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Original Article

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Cost-Effectiveness Analysis of Home-Based Hospice-Palliative Care for Terminal Cancer Patients

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Purpose: We compared cost-effectiveness parameters between inpatient and home-based hospice-palliative care services for terminal cancer patients in Korea. **Methods:** A decision-analytic Markov model was used to compare the cost-effectiveness of hospice-palliative care in an inpatient unit (inpatient-start group) and at home (home-start group). The model adopted a healthcare system perspective, with a 9-week horizon and a 1-week cycle length. The transition probabilities were calculated based on the reports from the Korean National Cancer Center in 2017 and Health Insurance Review & Assessment Service in 2020. Quality of life (QOL) was converted to the quality-adjusted life week (QALW). Modeling and cost-effectiveness analysis were performed with TreeAge software. The weekly medical cost was estimated to be 2,481,479 Korean won (KRW) for inpatient hospice-palliative care and 225,688 KRW for home-based hospice-palliative care. One-way sensitivity analysis was used to assess the impact of different scenarios and assumptions on the model results. **Results:** Compared with the inpatient-start group, the incremental cost of the home-start group was 697,657 KRW, and the incremental effectiveness based on QOL was 0.88 QALW. The incremental cost-effectiveness ratio (ICER) of the home-start group was 796,476 KRW/QALW. Based on one-way sensitivity analyses, the ICER was predicted to increase to 1,626,988 KRW/QALW if the weekly cost of home-based hospice doubled, but it was estimated to decrease to −2,898,361 KRW/QALW if death rates at home doubled. **Conclusion:** Home-based hospice-palliative care may be more cost-effective than inpatient hospice-palliative care. Home-based hospice appears to be affordable even if the associated medical expenditures double.

Key Words: Hospices, Palliative care, Costs and cost analysis, Quality of life, Decision trees, Markov chains

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INTRODUCTION

1. Background

Hospice-palliative care is a specific type of care that includes physical, psychological, social, and spiritual support for patients at the end of life and is provided by health care professionals and volunteers [1]. A pilot project for fostering a hospice-palliative care program was initiated by the Korean Ministry of Health & Welfare in 2003 [2]. Subsequently, a hospital cost and service provision system was established through two pilot projects for inpatient hospice-palliative ser-

vices in 2009 and 2011. The National Health Insurance Service started to provide reimbursements for inpatient hospice-palliative care in 2015. A home-based hospice-palliative care pilot project began in 2016. Due to the active policy-making and improved public awareness of hospice-palliative care, the rate of use of hospice-palliative care as a proportion of cancer deaths has steadily increased from 7.3% in 2008 to 24.3% in 2019 [3].

Several studies have reported that inpatient hospice-palliative care units were more cost-effective than care by oncologic specialists in general wards [4,5]. No significant difference in survival time was found between patients who used hospice-palliative units and patients who did not [5], while the rates of aggressive management, such as cardiopulmonary resuscitation or endotracheal intubation, and average hospital costs were lower in patients who used hospice-palliative units than in patients who did not [5]. Another study in Korea demonstrated that care in hospice-palliative units for terminal cancer patients was more cost-effective than care in general wards [4]. A systematic review and meta-analysis stated that hospice palliative care improved patients' quality of life (QOL) and symptoms to a greater extent than usual care [6]. However, that study reported that it was inconclusive whether hospice-palliative care or usual care was more cost-effective. These conflicting findings are thought to be due to differences in culture, economic resources, medical insurance systems, and hospice-palliative care provision systems in each country. Although many patients at the end of life prefer to remain at home, studies have reported an increasing trend in hospital deaths in Korea [7]. Expanding the availability of death at home at the end of life could reduce unnecessary social hospitalizations and enable the more effective utilization of limited medical resources. According to a recent Korean study, patients who had ever used home-based hospice-palliative care were more likely to choose their home as their preferred place of care and were more likely to die at home [8]. Home-based hospice-palliative care is an option to increase the frequency of death at home and comply with patients' preferences. However, there is a lack of evidence on whether home-based hospice-palliative care is cost-effective compared with inpatient hospice-palliative care. In addition, the costs of home-based hospice-palliative care cost are not accurately known.

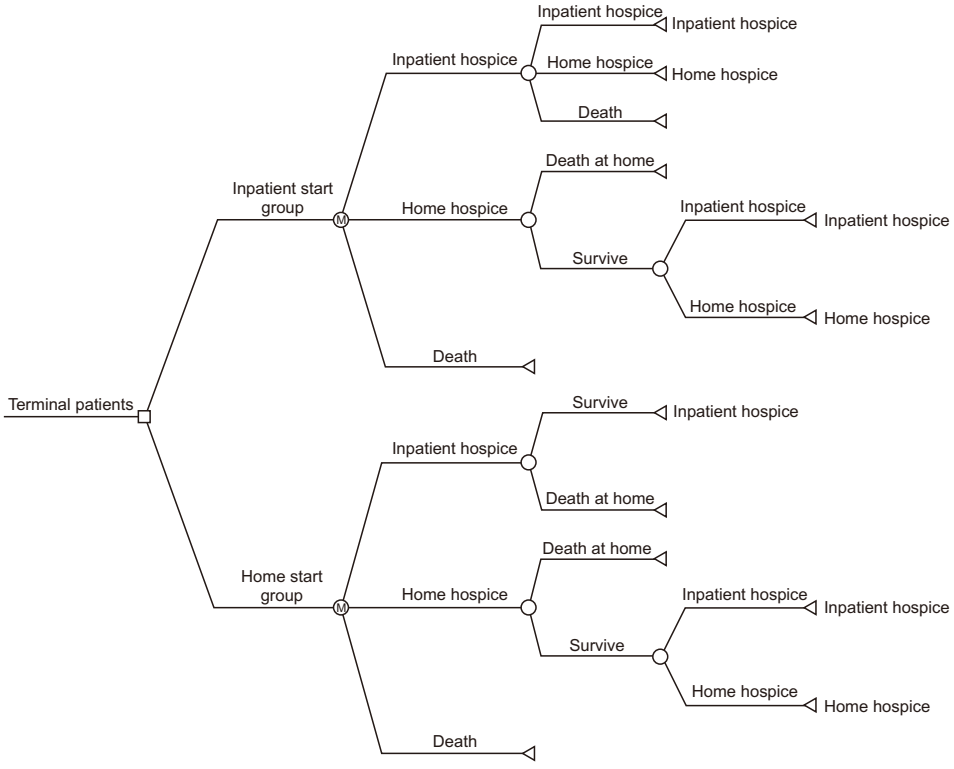

Figure 1. Decision tree for cost-effectiveness analysis. This decision tree was designed using the TreeAge® program. The hypothetical patient cohort in this decision tree begins with the health state of terminal cancer. A square (a decision node) indicates where a decision is made; open circles (chance nodes) indicate what will happen as a result of it; triangles (terminal nodes) indicate that we have observed the outcome we are looking for; M (Markov nodes) indicate where a hypothetical patient's transition across different health states over time happens.

2. Purpose

The aim of this study was to investigate whether home-based hospice-palliative care is cost-effective compared with inpatient hospice-palliative care and to suggest appropriate reimbursement for home-based hospice-palliative care.

METHODS

1. Model description

A decision-analytic Markov model was developed to simulate the cost-effectiveness of hospice-palliative care in terminal cancer patients based on differences in care at home and inpatient hospice-palliative units. The Markov model involves a hypothetical patient's transition across different health states over time, divided into equally spaced cycles [9]. The health states were limited to inpatient hospice-palliative care, home-based hospice-palliative care, and death. The model was constructed from a healthcare-system perspective, with a 9-week horizon and a 1-week cycle length. This model targeted a hypothetical cohort of terminal cancer patients who received hospice-palliative care in Korea.

A decision tree is shown in Figure 1, and the health state and transition probabilities for the Markov model are shown in Figure 2. Transitions between different health states occur at the end of cycles and are determined by transition probabilities derived from the literature, as discussed below. Within each state, costs and utilities are assigned according to the health state decision subtree's probabilities. We assumed that the transition from inpatient hospice-palliative care to home-based hospice-palliative care would occur only once, because the likelihood of more than two transitions was less than 1%, according to a report from the Health Insurance Review & Assessment Service (HIRAS) in 2020 [10].

All statistical and research procedures followed the 1975 Declaration of Helsinki. The Institutional Review Board of Chungbuk National University approved this study (CBNU-202012-HR-0202).

2. Input parameters

The model parameters are summarized in Table 1. The tran-

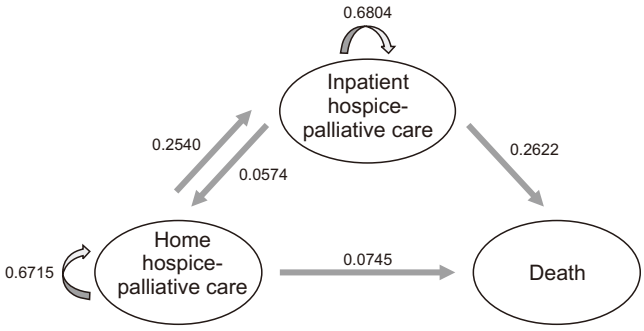

Figure 2. Health states in the Markov model.

Table 1. Parameters Used in the Markov Model.

Parameter	Value	Source
Utilization of hospice-palliative care		
Registration period for inpatient hospice-palliative care (days)	53	National Hospice Center & Ministry of Health and Welfare [12]
Registration period for home hospice-palliative care (days)	80	
Transition percentage of inpatient to home hospice-palliative care (%)	11.6	Oh JY, et al. [10]
Transition percentage of home to inpatient hospice-palliative care (%)	25.4	
Percentage of death at home in home hospice-palliative care group (%)	40.8	
Cost (KRW per week)		Oh JY, et al. [10]
Inpatient hospice-palliative care	2,481,479	
Home hospice-palliative care	225,688	
Global quality of life*		Leppert W, et al. [11]
Terminal cancer patient (initial)	0.3562	
Inpatient hospice-palliative care (one week after transition)	0.5163	
Home hospice-palliative care (one week after transition)	0.5327	

*Global quality of life was measured at day 7 after transition to inpatient and home-based hospice-palliative care. The score was converted into a value from 0 to 1. A higher indicated better global quality of life.
KRW: Korean won.

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sition probabilities, costs, and health outcomes for use in the model analysis were obtained through domestic and overseas studies published until September 31, 2020 [10-12].

The transition probabilities of each health status were calculated based on the Korean National Cancer Center's information reported in 2017 and the information published by the HIRAS in 2020 [3,10]. The Korean National Cancer Center report in 2017 was an analysis of patient information from the hospice-palliative care system database for patients who had died between January 1, 2017 and December 31, 2017. This database includes information on terminal cancer patients who have used hospice-palliative care, including the type of cancer, preferred place of death, and medical usage in hospice-palliative care. Of these, the total number of hospitalizations, average length of hospitalization, average length of hospitalization per episode, and average duration of service use were used to calculate the transfer probability [12]. The 2020 research report, which analyzed the status of the use of inpatient, home-based, and advisory hospice-palliative care services, used data on health insurance claims from January 1, 2016 to March 31, 2019 and death information from Statistics Korea [13]. Data were constructed for patients who received hospice-palliative care at least once among Korean national health insurance holders and Medical Aid patients. In this 2020 report, the result of the analysis of the proportion of patients who sequentially used various types of hospice-palliative care, information on medical use at the time of death, and the place of death were included [10]. The transition probability to death from each type of hospice-palliative care use per week was calculated using period durations in which 90% of patients enrolled in inpatient and home-based hospice-palliative care died.

The registration periods for home-based and inpatient hospice-palliative care were 80 and 53 days, respectively (Table 1). The transition percentage was 11.6% from inpatient to home-based hospice-palliative care, 25.4% from home-based to inpatient hospice-palliative care, and 40.8% for death at home in the home-based hospice-palliative care group (Table 1) [10].

The cost of this analysis only included direct medical and medication costs and was obtained from the HIRAS report in 2020. All costs were calculated in Korean won (KRW). The average daily hospital cost of inpatient hospice-palliative care was calculated as 354,497 KRW/day (including a per diem fee, 2018) [10]. The average daily medical cost of home-based hospice-palliative care was 150,459 KRW/visit. Healthcare providers visited patients' homes an average of 1.5 times per week, and the average weekly medical cost was calculated as 225,688 KRW/week [10]. Indirect costs for transportation, time, and care were not taken into account.

We measured health outcomes for QOL in terms of the quality-adjusted life week (QALW), which was defined as the weekly overall QOL in terminal cancer patients and measured by the European Organization for Research and Treatment of Cancer (EORTC) QLQ-C15-PAL [14]. The EORTC QLQ-C15-PAL is a self-administered, structured questionnaire that consists of a total of 15 items and includes the global health status and QOL, in addition to other questions regarding pain, physical function, emotional function, and fatigue. The QOL was measured based on the 15th question from the EORTC QLQ-C15-PAL: "How would you rate your overall quality of life during the past week?" The answers were organized on a 7-point Likert scale from 1 (very poor) to 7 (excellent). Based on this assessment, higher scores correspond to better QOL. Because data for measuring the global QOL for each type of hospice transition in Korea are not available, we adopted the QOL score measured by Lepper et al. [11], who measured global QOL at day 7 after the transition to inpatient and home-based hospice-palliative care. Leppert et al. [11] converted the 7-point QOL score to values from 0 to 100 points. In this study, we converted the scores into values from 0 to 1. In addition, the QOL estimated by terminal cancer patients for the last week was converted to QALWs. In this analysis, one QALW was equal to the best QOL state for one week as considered by the terminal cancer patients.

3. Research model

The transition model was simplified into inpatient hospice-palliative care, home-based hospice-palliative care, and death, as presented in Figure 2. Each transition—from inpatient to home-based hospice-palliative care, home-based to inpatient hospice-palliative care, and death at home—was calculated using the periods and rates described in Table 1. The calculation formula was provided in a previous study [15]. The weekly transition probabilities were as follows: 0.2540 from

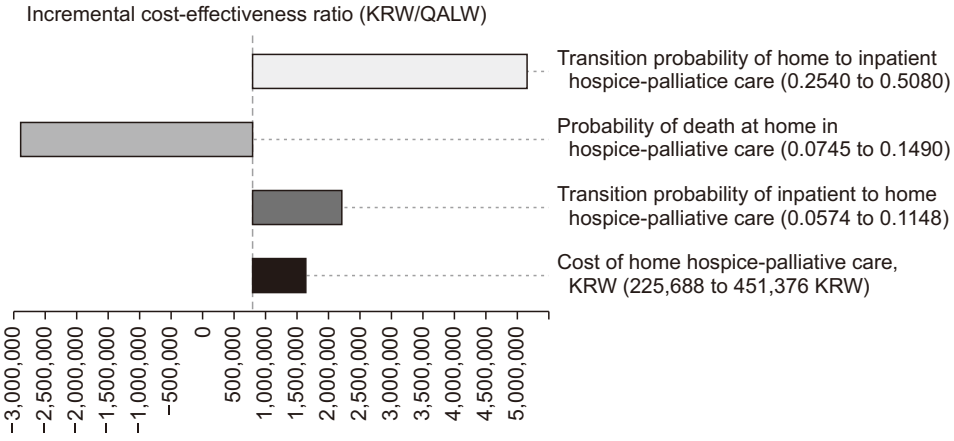
home-based to inpatient hospice-palliative care, 0.0745 from home-based hospice-palliative care to death, and 0.6715 for staying in home-based hospice-palliative care. The transition probabilities were 0.0574 from inpatient to home-based hospice-palliative care, 0.2622 from inpatient hospice-palliative care to death, and 0.6804 for staying in inpatient hospice-palliative care. Additional results from the Markov simulation are presented in Supplementary Table 1.

4. Statistical analysis

The incremental cost-effectiveness ratio (ICER) was calculated as the additional cost of a strategy divided by its additional health benefit (in this case, QALW) compared with the reference strategy. We conducted a one-way sensitivity analysis to confirm the ICER change and model robustness according to the following parameter changes, as summarized in Figure 3: After doubling each parameter of the basic scenario related to home-based hospice-palliative care, individual ICERs were calculated. The analyses were performed using TreeAge Pro 2020, version 20.2.1-v20200811 (TreeAge Software Inc., Williamstown, MA, USA). This study follows the recommendations of the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) reporting guideline [16].

RESULTS

Table 2 presents cost-effectiveness according to the place where hospice-palliative care was initiated. For the base-case analysis, the total cost in the inpatient-start group was 11,748,361 KRW for 9 weeks and the total effectiveness was 1.86 QALW, while the total cost in the home-start group was 12,446,018 KRW and the total effectiveness was 2.73 QALW. The group that started at home-based hospice-palliative care had higher QALW values by a factor of 0.88 for 9 weeks, and their costs were 697,657 KRW higher than those of the group that started at inpatient hospice-palliative care. Thus, the



Parameter		Value	ICER, KRW/QALW
Transition probability of home to inpatient hospice-palliatice care	Base	0.254	796,476
	After doubling base value	0.508	5,156,668
Probability of death at home in home hospice-palliative care	Base	0.0745	796,476
	After doubling base value	0.149	−2,898,361
Transition probability of inpatient to home hospice-palliative care	Base	0.0574	796,476
	After doubling base value	0.1148	2,216,908
Cost of home hospice-palliative care, KRW	Base	225,688	796,476
	After doubling base value	451,376	1,626,988

Figure 3. Tornado diagram for one-way sensitivity analysis. KRW: Korean won, QALW: quality-adjusted life week, ICER: incremental cost-effectiveness ratio.

Table 2. Cost-Effectiveness According to the Starting Place of Hospice-Palliative Care.

Strategy	Total cost, KRW	Incremental cost, KRW	Total effectiveness, QALW	Incremental effectiveness, QALW	ICER, KRW/QALW
Inpatient-start group	11,748,361	-	1.86	-	Reference
Home-start group	12,446,018	697,657	2.73	0.88	796,476

KRW: Korean won, QALW: quality-adjusted life week, ICER: incremental cost-effectiveness ratio.

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ICER for the home-start group was calculated as a weekly cost of 796,476 KRW/QALW.

We further calculated the ICER/QALW according to individual assumptions as outlined in Figure 3. The sensitivity analysis was conducted by increasing each parameter related to the home-based hospice-palliative care for up to 200% of the base scenario. If the weekly cost of home-based hospice-palliative care doubled from 225,688 KRW to 451,376 KRW, the ICER increased to 1,626,988 KRW/QALW. If the transition probability from home-based to inpatient hospice-palliative care doubled, the ICER increased to 5,156,668 KRW/QALW. Conversely, if the transition probability for inpatient to home-based hospice-palliative care doubled, the ICER increased to 2,216,908 KRW/QALW. However, if the death rate doubled at home, the ICER significantly decreased from 796,476 to −2,898,351 KRW/QALW, which was the most-effective scenario based on the one-way sensitivity analyses.

DISCUSSION

This study demonstrated that the ICER of the home-start group was 796,476 KRW/QALW compared with the inpatient-start group. In order to determine whether home-based hospice-palliative care is cost-effective, willingness to pay (WTP) should be considered. WTP is the maximal price at or below which consumers (patients) will buy one unit of a service or product [17]. WTP varies depending on each country's economic situation and culture. A previous Korean study reported that the WTP was around 10.5 to 36.4 million Korean won per quality-adjusted life year (QALY) in 2010 [18]. The ICER of 796,476 KRW/QALW found in this study is roughly equivalent to the range of WTP, considering inflation and economic growth in Korea. Therefore, home-based hospice-palliative care seems to be an alternative option to inpatient hospice-palliative care.

Several studies have reported that hospice-palliative care was cost-effective compared with usual care in a general ward [4-6]. However, there is a lack of evidence on whether home-based hospice-palliative care is as cost-effective as inpatient hospice-palliative care. A study by Ahn reported that ever-users of home-based hospice-palliative care preferred to stay at home and used hospice-palliative care for longer durations than patients who used only inpatient hospice-palliative care [8]. In addition, home-based hospice-palliative care users had better performance statuses than inpatient hospice-palliative care users. However, Ahn's study did not conduct a cost-effectiveness analysis to compare the effectiveness in terms of QOL and overall medical expenditures between home-based and inpatient hospice-palliative care. A Korean study demonstrated that hospital deaths of end-of-life patients increased despite preferences for death at home [7]. Avoidance of unnecessary social hospitalizations by using home-based hospice-palliative care allows more efficient use of medical resources by increasing the number of deaths at home. In this study, the cost-effectiveness analysis was conducted on the basis of a literature review on Korean hospice-palliative care. In addition, the possible health states were simplified using a Markov model, and a one-way sensitivity analysis was conducted by changing each parameter of the basic scenario related to the home-based hospice-palliative care.

In this study, the global QALW was determined to be 0.3562 in terminal cancer patients at initial enrollment in hospice-palliative care, 0.5163 in inpatient hospice-palliative care patients at week 1 after transition, and 0.5327 in home-based hospice-palliative care patients at week 1 after transition, based on the study of Leppert et al. [11]. This indicates that the QOL values for terminal cancer patients before hospice-palliative care are relatively poor, but rapidly improve after patients receive hospice-palliative care. However, the weekly medical cost of home-based hospice-palliative care is significantly lower than that of inpatient hospice-palliative care (225,688 KRW vs. 2,481,479 KRW). This huge difference might be due to the reimbursement system of Korean hospice-palliative care policies. The Korean authorities have adopted daily flat payment systems for hospice-palliative care. However, pain-relief medications such as opioids, as well as several procedures such as percutaneous nephrostomy, percutaneous drainage, and nerve blocks, are charged separately. The average daily flat payment for inpatient hospice-palliative care depends on the type of medical institution, but ranges from 337,000 KRW in the clinic setting to 410,000 KRW in a general hospital [10]. In contrast, the average daily medical cost of home-based hospice-palliative care was 150,459 KRW and the weekly cost was calculated as 225,688 KRW because

care providers visited the patient's home 1.5 times/week. The transition probability for home-based to inpatient hospice-palliative care was significantly higher than that in inpatient to home-based hospice-palliative care (0.2540 vs. 0.0574). The results indicated that this high probability is an important factor responsible for increasing the total medical costs in the home-start group.

As mentioned in the Methods section, we adopted the healthcare system perspective for this analysis. Thus, we assumed that indirect costs such as nursing expenses were consistent between groups and did not include those costs in the analyses. In the home-start group, the total overall cost was higher than in the inpatient-start group, although the total effectiveness was higher. However, this increased expenditure might be acceptable considering WTP in Korea [18]. The increase in the total cost for the home-start group may be due to an increase in the use of inpatient hospice-palliative care as terminal patients' symptoms worsen. Thus, one-way sensitivity analyses were performed to investigate which factors affected the ICER. Doubling the probability of death at home in home-based hospice-palliative care users could reduce the ICER to −2,898,361 KRW/QALW. However, doubling the transition probability of home-based to inpatient hospice-palliative care increased the ICER. Patients who used home-based hospice-palliative care had higher death rates at home than patients who had never used home-based hospice-palliative care [8]. Hyun et al. reported that death at home was significantly associated with the place of terminal care [19]. Inpatient hospice-palliative care was correlated with a higher probability of death in the hospital than home-based care [19]. Furthermore, many terminal patients prefer to die at home [20,21]. According to Aldridge et al., the mean total patient care cost of home-based hospice-palliative care per patient day was 153.3 USD in the United States [22]. They showed that patients cared for by hospice services with lower patient care costs were more likely to be admitted to the hospital and the intensive care units, visit the emergency department, and die in the hospital than those cared for by services with higher patient care costs [22]. This indicates that adequate reimbursement policies and quality control will reduce death in hospitals and improve the QOL of terminal patients who use hospice-palliative care. This study's findings support the results of the study by Aldridge et al. Based on the one-way sensitivity analyses, we estimated that an increase in inpatient to home-based hospice-palliative care costs may significantly increase total medical expenses (796,476 to 2,216,908 KRW/QALW) but improve patients' QOL (Figure 3). In addition, increasing the number of deaths at home through an active home-based hospice-palliative care reimbursement policy would also be expected to reduce the overall medical costs for hospice-palliative care.

There were several limitations to this study that should be considered in its interpretation. We were not able to use real-world data for hospice-palliative care. Additionally, domestic research that could be referenced for the analysis model was very limited. Thus, we used research data from international studies and findings instead of Korean data. Because of these limitations, a detailed cost-effective analysis based on a Korean database could not be conducted. Further research based on real-world Korean data is warranted. There may be differences between the study groups (individuals who used inpatient or home-based hospice-palliative care). Home-based hospice-palliative care users are likely to be healthier and have better performance status than inpatient hospice-palliative care users. Patients might also move between the two types of hospice-palliative care depending on various factors such as health conditions and personal preferences. These could affect the results of cost-effectiveness analyses. The QALW based on the EORTC QLQ-C15-PAL questionnaire was used as an indicator of effectiveness instead of QALY. This is partly because the life expectancy of terminal cancer patients is not long enough to be converted into years, and partly because there is a lack of Korean research on the QOL of terminal cancer patients. QOL might also show differences according to country, culture, and ethnicity. Indirect costs were not accounted for in detail. Even though we adopted a healthcare system perspective, costs related to patient care, transportation, and loss of work due to care should also be taken into accounted in future studies. Furthermore, home-based hospice-palliative care was a pilot program at the time when the research was ongoing. Therefore, in the future, it will be essential to use real-world data from regular home-based hospice-palliative care programs.

Despite several limitations, this study provided unique in-

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sights and compared the cost-effectiveness between home-based and inpatient hospice-palliative care in Korea. Cost-effectiveness analysis is a decision-making method that allocates limited resources to achieve technical efficiency, considering performance and cost simultaneously rather than cross-sectionally. Although the total cost of the home-start group was higher than that of the inpatient-start group, home-based hospice-palliative care reflects patient-oriented outcomes and is affordable according to WTP in Korea. Home-based hospice-palliative care complies with the principles of biomedical ethics, reflecting patient preference (respect of autonomy) and saving more beds for acute-stage patients (justice) [23]. Home-based hospice-palliative care has advantages of patient satisfaction and preference and efficient allocation of medical resources despite several disadvantages in terms of actively responding to patients' symptoms. In order to confirm the cost-effectiveness, ICER changes, and model robustness, one-way sensitivity analyses were performed. Based on these simulations, we demonstrated that death at home is the most important factor for improving the cost-effectiveness of home-based hospice-palliative care.

In conclusion, home-based hospice-palliative care appears to be more cost-effective than inpatient hospice-palliative care. These results support the hypothesis that home-based hospice is affordable even if the medical expenditures and death rates at home double. Based on these findings, policy support is needed so that patients with terminal illness can receive hospice-palliative care at the end of their life and die comfortably in their homes. Further research using Korean data to compare the cost-effectiveness between home-based hospice-palliative care and usual care without hospice care is required.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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AUTHOR'S CONTRIBUTIONS

Conception or design of the work: all authors. Data collection: YK. Data analysis and interpretation: YK, EH. Drafting the article: YK, HTK. Critical revision of the article: YK, EH, HTK. Final approval of the version to be published: all authors.

SUPPLEMENTARY MATERIALS

Supplementary materials can be found via https://doi.org/10.14475/jhpc.2022.25.2.76.

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