The Journal of Frailty & Aging 14 (2025) 100063

Contents lists available at ScienceDirect

The Journal of Frailty & Aging

journal homepage: www.elsevier.com/locate/tjfa

Original Research

Healthcare utilization, pharmacotherapy prescriptions, and clinical outcomes across a 5-year duration preceding and succeeding the initiation of home health care in a nationwide population-based cohort of 187,547 older adults with disabilities

Shih-Tsung Huang[a,b], Fei-Yuan Hsiao[c,d,e,**], Wei-Ju Lee[b,f], Ming-Yueh Chou[b,g], Chih-Kuang Liang[b,g], Chu-Sheng Lin[b,h,i], Ching-Hui Loh[j], Liang-Kung Chen[b,k,l,*]

[a] Department of Pharmacy, National Yang Ming Chiao Tung University, Taipei, Taiwan
[b] Center for Healthy Longevity and Aging Sciences, National Yang Ming Chiao Tung University, Taipei, Taiwan
[c] Graduate Institute of Clinical Pharmacy, College of Medicine, National Taiwan University, Taipei, Taiwan
[d] School of Pharmacy, College of Medicine, National Taiwan University, Taipei, Taiwan
[e] Department of Pharmacy, National Taiwan University Hospital, Taipei, Taiwan
[f] Department of Family Medicine, Taipei Veterans General Hospital Yuanshan Branch, Yi-Lan, Taiwan
[g] Center for Geriatrics and Gerontology, Kaohsiung Veterans General Hospital, Taiwan
[h] Department of Family Medicine, Taichung Veterans General Hospital, Taichung, Taiwan
[i] Center for Geriatrics and Gerontology, Taichung Veterans General Hospital, Taichung, Taiwan
[j] Center for Aging and Health, Hualien Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, Hualien, Taiwan
[k] Center for Geriatrics and Gerontology, Taipei Veterans General Hospital, Taipei, Taiwan
[l] Taipei Municipal Gan-Dau Hospital (Managed by Taipei Veterans General Hospital), Taipei, Taiwan

ARTICLE INFO

Keywords:
Home healthcare
Healthcare utilization
Polypharmacy
Antibiotic
Mortality

ABSTRACT

Background: Longitudinal trajectories of healthcare utilization, medication prescription, and clinical outcomes among older adults with disabilities receiving home healthcare (HHC) holds significance but remains elusive.
Methods: People aged≥65 years who newly received Taiwan's National Health Insurance funded HHC program from January 2005 to December 2013 were identified. Healthcare utilization, life-sustaining treatment, medication prescriptions (polypharmacy, psychotropics, anticholinergic burden and antibiotics), health status (Charlson's comorbidity index, CCI), and mortality were assessed over a 10-year period spanning 5 years before and after initiating HHC.
Results: Overall, 187,547 patients (80.6 ± 7.7 years, 51.2 % females, CCI 3+: 51.2 %) with a high prevalence of dementia (34.0 %), stroke (38.7 %), and pneumonia (49.5 %), and usage of life-sustaining treatment (urinary catheters: 82.8 % and nasogastric feeding: 78.7 %) were obtained. A sudden peak of admission rate at 1 year (91.7 %) before HHC, followed by the 70 % and 60 % admission rate in the first and second year after receiving HHC were found. Quarterly changes of using life-sustaining treatment showed significant increases from as early as 1 year prior to HHC. Gradual increases of polypharmacy, use of psychotropics, and antibiotic (4.5-fold and 3-fold) after HHC further demonstrated the complex needs (both $p < 0.01$). The 5-year cumulative mortality rate was 81 % (40 % in the first year with an annual rate of 25 %).
Interpretation: HHC recipients embody a confluence of complex care needs and high mortality risk, whereby various interventions aim to alleviate symptoms and sustain life. Engaging in proactive advanced care planning and end-of-life care should be prioritized when home healthcare is being contemplated.

* Corresponding author at: Center for Geriatrics and Gerontology, Taipei Veterans General Hospital, No. 201, Sec 2, Shih-Pai Road, Taipei 11217, Taiwan.
** Corresponding author at: Graduate Institute of Clinical Pharmacy, College of Medicine, National Taiwan University, Room 220, 33 Linsen S. Rd, Taipei 10050, Taiwan.
E-mail addresses: fyshsiao@ntu.edu.tw (F.-Y. Hsiao), lkchen2@vghtpe.gov.tw (L.-K. Chen).

https://doi.org/10.1016/j.tjfa.2025.100063
Received 17 April 2025; Received in revised form 9 June 2025; Accepted 10 June 2025

1. Introduction

The extended life expectancy and disability-adjusted life years in aging population have resulted in a greater demand for healthcare among older individuals, particularly those with functional limitations and chronic conditions [1–3]. Since multimorbidity and functional limitations in older adults commonly require specialized and extensive care [4], comprehensive care that encompasses personal, medical, nursing, and social needs is necessary for these older individuals with severe disabilities to prevent unfavorable clinical outcomes and alleviate stressors. Despite the availability of nursing home care, home and community-based care is preferable due to its superior quality, social connectedness, reduced costs, and other benefits [5]. Therefore, home healthcare (HHC) services, defined as care provided by professionals to a person at their own home, have been the primary service providers for older individuals with severe disabilities, catering to their complex health and social care needs [6,7].

Despite previous studies support the lower mortality and spending among older individuals with complete home health referrals, the effectiveness of HHC in reducing readmissions after acute care hospitalization remains inconclusive [8,9], indicating a need for HHC programs to prioritize strategies aimed at enhancing their effectiveness [10]. Furthermore, the persistently high rates of hospitalization and mortality among these patients indicate the ongoing challenges posed by their poor health status [11]. These findings suggest that while HHC may be a viable option for older individuals with severe disabilities, there is an urgent need for optimized and advanced care plans to improve their clinical outcomes and alleviate the heavy burden of healthcare utilization. In addition, due to the limited life expectancy among older individuals with severe dependence, the inclusion of palliative care in HHC becomes a critical issue that warrants further discussion.

Gaining insights into healthcare utilization changes among patients receiving HHC might be the first step for developing an advanced care plan aimed at improving clinical outcomes and reducing the burden. However, there is a paucity of studies with longitudinal data specifically examining the changes in healthcare resource utilization among older people receiving HHC, particularly prior to and following its initiation. An in-depth analysis of healthcare resource utilization among older adults receiving HHC, especially the life-sustaining treatment and intensive care utilization, provides valuable insights into the current healthcare plan, resource consumption, and areas in need of improvement. Through a thorough understanding of the utilization patterns, we are able to develop effective advanced healthcare plans that optimize resource utilization and enhance patient outcomes.

Furthermore, a multitude of studies consistently demonstrate the heightened risk of adverse clinical events associated with polypharmacy, psychotropic agents, and anticholinergic burden in older adults. Given the complex nature of their severe medical conditions and medication regimens, it is imperative to comprehensively acquire a medication utilization patterns and their changes throughout the course of HHC among this population. Additionally, older individuals with severe disabilities are particularly vulnerable to infections and related adverse outcomes due to compromised immune systems, reduced physiological reserves, and the impact of comorbidities. The utilization of antibiotics among older people receiving HHC, a highly susceptible population, warrants significant attention and thorough discussion.

Despite the prevalence of HHC in older adults with disabilities and their potential benefits, knowledge gaps persist regarding their health condition progression, healthcare utilization patterns, life-sustaining treatment utilization, medication prescriptions, and clinical outcomes, creating challenges for care quality improvement and healthcare system optimization. The present investigation endeavors to redress this void through an analysis of the inherent course of action of homebound older persons with disabilities prior to and post receipt of HHC provisions, utilizing an all-encompassing dataset representative of the nation and encompassing all the aforementioned constituents.

2. Methods

2.1. Data source

This population-based retrospective longitudinal study used Taiwan's National Health Insurance (NHI) data and analyzed the period between January 1, 2001, and December 31, 2018. The database was described in detail in **Supplement 1**. Mortality data obtained from the National Death Registry in Taiwan were used to estimate all-cause and cause-specific mortality [12].

2.2. Study population

We identified beneficiaries ≥ 65 years who newly received NHI-financed HHC between 2005 and 2013, defined operationally as at least one outpatient visits with the case type code in 61, A1 (HHC providing in the homes), 66, 67, A6 or A7 (HHC providing in the long-term care facilities). The information of NHI-financed HHC was described in **Supplement 2**. The study defined incident cases as those individuals who lacked prior documentation of HHC for a span of three years preceding the index date, yet were recognized as having availed of such services for the initial time throughout the study phase, in consonance with the aforesaid standards. All eligible patients were followed from the index date until: 1) death, 2) the end of 5-year follow-up, whichever came first. To evaluate the temporal variations in coexisting healthcare utilization, medication prescriptions, and clinical outcomes among individuals receiving HHC, we extracted information from the 5-year period before (baseline) and 5 years after the initial date of service reception, resulting in a 10-year observational timeframe. Baseline characteristics of each case comprised age, sex, comorbidities, Charlson's Comorbidity Index (CCI) as general health indicator, admission within 1 year before HHC. Valid comorbidities were determined by diagnoses documented at least three times during outpatient visits or once upon admission, and their corresponding ICD-9-CM and ICD-10-CM codes are listed in **Table S1**. Medication prescriptions, such as antibiotics, polypharmacy, and anticholinergic burden were also collected within 90 days before HHC.

3. Measures

3.1. Healthcare utilization

Over a 10-year period (5 years prior and post-index date), healthcare utilization data was extracted among patients receiving HHC, including outpatient visits, emergency department (ED) visits, and admissions. The utilization of life-sustaining treatment, which are aimed at supporting physiological functions, were evaluated on a quarterly basis. These treatments included noninvasive positive pressure ventilators, endotracheal intubation, tracheostomy, nasogastric tube feeding, urinary catheter, central venous catheter, total parenteral nutrition, dialysis, extracorporeal membrane oxygenation, cardiopulmonary resuscitation, and inotropic agents.

3.2. Medication prescriptions

Changes in medication prescription, including polypharmacy, psychotropic medications, anticholinergics, and antibiotics were analyzed with quarterly measurements over a 10-year period from 5 years before the index date to 5 years after. Comprehensive information and the operational definition pertaining to medication prescriptions in detail can be found in **Supplement 3**.

3.3. Clinical outcomes

We investigated dynamic changes in the CCI as a measure of overall health status 5 years prior to and after the start of HHC [13]. To gain

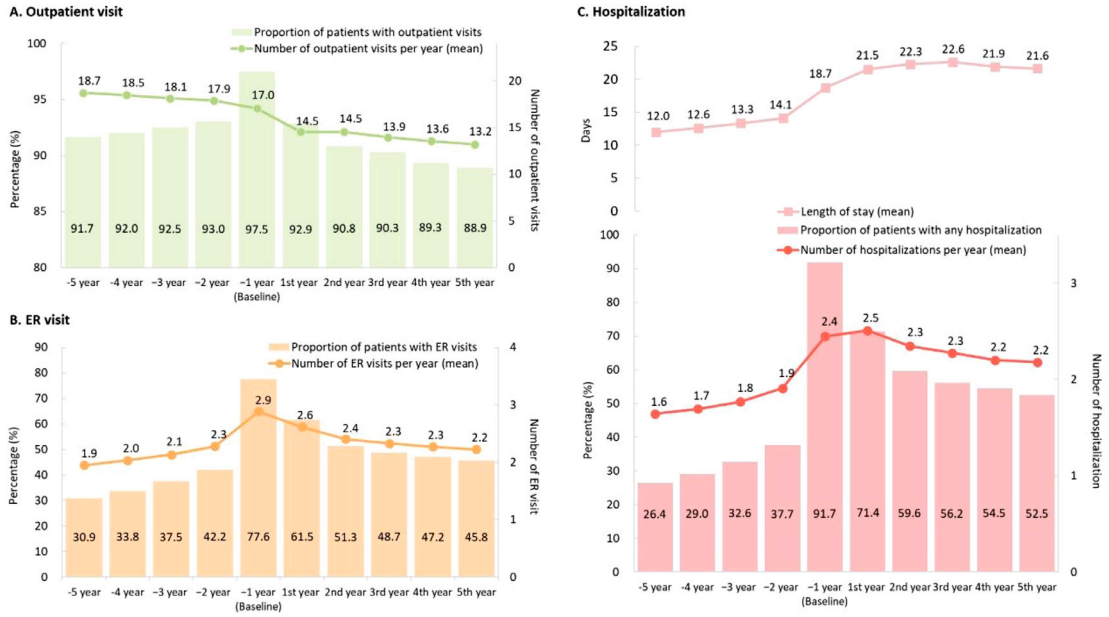

Fig. 1. Annual Healthcare utilization among patients newly receiving home healthcare services over a 10-year time frame before and after initiation of services. A. Outpatient visit; B. Emergency room (ER) visit; C. Hospitalization.

deeper insight into their health status, 22 commonly reported diseases among older people were also analysed and displayed using normalized heat maps to represent the data. In addition, all-cause and cause-specific mortality were examined within one to five years after the index date. Kaplan-Meier survival curves were plotted to evaluate all-cause mortality, while cause-specific mortality for various diseases, including cardiovascular disease, stroke, respiratory disease, pneumonia, infectious disease, and cancer, were reported with their corresponding ICD-9/-10-CM codes in Table S2.

3.4. Statistical analysis

In this study, descriptive analyses were conducted using the commercial software (SAS version 9.4, SAS Institute Inc. of Cary, NC, USA) and Joinpoint Trend Analysis software version 4.6.0.0 (National Cancer Institute, Bethesda, MD, USA). Baseline characteristics of the study population were presented as numbers and frequencies (in percentage) for categorical data and mean and standard deviation for continuous data. $\chi 2$ test and Joinpoint Trend Analysis were used to examine significant changes in the healthcare utilization and medication prescriptions over 10-year time frame. Significance was considered at the confidence level of alpha (a)=0.05. Kaplan-Meier survival curves of all-cause mortality were plotted using the life table method, which is implemented in the SAS LIFETEST procedure.

4. Results

4.1. Characteristics of people newly receiving HHC

We assessed the attributes and medical resource utilization of 187,547 older people who received NHI-financed HHC in Taiwan from 2005 to 2013, analyzing information from both pre- and post-index dates over a period of 10 years to observe variations over time. **Table S3** presents the baseline characteristics of the study population, revealing a mean age of 80.6 ± 7.7 years at the index date, a slight majority of 51.2 % women, and a high prevalence (51 %) of a CCI of 3 or more, reflecting a poor health condition. A significant portion of identified cases had dementia (34.0 %), fracture (21.5 %), stroke (38.7 %), and pneumonia (49.5 %) at baseline, which are common indications for receiving HHC. The prevalence of cardiometabolic comorbidities including hypertension (66.4 %), diabetes mellitus (38.0 %), ischemic heart disease (20.1 %), and heart failure (16.0 %) was also high. Moreover, frequently observed life-sustaining treatment, such as urinary catheterization (82.8 %) and nasogastric tube feeding (78.7 %), were prevalent. The majority of individuals had a history of hospitalization (91.8 %) and intensive care unit admission (45.5 %) at baseline, and a high percentage had received antibiotics (83.1 %) and intravenous antibiotics (72.3 %) within the 90 days prior to initiating HHC. In addition, the prevalence of polypharmacy (36.5 %) and excessive polypharmacy (41.9 %) at baseline was considerable.

4.2. Healthcare utilization

In contrast to pre-services healthcare utilization, individuals required fewer outpatient visits compared to the pre-services period, with the annual visits decreasing from 18.7 visits at five years prior to 13.2 visits at year 5 after HHC ($p < 0.01$) (Fig. 1A). However, individuals were more likely to require ED visits ($p < 0.01$) and experience hospitalizations ($p < 0.01$) post-receiving HHC compare to pre-services healthcare utilization, with extended duration of stay (Fig. 1B and 1C). Furthermore, the proportion of patients with hospitalizations increased gradually in the five years before receiving HHC (from 26.4 % in −5 years to 37.7 % in −2 year, $p < 0.01$), followed by a sudden peak at −1 year (91.7 %). Approximately 70 % and 60 % of HHC recipients ever admitted in the first (71.4 %) and second year (59.6 %), with a subsequent plateau from the third to fifth year (ranging from 56.2 % at year 3 to 52.5 % at year 5) after receiving HHC. The duration of hospital stays gradually increased starting one year prior to receiving HHC, with a mean duration of 14.1 days at two years prior and 18.7 days at one year prior ($p < 0.01$), which peaked at 21.5 days at year 1 and then remained consistent from year 2 to year 5 ($p = 0.8$). Similar trends were found in ED visits over 10-year time frame.

The quarterly changes in utilization rates of life-sustaining treatment showed an evident increase from as early as 1 year prior to receiving services ($p < 0.01$), reaching a peak in the last quarter before or the first quarter after receiving services (Fig. 2**A and Table S4**). For instance, nasogastric tube feeding showed an obvious increased from 8.4 % at –Q4 to 77.0 % at Q1 ($p < 0.01$), and urinary catheterization increased from

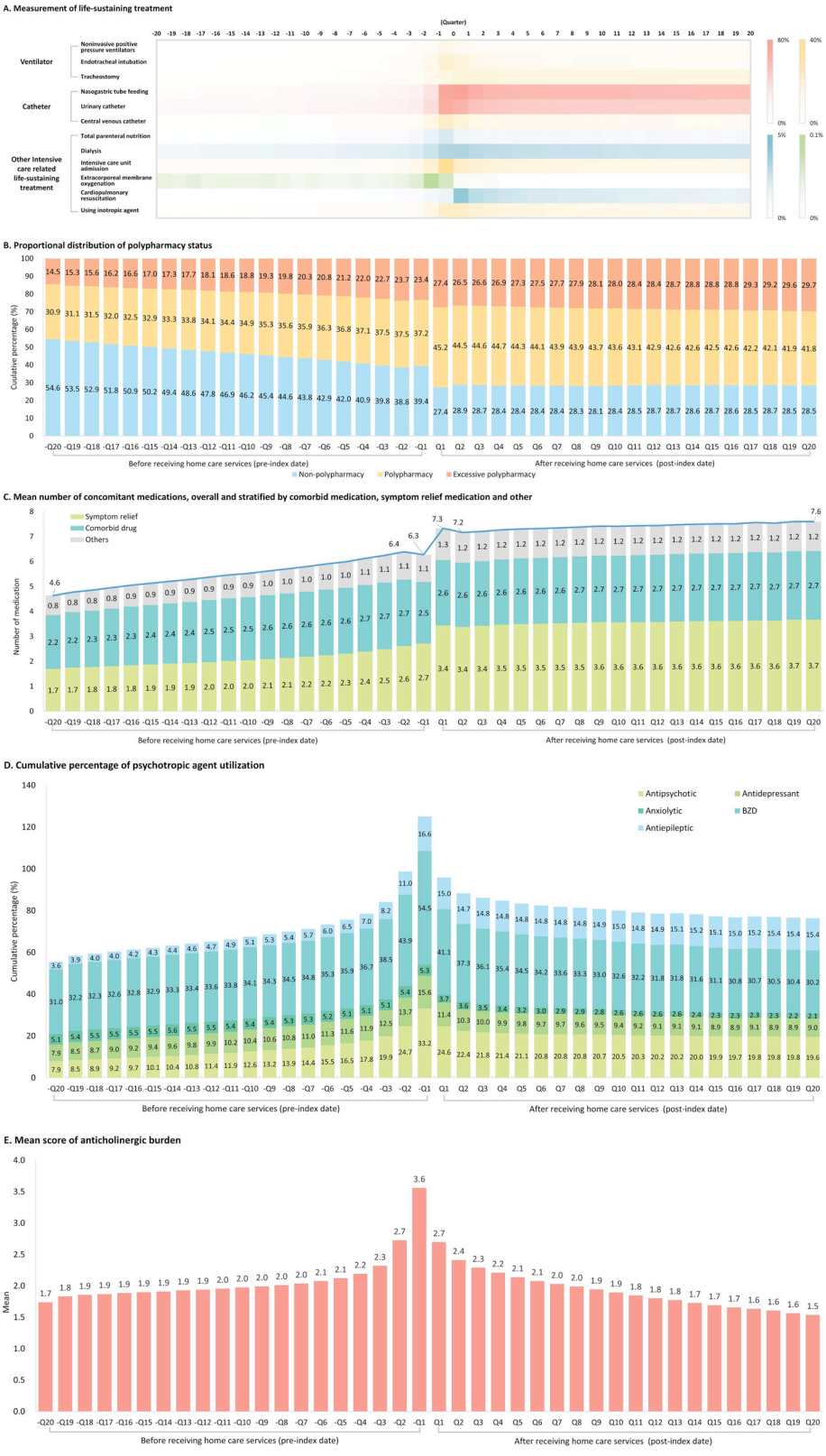

Fig. 2. Quarterly changes in life-sustaining treatment and medication prescriptions among patients newly receiving home healthcare services within 5 years preceding and afterwards. A. Measurement of life-sustaining treatment; Proportional distribution of polypharmacy status; B. Mean number of concomitant medications, overall and stratified by comorbid medication, symptom relief medication and other; C. Cumulative percentage of psychotropic agent utilization, including antipsychotic, antidepressant, anxiolytic, BZD, and antiepileptic; D. Mean score of anticholinergic burden.

12.1 % at –Q4 to 70.5 % at -Q1 ($p < 0.01$). Although the utilization rate of life-sustaining treatment gradually decreased after the first quarter of receiving services and stabilized after the fifth quarter ($p < 0.01$), the utilization rate was still higher (e.g. nasogastric tube: 54.2 % at Q20) compared to pre-service period.

4.3. Medication prescriptions

Over the 5 years leading up to the receipt of HHC, there was a gradual increase in both the prevalence of polypharmacy (polypharmacy: from 30.9 % at -Q20 to 37.2 % at –Q1, $p < 0.01$; excessive polyphar-

macy: from 14.5 % at -Q20 to 23.4 % at –Q1, $p < 0.01$) and the mean number of concomitant medications prescribed (from 4.6 medications at -Q20 to 6.3 medications at –Q1, $p < 0.01$), which both contributed from the increase in medication for symptom relief (from 1.7 medications at -Q20 to 2.7 medications at –Q1, $p < 0.01$), comorbidity (from 2.2 medications at -Q20 to 2.5 medications at –Q1, $p < 0.01$), and other medications (from 0.8 medications at -Q20 to 1.1 medications at –Q1, $p < 0.01$) (Fig. 2**B and** 2**C**). The increase was notably more pronounced at the first quarter following the receipt of HHC, with a polypharmacy prevalence of 45.2 %, an excessive polypharmacy prevalence of 27.4 %, and a mean number of 7.3 medications, subsequently remaining stable. The surge in polypharmacy at the first quarter was primarily driven by the augment in symptom relief medications (from 2.7 medications at -Q1 to 3.4 medications at Q1, $p < 0.01$) and other medications (from 1.1 medications at -Q1 to 1.3 medications at Q1, $p < 0.01$), compared to comorbid medications (from 2.5 medications at -Q1 to 2.6 medications at Q1). As per the Anatomical Therapeutic Chemical system, there was a similar trend observed in the utilization of all medication categories during study period (**Fig. S1**).

The utilization patterns of psychotropic medications exhibited a similar trend. However, the notable increase in psychotropic medication use following the initiation of HHC was primarily attributed to antipsychotics (from 7.9 % at -Q20 to 19.6 % at Q20, $p < 0.01$) and antiepileptics (from 3.6 % at -Q20 to 15.4 % at Q20, $p < 0.01$). At 5 years after receiving the HHC, approximately one in five (19.6 %) of HHC recipients were prescribed antipsychotics while one in seven (15.4 %) of HHC recipients were prescribed antiepileptics (Fig. 2**D**). Conversely, the utilization of anxiolytics decreased after receiving HHC, with a decline from 5.1 % at -Q20 to 2.1 % at Q20 ($p < 0.01$). Besides, the mean score of anticholinergic burden increased gradually during the year preceding the receipt of HHC (from 1.7 at -Q20 to 2.3 at -Q3, $p < 0.01$), peaking during the quarter just before service commencement (3.6 at -Q1). Nevertheless, following the initiation of services, there was a steady decrease in the anticholinergic burden score (from 2.7 at Q1 to 1.5 at Q20, $p < 0.01$) (Fig. 2**E**).

Regarding the utilization of antibiotics, the increase was most profound at the half-year period leading up to service commencement (from 35.5 % at -Q3 to 86.9 % at -Q1) (Fig. 3**A**). While there was a gradual decrease in antibiotic utilization at year 1 after receiving HHC, the rate remained high, approximately 2-fold compared to the pre-service period, throughout years 2 to 5 (22.6 at -Q20 and 43.7 at Q20, $p < 0.01$). Similarly, both the utilization of antibiotics during admission and the use of intravenous antibiotics reached a peak during the quarter prior to service initiation (77.6 % and 24.9 %, respectively), and experiencing approximately 4.5-fold and 3-fold increases, respectively, after 5 years of receiving HHC compared to the pre-service period (Fig. 3B and 3C).

4.4. Clinical outcomes

The Sankey plot demonstrated a gradual decline in general health status over a 10-year time frame, assessed by CCI, with a significant increase observed in the proportion of individuals with a CCI score of 5 or higher, rising from 19 % to 40 % prior to initiation of HHC (Fig. 4). The proportional distribution of CCI scores remaining stable after the initial year of HHC provision, with scores of 0 at approximately 1 %, 1 at 3–5 %, 2 at 7–11 %, 3 at 13–16 %, 4 at 17–18 %, and 5 or higher at 50–60 % (**Table S5**). Temporal changes in the prevalence rates of various morbidities, depicted using heat maps to present standardized data, were consistent with the findings observed in the CCI, indicating a decline in health status (**Figure S2, Table S6 and S7**). Higher prevalence rates of comorbidities among individuals were found after receiving HHC, particularly in Parkinson's disease, depression, anxiety, and dementia with increases of 45.7 %, 66.2 %, 47.5 %, and 49.7 %, respectively, compared to their corresponding baseline prevalence rates.

In addition, the 1-, 2-, 3-, 4-, and 5-year cumulative mortality rates were found to be 37.6 %, 54.5 %, 66.1 %, 74.4 %, and 80.7 %, respectively, as demonstrated by Fig. 5 **and Table S8**. Moreover, the highest annual mortality rate was observed in the first year (37.6 %), which remained relatively constant at around 25 % from the second to fifth years of follow-up, according to **Table S9**. Kaplan-Meier analysis indicated that the median survival time among patients who newly received HHC was 1.7 years, with interquartile range (IQR) of 0.52 to 4.1 years (**Figure S3**). Among all-cause deaths, cardiovascular disease, stroke, respiratory disease, pneumonia, infectious disease, and cancer accounted for 13 %, 15 %, 11 %, 13 %, 5 %, and 10 %, respectively, among individuals receiving HHC throughout the study period (Fig. 5).

5. Interpretation

To our best knowledge, this is the first study of national longitudinal data to ascertain long-term temporal trends in healthcare utilization, medication prescriptions, and clinical outcome among older adults receiving HHC. Compared to existing studies, our research offers several methodological advantages, including the use of highly representative national-level data with a large sample size of approximately 180,000 individuals, a long-term follow-up spanning 10 years, and an examination of both pre-service and post-service trends, providing a comprehensive understanding of the entire journey associated with the initiation of HHC. Therefore, this study offers a comprehensive and extended comprehension of healthcare utilization trends among HHC recipients, exceeding the ambit of prior publications.

This study's findings on the escalation of hospitalization and ED visits within a year before HHC align with previous research that showed an increase in hospitalization rates during the 9-month period before entering skilled nursing care [14]. A considerable rise in healthcare requirements was observed during the first year of HHC initiation in this study, particularly following significant events like dementia, stroke, myocardial infarction, fracture, and severe respiratory disease. Despite a significant decrease in outpatient visits following the initiation of HHC, which could be attributed to integrated physician monthly visits provided by HHC, limited access to services, or palliative interventions by caregivers, there was a persistent higher demand for hospitalizations and ED visits compared to the pre-service period, continuing throughout the 5-year observation period after receiving HHC. Moreover, our study demonstrated that the extremely poor health status (CCI 5+: 50–60 %) with high demand for life-sustaining treatment among identified cases remained prevalent and unimproved after initiation of HHC, with a notable increase in mortality risk within the first year (approximately 40 %) and consistently high annual mortality rates (around 25 %) among individuals receiving HHC. Despite receiving more healthcare resources under HHC compared to the general older population, the cumulative 5-year mortality rate among this population was approximately 80 %, with half of the deaths being ascribed to pre-existing comorbidities such as cancer, cardiovascular disease, respiratory disease, and stroke. Our study contributes to the existing literature by demonstrating consistent unwellness and mortality findings among HHC recipients across various developed countries, despite differences in ethnicity, study design, and entry criteria,[14–17] with the added strength of a longer follow-up period.

Besides, medication utilization analysis showed an increase in prescribed drugs and prevalence of polypharmacy from five years before receiving HHC to the first quarter after using HHC. Our findings are consistent with a previous analysis conducted in six European countries, which revealed that 39 % of HHC patients had polypharmacy, and 23.1 % had excessive polypharmacy [18]. Polypharmacy and advancing age were identified as the most prevalent risk factors for drug-related problems in home care [19,20], which may increase the risk of clinical adverse outcome [21]. Given the elevated mortality risk and the prevalence of inappropriate medication use among individuals receiving HHC, conducting a comprehensive system-level medication review and engaging professional pharmacists in deprescribing efforts are es-

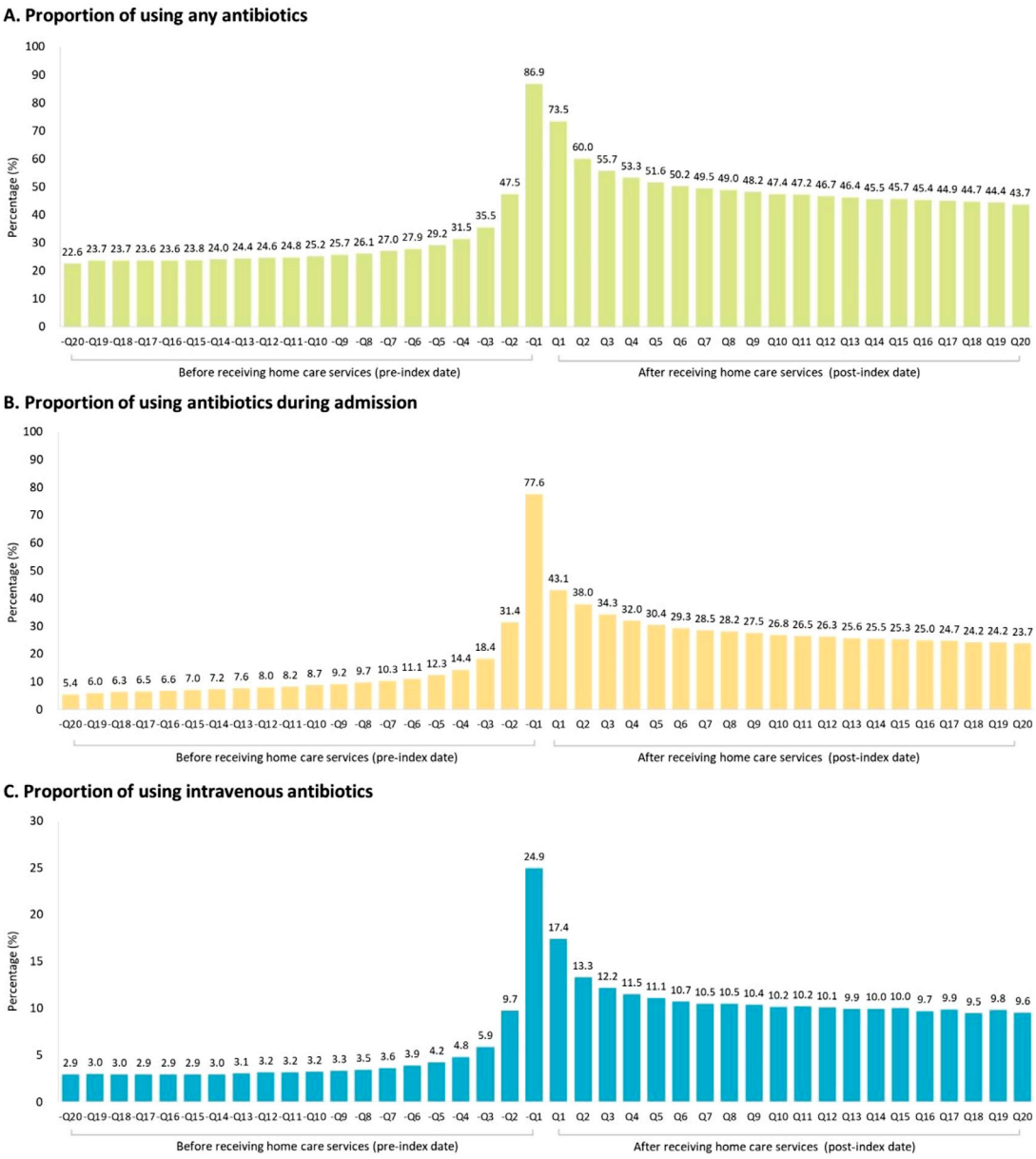

Fig. 3. Quarterly changes in antibiotics prescription among patients newly receiving home healthcare services within 5 years preceding and afterwards. A. Proportion of using any antibiotics; B. Proportion of using antibiotics during admission; C. Proportion of using intravenous antibiotics.

sential to improve their quality of life and enhance the overall service quality [22].

As far as our knowledge, this is the first study to dissect the main factors contributing to polypharmacy and investigate specific medication issues, including psychotropic medication and anticholinergic use. An interesting finding regarding the increase in polypharmacy after initiation of HHC was primarily driven by the augmentation in symptom relief medications rather than comorbid medications. A similar finding in our study is that the post-initiation increases in psychotropic medication use among individuals receiving HHC was mainly driven by the prescription of antipsychotics and antiepileptics, often prescribed to manage behavioral and psychological symptoms and provide pain control, respectively, for older individuals with severe disabilities [23,24]. These findings may be attributed to the need to address the complex and diverse symptoms/signs that arise during the care process or to provide palliative interventions by caregivers.

All of above findings highlight the unmet medical needs and unfavorable clinical prognosis among older individuals receiving HHC and emphasize the urgency of implementing early initiation of advanced care planning and end-of-life care, tailored specifically to the unique needs of HHC recipients. The implementation of value-based payment methods may represent a potential solution to improve these conditions [25]. Moreover, the thorough assessment of healthcare utilization, medication prescriptions and life-sustaining treatment utilization among HHC beneficiaries in this study can potentially prompt family members, healthcare providers, and policy-makers to reevaluate their care objectives and service configurations, with the aim of improving the autonomy, dignity, and overall well-being of HHC beneficiaries. Moreover, the current study underscores the criticality of integrating end-of-life care into HHC, particularly for patients afflicted with non-cancerous comorbidities such as dementia and advanced cardiovascular disease [26]. Although palliative care for non-cancerous comorbidities in HHC is commonplace, there remains ample opportunity for enhancement, signifying the necessity for specialized palliative care training for multidisciplinary teams [27,28].

Another notable finding in this study is the utilization of antibiotics. While infectious diseases may not directly cause disabilities requiring

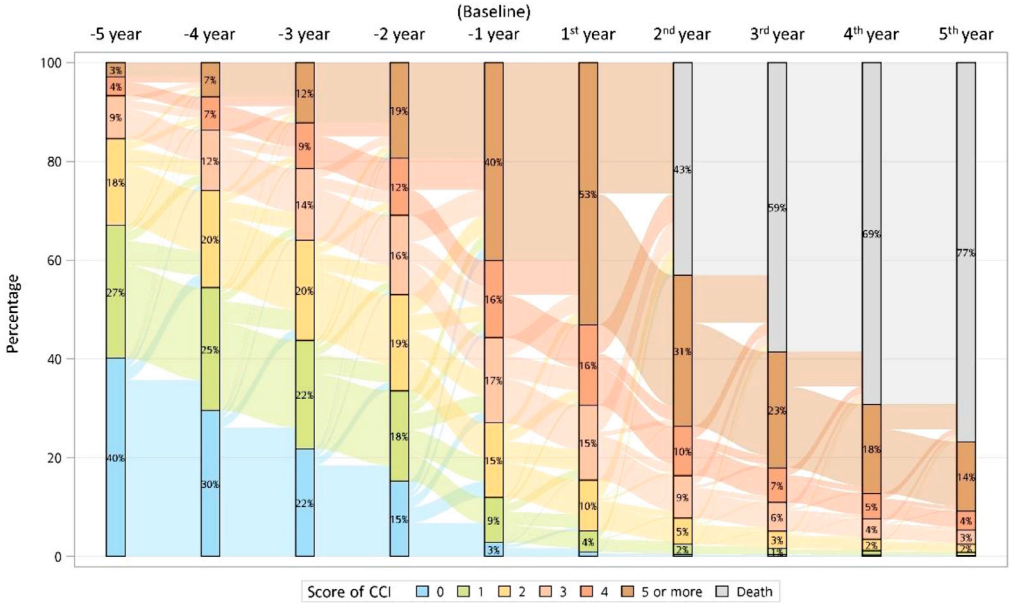

Fig. 4. Changes in Charlson Comorbidity Index distribution among surviving home healthcare recipients at each annual time point within 5 years preceding and following HHC initiation.

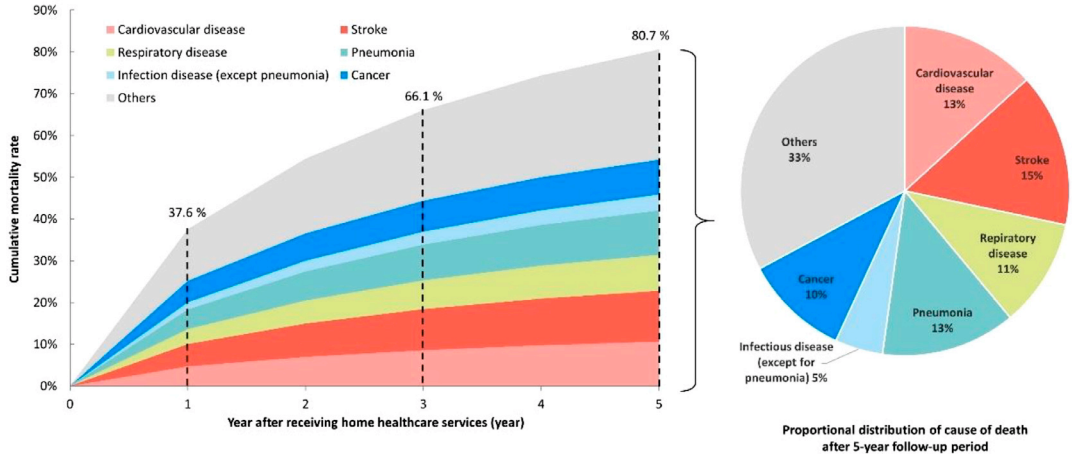

Fig. 5. Overall and cause-specific mortality rates for 5 years after receiving home healthcare services.

HHC, the high prevalence of antibiotic use suggests a possible link between repeated infection episodes and increased functional dependence among older adults. Older individuals, particularly those with disabilities, are well-established to be highly susceptible to infections and their related complications [29,30]. This vulnerability can be attributed to various factors, including the presence of atypical symptoms, the coexistence of multiple chronic conditions, the manifestation of geriatric syndromes, and functional limitations [29–31]. Conversely, infectious diseases in older individuals can also exacerbate existing comorbidities and contribute to a further decline in their frailty status [32]. In our study, we found a notable surge in antibiotic utilization (86.9 %) during the quarter preceding the initiation of HHC services, indicating a potential co-occurrence of infection alongside significant events. Furthermore, the sustained demand for antibiotics throughout the post-service period, approximately doubling compared to the pre-service period, highlights the heightened susceptibility to infections among these individuals and suggests a potential impact on the worsening clinical outcomes. Hence, given the significant interdependency between infections, immunity, and frailty, it is imperative to prioritize effective management of infectious diseases and implement preventive measures for older individuals receiving HHC services.

Despite the extensive efforts of our research, it is essential to acknowledge the several limitations that warrant consideration. Firstly, due to the observational nature of the study, the potential to investigate whether tailored interventions could enhance the clinical outcomes or quality of life for HHC recipients was limited. Secondly, while all individuals eligible for HHC are also eligible for nursing home care, the inclination towards home healthcare preferences was not probed within the NHI reimbursement data. Additionally, our comorbidity analysis focused on specific disease-based ICD codes rather than ICD-10 R00–99 symptom-based diagnoses that capture geriatric syndromes such as frailty, potentially missing important information about changes in these syndromes before and after HHC initiation. However, we did not specifically examine these geriatric syndromes due to the low sensitivity of Taiwan's NHIRD for recording ICD-10 R00–99 codes, as healthcare providers preferentially use disease-specific codes for reimbursement purposes, leading to systematic under-recording of geriatric syndromes. Lastly, although family caregivers tend to adopt a more palliative care approach when caring for these patients, it cannot be confirmed whether the reduced healthcare utilization is due to the palliative care approach or limited accessibility to healthcare services. Despite the study's limitations, it offers distinctive insights into the natural progression of older

adults towards severe disabilities and the subsequent utilization of HHC. Specifically, the study's data sheds light on mortality trends, healthcare utilization, medication usage, and life-supporting services, thus providing valuable insights into enhancing the quality of HHC while preserving the autonomy and dignity of disabled older individuals who are confined to their homes. At the very least, given the heightened mortality risk within the initial year of receiving HHC subsequent to catastrophic medical conditions, it is imperative to initiate advanced care planning upon entering these services to ensure that older individuals with severe disabilities attain an optimal quality of life.

6. Conclusions

Upon entering HHC services, older individuals with catastrophic medical conditions often exhibit a notable escalation in healthcare utilization prior to the event, which tends to peak after service initiation before gradually diminishing. Nevertheless, mortality rates remain alarmingly high, with approximately 40 % of HHC recipients succumbing to their medical conditions within the first year, and an annual mortality risk of 25 %. Moreover, the employment of antibiotic use and polypharmacy continues to proliferate, with an emphasis on prescription of symptom-relief agents to address the intricate and multifaceted symptoms/signs encountered throughout the care process. Given these challenges, further research is warranted to facilitate the systematic implementation of palliative-focused care models through advanced care planning, with emphasis on appropriate medication management and infection prevention strategies tailored to the complex medical needs and poor prognosis of home healthcare recipients.

Ethical statement

The identification numbers for all entries in the NHI data were encrypted to protect the privacy of individual patients. The study protocol was approved by the Institutional Review Board of the National Taiwan University Hospital (No. 201803134RINC).

Authors' relationships and activities

All authors have declared: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Data sharing

Due to privacy issues of data and the data protection policy from the Health and Welfare Data Science Center, Ministry of Health and Welfare, Taiwan, it is not available to the community via open repository.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests

CRediT authorship contribution statement

Shih-Tsung Huang: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis. **Fei-Yuan Hsiao:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology. **Wei-Ju Lee:** Methodology. **Ming-Yueh Chou:** Methodology. **Chih-Kuang Liang:** Methodology. **Chu-Sheng Lin:** Methodology. **Ching-Hui Loh:** Methodology. **Liang-Kung Chen:** Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Investigation, Funding acquisition, Conceptualization.

Acknowledgments

The authors thank the Ministry of Science and Technology, Taiwan (MOST 110–2634-F-010–001), National Science and Technology Council, Taiwan (NSTC 113–2321-B-A49–028-) for the funding of this project, the Health and Welfare Data Science Center, Ministry of Health and Welfare, Taiwan for making available the databases for this study, and the Interdisciplinary Research Center for Healthy Longevity of National Yang Ming Chiao Tung University from The Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan for supporting the research work. The content of this article, however, in no way represents any official position of the Health and Welfare Data Science Center. The author had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tjfa.2025.100063.

References

[1] Economic UNDo, Affairs S. World population ageing 2019: UN, 2020.
[2] Abdi S, Spann A, Borilovic J, de Witte L, Hawley M. Understanding the care and support needs of older people: a scoping review and categorisation using the WHO international classification of functioning, disability and health framework (ICF). BMC Geriatr 2019;19(1):195 In eng. doi:10.1186/s12877-019-1189-9.
[3] Freedman VA, Kasper JD. Cohort Profile: the National Health and Aging Trends Study (NHATS). Int J Epidemiol 2019;48(4):1044–1045g In eng. doi:10.1093/ije/dyz109.
[4] Meng LC, Huang ST, Chen HM, Hashmi AZ, Hsiao FY, Chen LK. Health care utilization and potentially preventable adverse outcomes of high-need, high-cost middle-aged and older adults: needs for integrated care models with life-course approach. Arch Gerontol Geriatr 2023;109:104956 In eng. doi:10.1016/j.archger.2023.104956.
[5] Chen L-K. Meeting growing demands and service gaps of home health care for older adults with disabilities. Elsevier; 2023.
[6] Murkofsky RL, Alston K. The past, present, and future of skilled home health agency care. Clin Geriatr Med 2009;25(1):1–17 v. (In eng). doi:10.1016/j.cger.2008.11.006.
[7] Thomé B, Dykes AK, Hallberg IR. Home care with regard to definition, care recipients, content and outcome: systematic literature review. J Clin Nurs 2003;12(6):860–72 In eng. doi:10.1046/j.1365-2702.2003.00803.x.
[8] Demiralp B, Speelman JS, Cook CM, et al. Incomplete home health care referral after hospitalization among Medicare beneficiaries. J Am Med Dir Assoc 2021;22(5):1022–1028.e1 In eng. doi:10.1016/j.jamda.2020.11.039.
[9] Werner RM, Coe NB, Qi M, Konetzka RT. Patient outcomes after hospital discharge to home with home health care vs to a skilled nursing facility. JAMA Intern Med 2019;179(5):617–23 In eng. doi:10.1001/jamainternmed.2018.7998.
[10] Siclovan DM, Bang JT, Yakusheva O, et al. Effectiveness of home health care in reducing return to hospital: evidence from a multi-hospital study in the US. Int J Nurs Stud 2021;119:103946 In eng. doi:10.1016/j.ijnurstu.2021.103946.
[11] Courtright KR, Jordan L, Murtaugh CM, et al. Risk factors for long-term mortality and patterns of end-of-life care among Medicare sepsis survivors discharged to home health care. JAMA Netw Open 2020;3(2):e200038 In eng. doi:10.1001/jamanetworkopen.2020.0038.
[12] Lu TH, Lee MC, Chou MC. Accuracy of cause-of-death coding in Taiwan: types of miscoding and effects on mortality statistics. Int J Epidemiol 2000;29(2):336–43 In eng. doi:10.1093/ije/29.2.336.
[13] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40(5):373–83 In eng. doi:10.1016/0021-9681(87)90171-8.
[14] Reilev M, Lundby C, Jensen J, Larsen SP, Hoffmann H, Pottegård A. Morbidity and mortality among older people admitted to nursing home. Age Ageing 2019;49(1):67–73 In eng. doi:10.1093/ageing/afz136.
[15] Shah SM, Carey IM, Harris T, DeWilde S, Cook DG. Mortality in older care home residents in England and Wales. Age Ageing 2013;42(2):209–15 In eng. doi:10.1093/ageing/afs174.
[16] Vossius C, Selbæk G, Šaltytė Benth J, Bergh S. Mortality in nursing home residents: a longitudinal study over three years. PLoS One 2018;13(9):e0203480 In eng. doi:10.1371/journal.pone.0203480.
[17] Braggion M, Pellizzari M, Basso C, et al. Overall mortality and causes of death in newly admitted nursing home residents. Aging Clin Exp Res 2020;32(2):275–80 In eng. doi:10.1007/s40520-019-01441-x.
[18] Giovannini S, van der Roest HG, Carfì A, et al. Polypharmacy in home care in Europe: cross-sectional data from the IBenC study. Drugs Aging 2018;35(2):145–52 In eng. doi:10.1007/s40266-018-0521-y.

[19] Meyer-Massetti C, Meier CR, Guglielmo BJ. The scope of drug-related problems in the home care setting. Int J Clin Pharm 2018;40(2):325–34 In eng. doi:10.1007/s11096-017-0581-9.
[20] Wang J, Shen JY, Yu F, et al. Medications associated with geriatric syndromes (MAGS) and hospitalization risk in home health care patients. J Am Med Dir Assoc 2022;23(10):1627–1633.e3 In eng. doi:10.1016/j.jamda.2022.03.012.
[21] Romskaug R, Skovlund E, Straand J, et al. Effect of clinical geriatric assessments and collaborative medication reviews by geriatrician and Family physician for improving health-related quality of life in home-dwelling older patients receiving polypharmacy: a cluster randomized clinical trial. JAMA Intern Med 2020;180(2):181–9 In eng. doi:10.1001/jamainternmed.2019.5096.
[22] Garland CT, Guénette L, Kröger E, Carmichael PH, Rouleau R, Sirois C. A new care model reduces polypharmacy and potentially inappropriate medications in long-term care. J Am Med Dir Assoc 2021;22(1):141–7 In eng. doi:10.1016/j.jamda.2020.09.039.
[23] Ushkalova EA, Zyryanov SK, Butranova OI. Features of the choice and the use of antiepileptic drugs as analgesics in elderly. Adv Gerontol 2022;35(5):766–74 In eng.
[24] Bjerre LM, Farrell B, Hogel M, et al. Deprescribing antipsychotics for behavioural and psychological symptoms of dementia and insomnia: evidence-based clinical practice guideline. Can Fam Physician 2018;64(1):17–27 In eng.
[25] Landers S, Madigan E, Leff B, et al. The future of home health care: a strategic framework for optimizing value. Home Health Care Manag Pract 2016;28(4):262–78 In eng. doi:10.1177/1084822316666368.
[26] Connolly MJ, Broad JB, Boyd M, Kerse N, Gott M. Residential aged care: the de facto hospice for New Zealand's older people. Australas J Ageing 2014;33(2):114–20 In eng. doi:10.1111/ajag.12010.
[27] Hess S, Stiel S, Hofmann S, Klein C, Lindena G, Ostgathe C. Trends in specialized palliative care for non-cancer patients in Germany–data from the national hospice and palliative care evaluation (HOPE). Eur J Intern Med 2014;25(2):187–92 In eng. doi:10.1016/j.ejim.2013.11.012.
[28] Boyd M, Frey R, Balmer D, et al. End of life care for long-term care residents with dementia, chronic illness and cancer: prospective staff survey. BMC Geriatr 2019;19(1):137 In eng. doi:10.1186/s12877-019-1159-2.
[29] Beeson PB. Alleged susceptibility of the elderly to infection. Yale J Biol Med 1985;58(2):71–7 In eng.
[30] Gardner ID. The effect of aging on susceptibility to infection. Rev Infect Dis 1980;2(5):801–10 In eng. doi:10.1093/clinids/2.5.801.
[31] Schneider EL. Infectious diseases in the elderly. Ann Intern Med 1983;98(3):395–400 In eng. doi:10.7326/0003-4819-98-3-395.
[32] Davydow DS, Hough CL, Levine DA, Langa KM, Iwashyna TJ. Functional disability, cognitive impairment, and depression after hospitalization for pneumonia. Am J Med 2013;126(7) 615-24.e5. (In eng). doi:10.1016/j.amjmed.2012.12.006.