The Impact of Continuous Use of Home Health Care Resources on End-of-Life Care at Home in Older Patients with Cancer: A Retrospective Cohort Study in Fukuoka, Japan

山尾, 玲子

The impact of continuous use of home health care resources on end-of-life care at home in older patients with cancer: A retrospective cohort study in Fukuoka, Japan

Reiko Yamao[1], Akira Babazono[1], Ning Liu[2], Yunfei Li[3], Reiko Ishihara[4], Shinichiro Yoshida[5], Sung-A Kim[1], Aziz Jamal[6]

[1]Department of Health Care Administration & Management, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan

[2]Department of Preventive Medicine and Community Health, University of Occupational and Environmental Health, Kitakyushu, Japan

[3]Epidemiology and Prevention Department, Center for Clinical Sciences, National Center for Global Health and Medicine, Tokyo Japan

[4]Faculty of Human Sciences Osaka University of Economics, Osaka Japan

[5]Department of Intensive Care Medicine, Sapporo Medical University School of Medicine, Sapporo, Japan

[6]Health Administration Program, Faculty of Business & Management, Universiti Teknologi MARA, 42300 Selangor, Malaysia

*Corresponding author
Reiko Yamao: 3MD17061M@s.kyushu-u.ac.jp

Short title: Use of home health care for end-of-life care.

Keywords: patients with cancer; end-of-life care; home nursing care; home health care; death at home; retrospective cohort study

Abstract

This study aimed to examine the effect of continued use of home health care resources on end-of-life care at home in older patients with cancer. This retrospective cohort study was conducted using medical and long-term care (LTC) claims data of 6435 older patients with cancer who died between April 2016 and March 2019 in Fukuoka Prefecture. The main explanatory variables were enhanced home support clinics/hospitals (HCSCs), enhanced HCSCs with beds, conventional HCSCs, other HCSCs, and home visit nursing care. The covariates were sex, age, required level of care, and the Charlson Comorbidity Index (CCI). A logistic regression model was used. The results of the multilevel logistic regression analysis showed that the following were significantly associated with end-of-life care at home: use of enhanced HCSCs with beds (odds ratio, OR: 8.66; 95% confidence interval, CI: [4.31-17.40]), conventional HCSCs (OR: 5.78; 95% CI: [1.86 -17.94]), enhanced HCSCs (OR: 4.44; 95% CI: [1.47-13.42]), and home-visit nursing care (OR: 1.86; 95% CI: [1.42-2.44]) and a severe need for care (OR: 3.89; 95% CI: [2.92-5.18]). The results suggest that the continued use of home health care resources in older patients with cancer who require out-of-hospital care may lead to increased end-of-life care at home. Particularly, use of enhanced HCSCs with beds is most strongly associated with end-of-life care at home.

Introduction

With the aging population, the demand for improving the quality of end-of-life care is expanding. In particular, there is significant focus on the desired place of death of patients with diseases without a prospect of recovery, such as terminal cancer[1-3]. Over the past few decades, hospitals have been the most common place of death, instead of home, in developed countries, including Japan[2,4], while many patients with cancer wish to die at home[3,5-8]. Home-based palliative care is expected to improve quality of life (QOL) and reduce the physical and emotional burden on patients[7-9]. Additionally, it has been highlighted that the use of home care by patients who wish to die at home can lead to shorter hospital stays, prevent readmission, and improve the quality of palliative care[10,11] by optimizing the allocation of medical resources and financial burden.

A main barrier to death at home is the lack of palliative care services due to inadequate development of home health care delivery system[3,12,13]. For example, Wye et al. suggested that specialized 24-hour integrated palliative care services increase family carer satisfaction and more deaths in the community [14]. Therefore, to improve the quality of end-of-life care, Japan is promoting the development of a system for the provision of home health care by enhancing reimbursement for institutions such as home care, 24-hour home care support clinics and hospitals (HCSCs), and home-visit nursing care services[15-17]. One such application is home

health care services that is covered by Japan's Universal Health Insurance system. As of 2023, the home health care services, which are mainly used by patients who are terminally ill such as those with cancer, are divided into four types depending on the medical institution providing service to them: enhanced HCSCs with or without bed, conventional HCSCs, and other HCSCs[18]. Patients can freely choose from these services according to their preferences. In particular, conventional HCSCs play a central role in home health care by attending to emergency house calls and providing 24 hour home-visit nursing care and end-of-life care at home. In 2012, the enhanced HCSC category was introduced to the existing HCSC requirements, adding three or more full-time doctors and ensuring a certain level of experience in attending to emergency house calls and providing end-of-life care, to provide a wider range of services[17,18]. The current reimbursement system provides the greatest incentive for home health services to enhanced HCSCs by which have beds or not[17,18].

Another health care service that complements home health care services is home-visit nursing care, which is covered by both medical and long-term care (LTC) insurance[19]. Some home-visit nursing care under the HCSC is provided on a 24-hour basis, whereas others are implemented flexibly according to the instructions of the family doctor and the form of the visiting nursing agency. However, few empirical studies have examined how the home health care provision system that has been promoted in Japan since 2013 and include home-visit

nursing care affects the end-of-life care at home in patients with cancer. Recent studies have shown that the use of enhanced HCSCs (with or without beds) and conventional HCSCs increases the rate of death at home[20,21]; however, they do not focus on home-visit nursing care services separately from home health care services. Moreover, the effects of continuing services have not been measured.

Therefore, this study aimed to assess the impact on end-of-life care at home of older patients with cancer in Japan, with a focus on the continued use of home health care services and home-visit nursing care.

Methods

Database

The medical and LTC insurance databases from April 1, 2016, to March 31, 2019, were obtained from the Fukuoka Prefecture Association of Latter-Stage Elderly Healthcare, Japan's public insurance system for individuals aged 75 years and older and those aged 65-74 with specified illnesses. Medical claims information include patient characteristics such as age, sex, admission and discharge status, disease diagnosis, medical treatment practices, and drug prescriptions for those who have received insurance treatment. LTC is the public insurance for older people aged 65 years and above and adults aged 40 years and above with specified illnesses. This care fee

claim contains monthly information on age, sex, required level of care, and service use for all persons certified to use care insurance[22]. LTC insurance classifies the required level of care into seven levels. The two lowest levels are classified as "support required" (levels 1 and 2), for users who often live independently and require little or no care services. The other five levels are classified as "care required" (levels 1, 2, 3, 4, and 5), with higher levels indicating greater care dependency[22]. Administrative claims data were integrated by reconstructing the database to ensure that individuals were not identified using workstations that were not connected to the network.

Study design

This study had a retrospective cohort design. It analyzed the data for patients with cancer who died between April 1, 2016, and March 31, 2019. Cancer diagnosis was classified according to the International Classification of Diseases, tenth revision (ICD-10) codes (C00-C96). Apart from the diagnosis, patients with cancer were categorized using the medical practices. Surgical treatments were categorized using surgical codes, chemotherapy and radiotherapy using drug codes, and place of death as home death and other deaths based on billing code records of end-of-life care in medical and LTC claims. The term "home" in this study referred to a home for older adults from the perspective of living a convalescent life in a familiar environment with a

consideration for QOL, even if medical needs were high, and included serviced-housing for older adults, small-scale multifunctional nursing homes, fee-paying nursing homes, and group homes for older individuals with dementia. Figure 1 shows the participant selection process flow diagram. Supplementary Appendix 1 shows the codes used to identify medical treatments and end-of-life care.

To evaluate the outcomes of end-of-life care at home, the main explanatory variables were the use or non-use of home health care services and home-visit nursing care. Types of home health care services by medical claims were enhanced HCSCs without beds, enhanced HCSCs with beds, conventional HCSCs mixed with beds and without beds, and other HCSCs such as general clinics. Therefore, there were four main explanatory variables: enhanced HCSCs, enhanced HCSCs with beds, conventional HCSCs, and other HCSCs. Details regarding the definitions for the HCSC explanatory variables are described in Figure 2. Enhanced HCSCs, enhanced HCSCs with beds, conventional HCSCs, and other HCSCs were considered if a patient was diagnosed with cancer between April 1, 2016, and March 31, 2017, used the service at least once a month, and received treatment for at least three months. The reason for this definition was to exclude those who only used the service immediately before death, as patients with cancer require extensive care and treatment from approximately one month before death[23]. The definition of home-visit nursing care was identified from the visit nursing instructions of

the medical claims and home care nursing service codes of the LTC claims. Note that home nursing covered by health insurance is usually ordered once a month by the primary care physician, but is valid for up to six months. It is therefore possible that some patients may not be billed every month depending on the doctor's decision. To ensure continuity, home nursing for medical insurance includes patients who have had a home nursing order for at least two months. Residents who migrated to other prefectures were excluded from the tracking period. Supplementary Appendix 2 contains the codes used to identify exposure. Supplementary Appendix 3 shows the details of the types of home health care facilities.

Sex, age, care, and Charlson comorbidity index (CCI) scores were used as covariates. Age was divided into four categories–75-79, 80-84, 85-89, and ≧90 years. CCI scores showing the weighted number of individuals with co-existing disorders were calculated and divided into three categories–0-3, 4-5, and ≧6[24].

Statistical Analysis

Patients who used enhanced HCSC, enhanced HCSC with beds, conventional HCSC, other HCSC, or home nursing were defined as the home-care group and others as the non-home care group; the data for these two groups were compared. The authors conducted chi-squared for sex, age, care, CCI, residential area, and the presence or absence of symptoms at home. Three

logistic regression models were adopted to investigate the effects of home health care services and home-visit nursing care on deaths at home. Model 1 was a single-variate regression model and Model 2 was a multivariate regression model adjusted for the covariates. Based on the possibility of providing home health care and home-visit nursing care at home[25], the authors constructed Model 3 for the 13 areas in Fukuoka Prefecture as multilevel[26]. In this case, the primary level was the patient and secondary level was the secondary medical area. The model was evaluated using Akaike's information criterion (AIC).

Statistical significance was set at $P < 0.05$. Data were extracted using the SQL Server 2014, and all analyses were performed using Stata ver.14.2 (Stata Corp, Texas).

Ethical Considerations

The data used in this study were anonymized. This study was approved by the Ethics Committee of Kyushu University.

Result

Table 1 shows the characteristics of the participants (n=6,435; 61.7% men). Average age was 81.9 years (standard deviation, SD±4.9), the average CCI score was 5.6 (SD±2.0). Among the 13 secondary medical areas, Kitakyushu had the largest proportion of patients (26.3%).

Table 2 shows the details of the home medical resource use. The number of patients who used home health care services was 75 (1.2%), and enhanced HCSCs with beds was 41 (0.6%). There were 453 (7.0%) home-visit nursing care users.

Table 3 shows the results of the three models used to estimate the relationship between the use of home health care services and home-visit nursing care and death at home. In all models, enhanced HCSCs, enhanced HCSCs with beds, conventional HCSCs, home-visit nursing care, and severe nursing care were significantly associated with death at home. Model 3 showed that those who used enhanced HCSCs were 4.44 times more likely to die at home (odds ratio, OR: 4.44; 95% confidence interval, CI: [1.47-13.42]); those who used enhanced HCSCs with beds were 8.66 times more likely to die at home (OR: 8.66; 95% CI: [4.31-17.40]); those who used conventional HCSCs were 5.78 times more likely to die at home (OR: 5.78; 95% CI: [1.86-17.94]); and those who used home-visit nursing care were 1.86 times more likely to die at home (OR: 1.86; 95% CI: [1.42-2.44]). Compared with patients with no care needs, those with most advanced level of care needs were 3.89 times more likely to die at home (OR: 3.89; 95% CI: [2.92-5.18]). Sex, age, CCI score, and secondary medical care areas were not significantly associated with death at home. In Model 3, the variance of random effects was not significant, but the improvement in the model was due to the improvement in Log-likelihoods, AIC, and Bayesian information criterion (BIC).

Discussion

This retrospective study found that the continued use of home health care services and home-visit nursing care was associated with improved end-of-life care at home in older patients with cancer. The continued use of both home health care services and home-visit nursing care was positively associated with death at home, with the highest effect of use of enhanced HCSCs with beds equipped with 24-hour, 365-day physician visits and home nursing.

Recently, several Japanese researchers have reported that areas with abundant home health care resources had significantly more death at home[25,27,28]. In other words, to improve the quality of end-of-life care by increasing the proportion of deaths at home, desired by many patients who are terminally ill, the priority of health policy should be to establish a system for the provision of home health care services and home-visit nursing care. In this study, the probability of death at home was not significant for any region, as represented by the 13 secondary medical districts in Fukuoka Prefecture (Table 3, Model 3 results). However, the multilevel logistic regression model adjusted for region as a random effect proved that the continuous availability of home health care services and home-visit nursing care was more likely to be associated with death at home. Therefore, the findings are consistent with that of previous literature.

Compared with users of other HCSCs, those who used enhanced HCSCs (with or without beds) and conventional HCSCs were significantly more likely to die at home for the following reasons. The first is the home care system of the facility. Previous studies have reported that the use of enhanced HCSCs (with or without beds) and conventional HCSCs is effective in reducing readmissions, with more deaths occurring at home, and timely management of emergency house calls when patient conditions deteriorate[20,21]. Enhanced HCSCs (with or without beds) and conventional HCSCs provide home health care services during the day and night, whereas other HCSCs attend to home calls and visit homes as an adjunct to their practice. This means that enhanced HCSCs (with or without beds) and conventional HCSCs have the following facility criteria: 1) contact doctors and nurses 24 hours and 365 days; 2) provide home visits and home nursing care 24 hours and 365 days; 3) accept patients for admission or arrange admission to a linked medical institution in an emergency; and 4) cooperate with local medical institutions and welfare services[18]. Furthermore, most conventional HCSCs and other HCSCs have one full-time doctor, whereas enhanced HCSCs (with or without beds) have three or more full-time doctors compared to HCSCs. Therefore, they are likely to be more flexible in dealing with sudden changes in the condition of older patients with cancer and complex medical procedures such as palliative care. In 2022, HCSC facility standards needed to consider quality of death (QOD) and QOL, as requirements such as creating guidelines on appropriate decision-making

support were added to the HCSC facility standards[17,29]. The current study results showed a strong association between death at home and severity of care. People with cancer near their end of life as their level of care progresses[23] and they are less willing to use active medical intervention[11,14]. People who use care resources die more at home[1,30], confirming a scenario similar to that reported in previous studies.

As older patients with cancer have multifaceted health care needs, it is essential to have a home health care provision system in the community as the core of care, capable of attending to emergencies and providing urgent hospital admissions, equipped with general medicine and palliative care departments, and capable of working closely with patients' home[31]. Most previous studies have suggested that early intervention in palliative care and the involvement of a home palliative care team improve the possibility of death at home[32] and that the provision of multidisciplinary professional health and care services increases deaths at home[1,30]. A previous report showed that enhanced HCSCs with beds were particularly effective in reducing the length of hospital stay[20]. In this study, older patients with cancer who used the enhanced HCSC beds were seamlessly transferred to hospital admission when their condition deteriorated and to home care after recovery. The necessary medical and nursing services were provided in an integrated and continuous manner until end-of-life care, which may have contributed to high-quality, comprehensive home care through multidisciplinary cooperation.

Another point to note is the inpatient functions provided by home health care services. In all analytical models in this study, the use of enhanced HCSCs without beds had a lower OR for death at home than conventional HCSCs, which consisted of a mix of beds and without beds. This may be due to the fact that when enhanced HCSCs had no beds, patients had to be admitted to hospitals in case of an acute deterioration, which weakened the relationship between the patient and their family doctor and did not reflect the patient's wishes.

Second, the use of home-visit nursing care. A high proportion of the home care group used home-visit nursing care (> 90%). This revealed that older people with cancer spent their lives with the support of home-visit nursing care the helps them stay at their familiar home environment. It can also be inferred that nurses and home nursing stations within hospitals and clinics worked together with primary physicians and supported the patients in their recuperation and end-of-life care at home through an effective interaction process. Prior studies have reported that the use of home-visit nursing care contributes to a reduction in death at home and hospital admissions[14]. This study suggests that home-visit nursing care is a strong backup and important for primary care physicians.

The Ministry of Health, Labour and Welfare (MHLW) has reported changes in the place of deaths in Japan after 2020 due to the impact of the COVID-19 pandemic. Deaths at home increased to 17.2% in 2021, while hospital deaths decreased to 65.9%[4]. This is due to a number

of factors, including an increase in the number of patients and their families willing to receive home care or spend the last days of their lives at home, as hospitals restricted visits due to the pandemic[33]. During the pandemic, health care was under pressure and people could not be hospitalized as hospital beds were reserved for patients with COVID-19 infection[34]. The Government of Japan has highlighted the need to establish a system to ensure the stable and continuous provision of medical and nursing services at home in the event of a similar crises such as the COVID-19 pandemic and natural disasters[35]. In this study, a small proportion of older patients with cancer were in the home care continuation group (7.4%). However, the results showed a significant difference in the proportion of deaths at home in the continuing home care group (25.7%), which was approximately 3.3 times higher than that in the non-continuing group. This suggests that the utilization of home health care resources is likely to be effective for those who wish to receive end-of-life care at home. With the aging population, cancer has been the leading cause of death among Japanese people since 1981. Cancer survival rates are increasing for many organ sites[36], and the demand for home care for patients with cancer is expected to increase in the future. In this study, enhanced HCSCs with beds and home-visit nursing care facilities were the most effective home health care resources for providing end-of-life care to older patients with cancer.

The study findings are crucial in assessing how limited resources can be effectively used for

end-of-life home care for older patients with cancer. The study covered all 75-year-old and above residents living in Fukuoka Prefecture, which has high per capita medical costs and an abundance of hospital beds[40]. Presently, enhanced without beds get higher reimbursement than conventional HCSCs under the reimbursement system. However, end-of-life care for older patients with cancer at home was primarily facilitated by enhanced HCSCs with beds, followed by conventional HCSCs. To expand the role of enhanced HCSCs in end-of-life care for older patients with cancer at home, it is necessary to evaluate bed availability, physician coverage, and collaboration with other clinics. Conducting an objective evaluation of these factors would aid in the development of improved home health care services. It is essential to maintain objectivity when evaluating these factors to ensure that home health care services are effective and meet the needs of patients. While regional variations exist in both resources and circumstances, implementing a reimbursement system that supports functional differentiation and coordination within the home healthcare delivery system would enhance resources and promote the aging in place of older patients with cancer. This would also lead to an improvement in the quality of end-of-life care.

According to the MHLW, in 2021, enhanced HCSCs (with or without beds) in Japan accounted for 25.9% of all HCSCs[37]. If the number of nurses engaged in home-visit nursing care is to be increased to approximately 30% of the proportion of deaths at home in the

Netherlands, France, and other countries, approximately 150,000 nurses will be needed[38,39]. Home health care in Japan is insufficient in terms of both quality and quantity[35]. It is necessary to create a home health care provision system in each region which include not only doctors, but also visiting nurses and caregivers, to provide care to people who wish to receive end-of-life care at home.

This study had several limitations. First, it was conducted using data only from residents of Fukuoka Prefecture, Japan, limiting its generalizability[40]. Second, patients who received home nursing care provided by nurses from hospitals and clinics were excluded, as no home nursing instructions were issued. Third, although end-of-life care at home is influenced by patients' wishes, living conditions reflecting family structure, characteristics, and socioeconomic factors were not identified in this study. Fourth, because the study focused on the use of home care and nursing, it did not include clinical data of individual patients (e.g., disease progression or test results). Hence, the data might have been influenced by residual confounding factors. Finally, the possibility of some patients moving from home to a nursing home during the follow-up period was not addressed.

In conclusion, this retrospective study found that the continued use of home health care resources by older patients with cancer improves the end-of-life care at home. In particular, the

current study findings suggest that promotion of agencies with enhanced HCSC, beds, and home-visit nursing care functions is advantageous when providing home health care services to patients with cancer. The current study provides useful information to consider home health care for patients with cancer as part of a community-based integrated care system.

Acknowledgements

The authors thank the Fukuoka Prefecture Association of Latter-Stage Elderly Healthcare for providing health care claims database. The authors also thank Miwa Shiratani, Home Hospice Shizuku Representative; Yoriko Hirano, Home-Visit Nursing Station Hana General Manager; and Manami Miyagawa, Home-Visiting Nurse, for their cooperation in providing information regarding home care support initiatives.

Conflicts of interest

The authors declare that there is no conflicts of interest.

Author Contributions

Reiko Yamao designed the study, collected and analyzed the data, and wrote the manuscript. Akira Babazono contributed to the study design, data interpretation, and contributed extensively

to the preparation of the manuscript. Ning Liu contributed to study design, data collection and interpretation, critical review, and manuscript revision. Yunfei Li, Reiko Ishihara, Shinichiro Yoshida, Sung-A Kim, and Aziz Jamal contributed to data collection, interpretation, and manuscript revision. All authors approved the final version and are responsible for submitting the manuscript for publication.

References

1. Gomes B, Higginson IJ. Factors influencing death at home in terminally ill patients with cancer: systematic review. BMJ 2006;332(7540):515-21, doi:10.1136/bmj.38740.614954.55

2. Cabanero-Martinez MJ, Nolasco A, Melchor I, Fernández-Alcántara M, Cabrero-García J. Place of death and associated factors: a population-based study using death certificate data. Eur J Public Health 2019;29(4):608-615, doi:10.1093/eurpub/cky267

3. Alsirafy SA, Hammad AM, Ibrahim NY, Farag DE, Zaki O. Preferred place of death for patients with incurable cancer and their family caregivers in Egypt. Am J Hosp Palliat Care 2019;36(5):423-428, doi:10.1177/1049909118813990

4. Ministry of Health LaW. kousei toukei youran (2022) [Compendium of Health and Welfare Statistics]. 2022. Available from: https://www.mhlw.go.jp/toukei/youran/index-kousei.html [Last accessed; 23 May 2023].

5. Townsend J, Frank AO, Fermont D, Dyer S, Karran O, Walgrove A, Piper M. Terminal cancer

care and patients' preference for place of death: a prospective study. BMJ 1990;301(6749):415-7, doi:10.1136/bmj.301.6749.415

6. Higginson IJ, Sen-Gupta GJ. Place of care in advanced cancer: a qualitative systematic literature review of patient preferences. J Palliat Med 2000;3(3):287-300, doi:10.1089/jpm.2000.3.287

7. Khan SA, Gomes B, Higginson IJ. End-of-life care--what do cancer patients want? Nat Rev Clin Oncol 2014;11(2):100-8, doi:10.1038/nrclinonc.2013.217

8. Nilsson J, Blomberg C, Holgersson G, Carlsson T, Bergqvist M, Bergström S. End-of-life care: Where do cancer patients want to die? A systematic review. Asia Pac J Clin Oncol 2017;13(6):356-364, doi:10.1111/ajco.12678

9. Fereidouni A, Rassouli M, Salesi M, Ashrafizadeh H, Vahedian-Azimi A, Barasteh S. Preferred Place of Death in Adult Cancer Patients: A Systematic Review and Meta-Analysis. Front Psychol 2021;12(704590), doi:10.3389/fpsyg.2021.704590

10. Kerr CW, Donohue KA, Tangeman JC, et al. Cost savings and enhanced hospice enrollment with a home-based palliative care program implemented as a hospice-private payer partnership. J Palliat Med 2014;17(12):1328-35, doi:10.1089/jpm.2014.0184

11. Lustbader D, Mudra M, Romano C, et al. The Impact of a Home-Based Palliative Care Program in an Accountable Care Organization. J Palliat Med 2017;20(1):23-28, doi:10.1089/jpm.2016.0265

12. Gomes B, Calanzani N, Curiale V, McCrone P, Higginson IJ. Effectiveness and cost-effectiveness of home palliative care services for adults with advanced illness and their caregivers. Cochrane Database Syst Rev 2013;2013(6):CD007760, doi:10.1002/14651858.CD007760.pub2

13. Natsume M, Watanabe K, Matsumoto S, et al. Factors Influencing Cancer Patients' Choice of End-of-Life Care Place. J Palliat Med 2018;21(6):751-765, doi:10.1089/jpm.2017.0481

14. Wye L, Lasseter G, Percival J, Duncan L, Simmonds B, Purdy S. What works in 'real life' to facilitate home deaths and fewer hospital admissions for those at end of life?: results from a realist evaluation of new palliative care services in two English counties. BMC Palliat Care 2014;13(37), doi:10.1186/1472-684X-13-37

15. Cabinet PMojaH. Report of the National Council for Social Security Reform. Pathways to pass on reliable social security to future generations. 2013. Available from: https://warp.ndl.go.jp/info:ndljp/pid/8295038/www.kantei.go.jp/jp/singi/kokuminkaigi/pdf/houkokusyo.pdf [Last accessed 27 Feb 2023].

16. Japanese Ministry of Health LaW. Reference materials for the 1st National Conference on home medical care. 2016. Available from: https://www.mhlw.go.jp/file/05-Shingikai-10801000-Iseikyoku-Soumuka/0000129546.pdf.

17. Ministry of Health LaW. Shinryo hoshu kaitei no gaiyo zaitaku (zaitaku iryo homon kango)[Overview of the revision of medical fees Home (Home health care, home nursing)]. 2022.

Available from: https://www.mhlw.go.jp/content/12400000/000920430.pdf [Last accessed: 17 May 2023].

18. Ministry of Health LaW. Chuo shakai hoken iryo kyogikai (dai 237 kai) zaitaku iryo ni tsui te (sono 1)[Central Social Insurance Medical Council (237th meeting) on home health care (Part 1)]. 2013. Available from: https://www.mhlw.go.jp/stf/shingi/2r9852000002ueo9-att/2r9852000002uvk3_1.pdf [Last accessed: 21 May 2023].

19. Foundation JVN. Structure of the Visiting Nursing system in Japan. 2021. Available from: https://www.jvnf.or.jp/global/Structure_of_the_Visiting_Nursing_system_in_Japan_EN.pdf [Last accessed; 19 Apr 2023].

20. Kim SA, Babazono A, Jamal A, Li Y, Liu N. Comparison of care utilisation and medical institutional death among older adults by home care facility type: a retrospective cohort study in Fukuoka, Japan. BMJ Open 2021;11(4):e041964, doi:10.1136/bmjopen-2020-041964

21. Sun Y, Iwagami M, Komiyama J, et al. Association between types of home healthcare and emergency house calls, hospitalization, and end-of-life care in Japan. J Am Geriatr Soc 2023, doi:10.1111/jgs.18268

22. Olivares-Tirado P, Tamiya N. Trends and Factors in Japan's LongTerm Care Insurance System: Japan's 10- year Experience. 2014.

23. Soeda R, Mitsuhashi M, Okano S, et al. Shu matsuki gan kanja no shibo mae 6 shukan no

1 nichijo seikatsu dosa no keiji teki henka [Trajectory of ADL (Activities of Daily Living) for Six Weeks
2 before Death in Patients with Terminal Cancer]. Palliat Care Res 2020;15(3):167-174
3 24. D'Hoore W, Sicotte C, Tilquin C. Risk adjustment in outcome assessment: the Charlson
4 comorbidity index. Methods Inf Med 1993;32(5):382-7
5 25. Morioka N, Tomio J, Seto T, Yumoto Y, Ogata Y, Kobayashi Y. Association between local-
6 level resources for home care and home deaths: A nationwide spatial analysis in Japan. PLoS One
7 2018;13(8):e0201649, doi:10.1371/journal.pone.0201649
8 26. Jamal A, Babazono A, Li Y, Yoshida S, Fujita T. Multilevel analysis of hemodialysis-associated
9 infection among end-stage renal disease patients: results of a retrospective cohort study utilizing the
10 insurance claim data of Fukuoka Prefecture, Japan. Medicine (Baltimore) 2020;99(18):e19871,
11 doi:10.1097/MD.0000000000019871
12 27. Ikeda T, Tsuboya T. Place of Death and Density of Homecare Resources: A Nationwide Study
13 in Japan. Ann Geriatr Med Res 2021;25(1):25-32, doi:10.4235/agmr.21.0003
14 28. Abe K, Kawachi I, Taniguchi Y, Tamiya N. Municipal Characteristics of In-Home Death
15 Among Care-Dependent Older Japanese Adults. JAMA Netw Open 2022;5(1):e2142273,
16 doi:10.1001/jamanetworkopen.2021.42273
17 29. Ministry of Health LaW. 2018. Available from: https://www.mhlw.go.jp/file/04-
18 Houdouhappyou-10802000-Iseikyoku-Shidouka/0000197701.pdf [Last Accessed; 3 Apr 2023].

30. Abe K, Miyawaki A, Kobayashi Y, Watanabe T, Tamiya N. Place of death associated with types of long-term care services near the end-of-life for home-dwelling older people in Japan: a pooled cross-sectional study. BMC Palliat Care 2020;19(1):121, doi:10.1186/s12904-020-00622-0

31. Cancer JAoSCi. Koureisya gan iryou Q&A souron [Cancer Care for the Elderly Q&A General] 2022. Available from: http://jascc.jp/publications/1994/ [Last accessed; 25 Feb 2023].

32. Costa V, Earle CC, Esplen MJ, et al. The determinants of home and nursing home death: a systematic review and meta-analysis. BMC Palliat Care 2016;15(8), doi:10.1186/s12904-016-0077-8

33. Hamano J, Tachikawa H, Takahashi S, et al. Changes in home visit utilization during the COVID-19 pandemic: a multicenter cross-sectional web-based survey. BMC Res Notes 2022;15(1):238, doi:10.1186/s13104-022-06128-7

34. Ministry of Health LaW. Shingata koronauirusu kansensho no hoken iryo teikyo taisei kakuho keikaku [Plan for ensuring health and health care delivery systems for new coronavirus infections.]. Available from: https://www.mhlw.go.jp/stf/seisakunitsuite/newpage_00056.html [Last accessed; 23 May 2023].

35. Ministry of Health LaW. Dai2kai Zaitakuiryo oyobi iryo kaigo renkei ni kansuru wakingu gurupu shiryo [Second working group on home health care and cooperation between medical and nursing care providers Materials]. 2022. Available from: https://www.mhlw.go.jp/stf/newpage_24354.html.

36. Japan NCC. Cancer statistics. 2022. Available from: https://ganjoho.jp/reg_stat/statistics/stat/annual.html [Last accessed; 2 Apr 2023].

37. Ministry of Health LaW. Zaitaku iryou ni kakaru tiiki betsu de-ta syuu [Regional data collection on home health care]. 2023. Available from: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000061944.html [Last Accessed; 23 May 2023].

38. Service TNAfVN. Houmon kango akusyon puran 2025-2025 nen wo meza si ta houmon kango [Home care nursing action plan 2025-Home care nursing for 2025.]. Available from: https://www.jvnf.or.jp/2017/actionplan2025.pdf [Last accessed; 23 May 2023].

39. Ministry of Health LaW. Dai 93 kai shakai hosho shingi kai iryo bukai shiryo 3-2 iryo no ninaite no kakuho ni tsuite [93rd Session of the Health Care Subcommittee of the Council for Social Security, Document 3-2: Securing the medical workforce]. 2022. Available from: https://www.mhlw.go.jp/content/12601000/001016975.pdf [Last accessed; 23 May 2023].

40. Ministry of Health LaW. Labour and Welfare. Iryouhino Chiikisa Bunseki [regional difference analysis of medical expenses]. 2017. Available from: https://www.mhlw.go.jp/content/iryohi_h29.pdf [Last accessed; 21 May 2023].

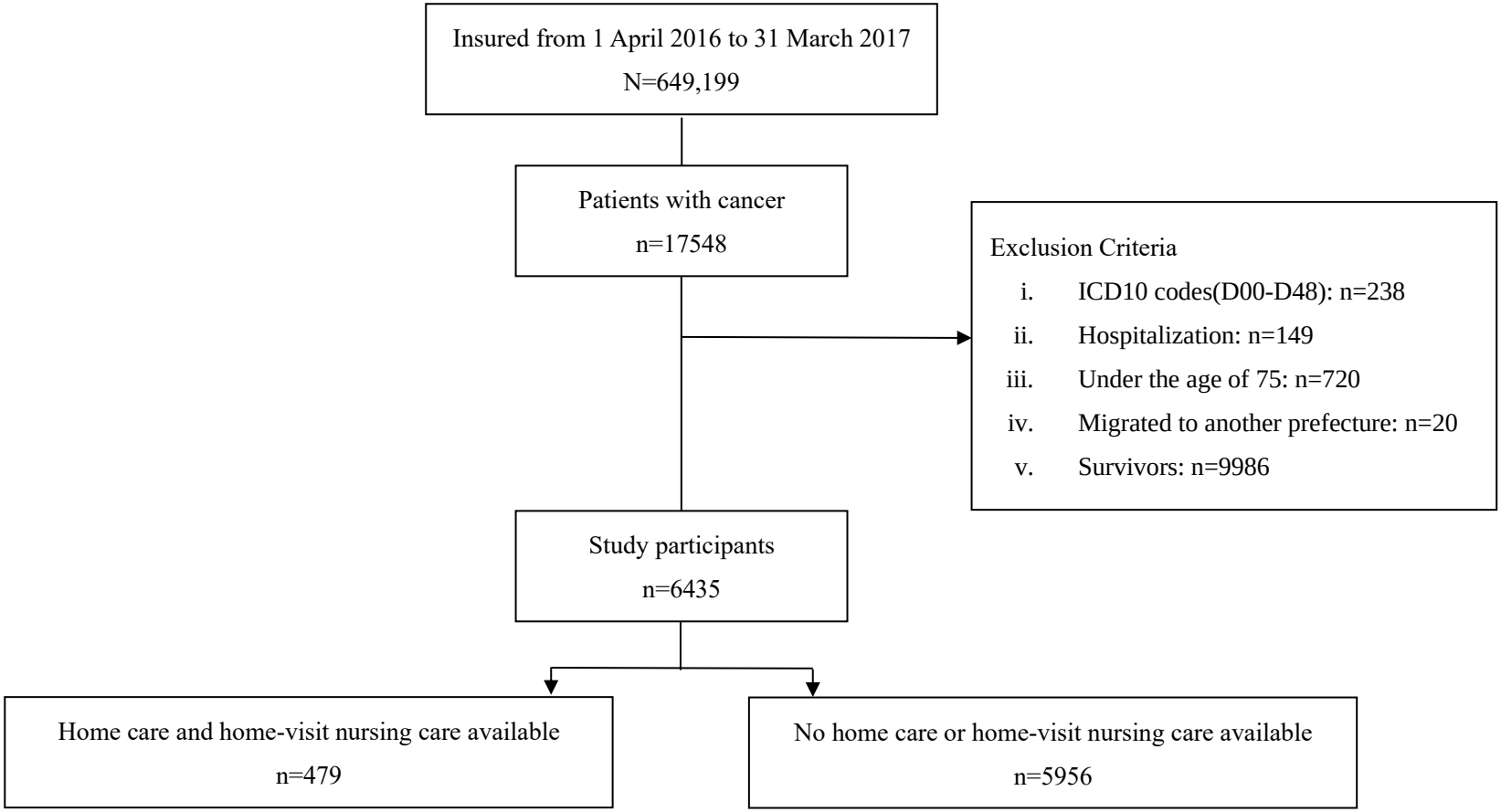

Figure 1 Flowchart of study participant selection.

Progress*	Name	Definition	
	Other HCSCs	A.	Mixed with or without beds.
		B.	Independently operated by one or more full-time physician.
		C.	Physicians have the discretion to decide whether to provide 24 hours and 365 days contact, house calls, home nursing, emergency hospitalization, and end-of-life care.
		D.	Based on the patient's request or needs.
		E.	No requirements.
	Conventional HCSCs	A.	Mixed with or without beds.
		B.	Independently operated by one or more full-time physician.
		C.	The system provides 24 hours and 365 days support, and physicians and nurses are available to visit and care for patients at home at the patient's request, accept hospitalization in the event of an emergency, or arrange admission to a linked medical institution.
		D.	Work in cooperation with local medical institutions and welfare services.
		E.	Required to provide end-of-life care and emergency house calls at patients' homes and report the total number to the Ministry of Health, Labour and Welfare once a year.
	Enhanced HCSCs	A.	No hospital beds.
		B.	Operated either independently or in collaboration with other facilities, this organization is staffed with at least three full-time physicians.
		C.	Same as conventional HCSCs type.
		D.	Same as conventional HCSCs type.
		E.	Required: To provide a number of at least 4 end-of-life home care cases (at least 2 cases in each facility for collaborative types) and at least 10 emergency house calls per year (4 or more cases in each facility for collaborative types), and to report the total number to the Ministry of Health, Labour and Welfare once a year.
	Enhanced HCSCs with beds	A.	Equipped with hospital beds.
		B.	Same as enhanced HCSCs type.
		C.	Same as conventional HCSCs type.
		D.	Same as conventional HCSCs type.
		E.	Same as enhanced HCSCs type.

Figure 2 Definitions of HCSCs explanatory variables. A refers to the availability of beds in the facility, B refers to the number of full-time physicians and the operating condition, C refers to the home health care system, and D refers to functions of cooperation, E refers to the level of the facility's needs.

* It means to promote the home health care service system. The arrow indicates the direction of time flow.

Abbreviation: HCSCs, home care support clinics/hospitals.

Note: Quoted and altered from Presentation Materials of Overview of the Revision of Medical Fees Home (Home health care, home nursing) (in Japanese) 2022. Japanese Ministry of Health, Labour and Welfare (online). Available at https://www.mhlw.go.jp/content/12400000/000920430.pdf

Supplementary Appendix 1. Codes used to identify medical treatments and outcomes

Medical practice	
Medical claims	
Surgical therapy	Derma/K007 Musculoskeletal system, limbs and trunk/K031,K053 Nervous system and cranium/K162 Eye/K216,K225-4,K236,K225-4 Otolaryngology/K293,K294,K314,K343,K374,K376,K379,K394, K395 Facial, oral and cervical /K410,K412,K415,K422,K424,K425, K439, K442,K455,K458,K463,K465,K470 Breast, lung and oesophagus /K475,K476,K484,K504,K514,K527, K529 Stomach, liver, bile, colon and anus /K643,K653,K655,K657,K675, K677,K697,K719,K721,K748 Urinary system, adrenal glands, kidneys and bladder /K756,K773, K803,K817 Genital /K827,K833,K843,K850,K857,K879,K889
Chemotherapy	Code of the drug listed in the NHI Drug Price List Left 2 digits 42
Radiation therapy	113001110,113011310,113014110,113014270,140048550, 140053010,140053110,140053210,140053310,140061110, 150216650,150275410,150327010,150346010,150351910, 150411250,180008810,180009270,180009410,180009510, 180009610,180009710,180012710,180012810,180012910, 180016970,180017010,180018410,180018510,180018610, 180018770,180018870,180018910,180019010,180019110, 180019210,180019310,180019410,180019710,180020170, 180020710,180020810,180020910,180021010,180021110, 180021210,180021310,180021410,180021510,180021610, 180021710,180021810,180021910,180022010,180025270, 180026510,180026610,180026750,180026810,180026910, 180027010,180027110,180027270,180031710,180031870, 180031910,180032010,180032110,180032310,180033510, 180033610,180033770,180034890,180034990,180035090, 180035190,180035270,180035310,180035470,180035570, 180043270,180054470,180054510,180054670,180054770, 180054870,180054970,180069910,180070010,190197910,

	190198010,190243410,190243510,190266410,190266510
Death at home	
Medical claims End-of-life care in facilities*	190144870,190144970,190145170,190145270
End-of-life care and death certificates	114007270,114018670,114019970,114018570,114018170, 114042370,114042970,114018270,114042470,114043070, 114018370,114042570,114043170,114018470,114042670, 114044370,114043270
Long-term care claims End-of-life care	Service type code/Service item code 13/7000 33/6125,6126,6127,6120,6137,6138,6139,6140 36/6125,6126,6127,6124,6137,6138,6139,6140 76/6100 77/6100

* The codes for end-of-life care in facilities were used to confirm all deaths, although they were excluded in the definition of death at home.

Supplementary Appendix 2. List of codes used to identify exposure

Types of home health care facilities	
Medical claims	
Enhanced HCSCs	114017770,114017870,114017970,114019710,114019810, 114022670,114022770,114022870,114029370,114030070, 114031610,114031710,114031810,114031910,114032010, 114032110,114032210,114032310,114032410,114036410, 114036510,114036610,114036710,114036810,114036910, 114037010,114037110,114037210,114055910,114056010, 114056110,114056210,114056310,114056410,114058610, 114058710,114058810,114058910,114059010,114059110
Enhanced HCSCs with beds	114017470,114017570,114017670,114019510,114019610 ,114022370,114022470,114022570,114029270,114029970, 114030710,114030810,114030910,114031010,114031110 ,114031210,114031310,114031410,114031510,114035510, 114035610,114035710,114035810,114035910,114036010, 114036110,114036210,114036310,114055310,114055410, 114055510,114055610,114055710,114055810,114058010, 114058110,114058210,114058310,114058410,114058510
Conventional HCSCs	114007610,114007710,114011570,114011670,114011770, 114011870,114011970,114012070,114029470,114030170, 114032510,114032610,114032710,114032810,114032910, 114033010,114033110,114033210,114033310,114037310, 114037410,114037510,114037610,114037710,114037810, 114037910,114038010,114038110,114040370,114040470, 114056510,114056610,114056710,114056810,114056910, 114057010,114059210,114059310,114059410,114059510, 114059610,114059710,190145410
Other HCSCs	114000370,114000470,114000570,114001870,114001970, 114002070,114029570,114030270,114033410,114033510, 114033610,114033710,114033810,114033910,114034010, 114034110,114034210,114038210,114038310,114038410, 114038510,114038610,114038710,114038810,114038910, 114039010,114043770,114057110,114057210,114057310, 114057410,114057510,114057610,114057870,114059810, 114059910,114060010,114060110,114060210,114060310
Home-visit nursing care	
Medical claims	

Home nursing directive	114008010

Long-term care claims	
Home-visit nursing care service	Service type code/Service item code 13 31/1261,1262,1263,1264 33/1511,1517,1512,1513,1514,1521,1525,1522,1523,1524 34/1261,1262,1263,1264 35/1511,1517,1512,1513,1514,1521,1525,1522,1523,1524 63 76/1211,1213,1221,1223,1231,1233,1241,1243,1251,1253, 1212,1214,1222,1224,1232,1234,1242,1244,1252,1254 77/6001,6003,6005,6007,6009,6011,6012,6013,6014,6015, 6002,6004,6006,6008,6010

HCSCs, home support clinics/hospitals

Supplementary Appendix 3. Types of facilities providing home health care, main standards, and reimbursements

○：Establishment of systems and facility criteria requirements —：No requirement for facility standards		Full-time physician	24-hour system				At home comprehensive medical management fee*	At facility comprehensive medical management fee*
			Number of emergency house calls	Number of end-of-life care at home	Home-visit nursing care	Hospitalization system for emergencies		
Home care support clinic/ hospital	Stand-alone enhanced type	three or more	More than 10 cases per year	More than four cases in the past year	○	○	○	○
	Cooperation with several clinics/ hospital enhanced type		More than four cases in the past year at each facility	More than two cases in the past year at each facility	○	○	○	○
	Conventional type	—	Only system	Only system	○	○	○	○
Clinics other than home care support clinics		—	—	—	—	—	○	○

* Facility standards include the assignment of care managers, social workers, full-time home health care physicians, and efforts to coordinate with other health and welfare services and provide information to municipalities. To claim an additional fee, there are set categories such as the frequency of regular home visits, use of information and communication devices, severity of the patient's condition, and number of patients treated in a single building. The comprehensive medical management fee is billed either at home or at a facility depending on where the patient lives.

Table 1 Participants' characteristics at baseline

	Total	Home care or home visiting nurse available	Not available	P value
Number of patients with cancer	6,435	479	5,956	
Sex (%)				
Male	3,972(61.7)	275(57.4)	3,697(62.1)	0.04
Female	2,463(38.3)	204(42.6)	2,259(37.9)	
Age				
Mean ± SD	81.9 ±4.9	82.7±5.1	81.8±4.9	
75-79 (%)	2,367(36.8)	149(31.1)	2,218(37.2)	0.005
80-84 (%)	2,313(35,9)	169(35.3)	2,144(36.0)	
85-89 (%)	1,228(19.1)	116(24.2)	1,112(18.7)	
＞=90	527(8.2)	45(9.4)	482(8.1)	
Care-need level (%)				
None	3,902(60.6)	79(16.5)	3,823(64.2)	<0.001
Support level 1	278(4.3)	19(4.0)	259(4.3)	
Support level 2	341(5.3)	39(8.1)	302(5.1)	
Care level 1	645(10.0)	104(21.7)	541(9.1)	
Care level 2	542(8.4)	104(21.7)	438(7.4)	
Care level 3	282(4.4)	50(10.4)	232(3.9)	
Care level 4	297(4.6)	58(12.1)	239(4.0)	
Care level 5	148(2.3)	26(5.4)	122(2.0)	
Charlson Comorbidity Index (%)				
0-3	528(8.2)	32(6.7)	496(8.3)	0.06
4-5	2,584(40.2)	175(36.5)	2,409(40.4)	
＞=6	3,323(51.6)	272(56.8)	3,051(51.2)	
Comorbidity score, median (IQR)	5.6±2.0	5.8±2.0	5.5± 2.0	
Medical district				
Fukuoka, Itoshima	1,458(22.7)	132(27.6)	1,326(22.3)	0.02
Kasuya	256(4.0)	17(3.5)	239(4.0)	
Munakata	194(3.0)	17(3.5)	177(3.0)	
Chikushi	416(6.5)	38(7.9)	378(6.3)	
Asakura	138(2.1)	5(1.0)	133(2.2)	
Kurume	657(10.2)	46(9.6)	611(10.3)	
Yame/Chikugo	239(3.7)	19(4.0)	220(3.7)	
Ariake	466(7.2)	30(6.3)	436(7.3)	
Iizuka	264(4.1)	22(4.6)	242(4.1)	
Nogata/Kurate	191(3.0)	19(4.0)	172(2.9)	
Tagawa	210(3.3)	21(4.4)	189(3.2)	
Kitakyushu	1,690(26.3)	101(21.1)	1,589(26.7)	
Keichiku	256(4.0)	12(2.5)	244(4.1)	

P value < 0.001 across spending trajectories, $\chi 2$ test to compare proportions.

IQR, interquartile range; SD, standard deviation.

Table 2 Details of home health care resource users

	Total	Enhanced HCSCs	Enhanced HCSCs with beds	Conventional HCSCs	Other HCSCs	Home-visit nursing care
Number of patients with cancer		14	41	13	7	453
Sex (%)						
Male		7(50.0)	23(56.1)	7(53.9)	1(14.3)	263(58.1)
Female		7(50.0)	18(43.9)	6(46.1)	6(85.7)	190(41.9)
Age						
Mean ± SD		81.6±4.4	80.8±3.7	82.5±6.3	82.9±2.0	82.8 ±5.1
75-79 (%)		5(35.7)	16(39.0)	5(38.5)	0(0.0)	145(32.0)
80-84 (%)		6(42.9)	19(46.3)	5(38.5)	6(85.7)	151(33.3)
85-89 (%)		2(14.3)	6(14.6)	1(7.7)	1(14.3)	113(24.9)
＞=90		1(7.1)	0(0.0)	2(15.4)	0(0.0)	44(9.7)
Care-need level (%)						
None		2(14.3)	13(31.7)	1(7.7)	0(0.0)	73(16.1)
Support level 1		1(7.1)	0(0.0)	0(0.0)	1(14.3)	18(4.0)
Support level 2		0(0.0)	4(9.8)	1(7.7)	0(0.0)	36(7.9)
Care level 1		2(14.3)	7(17.1)	0(0.0)	1(14.3)	102(22.5)
Care level 2		1(7.1)	6(14.6)	5(38.5)	0(0.0)	98(21.6)
Care level 3		3(21.4)	3(7.3)	2(15.4)	3(42.9)	48(10.6)
Care level 4		3(21.4)	4(9.8)	2(15.4)	2(28.6)	54(11.9)
Care level 5		2(14.3)	4(9.8)	2(15.4)	0(0.0)	24(5.3)
Charlson Comorbidity Index (%)						
0-3		0(0.0)	0(0.0)	0(0.0)	1(14.3)	32(7.1)
4-5		5(35.7)	15(36.6)	4(30.8)	2(28.6)	165(36.4)
＞=6		9(64.3)	26(63.4)	9(69.2)	4(57.1)	256(56.5)
Comorbidity score, median (IQR)		5.8±1.7	6.4±1.8	5.7±0.8	5.9± 2.3	5.8±2.0
Medical district						
Fukuoka, Itoshima		2(14.3)	15(36.6)	3(23.1)	1(14.3)	125(27.6)
Kasuya		0(0.0)	2(4.9)	0(0.0)	0(0.0)	15(3.3)
Munakata		4(28.6)	0(0.0)	0(0.0)	0(0.0)	16(3.5)
Chikushi		2(14.3)	5(12.2)	0(0.0)	0(0.0)	33(7.3)
Asakura		0(0.0)	0(0.0)	0(0.0)	0(0.0)	5(1.1)
Kurume		3(21.4)	8(19.5)	2(15.4)	0(0.0)	43(9.5)
Yame/Chikugo		0(0.0)	0(0.0)	1(7.7)	0(0.0)	19(4.2)
Ariake		0(0.0)	0(0.0)	0(0.0)	1(14.3)	30(6.6)
Iizuka		0(0.0)	6(14.6)	1(7.7)	1(14.3)	22(4.9)
Nogata/Kurate		0(0.0)	2(4.9)	1(7.7)	2(28.6)	17(3.8)
Tagawa		0(0.0)	2(4.9)	0(0.0)	1(14.3)	20(4.4)
Kitakyushu		2(14.3)	1(2.4)	4(30.8)	1(14.3)	97(21.4)
Keichiku		1(7.1)	0(0.0)	1(7.7)	0(0.0)	11(2.4)
Home-based end-of-life care (%)						
Yes (%)	123(25.7)	7(50.0)	25(61.0)	7(53.8)	3(42.9)	109(24.1)
No (%)	356(74.3)	7(50.0)	16(39.0)	6(46.2)	4(57.1)	344(75.9)

IQR, interquartile range; SD, standard deviation.

HCSCs, home care support clinics/hospitals.

Table 3 Association between the utilization of home care resources and death at home

	Model 1（univariate）			Model 2（multivariate）*			Model 3（multilevel logistic regression model）**		
	Odds ratio	95% CI	P	Odds ratio	95% CI	P	Odds ratio	95% CI	P
Type of home care facility									
Enhanced HCSCs									
Not available	Reference			Reference			Reference		
Available	10.17	3.55, 29.09	<0.001	4.74	1.58, 14.24	0.006	4.44	1.47, 13.42	0.008
Enhanced HCSCs with beds									
Not available	Reference			Reference			Reference		
Available	16.37	8.69, 30.85	＜0.001	9.34	4.69, 18.61	＜0.001	8.66	4.31, 17.40	＜0.001
Conventional HCSCs									
Not available	Reference			Reference			Reference		
Available	11.86	3.97, 35.42	<0.001	5.86	1.91, 18.00	0.002	5.78	1.86, 17.94	0.002
Other HCSCs									
Not available	Reference			Reference			Reference		
Available	7.58	1.69, 33.93	0.008	3.27	0.72, 14.97	0.13	3.64	0.78, 16.96	0.10
Home-visit nursing care									
Not available	Reference			Reference			Reference		
Available	3.69	2.92, 4.67	<0.001	1.90	1.45, 2.49	<0.001	1.86	1.42, 2.44	<0.001
Sex									
Male				Reference			Reference		
Female				1.06	0.89, 1.27	0.52	1.06	0.89, 1.28	0.51
Age category									
75-79				Reference			Reference		
80-84				1.06	0.86, 1.31	0.57	1.06	0.86, 1.31	0.59
85-89				0.84	0.65, 1.08	0.18	0.84	0.65, 1.09	0.18
95-				0.78	0.56, 1.11	0.17	0.79	0.56, 1.11	0.18
Care-need level									
None				Reference			Reference		
Support level 1,2				1.41	1.01, 1.95	0.04	1.41	1.01, 1.96	0.04
Care level 1-3				2.52	2.04, 3.12	<0.001	2.55	2.05, 3.16	<0.001

Care level 4,5	3.76	2.83, 5.00	<0.001	3.89	2.92, 5.18	<0.001
CCI						
0-3	Reference			Reference		
4-5	1.10	0.79, 1.54	0.57	1.13	0.81, 1.58	0.48
＞=6	0.92	0.66, 1.29	0.64	0.94	0.67, 1.32	0.74
Random effect						
Variation (Standard Error)				0.069(0.046)		
Log likelihood	-1812.57			-1804.05		
AIC	3655.14			3640.10		
BIC	3756.68			3748.41		

* Multivariate logistic regression models adjusted for sex, age, care-need level and CCI as covariates.

** The explanatory variables were divided into two levels. The primary level was individual patients and the secondary level was the secondary health care area. In addition, multilevel logistic regression models adjusted for sex, age and CCI as covariates.

HCSCs, home care support clinics/hospitals; AIC, Akaike information criterion; BIC, Bayesian information criterion; CCI, Charlson comorbidity index; CI, confidence interval.