	304,326	1,214,435	<.0001	326,480	1,184,174	561,180	2,073,648	<.0001
ICU cost	64,220	739,801	305,246	1,303,815	<.0001	180,135	1,875,367	550,269	2,330,014	<.0001	276,781	2,465,490	708,334	2,875,375	<.0001
Narcotic painkillers cost	11,974	114,802	16,071	152,036	0.1053	38,887	246,989	40,794	223,664	0.7716	70,885	414,503	71,732	352,379	0.9521
Hospice cost	1,879,824	3,258,783	692,048	1,966,818	<.0001	4,895,660	7,027,837	1,269,233	3,536,955	<.0001	6,772,708	10,274,305	1,461,137	4,254,355	<.0001
CPR cost	357	7,320	5,366	33,646	<.0001	500	9,076	5,271	34,181	<.0001	684	10,778	4,732	34,105	<.0001
Hemodialysis cost	16,867	270,303	68,641	448,821	<.0001	46,326	497,093	122,872	903,135	<.0001	62,886	564,360	166,848	1,165,977	0.0016
Mechanical ventilation cost	16,078	196,682	74,431	374,773	<.0001	48,567	545,909	125,800	617,140	<.0001	73,381	755,741	158,528	747,288	0.0019
Chemotherapy cost	548	26,721	12,463	184,074	<.0001	6,406	161,354	49,810	531,354	<.0001	18,211	295,365	72,724	515,923	0.0003
Utilization															
Days of hospitalization	12.25	11.84	14.82	12.05	<.0001	33.57	21.63	31.77	22.30	0.0033	52.19	32.92	42.55	31.22	<.0001
Outpatient visit	0.97	2.31	2.08	3.20	<.0001	3.10	5.10	5.40	6.45	<.0001	5.79	7.88	9.09	9.34	<.0001
ICU use	0.08	0.76	0.37	1.68	<.0001	0.14	1.21	0.53	2.11	<.0001	0.20	1.39	0.68	2.80	<.0001
Narcotic painkillers use	0.11	0.65	0.21	0.79	<.0001	0.40	1.42	0.52	1.41	0.0018	0.78	2.36	0.92	2.18	0.0761

Hospice use	2.76	4.40	1.27	3.03	<.0001	5.18	7.55	1.92	4.10	<.0001	6.56	10.11	2.37	4.64	<.0001
CPR use	0.00	0.05	0.04	0.20	<.0001	0.00	0.06	0.03	0.20	<.0001	0.00	0.07	0.03	0.18	<.0001
Hemodialysis use	0.06	0.83	0.30	1.97	<.0001	0.22	2.57	0.62	4.35	<.0001	0.39	4.66	1.00	7.40	0.0061
Mechanical ventilation use	0.05	0.60	0.28	1.10	<.0001	0.10	0.90	0.38	1.36	<.0001	0.12	0.88	0.44	1.58	<.0001
Chemotherapy use	0.01	0.18	0.03	0.29	<.0001	0.03	0.38	0.08	0.61	<.0001	0.05	0.53	0.13	0.74	0.0022

4. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan by implementation of LSTP, in the last 30, 60, 90 days of life

Table 12 shows the general characteristics of the study population's healthcare expenditure and utilization by implementation of the LSTP in the last 30, 60, and 90 days of life.

In the LSTP case group, 4,283 participants were alive for more than 30 days and implemented the plan; 1,457 were alive for more than 30 days and did not implement the plan. The total cost incurred by the participants of the group that implemented the plan and was alive for more than 30 days was ₩4,020,044; the total cost incurred by the group which did not implement the plan and was alive for more than 30 days was ₩4,619,380.

Of the participants, 1,862 were alive for more than 60 days and implemented the plan, and 817 were alive for more than 60 days and did not implement the plan. The total cost of incurred by the group which implemented the plan and was alive for more than 60 days was ₩11,434,578, while the total cost of the group which did not implement the plan and was alive for more than 60 days was ₩10,608,282.

Of the participants, 1,048 were alive for more than 90 days and implemented the plan, and 519 were alive more than 90 days and did not implement the plan. The total cost incurred by the group which implemented the plan and was alive for more than 90 days was ₩17,894,454, while the total cost

incurred by the group which did not implement the plan and was alive for more than 90 days was ₩15,328,788.

Table 12. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan by implementation of LSTP, in the last 30, 60, 90 days of life

Variables	Life-Sustaining Treatment Plan (LSTP)						P-value
	Yes				No		
	Implementation		Non-implementation				
	Mean	SD	Mean	SD	Mean	SD	
Last 30 days of life	N=4,283		N=1,457		N=5,561		
Expenditure (in ₩)							
Total cost	4,020,044	5,327,351	4,619,380	4,527,297	6,189,690	7,675,425	<.0001
Hospitalization cost	3,892,004	5,292,686	4,355,752	4,508,781	5,824,644	7,648,186	<.0001
Outpatient cost	98,982	398,358	190,772	599,294	268,469	701,436	<.0001
Medication cost	29,058	208,669	72,856	300,235	96,577	507,861	<.0001
ICU cost	71,093	823,158	44,015	404,943	305,246	1,303,815	<.0001
Narcotic painkillers cost	8,143	93,909	23,236	160,757	16,071	152,036	0.0003
Hospice cost	1,747,612	3,221,241	2,268,476	3,337,639	692,048	1,966,818	<.0001
CPR cost	304	6,632	511	9,047	5,366	33,646	<.0001
Hemodialysis cost	18,893	302,984	10,914	134,034	68,641	448,821	<.0001
Mechanical ventilation cost	18,695	215,329	8,388	126,635	74,431	374,773	<.0001
Chemotherapy cost	730	30,932	13	342	12,463	184,074	<.0001
Utilization							
Days of hospitalization	11.42	11.72	14.71	11.84	14.82	12.05	<.0001
Outpatient visit	0.81	2.12	1.44	2.74	2.08	3.20	<.0001

ICU use	0.09	0.85	0.06	0.39	0.37	1.68	<.0001
Narcotic painkillers use	0.07	0.51	0.22	0.94	0.21	0.79	<.0001
Hospice use	2.56	4.36	3.34	4.49	1.27	3.03	<.0001
CPR use	0.00	0.05	0.00	0.06	0.04	0.20	<.0001
Hemodialysis use	0.06	0.86	0.05	0.76	0.30	1.97	<.0001
Mechanical ventilation use	0.06	0.67	0.03	0.29	0.28	1.10	<.0001
Chemotherapy use	0.01	0.20	0.00	0.11	0.03	0.29	<.0001
Last 60 days of life	N=1,862		N=817		N=2,493		
Expenditure (in ₩)							
Total cost	11,434,578	9,606,179	10,608,282	7,751,351	12,567,891	12,305,079	<.0001
Hospitalization cost	10,929,029	9,677,878	9,900,988	7,832,220	11,502,433	12,263,526	0.0009
Outpatient cost	383,018	996,399	488,658	989,504	761,132	1,560,621	<.0001
Medication cost	122,531	613,000	218,636	888,493	304,326	1,214,435	<.0001
ICU cost	226,261	2,219,057	74,955	542,504	550,269	2,330,014	<.0001
Narcotic painkillers cost	29,528	214,106	60,230	308,253	40,794	223,664	0.0078
Hospice cost	4,814,278	7,031,865	5,081,237	7,019,415	1,269,233	3,536,955	<.0001
CPR cost	380	7,839	773	11,409	5,271	34,181	<.0001
Hemodialysis cost	57,197	577,867	21,537	219,973	122,872	903,135	0.0004
Mechanical ventilation cost	62,809	638,299	16,090	217,267	125,800	617,140	<.0001

Chemotherapy cost	7,158	187,088	4,690	74,845	49,810	531,354	0.0003
Utilization							
Days of hospitalization	33.30	21.77	34.18	21.29	31.77	22.30	0.0084
Outpatient visit	2.80	4.96	3.77	5.33	5.40	6.45	<.0001
ICU use	0.17	1.41	0.09	0.47	0.53	2.11	<.0001
Narcotic painkillers use	0.32	1.29	0.59	1.67	0.52	1.41	<.0001
Hospice use	5.00	7.50	5.59	7.64	1.92	4.10	<.0001
CPR use	0.00	0.05	0.00	0.07	0.03	0.20	<.0001
Hemodialysis use	0.28	3.04	0.07	0.77	0.62	4.35	<.0001
Mechanical ventilation use	0.12	1.04	0.04	0.37	0.38	1.36	<.0001
Chemotherapy use	0.03	0.44	0.01	0.18	0.08	0.61	0.0001
<hr/>							
Last 90 days of life	N=1,048		N=519		N=1,438		
<hr/>							
Expenditure (in ₩)							
Total cost	17,894,454	13,656,183	15,328,788	10,826,099	17,063,578	16,011,299	0.0042
Hospitalization cost	16,787,888	13,875,424	14,005,353	10,988,725	15,091,611	15,863,920	0.0005
Outpatient cost	806,277	1,817,746	944,066	1,752,305	1,410,787	2,697,506	<.0001
Medication cost	300,288	1,162,978	379,369	1,225,292	561,180	2,073,648	0.0004
ICU cost	352,006	2,937,135	124,881	951,552	708,334	2,875,375	<.0001

Narcotic painkillers cost	56,215	369,454	100,509	492,152	71,732	352,379	0.1015
Hospice cost	6,786,862	10,372,537	6,744,127	10,082,882	1,461,137	4,254,355	<.0001
CPR cost	585	10,032	885	12,153	4,732	34,105	<.0001
Hemodialysis cost	79,905	655,375	28,520	304,893	166,848	1,165,977	0.0040
Mechanical ventilation cost	94,363	898,034	31,013	306,460	158,528	747,288	0.0024
Chemotherapy cost	21,562	351,172	11,444	120,044	72,724	515,923	0.0015
Utilization							
Days of hospitalization	53.74	33.35	49.06	31.83	42.55	31.22	<.0001
Outpatient visit	5.38	7.79	6.61	8.03	9.09	9.34	<.0001
ICU use	0.25	1.65	0.11	0.58	0.68	2.80	<.0001
Narcotic painkillers use	0.64	2.19	1.05	2.63	0.92	2.18	0.0006
Hospice use	6.27	9.93	7.14	10.45	2.37	4.64	<.0001
CPR use	0.00	0.06	0.01	0.08	0.03	0.18	<.0001
Hemodialysis use	0.55	5.66	0.07	0.83	1.00	7.40	0.0081
Mechanical ventilation use	0.14	1.00	0.07	0.55	0.44	1.58	<.0001
Chemotherapy use	0.06	0.60	0.04	0.32	0.13	0.74	0.0080

5. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients, in the last 30, 60, 90 days of life

Table 13 shows the results of GLM for the LSTP case group on healthcare expenditure and utilization in the last 30, 60, and 90 days of patients' life.

Compared to the control group, the LSTP case group had a lower EXP(β) of 0.81 and 0.94 of total cost in the last 30 days (95% CI: 0.78-0.85) and in the last 60 days of life (95% CI: 0.90-0.99), respectively. However, the LSTP group had a higher total cost (EXP(β): 1.08, 95% CI: 1.02-1.14) than the control group in the last 90 days of life.

Among the four life-sustaining treatment costs, the CPR and chemotherapy costs were lower in the LSTP case group than in the control group.

However, the LSTP case group had higher EXP(β) of 1.59, 2.41, and 3.13 of hospice costs in the last 30 days (95% CI: 1.48-1.72), in the last 60 days (95% CI: 2.15-2.69), and in the last 90 days of life (95% CI: 2.68-3.66), respectively. Similarly, the LSTP case group had higher EXP(β) of 2.08, 2.63, and 2.69 of hospice use in the last 30 days (95% CI: 1.87-2.31), in the last 60 days (95% CI: 2.31-2.98), and in the last 90 days of life (95% CI: 2.29-3.16), respectively.

Table 13. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients, in the last 30, 60, 90 days of life

Variables	Life-Sustaining Treatment Plan (LSTP)							
	No	Yes						
		Last 30 days of life		Last 60 days of life		Last 90 days of life		
		EXP(β)	95% CI	EXP(β)	95% CI	EXP(β)	95% CI	
Expenditure								
Total cost	1.00	0.81	(0.78 – 0.85)	0.94	(0.90 – 0.99)	1.08	(1.02 – 1.14)	
Hospitalization cost	1.00	0.83	(0.80 – 0.87)	0.97	(0.93 – 1.02)	1.12	(1.06 – 1.20)	
Outpatient cost	1.00	0.82	(0.75 – 0.89)	0.83	(0.76 – 0.91)	0.85	(0.77 – 0.95)	
Medication cost	1.00	0.93	(0.84 – 1.03)	0.87	(0.79 – 0.97)	0.94	(0.83 – 1.06)	
ICU cost	1.00	1.01	(0.85 – 1.22)	1.35	(1.05 – 1.73)	1.18	(0.89 – 1.56)	
Narcotic painkillers cost	1.00	1.50	(1.22 – 1.84)	1.48	(1.22 – 1.80)	1.48	(1.18 – 1.86)	
Hospice cost	1.00	1.59	(1.48 – 1.72)	2.41	(2.15 – 2.69)	3.13	(2.68 – 3.66)	
CPR cost	1.00	0.90	(0.72 – 1.12)	0.82	(0.63 – 1.07)	0.90	(0.63 – 1.27)	
Hemodialysis cost	1.00	1.25	(0.98 – 1.60)	1.41	(0.98 – 2.03)	1.53	(0.92 – 2.53)	
Mechanical ventilation cost	1.00	1.24	(0.96 – 1.59)	1.77	(1.26 – 2.49)	1.84	(1.23 – 2.76)	
Chemotherapy cost	1.00	0.24	(0.11 – 0.51)	0.31	(0.16 – 0.63)	0.28	(0.15 – 0.53)	
Utilization								
Days of hospitalization	1.00	0.82	(0.78 – 0.86)	1.04	(0.99 – 1.10)	1.21	(1.14 – 1.30)	
Outpatient visit	1.00	0.45	(0.42 – 0.48)	0.57	(0.53 – 0.62)	0.64	(0.59 – 0.70)	
ICU use	1.00	0.21	(0.17 – 0.24)	0.25	(0.20 – 0.32)	0.32	(0.24 – 0.43)	
Narcotic painkillers use	1.00	0.51	(0.43 – 0.62)	0.81	(0.67 – 0.98)	0.90	(0.72 – 1.12)	

Hospice use	1.00	2.08	(1.87 – 2.31)	2.63	(2.31 – 2.98)	2.69	(2.29 – 3.16)
CPR use	1.00	0.07	(0.04 – 0.12)	0.11	(0.05 – 0.21)	0.15	(0.07 – 0.33)
Hemodialysis use	1.00	0.17	(0.12 – 0.24)	0.29	(0.15 – 0.55)	0.49	(0.18 – 1.31)
Mechanical ventilation use	1.00	0.17	(0.14 – 0.21)	0.23	(0.17 – 0.31)	0.26	(0.18 – 0.37)
Chemotherapy use	1.00	0.28	(0.20 – 0.40)	0.31	(0.18 – 0.55)	0.50	(0.28 – 0.90)

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

6. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients, in the last 30, 60, 90 days of life (in cost and frequency)

Table 14 depicts the results of GLM for the LSTP group on healthcare expenditure and utilization, in the last 30, 60, and 90 days of life in terms of cost and frequency.

The total cost in the last 30 days of life (estimate: -₩2,197,266, p-value: <.0001) and in the last 60 days of life (estimate: -₩921,134, p-value: 0.0020) incurred by LSTP group, were lower than those of the control group.

Hospitalization cost, outpatient cost, and medication cost of the LSTP group were lower than those of the control group. However, hospice cost in the last 30 days of life (estimate: ₩1,100,786, p-value: <.0001), in the last 60 days of life (estimate: ₩3,458,341 p-value: <.0001) and in the last 90 days of life (estimate: ₩5,190,876 p-value: <.0001) of the LSTP group were higher than that of the control group.

Similarly, the hospice use of the LSTP group in the last 30 days of life (estimate: 1.38, p-value: <.0001), in the last 60 days of life (estimate: 3.15 p-value: <.0001), and in the last 90 days of life (estimate: 4.15 p-value: <.0001) were higher than that of the control group.

Table 14. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients in the last 30, 60, 90 days of life (in cost and frequency)

Variables	Life-Sustaining Treatment Plan (LSTP)									
	No	Yes								
		Last 30 days of life			Last 60 days of life			Last 90 days of life		
		Estimate	S.E.	P-value	Estimate	S.E.	P-value	Estimate	S.E.	P-value
Expenditure (in ₩)										
Total cost	ref.	-2,197,266	122,958	<.0001	-1,388,589	296,835	<.0001	582,455	517,444	0.2603
Hospitalization cost	ref.	-1,989,423	122,480	<.0001	-921,134	297,614	0.0020	1,277,795	519,977	0.0140
Outpatient cost	ref.	-151,242	11,307	<.0001	-320,678	36,578	<.0001	-478,382	84,007	<.0001
Medication cost	ref.	-56,601	7,558	<.0001	-146,777	27,877	<.0001	-216,958	62,022	0.0005
ICU cost	ref.	-247,242	20,203	<.0001	-362,559	59,734	<.0001	-383,084	99,532	0.0001
Narcotic painkillers cost	ref.	-3,353	2,580	0.1937	2,855	6,682	0.6692	9,545	14,371	0.5066
Hospice cost	ref.	1,100,786	51,718	<.0001	3,458,341	158,576	<.0001	5,190,876	295,646	<.0001
CPR cost	ref.	-5,074	464	<.0001	-4,638	699	<.0001	-4,035	930	<.0001
Hemodialysis cost	ref.	-53,393	7,076	<.0001	-75,335	20,462	0.0002	-88,554	33,695	0.0086
Mechanical ventilation cost	ref.	-61,209	5,707	<.0001	-75,437	16,482	<.0001	-71,712	28,031	0.0105
Chemotherapy cost	ref.	-10,410	2,508	<.0001	-39,486	10,939	0.0003	-47,897	15,467	0.0020
Utilization										
Days of hospitalization	ref.	-2.71	0.23	<.0001	1.36	0.62	0.0273	9.26	1.18	<.0001
Outpatient visit	ref.	-1.12	0.05	<.0001	-2.24	0.16	<.0001	-3.11	0.32	<.0001
ICU use	ref.	-0.30	0.02	<.0001	-0.39	0.05	<.0001	-0.44	0.08	<.0001
Narcotic painkillers use	ref.	-0.10	0.01	<.0001	-0.09	0.04	0.0217	-0.09	0.08	0.2991

Hospice use	ref.	1.38	0.07	<.0001	3.15	0.17	<.0001	4.15	0.30	<.0001
CPR use	ref.	-0.03	0.00	<.0001	-0.03	0.00	<.0001	-0.03	0.01	<.0001
Hemodialysis use	ref.	-0.24	0.03	<.0001	-0.39	0.10	<.0001	-0.54	0.23	0.0177
Mechanical ventilation use	ref.	-0.24	0.02	<.0001	-0.28	0.03	<.0001	-0.30	0.05	<.0001
Chemotherapy use	ref.	-0.02	0.00	<.0001	-0.05	0.01	0.0002	-0.06	0.02	0.0188

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

7. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan by implementation of LSTP, in the last 30, 60, 90 days of life

Table 15 shows the results of the GLM for the LSTP group on healthcare expenditure and utilization by implementation of the LSTP in the last 30, 60, and 90 days of life.

The group with LSTP implemented had a lower EXP(β): 0.84, 95% CI: 0.80-0.88) than the control group, in the last 30 days of life. However, the group that did not implement LSTP, had a lower EXP(β) of 0.75 of total cost in the last 30 days of life (95% CI: 0.71-0.80), than the control and implemented groups.

Table 15. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan by implementation of LSTP in the last 30, 60, 90 days of life

Variables	Life-Sustaining Treatment Plan (LSTP)								
	No	Yes							
		Implementation			Non-implementation				
		EXP(β)	95% CI		EXP(β)	95% CI			
Last 30 days of life									
Expenditure									
Total cost	1.00	0.84	(0.80	–	0.88)	0.75	(0.71	–	0.80)
Hospitalization cost	1.00	0.87	(0.83	–	0.90)	0.76	(0.72	–	0.80)
Outpatient cost	1.00	0.76	(0.70	–	0.84)	0.92	(0.82	–	1.03)
Medication cost	1.00	0.83	(0.73	–	0.94)	1.09	(0.94	–	1.27)
ICU cost	1.00	1.11	(0.91	–	1.36)	0.72	(0.52	–	1.01)
Narcotic painkillers cost	1.00	1.54	(1.19	–	2.00)	1.45	(1.11	–	1.90)
Hospice cost	1.00	1.59	(1.47	–	1.73)	1.59	(1.44	–	1.76)
CPR cost	1.00	0.92	(0.70	–	1.20)	0.86	(0.58	–	1.26)
Hemodialysis cost	1.00	1.28	(0.98	–	1.69)	1.14	(0.70	–	1.85)
Mechanical ventilation cost	1.00	1.34	(1.02	–	1.76)	0.80	(0.47	–	1.36)
Chemotherapy cost	1.00	0.33	(0.15	–	0.75)	0.03	(0.01	–	0.14)
Utilization									
Days of hospitalization	1.00	0.76	(0.72	–	0.80)	0.97	(0.90	–	1.05)
Outpatient visit	1.00	0.38	(0.35	–	0.41)	0.64	(0.58	–	0.71)
ICU use	1.00	0.22	(0.19	–	0.27)	0.15	(0.11	–	0.20)

Narcotic painkillers use	1.00	0.36	(0.29	–	0.44)	0.99	(0.76	–	1.29)
Hospice use	1.00	1.94	(1.73	–	2.17)	2.49	(2.12	–	2.92)
CPR use	1.00	0.07	(0.03	–	0.12)	0.10	(0.04	–	0.24)
Hemodialysis use	1.00	0.18	(0.12	–	0.27)	0.12	(0.07	–	0.22)
Mechanical ventilation use	1.00	0.20	(0.16	–	0.25)	0.10	(0.07	–	0.15)
Chemotherapy use	1.00	0.27	(0.14	–	0.54)	0.13	(0.04	–	0.40)
Last 60 days of life									
Expenditure									
Total cost	1.00	0.98	(0.93	–	1.03)	0.86	(0.80	–	0.92)
Hospitalization cost	1.00	1.02	(0.96	–	1.07)	0.89	(0.83	–	0.95)
Outpatient cost	1.00	0.85	(0.76	–	0.94)	0.81	(0.71	–	0.92)
Medication cost	1.00	0.84	(0.74	–	0.95)	0.93	(0.80	–	1.07)
ICU cost	1.00	1.66	(1.25	–	2.21)	0.69	(0.45	–	1.05)
Narcotic painkillers cost	1.00	1.54	(1.21	–	1.96)	1.41	(1.09	–	1.82)
Hospice cost	1.00	2.40	(2.12	–	2.71)	2.43	(2.09	–	2.82)
CPR cost	1.00	0.85	(0.59	–	1.22)	0.78	(0.52	–	1.18)
Hemodialysis cost	1.00	1.46	(0.98	–	2.17)	1.26	(0.61	–	2.59)
Mechanical ventilation cost	1.00	1.94	(1.33	–	2.82)	1.16	(0.56	–	2.40)
Chemotherapy cost	1.00	0.29	(0.13	–	0.63)	0.38	(0.12	–	1.25)
Utilization									
Days of hospitalization	1.00	1.03	(0.98	–	1.09)	1.07	(0.99	–	1.15)
Outpatient visit	1.00	0.52	(0.48	–	0.57)	0.68	(0.61	–	0.76)
ICU use	1.00	0.29	(0.22	–	0.37)	0.18	(0.12	–	0.26)

Narcotic painkillers use	1.00	0.66	(0.53	–	0.82)	1.12	(0.86	–	1.46)
Hospice use	1.00	2.52	(2.19	–	2.90)	2.86	(2.39	–	3.41)
CPR use	1.00	0.08	(0.03	–	0.21)	0.15	(0.05	–	0.42)
Hemodialysis use	1.00	0.42	(0.22	–	0.83)	0.08	(0.03	–	0.20)
Mechanical ventilation use	1.00	0.29	(0.21	–	0.40)	0.10	(0.06	–	0.17)
Chemotherapy use	1.00	0.37	(0.20	–	0.69)	0.21	(0.08	–	0.51)
Last 90 days of life									
Expenditure									
Total cost	1.00	1.14	(1.07	–	1.22)	0.95	(0.88	–	1.03)
Hospitalization cost	1.00	1.19	(1.11	–	1.27)	1.00	(0.92	–	1.09)
Outpatient cost	1.00	0.85	(0.75	–	0.96)	0.85	(0.73	–	0.99)
Medication cost	1.00	0.95	(0.82	–	1.09)	0.93	(0.79	–	1.09)
ICU cost	1.00	1.20	(0.88	–	1.64)	1.10	(0.65	–	1.86)
Narcotic painkillers cost	1.00	1.51	(1.14	–	1.99)	1.46	(1.10	–	1.94)
Hospice cost	1.00	3.14	(2.65	–	3.73)	3.11	(2.53	–	3.83)
CPR cost	1.00	0.95	(0.59	–	1.53)	0.81	(0.45	–	1.47)
Hemodialysis cost	1.00	1.57	(0.91	–	2.69)	1.34	(0.44	–	4.10)
Mechanical ventilation cost	1.00	1.97	(1.25	–	3.12)	1.45	(0.66	–	3.17)
Chemotherapy cost	1.00	0.21	(0.10	–	0.45)	0.45	(0.16	–	1.26)
Utilization									
Days of hospitalization	1.00	1.24	(1.16	–	1.34)	1.16	(1.06	–	1.27)
Outpatient visit	1.00	0.61	(0.55	–	0.67)	0.71	(0.63	–	0.80)
ICU use	1.00	0.39	(0.29	–	0.54)	0.18	(0.11	–	0.28)

Narcotic painkillers use	1.00	0.76	(0.59 – 0.98)	1.15	(0.85 – 1.54)
Hospice use	1.00	2.56	(2.14 – 3.06)	2.94	(2.37 – 3.66)
CPR use	1.00	0.13	(0.04 – 0.37)	0.18	(0.06 – 0.61)
Hemodialysis use	1.00	0.69	(0.24 – 1.96)	0.13	(0.03 – 0.53)
Mechanical ventilation use	1.00	0.31	(0.21 – 0.46)	0.15	(0.08 – 0.27)
Chemotherapy use	1.00	0.57	(0.28 – 1.14)	0.42	(0.18 – 0.94)

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

8. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients by implementation of LSTP in the last 30, 60, 90 days of life (in cost and frequency)

Table 16 shows the results of generalized linear model (GLM) for the LSTP group on healthcare expenditure and utilization by implementation of LSTP in the last 30, 60, and 90 days of life in terms of cost and frequency.

Total cost (estimate: ~~₩~~2,319,717, p-value: <.0001) including hospitalization cost (estimate: ~~₩~~2,083,314, p-value: <.0001), outpatient cost (estimate: ~~₩~~170,817, p-value: <.0001), and medication cost (estimate: ~~₩~~65,586, p-value: <.0001) of the group which implemented LSTP in the last 30 days of life was lower than that of the control group.

Similarly, total cost (estimate: ~~₩~~1,845,279, p-value: <.0001) including hospitalization cost (estimate: ~~₩~~1,719,532, p-value: <.0001), outpatient cost (estimate: ~~₩~~94,973, p-value: <.0001), and medication cost (estimate: ~~₩~~3,077, p-value: 0.0084) of the group which did not implement the LSTP in the last 30 days of life, were lower than that of the control group.

Table 16. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients by implementation of LSTP, in the last 30, 60, 90 days of life (in cost and frequency)

Variables	Life-Sustaining Treatment Plan (LSTP)						
	No	Yes					
		Implementation			Non-implementation		
		Estimate	S.E.	P-value	Estimate	S.E.	P-value
Last 30 days of life							
Expenditure (in ₩)							
Total cost	ref.	-2,319,717	132,868	<.0001	-1,845,279	190,061	<.0001
Hospitalization cost	ref.	-2,083,314	132,365	<.0001	-1,719,532	189,341	<.0001
Outpatient cost	ref.	-170,817	12,211	<.0001	-94,973	17,468	<.0001
Medication cost	ref.	-65,586	8,167	<.0001	-30,774	11,682	0.0084
ICU cost	ref.	-236,686	21,836	<.0001	-277,587	31,235	<.0001
Narcotic painkillers cost	ref.	-6,556	2,787	0.0187	5,853	3,987	0.1421
Hospice cost	ref.	960,255	55,792	<.0001	1,504,745	79,807	<.0001
CPR cost	ref.	-5,130	502	<.0001	-4,911	718	<.0001
Hemodialysis cost	ref.	-50,412	7,648	<.0001	-61,961	10,940	<.0001
Mechanical ventilation cost	ref.	-57,670	6,168	<.0001	-71,381	8,823	<.0001
Chemotherapy cost	ref.	-10,208	2,711	0.0002	-10,990	3,877	0.0046
Utilization							
Days of hospitalization	ref.	-3.54	0.25	<.0001	-0.33	0.35	0.3502
Outpatient visit	ref.	-1.27	0.06	<.0001	-0.71	0.08	<.0001
ICU use	ref.	-0.29	0.03	<.0001	-0.34	0.04	<.0001

Narcotic painkillers use	ref.	-0.13	0.01	<.0001	0.00	0.02	0.9887
Hospice use	ref.	1.18	0.08	<.0001	1.96	0.11	<.0001
CPR use	ref.	-0.03	0.00	<.0001	-0.03	0.00	<.0001
Hemodialysis use	ref.	-0.24	0.03	<.0001	-0.26	0.04	<.0001
Mechanical ventilation use	ref.	-0.23	0.02	<.0001	-0.26	0.03	<.0001
Chemotherapy use	ref.	-0.02	0.01	0.0006	-0.02	0.01	0.0021
Last 60 days of life							
Expenditure (in ₩)							
Total cost	ref.	-1,099,805	327,885	0.0008	-2,016,080	424,223	<.0001
Hospitalization cost	ref.	-590,344	328,704	0.0725	-1,639,898	425,283	0.0001
Outpatient cost	ref.	-341,020	40,416	<.0001	-276,478	52,290	<.0001
Medication cost	ref.	-168,441	30,797	<.0001	-99,704	39,846	0.0123
ICU cost	ref.	-309,727	65,987	<.0001	-477,355	85,375	<.0001
Narcotic painkillers cost	ref.	-4,546	7,380	0.5379	18,935	9,549	0.0474
Hospice cost	ref.	3,325,934	175,183	<.0001	3,746,045	226,655	<.0001
CPR cost	ref.	-4,717	772	<.0001	-4,467	999	<.0001
Hemodialysis cost	ref.	-61,600	22,607	0.0064	-105,181	29,250	0.0003
Mechanical ventilation cost	ref.	-59,919	18,207	0.0010	-109,157	23,556	<.0001
Chemotherapy cost	ref.	-37,486	12,088	0.0019	-43,831	15,639	0.0051
Utilization							
Days of hospitalization	ref.	0.98	0.68	0.1523	2.21	0.88	0.0126
Outpatient visit	ref.	-2.49	0.18	<.0001	-1.69	0.23	<.0001
ICU use	ref.	-0.35	0.05	<.0001	-0.46	0.07	<.0001

Narcotic painkillers use	ref.	-0.16	0.04	0.0003	0.06	0.06	0.3042
Hospice use	ref.	2.95	0.19	<.0001	3.59	0.25	<.0001
CPR use	ref.	-0.03	0.00	<.0001	-0.03	0.01	<.0001
Hemodialysis use	ref.	-0.32	0.11	0.0042	-0.56	0.14	0.0001
Mechanical ventilation use	ref.	-0.26	0.04	<.0001	-0.34	0.05	<.0001
Chemotherapy use	ref.	-0.05	0.02	0.0028	-0.07	0.02	0.0012
Last 90 days of life							
Expenditure (in ₩)							
Total cost	ref.	1,493,986	576,181	0.0095	-1,170,642	713,016	0.1006
Hospitalization cost	ref.	2,211,777	578,952	0.0001	-518,479	716,446	0.4693
Outpatient cost	ref.	-491,929	93,739	<.0001	-452,330	116,001	<.0001
Medication cost	ref.	-225,862	69,207	0.0011	-199,833	85,643	0.0196
ICU cost	ref.	-300,402	111,012	0.0068	-542,101	137,376	<.0001
Narcotic painkillers cost	ref.	-1,851	16,029	0.9081	31,464	19,836	0.1127
Hospice cost	ref.	5,178,621	329,901	<.0001	5,214,447	408,249	<.0001
CPR cost	ref.	-4,051	1,038	<.0001	-4,006	1,284	0.0018
Hemodialysis cost	ref.	-68,732	37,590	0.0675	-126,678	46,517	0.0065
Mechanical ventilation cost	ref.	-50,047	31,266	0.1094	-113,377	38,692	0.0034
Chemotherapy cost	ref.	-41,841	17,258	0.0153	-59,543	21,356	0.0053
Utilization							
Days of hospitalization	ref.	10.54	1.32	<.0001	6.79	1.63	<.0001
Outpatient visit	ref.	-3.41	0.36	<.0001	-2.54	0.44	<.0001
ICU use	ref.	-0.38	0.09	<.0001	-0.55	0.11	<.0001

Narcotic painkillers use	ref.	-0.20	0.09	0.0347	0.13	0.12	0.2795
Hospice use	ref.	3.83	0.33	<.0001	4.76	0.41	<.0001
CPR use	ref.	-0.03	0.01	<.0001	-0.02	0.01	0.0005
Hemodialysis use	ref.	-0.38	0.25	0.1393	-0.86	0.32	0.0065
Mechanical ventilation use	ref.	-0.28	0.05	<.0001	-0.35	0.07	<.0001
Chemotherapy use	ref.	-0.05	0.03	0.0747	-0.07	0.03	0.0274

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

9. Results of the subgroup analysis of LSTP on healthcare expenditure and utilization, stratified by cancer type, in the last 30, 60, 90 days of life

Table 17 shows the results of the subgroup analysis of LSTP on healthcare expenditure and utilization stratified by cancer type, in the last 30, 60, and 90 days of life.

Participants of the LSTP group who had been suffering from cancer of the digestive organs (EXP(β): 0.80, 95% CI: 0.74-0.88), respiratory and intrathoracic organ cancer (EXP(β): 0.93, 95% CI: 0.83-1.05), lymphoid, hematopoietic, and related tissue cancer (EXP(β): 0.81, 95% CI: 0.71-0.93), and other types of cancers (EXP(β): 0.80, 95% CI: 0.76-0.85) had a lower total cost than the control group, in the last 30 days of life. However, hospice cost and hospice use were higher in the LSTP group than the control group, in the last 30, 60, and 90 days of life, regardless of the type of cancer.

Table 17. Results of the subgroup analysis of LSTP on healthcare expenditure and utilization, stratified by cancer type, in the last 30, 60, 90 days of life

Variables	Cancer type (of)	No	Life-Sustaining Treatment Plan (LSTP)							
			Yes							
			Last 30 days of life			Last 60 days of life			Last 90 days of life	
			EXP (β)	95% CI		EXP (β)	95% CI		EXP (β)	95% CI
Expenditure										
Total cost	Digestive organs	1.00	0.80	(0.74 – 0.88)	0.91	(0.82 – 1.01)	1.04	(0.92 – 1.18)		
	Respiratory and intrathoracic organs	1.00	0.93	(0.83 – 1.05)	1.08	(0.93 – 1.25)	1.10	(0.92 – 1.33)		
	Lymphoid, hematopoietic and related tissue	1.00	0.81	(0.71 – 0.93)	1.09	(0.93 – 1.28)	1.16	(0.93 – 1.45)		
	Others	1.00	0.80	(0.76 – 0.85)	0.92	(0.86 – 0.98)	1.07	(0.99 – 1.15)		
Hospitalization cost	Digestive organs	1.00	0.83	(0.76 – 0.90)	0.95	(0.86 – 1.05)	1.12	(0.98 – 1.28)		
	Respiratory and intrathoracic organs	1.00	0.95	(0.85 – 1.07)	1.14	(0.98 – 1.33)	1.15	(0.93 – 1.41)		
	Lymphoid, hematopoietic and related tissue	1.00	0.80	(0.71 – 0.91)	1.10	(0.94 – 1.28)	1.16	(0.94 – 1.42)		
	Others	1.00	0.83	(0.78 – 0.87)	0.95	(0.89 – 1.01)	1.11	(1.03 – 1.21)		
Outpatient cost	Digestive organs	1.00	0.60	(0.51 – 0.72)	0.68	(0.56 – 0.82)	0.63	(0.51 – 0.78)		
	Respiratory and intrathoracic organs	1.00	1.10	(0.87 – 1.39)	1.17	(0.89 – 1.54)	1.18	(0.87 – 1.61)		

	Lymphoid, hematopoietic and related tissue	1.00	0.95	(0.71	-	1.26)	1.12	(0.82	-	1.55)	1.05	(0.72	-	1.53)
	Others	1.00	0.83	(0.74	-	0.92)	0.79	(0.71	-	0.89)	0.83	(0.72	-	0.96)
Medication cost	Digestive organs	1.00	0.83	(0.68	-	1.02)	1.06	(0.85	-	1.32)	1.18	(0.92	-	1.51)
	Respiratory and intrathoracic organs	1.00	0.99	(0.75	-	1.31)	0.84	(0.60	-	1.17)	1.03	(0.70	-	1.51)
	Lymphoid, hematopoietic and related tissue	1.00	1.13	(0.78	-	1.63)	1.06	(0.70	-	1.62)	0.90	(0.60	-	1.36)
	Others	1.00	1.01	(0.88	-	1.17)	0.91	(0.79	-	1.05)	0.91	(0.77	-	1.08)
ICU cost	Digestive organs	1.00	0.99	(0.68	-	1.43)	1.04	(0.66	-	1.65)	1.14	(0.66	-	1.96)
	Respiratory and intrathoracic organs	1.00	1.45	(0.84	-	2.53)	2.14	(1.02	-	4.52)	0.80	(0.36	-	1.76)
	Lymphoid, hematopoietic and related tissue	1.00	0.66	(0.32	-	1.39)	0.67	(0.19	-	2.38)	0.52	(0.21	-	1.26)
	Others	1.00	0.91	(0.71	-	1.17)	1.21	(0.87	-	1.69)	1.38	(0.95	-	2.01)
Narcotic painkillers cost	Digestive organs	1.00	1.40	(0.90	-	2.19)	1.95	(1.27	-	2.98)	2.21	(1.42	-	3.43)
	Respiratory and intrathoracic organs	1.00	1.19	(0.53	-	2.67)	0.84	(0.29	-	2.41)	0.87	(0.24	-	3.19)
	Lymphoid, hematopoietic and related tissue	1.00	2.17	(0.91	-	5.17)	2.18	(0.91	-	5.27)	1.06	(0.43	-	2.59)
	Others	1.00	1.62	(1.23	-	2.14)	1.36	(1.05	-	1.76)	1.40	(1.04	-	1.89)

Hospice cost	Digestive organs	1.00	1.93	(1.59	-	2.33)	3.02	(2.32	-	3.94)	3.68	(2.51	-	5.41)
	Respiratory and intrathoracic organs	1.00	1.44	(1.14	-	1.83)	2.70	(1.86	-	3.92)	2.93	(1.54	-	5.54)
	Lymphoid, hematopoietic and related tissue	1.00	1.51	(1.19	-	1.92)	2.82	(1.92	-	4.14)	4.04	(2.29	-	7.13)
	Others	1.00	1.56	(1.42	-	1.72)	2.24	(1.95	-	2.58)	2.92	(2.40	-	3.54)
CPR cost	Digestive organs	1.00	0.92	(0.72	-	1.18)	0.74	(0.41	-	1.33)	-			
	Respiratory and intrathoracic organs	1.00	3.20	(1.83	-	5.58)	-				-			
	Lymphoid, hematopoietic and related tissue	1.00	1.00	(1.00	-	1.00)	1.00	(1.00	-	1.00)	1.00	(1.00	-	1.00)
	Others	1.00	0.91	(0.65	-	1.27)	0.65	(0.43	-	0.99)	0.69	(0.35	-	1.33)
Hemodialysis cost	Digestive organs	1.00	1.55	(0.88	-	2.74)	1.70	(0.60	-	4.84)	-			
	Respiratory and intrathoracic organs	1.00	2.51	(1.13	-	5.60)	0.02	(0.00	-	0.60)	-			
	Lymphoid, hematopoietic and related tissue	1.00	0.93	(0.36	-	2.39)	-				-			
	Others	1.00	0.97	(0.70	-	1.33)	1.01	(0.61	-	1.68)	1.32	(0.70	-	2.51)
Mechanical ventilation cost	Digestive organs	1.00	1.19	(0.74	-	1.91)	0.99	(0.53	-	1.87)	0.71	(0.27	-	1.86)
	Respiratory and intrathoracic organs	1.00	0.53	(0.18	-	1.59)	-				1.00	(1.00	-	1.00)

	Lymphoid, hematopoietic and related tissue	1.00	1.89	(0.65	–	5.50)	1.80	(0.54	–	6.00)	1.70	(0.88	–	3.27)
	Others	1.00	1.16	(0.83	–	1.63)	1.51	(0.98	–	2.33)	2.13	(1.30	–	3.49)
Chemotherapy cost	Digestive organs	1.00	1.32	(0.61	–	2.86)	3.62	(3.20	–	4.09)	3.09	(1.00	–	9.50)
	Respiratory and intrathoracic organs	1.00	1.00	(1.00	–	1.00)	0.36	(0.19	–	0.68)	–			
	Lymphoid, hematopoietic and related tissue	1.00	0.28	–			–			–				
	Others	1.00	0.12	(0.04	–	0.35)	0.17	(0.05	–	0.54)	0.12	(0.05	–	0.27)
Utilization														
Days of hospitalization	Digestive organs	1.00	0.83	(0.75	–	0.92)	1.06	(0.95	–	1.18)	1.21	(1.04	–	1.40)
	Respiratory and intrathoracic organs	1.00	0.83	(0.72	–	0.96)	1.10	(0.94	–	1.29)	1.24	(0.99	–	1.55)
	Lymphoid, hematopoietic and related tissue	1.00	0.89	(0.75	–	1.05)	1.19	(0.98	–	1.44)	1.16	(0.89	–	1.53)
	Others	1.00	0.80	(0.75	–	0.86)	1.02	(0.96	–	1.09)	1.20	(1.11	–	1.31)
Outpatient visit	Digestive organs	1.00	0.42	(0.37	–	0.48)	0.56	(0.47	–	0.65)	0.62	(0.52	–	0.74)
	Respiratory and intrathoracic organs	1.00	0.43	(0.35	–	0.52)	0.66	(0.52	–	0.85)	0.82	(0.62	–	1.08)
	Lymphoid, hematopoietic and related tissue	1.00	0.40	(0.31	–	0.51)	0.59	(0.44	–	0.79)	0.77	(0.55	–	1.06)
	Others	1.00	0.46	(0.42	–	0.51)	0.55	(0.49	–	0.61)	0.60	(0.54	–	0.68)

ICU use	Digestive organs	1.00	0.21	(0.17	–	0.27)	0.25	(0.16	–	0.39)	0.31	(0.17	–	0.59)
	Respiratory and intrathoracic organs	1.00	0.20	(0.14	–	0.26)	0.18	(0.08	–	0.37)	0.18	(0.07	–	0.47)
	Lymphoid, hematopoietic and related tissue	1.00	0.11	(0.07	–	0.17)	0.23	(0.09	–	0.61)	0.19	(0.07	–	0.51)
	Others	1.00	0.23	(0.20	–	0.26)	0.23	(0.17	–	0.30)	0.32	(0.22	–	0.47)
Narcotic painkillers use	Digestive organs	1.00	0.40	(0.28	–	0.57)	0.80	(0.55	–	1.15)	1.03	(0.68	–	1.56)
	Respiratory and intrathoracic organs	1.00	0.38	(0.22	–	0.66)	0.90	(0.44	–	1.82)	1.38	(0.59	–	3.26)
	Lymphoid, hematopoietic and related tissue	1.00	0.40	(0.18	–	0.91)	0.88	(0.41	–	1.92)	1.37	(0.51	–	3.67)
	Others	1.00	0.56	(0.43	–	0.72)	0.73	(0.57	–	0.95)	0.75	(0.56	–	1.01)
Hospice use	Digestive organs	1.00	1.94	(1.52	–	2.46)	1.89	(1.43	–	2.49)	1.88	(1.31	–	2.68)
	Respiratory and intrathoracic organs	1.00	2.10	(1.47	–	3.01)	3.69	(2.18	–	6.26)	4.65	(2.24	–	9.64)
	Lymphoid, hematopoietic and related tissue	1.00	2.14	(1.52	–	3.00)	2.82	(1.84	–	4.33)	2.56	(1.39	–	4.71)
	Others	1.00	2.17	(1.89	–	2.49)	2.83	(2.41	–	3.32)	2.84	(2.32	–	3.46)
CPR use	Digestive organs	1.00	0.15	(0.06	–	0.37)	0.12	(0.03	–	0.54)	0.19	(0.04	–	0.91)
	Respiratory and intrathoracic organs	1.00	0.10	(0.02	–	0.45)	0.21	(0.04	–	0.98)	1.04	(0.13	–	8.26)

	Lymphoid, hematopoietic and related tissue	1.00	–			–				0.00	(0.00 – 9.20)
	Others	1.00	0.06	(0.03 – 0.12)		0.10	(0.04 – 0.25)			0.10	(0.03 – 0.33)
Hemodialysis use	Digestive organs	1.00	0.16	(0.11 – 0.25)		0.33	(0.05 – 1.98)			–	
	Respiratory and intrathoracic organs	1.00	0.07	(0.03 – 0.15)		–				0.10	(0.00 – 6.12)
	Lymphoid, hematopoietic and related tissue	1.00	0.09	(0.04 – 0.21)		0.14	(0.01 – 3.49)			–	
	Others	1.00	0.19	(0.14 – 0.24)		0.10	(0.05 – 0.21)			0.08	(0.03 – 0.25)
Mechanical ventilation use	Digestive organs	1.00	0.16	(0.11 – 0.25)		0.22	(0.12 – 0.40)			0.27	(0.12 – 0.64)
	Respiratory and intrathoracic organs	1.00	0.07	(0.03 – 0.15)		0.05	(0.01 – 0.23)				
	Lymphoid, hematopoietic and related tissue	1.00	0.09	(0.04 – 0.21)		0.10	(0.03 – 0.37)			0.08	(0.02 – 0.32)
	Others	1.00	0.19	(0.14 – 0.24)		0.23	(0.15 – 0.33)			0.31	(0.19 – 0.49)
Chemotherapy use	Digestive organs	1.00	0.13	(0.03 – 0.51)		–				1.10	(0.28 – 4.35)
	Respiratory and intrathoracic organs	1.00	–			0.00	(0.00 – 0.26)			0.06	(0.00 – 1.02)
	Lymphoid, hematopoietic and related tissue	1.00	–	(0.00 – 0.25)		0.00	(0.00 – 0.01)			–	
	Others	1.00	0.38	(0.14 – 1.02)		0.00	(0.00 – 0.03)			0.49	(0.23 – 1.02)

V. Discussion

1. Discussion of the Study Methods

The aim of this study was to investigate the effects of the Life-sustaining Treatment Plan on healthcare expenditure and healthcare utilization of patients who died from cancer.

A major strength of this study is that we used data from the National Health Information DB of the National Health Insurance Service of Korea, collected nationally between 2018 and 2020. This database refers to big data, which includes 1.3 trillion qualifying cases, insurance rate, medical examination results, treatment details, clinic status, cancer, and rare disease information among many others.

For correlation between the LSTP and control groups, we conducted a propensity score matching using sex, age, medical coverage type, cancer type, cancer start date, duration until death, and hospital type. Propensity score matching reduces the influence of confounders by making the distribution of independent variables in the study similar ⁴⁷.

In general, the Poisson regression or negative binomial regression is performed when the dependent variables are numerical data such as the number of outpatient visits or hospitalization. However, in this study, a negative binomial regression was performed because the dependent variable, medical utilization, had

a nonnegative integer value, which caused concern over this type of overdispersion ^{48,49}.

To the best of our knowledge, this study is among the first few to attempt and investigate the association between the decision to withdraw life-sustaining treatment and healthcare expenditure and utilization, in South Korea. However, a number of limitations must be noted.

First, we could not distinguish between withdrawing life-sustaining treatment and withholding life-sustaining treatment. Although ethicists consistently point out that there is no ethical difference between the decision not to begin and the decision not to pursue life-sustaining treatment, surveys broadly show that health professionals widely dispute the ethical equivalence of the suspension and discontinuation of treatment ⁵⁰. Similarly, a study indicates that the distinction between withholding and withdrawal of treatment was not clinically meaningful, nevertheless relevant because of individual religious beliefs and Korean cultural traditions ⁵¹. Further research is needed to determine the difference between withdrawing life-sustaining treatment and withholding life-sustaining treatment.

Second, we could not determine the severity of the cancers that patients were suffering from. However, we considered surgery, radiation therapy, and chemotherapy to partially control for the severity of cancers.

Third, because of data limitations, we could not include potential confounders that could affect expenditure and utilization, including health-related behaviors such as smoking, drinking, and physical activity.

2. Discussion of the Results

The Life-sustaining Treatment Plan was associated with a reduction in total cost in the last 30 and 60 days of life. In addition, LSTP was associated with a reduction in hospitalization cost, outpatient cost, and medication cost in the last 30 and 60 days of life. Similarly, the decision to withdraw life-sustaining treatment was associated with a reduction in the days of hospitalization and outpatient visits in the last 30 days of life.

On the other hand, LSTP was associated with an increase in hospice costs in the last 30, 60, and 90 days of life. Hospice use increased in the last 30, 60, and 90 days of life for the LSTP group compared to the control group. The Determination of the Life-Sustaining Treatment Act requires confirmation of the intention to use hospice palliative care at the time of preparing the LSTP. A previous study suggests that cancer patients who availed POLST showed a significant difference in their hospice utilization rate—49.9% compared to 27% of those who availed ADs—helping to resolve the negative perceptions about hospice⁵².

Among the four life-sustaining treatments, CPR and chemotherapy costs were reduced in the last 30, 60, and 90 days. A previous study indicates that the provider decision on withdrawing CPR more frequently matched with patient's preferences than any other life-sustaining treatment such as dialysis, mechanical ventilation, etc.⁵³. Before the legislation of the Determination of Life-Sustaining Treatment Act, DNR orders were formally implemented in some medical

institutions⁵⁴. This may allow physicians and patients to decide to withdraw CPR, which is less burdensome than any other life-sustaining treatment. A study of cancer patients with DNR indicates that participants with DNR received less CPR and chemotherapy than non-DNR cancer patients in oncology wards⁵⁵.

The LSTP group incurred higher ICU costs and use than the control group. A previous study suggests that ICU admission is the one factor that is highly associated with the decision to limit life-sustaining treatment³⁷. Another study indicates that patients who have limited access to life-sustaining treatment are more likely to suffer from organ system failure⁵⁶. It can be inferred that the medical condition of the LSTP group was worse than the control group, and most were already using the ICU more than the control group participants. Although many studies suggest that withdrawing life-sustaining treatment is not associated with reducing ICU admission, some studies imply a strong association between withdrawing life-sustaining treatment and a reduction of ICU admission. One study suggests that limiting life-sustaining treatment is associated with lower rates of ICU admission compared with patients who access complete treatment³³.

A study on family decision-making to withdraw life-sustaining treatment indicates that one of the reasons for withdrawal is financial burden. Patients' families pay a number of incidental medical bills during hospitalization. In addition, patients and their families complain of financial burden such as hospital room fee and caregiver cost⁵⁷. Another study suggests that there was a significant difference in attitude toward withdrawing life-sustaining treatment according to the patient's self-perceived amount of treatment cost burden; a more positive

response to the withdrawal of life-sustaining treatment was found in the case of patients perceiving a burden in treatment costs ⁵⁸.

Approximately 75%, 70%, and 67% of the LSTP group implemented their plans in the last 30, 60, and 90 days of life, respectively. In the US, the consistency rate of POLST varies from 46% to 94% ^{29,30}. This is because POLST allows patients to choose among four medical treatments that will not be received, while LSTP should not be used for life-sustaining treatment without selecting them. For this reason, the consistency rate of LSTP is low due to the burden on patients and their caregivers. Although it was not statistically significant, the LSTP group, which implemented the plan, spent less money on almost every expenditure variable. These results indicate that it is important not only to provide a written form of the LSTP but also implement the plan to save medical costs.

Withdrawing life-sustaining treatment for a patient by their family is difficult, requires a fair process, and can have adverse consequences for the family members. Such approaches can be helpful, but they are unlikely to result in significant cost savings because they choose resource-intensive care in the face of low chances of survival ^{59,60}.

VI. Conclusion

In this study, we found that the Life-sustaining Treatment Plan reduced healthcare expenditure and utilization in the last 30 days of life. Adversely, we found that increased costs and use of hospice were associated with the decisions to withdraw life-sustaining treatment.

Although there are numerous limitations to our data and analogy, we believe that this study can have a significant impact socially, politically, and economically, by increasing awareness of the positive association between the decision to withdraw life-sustaining treatment and healthcare expenditure and utilization.

There will be a moment when patients who are terminally ill or at the end stage of life have to decide whether to continue life-sustaining treatment or not. Helping patients and their families to make self-directed judgments related to life-sustaining treatment is a major factor in achieving an assisted and easy passing.

As the decision to withdraw life-sustaining treatment is effective in reducing healthcare expenditure and utilization in the last 30 days of life, it is necessary to educate and promote the medical staff, patients, and their caregivers to prepare necessary and relevant LSTP.

Abbreviations

AD — advance directives
ADRT — advance decisions to refuse treatment
ANOVA — analysis of variance
CPR — cardio-pulmonary resuscitation
DNR — do not resuscitate
DNI — do not intubate
EMR — electronic medical record
ER — emergency room
GLM — generalized linear model
ICU — intensive care unit
LPA — lasting power of attorney
LSTP — life-sustaining treatment plan
POLST — physician orders for life sustaining treatment

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국문요약

연명의료 계획서 작성이 암환자의 의료비 및 의료이용에 미치는 영향

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서론: 암환자의 의료비는 진단 전 급격히 증가했다가 진단 후 감소했다가 죽음에 가까워 지면서 다시 급증하는 양상을 보인다. 의료이용 역시 사망 마지막 한 달 동안 증가한다. 이에 무의미한 연명의료를 거부할 수 있는 환자의 권리가 논의됐고, 연명의료중단에 관한 법률이 제정되었다. 말기 환자와 임종 직전의 환자는 자신의 연명의료 중단에 관하여 연명의료계획서를 작성할 수 있다. 이 연구는 암으로 사망한 환자의 연명의료계획서 작성이 의료비 지출 및 의료이용에 미치는 영향을 분석하고자 하였다.

연구방법: 이 연구는 2018년부터 2020년까지 수집된 국민건강보험공단 청구 자료를 사용하였다. 암환자 중 연명의료계획서 작성군과 비작성군을 1:1 성향점수매칭기법을 사용하여 총 23,494 명의 대상자를 산출해냈다. 작성군과 비작성군의 사망 전 의료비와 의료이용을 사망 전 30일, 60일, 90일의 3구간으로 나누어 분석하였다. 연명의료계획서 작성 여부가 의료비와 의료이용에 미치는 영향을 알아보기 위하여 일반화선형모형을 사용하였다. 암종과 따라 하위그룹분석을 실시하였다.

연구결과: 대상자 23,494명 중 작성군과 비작성군은 각각 11,747명이었다. 30일 이상 생존한 그룹이 11,301명, 60일 이상 생존한 그룹이 5,173명, 90일

이상 생존한 그룹이 3,005 명이었다. 비작성군에 비해 작성군의 총의료비는 사망 30 일 ($EXP(\beta)$: 0.81, 95% CI: 0.78-0.85), 60 일 ($EXP(\beta)$: 0.90, 95% CI: 0.90-0.99)에서 적었다. 4 가지 연명의료에서 중 CPR 과 항암치료가 비작성군에 비해 작성군의 의료비가 적었다. 그러나 호스피스 비용과 이용은 비작성군에 비해 작성군에서 더 높은 $EXP(\beta)$ 을 보였다.

결론: 이 연구에서는 연명의료계획서 작성이 사망 전 30 일 동안 의료비와 의료이용을 감소 시킨다는 분석결과를 확인하였다. 그러나 호스피스의 이용 및 비용이 증가한 것으로 분석되었다. 연명의료계획서 작성이 의료비와 의료이용을 줄일 수 있기 때문에 연명의료계획서 작성을 위해 의료진, 환자 및 보호자를 교육하고 홍보할 필요가 있다.

Appendix

Appendix 1. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients

Appendix 2. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan by implementation of LSTP

Appendix 3. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients

Appendix 4. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients (in cost and frequency)

Appendix 5. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan by implementation of LSTP

Appendix 6. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan by implementation of LSTP (in cost and frequency)

Appendix 7. Results of subgroup analysis of the LSTP on healthcare expenditure and utilization, stratified by cancer type

Appendix 1. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients

Variables	Life-Sustaining Treatment Plan (LSTP)				P-value
	Total				
	Yes		No		
	Mean	SD	Mean	SD	
Expenditure (in ₩)					
Total cost	16,184,856	19,442,936	12,588,698	17,253,642	<.0001
Hospitalization Cost	15,584,581	18,515,287	11,388,471	15,767,382	<.0001
Outpatient cost	428,886	2,597,815	922,751	3,659,409	<.0001
Medication cost	171,389	2,309,070	277,475	1,731,392	<.0001
ICU cost	543,996	3,041,731	491,694	1,992,872	0.1193
Narcotic painkillers cost	31,075	461,789	33,185	338,679	0.6898
Hospice cost	3,922,945	10,222,729	842,553	3,045,726	<.0001
CPR cost	1,234	16,303	8,167	41,611	<.0001
Hemodialysis cost	99,628	1,078,582	130,398	1,144,355	0.0340
Mechanical ventilation cost	117,068	880,365	110,253	521,235	0.4706
Chemotherapy cost	11,802	470,122	54,003	729,892	<.0001
Utilization					
Days of hospitalization	41.49	52.05	28.95	37.51	<.0001
Outpatient visit	2.92	11.64	5.75	15.65	<.0001
ICU use	0.44	2.11	0.56	1.78	<.0001
Narcotic painkillers use	0.33	2.38	0.44	2.02	0.0002
Hospice use	3.83	8.90	1.17	3.24	<.0001
CPR use	0.01	0.10	0.06	0.26	<.0001
Hemodialysis use	0.36	7.45	0.70	10.90	0.0054
Mechanical ventilation use	0.26	1.28	0.40	1.27	<.0001
Chemotherapy use	0.03	0.50	0.09	0.88	<.0001

Appendix 2. General characteristics of the study population's healthcare expenditure and utilization, after the date of plan by implementation of LSTP

Variables	Life-Sustaining Treatment Plan (LSTP)						P-value
	Total						
	Yes				No		
	Implementation		Non-implementation				
	N=9,537		N=2,210		N=11,747		
	Mean	SD	Mean	SD	Mean	SD	
Expenditure (in ₩)							
Total cost	15,908,186	19,736,067	17,378,794	18,079,402	12,588,698	17,253,642	<.0001
Hospitalization cost	15,447,019	18,909,459	16,178,212	16,698,954	11,388,471	15,767,382	<.0001
Outpatient cost	325,421	2,357,910	875,380	3,411,509	922,751	3,659,409	<.0001
Medication cost	135,746	2,068,672	325,201	3,138,178	277,475	1,731,392	<.0001
ICU cost	604,396	3,233,937	283,348	1,991,348	491,694	1,992,872	<.0001
Narcotic painkillers cost	23,644	458,180	63,145	475,826	33,185	338,679	0.0002
Hospice cost	3,640,290	9,977,800	5,142,712	11,138,971	842,553	3,045,726	<.0001
CPR cost	1,358	17,464	696	9,813	8,167	41,611	<.0001
Hemodialysis cost	110,959	1,177,092	50,731	449,088	130,398	1,144,355	0.0780
Mechanical ventilation cost	132,584	951,951	50,111	451,261	110,253	521,235	<.0001
Chemotherapy cost	10,896	509,680	15,716	231,907	54,003	729,892	<.0001
Utilization							
Days of hospitalization	39.43	50.40	50.36	57.79	28.95	37.51	<.0001
Outpatient visit	2.23	10.77	5.86	14.44	5.75	15.65	<.0001
ICU use	0.47	2.14	0.33	1.96	0.56	1.78	<.0001

Narcotic painkillers use	0.22	2.09	0.83	3.32	0.44	2.02	<.0001
Hospice use	3.44	8.44	5.48	10.49	1.17	3.24	<.0001
CPR use	0.01	0.11	0.01	0.07	0.06	0.26	<.0001
Hemodialysis use	0.41	8.24	0.16	1.52	0.70	10.90	0.0111
Mechanical ventilation use	0.29	1.34	0.13	0.97	0.40	1.27	<.0001
Chemotherapy use	0.02	0.43	0.07	0.74	0.09	0.88	<.0001

Appendix 3. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients

Variables	Life-Sustaining Treatment Plan (LSTP)			
	No	Total		
		EXP(β)	Yes	
			95% CI	
Expenditure				
Total cost	1.00	1.25	(1.22	- 1.28)
Hospitalization cost	1.00	1.34	(1.30	- 1.38)
Outpatient cost	1.00	0.43	(0.38	- 0.48)
Medication cost	1.00	0.49	(0.41	- 0.58)
ICU cost	1.00	1.14	(0.89	- 1.45)
Narcotic painkillers cost	1.00	0.82	(0.59	- 1.15)
Hospice cost	1.00	2.61	(2.17	- 3.15)
CPR cost	1.00	0.15	(0.08	- 0.28)
Hemodialysis cost	1.00	0.96	(0.62	- 1.47)
Mechanical ventilation cost	1.00	1.04	(0.78	- 1.40)
Chemotherapy cost	1.00	0.26	(0.13	- 0.53)
Utilization				
Days of hospitalization	1.00	1.35	(1.32	- 1.39)
Outpatient visit	1.00	0.45	(0.42	- 0.47)
ICU use	1.00	0.78	(0.72	- 0.85)
Narcotic painkillers use	1.00	0.64	(0.57	- 0.73)
Hospice use	1.00	2.81	(2.59	- 3.04)
CPR use	1.00	0.16	(0.13	- 0.20)
Hemodialysis use	1.00	0.59	(0.50	- 0.70)
Mechanical ventilation use	1.00	0.64	(0.58	- 0.71)
Chemotherapy use	1.00	0.41	(0.27	- 0.61)

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

Appendix 4. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan or matched date in non-plan patients (in cost and frequency)

Variables	Life-Sustaining Treatment Plan (LSTP)			
	No	Total		
		Estimate	S.E.	P-value
Expenditure (in ₩)				
Total cost	ref.	2,743,478	235,431	<.0001
Hospitalization cost	ref.	3,553,097	221,493	<.0001
Outpatient cost	ref.	-648,242	41,652	<.0001
Medication cost	ref.	-161,377	27,193	<.0001
ICU cost	ref.	52,388	34,265	0.1263
Narcotic painkillers cost	ref.	-8,810	5,403	0.1030
Hospice cost	ref.	2,821,773	99,818	<.0001
CPR cost	ref.	-6,638	422	<.0001
Hemodialysis cost	ref.	-33,350	14,844	0.0247
Mechanical ventilation cost	ref.	4,438	9,655	0.6457
Chemotherapy cost	ref.	-51,421	8,189	<.0001
Utilization				
Days of hospitalization	ref.	10.60	0.59	<.0001
Outpatient visit	ref.	-3.67	0.18	<.0001
ICU use	ref.	-0.12	0.03	<.0001
Narcotic painkillers use	ref.	-0.18	0.03	<.0001
Hospice use	ref.	2.42	0.09	<.0001
CPR use	ref.	-0.05	0.00	<.0001
Hemodialysis use	ref.	-0.38	0.12	0.0025
Mechanical ventilation use	ref.	-0.14	0.02	<.0001
Chemotherapy use	ref.	-0.07	0.01	<.0001

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

Appendix 5. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan by implementation of LSTP

Variables	Life-Sustaining Treatment Plan (LSTP)								
	Total								
	No	Yes				Non-implementation			
		Implementation		Non-implementation		Implementation		Non-implementation	
	EXP(β)	95% CI	EXP(β)	95% CI	EXP(β)	95% CI	EXP(β)	95% CI	
Expenditure									
Total cost	1.00	1.24	(1.21 – 1.27)	1.30	(1.24 – 1.36)				
Hospitalization cost	1.00	1.28	(1.25 – 1.32)	1.31	(1.25 – 1.36)				
Outpatient cost	1.00	0.74	(0.69 – 0.79)	1.07	(0.98 – 1.18)				
Medication cost	1.00	1.28	(1.17 – 1.41)	1.22	(1.09 – 1.36)				
ICU cost	1.00	1.73	(1.61 – 1.87)	1.26	(1.08 – 1.47)				
Narcotic painkillers cost	1.00	2.03	(1.71 – 2.42)	1.25	(1.05 – 1.48)				
Hospice cost	1.00	1.72	(1.64 – 1.82)	1.64	(1.53 – 1.76)				
CPR cost	1.00	1.11	(0.99 – 1.24)	0.77	(0.59 – 0.99)				
Hemodialysis cost	1.00	1.47	(1.31 – 1.65)	1.30	(0.99 – 1.69)				
Mechanical ventilation cost	1.00	1.94	(1.75 – 2.14)	1.60	(1.24 – 2.05)				
Chemotherapy cost	1.00	0.43	(0.27 – 0.67)	0.44	(0.27 – 0.71)				
Utilization									
Days of hospitalization	1.00	1.29	(1.26 – 1.33)	1.61	(1.54 – 1.68)				
Outpatient visit	1.00	0.34	(0.32 – 0.36)	0.90	(0.82 – 0.99)				
ICU use	1.00	0.83	(0.76 – 0.90)	0.57	(0.49 – 0.66)				

Narcotic painkillers use	1.00	0.44	(0.38	–	0.50)	1.48	(1.22	–	1.81)
Hospice use	1.00	2.56	(2.36	–	2.79)	3.80	(3.31	–	4.36)
CPR use	1.00	0.17	(0.14	–	0.22)	0.11	(0.06	–	0.19)
Hemodialysis use	1.00	0.63	(0.52	–	0.77)	0.32	(0.23	–	0.46)
Mechanical ventilation use	1.00	0.72	(0.65	–	0.80)	0.31	(0.25	–	0.38)
Chemotherapy use	1.00	0.31	(0.27	–	0.36)	0.63	(0.53	–	0.75)

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

Appendix 6. Results of GLM for LSTP on healthcare expenditure and utilization, after the date of plan by implementation of LSTP (in cost and frequency)

Variables	Life-Sustaining Treatment Plan (LSTP)			
	Non-implementation	Total		
		Estimate	S.E.	P-value
Expenditure (in ₩)				
Total cost	ref.	3,652,203	366,684	<.0001
Hospitalization cost	ref.	3,572,053	371,871	<.0001
Outpatient cost	ref.	12,729	53,451	0.8118
Medication cost	ref.	67,421	53,507	0.2077
ICU cost	ref.	433,860	72,825	<.0001
Narcotic painkillers cost	ref.	-4,257	10,931	0.6969
Hospice cost	ref.	-247,666	229,800	0.2811
CPR cost	ref.	637	392	0.1046
Hemodialysis cost	ref.	95,671	25,872	0.0002
Mechanical ventilation cost	ref.	111,983	21,108	<.0001
Chemotherapy cost	ref.	16,714	11,246	0.1372
Utilization				
Days of hospitalization	ref.	3.05	0.92	0.0009
Outpatient visit	ref.	-0.49	0.21	0.0198
ICU use	ref.	0.20	0.05	<.0001
Narcotic painkillers use	ref.	-0.30	0.05	<.0001
Hospice use	ref.	-1.12	0.20	<.0001
CPR use	ref.	0.00	0.00	0.1838
Hemodialysis use	ref.	0.61	0.18	0.0006
Mechanical ventilation use	ref.	0.19	0.03	<.0001
Chemotherapy use	ref.	0.00	0.01	0.6804

*Controlled for Gender, Age, Medical coverage type, Insurance premium, Cancer type, Hospital type, Surgery, Radiation therapy, and Chemotherapy.

Appendix 7. Results of subgroup analysis of the LSTP on healthcare expenditure and utilization, stratified by cancer type

Variables	Cancer type (affecting)	Life-Sustaining Treatment Plan (LSTP)				
		No	Total			
			EXP(β)	Yes		
			95% CI			
Expenditure						
Total cost	Digestive organs	1.00	1.23	(1.18	–	1.28)
	Respiratory and intrathoracic organs	1.00	1.25	(1.18	–	1.32)
	Lymphoid, hematopoietic and related tissue	1.00	1.26	(1.17	–	1.37)
	Others	1.00	1.26	(1.22	–	1.31)
Hospitalization cost	Digestive organs	1.00	1.26	(1.20	–	1.32)
	Respiratory and intrathoracic organs	1.00	1.29	(1.22	–	1.37)
	Lymphoid, hematopoietic and related tissue	1.00	1.27	(1.18	–	1.37)
	Others	1.00	1.30	(1.26	–	1.34)
Outpatient cost	Digestive organs	1.00	0.46	(0.41	–	0.51)
	Respiratory and intrathoracic organs	1.00	0.58	(0.51	–	0.67)
	Lymphoid, hematopoietic and related tissue	1.00	0.97	(0.80	–	1.18)
	Others	1.00	0.83	(0.76	–	0.90)
Medication cost	Digestive organs	1.00	0.78	(0.68	–	0.90)
	Respiratory and intrathoracic organs	1.00	0.72	(0.59	–	0.87)

	Lymphoid, hematopoietic and related tissue	1.00	0.91	(0.72	–	1.16)
	Others	1.00	0.99	(0.90	–	1.09)
ICU cost	Digestive organs	1.00	1.57	(1.36	–	1.82)
	Respiratory and intrathoracic organs	1.00	1.60	(1.31	–	1.95)
	Lymphoid, hematopoietic and related tissue	1.00	1.76	(1.33	–	2.35)
	Others	1.00	1.75	(1.59	–	1.92)
Narcotic painkillers cost	Digestive organs	1.00	1.80	(1.36	–	2.40)
	Respiratory and intrathoracic organs	1.00	1.25	(0.75	–	2.06)
	Lymphoid, hematopoietic and related tissue	1.00	1.30	(0.76	–	2.22)
	Others	1.00	1.31	(1.09	–	1.56)
Hospice cost	Digestive organs	1.00	1.76	(1.57	–	1.98)
	Respiratory and intrathoracic organs	1.00	1.53	(1.34	–	1.76)
	Lymphoid, hematopoietic and related tissue	1.00	1.60	(1.38	–	1.86)
	Others	1.00	1.76	(1.65	–	1.89)
CPR cost	Digestive organs	1.00	0.91	(0.76	–	1.11)
	Respiratory and intrathoracic organs	1.00	1.28	(0.90	–	1.83)
	Lymphoid, hematopoietic and related tissue	1.00	1.02	(0.76	–	1.39)
	Others	1.00	1.06	(0.92	–	1.23)

Hemodialysis cost	Digestive organs	1.00	1.30	(0.99	–	1.69)
	Respiratory and intrathoracic organs	1.00	1.23	(0.93	–	1.62)
	Lymphoid, hematopoietic and related tissue	1.00	1.39	(0.89	–	2.17)
	Others	1.00	1.53	(1.33	–	1.77)
Mechanical ventilation cost	Digestive organs	1.00	1.55	(1.29	–	1.86)
	Respiratory and intrathoracic organs	1.00	2.25	(1.64	–	3.09)
	Lymphoid, hematopoietic and related tissue	1.00	3.21	(2.15	–	4.79)
	Others	1.00	2.01	(1.77	–	2.29)
Chemotherapy cost	Digestive organs	1.00	0.87	(0.45	–	1.69)
	Respiratory and intrathoracic organs	1.00	0.57	(0.21	–	1.50)
	Lymphoid, hematopoietic and related tissue	1.00	0.39	(0.13	–	1.19)
	Others	1.00	0.27	(0.16	–	0.47)
Utilization						
Days of hospitalization	Digestive organs	1.00	1.30	(1.24	–	1.35)
	Respiratory and intrathoracic organs	1.00	1.29	(1.22	–	1.36)
	Lymphoid, hematopoietic and related tissue	1.00	1.45	(1.35	–	1.57)
	Others	1.00	1.36	(1.32	–	1.41)
Outpatient visit	Digestive organs	1.00	0.30	(0.27	–	0.33)
	Respiratory and intrathoracic organs	1.00	0.27	(0.24	–	0.31)

	Lymphoid, hematopoietic and related tissue	1.00	0.39	(0.32	–	0.47)
	Others	1.00	0.46	(0.42	–	0.50)
ICU use	Digestive organs	1.00	0.77	(0.65	–	0.92)
	Respiratory and intrathoracic organs	1.00	0.75	(0.60	–	0.94)
	Lymphoid, hematopoietic and related tissue	1.00	0.49	(0.36	–	0.66)
	Others	1.00	0.85	(0.76	–	0.95)
Narcotic painkillers use	Digestive organs	1.00	0.35	(0.28	–	0.44)
	Respiratory and intrathoracic organs	1.00	0.33	(0.23	–	0.47)
	Lymphoid, hematopoietic and related tissue	1.00	0.57	(0.32	–	1.03)
	Others	1.00	0.68	(0.57	–	0.80)
Hospice use	Digestive organs	1.00	2.44	(2.02	–	2.95)
	Respiratory and intrathoracic organs	1.00	2.31	(1.83	–	2.92)
	Lymphoid, hematopoietic and related tissue	1.00	3.00	(2.36	–	3.80)
	Others	1.00	3.03	(2.73	–	3.36)
CPR use	Digestive organs	1.00	0.24	(0.15	–	0.37)
	Respiratory and intrathoracic organs	1.00	0.15	(0.08	–	0.29)
	Lymphoid, hematopoietic and related tissue	1.00	0.12	(0.06	–	0.24)
	Others	1.00	0.14	(0.11	–	0.20)

Hemodialysis use	Digestive organs	1.00	0.51	(0.30	–	0.89)
	Respiratory and intrathoracic organs	1.00	0.86	(0.53	–	1.39)
	Lymphoid, hematopoietic and related tissue	1.00	0.60	(0.26	–	1.38)
	Others	1.00	0.49	(0.40	–	0.60)
Mechanical ventilation use	Digestive organs	1.00	0.77	(0.63	–	0.95)
	Respiratory and intrathoracic organs	1.00	0.52	(0.37	–	0.71)
	Lymphoid, hematopoietic and related tissue	1.00	0.42	(0.28	–	0.62)
	Others	1.00	0.66	(0.58	–	0.76)
Chemotherapy use	Digestive organs	1.00	0.29	(0.14	–	0.59)
	Respiratory and intrathoracic organs	1.00	0.04	(0.01	–	0.10)
	Lymphoid, hematopoietic and related tissue	1.00	0.09	(0.04	–	0.21)
	Others	1.00	0.47	(0.34	–	0.66)
