Impact of Type of Hospice Use on End-of-Life Care Patterns and Expenditures of Cancer Deaths

Il Yun

The Graduate School

Yonsei University

Department of Public Health

Impact of Type of Hospice Use on End-of-Life Care Patterns and Expenditures of Cancer Deaths

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Il Yun

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This certifies that the dissertation of ***Il Yun*** is approved.

Sung-In Jang: Thesis Supervisor

Eun-Cheol Park: Thesis Committee Member #1

Chung Mo Nam: Thesis Committee Member #2

Jaeyong Shin: Thesis Committee Member #3

Suk-Yong Jang: Thesis Committee Member #4

The Graduate School

Yonsei University

December 2023

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Il Yun

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ABSTRACT

Impact of Type of Hospice Use on End-of-Life Care Patterns and Expenditures of Cancer Deaths

Il Yun
Dept. of Public Health
The Graduate School
Yonsei University

Background: Patients with advanced cancer often experience physical and psychological symptoms related to their conditions, treatment or comorbidities. Unfortunately, these symptoms are frequently left unaddressed by conventional medical care, resulting in a negative impact on patients' well-being. To address this, hospice and palliative care initiatives were introduced to prioritize symptom relief and improve the quality of life (QoL) for terminally ill patients and their caregivers. In Korea, discussions on dignified end-of-life (EoL) decisions are active in response to the rapid aging population and increasing number of cancer patients. As a result, three types of hospice care services - hospital-based hospice, home-based hospice and consultative hospice - became mandatory to be covered by health insurance, but few studies have examined the differences in the effects of each type on healthcare utilization at the EoL. Therefore, this study aims to evaluate the effects

of type of hospice use on EoL care patterns and expenditures for cancer deaths.

Methods: In this population-based cohort study, the Korean National Health Insurance Service (NHIS)-customized cohort data containing all registered cancer patients who died between 2017 and 2021 were used. According to the exclusion criteria, 408,964 individuals were finally eligible for analysis. The variable of interest was the type of hospice used within 6 months before death, which was classified into four categories as follows: (1) non-hospice users; (2) hospital-based hospice single users; (3) home-based hospice single users; (4) combined hospice users. The outcomes were determined to the following two: (1) care patterns, which were divided into intense care and supportive care; (2) expenditures, which were divided into total medical expenses and out-of-pocket expenses (OOPs). To identify differences in outcomes between hospice types, a generalized linear model (GLM) was used. First, in analyses exploring differences in care patterns, we applied a GLM with zero-inflated negative binomial distribution. Next, in analyses exploring differences in expenditures, a GLM with a Gamma distribution was applied. Last, to analyze time trends and changes of outcomes according to hospice enrollment, we conducted an interrupted time series (ITS) with segmented Poisson regression.

Results: Hospice enrollment was associated with less intense care and more supportive care near death. Notably, those who used combined hospice care had the lowest probability and intensity of intense care (aOR: 0.18, 95% CI: 0.17-0.19, aRR: 0.47, 95% CI: 0.44-0.49), while home-based hospice single users had the highest probability and intensity of

supportive care (Prescription for narcotic analgesics, aOR: 2.95, 95% CI: 2.69-3.23, aRR: 1.45, 95% CI: 1.41-1.49; Mental health care, aOR: 3.40, 95% CI: 3.13-3.69, aRR: 1.35, 95% CI: 1.31-1.39). In addition, hospice enrollment had a significant effect on reducing OOPs spent at the EoL (Hospital-based hospice only, Exp(β)=0.91, 95% CI: 0.90-0.92; Home-based hospice only, Exp(β)=0.50, 95% CI: 0.48-0.52; Combined hospice, Exp(β)=0.69, 95% CI: 0.67-0.71). In ITS analysis, immediate policy effects and trend changes were observed following the intervention. After terminal cancer patients used in hospice, unnecessary intense care was noticeable reduced, and QoL was improved through appropriate pain management and mental health care. Medical expenditures increased as death approaches, but the increase tends to slow after hospice enrollment.

Conclusions: Our findings identified that enrolling in hospice care was associated with less intense care, more supportive care and reduction in cost burden at the EoL. This suggests that although aggressive for life-sustaining decreases with hospice enrollment, QoL at the EoL actually improves with appropriate supportive care. This study is meaningful in that it not only offers valuable insight into hospice care for terminally ill patients, but also provides policy implications for the introduction of patient-centered community-based hospice services.

Keywords: Hospice, Cancer deaths, End-of-life care, Medical Expense, Quality of life

I. Introduction

1. Background

In recent decades, cancer has emerged as the primary cause of mortality worldwide. By the year 2020, approximately 10 million people died from cancer, which is accounting for roughly one-sixth of all recorded deaths [1]. Even though there have been notable improvements in cancer detection and treatment, which have extended the lifespans of many cancer patients, a substantial number continue to receive diagnoses at advanced terminal stage of their illness. Those afflicted with advanced care often contend with physical and psychological symptoms stemming from their illness, treatment or concurrent health issues [2]. Regrettably, these symptoms are frequently left unaddressed by conventional medical care, resulting in a profound impact on patients' well-being and relationship with their families [3-5]. Accordingly, hospice and palliative care initiatives were introduced to enhance the quality of life (QoL) of terminally ill patients and their caregivers by prioritizing relief rather than cure [6].

Hospice and palliative care are integral components of patient-centered healthcare and a part of a global ethical obligation to mitigate profound impacts of severe health conditions, encompassing physical, emotional, and spiritual dimensions [7]. The delivery of hospice care services can vary across different settings, including hospitals, nursing homes, and patients'

own residence [8-12], contingent upon the healthcare infrastructure of each nation. The World Health Organization estimates that approximately 56.8 million individuals, including 25.7 million in their final year of life, require palliative care annually [13,14]. This demand is on the rise due to the global aging trends and the increasing prevalence of chronic illnesses such as cancer, heart diseases, and dementia. However, the current provision of palliative care falls far short of meeting this need, with only approximately 14% of those requiring it receiving these services [13,14].

Furthermore, in response to Korea's rapidly aging population, deliberations regarding dignified end-of-life (EoL) decisions are ongoing. In 2016, the Korean National Assembly enacted the "Act on Hospice and Palliative Care and Decision on Life-Sustaining Treatment for Patients at End of Life" [15,16], which permits terminally ill patients to make the choice to forego life-sustaining treatment (LST). The primary objective of this act is to protect the best interests of patients and uphold their autonomy in exercising their right to self-determination when opting to discontinue LST, particularly when its continuation would only meaninglessly prolong the EoL phase [15,16]. Since this act went into effect, the three types of hospice services - hospital-based hospice, home-based hospice and consultative hospice - have been covered by health insurance one by one, actively encouraging the use of hospice care.

It's noteworthy that in Korea, cancer accounts for one in every four deaths, and approximately 23.2% of all cancer-related fatalities are involved in hospice care services [17], indicating the withdrawal of LST. Although three types of hospice services have been introduced in Korea, the majority of patients opt for hospital-based hospice care. Only 4%

of patients choose home-based hospice care [17], whereas consultative hospice services serve as a supplementary step before patient enrollment in hospital- or home-based hospice care. This current state of hospice utilization in Korea prompted us to consider the efficacy of this policy.

A number of prior studies have examined the impact of hospice on healthcare utilization and costs for terminally ill cancer patients. They suggested that offering hospice care at an earlier stage may have the potential to reduce unnecessary hospital admissions and healthcare resource utilization [18]. Furthermore, the adoption of hospice care tends to lower medical expenses by discontinuing unnecessary medical interventions [19]. Several studies have also demonstrated that hospice care effectively manages severe pain and enhances the patients' overall QoL [20,21]. In countries with diverse hospice service offerings, researches have explored the outcomes of both hospital-based and home-based hospice models.

Patients who opt for home-based hospice care receive palliative support at their own residences and eventually pass away in a familiar and comfortable environment. Therefore, insurance mandates for home-based hospice care in Korea were recently introduced. However, this mandate leads to limited number of studies assessing the effectiveness of each type of care; and no studies have evaluated whether this policy has been implemented as intended. Moreover, although a significant number of patients use more than one type of hospice care depending on their health status or preferences, the effects of this multiple use on healthcare utilization and health outcomes have never been evaluated.

Therefore, we realized that more objective and useful information was needed in order for terminally ill patients to more actively exercise their right to self-determination at EoL and improve their QoL, in accordance with the initial legal and policy objectives of hospice care services. This served as a key opportunity for us to explore more advanced hospice types by analyzing the differences in outcomes between types of hospice use. Our findings will contribute to ensuring a dignified EoL by providing evidence-based information to terminally ill patients who are hesitant about discontinuing LST, such as using hospice. Furthermore, it will provide meaningful policy implications in terms of effective medical use and medical supply at the EoL.

2. Study Objectives

This cohort study aims to investigate the impact of type of hospice use on EoL care patterns and expenditures of cancer deaths. Specifically, we will identify differences in outcomes near death depending on the type of hospice used, and also explore trend changes in outcomes following the hospice enrollment. Ultimately, our findings will provide information on the use of hospice as a means for terminally ill patients to exercise their right to self-determination at the end of their lives, and will contribute to providing policy implications and insights for the development of domestic EoL care system.

Details of the study objectives are as follows:

(1) To explore differences in whether and how intense care was received in their last 30 and 90 days of life according to the type of hospice used.

(2) To explore differences in whether and how supportive care such as narcotic analgesics prescriptions and mental health care received in their last 30 and 90 days of life according to the type of hospice used.

(3) To explore differences in total medical expenses and out-of-pocket expenses in their last 30 and 90 days of life according to the type of hospice used.

(4) To explore trend changes in care patterns and expenditures following the hospice enrollment.

II. Literature Review

1. Policy Background

1) End-of-Life Care

The increase in discussions on EoL care, encompassing hospice/palliative care and the discontinuation of LST, is strongly related to the aging population [22]. Particularly, Korea stands out as the world's most rapidly aging country, with the elderly population accounting for approximately 18.4% as of 2023, classifying it as an aged society. The swift aging of the population has led to various challenges, including prolonged suffering and disability among elderly patients and their families until death. In addition, it has significantly increased the economic burden associated with LST [23]. Against this background, global interest in the process of making decisions regarding one's own death or LST based on the right to self-determination and actively preparing for the EoL has grown [24].

It has only been a few years ago that deliberations on respecting the right to self-determination at the EoL have become active in Korea. A new turning point in EoL care has arrived with the "Act on Hospice and Palliative Care and Decision on Life-Sustaining Treatment for Patients at End of Life" and the so-called "Well-dying Act" with came into force in 2018 [16,22,25]. In Korean Society, well-dying is defined as a concept with the aspects

such as reflection of death, acceptance of death, advance care planning, and transcendence [26,27]. The key aspect of this act is the ability to withdraw LST against a patient's wishes at any time [22].

LST is defined as any treatment that extends life without addressing the underlying medical interventions, including procedures like mechanical ventilation, renal dialysis, chemotherapy, antibiotics, and artificial nutrition and hydration. The relevant legislation aims to safeguard the best interests of patients and uphold their rights to self-determination. In countries where legislation addressing EoL care was implemented earlier, there has been extensive research and interventions regarding withdrawal of LST. This has included studies on patients' perceptions of EoL care, physicians' orders related to LST, and ethical considerations. For critically ill patients and the elderly who are nearing the EoL, the medical decision to forgo or withdraw LST is particularly important. Thus, there were several studies that explored the preferences and decision-making process for LST among the terminally ill and their caregivers [28-31]. When LST become ineffective or do not align with the patient's preferences, restrictions can be established to withhold or withdraw these treatments to the patient. They found that the frequency of restricting LST increased over time, suggesting a shift in attitudes toward aggressive care received at the EoL [28,29].

Enrolling in hospice indicates a decision to withhold LST, and the patterns of EoL care has changed significantly due to the introduction and development of the hospice services. Several studies have shown that patients who have ever received hospice care have significantly lower average medical utilization and costs at the EoL [32]. Furthermore, In the previous findings, it was observed that the average frequency of emergency room visits,

intensive care unit (ICU) admissions, and other life-prolonging active treatment was significantly decreased after hospice enrollment [33,34]. However, in Korea, shortly after the enactment of the Well-dying Act, there is ongoing effort to establish societal consensus, resulting in a limited number of prior research investigations on the impact of withdrawing LST and using hospice on changes in EoL care patterns.

Given Korea's rapid aging, the demand for dignified EoL care is expected to steadily increase. While the general awareness of "Well-dying" is not keeping up with the rate at which our society is aging, there is growing interest in improving the quality of death (QoD) that mirrors the increasing emphasis on improving the QoL. In particular, establishing an institutional mechanism to respect the self-determination rights of patients at the EoL regarding meaningless LST and help them end their lives without pain is one of the important tasks of domestic public health policy.

2) Development of Hospice Care in Korea

(1) History of hospice care program in Korea

Korea was the first country in Asia to introduce hospice care services in 1965, but it took a long time to institutionalize it. Since the Cancer Control Act was enacted in 2003, a pilot program for hospice care has been implemented for patients with terminal cancer, and a pilot program for health insurance coverage of these services has been introduced since 2009 [35]. It was not until 2011 that the legal basis for hospice care was established in the Cancer Control Act, and in July 2015, health insurance mandates for hospital-based hospice care were introduced [36]. The Act on Hospice and Palliative Care and Decision on Life-Sustaining Treatment for Patients at End of Life, enacted the following year, became a new turning point for EoL care for terminally ill cancer patients. In March 2016, a pilot program for health insurance coverage for home-based hospice care was adopted, and in August 2017, a pilot gram for health insurance coverage for consultative hospice care was implemented [36,37]. And for these two types of hospice began to be covered by health insurance in September 2020 and January 2022, respectively [38]. Through this history, as of 2023, three types of hospice care are covered by national health insurance in Korea: hospital-based hospice, home-based hospice, and consultative hospice.

(2) Patients eligible for hospice care in Korea

According to Article 2, Paragraph 6 of the Act on Hospice and Palliative Care and Decision on Life-Sustaining Treatment for Patients at End of Life, patients eligible for hospice care are designated as terminally ill patients or patients in the process of dying and their families, who are suffering from one of the following five diseases: (i) Cancer, (ii) AIDS, (iii) COPD, (iv) Liver cirrhosis, (v) Other diseases designated Ordinance of the Ministry of Health and Welfare [17,39].

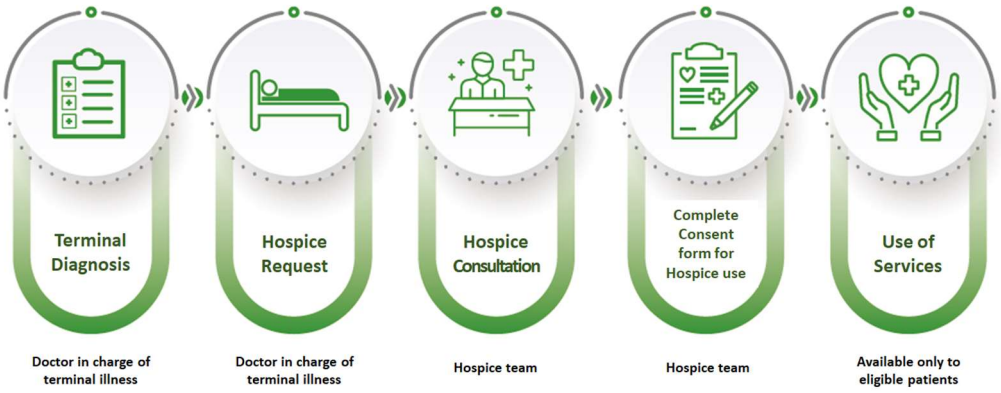
(3) Hospice care services provided in Korea

In Korea, three types of hospice care services are currently provided with the purpose of contributing to improving the QoL by alleviating the physical, psychosocial, and spiritual pain of terminally ill patients and their families. Hospice care services is covered by health insurance like general medical care, and the out-of-pocket rate for cancer patients is 5% [40]. The delivery procedures and payment systems for hospice care services are depicted in Figure 1 and Appendix 2, respectively.

First, hospital-based hospice refers to providing specialized palliative care services to terminally ill cancer patients and their families hospitalized in the hospice ward of a specialized institution designated by the Ministry of Health and Welfare. Unlike other types of hospice, it only targets patients with terminal cancer. For hospital-based hospice care services, per diem payment is adopted [40].

Second, home-based hospice refers that a hospice team from a specialized institution designated by the Ministry of Health and Welfare visits the homes of terminally ill patients and their families who wish to stay at home and provide specialized palliative care services. It provides services to patients with cancer, AIDS, COPD, cirrhosis, and chronic respiratory failure. Home-based hospice care services are priced on a fee-for-service basis [40].

Third, consultative hospice refers to the provision of specialized palliative care services by the hospice team together with the attending physician to terminally ill patient and their families receiving treatment in general wards and outpatient clinics. Likewise, it targets patients with cancer, AIDS, COPD, cirrhosis, and chronic respiratory failure. Consultative hospice care services include both inpatient and outpatient services, so both a flat-fee payment system and fee-for-service payment system are applied [40].



Source: National Hospice Center & Ministry of Health and Welfare. 2022 Annual report on national hospice and palliative care. 2023.

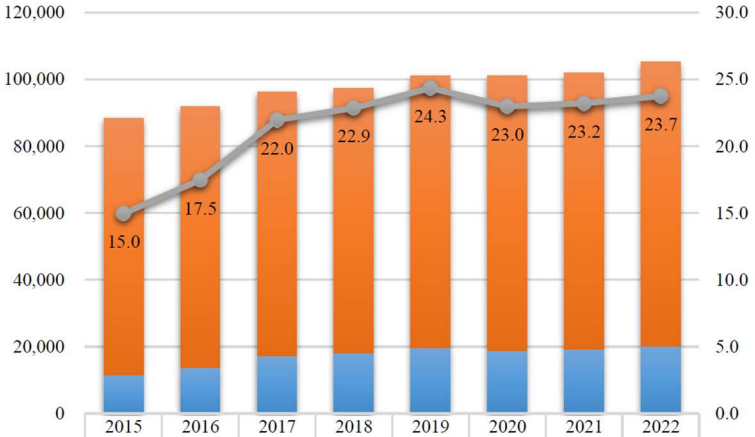
Figure 1. Delivery system for hospice care service

(4) Status of hospice care use in Korea

The National Hospice Center and the Ministry of Health and Welfare publish an annual report on hospice and palliative care every year. According to the most recently released 2022 report [40], as of the end of 2022, there were 181 hospice specialized institutions. Hospital-based hospice institutions were the largest at 89, followed by home-based and consultative hospice institution at 38, 37, respectively. In addition, the number of hospice beds nationwide was 1,601, of which the metropolitan area (Seoul, Gyeonggi, and Incheon) has 72 beds, accounting for about 50% of the total hospice beds.

In 2015, when the hospital-based hospice care was first covered by health insurance, the proportion of new patients using hospice among all cancer deaths was only 15.0%. However, as the home-based hospice and consultative hospice were also covered, the hospice use rate gradually increased, reaching 23.7% in 2022 (Figure 2).

As the result of investigating the average period of use by hospice type, using all three types was the longest at 80.0 days. Among the combined types that used the two hospices in combination, the type that combined hospital-based and home-based hospice use had the longest period of use at 62.3 days. Meanwhile, those who used only hospital-based hospices used an average of 23.6 days, those who used only home-based hospices used for an average 40.9 days, and those who used only consultative hospices used for an average of 9.3 days.



	2015	2016	2017	2018	2019	2020	2021	2022
Cancer deaths	76,855	78,194	78,863	79,153	81,203	82,204	82,688	85,075
Patients newly enrolled in hospice	11,504	13,662	17,317	18,091	19,772	18,893	19,185	20,198
Hospice use rate (%)	15.0	17.5	22.0	22.9	24.3	23.0	23.2	23.7

Source: Statistics Korea. 2022 Cause of Death Statistics. 2023; National Hospice Center & Ministry of Health and Welfare. 2022 Annual report on national hospice and palliative care. 2023.

Figure 2. Hospice use rate from 2015 to 2022

3) Policy Trends on Hospice Care in Major Countries

(1) Overview of hospice care systems in major countries

The hospice system may be operated differently depending on the social background and medical delivery system of each country. Nevertheless, considering the cases of major countries that have early experience in institutionalizing and operating hospice care can have important implications for those of us who established the hospice system relatively recently. We selected major countries to examine hospice policy trends by referring to the QoD Ranking, which ranked the quality of palliative care in 80 countries published by the Economist Intelligence Unit in 2015 [41]. The United Kingdom (UK), which ranked first in QoD, the United States (US), which ranked relatively high [42], and Japan and Taiwan, which ranked high among Asian countries [43], were selected as major countries.

In the UK, patients who are judged to have little life left to live are designated as hospice-eligible patients, and unlike in Korea, the health insurance coverage does not vary by disease [44]. Since 2004, non-cancerous diseases have been included in the hospice-eligible diseases, and recently new guidelines are announced that also include non-cancer pediatric and adolescent patients [45]. Hospice care services in the UK are divided into inpatient, community-based, advisory, day ward, outpatient, and bereavement support types, and can be provided in both inpatient and outpatient settings [46,47]. In homes and communities, general practitioners and community nurses, and in hospices, specialized hospice teams, doctors, nurses, and social workers support linkage between hospice types

[48]. To support patients when they wish to change the type of service or institution provided, the Electronic Palliative Care Coordination System (EPaCCS) and Proactive Identification Guidance (PIG) tools has been developed [49,50]. All hospice services are provided completely free of charge to patients due to the nature of UK healthcare system, and a per-diem payment system has been adopted [46]. In addition, the UK is promoting hospice and palliative care by rewarding hospice-related performance and quality improvement through the incentive system called Quality and Outcomes Framework (QOF) [51].

In the US, hospice services are covered only for those who qualify for Medicare Part A, and only terminally ill patients diagnosed by doctor with a life expectancy of six months or less are eligible. No specific disease is designated as hospice-eligible disease [52]. Depending on the intensity and location of hospice care provision, the home type includes routine home care (RHC) and continuous home care (CHC), and the inpatient type includes inpatient respite care and general inpatient care. In order to use services other than RHC, the reason why service should be provided must be clear [53]. Only CHC is paid on an hourly basis, and the remaining service types are compensated on a per-diem basis [54]. Before providing hospice care, services must be provided according to a care plan designed by the attending physician, medical director, and multidisciplinary team, and this care plan must be periodically reviewed and adjusted. Hospice quality reporting was mandated by the Affordable Care Act in 2010, and quality reporting on hospice services has been conducted since 2014 [55].

In Japan, hospice and palliative care was institutionalized in 1990 when health insurance covered hospitalization fees for hospice wards. Hospice services in Japan are comprised of inpatient and advisory types [56]. The home type is no limited to the hospice care system, but is included in the home medical service category and has a system in which services can be provided in all situations. Inpatient hospice care is provided in the hospice ward, mainly for cancer patients and acquired immune deficiency syndrome patients. The fee is per-diem, but in 2018, in order to strengthen the connection between hospice care and the community care, a differential hospitalization payment system was introduced based on the return-to-home rate. In addition, in the case of the advisory hospice type, the target patients were expanded by including end-stage heart failure patients as hospice-eligible diseases [57]. Recently, Japan focused on strengthening community care, and has established and operated a palliative care center that integrates inpatient, advisory, and home hospice care within local cancer base hospitals to realize a regional comprehensive system and home care-centered services [57,58].

In Taiwan, there are 13 diseases eligible for hospice care, including terminal cancer, advanced cancer, terminal motor neuron disorder, elderly patients, early-stage organic neurological disease, brain lesion disease, COPD, acute renal failure, pulmonary failure, chronic liver disease, liver lesions, heart failure, and chronic renal failure [59,60]. Patients with advanced cancer can also use the hospice services, even if they are not terminally ill patients with less than six months to live. Hospice services in Taiwan are operated in the form of inpatient care, home care, shared care, and community care depending on the location and service content provided [61]. Shared hospice care is the same as Korea's consultative hospice

[61], and community hospice care refers that doctors and nurses at local clinic provide early palliative care services in the form of outpatient or home visits. In Taiwan, there is no cost burden on patients when using medical services such as outpatient visit, emergency room visit, or hospitalization for diseases such as cancer, and all are covered by health insurance. Hospice services also involve no out-of-pocket costs for patients [62]. In the case of inpatients hospice care, per-diem payment system is adopted, but in order to prevent long-term hospitalization, only 60% of the total cost is paid by health insurance when hospitalized for more than 17 days [63]. Home hospice care are calculated on a fee-for-service basis. All visit fees are covered by health insurance, but transportation fees are borne by the patient. For shared hospice and community hospice care, a fixed fee is charged per visit in case of visiting treatment [64].

(2) Focus on patient-centered community-based hospice care

As a result of reviewing policy trends on hospice care in major countries, it can be seen that all four countries are pursing policies to strengthen linkage with patient-centered community care. This policy was promoted that considering that the majority of patients nearing the end of their lives wish to receive care at their preferred place, such as at home. For example, the UK has developed tools such as PIG to early identify patients seeking community-based hospice acre, and is using EPaCCs to quickly reflect patients' needs. The US also made efforts to predict patients' needs for hospice in advance by introducing Medicare Care Choices Model, which allows patients to continuously receive general

medical care and hospice care at the same time [65]. Japan has also established an integrated center that can provide all types of hospice services simultaneously and in conjunction. In Taiwan, community hospice care exists as one type of hospice, and fees are calculated for clinic-level doctors and nurses to provide early hospice services in the form of outpatient or home visits.

(3) Reform of the payment system for hospice care

In major countries, concerns about appropriate fees for hospice care depending on hospice usage status and preferences are being reflected in policies. For example, in Japan, the hospitalization fee for hospice wards was recently revised to differentiate depending on the waiting period and return-to-home rate, and the diseases covered by hospice care were expanded as needed. The UK has strengthened quality management of hospice services by raising the hospice-related score with in the QOF, and is setting fees based on quality evaluation results [51]. The US is lowering the rate of return for long-term provision of services and continuously adjusting fees based on collected period-specific cost data and billing data.

2. Studies Evaluating the Effects of Hospice Use

1) Effects of hospice use on healthcare utilization and expenditures at the end of life

Several observational studies have been explored the impact of hospice and palliative care on healthcare utilization and expenditures in patients nearing death. To summarize their findings, the behavior of discontinuing LST among patients with terminally ill patients is gradually increasing, and use of hospice care and palliative care was associated with lower procedure burden at the EoL [66,67]. Furthermore, in studies that investigating the differences in medical costs for EoL patients receiving traditional care and those receiving hospice are, it was found that hospice care can effectively save a large amount of medical expenditures nearing death [68-71]. Early palliative referrals were also associated with greater cost savings and less aggressive EoL care [71-73]. They also reported that different types of hospice care program have different effects on healthcare utilization reduction and cost-saving at different stage of EoL of terminal cancer patients [32].

Previous studies that demonstrated the association between hospice and palliative care and EoL healthcare utilization and expenditures for terminally ill patients are summarized in Table 1.

Table 1. Summary of previous studies on the effects of hospice use on healthcare utilization and expenditures at the end of life

Source	Summary
Emanuel EJ, Ash A, Yu W, Gazelle G, Levinsky NG, Saynina O, et al. Managed care, hospice use, site of death, and medical expenditures in the last year of life. Archives of internal medicine 2002;162:1722-8.	Medicare-insured decedents in California were 50% more likely to use a hospice, and a 30% lower hospitalization rate than in Massachusetts. Patients with cancer using hospice did have significant savings.
Wang L, Piet L, Kenworthy CM, Dy SM. Association between palliative case management and utilization of inpatient, intensive care unit, emergency department, and hospice in Medicaid beneficiaries. American Journal of Hospice and Palliative Medicine 2015;32:216-20.	Health plan-provided case management in palliative care for Medicaid beneficiaries lowers inpatient and ICU utilizations.
Amano K, Morita T, Tatara R, Katayama H, Uno T, Takagi I. Association between early palliative care referrals, inpatient hospice utilization, and aggressiveness of care at the end of life. Journal of palliative medicine 2015;18:270-3.	Early palliative referrals were associated with more inpatient hospice utilization and less aggressive EoL care.
Chen L-F, Chang C-M, Huang C-Y. Home-based hospice care reduces end-of-life expenditure in Taiwan: a population-based study. Medicine 2015;94.	Home-based hospice reduced one-fifth expenditure at the EoL of cancer deaths treated in hospitals with different spending intensity.
Jang RW, Krzyzanowska MK, Zimmermann C, Taback N, Alibhai SM. Palliative care and the aggressiveness of end-of-life care in patients with advanced pancreatic cancer. Journal of the National Cancer Institute 2015;107:dju424.	Palliative consultation (PC) and a higher intensity of PC were associated with less aggressive care near death in patients with terminal pancreatic cancer.
Chang H-T, Lin M-H, Chen C-K, Chen T-J, Tsai S-L, Cheng S-Y, et al. Medical care utilization and costs on end-of-life cancer patients: the role of hospice care. Medicine 2016;95.	Different types of hospice care program have different effects on healthcare utilization reduction and cost-saving at different stage of EoL of terminal cancer patients.

Patel AA, Walling AM, Ricks-Oddie J, May FP, Saab S, Wenger N. Palliative care and health care utilization for patients with end-stage liver disease at the end of life. Clinical Gastroenterology and Hepatology 2017;15:1612-9.	Hospice and palliative care was associated with lower cost and procedure burden at the EoL.
Huang Y-T, Wang Y-W, Chi C-W, Hu W-Y, Lin Jr R, Shiao C-C, et al. Differences in medical costs for end-of-life patients receiving traditional care and those receiving hospice care: A retrospective study. PLoS One 2020;15:e0229176.	Hospice care can effectively save a large amount of medical expenditures nearing death, and more costs are saved when patients are referred to hospice care earlier.
Davis MP, Vanenkevort EA, Elder A, Young A, Correa Ordonez ID, Wojtowicz MJ, et al. The financial impact of palliative care and aggressive cancer care on end-of-life health care costs. American Journal of Hospice and Palliative Medicine 2023;40:52-60.	Cancer medical cost increase with indicators of aggressive cancer care at the end-of-life (ACEOL). Palliative care consultations > 90 days before death; Advance directives reduce cancer medical costs.

2) Effects of hospice use on quality of life and quality of death

As the main goal of hospice and palliative care is to achieve the best QoL for patients and their families [74], there have been a number of studies evaluating the QoL of patients and their caregivers using hospice care. In particular, Hospice Quality of Life Index was newly developed to measure valid and reliable QoL [75]. Their findings identified that anxiety and pain impact significantly on QoL in hospice, suggesting that continued effort is needed in important area of psychological and physical symptom management [76-78]. Although there have not been many studies exploring the changed QoL of terminally ill patients after hospice enrollment, some studies suggested that QoL would have improved as pain management, such as narcotic analgesic medication, improved after hospice enrollment [79,80]. In addition, the Quality of Death Index was also developed to objectively measure the QoD just before death, and is also used as a proxy indicator to evaluate the level and quality of palliative care in each country [41,81]. As a result of exploring the QoD of people who died after experiencing hospice care, a "good death" was associated with death at home and satisfaction with hospice services [82].

Table 2 provides a summary of prior studies that evaluated the impact of hospice and palliative care on QoL and QoD for terminally ill patients.

Table 2. Summary of previous studies on the effects of hospice use on quality of life and quality of death

Source	Summary
McMillan S, Mahon M. Measuring quality of life in hospice patients using a newly developed Hospice Quality of Life Index. Quality of Life Research 1994;3:437-47.	The content validity index (0.83) and the alpha coefficients (r=0.87 and 0.83) supported the validity and reliability of the Hospice Quality of Life Index (HQLI). Item analysis revealed items with which patients were most satisfied and aspects of quality of life that were considered to be most important.
Garrison CM, Overcash J, McMillan SC. Predictors of quality of life in elderly hospice patients with cancer. Journal of hospice and palliative nursing: JHPN: the official journal of the Hospice and Palliative Nurses Association 2011;13:288.	Anxiety and pain were negatively associated with QoL, while spirituality and 'Instrumental Support' coping style were positively associated with QoL. QoL could be related to physical and psychological symptoms, and this reiterates the importance of faith in end-of-life care.
McMillan SC. Symptom distress and quality of life in patients with cancer newly admitted to hospice home care. Number 10/2002 2002;29:1421-8.	QoL was affected by symptom distress in people with advanced cancer near the end of life. Continued effort is needed in the important area of symptom management.
Bovero A, Leombruni P, Miniotti M, Rocca G, Torta R. Spirituality, quality of life, psychological adjustment in terminal cancer patients in hospice. European Journal of Cancer Care 2016;25:961-9.	Because both physical symptoms and depression are predictors of quality of life, a continued focus is needed on these factors by those providing care to older adults with cancer near the end of life.
Miller SC, Mor V, Teno J. Hospice enrollment and pain assessment and management in nursing homes. Journal of pain and symptom management 2003;26:791-9.	Hospice enrollment improves pain assessment and management for nursing home residents; they also document the need for continued improvement of pain management in nursing homes.
Miller SC, Mor V, Wu N, Gozalo P, Lapane K. Does receipt of hospice care in nursing homes improve the management of pain at the end of life? Journal of the American Geriatrics Society 2002;50:507-15.	Findings suggest that analgesic management of daily pain is better for nursing home residents used in hospice than for those not used in hospice.
Hong S, Cagle JG, Plant AJ, Culler KL, Carrion IV, Van Dussen DJ. Quality of death among hospice decedents: Proxy observations from a survey of community-dwelling adults in the contiguous United States. Death Studies 2016;40:529-37.	A "good death" was associated with older patients who died at home, and respondent satisfaction with hospice service. A "good death" was mapped as 29 nodes and 79 links using semantic network analysis. Three subjects (patient, family, hospice), three timeframes (end-of-life, moment of dying, death), and four central causes (home, peaceful, pain-free, and expected) were identified.

III. Material and Methods

1. Data Source and Study Population

In this population-based cohort study, data were obtained from the Korean National Health Insurance Service (NHIS) database. Since the implementation of universal health coverage in 1989, all South Korean citizens have been obliged to subscribe to the NHIS, and approximately 98% of the entire population has been enrolled. The NHIS database comprises a various type of data, such as medical check-up data, medical claims data, sociodemographic data, and mortality data for all Koreans. Among these, the medical claims data is the most extensive database provided by the NHIS, encompassing details about the medical utilization of the entire Korean population. This information includes International Classification of Diseases 10th revision (ICD-10) diagnostic codes, prescriptions for medications, lengths of hospital stays, medical expenses, and information regarding healthcare provisions [83]. The NHIS provides researchers with customized cohort data for the purpose of policy making and academic research.

To explore the effects of hospice enrollment on care patterns and expenditures at EoL for cancer deaths, we target cancer patients who died after registering for expanded benefit coverage due to sever cancer (claim code: “V027”, V193”, “V194”). Since the hospice use record, which is the intervention to be evaluated in this study, was identifiable

from 2017 on the claims data, the follow-up period was set from 2017 to 2021, the most recent data. Therefore, the NHIS customized cohort data we obtained includes medical utilization records for all 521,452 registered cancer patients who died between January 1, 2017 and December 31, 2021.

Among all participants, those who survived more than 5 years after their first cancer diagnosis (N=23,795), those who had no medical records for 6 months before death (N=1,328), and those who were under 20 years old or had missing data (N=19,126) were sequentially excluded, resulting in a total of 477,203 participants. Among them, 76,894 individuals had used hospice within 6 months before death, and 400,309 individuals had not. Because the purpose of this study was to investigate care patterns and expenditures in the 1 month before and 3 months before death according to whether or not patients had used hospice, we excluded those who died within 3 months of their cancer diagnosis (N=67,283). In addition, it was difficult to consider those who died on the day of hospice enrollment as an intervention group, so they were also excluded (N=956). Finally, a total of 408,964 individuals were eligible for analysis, of which 67,522 individuals were in the intervention group ((1) Hospital-based hospice single users (N=59,143); (2) Home-based hospice single users (N=2,621), (3) Combined hospice users (N=5,758)) and 341,422 individuals were in the control group (Figure 3).

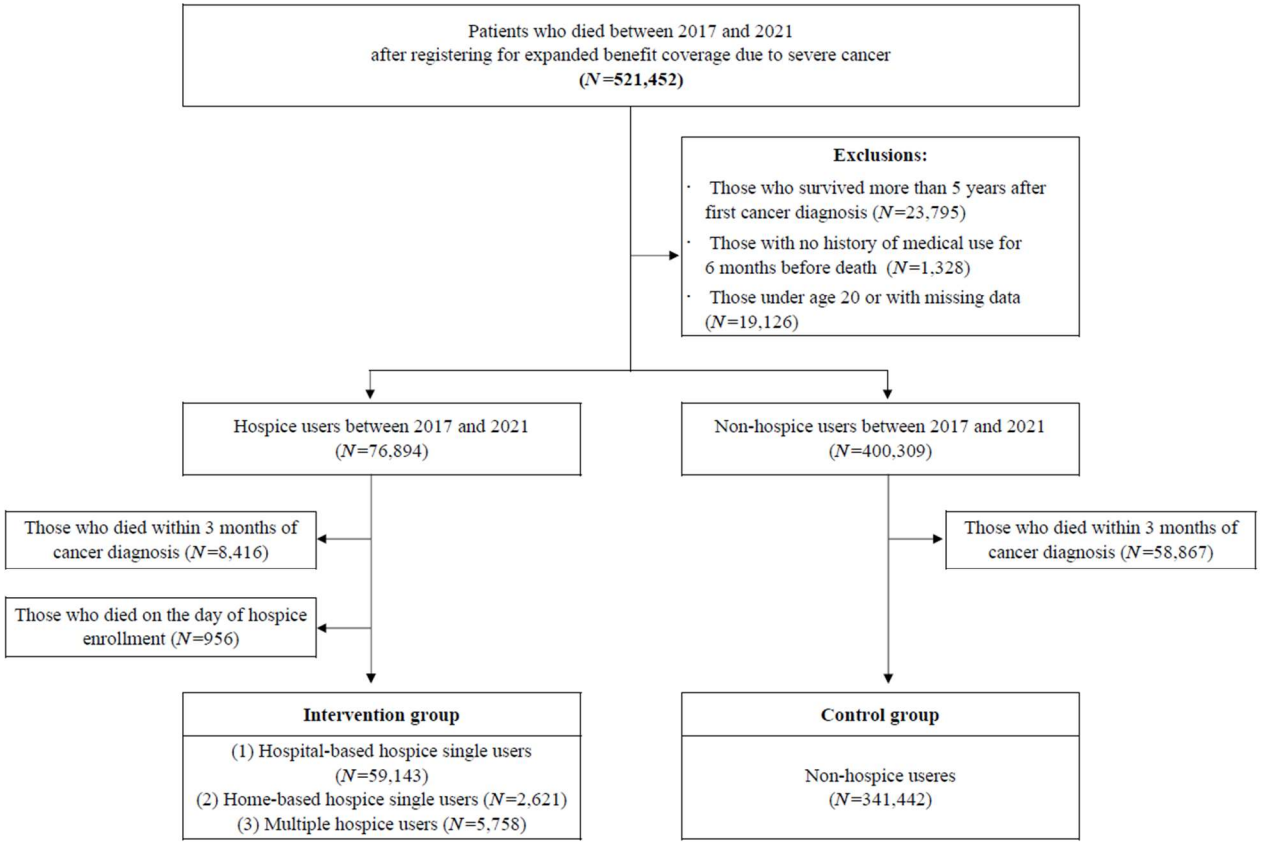


Figure 3. Flow chart of study population selection

2. Definition of Variables

1) Dependent Variables

The primary dependent variables were patterns of care, which was divided into intense care and supportive care. Intense care refers to aggressive treatment cancer patients receive to prolong life [84], and in this study, it was specifically defined as the intubation and ventilator use, cardiopulmonary resuscitation (CPR), hemodialysis, ICU care, or computed tomography (CT) use. In addition, supportive care was defined as management for pain control and psychological relief that can have significant impact on the cancer patients' QoL [85-88], and was identified as prescription of narcotic analgesics and visits to psychiatry and family medicine (Table 3). For all of these outcome, in their last 30 and 90 days of life, whether the patient received care was identified as a binary variable, and the intensity of care was identified as a count variable.

The secondary dependent variables were expenditures at the EoL, and specifically, total medical expenses and out-of-pocket expenses (OOPs) spent in their last 30 and 90 days of life were determined. In order to accurately analyze expenditures reflecting the inflation rate, a conversion factor of the annual relative value scale was applied to the total medical expenses and the total OOPs variables [89]. To apply the log-link function in statistical analysis, all observations with ₩ 0 were adjusted by adding ₩ 1. In addition, extreme outliers were removed from the analysis.

Table 3. Identification of primary dependent variables in claims data

Variables	Claim codes
Intense care[a]	
Intubation and ventilator use	"M5859", "M5850", "M5857", "M5858", "M5860"
CPR	"M5873", "M5874", "M5875 , "M5876", "M5877"
Hemodialysis	"O7020", "O7021", "O7031", "O7032", "O7033", "O7034"
ICU care	"AJ001", "AJ003", "AJ010", "AJ020", "AJ100", "AJ200", "AJ300"
CT use	"HA4-"
Supportive care	
Prescriptions for narcotic analygesics[b]	"811", "821", "114"
Mental health care[c]	"03", "23"

[a] Procedure codes extracted from the medical history database

[b] Drug classification codes extracted from the prescription database, including prescription information for Codeine, Fentanyl, Hydrocodone, Oxycodone, Hydromorphone, Tramadol, Morphine, and Pethidine

[c] Medical department codes extracted from the medical history database, code “03” for psychiatric treatment and “23” for family medicine treatment

2) Variable of Interest

The variable of interest was the type of hospice used within 6 months before death, identified by claim codes recorded between 2017 and 2021. In an analysis aimed at investigating differences in outcomes among the type of hospice used for cancer deaths, it was classified into four categories as follows: (1) Those who have never used hospice within 6 months before death (reference group); (2) Those who have only used hospital-based hospice within 6 months before death (claim codes: “WJ-”, “WK-”, “WL-”, “WM-”, “WN-”, “WO-”, “WG-”, “WH-”); (3) Those who have only used home-based hospice within 6 months before death (claim codes: “AP-”); (4) Those who used both hospital-based hospice and home-based hospice within 6 months before death.

Furthermore, in the analysis to identify trend changes in outcomes before and after hospice enrollment for each type, an index date had to be created. Therefore, in this study, each individual’s first date of hospice enrollment was set as the index date (in other words, Time Zero).

3) Independent Variables

There were 10 independent variables included while exploring the effects of hospice enrollment cancer patients' care patterns and expenditures at the EoL. First, as sociodemographic factors, sex, age, region of residence, income level, and type of health insurance subscription were included in the analysis. Income level was categorized based on income quintile, which is an indicator that divides the income level of all households in Korea from level 1 to level 20. Health insurance type was classified according to who pays the insured contribution. Second, as factors related health status, we adjusted for Charlson comorbidity index (CCI) score, primary cancer type, and survival time after cancer diagnosis, and also included year of death. The CCI score was calculated by assigning weights to each condition according to Quan's method [90,91] (Appendix 1). Primary cancer type was divided into the top 10 cancers with the highest mortality rate in Korea and other cancers [91]. The categories of each independent variable were depicted in detail in Table 4.

Table 4. Description of independent variables included in the analysis

Variables	Description
Sociodemographic factors	
Sex	Men; Women
Age (years)	< 30, 30~39, 40~49, 50~59, 60~69, ≥ 70
Region	Seoul and metropolitan cities; Small cities and rural
Income level	Low (quintile, 1~6); Middle (7~13); High (14~20)
Health insurance type	Regionally-insured; Workplace-insured; Medicaid
Health-related factors	
CCI score	0~1; ≥ 2
Primary cancer type	Lung cancer; Liver cancer; Colorectal cancer; Gastric cancer; Pancreatic cancer; Gallbladder/bile duct cancer; Breast cancer; Prostate cancer; Non-Hodgkin's Lymphoma; Leukemia; Other
Survival time after cancer diagnosis (days)	90~365; 366~730; 731~1095; ≥ 1096
Year of death	2017; 2018; 2019; 2020; 2021

3. Statistical Methods

To examine the distribution of the general characteristic of study population in year of death, Chi-squared test was conducted. General characteristics were presented as frequencies (N) and percentages (%). Then, descriptive statistics on all dependent variables were reported as means and standard deviations.

To identify differences in outcomes between hospice types, a generalized linear model (GLM) was used. First, in analyses exploring differences in care patterns, we applied a GLM with zero-inflated negative binomial (ZINB) distribution. Count data containing large number of zeros is commonly observed across various fields, such as medicine and public health [92,93]. Zero-inflation, which often signifies over-dispersion, indicates that the frequency of zero counts exceeds what would be expected. When the over-dispersion in raw data is due to zero-inflation, the zero-inflated Poisson (ZIP) model serves as a standard framework for fitting the data [94]. After factoring in zero-inflation and if the data persistently indicate further over-dispersion, the ZINB model should be considered [95]. This model combines a distribution degenerate at zero with a baseline negative binomial distribution, as an alternative to the ZIP model [96,97].

The GENMOD procedure, which includes the ZEROMODEL statement, was used. As a result, the ZINB model has two components [98,99]: First, we can estimate odds ratios (OR) from logistic regression model (zero component). Second, we can also estimate risk ratios (RR) with the results of negative binomial regression model (count component). In

this study, the zero component was modeled to estimate the probability that excess zero will not occur, that is, non-excess zero probability. Therefore, OR refers to the possibility that an outcome will occur in the case group compared to the reference group among all study participants. RR refers to the ratio of intensity of an outcome in the case group compared to the reference group among those in whom the outcome occurred.

Next, in analyses exploring differences in expenditures, given the pronounced concentration and uneven dispersion observed in the distribution of medical expenditure variables [100], a GLM with a Gamma distribution and log link function was applied. This approach is recommended to address the positively skewed nature of the expenditure distribution and can be implemented through the GENMOD procedure [101,102].

Subsequently, to analyze time trends and changes of outcomes according to hospice enrollment, we conducted an interrupted time series (ITS) with segmented Poisson regression. This study design is well-suited for evaluating public health interventions, particularly those introduced at a population level over a specific time period, targeting population-level health outcomes [103,104]. The ITS analysis employed a linear regression model with three time-related variables. The regression coefficients were utilized to estimate various aspects of the intervention's effect, including the baseline slope, the level change, and the slope change [105].

The equation for ITS analysis using a generalized estimating equation (GEE) to evaluate the effects of hospice enrollment is as follows:

$$\mathbf{g}(\mathbf{E}(Y_{it})) = \beta_0 + \beta_1 \times Time_{it} + \beta_2 \times Intervention_{it} + \beta_3 \times Time\ after\ intervention_{it} + \gamma' X_{it}$$

g: link function

E: Expectation

Y: dependent variables

i: individual

t: time period

$Time$: time variable before and after first hospice enrollment date (continuous variable in units of one week (7days))

$Intervention$: dummy variable that is assigned "1" if time of episode is after the first hospice enrollment (intervention=1: after hospice enrollment, intervention=0: before hospice enrollment)

$Time\ after\ Intervention$: continuous variable, with "0" assigned during the pre-intervention period, "1" assigned at the start of intervention (index date), and 1 added every 7 days thereafter

X_{it}: covariate vector (sex, age, region, income level, health insurance type, CCI score, primary cancer type, survival time after cancer diagnosis, year of death)

In this ITS model, what each regression coefficient estimates is as follows [103]:

β_0: the baseline level of the outcome (intercept)

β_1: the baseline trend of the outcome

β_2: the level change after the intervention, which indicates the immediate effect size of the intervention

β_3: the change in trend after intervention

$\beta_1 + \beta_3$: the slope after intervention, which indicates the follow-up outcome trend

γ': regression coefficient vector

As the key results of GLM analysis, we calculated the adjusted odds ratios (aOR), adjusted risk ratios (aRR), 95% confidence intervals (CIs), and p-values. Then, for results of ITS analysis, parameter estimates, standard errors, 95% CI, and p-values were presented. In all analyses using the GENMOD procedure with log link, the estimated coefficients should be converted to exponentials [Exp(β)]. This was to show the trends and changes in outcomes on the original scale, and therefore, the model coefficients would be interpreted multiplicatively [106]. All statistical analyses were conducted using SAS version 9.4 software (SAS Institute Inc., Cary, NC, USA). A p-value < 0.05 was considered statistically significant.

4. Ethics Statement

The study protocol was reviewed and approved by the Institutional Review Board of Yonsei University's Health System in accordance with the principles of the Declaration of Helsinki (IRB Number: 4-2022-1599). The requirement for informed consent was waived since NHIS database we obtained (NHIS-2023-1-456) does not contain any personally identifiable information.

IV. Results

1. General Characteristics of the Study Population

Table 5 presents the general characteristics of the study population in year of death. Those eligible for this analysis were those who died between 2017 and 2021 after registering for expanded benefit coverage due to severe cancer, and a total of 408,964 individuals were included. Among the study population, those who had no experience using hospice in the six months before death accounted for 83.5% (N=341,442), and those who used more than one type of hospice accounted for 16.5% (N=67,522). The intervention group was further divided into three groups according to the type of hospice used. Those who used only hospital-based hospice were reported to be 14.5% (N=59,143), those who used only home-based hospice were reported to be 0.6% (N=2,621), and those who used both hospital-based and home-based hospice were reported to be 1.4% (N=5,758).

Among all participants, the proportion of men, over 60 years old, high-income, and the regionally-insured was reported to be high regardless of the type of hospice used. Meanwhile, in the non-hospice user group, there were more people living in small cities or rural areas, but in the home-based hospice single user group and the combined hospice user group, there were much more people living in Seoul and metropolitan cities. In addition, in all hospice types, those with a CCI score of 0 to 1 and those with a survival period of more

than 3 years (1096 days) were most frequently reported. Looking at the distribution of primary cancer type, lung cancer and colorectal cancer accounted for the highest proportion among the top 10 cancers. The number of cancer deaths tends to increase every year, but during the COVID-19 pandemic in 2020 and 2021, the proportion of those using only hospital-based hospice and combined hospice users decreased, while the proportion of those who used only home-based hospice and non-hospice users increased noticeably.

Table 5. General characteristics of study population in year of death

Characteristics	Type of hospice use								P-value
	Hospital-based hospice only		Home-based hospice only		Combined hospice		None		
	N	%	N	%	N	%	N	%	
Total (N=408,964)	59,143	14.5	2,621	0.6	5,758	1.4	341,442	83.5	
Sex									<.0001
Men	34,424	58.2	1,484	56.6	3,002	52.1	216,926	63.5	
Women	24,719	41.8	1,137	43.4	2,756	47.9	124,516	36.5	
Age (years)									<.0001
< 30	656	1.1	23	0.9	78	1.4	3,352	1.0	
30 ~ 39	2,348	4.0	84	3.2	229	4.0	8,993	2.6	
40 ~ 49	7,214	12.2	268	10.2	603	10.5	27,969	8.2	
50 ~ 59	14,233	24.1	499	19.0	1,326	23.0	61,860	18.1	
60 ~ 69	16,934	28.6	802	30.6	1,647	28.6	90,559	26.5	
≥ 70	17,758	30.0	945	36.1	1,875	32.6	148,709	43.6	
Region									<.0001
Seoul and metropolitan cities	28,505	48.2	1,563	59.6	3,326	57.8	150,814	44.2	
Small cities and rural	30,638	51.8	1,058	40.4	2,432	42.2	190,628	55.8	
Income level									<.0001
Low	15,423	26.1	605	23.1	1,273	22.1	95,464	28.0	
Middle	16,823	28.4	691	26.4	1,522	26.4	92,166	27.0	
High	26,897	45.5	1,325	50.6	2,963	51.5	153,812	45.0	
Health insurance type									<.0001
Regionally-insured	35,725	60.4	1,698	64.8	3,758	65.3	198,537	58.1	
Workplace-insured	20,812	35.2	836	31.9	1,830	31.8	119,161	34.9	
Medicaid	2,606	4.4	87	3.3	170	3.0	23,744	7.0	
CCI score									<.0001
0 ~ 1	53,657	90.7	2,372	90.5	5,200	90.3	317,086	92.9	
≥ 2	5,486	9.3	249	9.5	558	9.7	24,356	7.1	

Primary cancer type									<.0001
Lung cancer	5,942	10.0	256	9.8	542	9.4	33,069	9.7	
Liver cancer	4,156	7.0	156	6.0	330	5.7	23,356	6.8	
Colorectal cancer	5,746	9.7	276	10.5	631	11.0	30,266	8.9	
Gastric cancer	5,146	8.7	227	8.7	496	8.6	30,187	8.8	
Pancreatic cancer	3,124	5.3	123	4.7	380	6.6	8,865	2.6	
Gallbladder/bile duct cancer	2,214	3.7	105	4.0	218	3.8	9,558	2.8	
Breast cancer	2,254	3.8	113	4.3	226	3.9	10,018	2.9	
Prostate cancer	1,321	2.2	71	2.7	151	2.6	13,300	3.9	
Non-Hodgkin's Lymphoma	541	0.9	19	0.7	46	0.8	4,391	1.3	
Leukemia	241	0.4	3	0.1	18	0.3	4,186	1.2	
Other	28,458	48.1	1,272	48.5	2,720	47.2	174,246	51.0	
Survival time after cancer diagnosis (days)									<.0001
90 ~ 365	16,707	28.2	680	25.9	1,355	23.5	86,287	25.3	
366 ~ 730	13,504	22.8	574	21.9	1,298	22.5	63,715	18.7	
731 ~ 1095	8,331	14.1	377	14.4	871	15.1	43,494	12.7	
≥ 1096	20,601	34.8	990	37.8	2,234	38.8	147,946	43.3	
Year of death									<.0001
2017	11,023	18.6	311	11.9	917	15.9	64,170	18.8	
2018	11,808	20.0	388	14.8	1,007	17.5	65,792	19.3	
2019	12,969	21.9	519	19.8	1,294	22.5	66,886	19.6	
2020	11,939	20.2	645	24.6	1,265	22.0	70,579	20.7	
2021	11,404	19.3	758	28.9	1,275	22.1	74,015	21.7	

2. Differences in Care Patterns according to the Type of Hospice Use

1) Intense Care

Descriptive statistics on intense care, one of the primary dependent variables, are presented in Table 6 and 7. The non-hospice user group had the highest total number of times intense care in their last 30 days of life, averaging 22.29 times. The average number of intense care in their last 90 days of life was 45.54 times. Among the intervention groups, home-based hospice single users were reported to be the most aggressive in treatment, receiving intense care an average of 8.06 times in the last 30 days. Hospital-based hospice single users and combined hospice users used an average of 7.34 and 3.7 times, respectively. On the other hand, the total number of intense care in the last 90 days of life was reported to be the highest for hospital-based hospice single users with an average of 26.97 times, while home-based hospice single users used an average of 24.73 times and combined hospice users used an average of 17.15 times.

Table 6. Descriptive statistics on intense care in the last 30 days of life

Variables	Intense care in the last 30 days of life (times, Mean±SD)					
	Overall	Intubation and ventilator use	CPR	hemodialysis	ICU care	CT use
Type of hospice use						
None	22.29 ± 41.36	5.42 ± 16.22	1.33 ± 3.89	4.02 ± 26.67	0.74 ± 5.69	10.76 ± 15.96
Hospital-based hospice only	7.34 ± 16.19	0.15 ± 2.66	0.02 ± 0.50	0.53 ± 9.52	0.06 ± 1.07	6.57 ± 12.07
Home-based hospice only	8.06 ± 18.40	0.96 ± 5.45	0.50 ± 2.38	0.57 ± 10.89	0.06 ± 0.93	5.97 ± 12.48
Combined hospice	3.70 ± 10.16	0.08 ± 1.29	0.04 ± 0.70	0.18 ± 5.37	0.02 ± 0.63	3.38 ± 8.42
Sex						
Men	21.11 ± 40.22	4.95 ± 15.63	1.21 ± 3.73	3.80 ± 26.07	0.68 ± 5.39	10.47 ± 15.58
Women	17.53 ± 36.09	3.90 ± 13.86	0.98 ± 3.37	2.84 ± 22.22	0.53 ± 4.92	9.28 ± 15.20
Age (years)						
< 30	20.31 ± 29.24	5.15 ± 12.62	1.19 ± 3.42	2.04 ± 12.08	0.71 ± 5.78	11.22 ± 15.56
30 ~ 39	23.48 ± 36.04	5.13 ± 14.47	1.17 ± 3.69	2.64 ± 20.68	0.62 ± 5.82	13.92 ± 17.11
40 ~ 49	22.87 ± 39.46	4.81 ± 15.51	1.07 ± 3.60	3.20 ± 23.81	0.63 ± 4.87	13.15 ± 17.24
50 ~ 59	22.63 ± 39.48	4.84 ± 15.11	1.11± 3.65	3.59 ± 25.02	0.64 ± 5.05	12.46 ± 16.57
60 ~ 69	23.11 ± 42.48	5.35 ± 16.52	1.21 ± 3.77	4.25 ± 27.84	0.69 ± 5.19	11.61 ± 16.10
≥ 70	17.52 ± 37.03	4.16 ± 14.33	1.09 ± 3.53	3.16 ± 23.61	0.60 ± 5.28	8.52 ± 14.51
Region						
Seoul and metropolitan cities	20.92 ± 40.08	4.96 ± 15.78	1.18 ± 3.71	3.72 ± 25.53	0.60 ± 4.81	10.46 ± 15.71
Small cities and rural	18.89 ± 37.70	4.25 ± 14.36	1.07 ± 3.52	3.23 ± 24.05	0.65 ± 5.52	9.69 ± 15.23
Income level						
Low	19.32 ± 39.82	4.40 ± 14.72	1.13 ± 3.64	3.67 ± 26.22	0.62 ± 5.14	9.51 ± 15.15
Middle	19.84 ± 37.67	4.59 ± 15.40	1.11 ± 3.59	3.12 ± 23.02	0.61 ± 5.13	10.41 ± 15.59
High	20.01 ± 38.70	4.63 ± 14.94	1.12 ± 3.59	3.48 ± 24.63	0.65 ± 5.32	10.14 ± 15.54
Health insurance type						
Regionally-insured	19.67 ± 38.15	4.59 ± 15.20	1.11 ± 3.57	3.26 ± 23.82	0.64 ± 5.33	10.08 ± 15.43
Workplace-insured	20.15 ± 38.61	4.59 ± 14.78	1.13 ± 3.63	3.45 ± 24.63	0.60 ± 4.63	10.39 ± 15.71
Medicaid	19.10 ± 43.22	4.24 ± 14.37	1.17 ± 3.71	4.66 ± 30.28	0.65 ± 6.31	8.38 ± 14.50

CCI score						
0 ~ 1	19.37 ± 37.17	4.61 ± 15.00	1.14 ± 3.62	2.98 ± 22.44	0.63 ± 5.28	10.01 ± 15.42
≥ 2	24.70 ± 54.60	3.92 ± 14.94	0.91 ± 3.32	9.13 ± 43.61	0.53 ± 4.50	10.20 ± 15.82
Primary cancer type						
Lung cancer	17.97 ± 32.05	4.48 ± 15.48	1.03 ± 3.42	1.58 ± 16.12	0.54 ± 4.18	10.33 ± 14.98
Liver cancer	18.45 ± 34.24	3.51 ± 12.16	0.89 ± 3.25	3.31 ± 22.38	0.52 ± 4.03	10.23 ± 14.60
Colorectal cancer	17.18 ± 37.15	3.86 ± 13.71	1.05 ± 3.51	3.14 ± 24.30	0.53 ± 4.86	8.60 ± 14.35
Gastric cancer	18.30 ± 36.74	4.41 ± 14.87	1.13 ± 3.59	2.78 ± 22.52	0.59 ± 4.91	9.39 ± 14.99
Pancreatic cancer	13.94 ± 26.52	2.22 ± 10.68	0.55 ± 2.55	1.44 ± 14.97	0.27 ± 2.16	9.48 ± 14.27
Gallbladder/bile duct cancer	14.93 ± 29.43	2.61 ± 10.22	0.74 ± 2.96	1.87 ± 18.01	0.39 ± 3.11	9.33 ± 14.33
Breast cancer	20.19 ± 37.11	4.40 ± 14.67	1.05 ± 3.58	2.64 ± 22.37	0.51 ± 4.71	11.58 ± 16.50
Prostate cancer	20.75 ± 41.32	5.56 ± 17.10	1.43 ± 3.98	3.70 ± 25.79	0.72 ± 5.39	9.32 ± 15.69
Non-Hodgkin's Lymphoma	26.16 ± 39.75	6.38 ± 16.43	1.35 ± 3.86	3.55 ± 21.04	1.25 ± 9.07	13.63 ± 18.84
Leukemia	30.86 ± 43.75	9.61 ± 19.01	1.78 ± 4.12	4.35 ± 22.47	2.20 ± 13.44	12.93 ± 16.20
Other	21.17 ± 41.76	4.90 ± 15.61	1.20 ± 3.73	4.21 ± 27.60	0.67 ± 5.47	10.19 ± 15.81
Survival time after cancer diagnosis (days)						
90 ~ 365	17.79 ± 33.50	3.79 ± 13.47	0.91 ± 3.24	2.38 ± 19.30	0.58 ± 4.85	10.13 ± 15.27
366 ~ 730	17.79 ± 34.41	3.71 ± 13.49	0.91 ± 3.24	2.58 ± 20.95	0.53 ± 5.01	10.06 ± 15.19
731 ~ 1095	18.97 ± 37.73	4.15 ± 14.20	1.06 ± 3.54	3.19 ± 23.79	0.56 ± 5.41	10.01 ± 15.58
≥ 1096	22.13 ± 37.49	5.53 ± 16.63	1.36 ± 3.96	4.56 ± 29.08	0.71 ± 5.55	9.96 ± 15.63
Year of death						
2017	14.64 ± 28.28	3.14 ± 9.40	0.78 ± 2.66	2.45 ± 17.82	1.12 ± 5.07	7.16 ± 10.81
2018	17.46 ± 32.87	3.99 ± 11.54	1.02 ± 3.25	2.93 ± 20.39	0.86 ± 4.87	8.66 ± 12.87
2019	19.77 ± 37.31	4.47 ± 14.31	1.10 ± 3.55	3.41 ± 23.64	0.30 ± 4.39	10.50 ± 15.46
2020	22.07 ± 42.94	5.15 ± 17.12	1.23 ± 3.87	3.97 ± 27.53	0.48 ± 5.75	11.25 ± 17.10
2021	24.04 ± 47.01	5.79 ± 19.34	1.41 ± 4.30	4.28 ± 30.68	0.44 ± 5.76	12.11 ± 18.49

Table 7. Descriptive statistics on intense care in the last 90 days of life

Variables	Intense care in the last 90 days of life (times, Mean±SD)					
	Overall	Intubation and ventilator use	CPR	hemodialysis	ICU care	CT use
Type of hospice use						
None	45.54 ± 95.26	6.80 ± 21.16	1.33 ± 3.91	11.65 ± 8.25	1.18 ± 9.61	24.59 ± 26.10
Hospital-based hospice only	26.97 ± 41.43	0.44 ± 4.52	0.03 ± 0.55	2.03 ± 33.19	0.21 ± 2.17	24.27 ± 23.20
Home-based hospice only	24.73 ± 42.87	1.13 ± 6.35	0.50 ± 2.38	1.79 ± 34.42	0.09 ± 1.12	21.22 ± 23.98
Combined hospice	17.15 ± 26.89	0.16 ± 2.13	0.04 ± 0.68	0.66 ± 18.57	0.06 ± 1.03	16.22 ± 19.26
Sex						
Men	45.01 ± 93.51	6.27 ± 20.50	1.20 ± 3.74	11.20 ± 82.03	1.11 ± 9.55	25.22 ± 25.58
Women	37.81 ± 80.32	4.87 ± 17.84	0.97 ± 3.39	8.08 ± 68.50	0.85 ± 7.49	23.04 ± 25.65
Age (years)						
< 30	42.39 ± 52.45	6.52 ± 14.10	1.22 ± 3.55	3.79 ± 36.19	1.07 ± 6.82	29.76 ± 27.72
30 ~ 39	51.38 ± 69.32	6.89 ± 20.77	1.18 ± 3.76	5.92 ± 54.71	1.00 ± 7.81	36.39 ± 30.11
40 ~ 49	50.65 ± 82.69	5.85 ± 19.00	1.06 ± 3.60	8.24 ± 70.21	1.10 ± 10.53	34.35 ± 28.32
50 ~ 59	51.29 ± 92.74	6.13 ± 19.77	1.10 ± 3.64	10.80 ± 81.64	1.00 ± 7.01	32.26 ± 27.27
60 ~ 69	50.86 ± 99.41	6.70 ± 20.96	1.21 ± 3.80	12.86 ± 88.35	1.07 ± 8.79	29.01 ± 26.26
≥ 70	35.58 ± 84.15	5.22 ± 18.96	1.08 ± 3.53	9.08 ± 72.80	0.99 ± 9.11	19.21 ± 23.09
Region						
Seoul and metropolitan cities	44.67 ± 91.69	6.25 ± 20.51	1.18 ± 3.72	10.78 ± 79.79	0.99 ± 8.21	25.47 ± 26.03
Small cities and rural	40.47 ± 86.55	5.35 ± 18.77	1.07 ± 3.53	9.44 ± 75.21	1.04 ± 9.29	23.57 ± 25.26
Income level						
Low	42.01 ± 93.13	5.50 ± 19.00	1.13 ± 3.65	10.98 ± 81.92	1.00 ± 9.47	23.40 ± 25.26
Middle	42.60 ± 84.49	5.63 ± 18.88	1.09 ± 3.57	9.11 ± 73.07	1.00 ± 7.92	25.76 ± 26.04
High	42.34 ± 88.54	5.96 ± 20.26	1.12 ± 3.61	9.96 ± 76.54	1.03 ± 8.90	24.27 ± 25.57
Health insurance type						
Regionally-insured	41.86 ± 86.59	5.77 ± 19.50	1.10 ± 3.58	9.54 ± 74.96	1.01 ± 8.72	24.44 ± 25.58
Workplace-insured	43.17 ± 87.83	5.81 ± 19.94	1.12 ± 3.63	9.73 ± 75.83	1.00 ± 8.40	25.52 ± 26.12
Medicaid	42.37 ± 106.86	5.37 ± 18.54	1.20 ± 3.77	14.68 ± 96.15	1.12 ± 10.97	20.00 ± 23.49

CCI score						
0 ~ 1	40.56 ± 81.96	5.81 ± 19.59	1.13 ± 3.63	8.39 ± 69.54	1.02 ± 8.86	24.20 ± 25.47
≥ 2	63.98 ± 148.07	4.94 ± 19.18	0.92 ± 3.36	30.31 ± 139.60	0.92 ± 8.26	26.89 ± 27.25
Primary cancer type						
Lung cancer	37.92 ± 65.79	5.63 ± 18.80	1.04 ± 3.45	4.69 ± 52.99	0.81 ± 6.14	25.75 ± 25.09
Liver cancer	40.24 ± 82.39	4.09 ± 14.73	0.87 ± 3.21	9.54 ± 72.72	0.86 ± 6.91	24.88 ± 24.14
Colorectal cancer	36.97 ± 85.16	4.82 ± 18.73	1.04 ± 3.49	9.25 ± 74.33	0.87 ± 7.79	20.99 ± 23.66
Gastric cancer	38.21 ± 82.39	5.46 ± 19.67	1.11 ± 3.57	8.05 ± 70.31	0.97 ± 10.54	22.62 ± 24.51
Pancreatic cancer	33.66 ± 58.78	2.63 ± 13.43	0.54 ± 2.56	4.12 ± 48.77	0.44 ± 2.83	25.93 ± 23.81
Gallbladder/bile duct cancer	34.78 ± 63.60	3.25 ± 15.36	0.72 ± 2.93	4.90 ± 52.11	0.74 ± 6.88	25.16 ± 24.88
Breast cancer	42.59 ± 77.86	5.44 ± 18.92	1.07 ± 3.62	7.09 ± 66.10	0.78 ± 6.04	28.20 ± 26.88
Prostate cancer	39.74 ± 90.38	7.00 ± 22.06	1.43 ± 3.98	10.11 ± 77.43	1.23 ± 10.67	19.97 ± 24.51
Non-Hodgkin's Lymphoma	54.46 ± 79.93	8.33 ± 20.95	1.32 ± 3.87	8.30 ± 62.89	1.92 ± 11.81	34.59 ± 32.43
Leukemia	53.56 ± 83.34	12.11 ± 23.46	1.83 ± 4.58	9.92 ± 66.25	3.10 ± 16.61	26.60 ± 25.07
Other	45.71 ± 98.23	6.27 ± 20.56	1.20 ± 3.74	12.49 ± 86.59	1.09 ± 9.34	24.66 ± 26.25
Survival time after cancer diagnosis (days)						
90 ~ 365	39.89 ± 72.89	4.96 ± 16.93	0.91 ± 3.27	6.75 ± 60.28	0.99 ± 8.52	26.27 ± 26.32
366 ~ 730	39.67 ± 78.02	4.70 ± 18.35	0.91 ± 3.25	7.45 ± 65.86	0.90 ± 9.45	25.71 ± 25.51
731 ~ 1095	40.84 ± 85.79	5.15 ± 18.01	1.05 ± 3.52	9.31 ± 74.82	0.89 ± 7.70	24.45 ± 25.41
≥ 1096	45.48 ± 102.29	6.89 ± 21.87	1.35 ± 3.97	13.45 ± 90.79	1.13 ± 9.05	22.65 ± 25.18
Year of death						
2017	31.31 ± 64.12	3.90 ± 12.27	0.76 ± 2.65	6.78 ± 55.36	1.79 ± 9.59	18.07 ± 18.13
2018	37.09 ± 73.51	4.95 ± 14.73	1.02 ± 3.26	8.09 ± 62.94	1.43 ± 9.41	21.62 ± 21.39
2019	42.77 ± 84.74	5.62 ± 18.93	1.09 ± 3.55	9.69 ± 73.71	0.49 ± 7.04	25.87 ± 25.59
2020	47.12 ± 97.64	6.50 ± 22.19	1.23 ± 3.90	11.54 ± 85.31	0.74 ± 9.11	27.12 ± 27.99
2021	51.59 ± 110.94	7.47 ± 25.40	1.41 ± 4.32	13.51 ± 97.60	0.72 ± 8.77	28.48 ± 30.55

Subsequently, we examined the effect of the type of hospice used on intense care before death using the ZINB regression model. As presented in Table 8, the likelihood of receiving intense care in the last 30 days of life was significantly lower for hospice users than for non-hospice users. In particular, the possibility for combined users was estimated to be low as 82% (Hospital-based hospice only, aOR: 0.36, 95% CI: 0.35-0.37; Home-based hospice only, aOR: 0.37, 95% CI: 0.34-0.40; Combined hospice, aOR: 0.18, 95% CI: 0.17-0.19). In addition, as a result of analyzing people who received intense care at least once in the last 30 days by applying the count model, the intensity of intense care among hospice users was significantly lower than that of non-hospice users. Similar to the results of the logistic model, the difference in the intensity of intense care between non-hospice users was found to be largest in combined hospice users (Hospital-based hospice only, aRR: 0.57, 95% CI: 0.56-0.58; Home-based hospice only, aRR: 0.61, 95% CI: 0.58-0.65; Combined hospice, aRR: 0.47, 95% CI: 0.44-0.49).

When the outcome was set as intense care in the last 90 days of life, a similar tendency was observed (Table 9). The probability of experiencing intense care in their last 90 days was significantly lower among hospice users, irrespective of the specific hospice type, in comparison to non-hospice users (Hospital-based hospice only, aOR: 0.89, 95% CI: 0.87-0.91; Home-based hospice only, aOR: 0.68, 95% CI: 0.62-0.74; Combined hospice, aOR: 0.41, 95% CI: 0.39-0.43). There were notable differences in the intensity of intense care in the last 90 days depending on the type of hospice used (Hospital-based hospice only, aRR: 0.60, 95% CI: 0.59-0.60; Home-based hospice only, aRR: 0.58, 95% CI: 0.56-0.60; Combined hospice, aRR: 0.48, 95% CI: 0.46-0.49).

Table 8. Differences in intense care in the last 30 days of life according to the type of hospice use

Variables	Intense care in the last 30 days of life							
	Zero-inflation (logistic model, non-excess zero probability)				Negative Binomial (count model)			
	aOR	95% CI		P-value	aRR	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	0.36	(0.35	- 0.37)	<.0001	0.57	(0.56	- 0.58)	<.0001
Home-based hospice only	0.37	(0.34	- 0.40)	<.0001	0.61	(0.58	- 0.65)	<.0001
Combined hospice	0.18	(0.17	- 0.19)	<.0001	0.47	(0.44	- 0.49)	<.0001
Sex								
Men	1.00				1.00			
Women	0.77	(0.76	- 0.78)	<.0001	0.95	(0.95	- 0.96)	<.0001
Age (years)								
< 30	1.00				1.00			
30 ~ 39	0.93	(0.83	- 1.05)	0.2354	1.28	(1.21	- 1.35)	<.0001
40 ~ 49	0.82	(0.73	- 0.91)	0.0002	1.31	(1.25	- 1.38)	<.0001
50 ~ 59	0.76	(0.69	- 0.84)	<.0001	1.30	(1.24	- 1.37)	<.0001
60 ~ 69	0.67	(0.61	- 0.74)	<.0001	1.35	(1.29	- 1.41)	<.0001
≥ 70	0.39	(0.35	- 0.43)	<.0001	1.26	(1.20	- 1.32)	<.0001
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.88	(0.87	- 0.90)	<.0001	0.96	(0.95	- 0.97)	<.0001
Income level								
Low	0.87	(0.86	- 0.89)	<.0001	0.98	(0.97	- 0.99)	<.0001
Middle	0.94	(0.92	- 0.95)	<.0001	0.97	(0.96	- 0.97)	<.0001
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	0.98	(0.96	- 0.99)	0.0006	1.01	(1.00	- 1.02)	0.0765
Medicaid	0.79	(0.77	- 0.81)	<.0001	1.09	(1.07	- 1.11)	<.0001
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.01	(0.99	- 1.04)	0.2728	1.29	(1.27	- 1.31)	<.0001

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.91	(0.88	-	0.94)	<.0001	1.02	(1.00	- 1.04)	0.0200
Colorectal cancer	0.73	(0.71	-	0.76)	<.0001	1.12	(1.10	- 1.14)	<.0001
Gastric cancer	0.79	(0.77	-	0.82)	<.0001	1.12	(1.10	- 1.14)	<.0001
Pancreatic cancer	0.85	(0.82	-	0.89)	<.0001	0.95	(0.93	- 0.98)	<.0001
Gallbladder/bile duct cancer	0.89	(0.85	-	0.93)	<.0001	0.98	(0.95	- 1.00)	0.0591
Breast cancer	1.00	(0.96	-	1.05)	0.9659	1.11	(1.09	- 1.14)	<.0001
Prostate cancer	0.82	(0.79	-	0.85)	<.0001	1.18	(1.15	- 1.21)	<.0001
Non-Hodgkin's Lymphoma	1.17	(1.10	-	1.25)	<.0001	1.33	(1.29	- 1.38)	<.0001
Leukemia	1.51	(1.41	-	1.63)	<.0001	1.39	(1.35	- 1.44)	<.0001
Other	0.90	(0.88	-	0.92)	<.0001	1.21	(1.19	- 1.22)	<.0001
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	0.98	(0.96	-	1.00)	0.0196	1.00	(0.99	- 1.01)	0.8998
731 ~ 1095	0.96	(0.94	-	0.99)	0.0010	1.06	(1.05	- 1.07)	<.0001
≥ 1096	1.05	(1.03	-	1.07)	<.0001	1.18	(1.16	- 1.19)	<.0001
Year of death								
2017	1.00				1.00			
2018	1.07	(1.05	-	1.10)	<.0001	1.16	(1.14	- 1.17)	<.0001
2019	1.14	(1.12	-	1.16)	<.0001	1.30	(1.28	- 1.32)	<.0001
2020	1.11	(1.09	-	1.14)	<.0001	1.44	(1.42	- 1.46)	<.0001
2021	1.12	(1.10	-	1.15)	<.0001	1.54	(1.53	- 1.56)	<.0001

Table 9. Differences in intense care in the last 90 days of life according to the type of hospice use

Variables	Intense care in the last 90 days of life							
	Zero-inflation (logistic model, non-excess zero probability)				Negative Binomial (count model)			
	aOR	95% CI		P-value	aRR	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	0.89	(0.87	0.91)	<.0001	0.60	(0.59	0.60)	<.0001
Home-based hospice only	0.68	(0.62	0.74)	<.0001	0.58	(0.56	0.60)	<.0001
Combined hospice	0.41	(0.39	0.43)	<.0001	0.48	(0.46	0.49)	<.0001
Sex								
Men	1.00				1.00			
Women	0.71	(0.69	0.72)	<.0001	0.91	(0.91	0.92)	<.0001
Age (years)								
< 30	1.00				1.00			
30 ~ 39	1.09	(0.94	1.28)	0.2582	1.29	(1.23	1.35)	<.0001
40 ~ 49	0.87	(0.76	1.00)	0.0536	1.28	(1.23	1.33)	<.0001
50 ~ 59	0.78	(0.68	0.89)	0.0002	1.28	(1.23	1.33)	<.0001
60 ~ 69	0.59	(0.51	0.67)	<.0001	1.29	(1.24	1.34)	<.0001
≥ 70	0.24	(0.21	0.28)	<.0001	1.09	(1.05	1.13)	<.0001
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.89	(0.88	0.91)	<.0001	0.94	(0.94	0.95)	<.0001
Income level								
Low	0.87	(0.85	0.88)	<.0001	0.95	(0.95	0.96)	<.0001
Middle	0.93	(0.91	0.94)	<.0001	0.95	(0.95	0.96)	<.0001
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	0.97	(0.95	0.98)	<.0001	1.00	(0.99	1.01)	0.9681
Medicaid	0.76	(0.74	0.78)	<.0001	1.10	(1.08	1.11)	<.0001
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.04	(1.01	1.07)	0.0070	1.52	(1.50	1.54)	<.0001

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.95	(0.91	-	0.99)	0.0117	1.04	(1.02 - 1.05)	<.0001
Colorectal cancer	0.66	(0.64	-	0.68)	<.0001	1.11	(1.09 - 1.12)	<.0001
Gastric cancer	0.76	(0.73	-	0.78)	<.0001	1.09	(1.07 - 1.10)	<.0001
Pancreatic cancer	1.08	(1.03	-	1.14)	0.0030	0.95	(0.93 - 0.97)	<.0001
Gallbladder/bile duct cancer	1.08	(1.02	-	1.13)	0.0039	1.00	(0.98 - 1.02)	0.6852
Breast cancer	0.95	(0.90	-	1.00)	0.0594	1.12	(1.10 - 1.14)	<.0001
Prostate cancer	0.69	(0.66	-	0.73)	<.0001	1.15	(1.13 - 1.18)	<.0001
Non-Hodgkin's Lymphoma	1.16	(1.07	-	1.25)	0.0002	1.40	(1.36 - 1.44)	<.0001
Leukemia	1.15	(1.05	-	1.25)	0.0019	1.32	(1.28 - 1.36)	<.0001
Other	0.85	(0.83	-	0.87)	<.0001	1.23	(1.22 - 1.24)	<.0001
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	0.99	(0.97	-	1.01)	0.3696	0.99	(0.98 - 1.00)	0.0118
731 ~ 1095	0.91	(0.89	-	0.93)	<.0001	1.03	(1.01 - 1.04)	<.0001
≥ 1096	0.87	(0.85	-	0.88)	<.0001	1.17	(1.16 - 1.18)	<.0001
Year of death								
2017	1.00				1.00			
2018	1.08	(1.05	-	1.11)	<.0001	1.17	(1.15 - 1.18)	<.0001
2019	1.12	(1.09	-	1.15)	<.0001	1.35	(1.33 - 1.36)	<.0001
2020	1.04	(1.02	-	1.07)	0.0005	1.49	(1.47 - 1.50)	<.0001
2021	0.99	(0.97	-	1.01)	0.3820	1.63	(1.61 - 1.65)	<.0001

The results of analyzing the differences in each of the five types of intense care according to the type of hospice use are presented in Appendix 3 and 4. For all five types of intense care, the likelihood of receiving it in the hospice users was significantly lower than in the non-hospice users. In addition, the four types of intense care excluding hemodialysis tended to be performed less frequently.

Moreover, we performed subgroup analyses on the impact of the type of hospice use on intense care according to income level and the survival period from first cancer diagnosis to death, and the results are noted in Appendix 5. The result of the analysis stratified by income level showed a similar trend to the main results. Meanwhile, it was estimated that when people with a survival period of more than 3 years from the first diagnosis of cancer to death use hospice care, the likelihood and intensity of intense care received in the last 30 days of life would be noticeably low (Hospital-based hospice only, aOR: 0.33, P<.0001, aRR: 0.51, P<.0001; Home-based hospice only, aOR: 0.35, P<.0001, aRR: 0.54, P<.0001; Combined hospice, aOR:0.17 P<.0001, aRR:0.43, P<.0001).

2) Supportive Care

Descriptive statistics for supportive care, another primary dependent variable, are presented in Table 10 and 11. The total number of narcotic analgesic prescriptions in their last 30 days of life for pain control was only 0.48 times on average for non-hospice users, but was much higher for hospice users. In particular, home-based hospice single users received an average of 1.85 prescriptions in the last 30 days, which was the highest among hospice use types. Meanwhile, the total number of prescriptions in the last 90 days of life was reported to be the highest in combined hospice users, with an average of 4.63 times. For psychological relief, the total number of mental health care received just before death was noticeably higher among hospice users compared to non-hospice users. In one month before death, home-based hospice single users received psychiatric care the most, with an average of 2.88 times, and in three months before death, combined hospice users visited the most, with an average of 4.81 times.

Table 10. Descriptive statistics on primary supportive care in the last 30 days of life

Variables	Supportive care in the last 30 days of life (times, Mean±SD)	
	Prescription of narcotic analgesics	Mental health care
Type of hospice use		
None	0.48 ± 1.58	0.32 ± 0.91
Hospital-based hospice only	0.89 ± 2.41	0.70 ± 1.08
Home-based hospice only	1.85 ± 3.30	2.88 ± 4.18
Combined hospice	1.41 ± 3.02	2.29 ± 3.45
Sex		
Men	0.57 ± 1.79	0.40 ± 1.08
Women	0.54 ± 1.75	0.45 ± 1.19
Age (years)		
< 30	0.85 ± 2.20	0.32 ± 1.19
30 ~ 39	1.00 ± 2.35	0.33 ± 1.07
40 ~ 49	0.90 ± 2.22	0.36 ± 1.05
50 ~ 59	0.83 ± 2.13	0.37 ± 1.07
60 ~ 69	0.67 ± 1.93	0.38 ± 1.09
≥ 70	0.38 ± 1.46	0.45 ± 1.15
Region		
Seoul and metropolitan cities	0.62 ± 1.88	0.43 ± 1.17
Small cities and rural	0.51 ± 1.69	0.40 ± 1.09
Income level		
Low	0.57 ± 1.79	0.42 ± 1.10
Middle	0.59 ± 1.83	0.39 ± 1.09
High	0.32 ± 1.33	0.42 ± 1.15
Health insurance type		
Regionally-insured	0.50 ± 1.67	0.42 ± 1.14
Workplace-insured	0.60 ± 1.83	0.40 ± 1.09
Medicaid	0.57 ± 1.80	0.45 ± 1.12
CCI score		
0 ~ 1	0.55 ± 1.77	0.42 ± 1.12
≥ 2	0.66 ± 1.91	0.42 ± 1.15

Primary cancer type		
Lung cancer	0.75 ± 1.99	0.41 ± 1.08
Liver cancer	0.59 ± 1.81	0.34 ± 1.00
Colorectal cancer	0.52 ± 1.72	0.47 ± 1.18
Gastric cancer	0.47 ± 1.66	0.43 ± 1.16
Pancreatic cancer	0.96 ± 2.26	0.48 ± 1.33
Gallbladder/bile duct cancer	0.63 ± 1.87	0.43 ± 1.19
Breast cancer	0.82 ± 2.14	0.44 ± 1.18
Prostate cancer	0.36 ± 1.41	0.46 ± 1.16
Non-Hodgkin's Lymphoma	0.38 ± 1.50	0.31 ± 0.96
Leukemia	0.33 ± 1.47	0.18 ± 0.61
Other	0.52 ± 1.72	0.41 ± 1.11
Survival time after cancer diagnosis (days)		
90 ~ 365	0.64 ± 1.89	0.41 ± 1.09
366 ~ 730	0.66 ± 1.91	0.42 ± 1.11
731 ~ 1095	0.58 ± 1.81	0.43 ± 1.16
≥ 1096	0.45 ± 1.62	0.42 ± 1.13
Year of death		
2017	0.50 ± 1.68	0.38 ± 1.00
2018	0.50 ± 1.68	0.39 ± 1.02
2019	0.54 ± 1.75	0.42 ± 1.10
2020	0.60 ± 1.84	0.43 ± 1.19
2021	0.63 ± 1.88	0.45 ± 1.25

Table 11. Descriptive statistics on supportive care in the last 90 days of life

Variables	Supportive care in the last 90 days of life (times, Mean±SD)	
	Prescription of narcotic analgesics	Mental health care
Type of hospice use		
None	1.40 ± 3.56	0.78 ± 2.12
Hospital-based hospice only	3.29 ± 5.32	1.31 ± 2.18
Home-based hospice only	4.61 ± 6.00	4.77 ± 7.49
Combined hospice	4.63 ± 6.11	4.81 ± 6.78
Sex		
Men	1.76 ± 4.04	0.89 ± 2.31
Women	1.71 ± 3.95	1.04 ± 2.55
Age (years)		
< 30	2.42 ± 4.67	0.62 ± 2.11
30 ~ 39	3.05 ± 5.15	0.80 ± 2.43
40 ~ 49	2.83 ± 5.01	0.78 ± 2.21
50 ~ 59	2.67 ± 4.81	0.80 ± 2.26
60 ~ 69	2.15 ± 4.40	0.82 ± 2.31
≥ 70	1.11 ± 3.18	1.04 ± 2.48
Region		
Seoul and metropolitan cities	1.90 ± 4.21	0.96 ± 2.43
Small cities and rural	1.61 ± 3.84	0.93 ± 2.39
Income level		
Low	1.62 ± 3.90	0.97 ± 2.40
Middle	1.93 ± 4.19	0.87 ± 2.29
High	1.72 ± 3.96	0.96 ± 2.47
Health insurance type		
Regionally-insured	1.77 ± 4.03	0.94 ± 2.42
Workplace-insured	1.85 ± 4.14	0.89 ± 2.32
Medicaid	1.02 ± 3.12	1.09 ± 2.59
CCI score		
0 ~ 1	1.71 ± 3.97	0.94 ± 2.40
≥ 2	2.16 ± 4.40	0.91 ± 2.46

Primary cancer type		
Lung cancer	2.40 ± 4.56	0.93 ± 2.33
Liver cancer	1.79 ± 3.94	0.73 ± 2.10
Colorectal cancer	1.56 ± 3.80	1.03 ± 2.51
Gastric cancer	1.37 ± 3.59	0.97 ± 2.48
Pancreatic cancer	3.43 ± 5.30	1.03 ± 2.59
Gallbladder/bile duct cancer	2.03 ± 4.16	0.92 ± 2.44
Breast cancer	2.37 ± 4.68	1.00 ± 2.53
Prostate cancer	1.05 ± 3.15	1.08 ± 2.54
Non-Hodgkin's Lymphoma	1.16 ± 3.23	0.63 ± 1.85
Leukemia	0.84 ± 3.01	0.40 ± 1.36
Other	1.63 ± 3.90	0.95 ± 2.42
Survival time after cancer diagnosis (days)		
90 ~ 365	2.03 ± 4.30	0.89 ± 2.25
366 ~ 730	2.09 ± 4.34	0.91 ± 2.33
731 ~ 1095	1.82 ± 4.07	0.96 ± 2.48
≥ 1096	1.38 ± 3.59	0.98 ± 2.50
Year of death		
2017	1.58 ± 3.84	0.85 ± 2.22
2018	1.64 ± 3.89	0.90 ± 2.23
2019	1.75 ± 4.01	0.96 ± 2.40
2020	1.84 ± 4.11	0.96 ± 2.47
2021	1.86 ± 4.13	1.01 ± 2.64

Subsequently, we conducted the ZINB regression analyses to investigate the effects of the type of hospice use on supportive care before death. As illustrated in Table 12, the likelihood of receiving a prescription for narcotic analgesics in the last 30 days of life was significantly higher among hospice users than among non-hospice users. Notably, home-based hospice single users had a 2.95 times higher probability (Hospital-based hospice only, aOR: 1.19, 95% CI: 1.15-1.22; Home-based hospice only, aOR: 2.95, 95% CI: 2.69-3.23; Combined hospice, aOR: 1.98, 95% CI: 1.85-2.13). In addition, when analyzing individuals who were prescribed narcotic analgesics at least one in their last 30 days using a count model, the intensity of prescriptions in hospice users was estimated to be significantly higher than that in the non-hospice users (Hospital-based hospice only, aRR: 1.39, 95% CI: 1.38-1.41; Home-based hospice only, aRR: 1.45, 95% CI: 1.41-1.49; Combined hospice, aRR: 1.45, 95% CI: 1.42-1.49).

As shown in Table 13, when we considered prescriptions for narcotic analgesics in the last 90 days of life as the outcome, a similar pattern emerged. There was a significant difference between the types of hospice use in both the probability of being prescribed narcotic analgesics (Hospital-based hospice only, aOR: 1.98, 95% CI: 1.94-2.02; Home-based hospice only, aOR: 3.40, 95% CI: 3.13-3.69; Combined hospice, aOR: 3.32, 95% CI: 3.13-3.51), and the intensity of prescriptions (Hospital-based hospice only, aRR: 1.27, 95% CI: 1.26-1.28; Home-based hospice only, aRR: 1.35, 95% CI: 1.31-1.39; Combined hospice, aRR: 1.34, 95% CI: 1.32-1.37), and in both models, the probability of home-based hospice single users was estimated to be the highest.

Table 12. Differences in prescriptions for narcotic analgesics in the last 30 days of life according to the type of hospice use

Variables	Prescriptions for narcotic analgesics in the last 30 days of life							
	Zero-inflation (logistic model, non-excess zero probability)				Negative binomial (count model)			
	aOR	95% CI		P-value	aRR	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	1.19	(1.15	- 1.22)	<.0001	1.39	(1.38	- 1.41)	<.0001
Home-based hospice only	2.95	(2.69	- 3.23)	<.0001	1.45	(1.41	- 1.49)	<.0001
Combined hospice	1.98	(1.85	- 2.13)	<.0001	1.45	(1.42	- 1.49)	<.0001
Sex								
Men	1.00				1.00			
Women	0.90	(0.88	- 0.92)	<.0001	0.99	(0.99	- 1.00)	0.2561
Age (years)								
< 30	1.00				1.00			
30 ~ 39	1.10	(0.96	- 1.26)	0.1758	0.98	(0.93	- 1.03)	0.4464
40 ~ 49	0.98	(0.87	- 1.11)	0.7839	0.96	(0.92	- 1.01)	0.1095
50 ~ 59	0.89	(0.79	- 1.01)	0.0695	0.95	(0.91	- 1.00)	0.0528
60 ~ 69	0.71	(0.63	- 0.80)	<.0001	0.94	(0.90	- 0.99)	0.0114
≥ 70	0.40	(0.36	- 0.46)	<.0001	0.93	(0.88	- 0.97)	0.0010
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.87	(0.86	- 0.89)	<.0001	0.98	(0.97	- 0.99)	<.0001
Income level								
Low	0.89	(0.86	- 0.92)	<.0001	0.99	(0.98	- 1.00)	0.0456
Middle	0.92	(0.89	- 0.94)	<.0001	0.99	(0.98	- 1.01)	0.3122
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	0.96	(0.93	- 0.98)	0.0001	1.00	(0.99	- 1.01)	0.6488
Medicaid	0.63	(0.60	- 0.66)	<.0001	0.99	(0.96	- 1.01)	0.2346
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.03	(0.99	- 1.07)	0.1114	0.99	(0.98	- 1.01)	0.2447

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.70	(0.66	-	0.73)	<.0001	1.00	(0.98 - 1.02)	0.7239
Colorectal cancer	0.69	(0.66	-	0.73)	<.0001	1.00	(0.98 - 1.02)	0.7068
Gastric cancer	0.59	(0.56	-	0.62)	<.0001	1.01	(0.99 - 1.03)	0.1772
Pancreatic cancer	1.07	(1.01	-	1.13)	0.0266	1.01	(0.99 - 1.03)	0.4320
Gallbladder/bile duct cancer	0.80	(0.75	-	0.86)	<.0001	1.00	(0.97 - 1.02)	0.8113
Breast cancer	0.98	(0.92	-	1.04)	0.4943	1.02	(1.00 - 1.05)	0.0686
Prostate cancer	0.61	(0.57	-	0.66)	<.0001	0.99	(0.96 - 1.02)	0.4595
Non-Hodgkin's Lymphoma	0.46	(0.41	-	0.51)	<.0001	0.99	(0.95 - 1.04)	0.7681
Leukemia	0.32	(0.28	-	0.37)	<.0001	1.12	(1.06 - 1.18)	<.0001
Other	0.66	(0.64	-	0.68)	<.0001	1.01	(1.00 - 1.02)	0.1538
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	1.00	(0.97	-	1.03)	0.8585	0.99	(0.98 - 1.00)	0.0397
731 ~ 1095	0.89	(0.86	-	0.92)	<.0001	0.99	(0.97 - 1.00)	0.0634
≥ 1096	0.74	(0.72	-	0.76)	<.0001	0.99	(0.98 - 1.00)	0.0155
Year of death								
2017	1.00				1.00			
2018	1.03	(1.00	-	1.07)	0.0839	0.99	(0.97 - 1.00)	0.1218
2019	1.08	(1.04	-	1.12)	<.0001	0.99	(0.98 - 1.01)	0.3243
2020	1.24	(1.20	-	1.28)	<.0001	1.00	(0.98 - 1.01)	0.7652
2021	1.32	(1.28	-	1.37)	<.0001	1.00	(0.98 - 1.01)	0.7607

Table 13. Differences in prescriptions for narcotic analgesics in the last 90 days of life according to the type of hospice use

Variables	Prescriptions for narcotic analgesics in the last 90 days of life							
	Zero-inflation (logistic model, non-excess zero probability)				Negative binomial (count model)			
	aOR	95% CI		P-value	aRR	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	1.98	(1.94	- 2.02)	<.0001	1.27	(1.26	- 1.28)	<.0001
Home-based hospice only	3.40	(3.13	- 3.69)	<.0001	1.35	(1.31	- 1.39)	<.0001
Combined hospice	3.32	(3.13	- 3.51)	<.0001	1.34	(1.32	- 1.37)	<.0001
Sex								
Men	1.00				1.00			
Women	0.94	(0.93	- 0.96)	<.0001	0.97	(0.96	- 0.98)	<.0001
Age (years)								
< 30	1.00				1.00			
30 ~ 39	1.17	(1.06	- 1.29)	0.0024	1.01	(0.97	- 1.05)	0.6451
40 ~ 49	1.05	(0.95	- 1.15)	0.3492	1.00	(0.96	- 1.04)	0.8818
50 ~ 59	0.97	(0.89	- 1.06)	0.5211	0.98	(0.95	- 1.02)	0.4018
60 ~ 69	0.73	(0.67	- 0.80)	<.0001	0.97	(0.93	- 1.00)	0.0870
≥ 70	0.38	(0.35	- 0.42)	<.0001	0.90	(0.86	- 0.93)	<.0001
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.91	(0.89	- 0.92)	<.0001	0.97	(0.96	- 0.98)	<.0001
Income level								
Low	0.90	(0.88	- 0.92)	<.0001	1.02	(1.01	- 1.02)	0.0012
Middle	0.94	(0.92	- 0.96)	<.0001	1.00	(1.00	- 1.01)	0.3875
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	0.95	(0.94	- 0.97)	<.0001	1.00	(0.99	- 1.01)	0.6072
Medicaid	0.63	(0.61	- 0.66)	<.0001	0.97	(0.95	- 0.99)	0.0003
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.05	(1.02	- 1.08)	0.0004	1.01	(1.00	- 1.02)	0.2501

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.67	(0.65	-	0.70)	<.0001	0.92	(0.91 - 0.94)	<.0001
Colorectal cancer	0.62	(0.60	-	0.65)	<.0001	0.96	(0.94 - 0.97)	<.0001
Gastric cancer	0.52	(0.50	-	0.54)	<.0001	0.95	(0.93 - 0.96)	<.0001
Pancreatic cancer	1.23	(1.17	-	1.28)	<.0001	1.03	(1.01 - 1.05)	0.0017
Gallbladder/bile duct cancer	0.83	(0.79	-	0.88)	<.0001	0.95	(0.93 - 0.97)	<.0001
Breast cancer	0.81	(0.77	-	0.85)	<.0001	1.03	(1.01 - 1.05)	0.0080
Prostate cancer	0.57	(0.54	-	0.60)	<.0001	0.97	(0.95 - 1.00)	0.0202
Non-Hodgkin's Lymphoma	0.43	(0.40	-	0.47)	<.0001	0.90	(0.87 - 0.94)	<.0001
Leukemia	0.26	(0.24	-	0.29)	<.0001	0.96	(0.91 - 1.01)	0.0989
Other	0.63	(0.61	-	0.65)	<.0001	0.97	(0.96 - 0.98)	<.0001
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	0.98	(0.96	-	1.01)	0.1289	0.99	(0.98 - 0.99)	0.0028
731 ~ 1095	0.88	(0.86	-	0.90)	<.0001	0.97	(0.96 - 0.98)	<.0001
≥ 1096	0.72	(0.70	-	0.73)	<.0001	0.95	(0.94 - 0.96)	<.0001
Year of death								
2017	1.00				1.00			
2018	1.06	(1.03	-	1.08)	<.0001	1.00	(0.99 - 1.01)	0.6573
2019	1.11	(1.08	-	1.14)	<.0001	1.00	(0.99 - 1.01)	0.9493
2020	1.21	(1.18	-	1.24)	<.0001	1.01	(1.00 - 1.02)	0.2522
2021	1.24	(1.21	-	1.27)	<.0001	1.01	(1.00 - 1.02)	0.0194

Additionally, we performed subgroup analyses on the impact of the type of hospice use on prescriptions for narcotic analgesics according to income level and the survival period from first cancer diagnosis to death. As presented in Appendix 6, it was found to when high-income patients used only hospital-based hospice or combined hospice at the EoL, the likelihood of being prescribed narcotic analgesics before death was noticeably higher ([In the last 30 days] Hospital-based hospice only, aOR: 1.28, P<.0001; Combined hospice, aOR:2.07 P<.0001; [In the last 90 days] Hospital-based hospice only, aOR: 2.08, P<.0001; Combined hospice, aOR:3.51, P<.0001). Likewise, in people whose survival period from first diagnosis of cancer to death was more than 3 years, use of three types of hospice was demonstrated to have an effect of significantly increase the possibility of being prescribed narcotic analgesics before death ([In the last 30 days] Hospital-based hospice only, aOR: 1.47, P<.0001; Home-based hospice only, aOR: 3.75, P<.0001; Combined hospice, aOR:2.36, P<.0001; [In the last 90 days] Hospital-based hospice only, aOR: 2.49, P<.0001; Home-based hospice only, aOR: 3.80, P<.0001; Combined hospice, aOR:3.98, P<.0001).

Subsequently, we analyzed differences in mental health care before death according to the type of hospice use. As noted in Table 14, compared to non-hospice users, the likelihood of hospice users receiving mental health care in their last 30 days of life was approximately four times higher for all three types (Hospital-based hospice only, aOR: 3.58, 95% CI: 3.51-3.66; Home-based hospice only, aOR: 4.96, 95% CI: 4.58-5.36; Combined hospice, aOR: 4.46, 95% CI: 4.22-4.72). The intensity of mental health care was also significantly associated with the type of hospice use (Hospital-based hospice only, aRR: 1.24, 95% CI: 1.22-1.26; Home-based hospice only, aRR: 5.91, 95% CI: 5.56-6.29; Combined hospice, aRR: 4.91, 95% CI: 4.69-5.15). In particular, home-based hospice single users were estimated to have received 5.91 times more care in the last 30 days than non-hospice users.

In Table 15, even when the differences in mental health care in the last 90 days of life was set as outcome, the tendency of the logistic model was similar to the above results (Hospital-based hospice only, aOR: 3.32, 95% CI: 3.26 -3.38; Home-based hospice only, aOR: 4.33, 95% CI: 4.00-4.68; Combined hospice, aOR: 4.28, 95% CI: 4.06-4.52). Meanwhile, as a result of the count model, it was estimated that the combined users had the largest difference in the intensity of mental health care in their last 90 days compared to non-hospice users (Hospital-based hospice only, aRR: 1.06, 95% CI: 1.05-1.08; Home-based hospice only, aRR: 3.48, 95% CI: 3.28-3.70; Combined hospice, aRR: 3.64, 95% CI: 3.49-3.79).

Table 14. Differences in mental health care in the last 30 days of life according to the type of hospice use

Variables	Mental health care in the last 30 days of life							
	Zero-inflation (logistic model, non-excess zero probability)				Negative binomial (count model)			
	aOR	95% CI		P-value	aRR	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	3.58	(3.51	- 3.66)	<.0001	1.24	(1.22	- 1.26)	<.0001
Home-based hospice only	4.96	(4.58	- 5.36)	<.0001	5.91	(5.56	- 6.29)	<.0001
Combined hospice	4.46	(4.22	- 4.72)	<.0001	4.91	(4.69	- 5.15)	<.0001
Sex								
Men	1.00				1.00			
Women	1.12	(1.10	- 1.14)	<.0001	0.98	(0.96	- 1.00)	0.0633
Age (years)								
< 30	1.00				1.00			
30 ~ 39	1.11	(0.95	- 1.30)	0.1716	0.86	(0.73	- 1.02)	0.0774
40 ~ 49	1.18	(1.02	- 1.36)	0.0228	0.86	(0.74	- 1.00)	0.0568
50 ~ 59	1.25	(1.09	- 1.44)	0.0019	0.88	(0.75	- 1.02)	0.0815
60 ~ 69	1.34	(1.17	- 1.54)	<.0001	0.90	(0.78	- 1.04)	0.1655
≥ 70	1.84	(1.60	- 2.11)	<.0001	0.96	(0.83	- 1.11)	0.5610
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.95	(0.94	- 0.97)	<.0001	0.93	(0.92	- 0.95)	<.0001
Income level								
Low	1.07	(1.05	- 1.10)	<.0001	1.00	(0.97	- 1.02)	0.8577
Middle	1.01	(0.99	- 1.03)	0.5203	0.99	(0.97	- 1.02)	0.5738
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	1.00	(0.98	- 1.02)	0.9422	0.99	(0.97	- 1.01)	0.2052
Medicaid	1.20	(1.16	- 1.24)	<.0001	1.01	(0.97	- 1.04)	0.6900
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	0.95	(0.93	- 0.98)	0.0026	1.03	(0.99	- 1.06)	0.1297

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.82	(0.79	-	0.86)	<.0001	0.95	(0.91 - 1.00)	0.0335
Colorectal cancer	1.06	(1.02	-	1.10)	0.0014	1.06	(1.02 - 1.10)	0.0063
Gastric cancer	1.02	(0.98	-	1.05)	0.4058	1.05	(1.01 - 1.09)	0.0211
Pancreatic cancer	0.96	(0.91	-	1.01)	0.1427	1.02	(0.97 - 1.08)	0.4563
Gallbladder/bile duct cancer	0.91	(0.86	-	0.96)	0.0003	1.04	(0.98 - 1.10)	0.1553
Breast cancer	0.99	(0.94	-	1.04)	0.6758	1.04	(0.98 - 1.10)	0.2155
Prostate cancer	1.15	(1.09	-	1.20)	<.0001	1.06	(1.01 - 1.12)	0.0325
Non-Hodgkin's Lymphoma	0.75	(0.69	-	0.81)	<.0001	0.98	(0.89 - 1.08)	0.6418
Leukemia	0.51	(0.46	-	0.57)	<.0001	0.83	(0.72 - 0.95)	0.0058
Other	0.98	(0.95	-	1.01)	0.1383	1.03	(1.00 - 1.06)	0.0822
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	1.02	(0.99	-	1.04)	0.1485	1.00	(0.97 - 1.02)	0.8720
731 ~ 1095	1.05	(1.02	-	1.08)	0.0004	1.00	(0.97 - 1.03)	0.8814
≥ 1096	1.06	(1.04	-	1.09)	<.0001	1.02	(1.00 - 1.04)	0.1214
Year of death								
2017	1.00				1.00			
2018	1.04	(1.02	-	1.07)	0.0011	1.03	(1.00 - 1.06)	0.0323
2019	1.06	(1.03	-	1.09)	<.0001	1.03	(1.00 - 1.06)	0.0243
2020	1.05	(1.03	-	1.08)	0.0001	1.10	(1.07 - 1.13)	<.0001
2021	1.07	(1.04	-	1.10)	<.0001	1.15	(1.12 - 1.18)	<.0001

Table 15. Differences in mental health care in the last 90 days of life according to the type of hospice use

Variables	Mental health care in the last 90 days of life							
	Zero-inflation (logistic model, non-excess zero probability)				Negative binomial (count model)			
	aOR	95% CI		P-value	aRR	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	3.32	(3.26	3.38)	<.0001	1.06	(1.05	1.08)	<.0001
Home-based hospice only	4.33	(4.00	4.68)	<.0001	3.48	(3.28	3.70)	<.0001
Combined hospice	4.28	(4.06	4.52)	<.0001	3.64	(3.49	3.79)	<.0001
Sex								
Men	1.00				1.00			
Women	1.13	(1.11	1.14)	<.0001	1.05	(1.03	1.06)	<.0001
Age (years)								
< 30	1.00				1.00			
30 ~ 39	1.18	(1.04	1.33)	0.0118	1.05	(0.92	1.20)	0.4802
40 ~ 49	1.22	(1.08	1.37)	0.0009	1.01	(0.89	1.15)	0.8499
50 ~ 59	1.26	(1.12	1.40)	<.0001	1.04	(0.92	1.17)	0.5512
60 ~ 69	1.34	(1.20	1.50)	<.0001	1.04	(0.92	1.18)	0.5157
≥ 70	1.82	(1.63	2.03)	<.0001	1.16	(1.03	1.31)	0.0184
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.98	(0.96	0.99)	0.0005	0.98	(0.97	1.00)	0.0323
Income level								
Low	1.05	(1.03	1.07)	<.0001	1.00	(0.98	1.02)	0.7312
Middle	0.98	(0.97	1.00)	0.0432	0.98	(0.96	0.99)	0.0084
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	1.00	(0.98	1.01)	0.7536	0.99	(0.98	1.01)	0.2984
Medicaid	1.16	(1.13	1.19)	<.0001	1.13	(1.09	1.16)	<.0001
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.19	(1.14	1.24)	<.0001	1.03	(1.00	1.06)	0.0357

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.80	(0.77	-	0.82)	<.0001	0.93	(0.89 - 0.96)	<.0001
Colorectal cancer	0.98	(0.95	-	1.01)	0.2480	1.08	(1.04 - 1.11)	<.0001
Gastric cancer	0.98	(0.95	-	1.02)	0.3231	1.05	(1.02 - 1.08)	0.0034
Pancreatic cancer	0.98	(0.94	-	1.03)	0.4409	1.01	(0.97 - 1.06)	0.6418
Gallbladder/bile duct cancer	0.89	(0.85	-	0.93)	<.0001	1.00	(0.96 - 1.05)	0.8518
Breast cancer	0.98	(0.93	-	1.03)	0.3785	1.02	(0.97 - 1.07)	0.4265
Prostate cancer	1.10	(1.05	-	1.14)	<.0001	1.10	(1.05 - 1.15)	<.0001
Non-Hodgkin's Lymphoma	0.72	(0.67	-	0.77)	<.0001	0.88	(0.81 - 0.95)	0.0013
Leukemia	0.51	(0.47	-	0.56)	<.0001	0.82	(0.74 - 0.91)	0.0002
Other	0.97	(0.95	-	1.00)	0.0267	1.04	(1.02 - 1.07)	0.0010
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	1.02	(1.00	-	1.04)	0.1151	1.02	(0.99 - 1.04)	0.1598
731 ~ 1095	1.06	(1.04	-	1.09)	<.0001	1.02	(1.00 - 1.05)	0.0562
≥ 1096	1.08	(1.07	-	1.10)	<.0001	1.07	(1.05 - 1.09)	<.0001
Year of death								
2017	1.00				1.00			
2018	1.06	(1.04	-	1.09)	<.0001	1.03	(1.01 - 1.05)	0.0141
2019	1.08	(1.06	-	1.11)	<.0001	1.04	(1.02 - 1.06)	0.0006
2020	1.08	(1.06	-	1.10)	<.0001	1.06	(1.03 - 1.08)	<.0001
2021	1.11	(1.08	-	1.13)	<.0001	1.09	(1.07 - 1.11)	<.0001

In addition, we conducted subgroup analyses on the impact of the type of hospice use on mental health care according to income level and the survival period from first cancer diagnosis to death, and the results are presented in Appendix 7. It was estimated that if low-income patients used only home-based hospice or combined hospice at the EoL, the likelihood of receiving mental health care near death was exceptionally high ([In the last 30 days] Home-based hospice only, aOR: 4.65, P<.0001; Combined hospice, aOR:4.40 P<.0001; [In the last 90 days] Home-based hospice only, aOR: 4.66, P<.0001; Combined hospice, aOR:4.52, P<.0001). Meanwhile, among people who received mental health care before death, it was confirmed that high-income people who used only home-based hospice had the highest intensity of psychiatric visits during the last 30 days of life (aRR: 6.11, P<0.0001). As a result of stratification by survival period, it was found that people who died within 1 year of their first diagnosis of cancer were significantly more likely to receive mental health care if they used only home-based hospice or combined hospice near death ([In the last 30 days] Home-based hospice only, aOR: 5.68, P<.0001; Combined hospice, aOR:5.15 P<.0001; [In the last 90 days] Home-based hospice only, aOR: 4.91, P<.0001; Combined hospice, aOR:4.87, P<.0001). On the other hand, the intensity of mental health care in their last 30 days of life was reported to be highest among those who had a survival period of more than 2 years and used only home-based hospice (731~1095 days, aRR:7.05, P<0.0001; ≥ 1096 days, aRR:6.01, P<.0001).

3. Differences in Expenditures according to the Type of Hospice Use

Descriptive statistics on expenditures before death are presented in Table 16 and 17. The average total medical expenses spent by non-hospice users in their last 30 days of life was ₩ 5,321,667, of which the average OOPs was ₩ 472,638. Compared to the non-hospice user group, the average total medical expenses were higher for hospital-based hospice single users (₩ 6,372,750), and significantly lower for home-based hospice single users (₩ 2,840,257), and roughly similar for combined hospice users (₩ 5,113,947). Meanwhile, all three hospice user groups spent less OOPs than the non-hospice user group (Hospital-based hospice only: ₩ 380,179; Home-based hospice only: ₩ 197,844; Combined hospice: ₩ 305,309). As expected, the total medical expenses spent in their last 90 days of life were the lowest in home-based hospice single users at ₩ 7,710,012 on average. The non-hospice user group (₩ 12,788,374) and the combined hospice user group (₩ 12,947,565) spent similarly, and the hospital-based single users were the highest at ₩ 16,150,403 on average. Meanwhile, the total OOPs for their last 90 days were highest in non-hospice users, with an average of ₩ 1,137,980 (Hospital-based hospice only: ₩ 1,059,207; Home-based hospice only: ₩ 596,099; Combined hospice: ₩ 829,758).

Table 16. Descriptive statistics on expenditures in the last 30 days of life

Variables	Expenditures in the last 30 days of life (KRW, Mean±SD)					
	Total medical expenses			Out-of-pocket		
Type of hospice use						
None	5,321,667	±	7,114,245	472,638	±	815,126
Hospital-based hospice only	6,372,750	±	3,398,618	380,179	±	311,102
Home-based hospice only	2,840,257	±	2,612,484	197,844	±	252,499
Combined hospice	5,113,947	±	2,993,258	305,309	±	222,756
Sex						
Men	5,577,074	±	6,830,621	466,629	±	780,307
Women	5,254,949	±	6,349,168	435,926	±	714,121
Age (years)						
< 30	11,407,614	±	14,045,589	861,232	±	1,721,992
30 ~ 39	8,278,844	±	9,298,044	631,923	±	1,211,727
40 ~ 49	7,418,167	±	8,104,267	539,950	±	1,010,666
50 ~ 59	7,034,250	±	7,793,128	504,743	±	831,107
60 ~ 69	6,505,986	±	7,398,187	496,637	±	779,018
≥ 70	4,469,060	±	5,522,403	415,478	±	673,838
Region						
Seoul and metropolitan cities	5,833,834	±	7,062,897	477,152	±	804,768
Small cities and rural	5,166,100	±	6,310,429	438,208	±	716,446
Income level						
Low	5,136,749	±	6,345,926	328,561	±	660,840
Middle	5,682,941	±	6,752,643	480,500	±	761,406
High	5,531,919	±	6,783,343	519,657	±	798,317
Health insurance type						
Regionally-insured	5,534,035	±	6,707,092	503,837	±	781,870
Workplace-insured	5,625,535	±	6,823,981	470,086	±	768,916
Medicaid	4,353,812	±	5,534,701	76,216	±	287,160
CCI score						
0 ~ 1	5,443,171	±	6,706,290	457,691	±	764,474
≥ 2	5,625,026	±	6,003,343	423,693	±	647,008

Primary cancer type						
Lung cancer	5,196,486	±	5,386,902	402,149	±	548,387
Liver cancer	5,618,495	±	6,663,116	424,128	±	628,104
Colorectal cancer	4,521,583	±	5,627,574	383,536	±	668,774
Gastric cancer	4,876,786	±	5,764,215	443,219	±	721,206
Pancreatic cancer	5,484,355	±	4,879,242	404,138	±	472,761
Gallbladder/bile duct cancer	5,264,659	±	5,210,215	403,791	±	536,142
Breast cancer	5,750,494	±	6,137,574	464,481	±	690,083
Prostate cancer	4,565,004	±	6,013,324	492,023	±	839,574
Non-Hodgkin's Lymphoma	8,867,762	±	10,875,784	685,808	±	1,442,331
Leukemia	13,594,271	±	14,446,490	998,390	±	1,979,377
Other	5,562,653	±	6,901,650	468,948	±	775,180
Survival time after cancer diagnosis (days)						
90 ~ 365	5,719,802	±	6,621,396	424,259	±	686,733
366 ~ 730	5,522,711	±	6,371,140	421,172	±	695,979
731 ~ 1095	5,359,800	±	6,324,398	431,898	±	737,935
≥ 1096	5,296,187	±	6,896,026	496,696	±	824,045
Year of death						
2017	4,750,871	±	5,726,148	349,950	±	573,500
2018	5,194,961	±	6,246,858	410,125	±	669,860
2019	5,523,034	±	6,547,110	459,425	±	749,849
2020	5,701,804	±	6,959,535	494,813	±	798,886
2021	6,001,859	±	7,449,120	543,980	±	903,822

Table 17. Descriptive statistics on expenditures in the last 90 days of life

Variables	Expenditures in the last 90 days of life (KRW, Mean±SD)					
	Total medical expenses			Out-of-pocket		
Type of hospice use						
None	12,788,374	±	14,586,095	1,137,980	±	1,565,427
Hospital-based hospice only	16,150,403	±	8,621,538	1,059,207	±	804,680
Home-based hospice only	7,710,012	±	6,771,248	596,099	±	699,849
Combined hospice	12,947,565	±	7,680,907	829,758	±	640,602
Sex						
Men	13,257,341	±	13,967,190	1,118,664	±	1,501,478
Women	13,240,565	±	13,574,806	1,118,811	±	1,406,975
Age (years)						
< 30	31,444,683	±	33,943,710	2,427,913	±	3,438,552
30 ~ 39	21,720,501	±	21,449,190	1,697,413	±	2,453,739
40 ~ 49	18,685,039	±	17,793,833	1,360,372	±	1,822,280
50 ~ 59	17,215,491	±	16,280,715	1,253,921	±	1,622,586
60 ~ 69	15,546,561	±	14,762,564	1,200,267	±	1,512,585
≥ 70	10,608,263	±	10,832,429	1,008,725	±	1,285,326
Region						
Seoul and metropolitan cities	14,097,601	±	14,565,738	1,165,885	±	1,557,845
Small cities and rural	12,593,444	±	13,176,987	1,082,080	±	1,390,845
Income level						
Low	12,660,351	±	13,201,689	812,225	±	1,282,478
Middle	13,859,237	±	14,143,079	1,178,485	±	1,448,241
High	13,283,362	±	14,001,338	1,275,119	±	1,552,147
Health insurance type						
Regionally-insured	13,367,121	±	14,054,404	1,237,644	±	1,508,870
Workplace-insured	13,682,676	±	14,019,873	1,449,275	±	1,470,134
Medicaid	10,916,183	±	10,976,989	191,549	±	542,645
CCI score						
0 ~ 1	13,171,014	±	13,936,246	1,120,975	±	1,482,376
≥ 2	14,238,057	±	12,276,190	1,090,900	±	1,258,479

Primary cancer type						
Lung cancer	12,468,489	±	10,912,423	976,838	±	1,084,496
Liver cancer	12,860,579	±	13,162,937	997,879	±	1,217,106
Colorectal cancer	10,914,216	±	10,998,007	951,846	±	1,258,672
Gastric cancer	11,579,015	±	11,238,992	1,059,018	±	1,400,984
Pancreatic cancer	13,508,709	±	10,012,408	1,028,283	±	951,244
Gallbladder/bile duct cancer	13,461,224	±	11,377,381	1,070,820	±	1,169,311
Breast cancer	13,552,439	±	12,269,000	1,108,742	±	1,313,376
Prostate cancer	10,445,819	±	11,635,285	1,145,523	±	1,628,806
Non-Hodgkin's Lymphoma	22,326,956	±	22,476,111	1,747,434	±	2,453,496
Leukemia	36,750,987	±	34,559,925	2,659,500	±	3,615,116
Other	13,593,031	±	14,188,159	1,161,238	±	1,507,592
Survival time after cancer diagnosis (days)						
90 ~ 365	14,638,629	±	14,687,278	1,120,465	±	1,387,082
366 ~ 730	13,619,172	±	13,491,535	1,062,250	±	1,379,398
731 ~ 1095	12,883,764	±	13,028,203	1,055,995	±	1,384,857
≥ 1096	12,345,560	±	13,585,344	1,163,063	±	1,572,556
Year of death						
2017	11,595,131	±	11,726,694	877,894	±	1,149,398
2018	12,661,986	±	12,843,557	1,011,251	±	1,273,891
2019	13,495,545	±	13,798,466	1,143,115	±	1,458,607
2020	13,837,941	±	14,521,737	1,214,067	±	1,565,566
2021	14,435,529	±	15,437,064	1,311,448	±	1,716,383

Subsequently, we performed a GLM with Gamma distribution to determine differences in expenditures according to the type of hospice use. As noted in Table 18, compared to non-hospice users, the total medical expenses for the last 30 days was statistically higher for hospital-based hospice single users by 1.22 times (95% CI: 1.20-1.23), while home-based hospice single users spent about 47% less (95% CI: 0.51-0.55). No significant differences were identified in combined hospice users. On the other hand, the OOPs spent in the last 30 days were significantly lower by approximately 20~59% in the three types of hospice users comparted to non-hospice users (Hospital-based hospice only, Exp(β)=0.80, 95% CI: 0.80-0.81; Home-based hospice only, Exp(β)=0.41, 95% CI: 0.39-0.43; Combined hospice, Exp(β)=0.62, 95% CI: 0.60-0.64).

As shown in Table 19, when comparing total medical expenses in the last 90 days of life with non-hospice users, hospital-based hospice single users and combined hospice users spent significantly more (Hospital-based hospice only, Exp(β)=1.28, 95% CI: 1.27-1.29; Combined hospice, Exp(β)=1.03, 95% CI:1.00-1.09). On the other hand, home-based hospice single users were estimated spend about 40% less (95% CI: 0.58-0.62). The total OOPs spend during the same period were significantly lower for all three types of hospice use compared to the non-user group (Hospital-based hospice only, Exp(β)=0.91, 95% CI: 0.90-0.92; Home-based hospice only, Exp(β)=0.50, 95% CI: 0.48-0.52; Combined hospice, Exp(β)=0.69, 95% CI: 0.67-0.71).

Table 18. Differences in expenditures in the last 30 days of life according to the type of hospice use

Variables	Expenditures in the last 30 days of life							
	Total medical expenses				Out-of-pocket			
	Exp(β)	95% CI		P-value	Exp(β)	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	1.22	(1.20	1.23)	<.0001	0.80	(0.80	0.81)	<.0001
Home-based hospice only	0.53	(0.51	0.55)	<.0001	0.41	(0.39	0.43)	<.0001
Combined hospice	0.99	(0.98	1.02)	0.1131	0.62	(0.60	0.64)	<.0001
Sex								
Men	1.00				1.00			
Women	0.92	(0.91	0.93)	<.0001	0.95	(0.94	0.96)	<.0001
Age (years)								
< 30	1.00				1.00			
30 ~ 39	0.82	(0.77	0.87)	<.0001	0.82	(0.77	0.88)	<.0001
40 ~ 49	0.75	(0.71	0.79)	<.0001	0.75	(0.71	0.80)	<.0001
50 ~ 59	0.72	(0.68	0.76)	<.0001	0.72	(0.68	0.76)	<.0001
60 ~ 69	0.67	(0.63	0.70)	<.0001	0.68	(0.65	0.72)	<.0001
≥ 70	0.46	(0.44	0.49)	<.0001	0.55	(0.52	0.58)	<.0001
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.89	(0.89	0.90)	<.0001	0.92	(0.91	0.92)	<.0001
Income level								
Low	0.92	(0.91	0.93)	<.0001	0.84	(0.83	0.85)	<.0001
Middle	0.95	(0.94	0.95)	<.0001	0.90	(0.90	0.91)	<.0001
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	0.98	(0.97	0.99)	<.0001	0.93	(0.92	0.94)	<.0001
Medicaid	0.84	(0.83	0.85)	<.0001	0.18	(0.18	0.19)	<.0001
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.01	(0.99	1.02)	0.2922	0.95	(0.94	0.97)	<.0001

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	1.02	(1.01	- 1.04)	0.0061	1.02	(1.00	- 1.04)	0.0281
Colorectal cancer	0.89	(0.88	- 0.91)	<.0001	0.99	(0.97	- 1.00)	0.0973
Gastric cancer	0.95	(0.93	- 0.96)	<.0001	1.08	(1.06	- 1.10)	<.0001
Pancreatic cancer	1.00	(0.97	- 1.02)	0.7667	1.03	(1.01	- 1.06)	0.0058
Gallbladder/bile duct cancer	1.04	(1.01	- 1.06)	0.0022	1.02	(1.00	- 1.05)	0.0715
Breast cancer	1.02	(1.00	- 1.04)	0.0951	1.06	(1.03	- 1.08)	<.0001
Prostate cancer	0.97	(0.95	- 0.99)	0.0022	1.14	(1.11	- 1.17)	<.0001
Non-Hodgkin's Lymphoma	1.60	(1.54	- 1.65)	<.0001	1.53	(1.48	- 1.59)	<.0001
Leukemia	2.31	(2.23	- 2.39)	<.0001	2.22	(2.13	- 2.30)	<.0001
Other	1.07	(1.06	- 1.08)	<.0001	1.14	(1.13	- 1.16)	<.0001
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	0.94	(0.93	- 0.95)	<.0001	0.97	(0.96	- 0.98)	<.0001
731 ~ 1095	0.94	(0.93	- 0.95)	<.0001	1.02	(1.01	- 1.03)	0.0028
≥ 1096	0.97	(0.96	- 0.98)	<.0001	1.18	(1.17	- 1.19)	<.0001
Year of death								
2017	1.00				1.00			
2018	1.09	(1.08	- 1.10)	<.0001	1.17	(1.16	- 1.18)	<.0001
2019	1.17	(1.15	- 1.18)	<.0001	1.33	(1.31	- 1.34)	<.0001
2020	1.21	(1.19	- 1.22)	<.0001	1.42	(1.40	- 1.44)	<.0001
2021	1.27	(1.26	- 1.28)	<.0001	1.56	(1.54	- 1.57)	<.0001

Table 19. Differences in expenditures in the last 30 days of life according to the type of hospice use

Variables	Expenditures in the last 90 days of life							
	Total medical expenses				Out-of-pocket			
	Exp(β)	95% CI		P-value	Exp(β)	95% CI		P-value
Type of hospice use								
None	1.00				1.00			
Hospital-based hospice only	1.28	(1.27	1.29)	<.0001	0.91	(0.90	0.92)	<.0001
Home-based hospice only	0.60	(0.58	0.62)	<.0001	0.50	(0.48	0.52)	<.0001
Combined hospice	1.03	(1.00	1.09)	<.0001	0.69	(0.67	0.71)	<.0001
Sex								
Men	1.00				1.00			
Women	0.97	(0.97	0.98)	<.0001	1.02	(1.01	1.02)	<.0001
Age (years)								
< 30	1.00				1.00			
30 ~ 39	0.80	(0.76	0.83)	<.0001	0.77	(0.73	0.81)	<.0001
40 ~ 49	0.71	(0.68	0.74)	<.0001	0.66	(0.63	0.69)	<.0001
50 ~ 59	0.67	(0.64	0.70)	<.0001	0.63	(0.60	0.66)	<.0001
60 ~ 69	0.61	(0.58	0.63)	<.0001	0.59	(0.56	0.62)	<.0001
≥ 70	0.42	(0.40	0.44)	<.0001	0.48	(0.46	0.51)	<.0001
Region								
Seoul and metropolitan cities	1.00				1.00			
Small cities and rural	0.91	(0.90	0.91)	<.0001	0.93	(0.93	0.94)	<.0001
Income level								
Low	0.93	(0.92	0.94)	<.0001	0.83	(0.82	0.83)	<.0001
Middle	0.95	(0.94	0.96)	<.0001	0.89	(0.89	0.90)	<.0001
High	1.00				1.00			
Health insurance type								
Regionally-insured	1.00				1.00			
Workplace-insured	0.99	(0.98	0.99)	<.0001	0.92	(0.91	0.93)	<.0001
Medicaid	0.88	(0.87	0.89)	<.0001	0.18	(0.18	0.18)	<.0001
CCI score								
0 ~ 1	1.00				1.00			
≥ 2	1.04	(1.03	1.05)	<.0001	0.98	(0.97	0.99)	0.0028

Primary cancer type								
Lung cancer	1.00				1.00			
Liver cancer	0.99	(0.98	- 1.01)	0.2865	0.99	(0.97	- 1.01)	0.1866
Colorectal cancer	0.91	(0.90	- 0.92)	<.0001	1.00	(0.98	- 1.01)	0.7618
Gastric cancer	0.94	(0.93	- 0.96)	<.0001	1.08	(1.06	- 1.09)	<.0001
Pancreatic cancer	0.99	(0.98	- 1.01)	0.5890	1.02	(1.00	- 1.04)	0.0608
Gallbladder/bile duct cancer	1.09	(1.07	- 1.11)	<.0001	1.09	(1.06	- 1.11)	<.0001
Breast cancer	0.99	(0.97	- 1.00)	0.1330	1.04	(1.01	- 1.06)	0.0011
Prostate cancer	0.99	(0.97	- 1.01)	0.1724	1.17	(1.15	- 1.20)	<.0001
Non-Hodgkin's Lymphoma	1.65	(1.61	- 1.70)	<.0001	1.58	(1.54	- 1.63)	<.0001
Leukemia	2.49	(2.42	- 2.56)	<.0001	2.33	(2.25	- 2.40)	<.0001
Other	1.09	(1.08	- 1.10)	<.0001	1.17	(1.16	- 1.18)	<.0001
Survival time after cancer diagnosis (days)								
90 ~ 365	1.00				1.00			
366 ~ 730	0.90	(0.89	- 0.91)	<.0001	0.93	(0.92	- 0.94)	<.0001
731 ~ 1095	0.88	(0.87	- 0.89)	<.0001	0.94	(0.93	- 0.95)	<.0001
≥ 1096	0.89	(0.88	- 0.90)	<.0001	1.06	(1.05	- 1.07)	<.0001
Year of death								
2017	1.00				1.00			
2018	1.09	(1.08	- 1.10)	<.0001	1.15	(1.14	- 1.16)	<.0001
2019	1.16	(1.15	- 1.17)	<.0001	1.31	(1.30	- 1.32)	<.0001
2020	1.20	(1.19	- 1.21)	<.0001	1.40	(1.38	- 1.41)	<.0001
2021	1.25	(1.24	- 1.26)	<.0001	1.51	(1.49	- 1.52)	<.0001

In addition, we performed subgroup analyses on the impact of the type of hospice use on expenditures according to income level and the survival period from first cancer diagnosis to death. As noted in Appendix 8, the results of stratification analysis according to income level did not reveal any interesting findings. Meanwhile, when stratified by survival period, it was found that cancer deaths with a survival period of more than 3 years had a particularly large effect on reducing OOPs when they used hospice before death ([In the last 30 days] Hospital-based hospice only, Exp(β)=0.70, P<.0001; Home-based hospice only, Exp(β)=0.35, P<.0001; Combined hospice, Exp(β)=0.54, P<.0001; [In the last 90 days] Hospital-based hospice only, Exp(β)=0.83, P<.0001; Home-based hospice only, Exp(β)=0.43, P<.0001; Combined hospice, Exp(β)=0.61, P<.0001).

4. Trend Changes in Outcomes Following Hospice Enrollment

To begin with, survival analysis was performed to explore the survival probability over time after hospice enrollment (index date), and the Kaplan-Meier survival plot was presented in Appendix 9 as a result. Hospital-based hospice single users survived an average of 35.35 days (SD: 71.65), home-based hospice single users survived an average of 72.44 days (SD: 163.21), and combined hospice users survived an average of 87.69 days (SD: 142.24). The majority of hospice users die within 3 months after enrollment, and since it is not common to use hospice for more than 3 months, only those who died within 3 months after hospice enrollment were included for this analysis.

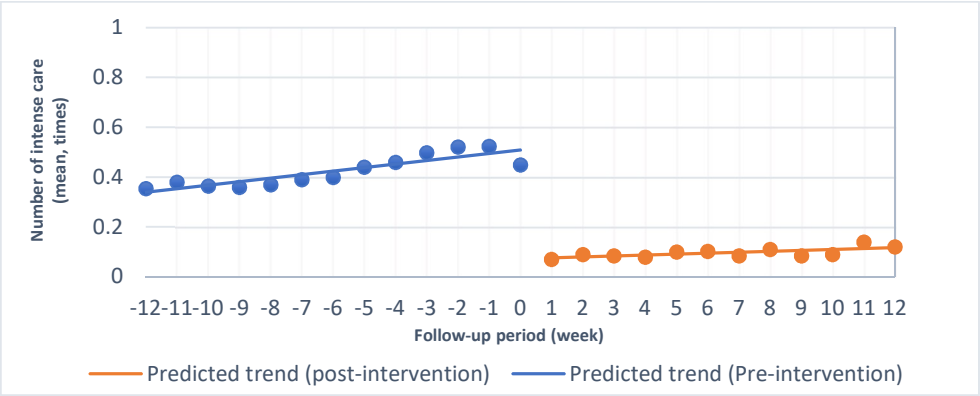
To explore trend changes in outcomes following hospice enrollment, we conducted single ITS with segmented Poisson regression analyses. Only those who had experience using hospice services within 6 months before death was targeted, and each individual's first date of hospice enrollment was set as the index date (Time Zero). As we included those who died within 3 months after hospice enrollment, the follow-up period was set to 12 weeks each before and after the index date to capture changes in the weekly intensity of the outcomes.

Table 20 presents the results of quantitatively confirming the size of level and trend change in the five dependent variables following hospital-based hospice enrollment by calculating the parameter estimates, and Figure 4 illustrates the results of intuitively confirming the outcome trend before and after the intervention. It was confirmed that there was an immediate significant reduction in the intensity of intense care following hospital-based hospice enrollment ($Exp(\beta_2)=0.124$, $P<.0001$). On the other hand, there was no notable change in the intensity of narcotic analgesic prescriptions. The intensity of mental health care increased by about 2.3 times immediately after the intervention ($Exp(\beta_2)=2.307$, $P<.0001$), but then tended to decrease again. Total medical expenses seemed to immediately increase upon the intervention ($Exp(\beta_2)=1.597$, $P<.0001$), but the slope was significantly flatter after the intervention compared to before ($Exp(\beta_3)=0.955$, $P<.0001$). No level change was observed in total OOPs, and the upward trend in OOPs slowed down slightly after the intervention ($Exp(\beta_3)=0.967$, $P<.0001$).

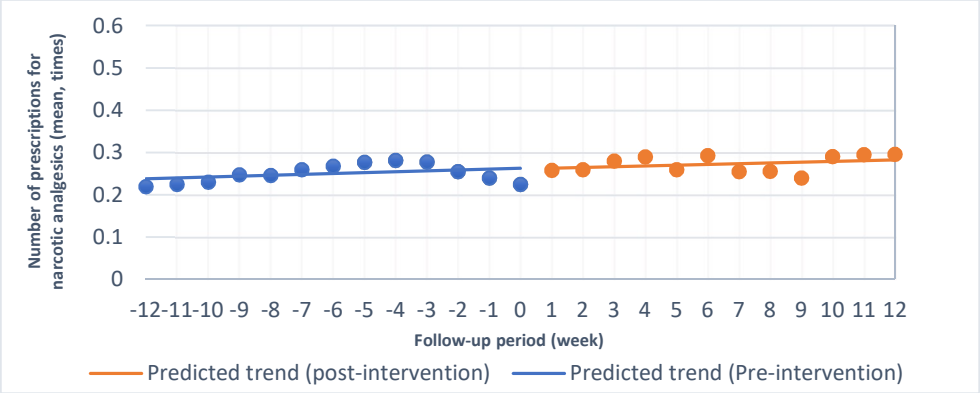
Table 20. Prediction of level changes and trend changes in outcomes following hospital-based hospice enrollment

Outcomes	Exp(β)	Exp(SE(β))	95% CI	*P*-value
Patterns of care				
A. Intense care				
Intercept β_0	0.668	1.050	(0.607 - 0.735)	<.0001
Baseline outcome trend β_1	1.038	1.001	(1.036 - 1.040)	<.0001
Level change after intervention β_2	0.124	1.026	(0.118 - 0.130)	<.0001
Trend change after intervention β_3	1.010	1.006	(1.000 - 1.022)	0.062
Follow-up outcome trend $\beta_1+\beta_3$	1.049	1.006	(1.074 - 1.139)	<.0001
B. Supportive care				
a. Prescriptions for narcotic analgesics				
Intercept β_0	0.385	1.078	(0.332 - 0.446)	<.0001
Baseline outcome trend β_1	1.009	1.001	(1.007 - 1.011)	<.0001
Level change after intervention β_2	1.006	1.009	(0.983 - 1.021)	0.451
Trend change after intervention β_3	1.005	1.010	(0.986 - 1.025)	0.622
Follow-up outcome trend $\beta_1+\beta_3$	1.014	1.010	(0.995 - 1.034)	0.154
b. Mental health care				
Intercept β_0	0.182	1.067	(0.160 - 0.206)	<.0001
Baseline outcome trend β_1	1.096	1.002	(1.092 - 1.101)	<.0001
Level change after intervention β_2	2.307	1.012	(2.255 - 2.360)	<.0001
Trend change after intervention β_3	0.901	1.003	(0.896 - 0.906)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	0.988	1.002	(0.984 - 0.992)	<.0001
Expenditures				
A. Total medical expenses				
Intercept β_0	3,014,064.325	1.036	(2812262.845 - 3230346.613)	<.0001
Baseline outcome trend β_1	1.047	1.001	(1.046 - 1.049)	<.0001
Level change after intervention β_2	1.597	1.006	(1.578 - 1.616)	<.0001
Trend change after intervention β_3	0.955	1.002	(0.952 - 0.958)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	1.000	1.001	(0.998 - 1.003)	0.828
B. Out-of-pocket				
Intercept β_0	197,244.627	1.046	(180719.250 - 215281.123)	<.0001
Baseline outcome trend β_1	1.044	1.001	(1.042 - 1.046)	<.0001
Level change after intervention β_2	1.013	1.009	(0.996 - 1.031)	0.139
Trend change after intervention β_3	0.967	1.002	(0.963 - 0.970)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	1.009	1.002	(1.006 - 1.012)	<.0001

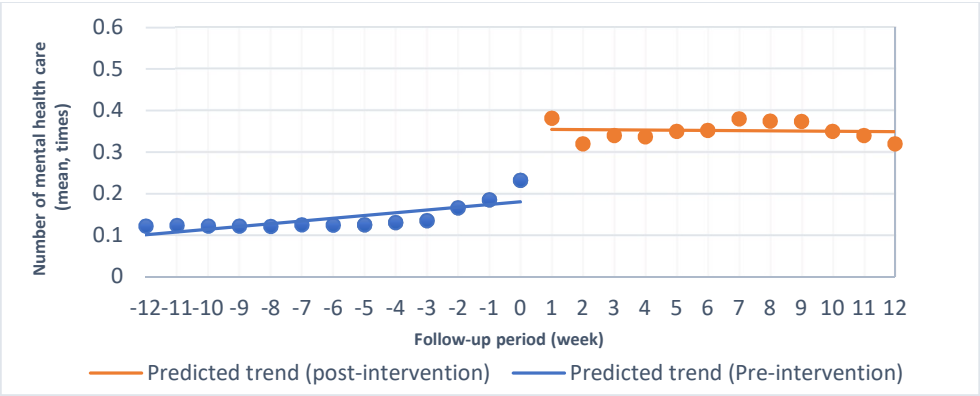
(A) Predicted trend in intense care



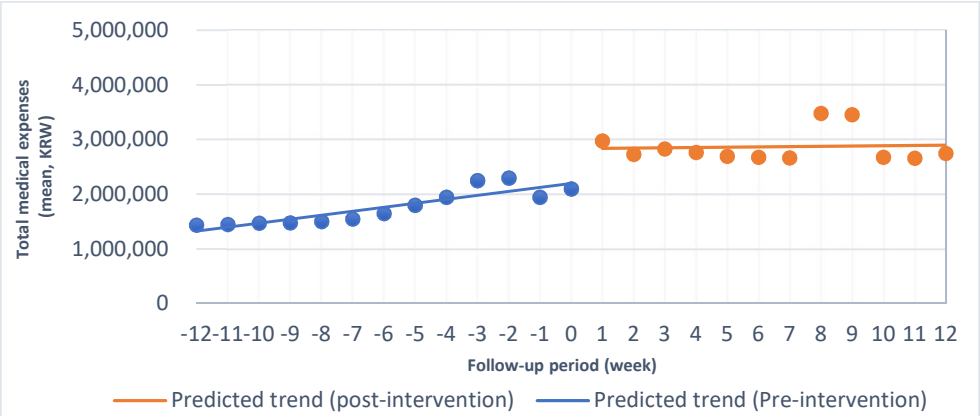
(B) Predicted trend in prescriptions for narcotic analgesics



(C) Predicted trend in mental health care



(D) Predicted trend in total medical expenses



(E) Predicted trend in out-of-pocket expenses

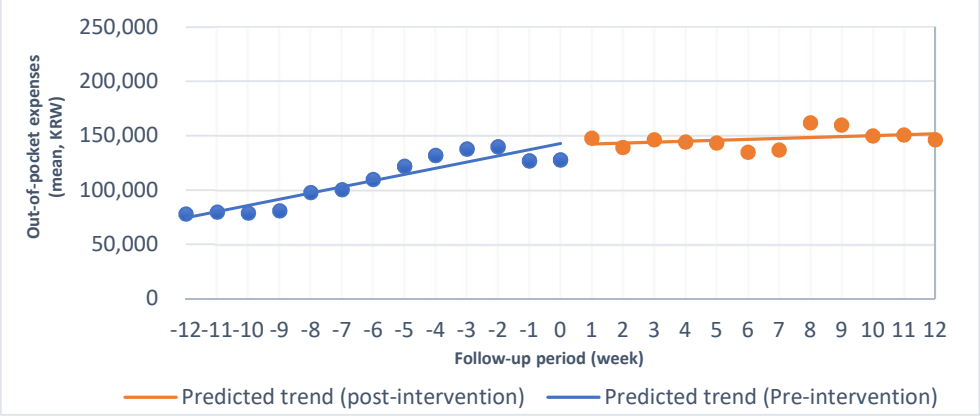


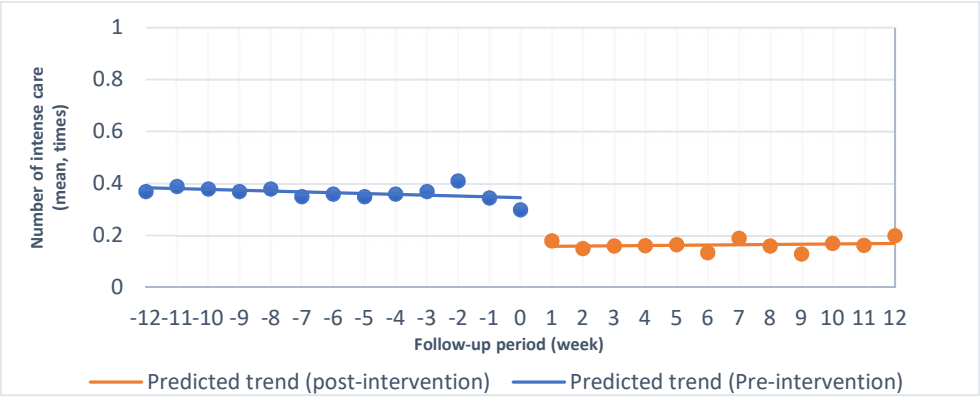
Figure 4. Predicted trends in outcomes before and after hospital-based hospice enrollment

Table 21 presents parameter estimates by predicting the changed level and trend size after home-based hospice enrollment, and Figure 5 visually represents the ITS results, providing an intuitive understanding of the trend changes before and after the intervention. There was an immediate and substantial reduction in the weekly intensity of intense care following home-based hospice enrollment ($Exp(\beta_2)$=0.460, P<.0001). In addition, as hypothesized, supportive care had a significant positive effect. Upon the intervention, the intensity of narcotic analgesic prescriptions and mental health care increased by 1.3 times ($Exp(\beta_2)$=1.304, P=.0002) and 2.9 times ($Exp(\beta_2)$=2.923, P<.0001), respectively. A significant reduction in expenditures was observed after home-based hospice enrollment. Total medical expenses and total OOPs immediately decreased by approximately 11% ($Exp(\beta_2)$=0.887, P=.006) and 23% ($Exp(\beta_2)$=0.774, P<.0001), respectively, at the time of intervention, and showed a significant decreasing trend even after intervention (Total medical expenses, $Exp(\beta_1+\beta_3)$=0.968, P<.0001; Total OOPs, $Exp(\beta_1+\beta_3)$=0.975, P=.006). In addition, a significant slope change in total medical expenses was also confirmed ($Exp(\beta_3)$=0.970, P<.0001).

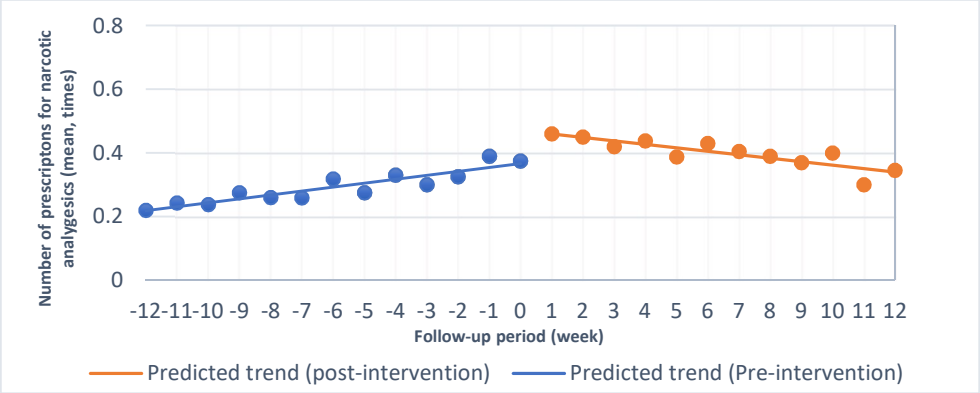
Table 21. Prediction of level changes and trend changes in outcomes following home-based hospice enrollment

Outcomes	Exp(β)	Exp(SE(β))	95% CI	*P*-value
Patterns of care				
A. Intense care				
Intercept β_0	0.338	1.222	(0.228 - 0.500)	<.0001
Baseline outcome trend β_1	0.997	1.004	(0.989 - 1.005)	0.467
Level change after intervention β_2	0.460	1.081	(0.394 - 0.536)	<.0001
Trend change after intervention β_3	1.017	1.013	(0.991 - 1.043)	0.214
Follow-up outcome trend $\beta_1+\beta_3$	1.013	1.013	(0.989 - 1.039)	0.293
B. Supportive care				
a. Prescriptions for narcotic analgesics				
Intercept β_0	0.138	1.420	(0.070 - 0.275)	<.0001
Baseline outcome trend β_1	1.052	1.005	(1.042 - 1.062)	<.0001
Level change after intervention β_2	1.304	1.074	(1.134 - 1.499)	0.0002
Trend change after intervention β_3	0.928	1.013	(0.905 - 0.952)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	0.976	1.012	(0.953 - 1.000)	0.053
b. Mental health care				
Intercept β_0	0.280	1.405	(0.144 - 0.545)	0.0002
Baseline outcome trend β_1	1.154	1.011	(1.130 - 1.178)	<.0001
Level change after intervention β_2	2.923	1.040	(2.708 - 3.156)	<.0001
Trend change after intervention β_3	0.836	1.012	(0.817 - 0.857)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	0.965	1.005	(0.955 - 0.975)	<.0001
Expenditures				
A. Total medical expenses				
Intercept β_0	1,163,682.379	1.159	(871263.730 - 1554244.293)	<.0001
Baseline outcome trend β_1	0.998	1.004	(0.990 - 1.006)	0.576
Level change after intervention β_2	0.887	1.045	(0.814 - 0.966)	0.006
Trend change after intervention β_3	0.970	1.008	(0.956 - 0.985)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	0.968	1.007	(0.955 - 0.981)	<.0001
B. Out-of-pocket expenses				
Intercept β_0	84,905.997	1.220	(57463.199 - 125442.153)	<.0001
Baseline outcome trend β_1	0.984	1.005	(0.975 - 0.993)	0.0004
Level change after intervention β_2	0.774	1.056	(0.696 - 0.861)	<.0001
Trend change after intervention β_3	0.992	1.010	(0.972 - 1.011)	0.403
Follow-up outcome trend $\beta_1+\beta_3$	0.975	1.009	(0.958 - 0.993)	0.006

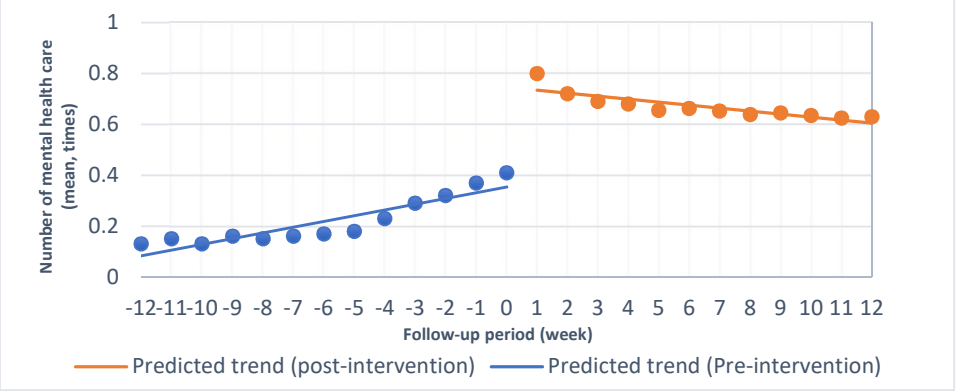
(A) Predicted trend in intense care



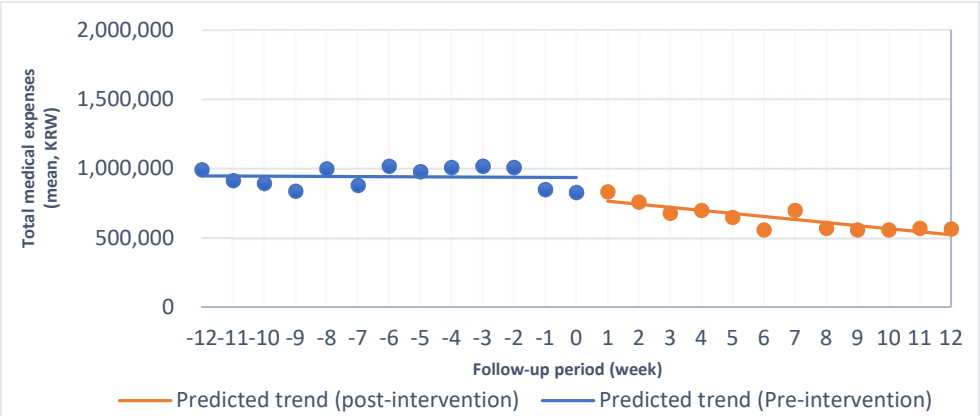
(B) Predicted trend in prescriptions for narcotic analgesics



(C) Predicted trend in mental health care



(D) Predicted trend in total medical expenses



(E) Predicted trend in out-of-pocket expenses

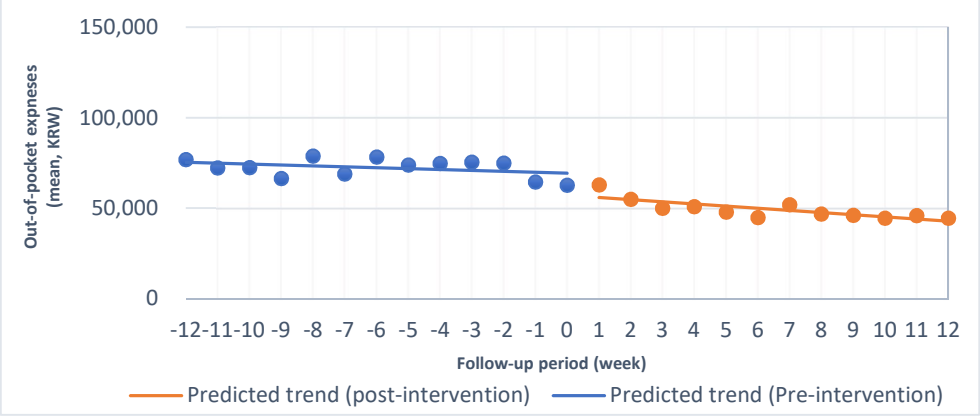


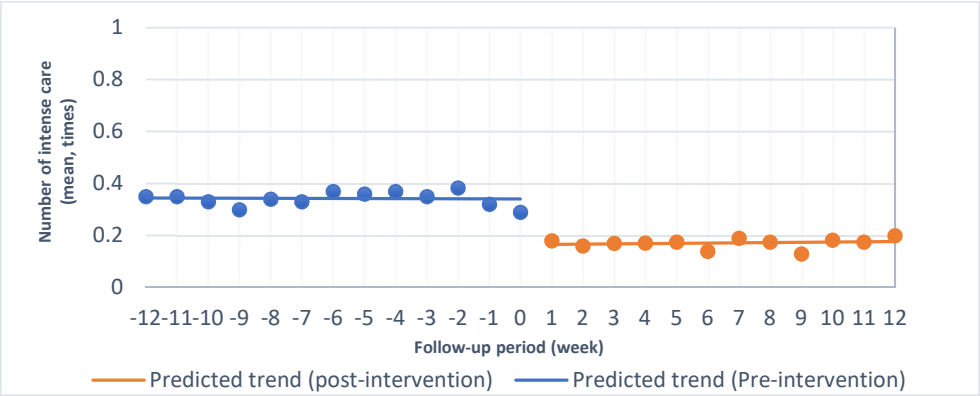
Figure 5. Predicted trends in outcomes before and after home-based hospice enrollment

Table 22 presents the results of predicting the size of level and trend change following combined hospice enrollment, and Figure 6 visually illustrates the ITS results, offering an easily understandable depiction of how trends shifted before and after the intervention. After enrolling in combined hospice care, there was an immediate reduction in the weekly intensity of intense care ($Exp(\beta_2)$=0.460, P<.0001). Furthermore, the provision of supportive care had a notable positive impact. Upon the intervention, there was a 1.3-fold increase in the prescription of narcotic analgesics ($Exp(\beta_2)$=1.282, P<.0001) and a 2.5-fold increase in mental health care ($Exp(\beta_2)$=2.504, P<.0001). Immediately following in the intervention, there appeared to be a rise in total medical expenses ($Exp(\beta_2)$=1.156, P<.0001), but after the intervention, there was a notable decrease in the steepness of the slope compared to before ($Exp(\beta_3)$=0.979, P<.0001). Regarding OOPs, neither level change nor trend change was significantly confirmed.

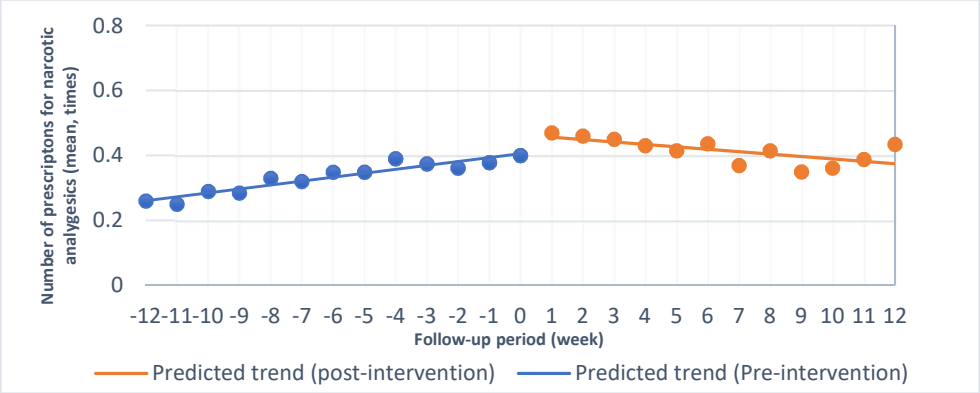
Table 22. Prediction of level changes and trend changes in outcomes following combined hospice enrollment

Outcomes	Exp(β)	Exp(SE(β))	95% CI	*P*-value
Patterns of care				
A. Intense care				
Intercept β_0	0.338	1.222	(0.231 - 0.475)	<.0001
Baseline outcome trend β_1	0.997	1.004	(0.979 - 0.999)	0.467
Level change after intervention β_2	0.460	1.081	(0.406 - 0.558)	<.0001
Trend change after intervention β_3	1.017	1.013	(0.406 - 0.558)	0.214
Follow-up outcome trend $\beta_1+\beta_3$	1.013	1.013	(0.989 - 1.039)	0.293
B. Supportive care				
a. Prescriptions for narcotic analgesics				
Intercept β_0	0.415	1.215	(0.283 - 0.607)	<.0001
Baseline outcome trend β_1	1.040	1.003	(1.034 - 1.046)	<.0001
Level change after intervention β_2	1.282	1.041	(1.185 - 1.387)	<.0001
Trend change after intervention β_3	0.933	1.007	(0.919 - 0.946)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	0.970	1.007	(0.957 - 0.983)	<.0001
b. Mental health care				
Intercept β_0	0.370	1.229	(0.247 - 0.555)	<.0001
Baseline outcome trend β_1	1.131	1.005	(1.119 - 1.143)	<.0001
Level change after intervention β_2	2.504	1.024	(2.392 - 2.622)	<.0001
Trend change after intervention β_3	0.850	1.006	(0.841 - 0.860)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	0.962	1.003	(0.956 - 0.967)	<.0001
Expenditures				
A. Total medical expenses				
Intercept β_0	1,978,006.347	1.104	(1629037.651 - 2401490.154)	<.0001
Baseline outcome trend β_1	1.028	1.003	(1.023 - 1.033)	<.0001
Level change after intervention β_2	1.156	1.026	(1.100 - 1.215)	<.0001
Trend change after intervention β_3	0.979	1.004	(0.971 - 0.987)	<.0001
Follow-up outcome trend $\beta_1+\beta_3$	1.006	1.004	(0.999 - 1.013)	0.074
B. Out-of-pocket expenses				
Intercept β_0	137,557.873	1.113	(111446.507 - 169787.002)	<.0001
Baseline outcome trend β_1	1.002	1.003	(0.996 - 1.007)	0.570
Level change after intervention β_2	1.009	1.005	(0.990 - 1.021)	0.132
Trend change after intervention β_3	1.002	1.005	(0.993 - 1.012)	0.670
Follow-up outcome trend $\beta_1+\beta_3$	1.004	1.004	(0.996 - 1.012)	0.359

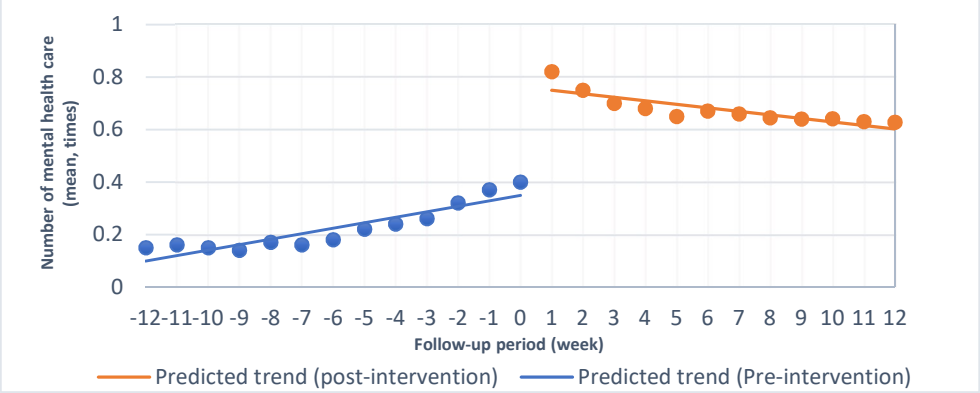
(A) Predicted trend in intense care



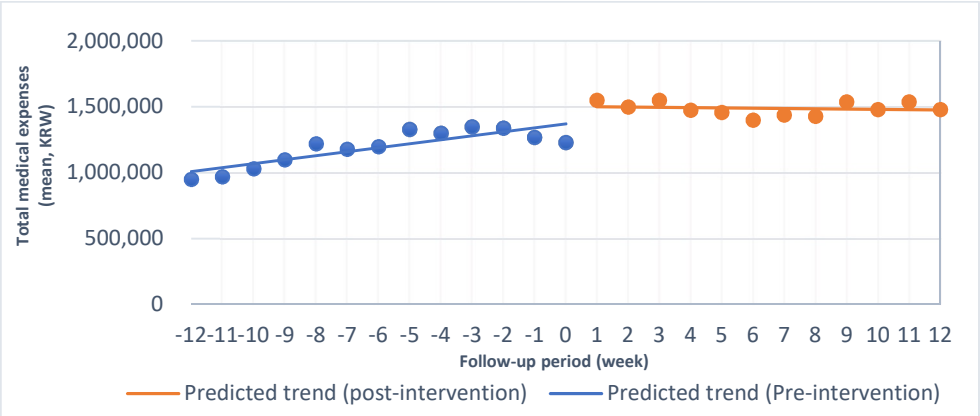
(B) Predicted trend in prescriptions for narcotic analgesics



(C) Predicted trend in mental health care



(D) Predicted trend in total medical expenses



(E) Predicted trend in out-of-pocket expenses

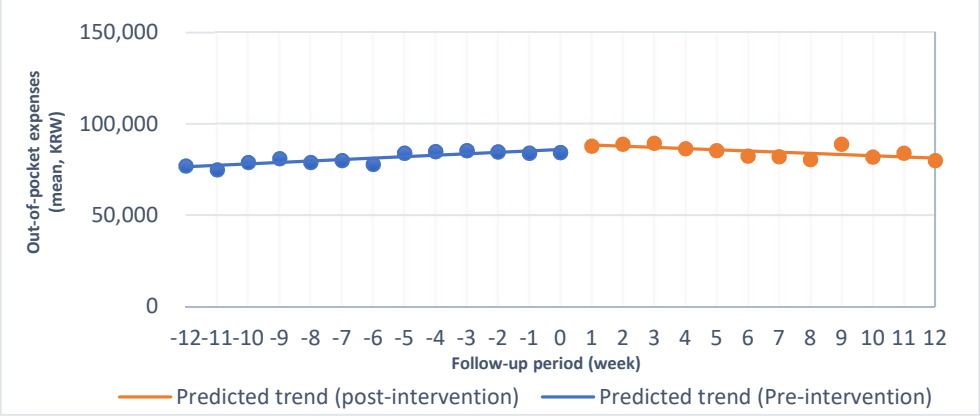
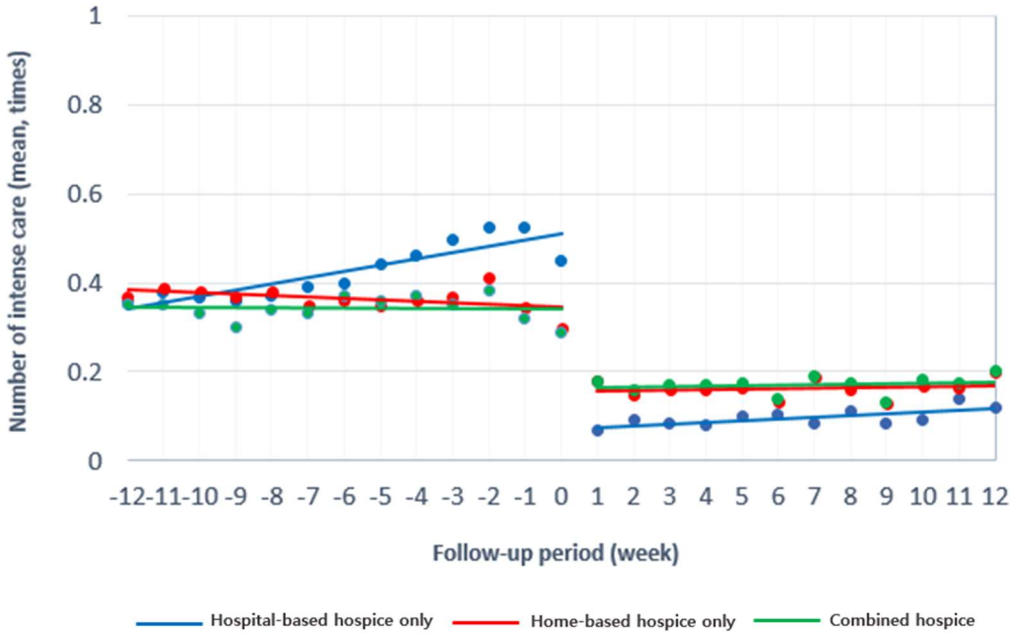


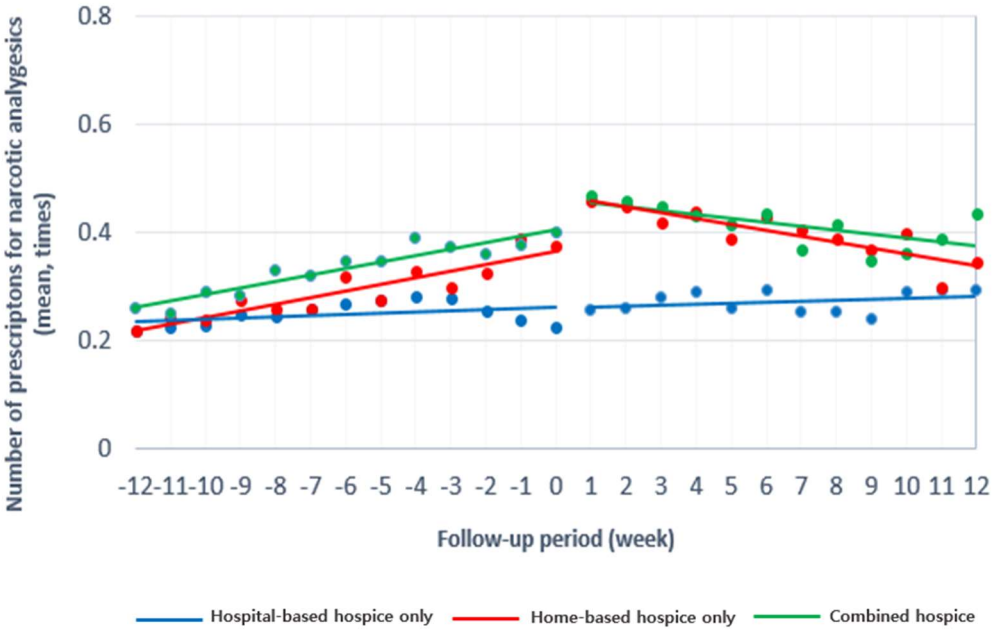
Figure 6. Predicted trends in outcomes before and after combined hospice enrollment

Due to the design of this analysis, it is not appropriate to compare changes in outcomes trends across the three hospice types, but Figure 7 is presented to provide a glance at the predicted trends in outcomes before and after the three types of hospice enrollment. If interpreted intuitively, the number of intense care decreased the most immediately after hospice enrollment in the group that used only hospital-based hospice among the three types. Meanwhile, the number of prescriptions for narcotic analgesics increased the most immediately after enrolling in the home-based hospice single users and the combined hospice users, with these two types showing similar trends overall. Likewise, the number of mental health care showed a similar trend in the home-based hospice single users and the combined hospice users, rapidly increasing immediately after intervention and then decreasing thereafter. Lastly, among the three hospice types, only the home-based hospice single users showed a notable reduction in the total medical expenses and OOPs, as hypothesized in this study.

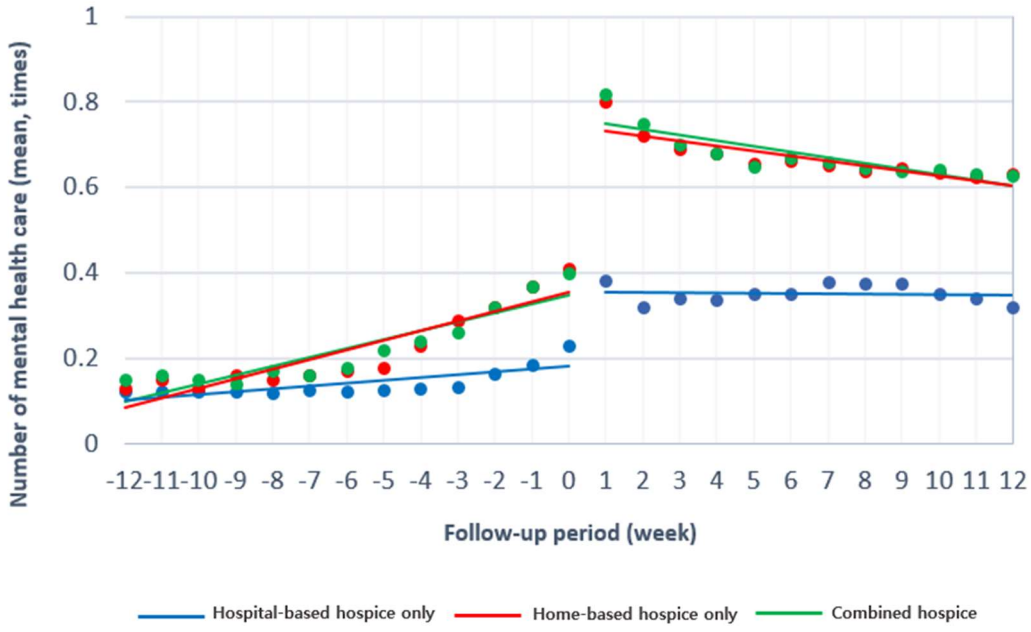
(A) Predicted trend in intense care



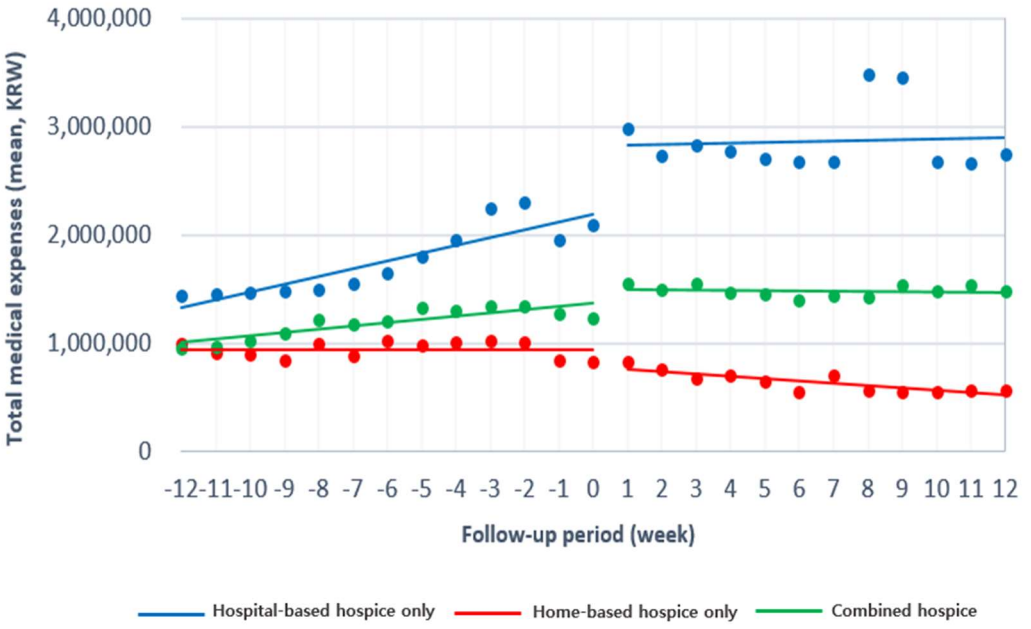
(B) Predicted trend in prescriptions for narcotic analgesics



(C) Predicted trend in mental health care



(D) Predicted trend in total medical expenses



(E) Predicted trend in out-of-pocket expenses

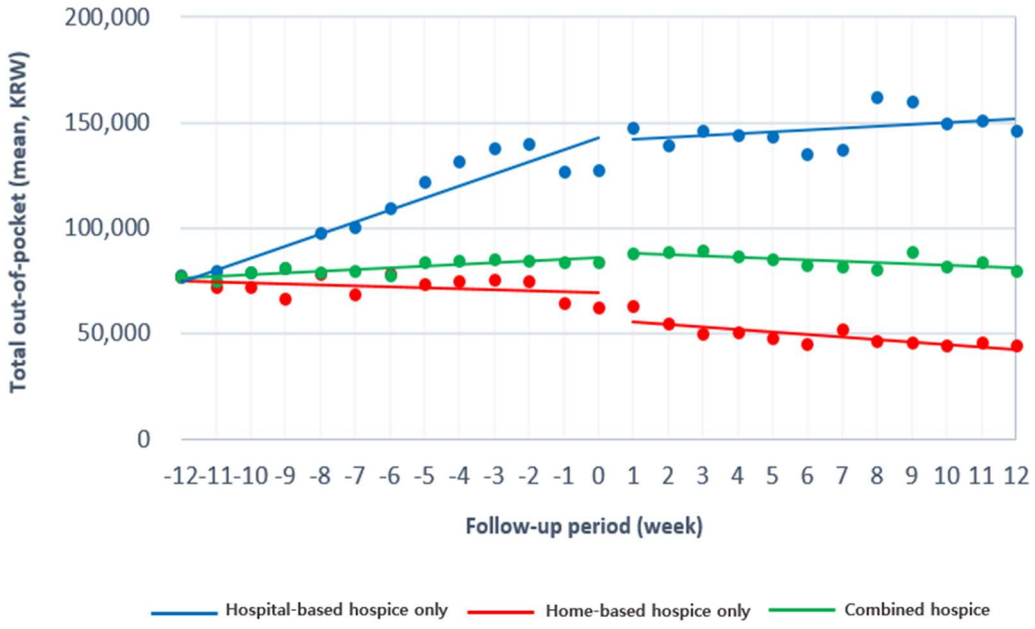


Figure 7. Predicted trends in outcomes before and after enrolling in three types of hospice

V. Discussion

1. Discussion of the Study Methods

This cohort study aimed to explore the impact of hospice enrollment on EoL care patterns and expenditures for terminally ill cancer patients. Specifically, we examined the differences in care patterns and expenditures during the last 30 and 90 days of life according to the type of hospice use, and further confirmed trend changes in outcomes following hospice enrollment.

Both prospective and retrospective approaches can be considered as a study design to evaluate the outcomes at the EoL. However, the NHIS claims data in the analysis of this study did not have information on the stage of cancer, making it very difficult to identify patients with terminal cancer. For this reason, a prospective design was not feasible, a retrospective approach was employed. This involved selecting individuals who had been diagnosed with cancer and subsequently passed away as the study subjects, with their EoL outcomes being tracked retrospectively.

The current study utilized the NHIS database, which contains cohort data representative of the entire population, ensuring its applicability for evaluating the impact of medical procedures and health outcomes. Because our analysis included all cancer deaths between 2017 and 2021 with a previous cancer diagnosis, the external validity of

our findings is very high due to the large sample size. Therefore, our study results may provide meaningful policy implications to other countries with similar population size and socio-demographic characteristics to Korea.

When examining differences in EoL care patterns between types of hospice used, a GLM analysis was performed. Due to the nature of EoL care patterns variables, a GLM with ZINB distribution was applied taking into account the skewed distribution with too many zeros and over-dispersion. When the over-dispersion in the original data is a result of zero-inflation, the commonly used approach for data fitting is the ZIP model, as established in previous research [93,94]. If, even after accounting for zero-inflation, the data continue to exhibit pronounced over-dispersion, it is advisable to contemplate the ZINB model [95-98]. Therefore, a two-part model was generated, through which we were able to determine the difference in the likelihood of receiving intense care and supportive care at the EoL in the logistic model, and even confirm the difference in the intensity of care times for those who received care in the count model. Subsequently, when examining differences in expenditures between types of hospice used, owing to the significant concentration and over-dispersion observed in the distribution of medical expenditure variables, we used a GLM with a Gamma distribution and a 'DSCALE' option [100-102].

We also took only the intervention group, set each individual's hospice enrollment date as the index date, and applied an ITS with segmented Poisson regression to capture trend changes in outcomes following the hospice enrollment. The ITS design is a robust quasi-experimental method for assessing the long-term effects of interventions [107]. This approach offers a significant advantage by leveraging the longitudinal nature of the data

and allowing for the consideration of pre-intervention trends [105]. In previous studies that evaluated the net effect of health care policy, usually only two time points were applied [108], or even if segmented regression was performed, less than 10 time points were employed [109]. As the time points of prior studies seemed to be insufficient to determine the net policy effects, this study applied a total of 24 time points (12 time points each before and after the intervention) to predict trend changes on outcomes more robustly.

Conventional epidemiological study designs, such as cohort and case-control studies, offer valuable insights into disease causation, but have limitations when it comes to intervention studies due to issues like confounding arising from group differences and, notably, healthy user bias [104]. Randomized controlled trials have been widely regarded as the optimal design for assessing intervention effectiveness, but they may not always be feasible, especially for population-level health policies. Additionally, there is a common need to retrospectively evaluate interventions that have been implemented, sometimes without randomization or involving an entire population without any control [110]. In such case, the ITS design is gaining popularity for evaluating public health interventions, especially those implemented at a population level within a well-defined time period and targeting population-level health outcomes [103,111].

This study had certain limitations. First, the NHIS cohort data we obtained only included patients who died between 2017 and 2021 after registering for expanded benefit coverage owing to severe cancer; therefore, we were unable to identify medical utilization records, sociodemographic information, and mortality for patients with diseases other than cancer. Hence, individuals who died from hospice-ineligible diseases were not included in

the comparison group. Instead, we included cancer patients who died without using hospice care within the same period as the intervention group as a comparison group. Second, although cancer stage is a very important confounder in evaluating the outcomes at EoL of cancer patients, this information was not included in the data we analyzed. Because of this, we had no choice but to first select people who died after being diagnosed with cancer and then follow them retrospectively. Third, the NHIS cohort dataset was constructed for administrative purposes; therefore, the ICD-10 codes recorded for health insurance claims may not provide detailed clinical information about the patients' conditions. Furthermore, potential incomplete coding, which could lead to misclassification or underestimation of the outcomes, remains a concern[112-114]. Finally, we attempted to account for potential factors that could affect EoL care patterns and expenditures in cancer patients, such as primary cancer type, survival time after initial cancer diagnosis, and comorbidities. However, it is important to note that we could not completely eliminate the possible impact of unmeasured variables, which could affect these confounding factors.

2. Discussion of the Results

This study examined the impact of hospice enrollment on care patterns and expenditures at the EoL among terminal cancer patients. Specifically, we identified differences in outcomes near death depending on the type of hospice used, and explored trend changes in outcomes following the hospice enrollment.

The key findings of this study are summarized as follows. First, hospice enrollment was associated with less intense care and more supportive care near death. Notably, those who used combined hospice care had the lowest probability and intensity of intense care, while home-based hospice single users had the highest probability and intensity of supportive care. This finding was consistent with previous studies reporting that hospice and palliative care are effective in reducing the procedure burden and aggressive care at the EoL [67,72]. In evaluating supportive care, this study identified narcotic analgesic prescriptions for pain control and psychiatric consultation for psychological relief [76,77]. This was intended to be used as a proxy indicator of QoL because the QoL of participants could not be measured due to the nature of the claims data used in the analysis. As a result, it could be suggested that patients who used only home-based hospice care experienced superior pain and mental health management, leading to an enhanced QoL during their final days. This has similar implications with the results of US studies, which demonstrated that nursing home residents used in hospice had better pain management than those not used in hospice [79,80].

Second, hospice enrollment had a significant effect on reducing OOPs spent at the EoL. In addition, the total medical expenses were observed to be notably less in the home-based hospice single users compared to non-hospice users. Through these findings, we confirmed that using hospice care near death has a clear advantage in reducing the cost burden from the patient's perspective. This was consistent with prior studies showing that use of hospice services can effectively reduce unnecessary healthcare utilization and ultimately save costs [32,68,71]. Meanwhile, we could not prove the effects of using hospital-based hospice and combined hospice in reducing total medical expenses. We expected this to be because the Korean government has continuously increased hospice fees to encourage the supply and use of hospice services, and because there is no patient OOPs for the activity costs of hospice assistants included in the hospital-based hospice fee. Therefore, to our knowledge, it is desirable to encourage the use of home-based hospice in order to expect EoL cost-saving effects from the perspectives of both insurers and patients.

Third, among each type of hospice user, immediate policy effects and trend changes were observed following the intervention. After terminal cancer patients used in hospice, unnecessary intense care was noticeable reduced, and QoL was improved through appropriate pain management and mental health care. Medical expenditures increased as death approaches, but the increase tends to slow after hospice enrollment. Specifically, upon enrollment in hospital-based hospice, the intensity of intense care immediately decreased, and the intensity of mental health care immediately increased. Although medical expenditures increased momentarily at the time of hospital-based hospice enrollment, the increase trend slowed significantly after the intervention. For home-based hospice users,

significant immediate policy effects in all five outcomes were confirmed, as hypothesized. Then, among combined hospice users, the effects of hospice enrollment on intense care and supportive care at the time of intervention was found, but there was no noticeable change in expenditures before and after intervention. Summarizing the results of this ITS analysis, from the perspective of actual hospice users, a positive improvement effect was confirmed in medical utilization, QoL, and cost burden after hospice enrollment.

According to the annual report on hospice use jointly published by Korea's National Hospice Center and Ministry of Health and Welfare, the average rate of new hospice enrollment among all cancer deaths each year during this study period was around 22% [40]. Meanwhile, in our study, among all cancer deaths, the proportion of three types of hospice users within 6 months before death was calculated to approximately 16.5%. This difference is expected because the claims data used in this study only contained procedure codes following the main program, making it impossible to identify the procedures during the hospice pilot program. Additionally, the national statistical data included information on the use of not only the three types of hospices we classified, but also consultative hospices and two or more other types of combined hospices.

There are several studies on evaluating the effects of hospital-based hospice care and home-based hospice care, which are relatively commonly used in major overseas countries. Primarily, they explored differences in pre-dying healthcare utilization, spending, and QoL among hospice users compared to non-hospice users. However, few cohort studies that used claims data on all cancer patients nationwide to explore differences in EoL care patterns and expenditures according to the type of hospice use. Moreover, this study was the first to

examine the effects of actual hospice use by setting the date each hospice user first used in the hospice as the index date and estimating the level change and trend change in outcome before and after the index date. The results of this study will provide useful information when choosing they type and pattern of EoL care for terminally ill patients.

3. Policy Implications

In Korea, which has the fastest aging rate in the world, the burden of continuously increasing EoL medical costs is an important issue for both insures and the insured. With the advancement of medical technology, the average lifespan is on the rise, and the number of patients with severe and chronic diseases, including cancer, also increases. Consequently, there is growing interest in EoL care and well-dying. Hospice and palliative care are public health intervention implemented with the purpose of respecting the self-determination rights and improving the QoL for the elderly and terminally ill patients nearing death. Because this means discontinuation of LST, if implemented well as the policy intends, healthcare utilization patterns will change, and the cost burden will also be reduced in the process of leading to a dignified death.

Although the domestic hospice use rate has increased compared to the past, it is still only 23.7% as of 2022 [40], which is low compared to major countries. Although health insurance mandates for three types of hospice services have implemented in Korea, most patients opt for hospital-based hospice care. Only 4% of patients prefer receiving only home-based hospice care, while consultative hospice care is commonly used as an intermediate step before patients decide to enroll in hospital-based hospice or home-based hospice. Even if patients express their intention to withdraw LST and wishes to die at their own' home, the majority of people receive hospice care in a hospital setting at the EoL due to family recommendations or anxiety about their health conditions. This phenomenon is

thought to have occurred because awareness of appropriate EoL care, including the use of hospice, has not yet been properly established in Korea. Accordingly, the results of this study will contribute to providing valuable information and insights to individuals who may still be hesitant about using hospice care, thereby enabling them to recognize their autonomy rights.

To our knowledge, the most recommended type of hospice for terminally ill cancer patients who wish to die with dignity according to their own decision is home-based hospice. These findings would provide significant implications not only for patients, but also for health care providers and policy makers. From the patients' perspective, using a home-based hospice not only improves the quality of life and death at the EoL by not receiving meaningless LST, but also reduces the financial burden of medical expenses. Meanwhile, from the perspective of health care providers and insurer, they can benefit from saving medical resources as unnecessary medical procedures are limited. In other words, if home-based hospice care is more actively recommended to terminally ill patients and its use increases, it could contribute to the efficient management and allocation of the country's medical resources. However, on the other hand, something that should never be overlooked is that as home-based hospice care is promoted, it will be necessary to consider how to supply the additional medical resources such as hospice specialist and home visiting nurses. The results of this study will provide especially timely implications for Korea, which is at risk of running out of insurance benefits due to the increase in the elderly population and the resulting increase in elderly care costs and EoL medical costs.

Our findings will provide implications that can actively promote and develop established policies. Currently, Korea's hospice-eligible diseases include five diseases, including cancer, which is limited compared with those of other major countries. Considering the continuously increasing mortality rates attributable to chronic and geriatric diseases such as dementia, hospice-eligible diseases should be expanded to ensure a dignified EoL for all patients. In addition, based on the policy trends in major countries, Korea should enhance its efforts in advocating for patient-centered community-based hospice care policies. This can be achieved by identifying places where patients express their preference for EoL care or where they would like to spend their final moments.

VI. Conclusion

This retrospective cohort study evaluated the effects of hospice enrollment on care patterns and expenditures near death of terminal cancer patients. We found that hospice use is associated with receiving less intense and supportive care at the EoL. Notably, because home-based hospice only users receive better pain management and mental health care, their QoL during the final days is expected to improve. Thus, although aggressive life-sustaining care decreases with hospice enrollment, QoL at the EoL improves with appropriate supportive care. In addition, hospice enrollment had a significant impact on reducing cost burden. Expenditures, which gradually increased as death approached, were observed to have significantly slowed down after hospice enrollment.

Our findings suggest that although aggressive care for life-sustaining decreases with hospice enrollment, QoL at the EoL actually improves with appropriate supportive care. The type of hospice use may vary depending on each patient's preferences and health conditions. Based on the policy trends of countries with advanced hospice care, developing patient-centered, community-based hospice care policies is advisable. This policy would offer advantages to both the government, by enabling efficient management of medical resources, and patients, who can assert their autonomy and die with dignity and without suffering.

Abbreviations

QoL - Quality of Life

EoL – End-of-Life

LST - Life-sustaining Treatment

ICU - Intensive Care Unit

QoD - Quality of Death

EPaCCS - Electronic Palliative Care Coordination System

PIG - Proactive Identification Guidance

QOF - Quality and Outcomes Framework

RHC - Routine Home Care

CHC - Continuous Home Care

NHIS - National Health Insurance Service

ICD-10 - International Classification of Diseases 10th revision

CPR - Cardiopulmonary Resuscitation

CT - Computed tomography

OOPs - Out-of-pocket Expenses

CCI - Charlson Comorbidity Index

GLM - Generalized Linear Model

ZINB - Zero-inflated Negative Binomial

ZIP - Zero-inflated Poisson

aOR - Adjusted Odds Ratio

aRR - Adjusted Risk Ratio

ITS - Interrupted Time Series

GEE - Generalized Estimating Equation

KM - Kaplan-Meier

CI - Confidence Interval

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Appendix

Appendix 1. Weighted index applied to calculate CCI score

Appendix 2. Fee for hospice care services in Korea

Appendix 3. Differences in five types of intense care in the last 30 days of life according to the type of hospice use

Appendix 4. Differences in five types of intense care in the last 90 days of life according to the type of hospice use

Appendix 5. Subgroup analyses on the impact of type of hospice use on intense care according to income level and survival time

Appendix 6. Subgroup analyses on the impact of type of hospice use on prescriptions for narcotic analgesics according to income level and survival time

Appendix 7. Subgroup analyses on the impact of type of hospice use on mental health care according to income level and survival time

Appendix 8. Subgroup analyses on the impact of type of hospice use on expenditures according to income level and survival time

Appendix 9. Kaplan-Meier survival plot of cancer patients after hospice enrollment (index date)

Appendix 1. Weighted index applied to calculate CCI score

Conditions	Assigned weights for each condition
Myocardial infarction	1
Congestive heart failure	1
Peripheral vascular disease	1
Cerebrovascular disease	1
Dementia	1
Chronic pulmonary disease	1
Connective tissue disease	1
Ulcer disease	1
Mild liver disease	1
Diabetes	1
Hemiplegia	2
Moderate or severe renal disease	2
Diabetes with end organ damage	2
Any tumor	2
Leukemia / lymphoma	2
Moderate or severe liver disease	3
Metastatic solid tumor	6
AIDS	6

Appendix 2. Fee for hospice care services in Korea

A. Hospital-based hospice care services (per-diem) (Unit: KRW)

Classification	Type of medical institution			
	Tertiary general hospital	General hospital	Hospital	Clinic
4 person room	410,760	406,420	327,540	332,010
2~3 person room	428,450	424,370	343,250	345,990
1 person room	410,760	406,420	327,540	406,590
Dying room	505,100	502,100	411,350	406,590
Isolation room	505,100	502,100	411,350	406,590

B. Home-based hospice care services (fee-for-service) (Unit: KRW)

Classification		Type of medical institution			
		Tertiary general hospital	General hospital	Hospital	Clinic
Visit fee	Doctor (1st session)	129,920	129,920	129,920	129,980
	Doctor (2nd session or more)	90,950	90,950	90,950	90,990
	Physician Assistant	87,220	87,220	87,220	87,430
	Social Worker	52,230	52,230	52,230	52,250
Integrated patient care fee	1st session (50% additional fee)	42,740	42,740	42,740	42,780
	2nd session or more	28,490	28,490	28,490	28,520
Transportation fee		8,490	8,490	8,490	9,770

C. Consultative hospice care services (Unit: KRW)

Classification		Type of medical institution			
		Tertiary general hospital	General hospital	Hospital	Clinic
Consultation fee (Inpatient)	1st session	103,890	103,890	103,890	112,460
	2nd session or more	69,960	69,960	69,960	75,720
Consultation fee (Outpatient)	1st session	103,890	103,890	103,890	112,460
	2nd session or more	61,520	61,520	61,520	66,600
End-of-life care fee		77,660	77,660	77,660	84,070
Dying room (per day)		322,100	235,900	189,540	162,390
Isolation room (per day)		322,100	235,900	189,540	162,390
Advance consultation fee		34,640	34,640	34,640	35,170

Appendix 3. Differences in five types of intense care in the last 30 days of life according to the type of hospice use

Interest of variable	Zero-inflation (logistic model)			Negative Binomial (count model)			
	aOR	95% CI	P-value	aRR	95% CI	P-value
	A. Intubation and ventilator use in the last 30 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.02	(0.02 - 0.03)	<.0001	1.06	(0.98 - 1.14)	0.1264
Home-based hospice only	0.20	(0.17 - 0.25)	<.0001	0.71	(0.63 - 0.80)	<.0001
Combined hospice	0.02	(0.01 - 0.03)	<.0001	0.62	(0.47 - 0.81)	0.0004
	B. CPR in the last 30 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.02	(0.01 - 0.02)	<.0001	0.93	(0.87 - 0.98)	0.0088
Home-based hospice only	0.36	(0.30 - 0.44)	<.0001	0.96	(0.91 - 1.01)	0.1123
Combined hospice	0.03	(0.02 - 0.05)	<.0001	0.96	(0.85 - 1.09)	0.5580
	C. Hemodialysis in the last 30 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.11	(0.10 - 0.12)	<.0001	1.14	(1.03 - 1.26)	0.0103
Home-based hospice only	0.09	(0.05 - 0.15)	<.0001	1.66	(0.99 - 2.77)	0.0530
Combined hospice	0.02	(0.01 - 0.05)	<.0001	2.26	(1.12 - 4.53)	0.0222
	D. ICU care in the last 30 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.11	(0.10 - 0.12)	<.0001	0.79	(0.73 - 0.86)	<.0001
Home-based hospice only	0.11	(0.06 - 0.19)	<.0001	0.84	(0.56 - 1.24)	0.3689
Combined hospice	0.03	(0.01 - 0.06)	<.0001	0.79	(0.47 - 1.34)	0.3873
	E. CT use in the last 30 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.49	(0.48 - 0.50)	<.0001	0.87	(0.87 - 0.88)	<.0001
Home-based hospice only	0.43	(0.40 - 0.47)	<.0001	0.86	(0.82 - 0.89)	<.0001
Combined hospice	0.24	(0.23 - 0.26)	<.0001	0.74	(0.72 - 0.77)	<.0001

Appendix 4. Differences in five types of intense care in the last 90 days of life according to the type of hospice use

Interest of variable	Zero-inflation (logistic model)			Negative Binomial (count model)			
	aOR	95% CI	P-value	aRR	95% CI	P-value
	A. Intubation and ventilator use in the last 90 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.06	(0.05 - 0.06)	<.0001	0.97	(0.93 - 1.02)	0.2701
Home-based hospice only	0.20	(0.17 - 0.24)	<.0001	0.66	(0.59 - 0.75)	<.0001
Combined hospice	0.03	(0.02 - 0.04)	<.0001	0.64	(0.52 - 0.80)	<.0001
	B. CPR in the last 90 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.02	(0.02 - 0.03)	<.0001	0.92	(0.88 - 0.96)	0.0007
Home-based hospice only	0.37	(0.31 - 0.44)	<.0001	0.95	(0.90 - 1.01)	0.0753
Combined hospice	0.03	(0.02 - 0.05)	<.0001	0.93	(0.82 - 1.05)	0.2375
	C. Hemodialysis in the last 90 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.14	(0.12 - 0.15)	<.0001	1.25	(1.12 - 1.40)	0.0001
Home-based hospice only	0.11	(0.07 - 0.17)	<.0001	1.49	(0.82 - 2.72)	0.1919
Combined hospice	0.04	(0.03 - 0.07)	<.0001	1.63	(0.86 - 3.08)	0.1328
	D. ICU care in the last 90 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	0.24	(0.22 - 0.25)	<.0001	0.72	(0.69 - 0.76)	<.0001
Home-based hospice only	0.13	(0.08 - 0.20)	<.0001	0.69	(0.48 - 0.98)	0.0385
Combined hospice	0.08	(0.06 - 0.11)	<.0001	0.69	(0.51 - 0.92)	0.0105
	E. CT use in the last 90 days of life					
Type of hospice use						
None	1.00			1.00		
Hospital-based hospice only	1.11	(1.09 - 1.14)	<.0001	0.90	(0.90 - 0.91)	<.0001
Home-based hospice only	0.80	(0.74 - 0.88)	<.0001	0.85	(0.82 - 0.87)	<.0001
Combined hospice	0.52	(0.49 - 0.55)	<.0001	0.75	(0.74 - 0.77)	<.0001

Appendix 5. Subgroup analyses on the impact of type of hospice use on intense care according to income level and survival time

Variables	A. Intense care in the last 30 days of life													
	Type of hospice use							Type of hospice use						
	None	Hospital-based hospice only		Home-based hospice only		Combined hospice		None	Hospital-based hospice only		Home-based hospice only		Combined hospice	
	Zero-inflation (logistic model, aOR, P-value)							Negative Binomial (count model, aRR, P-value)						
Income level														
Low	1.00	0.37	(<.0001)	0.40	(<.0001)	0.19	(<.0001)	1.00	0.56	(<.0001)	0.59	(<.0001)	0.46	(<.0001)
Middle	1.00	0.34	(<.0001)	0.32	(<.0001)	0.15	(<.0001)	1.00	0.58	(<.0001)	0.62	(<.0001)	0.48	(<.0001)
High	1.00	0.36	(<.0001)	0.37	(<.0001)	0.18	(<.0001)	1.00	0.57	(<.0001)	0.62	(<.0001)	0.46	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	0.39	(<.0001)	0.35	(<.0001)	0.18	(<.0001)	1.00	0.62	(<.0001)	0.70	(<.0001)	0.50	(<.0001)
366 ~ 730	1.00	0.37	(<.0001)	0.41	(<.0001)	0.19	(<.0001)	1.00	0.61	(<.0001)	0.67	(<.0001)	0.52	(<.0001)
731 ~ 1095	1.00	0.35	(<.0001)	0.38	(<.0001)	0.17	(<.0001)	1.00	0.56	(<.0001)	0.57	(<.0001)	0.45	(<.0001)
≥ 1096	1.00	0.33	(<.0001)	0.35	(<.0001)	0.17	(<.0001)	1.00	0.51	(<.0001)	0.54	(<.0001)	0.43	(<.0001)
	B. Intense care in the last 90 days of life													
	Zero-inflation (logistic model, aOR, P-value)							Negative Binomial (count model, aRR, P-value)						
Income level														
Low	1.00	0.90	(<.0001)	0.68	(<.0001)	0.42	(<.0001)	1.00	0.59	(<.0001)	0.57	(<.0001)	0.48	(<.0001)
Middle	1.00	0.86	(<.0001)	0.66	(<.0001)	0.37	(<.0001)	1.00	0.60	(<.0001)	0.57	(<.0001)	0.50	(<.0001)
High	1.00	0.90	(<.0001)	0.67	(<.0001)	0.41	(<.0001)	1.00	0.60	(<.0001)	0.59	(<.0001)	0.46	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	0.86	(<.0001)	0.60	(<.0001)	0.42	(<.0001)	1.00	0.65	(<.0001)	0.67	(<.0001)	0.51	(<.0001)
366 ~ 730	1.00	0.89	(<.0001)	0.68	(0.0001)	0.48	(<.0001)	1.00	0.65	(<.0001)	0.65	(<.0001)	0.53	(<.0001)
731 ~ 1095	1.00	0.90	(0.0005)	0.69	(0.0022)	0.41	(<.0001)	1.00	0.60	(<.0001)	0.56	(<.0001)	0.47	(<.0001)
≥ 1096	1.00	0.93	(<.0001)	0.76	(0.0002)	0.39	(<.0001)	1.00	0.53	(<.0001)	0.50	(<.0001)	0.44	(<.0001)

Appendix 6. Subgroup analyses on the impact of type of hospice use on prescriptions for narcotic analgesics according to income level and survival time

Variables	A. Prescriptions for narcotic analgesics in the last 30 days of life												
	Type of hospice use							Type of hospice use					
	None	Hospital-based hospice only		Home-based hospice only		Combined hospice		None	Hospital-based hospice only		Home-based hospice only		Combined hospice	
	Zero-inflation (logistic model, aOR, P-value)							Negative Binomial (count model, aRR, P-value)						
Income level														
Low	1.00	1.11	(0.0004)	2.75	(<.0001)	2.03	(<.0001)	1.00	1.40	(<.0001)	1.46	(<.0001)	1.43	(<.0001)
Middle	1.00	1.10	(<.0001)	3.03	(<.0001)	1.75	(<.0001)	1.00	1.38	(<.0001)	1.44	(<.0001)	1.43	(<.0001)
High	1.00	1.28	(<.0001)	2.98	(<.0001)	2.07	(<.0001)	1.00	1.41	(<.0001)	1.45	(<.0001)	1.48	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	1.05	(0.0867)	2.37	(<.0001)	1.93	(<.0001)	1.00	1.38	(<.0001)	1.43	(<.0001)	1.43	(<.0001)
366 ~ 730	1.00	1.03	(0.3702)	2.71	(<.0001)	1.50	(<.0001)	1.00	1.41	(<.0001)	1.47	(<.0001)	1.50	(<.0001)
731 ~ 1095	1.00	1.11	(0.0082)	2.52	(<.0001)	1.87	(<.0001)	1.00	1.40	(<.0001)	1.49	(<.0001)	1.48	(<.0001)
≥ 1096	1.00	1.47	(<.0001)	3.75	(<.0001)	2.36	(<.0001)	1.00	1.41	(<.0001)	1.46	(<.0001)	1.45	(<.0001)
	B. Prescriptions for narcotic analgesics in the last 90 days of life													
	Zero-inflation (logistic model, aOR, P-value)							Negative Binomial (count model, aRR, P-value)						
Income level														
Low	1.00	1.96	(<.0001)	3.78	(<.0001)	3.36	(<.0001)	1.00	1.25	(<.0001)	1.29	(<.0001)	1.38	(<.0001)
Middle	1.00	1.84	(<.0001)	3.37	(<.0001)	2.89	(<.0001)	1.00	1.26	(<.0001)	1.35	(<.0001)	1.32	(<.0001)
High	1.00	2.08	(<.0001)	3.25	(<.0001)	3.51	(<.0001)	1.00	1.28	(<.0001)	1.37	(<.0001)	1.34	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	1.64	(<.0001)	3.10	(<.0001)	2.94	(<.0001)	1.00	1.24	(<.0001)	1.26	(<.0001)	1.31	(<.0001)
366 ~ 730	1.00	1.74	(<.0001)	3.07	(<.0001)	2.58	(<.0001)	1.00	1.26	(<.0001)	1.41	(<.0001)	1.35	(<.0001)
731 ~ 1095	1.00	1.92	(<.0001)	3.32	(<.0001)	3.39	(<.0001)	1.00	1.27	(<.0001)	1.35	(<.0001)	1.36	(<.0001)
≥ 1096	1.00	2.49	(<.0001)	3.80	(<.0001)	3.98	(<.0001)	1.00	1.29	(<.0001)	1.37	(<.0001)	1.36	(<.0001)

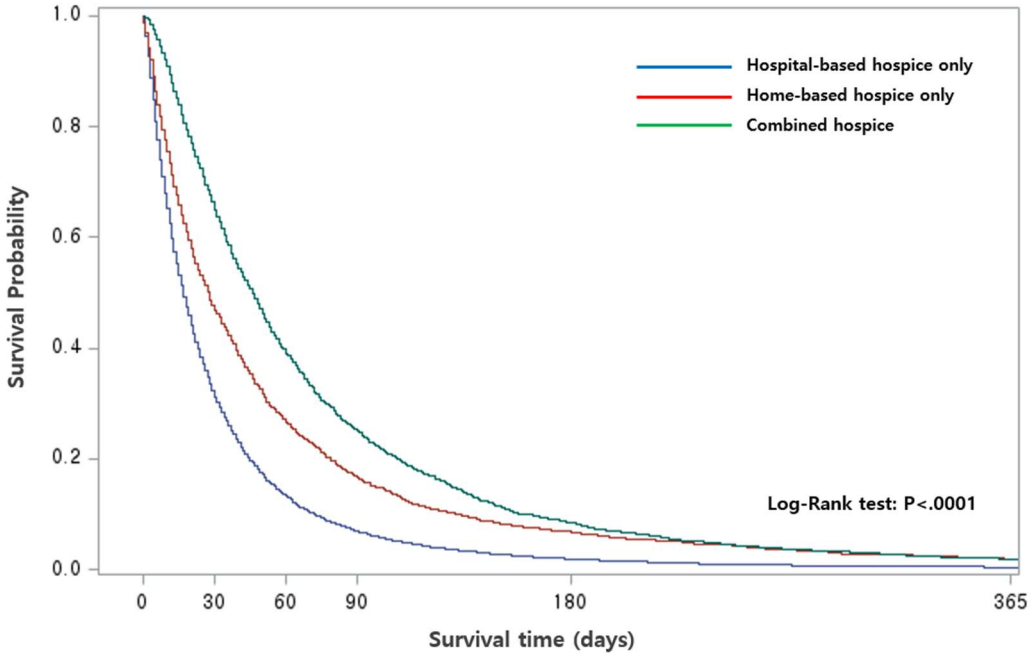
Appendix 7. Subgroup analyses on the impact of type of hospice use on mental health care according to income level and survival time

Variables	A. Mental health care in the last 30 days of life												
	Type of hospice use							Type of hospice use					
	None	Hospital-based hospice only		Home-based hospice only		Combined hospice		None	Hospital-based hospice only		Home-based hospice only		Combined hospice	
	Zero-inflation (logistic model, aOR, P-value)							Negative Binomial (count model, aRR, P-value)						
Income level														
Low	1.00	3.37	(<.0001)	4.65	(<.0001)	4.40	(<.0001)	1.00	0.95	0.0182	5.67	(<.0001)	4.54	(<.0001)
Middle	1.00	3.94	(<.0001)	5.43	(<.0001)	4.84	(<.0001)	1.00	0.94	0.0103	5.66	(<.0001)	5.31	(<.0001)
High	1.00	3.54	(<.0001)	4.93	(<.0001)	4.36	(<.0001)	1.00	0.92	(<.0001)	6.11	(<.0001)	4.86	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	3.71	(<.0001)	5.68	(<.0001)	5.15	(<.0001)	1.00	0.89	(<.0001)	5.67	(<.0001)	4.76	(<.0001)
366 ~ 730	1.00	3.71	(<.0001)	4.76	(<.0001)	4.50	(<.0001)	1.00	0.94	0.02	5.41	(<.0001)	5.06	(<.0001)
731 ~ 1095	1.00	3.54	(<.0001)	4.10	(<.0001)	4.14	(<.0001)	1.00	0.99	0.76	7.05	(<.0001)	5.24	(<.0001)
≥ 1096	1.00	3.44	(<.0001)	4.98	(<.0001)	4.19	(<.0001)	1.00	0.94	0.00	6.01	(<.0001)	4.81	(<.0001)
	B. Mental health care in the last 90 days of life													
	Zero-inflation (logistic model, aOR, P-value)							Negative Binomial (count model, aRR, P-value)						
Income level														
Low	1.00	3.22	(<.0001)	4.66	(<.0001)	4.52	(<.0001)	1.00	0.76	(<.0001)	3.27	(<.0001)	3.39	(<.0001)
Middle	1.00	3.59	(<.0001)	4.29	(<.0001)	4.32	(<.0001)	1.00	0.76	(<.0001)	3.57	(<.0001)	3.77	(<.0001)
High	1.00	3.24	(<.0001)	4.23	(<.0001)	4.20	(<.0001)	1.00	0.77	(<.0001)	3.53	(<.0001)	3.68	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	3.42	(<.0001)	4.91	(<.0001)	4.87	(<.0001)	1.00	0.77	(<.0001)	3.53	(<.0001)	3.73	(<.0001)
366 ~ 730	1.00	3.42	(<.0001)	4.19	(<.0001)	4.51	(<.0001)	1.00	0.77	(<.0001)	3.10	(<.0001)	3.40	(<.0001)
731 ~ 1095	1.00	3.22	(<.0001)	3.73	(<.0001)	4.08	(<.0001)	1.00	0.77	(<.0001)	3.84	(<.0001)	3.62	(<.0001)
≥ 1096	1.00	3.23	(<.0001)	4.31	(<.0001)	3.92	(<.0001)	1.00	0.76	(<.0001)	3.52	(<.0001)	3.68	(<.0001)

Appendix 8. Subgroup analyses on the impact of type of hospice use on expenditures according to income level and survival time

Variables	A. Expenditures in the last 30 days of life												
	Type of hospice use							Type of hospice use					
	None	Hospital-based hospice only		Home-based hospice only		Combined hospice		None	Hospital-based hospice only		Home-based hospice only		Combined hospice	
	Total medical expenses (Exp(β), P-value)							Out-of-pocket expenses (Exp(β), P-value)						
Income level														
Low	1.00	1.29	(<.0001)	0.56	(<.0001)	1.10	(0.0040)	1.00	0.79	(<.0001)	0.47	(<.0001)	0.61	(<.0001)
Middle	1.00	1.18	(<.0001)	0.52	(<.0001)	1.00	(0.8940)	1.00	0.83	(<.0001)	0.40	(<.0001)	0.64	(<.0001)
High	1.00	1.20	(<.0001)	0.52	(<.0001)	1.00	(0.9187)	1.00	0.80	(<.0001)	0.39	(<.0001)	0.60	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	1.23	(<.0001)	0.53	(<.0001)	1.09	(0.0016)	1.00	0.90	(<.0001)	0.46	(<.0001)	0.72	(<.0001)
366 ~ 730	1.00	1.24	(<.0001)	0.57	(<.0001)	1.05	(0.1318)	1.00	0.88	(<.0001)	0.48	(<.0001)	0.67	(<.0001)
731 ~ 1095	1.00	1.25	(<.0001)	0.55	(<.0001)	1.02	(0.5504)	1.00	0.83	(<.0001)	0.43	(<.0001)	0.65	(<.0001)
≥ 1096	1.00	1.20	(<.0001)	0.51	(<.0001)	0.99	(0.5695)	1.00	0.70	(<.0001)	0.35	(<.0001)	0.54	(<.0001)
	B. Expenditures in the last 90 days of life													
	Total medical expenses (Exp(β), P-value)							Out-of-pocket expenses (Exp(β), P-value)						
Income level														
Low	1.00	1.35	(<.0001)	0.59	(<.0001)	1.13	(<.0001)	1.00	0.91	(<.0001)	0.55	(<.0001)	0.70	(<.0001)
Middle	1.00	1.25	(<.0001)	0.57	(<.0001)	1.02	(0.3725)	1.00	0.94	(<.0001)	0.46	(<.0001)	0.69	(<.0001)
High	1.00	1.25	(<.0001)	0.60	(<.0001)	1.05	(0.0090)	1.00	0.90	(<.0001)	0.49	(<.0001)	0.68	(<.0001)
Survival time after cancer diagnosis (days)														
90 ~ 365	1.00	1.23	(<.0001)	0.57	(<.0001)	1.04	(0.0739)	1.00	0.98	(<.0001)	0.52	(<.0001)	0.77	(0.0036)
366 ~ 730	1.00	1.28	(<.0001)	0.64	(<.0001)	1.08	(0.0017)	1.00	0.98	(<.0001)	0.59	(<.0001)	0.76	(0.0879)
731 ~ 1095	1.00	1.31	(<.0001)	0.60	(<.0001)	1.09	(0.0093)	1.00	0.94	(<.0001)	0.52	(<.0001)	0.73	(<.0001)
≥ 1096	1.00	1.30	(<.0001)	0.59	(<.0001)	1.06	(0.0089)	1.00	0.83	(<.0001)	0.43	(<.0001)	0.61	(<.0001)

Appendix 9. Kaplan-Meier survival plot of cancer patients after hospice enrollment (index date)



Korean Abstract (국문 요약)

호스피스 이용 유형이 암 사망자의 생애말 치료행태와 의료비 지출에 미치는 영향

연세대학교 일반대학원 보건학과

윤 일

서론: 암 발견 및 치료 기술이 눈에 띄게 발전하여 암 환자들의 수명이 연장되었음에도 불구하고 상당수는 여전히 말기진단을 받고 있다. 말기질환자들은 그들의 질병, 치료과정, 동반질환 등으로 인해 신체적, 정신적 증상을 겪는 경우가 많지만, 안타깝게도 이러한 증상은 기존의 치료방식으로는 해결되지 않는 경우가 많아 환자의 웰빙에 부정적인 영향을 미치게 된다. 이를 해결하고자 말기환자의 증상 완화를 우선시하고 생애말 삶의 질을 향상시키기 위한 목적으로 하는 호스피스 및 완화의료가 도입되었다. 국내에서도 급속한 고령화 및 암환자 증가에 대응하여 존엄한 임종 결정에 대한 논의가 활발히 이루어지고 있는 가운데, 세 유형의 호스피스(입원형, 가정형, 자문형)에 차례로 건강보험 수가가 신설·적용되었다. 이러한 배경 속에서 본 연구는 호스피스 이용이 암환자의 생애말 치료행태와 의료비 지출에 미치는 영향을 평가하고자 하였다.

연구방법: 본 연구에는 중증 암 산정특례 등록 후 2017년부터 2021년 사이에 사망한 모든 암환자에 대한 국민건강보험공단 맞춤형 코호트 데이터가 사용되었으며, 제외기준에 따라 총 408,964명이 분석에 포함되었다.

흥미변수는 사망 전 6개월 이내에 이용한 호스피스 유형으로, (1) 호스피스 비이용자, (2) 입원형 호스피스 단일 이용자, (3) 가정형 호스피스 단일 이용자, (4) 복합형 (입원형, 가정형) 호스피스 이용자, 이렇게 네 범주로 구분하였다. 결과변수는 다음 두 가지로, (1) 치료행태 (집중 치료, 보조적 치료), (2) 의료비 지출 (총 의료비, 총 본인부담금)이 설정되었다. 이용한 호스피스 유형간 결과 차이를 확인하기 위해선 일반화 선형 모델(Generalized Linear Model)을 적용하였다. 먼저, 치료행태의 차이를 분석할 시엔 영과잉음이항 분포를 적용하였고, 다음으로 지출 차이를 분석할 시엔 감마 분포를 적용하였다. 마지막으로 호스피스 등록 전후 결과변수들의 추세변화를 확인하기 위해선 단절적 시계열 분석(Interrupted Time Series with Segmented Poisson Regression)을 수행하였다.

연구결과: 호스피스 이용은 암 환자들의 임종 직전 더 적은 집중 치료와 더 많은 보조적 치료 행위와 관련이 있었다. 특히, 네 유형 중 복합형 호스피스 이용자들이 집중 치료를 받을 확률과 강도가 가장 낮았으며(aOR: 0.18, 95% CI: 0.17-0.19, aRR: 0.47, 95% CI: 0.44-0.49), 가정형 호스피스 단일 이용자들은 보조적 치료를 받을 확률과 강도가 가장 높았다(마약성 진통제 처방, aOR: 2.95, 95% CI: 2.69-3.23, aRR: 1.45, 95% CI: 1.41-1.49; 정신건강 관리, aOR: 3.40, 95% CI: 3.13-3.69, aRR: 1.35, 95% CI: 1.31-1.39). 또한 호스피스 이용은 생애말에 지출된 본인부담금을 줄이는 데 유의한 영향을 미쳤다(입원형 단일 이용자, Exp(β)=0.91, 95% CI: 0.90-0.92; 가정형 단일 이용자, Exp(β)=0.50), 95% CI: 0.48-0.52; 복합형 이용자, Exp(β)=0.69, 95% CI: 0.67-0.71). 단절적 시계열 분석에서는 호스피스 등록 후 즉각적인 정책 효과와 추세변화가 관찰되었다. 말기암 환자가 호스피스에 등록한 후 불필요한 집중 치료가 눈에 띄게 줄었고, 적절한 통증 관리와 정신건강관리를 통해 삶의 질이 향상되었다. 의료비는 사망이 가까워질수록 증가하였으나, 호스피스 등록 이후 증가세가 유의하게 둔화되는 경향을 보였다.

결론: 본 연구결과는 말기암 환자가 호스피스에 등록함에 따라 연명을 위한 적극적 치료는 감소하였지만, 적절한 보조적 치료를 통해 생애말 삶의 질은 개선되었음을 확인하였다. 또한, 호스피스 이용으로 말기 환자들의 사망전 의료비 부담을 덜어줄 수 있음을 시사하였다. 이러한 발견은 말기환자들에게 생애말 자기결정권을 실현하는 수단으로서 호스피스 이용에 대한 유용한 정보를 제공할 뿐만 아니라, 환자 중심의 지역사회 기반 호스피스 서비스 도입을 위한 정책적 시사점을 제공한다는 점에서 의의가 있다.

제시어: 호스피스, 암 사망자, 생애말치료, 의료비, 삶의질