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Complete List of Authors:	González Ochoa, Jesús ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Garza-Silva, Arnulfo; Hospital Clínica Nova de Monterrey, Research Department González Peña, Omar; Hospital Infantil de Mexico Federico Gomez, Evidence-Based Medicine Research Unit; Universidad de Monterrey, Research and Development Directorate Romero-Ibarguengoitia, Maria Elena; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Fernández-Chau, Iván ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Villarreal Parra, Diana; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Torres Valerio, Nadia ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Sanz-Sánchez, Miguel ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Hughes García, Melissa; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences
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Cost Drivers and Feasibility of a Hospital-at-Home Program for Geriatric Care in Northeastern Mexico

Jesús S. González Ochoa[1,2], Arnulfo Garza-Silva MD[1], Omar I. González Peña PhD[1,3,4,5, *], María E. Romero-Ibargüengoitia PHD [1,2, *], Iván F. Fernández-Chau [1,2], Diana L. Villarreal Parra MD[1,2], Nadia D. Torres Valerio MD[1,2], Miguel Á. Sanz-Sánchez, MD[1,2], Melissa Hughes García MD[1,2].

[1] Research Department, Hospital Clínica Nova de Monterrey, Del Bosque Av. 139, San Nicolas, Nuevo León 66450, México.
[2] School of Medicine, Vice-Rectory of Health Sciences, Universidad de Monterrey, Ignacio Morones Prieto Ave. 4500 W, San Pedro Garza García, Nuevo León 66238, México.
[3] Evidence-Based Medicine Research Unit, Children's Hospital of Mexico Federico Gómez, National Institute of Health, Dr. Márquez 162, Col. Doctores, Del. Cuauhtémoc, Mexico City 06720, Mexico
[4] Research and Development Directorate, Vice-Rectory of Health Sciences, Universidad de Monterrey, Ignacio Morones Prieto Ave. 4500 W, San Pedro Garza Garcia, Nuevo León 66238, Mexico.
[5] Universidad Internacional de La Rioja (UNIR), Avenida de la Paz, 137, 26006 Logroño, La Rioja, Spain

* Corresponding author 1: María Elena Romero-Ibargüengoitia. Research and Education Department, Hospital Clínica Nova, Del Bosque Av. 139, San Nicolas, Nuevo León, México.
mromeroi@novaservicios.com.mx, +52 81 2102 9724.

*Corresponding author 2: Omar Israel González Peña. Evidence-Based Medicine Research Unit, Children's Hospital of Mexico Federico Gómez, National Institute of Health, Calle Dr. Marquez 162, Doctores, Mexico City, Mexico. ogonzalez.pena@gmail.com, +52 33 3489 0810.

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Brief summary:
The 'hospital at home' (HAH) concept is underused in Mexico, with its socioeconomic impact often overlooked. Its costs relate to procedure-related disorders and chronic medication use. HAH reduces hospital costs and hospitalization days.

Declaration of competing interest:

The authors declare that they have no conflicts of interest in the information presented.

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Author Contributions:

CRediT author statement	Authors´ Initials
Conceptualization	AG-S; OIGP; M.E.R-I
Methodology	AG-S; OIGP
Software	JSGO; AG-S;
Validation	AG-S; OIGP; M.E.R-I
Formal analysis	JSGO; AG-S; OIGP
Investigation	JSGO; AG-S; OIGP
Resources	M.E.R-I; DLVP; NDTV; MASS; MHG
Data Curation	JSGO; AG-S;
Writing - Original Draft	JSGO; AG-S; OIGP
Writing - Review & Editing	JSGO; AG-S; OIGP I.F.F-C
Visualization	JSGO; AG-S; OIGP
Supervision	M.E.R-I;
Project administration	M.E.R-I; OIGP
Funding acquisition	M.E.R-I; MASS; MHG

Ethics statement:
This study was carried out with human participants whose protocol was reviewed and approved with an ID reference number CI.- Ref.:12012023-CN-GER-CI by the Research and Ethics Committees respectively of Hospital Clínica Nova, in San Nicolas, Nuevo Leon, Mexico. The patients who agreed to participate in the study signed an informed consent letter.

Impact statement:

We certify that this work is A) novel.

The authors declare that our study is a novel original research to the extent that it contributes new knowledge to the literature in the following points.

Highlights of the novelty of this study:

1. **Comprehensive Economic Evaluation of HAH Programs in Latin America:**
   - Unlike previous studies primarily conducted in the US, Europe, and Australia, our research provides the first detailed cost analysis of a Hospital-at-Home (HAH) program in Northeastern Mexico. This addresses a significant gap in the literature concerning the economic feasibility and impact of HAH in Latin American contexts.
2. **Identification of Specific Cost Drivers in Geriatric HAH Care:**
   - Previous studies have not thoroughly explored the specific factors driving costs in HAH programs for the elderly. Our study uniquely identifies medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants as the primary cost

drivers, providing novel insights that can inform cost management strategies in similar settings.

3. **Cost-Effectiveness Compared to Traditional Hospitalization:**
   - While it is known that HAH programs can reduce healthcare costs, our study is the first to quantify these savings in a Mexican healthcare setting, demonstrating that HAH programs are three times more cost-effective than traditional hospital care. This significant finding supports the economic viability of HAH and encourages its adoption in regions with similar healthcare structures.
4. **Focus on a Broad Range of Diagnoses:**
   - Existing research often limits its scope to specific diseases treated under HAH programs. Our study broadens this perspective by analyzing the impact of HAH on a wide range of geriatric conditions, offering a more comprehensive understanding of its benefits and challenges across diverse medical scenarios.
5. **Policy and Implementation Insights:**
   - The study provides actionable recommendations for the implementation and scaling of HAH programs in developing countries. By addressing logistical, training, and integration challenges, our research fills a critical gap in the literature, offering a roadmap for policymakers and healthcare providers to optimize HAH services effectively.

Key Points:

- Pioneering Cost Analysis: This study provides the first in-depth economic evaluation of a Hospital-at-Home (HAH) program in Northeastern Mexico, highlighting its feasibility and cost-effectiveness.
- Identification of Cost Drivers: The research uniquely identifies key cost drivers, such as medical care-related disorders and specific medications, offering actionable insights for cost management in geriatric HAH care.
- Significant Cost Savings: This study demonstrates that HAH programs are three times more cost-effective than traditional hospital care, supporting the broader adoption of HAH models in similar healthcare settings.

Why does this paper matter?

This paper addresses a critical gap in the literature by providing a comprehensive economic evaluation of a Hospital-at-Home (HAH) program in a Latin American context, specifically Northeastern Mexico. Previous studies on HAH programs have primarily been conducted in high-income countries, leaving a void in understanding their feasibility and cost-effectiveness in developing regions. By identifying the specific cost drivers in geriatric HAH care, this research offers valuable insights for healthcare providers and policymakers aiming to optimize resource allocation and improve care delivery for the elderly. The findings demonstrate that HAH programs can significantly reduce healthcare costs while maintaining high-quality care, thus presenting a financially viable alternative to traditional hospital care. This study's recommendations for the implementation and scaling of HAH programs can guide similar initiatives in other developing regions, contributing to more efficient and effective healthcare systems globally.

Cost Drivers and Feasibility of a Hospital-at-Home Program for Geriatric Care in Northeastern Mexico

ABSTRACT

Introduction: Although the "hospital at home" (HAH) concept is gaining importance globally, it remains underadopted in Latin America, particularly in Mexico, where its socioeconomic impact is widely overlooked. This study evaluates the factors influencing the costs of an HAH program for geriatric patients in a Northeastern Mexican hospital and evaluates its cost-effectiveness compared to traditional hospital care. **Methodology:** This retrospective analysis examined the costs incurred by geriatric patients in an HAH program from February to December 2022. We collected data from clinical records and assessed medication and procedure costs through the hospital's financial department. Costs for traditionally hospitalized patients were reviewed for comparison. Statistical analysis included data normalization, Mann-Whitney-U tests for univariate analysis, and linear regression to identify factors driving cost increases in the HAH program. **Results:** We examined the expenses associated with 416 home visits to 49 patients in the HAH program. We found that the main factors influencing the program's overall cost were medical care and procedure-related disorders (β=0.333, p=0.002), sleep-regulators (β=0.561, p<0.001), laxatives (β=0.330, p=0.001), and anticoagulants (β=0.228, p=0.025). The HAH program's per capita cost was three times lower compared to that of traditional hospital care and resulted in a 40% reduction in hospitalization days. **Discussion:** This study highlights that the main factors influencing the HAH program's costs include medical care and procedure-related disorders, as well as medication extensively used in the elderly population. Additionally, we demonstrated the cost-effectiveness of the HAH program, which produces substantial savings and is a financially viable alternative to traditional hospital care.

1. INTRODUCTION

The concept of "hospital at home" (HAH) was pioneered at John Hopkins University Schools of Medicine and Public Health in the US in 1995. [1] It refers to a patient care model that provides necessary services directly in the individual's home rather than through hospital admission.[2] This type of program has focused on managing acute conditions such as pneumonia, cellulitis, and urinary tract infection (UTI), as well as exacerbations of chronic degenerative diseases such as chronic obstructive pulmonary disease (COPD) and heart failure. [3] This model addresses the challenge posed by the growing number of people needing medical care, surpassing hospitals' capacity to provide sufficient beds, especially during medical emergencies. Additionally, the aim is to avoid potential adverse effects associated with hospital care, such as functional decline, delirium, and iatrogenic diseases, among others. [2]

Spain and Australia have long practiced treating acute-care patients in their own residences. Other countries with publicly funded healthcare systems, such as England, Canada, and Israel, also have established home-hospital models. [1] The rising cost of hospital care, which accounts for approximately one-third of total medical expenditure in the US and results in considerable patient debt, [4] poses the question of whether these alternative models are more cost-effective. Previous studies have suggested that HAH models can contribute to cost reduction without compromising the quality of care, [5–13] but only a few have addressed the relationship between factors influencing HAH program costs and comparative budgets between traditional hospitalization and HAH. [4]

Research has been conducted on the feasibility of implementing an HAH program to reduce hospital costs, but there are still unexplored aspects that require attention. Specifically, there is a lack of knowledge about which diagnoses treated in an HAH program may generate higher expenses and affect hospital economics. Likewise, the trend of studies addressing HAH programs focuses on the care of specific and isolated diseases. [14–20] Therefore, it is worth

conducting a study that explains the impact of HAH on economic outcomes in relation to a broad group of conditions.

This study seeks to answer the following research question: What are the key factors influencing the costs of an HAH program for geriatric patients, and how does the cost-effectiveness of this program compare to traditional hospital care in a Northeastern Mexican hospital? We hypothesize that (1) the costs associated with the HAH program is significantly influenced by specific diagnoses and medications, commonly present in geriatric care and that (2) the HAH program is more cost-effective than traditional hospital care, resulting in substantial cost savings while maintaining quality of care.

2. METHODOLOGY

This is a retrospective analytic study focused on the expenses related to geriatric patients visited by an HAH geriatric program between February 2022 and December 2022. The research adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines, [21] and received approval from the local Institutional Review Board (IRB number: 18082023-HCN-INFT1-CI). As the study is retrospective, informed consent was not applicable.

The inclusion criteria encompassed individuals of both genders aged over 70 who received visits from the HAH program throughout 2022 and had updated clinical records and reported costs generated by the program as of the study date. Patients who needed intensive care unit (ICU) care throughout the follow-up or died during the study were excluded. No probabilistic sampling was conducted. Data selection relied on the visits made by the HAH program within the included year.

We examined the expenses associated with a total of 416 home visits made to 49 patients aged over 70 years of age enrolled in the HAH program during 2022. Data was gathered from the patients' clinical records, and the cost of medication and procedures was assessed by the hospital's financial and technological departments. Monetary values were converted from Mexican pesos to US dollars using an exchange rate of 1 dollar to 19.4143, as revised in the Bank of Mexico on the day of the last visit conducted by the HAH program (December 28th, 2022). This conversion is reflected throughout this research. [22]

The variables involved in this research were divided into three groups: demographic variables, those related to patients' medical procedures and treatments, and those related to patients' diagnoses. For the first group, variables include gender, age, retired work status, number of days admitted to the hospital through the follow-up, and number of days taken care of with the HAH program. The second group was composed of variables like medications, laboratory studies, provided service and procedure materials were included while the second group was composed of different diagnoses. The second group included the following variables: use of laboratory services, antibiotics, wound care materials, anticoagulants, neuropsychiatric drugs, antacids, sleep regulators, geriatric consult, antifungals, procedure materials, IV fluids, dietary supplements, ointments, antihypertensives, analgesics, corticosteroids, hypoglycemic agents, antispasmodics, antiemetics, diuretics, cardiac drugs, statins, probiotics, dental medications, bronchodilators, mucolytics, nasal sprays, laxatives, thyroid hormone replacement therapy, antidiarrheals, antihistamines, and hepatoprotective supplements. The aforementioned variables were assessed in a dichotomic manner. The grouping of the variables is shown in Table 1 from the supplemental material documents.

A total of 71 diagnoses were found, which then were categorized into different groups, including infectious disorders, cancer, muscular system disorders, digestive system disorders, urinary system disorders, neurogeriatric disorders, cardiometabolic disorders, pulmonary system disorders, general health disorders, and disorders related to medical care and procedures. Each diagnostic group was developed considering the characteristics of each diagnosis and implications regarding treatment, as well as the specific system of the human body which was affected. The aforementioned variables were assessed in a dichotomic manner, and the categorization of the diseases is shown in Table 2 from the supplemental material documents.

Data were gathered from clinical records and hospital expense records using a spreadsheet. The distribution of quantitative variables was analyzed using Shapiro-Wilk and histograms, indicating a non-normal distribution. Categorical data were expressed in frequencies and percentages, while non-normal data were described using median and interquartile ranges. A univariable analysis was conducted. The Mann-Whitney U test, a nonparametric statistical method, was applied to compare non-normal quantitative continuous data in our study. The multivariable analysis was a multiple linear regression where the dependent variable was the program's costs per patient, and the independent variables were groups of diagnosis, procedures, and drugs used by the patients. Multiple linear regression was chosen to identify the independent impact of each variable on the total costs, controlling for potential confounders and allowing for the evaluation of the relative importance of each factor. The variables were chosen upon significant p-values in the previous tests; collinearity was evaluated and addressed by removing variables with a variance inflation factor exceeding 10. Subsequently, the model underwent refinement, eliminating variables without statistical significance to reach the best R-squared value. All assumptions of multiple linear regression were met. A level of $p<0.05$

was considered statistically significant, and data analysis was carried out using SPSS, version 29.0.2.0 (IBM Corp. IBM SPSS Statistics for Windows, Armonk, NY).

3. RESULTS

3.1 Descriptive statistics

This study initially involved a total of 64 patients. After applying the previously mentioned selection criteria, encompassing age above 70 years old, data on HAH costs during 2022 and complete data in clinical files, the analysis was conducted on 49 patients. Patients had a median (IQR) age of 86 (9) years and consisted of 31 (63.3%) female subjects, with a median (IQR) of 6 (7) days of HAH visits and 12 (19) days admitted for traditional hospitalization. Demographic data is shown in Table 1.

3.2 Differences in costs across diagnostic groups, procedures, and treatments

A total of 71 diagnoses were presented, which were classified into 10 groups. Among these, the grouping of infectious disorders had the highest number of patients [27 (55.1%)], followed by the groupings of cancer and muscular system disorders, where 9 (18.4%) patients were grouped into each category. Regarding the differences in costs by diagnosis grouping, the median (IQR) cost when a disease from the pulmonary disorders group was present was 2.7 times higher compared to its absence [$2,058.48 ($1,459.95) vs. $753.98 ($1,493.54), p= 0.027]. For disorders related to medical care and procedures, 3.67 times higher [$2,931.24 ($1,144.72) vs $804.77 ($1,558.18), p= 0.044], and for infectious disorders, 1.8 times higher compared to its absence [$1,319.85 ($2,125.65) vs. $726.17 ($1,198.34), p=0.052]. Differences in costs by diagnosis grouping are shown in Table 2.

Regarding materials and medications, procedure materials were used for 46 (93.9%) patients, while intravenous solutions were used for 45 (91.8%). Antibiotics were used by 37 (75.5%) of the patients, and analgesics by 32 (65.3%) patients. The median (IQR) of the differences in costs related to medical procedures and treatments was notably higher in several categories, including laboratory studies [$1,560.14 ($2,112.62) vs. $473.05 ($969.18), p<0.001], antibiotics [$1,170.07 ($1713.84) vs. $376.01 ($543.67, p=0.003], wound care materials [$1,319.85 ($1,631.43) vs $418.61 ($666.88), p=0.010], anticoagulants [$2,976.00 ($930.91) vs. $799.62 ($1,516.72), p=0.009], neuropsychiatric drugs [$1,654.55 ($2,007.85) vs. $579.42 ($928.03), p=0.009], antacids [$1,605.67 ($1,764.16) vs $717.92 ($700.82), p=0.010], and sleep regulators [$3,231.23 ($1,654.50) vs $777.62 ($1,292.71), p<0.001]. The differences in costs related to medical procedures and treatments are detailed in Table 3.

3.3 Main Predictors of Total Costs in the HAH Program

The results from the linear regression analysis for predicting total HAH costs showed a statistically significant positive association with disorders related to medical care and procedures β=0.333 (95%CI: 12,957.2, 52,211.2). Particularly noteworthy were the associations with sleep-regulating drugs β=0.561 (95%CI: 26,240.6, 54,044.1), laxatives β=0.330 (95%CI: 7,238.6, 27,828.0), and anticoagulants β=0.228 (95%CI: 2,527.39, 36,594.85). For more detailed information, please consult Table 4, which presents a comprehensive breakdown of these results.

In 2022, the hospital incurred a total cost of $2,206,628.26, resulting in a per capita cost of $5,716.61 in patients aged >70 years old. For the Hospital-at-Home (HAH) program, including transportation costs, the expense was $86,469.36, with a per capita cost of $1,764.68. The

median (IQR) number of days in the HAH program was 6 (7) days, while the median (IQR) hospitalization duration for the patients in the study was 12 (19) days. Additionally, the median (IQR) percentage of days spent in the HAH program instead of traditional hospitalization was 40% (41.67).

DISCUSSION

A total of 49 patients were studied to assess the cost of HAH care. We found that the most relevant factors predicting the cost of HAH were medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants. The per capita cost of the HAH program was three times lower than traditional hospitalization, resulting in 40% of patients' days of care utilizing the HAH program instead of traditional hospitalization. Figure 1 shows a summary of the development of the study, the explanation of the findings, and the economic differences between the costs of the traditional hospitalization vs. HAH approaches, along with the potential impact of the program's implementation across multiple levels.

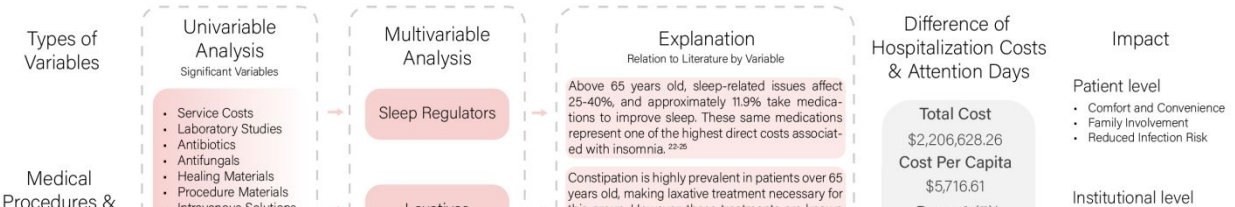

Figure 1 HAH program assessment and potential benefits. In the subheading "Types of variables" are described the two types of variables used for the study, then for "Phase 1" of the analysis, a univariable analysis was run to understand which variables affected the HAH program costs and they were used to develop the Multivariable Analysis from "Phase 2", which underscores the importance of sleep regulators, laxatives, anticoagulants and disorders related to medical care and procedures. Posteriorly, the comparison to the literature was assessed and expressed in the explanation. Then, in the subheading "Difference of Hospitalization costs & Attention days", total cost and cost per capita are compared between the classic model of patients staying in the hospital versus the at-home model, and with it, the median number of days spent by the patients in each one of those. In the end, the possible impact of the HAH programs is assessed at different levels: patient, institutional and public level.

In our study, a group of diagnoses named medical and surgical care-related disorders, which was composed of sequelae of complications from medical and surgical care, significantly influenced the HAH program's overall cost. Previous research on the economic considerations of surgical care and healthcare policies found that the financial impact of complications following abdominal surgery costs escalated significantly, with minor complications leading to a doubling of costs [23]. Another study found that complicated cases result in triple the average cost. [24] This aligns with our findings as all three studies show how complications can substantially increase healthcare costs, albeit in different healthcare settings.

Aging individuals often encounter increased sleep-related issues, with approximately half of older adults expressing dissatisfaction with sleep quality [25]. [26] Among the drug categories assessed in our study, sleep regulators notably impacted the HAH program's costs. A prospective observational study on the costs of insomnia revealed that medication expenses

comprised the largest portion (69.94%) of total direct costs, while productivity loss was the primary contributor to the overall economic burden, followed by medication. [27] This finding is supported by a review indicating extensive healthcare resource utilization among patients with insomnia. [28] Our study population primarily comprised geriatric retired individuals, which nullifies the cost of productivity loss and stresses the economic burden attributed to medication. These findings highlight the importance of addressing sleep health in geriatric care to manage costs effectively.

Constipation is a common issue within the ageing population [29], and half of the overall expenses related to this impediment are due to doctor visits, surpassing expenditures on both antihypertensive drugs and contraceptives in the UK's National Health System.[30] Similarly, we found that laxatives significantly influenced the overall cost of the HAH program. In a cost-effectiveness analysis evaluating the economic balance of medical intervention against alternative therapies for constipation, the researchers determined that laxatives are costly and not cost-effective compared to dietary management. [31] Our study exclusively enrolled patients aged 70 and above, leading to an increased number of patients requiring laxative therapy. In the elderly, the constraints posed by decreased physical activity, polypharmacy, and comorbidities make constipation prevalent and laxative use often necessary. [32]

Approximately seven million individuals globally rely on anticoagulants. These medications are commonly prescribed for health issues, including myocardial infarction, unstable angina, and acute coronary syndrome, whether in hospital or outpatient settings. [33] In our study, the cardiometabolic disorders group was not significantly expensive within the HAH program. However, anticoagulants, a medication group including apixaban, enoxaparin, and heparin, represented a significant economic burden. In a prospective cohort study of patients receiving

anticoagulants for any indication in the hospital's cardiology ward, enoxaparin stood out as the costliest anticoagulant, contributing even more to the overall financial impact when factoring in the expenses associated with its monitoring, [33]. This underscores the importance of careful management and monitoring of anticoagulant therapy to optimize cost-efficiency while ensuring patient safety.

In our study, the per capita cost of the HAH program was three times lower compared to the hospital per capita cost. In a study describing the implementation and evaluation of a healthcare delivery model known as "Hospital at Home", the per-patient cost excluding physician fees for Hospital at Home was compared to the variable costs per case for acute care inpatients, which also excluded physician fees, resulting in an average HAH patient cost 19% lower compared to traditional hospital setting per capita cost. [6] In contrast to this study, physician fees were included for both groups, but our HAH costs were also lower. The same study explains that these savings were due primarily to shorter average hospital stays and reduced utilization of clinical tests. This supports our results since, although patients may have initially required hospitalization, further care was provided at home, resulting in patients receiving care at home through the HAH program instead of traditional hospital stay during 40% of their total period of care and probably limiting the request of laboratory studies only when necessary.

Our study has potential implications for practice. At the patient level, HAH programs could enhance convenience and safety since patients benefit from reduced stress and heightened comfort in home environments and support from family [34]. Furthermore, the reduced risk of infection, a notable advantage of home-based care, suggests improved health outcomes [35]. On an institutional level, HAH can generate cost savings by reducing bed occupancy, alleviating congestion within hospitals, and through more efficient resource management, as was needed

during the pandemic of COVID-19 [36]. This is also true on a public level, as HAH models contribute to optimized healthcare delivery and disrupt the transmission of infectious diseases, fostering healthier populations. Moreover, integrating home-based care with community services promotes synergistic benefits for the healthcare system across multiple levels.

Implementing HAH programs on a larger scale presents organizational challenges, such as establishing new departments for patient transportation logistics, medical equipment supplies chain management, and coordination with home health providers. These departments must integrate into hospitals' existing structure through changes in administrative and operational workflows. Additionally, expanding HAH programs successfully depends on developing robust training programs for healthcare providers, including training in telemedicine, remote patient monitoring, and home-based medical procedures. [1] From a public health policy perspective, scaling up HAH programs require substantial investment in healthcare infrastructure and resources. Policymakers need to create supportive frameworks and funding models to integrate HAH into the broader healthcare system, address healthcare disparities, and invest in technologies for remote care delivery in underserved areas to ensure equitable access to home-based care. [34]

While our study provides valuable insights into the cost-effectiveness of the HAH program compared with traditional hospitalization, some limitations should be considered. Firstly, the time of the study was limited to one year and involved a relatively small population size of the HAH program, limiting the statistical power and generalizability of our findings. To compensate, we used the whole population as our sample. Additionally, this is a retrospective study design; thus, we had to rely on the existing information on the medical records. Future research should consider a prospective study to understand the sustainability of the program

and assess variables related to the optimization and development of logistics for the program. Although the HAH model has the potential benefit of reducing expenses and increasing patients' comfort, this conclusion was made with the per capita cost for each patient and does not imply a normal distribution for this data. Before attempting to extrapolate this study's findings, it must be considered that laboratory prices were included for comparing home hospitalization and traditional hospitalization, while other studies do not take laboratory expenses as part of the HAH.

CONCLUSION

The results of this study suggest that the most relevant factors influencing the overall cost of the HAH program were medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants. Also, the HAH program's per capita cost is three times lower compared to the per capita cost of hospitalization, proving the cost-effectiveness of the HAH program. The results of this research underscore the significance of considering the economic factor when implementing home hospitalization programs in Mexico. It's clear that this approach doesn't just provide a financially viable substitute for the traditional hospital model but also has the potential to yield substantial savings in healthcare costs. By focusing on key cost-driving factors and optimizing resource allocation, HAH programs can play a pivotal role in advancing healthcare delivery and achieving better economic outcomes.

CONFLICT OF INTEREST

The authors declare no financial or personal conflict of interest.

DATA STATEMENT

Data is available upon reasonable request to the authors.

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Table 1. Patient's demographic characteristics.

Variable	n=49 (%)
Female	31 (63.3)
Age (years)*	86 (9)
Retirees	46 (93.9)
Consultation Service †	46 (93.9)
Laboratories ‡	24 (49.0)
Patients with Palliative Care	25 (51)
Days in HAH program*	6 (7)
Days admitted in hospital*	12 (19)
Overall cost (US dollars)*	844.87 (1652.19)

*Median (Interquartile range)

† Use of the geriatric consultation service in HAH

‡ Use of laboratory studies regarding blood tests, urine tests, among others during HAH stay.

Table 2. Cost differences by diagnostic grouping.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Cancer	9 (18.4%)	406.66 (2058.79)	846.39 (1391.04)	0.73
Cardiometabolic disorders	6 (12.2%)	528.12 (567.47)	848.03 (1608.56)	0.30
Urinary system disorders	7 (14.3%)	1124.27 (2340.13)	804.77 (1582.91)	0.19
Digestive system disorders	8 (16.3%)	1402.21 (2008.62)	809.97 (1516.72)	0.23
Neurogeriatric disorders	7 (14.3%)	1124.27 (1135.25)	827.33 (1740.27)	1.00
Muscular system disorders	9 (18.4%)	871.26 (1348.39)	827.33 (1536.34)	0.60
General health disorders	3 (6.1%)	2860.83 (1041.60)	804.77 (1558.18)	0.12
Disorders related to medical care and procedures	3 (6.1%)	2931.24 (1144.72)	804.77 (1558.18)	0.044
Infectious disorders	27 (55.1%)	1319.85 (2125.65)	726.17 (1198.34)	0.052
Pulmonary system disorders	3 (6.1%)	2058.48 (1459.95)	753.98 (1493.54)	0.027

*Performed using the Mann-Whitney U test

Table 3. Differences in costs by medical procedures and treatments.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Consultation Services	46 (93.9)	859.68 (1572.55)	181.46 (114.55)	0.10
Palliative Care	25 (51)	15725,1 (35484.8)	19590.1 (31680.3)	0.92
Laboratories	24 (49.0)	1560.14 (2112.62)	473.05 (969.18)	<0.001
Antibiotics	37(75.5)	1170.07 (1713.84)	376.01 (543.67)	0.003
Wound Care Materials	33 (67.3)	1319.85 (1631.43)	418.61 (666.88)	0.010
Anticoagulants	4(8.2)	2976.00 (930.91)	799.62 (1516.72)	0.009
Neuropsychiatrics	22(44.9)	1654.55 (2007.85)	579.42 (928.03)	0.009
Antacids	23(46.9)	1605.67 (1764.16)	717.92 (700.82)	0.010
Sleep regulators	6(12.2)	3231.23 (1654.50)	777.62 (1292.71)	<0.001
Antifungals	9(18.4)	1352.56 (2029.64)	753.98 (1541.13)	0.046
Procedure materials	46(93.9)	859.68 (1572.55)	200.88 (119.71)	0.026
IV Fluids	45(91.8)	871.26 (1526.35)	303.75 (230.76)	0.020
Dietary supplements	3 (6.1)	1319. 85 (1290.96)	804.77 (1648.42)	0.23
Ointments	14(28.6)	1261.29 (1981.53)	777.62 (1565.55)	0.21
Antihypertensives	4(8.2)	1956.75 (2535.19)	844.69 (1581.41)	0.34
Analgesics	32(65.3)	1368.32 (1628.03)	713.86 (627.37)	0.046
Corticosteroids	11(22.4)	809.97 (1787.03)	857.98 (1558.18)	0.71
Hypoglycemic agents	4(8.2)	2184.83 (2359.65)	809.97 (1581.41)	0.12
Antispasmodics	11(22.4)	1703.44 (1569.41)	804.77 (1437.29)	0.30
Antiemetics	11(22.4)	1978.28 (1981.53)	753.98 (1173.05)	0.035
Diuretics	10(20.4)	2373.82 (2216.77)	799.62 (1292.71)	0.047
Cardiac drugs	1 (2%)	3199.65 (0)	827.33 (1584.46)	0.20
Statins	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Probiotics	2 (4.1%)	508.39 (221.90)	848.03 (1641.78)	0.35
Dental medications	1 (2%)	3706.24 (0)	827.33 (1548.86)	0.12
Bronchodilators	8(16.3)	2009.14 (2628.58)	777.62 (1325.11)	0.07
Mucolytics	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Nasal sprays	2 (4.1%)	2529.37 (1176.86)	809.97 (1616.64)	0.18
Laxatives	13(26.5)	2058.48 (1844.47)	680.89 (1307.80)	0.016
Thyroid hormones	2 (4.1%)	1889.54 (1310.12)	844.69 (1616.64)	0.58
Antidiarrheals	1 (2%)	334.24 (0)	846.39 (1634.83)	0.40
Antihistamines	1 (2%)	2856.19 (0)	827.33 (1584.86)	0.28
Hepatoprotectors	1 (2%)	2689.15 (0)	827.33 (1584.86)	0.36

*Performed using the Mann-Whitney U test

Table 4. Linear regression for predicting total HAH costs.

Variable	β	Standardized β	t value	95% Confidence Interval		p-value
				Inferior	Superior	
Disorders related to medical care and procedures	32,584.2	0.333	3.35	12,957.21	52,211.20	0.002
Sleep regulators	40,142.3	0.561	5.82	26,240.57	54,044.08	<0.001
Laxatives	17,533.3	0.330	3.42	7,238.63	27,828.01	0.001
Anticoagulants	19,561.1	0.228	2.31	2,527.39	36,594.85	0.025

Corrected R^2: 0.567

Types of Variables

Medical Procedures & Treatments

Diagnostic Grouping

Univariable Analysis

Significant Variables

- Service Costs
- Laboratory Studies
- Antibiotics
- Antifungals
- Healing Materials
- Procedure Materials
- Intravenous Solutions
- Analgesics
- Anticoagulants
- Neuropsychiatrics
- Antacids
- Antiemetics
- Diuretics

- Pulmonary Disorders
- Disorders Related to Medical Care and Procedures
- Infectious Disorders

Phase 1

Multivariable Analysis

Adjusted R^2= 0.564

- Sleep Regulators
- Laxatives
- Anticoagulants
- Disorders Related to Medical Care and Procedures

Phase 2

Explanation

Relation to Literature by Variable

Above 65 years old, sleep-related issues affect 25-40%, and approximately 11.9% take medications to improve sleep. These same medications represent one of the highest direct costs associated with insomnia. [22-25]

Constipation is highly prevalent in patients over 65 years old, making laxative treatment necessary for this group. However, these treatments are known to be costly, exceeding expenditures on extensive use medications like antihypertensives. [26-27]

The economical weight caused by the anticoagulants could be related to the use of enoxaparin, which was widely used in the hospital at home patients. [30]

Complications related to procedural or surgical settings can increase the overall costs for patients, escalating from 2 to 3 times the original cost. [20,21]

Difference of Hospitalization Costs & Attention Days

Classic Model

Total Cost

$2,206,628.26

Cost Per Capita

$5,716.61

Days: 6 (7)*

At-Home Model

Total Cost

$86,469.36

Cost Per Capita

$1,764.68

Days: 12 (19)*

*Presented in Median (IQR)

Impact

Patient level

- Comfort and Convenience
- Family Involvement
- Reduced Infection Risk

Institutional level

- Reduced Bed Occupancy
- Cost Savings
- Efficiency in the management of resources.

Public level

- Cost saving by efficient resource utilization.
- Reduced transmission of infection.
- Integration with community services.

Supplemetal Materials

Table S1. Grouping of Variables

Variables	Medicines/materials/labs
Laboratories	Complete Blood Count (CBC), Cytochemical Analysis Of Peritoneal Fluid, Creatine Kinase-MB (CK-MB), Creatine Phosphokinase (CPK), Stool Test, Wound Culture, Peritoneal Fluid Culture, Throat Culture, Lactate Dehydrogenase (LDH), D-Dimer, Urine Electrolytes (Single Sample), Blood Electrolytes, Thyroid-Stimulating Hormone (TSH), Blood Culture, Thyroid-Stimulating Hormone, NT-Probnp (N-Terminal Pro B-Type Natriuretic Peptide), Urinalysis, Biochemical Profile, Thyroid Profile, Procalcitonin, C-Reactive Protein (CRP), COVID-19 PCR Test, Rapid COVID-19 Antigen Test, Rapid Influenza A + B Test, Blood Chemistry, Fecal Immunochemical Test (FIT) For Occult Blood, Prothrombin Time (PT), Partial Thromboplastin Time (PTT), Troponin I, Urine Culture, Vitamin D (25-Hydroxy).
Antibiotics	Cefixime 400 Mg Capsule/Denvar C/10, Ceftazidime 1g Ampoule/Izadima, Ceftriaxone 500mg IV/Cefaxon, Ceftriaxone 1g IM Ampoule/GI Amsa 1 Ampoule, Ceftriaxone 1g IM Ampoule/Amsa Amcef 1 Ampoule, Ceftriaxone 1g IV/Cefaxon, Ceftriaxone 1g IV/Ceftrex 1 Ampoule, Ciprofloxacin 200 Mg Ampoule/Ciprobac, Ciprofloxacin 500mg Tablet/Ciprobac C/14, Clindamycin 600 Mg Ampoule/Dalacin C, Cefepime Hydrochloride Injection/Imation C/1, Dicloxacillin 500mg Capsules/Butimaxil C/20, Ertapenem 1g Ampoule/Invanz IV, Imipenem Cilastatin 500mg IV Ampoule/GI Pisa, Levofloxacin 500mg Tablet/Evocs III C/7, Levofloxacin 500mg Tablet/Lefloxin C/7, Levofloxacin 500mg Injection/Flouning Flexova, Linezolid 2mg/Ml/Yaprinca 300ml Injection, Meropenem 1g IV Ampoule/Merrem, Meropenem 1g IV Ampoule/Pisapem C/1, Moxifloxacin 400mg Ampoule/Avelox Amp, Silver Sulfadiazine/Argental Tube 28g, Trimethoprim-Sulfamethoxazole 160/800mg/Bactropin.
Wound care materials	Antiseptic EXGERM 1 Liter For EXGERM Hands, MICROPORE Tape 1/2 3M M.1530-0, TRANSPORE Tape 1 3M M.1527-1, TRANSPORE Tape 1/2 3M M.1527-0, Chlorhexidine JBN .12% CLORHEXI-CLEAN 60M, Sterile Gauze 10x10 PROTEC, Simple Gauze 10x10cm With 200 Pieces Non-Sterile, Blue Surgical Cap TECNOL TR, Sterile MEDI-GRIP Glove 6-1/2, Sterile Latex Glove CH AMBI M.0604560383, Sterile Latex Glove MED M.064560391, Non-Sterile Latex Glove CH M.D-04340-S, Non-Sterile Latex Glove MED M.D-04341-M, Cotton/Alcohol SWABS BD M.326899, TEGADERM 10x12cm 3M M.1626W, TEGADERM 6x7cm 3M

	M.1624W, TEGADERM CHG 10x12cm REF. 1658R With 25 Pieces, Gauze Bandage 10cm LE ROY, Gauze Bandage 5cm LE ROY, Gauze Bandage 7cm LE ROY, Elastic Bandage 5cm ELASTOMEDIC, Elastic Bandage 7cm LE ROY, White Elastic Bandage 10cm LE ROY, White Elastic Bandage 5cm LE ROY.
Anticoagulants	Apixaban 2.5mg Tablets/Elicuis C/60, Enoxaparin 20mg Injection/Bolenax C/2 Ampoules, Heparin 1000 U 10ml Ampoule/Heparin Pisa.
Neuropsychiatrics	Alprazolam 0.25mg/Neupax C/30 Tablets, Alprazolam 0.50mg/Neupax C/30 Tablets, Clonazepam 2mg/Kriadex C/30 Tablets, Escitalopram 10mg Tablet/Lamobrigan C/28 SDMDU, Haloperidol 2mg/Ml Drops/Haloperil 15ml, Haloperidol 5mg/Haldol C/20 Tablets, Haloperidol 5mg Injection/Pisa C/6 Ampoules, Levetiracetam 100mg I.V./Keppra C/10 Injections, Levetiracetam 500mg Tablet/Kepra C/30, Memantine 10mg Tablet/Eutebrol 10mg C/30, Midazolam 50mg/10ml Ampoule/Relacum C/5, Paroxetine 20mg/Andepa C/20 Tablets, Pregabalin 25mg Capsule/Lyrica C/28, Pregabalin 75mg Capsule/Dismodox C/28 SDMDU, Quetiapine 100mg/Seroquel C/30 Tablets, Quetiapine 25mg/Q-Mind C/28 Tablets, Sertraline 50mg Tablet/Sertex C/28.
Antacids	Magaldrate + Dimethicone Gel / Galaver 250ml, Omeprazole 20mg Capsule / G.I. Ultra C/30, Omeprazole 40mg Injectable Solution 10ml / GI Pisa, Pantoprazole 40mg Tablet / Apotex (Efectr) C/14, Pantoprazole I.V. Ampoule / Supacid C/1.
Sleep regulators	Melatonin 3mg Tablet / Cronocaps C/30
Consultation services	Intramuscular Injection Application, Intravenous Injection Application, Urinary Catheter Application Or Change, Geriatrics Consultation, First-Time Geriatrics Consultation, Subrogated Fees, Geriatric Hospitalization At Home, Home Hospitalization By Nursing Staff, Geriatric Assessment At Home By Nurse, Geriatric Assessment At Home By Geriatrician, Home Nursing Visit.
Antifungals	Fluconazole 100mg / Diflucan C/10 Capsules, Fluconazole 100mg Injection / Flucoxan C/1, Fluconazole 150mg Capsule / Afungil C/1, Fluconazole 50ml Ampoule / Diflucan, Ketoconazole 30g Cream / Mi-Ke-Sons, Miconazole Vaginal Cream / Gynodaktarin, Nystatin 100,000 IU/Ml / Micostatin 30ml, Voriconazole 200mg Injection / Vfend Ampoule C/1.
Procedure materials	AEROCHAMBER Adult Mask TRUDELL, Sterile Water Plastic 500ml Irrigadual PISA, Sterile Injectable Water 10ml PISA, Disposable Needle 18x38mm BD M.302347, Disposable Needle 21x32mm BD M.301731, Disposable Needle 22x32mm BD M.300081, ALLEVYN ADHESIVE Dressing 12.5x12.5 Cm, Asepto Plastic Syringe AMSINO M.AS11, Round Band-Aids 7/8 C/100, Surgeon's Gown Medium BARRIER M.650101,

	Disposable Patient Gown Long Sleeve MNGA LARG TR, New Image Bag HOLLISTER M.18184, Disposable 4-Field Pack, Sterile Eye Drape BOJO01, Adult Nasal Cannula Medium REF.OPT844, Oxygen Nasal Cannula UNOMEDICAL REF.309-, Peripheral Insertion Catheter VYGON 4FR., INTROCAN SAF Catheter 20G BRAUN C.4251644, INTROCAN SAF Catheter 22G BRAUN C.4251628, INTROCAN SAF Catheter 24G BRAUN C.4251601, Peripheral Catheter 3FR. 12CM SMARTMIDLIN, CHLORAPREP 10.5ML CAT.261715, 0.9% Sodium Chloride Prefilled Syringe C/30, Extension With Microclave 15cm, FLEBOTEK 0-100 With Clave 4001968 100ml VEN, FLEBOTEK With Clave For Pump 4002759 PISA, HEMOTEK FLEBOTEK For Blood Pump PISA, PVC-Free INFUSOMAT FLEBOTEK PISA, Surgical FLEBOTEK With Clave PISA 4001967, Sterile 100ml PSU Bottle, Sterile Water Bottle 760ml With Adapter M.037-33, Disposable Cover TR, Sterile Mayo Stand Cover SIDRASA, HOME PUMP 100ml IFLOW M.C100020, I.V. START PACK With Gloves BD M.386172, KY JELLY BD M.92699, 3ml PLASTIPAK Disposable Syringe BD M.302541, 5ml PLASTIPAK Disposable Syringe BD M.302552, 10ml PLASTIPAK Disposable Syringe BD M.302560, 20ml PLASTIPAK Disposable Syringe BD, PRE-HEPARIN POSIFLUSH Syringe 3ml/100UI, PRE-FILLED POSIFLUSH Syringe 3ml/10UI, PLASTIPAK TUBERCULIN Syringe BD M.302579, Percutaneous Drainage Kit Unique 9FR. 10800, Peripheral Venipuncture Kit With Chlorhexidine, BD CONTACT-ACTIVE Lancet 21x1.8mm 366593, 2% Lidocaine 10ml Ampoule/PISACAINA C/10, HUDSON Adult Mask M.1040 WITHOUT RESERVOIR, HUDSON Adult Mask M.1060 WITH RESERVOIR, Reservoir Adult Mask 106-E UNOMEDIC, Subrogated Medical Oxygen, HOLLISTER Plates C/5 M.14804, POSIFLUSH XS BD REF.306572 Prefilled Syringe, Disposable Foot Protector PM M.SPM280, RECEPTAL 1000cc BEMIS M.7H1004R, RECEPTAL 1500cc BEMIS M.1504R, Disposable Kidney Basin LOAIZA M.H300-05, Disposable Drawer Cover TR, SILA Foley Catheter 14FR. 5cc ROCH, SILA Foley Catheter 16FR. 30cc ROCH, SILA Foley Catheter 18FR. 30cc, SILASTIC Foley Catheter 18FR. 5cc BARD, BARDIA Nelaton Catheter 16FR. M.802416, AMA K-60 14FR. Suction Catheter, Support For Venoclisis Size C SOFER, HOLLISTER Foley Catheter Holder 9781, BD Rigid Digital Thermometer M.524059, PISA Surgical Towel M.4000699, CONOX-VASO Salter Labs Connector Tube, 10 Long Suction Tube 1 AMSINO M.AS826, UROTEK ND 2LTS

	Closed System PISA, SALTER Humidifier Cup 6PSI MXSAL7600-, SURGICAL Venopack NB For Surgery PISA.
IV Fluids	DEXTROSA-HARTMAN Solution Bottle 1000ml, DEXTROSA-HARTMAN Solution Bottle 500ml PISA, DEXTROSA-NACL Solution Bottle 1000ml, DEXTROSA-NACL Solution Bottle 500ml, CS 0.9% Injectable Solution 100ml PISA, CS 0.9% Injectable Solution Bottle 1000ml, CS 0.9% Injectable Solution Bottle 250ml FLEXOVAL, CS 0.9% Injectable Solution Bottle 500ml PISA, CS 0.9% Injectable Solution Bottle 50ml PISA, DX-5 Injectable Solution Bottle 5% Glucose 50ml, DX-50 Injectable Solution Bottle 50% Glucose 50ml, HARTMAN Solution Bottle 1000ml PISA, HARTMAN Solution Bottle 500ml PISA, Sodium Chloride Solution 17.7% 10ml Ampoule PISA.
Dietary supplements	DIHEXAZINA 140ml Syrup / Viternum, Potassium Phosphate Ampoule / Potassium Phosphate / 50.
Ointments	Ac. Acexamici 5/4g Cream / Recoveron Nc, Mineral Oil Ointment / Naturalag, Triticum Vulgare With 10 Gauze / Italdermol, Triticum Vulgare Cream 30g / Italdermol.
Antihypertensives	AMLODIPINE 5mg / Pequisy C/30 Tablets, AMLODIPINE + VALSARTAN 5/160mg / Exforge C/28, ATENOLOL 100mg / Tenormin C/28 Tablets, LOSARTAN 50mg Tablets / Viopxa C/30, METOPROLOL 95mg / Lopresor R C/20 Capsules.
Analgesics	BUPRENORPHINE 10mg/Soloro Patches, BUPRENORPHINE 20mg/Transtec C/2 Patches, BUPRENORPHINE 30mg/Transtec C/4 Patches, BUPRENORPHINE 5mg/Soloro-7 C/2 Patches, CELECOXIB 200mg Capsules/G.I. Ultra C/20, DEXKETOPROFEN 25mg/10ml/Velian C/10 Sachets, DICLOFENAC 75mg/3ml Injectable Solution C/2 Genepisa, IBUPROFEN 400mg Tablets/Dolver C/10, KETOROLAC 30mg/Onemer C/3 Ampoules PISA, MORPHINE 10mg/10ml Ampoule/Graten C/5, MORPHINE 2.5mg/2.5ml Ampoule/Graten C/5, PARACETAMOL 325/37.5mg Tablet/Tafitram C/20, PARACETAMOL 500mg/Kendrick G.I. C/10 Tablets, PARACETAMOL IV 1g Ampoule/Salpifar, PARECOXIB SODIUM 40mg 0.2ml Ampoule/Dynastat.
Corticosteroids	Beclomethasone/Innovair Nexth 100/6 120d, Beclomethasone + Formoterol/Innovair 120 Doses, Budesonide 250mcg Susp/Pulmicort 2ml, Dexamethasone 8mg/2ml Ampoule/Decorex, Dexamethasone Ampoule/Alin-Depot 4mg 1x2ml.
Hypoglycemic agents	Insulin Glargine 100u/50mcg/Soliqua C/3, Insulin Glargine 300u/Ml/Toujeo 3 Pen, Insulin Lispro 3 Ml Cartridge/Humalog Mix25, Metformin 500 Mg Tablet/Dabex Xr C/30, Metformin/Sitagliptin 500/50mg Tablet Janumet C/56.
Antispasmodics	Butylhyoscine 10 Mg/ Biomesina C/10 Tablets, Butylhyoscine 20mg / Capin C/3 Ampoules, Butylhyoscine Tablets /

	Espasmotex C/ 25, Butylhyoscine/Metamizole / Busconet C/1 Ampoule.
Antiemetics	Diphenidol 40 Mg/Diphafen Amp C/2, Metoclopramide 10mg / Pramotil C/6 Amp., Ondansetron 8 Mg/ Indansen C/ 3 Amp, Ondansetron 8mg/Amal C/10 Tabs, Ondansetron 8mg/4ml Amps/ Antivon C/3.
Diuretics	Bumetanide 1 Mg / Miccil C/ 20 Tablets, Espironolactone 50 Mg / Lasilacton C/, Furosemide 20mg / Henexal C/5 Ampoules Pisa, Furosemide 40 Mg / Diurmissel C/ 20 Tablets.
Cardiac drugs	Amiodarone / Braxan C/ 20 Tablets, Isosorbide 20 Mg / Elantan C/30 Tablets.
Statins	Atorvastatin 10 Mg / Lipitor C/ 30 Tab
Probiotics	Bacillus Calsicus Ampoule / Enterogermina
Dental medications	Dexpanthenol 250ml Solution / Bexident Gums
Bronchodilators	Ipratropium Aerosol 0.02mg 10ml / Atrovent, Ipratropium Spray 10 Ml / Berodual, Ipratropium-Salbutamol / Combivent C/10 Ampoules, Ipratropium+Salbutamol 0.5/2.5mg / Fevolut 10 Ampoules, Ipratropium+Salbutamol 0.5/2.5mg / Vinza C/10 Ampoules.
Mucolytics	Acetylcysteine 600mg Tablet / Lysomucil C/20
Nasal sprays	Sodium Chloride Solution 100 Ml / Sterimar Lubnas, Sodium Chloride Solution 100ml / Nasalub Max.
Laxatives	Sodium Citrate Suspension / Microlax Enema C/4, Lactulose Syrup / Duphalac 150ml, Lactulose Syrup / Oppelver 125ml, Polyethylene Glycol 255g / Contumax 15 Sachets, Senosides A-B 187 Mg Tablet / Senokot C/60, Senosides A-B 374 Mg / Senokot F C/ 30.
Thyroid hormones	Levothyroxine 100 Mcg / Eutirox C/ 50 Tablets
Antidiarrheals	Loperamide 2 Mg / Lomotil C/ 8 Tablets, Racecadotril 10mg Sachet / Hidrasec.
Antihistamines	Loratadine 10 Mg / Gi Ultra C/20 Tablets
Hepatoprotectors	Ursodeoxycholic Acid 250 Mg / Ursofalk C/50
Consultation services	Intramuscular Injection Application, Intravenous Injection Application, Urinary Catheter Application Or Change, Geriatrics Consultation, First-Time Geriatrics Consultation, Subrogated Fees, Geriatric Hospitalization At Home, Home Hospitalization By Nursing Staff, Geriatric Assessment At Home By Nurse, Geriatric Assessment At Home By Geriatrician, Home Nursing Visit.

Table 2. Grouping of Diagnosis

Diagnosis grouping	Diagnostics
Infectious disorders	Urinary tract infection, chronic osteomyelitis, generalized sepsis, renal and perirenal abscess, urosepsis, cellulitis, fever of undetermined origin, severe sepsis without septic shock, nonspecific peritonitis, pyelonephritis, leg cellulitis, erysipelas cellulitis.
Cancer	Prostate cancer, breast cancer, metastatic cancer, malignant tumor of the lateral bladder wall, unspecified tumor, malignant lymphoma, malignant kidney tumor except renal pelvis.
Muscular system disorders	Problems related to reduced mobility (bedridden or chair-bound), polymyositis, polymyalgia rheumatica, problems related to wasting disease (frailty).
Digestive system disorders	Abdominal pain, choledocholithiasis, pancreatitis, intestinal constipation, constipation, liver cirrhosis, hepatic encephalopathy.
Urinary system disorders	Chronic kidney disease requiring dialysis, extracorporeal dialysis, hematuria, acute kidney injury, acute renal failure, non-traumatic bladder rupture, hyposmolality and hyponatremia, urolithiasis, hyperosmolality and hypernatremia
Neurogeriatric disorders	Dementia in Parkinson's disease, Alzheimer's disease, vascular dementia, subacute confusional state, coma and drowsiness stupor sleepiness unconsciousness semicoma, anxiety, unspecified delirium, delirium superimposed on dementia.
Cardiometabolic disorders	Type 2 diabetes mellitus, peripheral arterial insufficiency, chronic ischemia, subconjunctival hemorrhage, ischemic heart disease, cerebral hemorrhage, arterial hypertension, acute myocardial infarction, congestive heart failure, arterial thrombosis, heart failure.
General health disorders	Urticaria, generalized pain, hyporexia and anemia.

Disorders related to medical care and procedures	Sequelae of complications from medical and surgical care, other adverse events during medical or surgical care, and procedures for other purposes that aid in health status.
Pulmonary system disorders	Contact and exposure to COVID-19 coronavirus, nonspecific bacterial pneumonia, nonspecific pneumoconiosis, nonspecific pneumonia, pleural effusion, respiratory distress.

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Complete List of Authors:	González Ochoa, Jesús ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Garza-Silva, Arnulfo; Hospital Clínica Nova de Monterrey, Research Department González Peña, Omar; Hospital Infantil de Mexico Federico Gomez, Evidence-Based Medicine Research Unit; Universidad de Monterrey, Research and Development Directorate Romero-Ibarguengoitia, Maria Elena; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Fernández-Chau, Iván ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Villarreal Parra, Diana; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Torres Valerio, Nadia ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Sanz-Sánchez, Miguel ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Hughes García, Melissa; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences
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Cost Drivers and Feasibility of a Hospital-at-Home Program for Geriatric Care in Northeastern Mexico. A Retrospective Observational Study.

ABSTRACT

Objective: The primary objective was to evaluate factors influencing the cost of a "hospital at home" (HAH) for geriatric patients in a Northeastern Mexican hospital. Secondarily to evaluate the *per capita* global cost-effectiveness compared to traditional hospital care

Design: This retrospective analysis examined the costs incurred by geriatric patients in an HAH program from February to December 2022

Setting: We collected data from clinical records and assessed medication and procedure costs through the hospital's financial department. Costs for traditionally hospitalized patients were reviewed for comparison

Participants: Subjects both gender seventy age and older that were treated in HAH during 2022 and Hospitalized subjects with the same age and gender treated in the same period

Intervention: NA

Primary and secondary outcome measures: Primary outcome: Factors that influence costs in HAH. Secondary, global per capital cost comparison between HAH and hospital care:

Results:

We examined the expenses associated with 416 home visits to 49 patients in the HAH program. The main factors influencing the program's overall cost were medical care and procedure-related disorders (β=0.333, p=0.002), sleep-regulators (β=0.561, p<0.001), laxatives (β=0.330, p=0.001), and anticoagulants (β=0.228, p=0.025). The HAH program's per capita cost was three times lower compared to that of traditional hospital care and resulted in a 40% reduction in hospitalization days.

Conclusions:

This study highlights that the main factors influencing the HAH program's costs include medical care and procedure-related disorders, as well as medication extensively used in the elderly population. Additionally, we demonstrated the cost-effectiveness of the HAH program, which produces substantial savings and is a financially viable alternative to traditional hospital care.

Strengths and limitations

- This study evaluates a under adopted in Latin America Hospital at Home Model (HAH).
- Close follow-up in cost implications in HAH were evaluated
- The study identified factors that increased cost in HAH model that can be mitigated in the future.
- This retrospective study occurred during COVID-19 pandemic; there were differences in eligibility criteria, severity in pathologies between HAH and traditional Hospitalization, so randomization or case-control design was not feasible.

Introduction

The concept of "hospital at home" (HAH) was pioneered at John Hopkins University Schools of Medicine and Public Health in the US in 1995. [1] It refers to a patient care model that provides necessary services directly in the individual's home rather than through hospital admission.[2] This type of program has focused on managing acute conditions such as pneumonia, cellulitis, and urinary tract infection (UTI), as well as exacerbations of chronic degenerative diseases such as chronic obstructive pulmonary disease (COPD) and heart failure. [3] This model addresses the challenge posed by the growing number of people needing medical care,

surpassing hospitals' capacity to provide sufficient beds, especially during medical emergencies. Additionally, the aim is to avoid potential adverse effects associated with hospital care, such as functional decline, delirium, and iatrogenic diseases, among others. [2]

Spain and Australia have long practiced treating acute-care patients in their own residences. Other countries with publicly funded healthcare systems, such as England, Canada, and Israel, also have established home-hospital models. [1] The rising cost of hospital care, which accounts for approximately one-third of total medical expenditure in the US and results in considerable patient debt, [4] poses the question of whether these alternative models are more cost-effective. Previous studies have suggested that HAH models can contribute to cost reduction without compromising the quality of care, [5–13] but only a few have addressed the relationship between factors influencing HAH program costs and comparative budgets between traditional hospitalization and HAH. [4]

Research has been conducted on the feasibility of implementing an HAH program to reduce hospital costs, but there are still unexplored aspects that require attention. Specifically, there is a lack of knowledge about which diagnoses treated in an HAH program may generate higher expenses and affect hospital economics. Likewise, the trend of studies addressing HAH programs focuses on the care of specific and isolated diseases. [14–20] Therefore, it is worth conducting a study that explains the impact of HAH on economic outcomes in relation to a broad group of conditions.

The primary objective of this study was to evaluate factors influencing the cost of a hospital at home (HAH) model for geriatric patients in a Northeastern Mexican hospital. Secondarily to evaluate the *per capita* global cost-effectiveness compared to traditional hospital care. We hypothesize that (1) the costs associated with the HAH program are significantly influenced by specific diagnoses and medications, commonly present in geriatric

care and that (2) the HAH program is more cost-effective than traditional hospital care, resulting in substantial cost savings while maintaining quality of care.

Methodology

This is a retrospective analytic cross sectional study focused on the expenses related to geriatric patients visited by an HAH geriatric program between February 2022 and December 2022. The research adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines, [21] and received approval from the local Institutional Review Board (Comité de Investigación de la Vicerrectoría de Ciencias de la Salud Universidad de Monterrey, number: 12012023-CN-GER-CI). As the study is retrospective, informed consent was not applicable; as well as, patients or the public WERE NOT involved in the design, or conduct, or reporting, or dissemination plans of our research.

Hospital Clinica Nova and the Hospital at Home Program

Hospital Clinica Nova (HCN), a small to mid-sized private hospital in northeastern Mexico, serves approximately 52,200 patients, including steelworkers from Ternium—one of Latin America's largest steel manufacturers—and their families in Monterrey, Nuevo León. Of these patients, around 10% (5,249 individuals) are aged 70 years or older.

The Hospital at Home (HAH) model at HCN provides a comprehensive service that integrates patients from various entry points, such as inpatient wards, geriatric consultations, and emergency services, based on frequency and need. Patients eligible for this service typically include those 70 years and older with conditions like frailty syndrome, cognitive decline, mobility issues, functional deterioration, or terminal palliative (end-of-life care) needs. Referrals are authorized by the HAH team and reviewed beforehand by geriatricians, emergency care providers, and primary care physicians, following strict admission criteria.

The multidisciplinary team operates daily from 8 a.m. to 8 p.m., consisting of geriatricians, nurses, social workers, psychologists, and other specialists. Team members are assigned based

on individual patient needs, with flexibility to ensure comprehensive diagnostic and therapeutic support at home. Monitoring is conducted daily in 2 to 3 shifts or as needed, with responsibility shared among the nursing staff and physicians. This includes both in-person visits and telemedicine support, such as video and phone calls, ensuring continuous supervision. Monitoring tools include vital sign tracking and instant messaging systems, allowing timely responses to patient needs. Emergency situations are managed 24/7 through direct links to urgent care services, with paramedics and ambulances available as needed, along with thorough education for family members on emergency response protocols.

In-home interventions are tailored to each patient's diagnosis and commonly include antibiotic therapy for infectious diseases, intravenous hydration, wound care, and the use of feeding and urinary catheters. Additional treatments may involve oxygen administration for patients requiring respiratory support. These interventions aim to address any acute or subacute needs identified through regular assessments. Basic laboratory tests are collected at home by nursing staff and analyzed at the hospital laboratory, while advanced imaging studies are scheduled for assisted hospital visits if necessary. This model enhances the continuity of care for acute and subacute conditions, minimizing the need for travel and hospital visits.

Hospital Clinica Nova's HAH model provides hospital-level care at home, closely following the World Hospital at Home Congress (WHAH) Congress definition through specialist-led management, daily nursing visits, telemedicine for remote monitoring, and urgent escalation protocols. Our interventions include palliative care, wound care, and basic lab testing conducted at home, ensuring continuity of acute-level care as an alternative to traditional hospital stays. However, unlike the WHAH model's 24/7 availability, our HAH services operate daily from 8 a.m. to 8 p.m, with education to patients in case of alarm signs, and availability to reference them to the emergency room in case of needing help outside attention hours. Additionally, advanced diagnostic procedures, such as imaging, require patients to visit

the hospital, as these are not yet available in-home. Our model of HAH includes taking care of both acute and subacute patients.

The inclusion criteria encompassed individuals of both genders aged over 70 who received visits from the HAH program throughout 2022 and had updated clinical records and reported costs generated by the program as of the study date. Patients who needed intensive care unit (ICU) care throughout the follow-up or died during the study were excluded. No probabilistic sampling was conducted. Data selection relied on the visits made by the HAH program within the included year. A formal sample size was not determined, as all patients from the HAH program were included in the analysis.

We examined the expenses associated with a total of 416 home visits made to 49 patients aged over 70 years of age enrolled in the HAH program during 2022. Data was gathered from the patients' clinical records, and the cost of medication and procedures was assessed by the hospital's financial and technological departments. Additionally, data on the costs and hospitalizations of patients aged 70 and older in traditional hospital settings were analyzed to calculate the per capita costs for hospitalized patients in 2022. This analysis allowed for a comparison of overall per capita costs and the cost differences associated with the most common diagnoses treated in the Hospital-at-Home program. Monetary values were converted from Mexican pesos to US dollars using an exchange rate of 1 dollar to 19.4143, as revised in the Bank of Mexico on the day of the last visit conducted by the HAH program (December 28th, 2022). This conversion is reflected throughout this research [22].

The variables involved in this research were divided into three groups: demographic variables, those related to patients' medical procedures and treatments, and those related to patients' diagnoses. For the first group, variables include gender, age, retired work status, number of days admitted to the hospital through the follow-up, and number of days taken care of with the HAH program. The second group was composed of variables like medications, laboratory

studies, provided service and procedure materials were included while the second group was composed of different diagnoses. The second group included the following variables: use of laboratory services, antibiotics, wound care materials, anticoagulants, neuropsychiatric drugs, antacids, sleep regulators, geriatric consult, antifungals, procedure materials, IV fluids, dietary supplements, ointments, antihypertensives, analgesics, corticosteroids, hypoglycemic agents, antispasmodics, antiemetics, diuretics, cardiac drugs, statins, probiotics, dental medications, bronchodilators, mucolytics, nasal sprays, laxatives, thyroid hormone replacement therapy, antidiarrheals, antihistamines, and hepatoprotective supplements. The aforementioned variables were assessed in a dichotomic manner. The grouping of the variables is shown in Table S1. Grouping of Variables from the supplemental material documents.

A total of 71 diagnoses were found, which then were categorized into different groups, including infectious disorders, cancer, muscular system disorders, digestive system disorders, urinary system disorders, neurogeriatric disorders, cardiometabolic disorders, pulmonary system disorders, general health disorders, and disorders related to medical care and procedures. Each diagnostic group was developed considering the characteristics of each diagnosis and implications regarding treatment, as well as the specific system of the human body which was affected. The aforementioned variables were assessed in a dichotomic manner, and the categorization of the diseases is shown in Table S2. Grouping of Diagnosis from the supplemental material documents.

Data were gathered from clinical records and hospital expense records using a spreadsheet. The distribution of quantitative variables was analyzed using Shapiro-Wilk and histograms, indicating a non-normal distribution. Categorical data were expressed in frequencies and percentages, while non-normal data were described using median and interquartile ranges. A univariable analysis was conducted. The Mann-Whitney U test, a nonparametric statistical

method, was applied to compare non-normal quantitative continuous data in our study. The multivariable analysis was a multiple linear regression where the dependent variable was the program's costs per patient, and the independent variables were groups of diagnosis, procedures, and drugs used by the patients. Multiple linear regression was chosen to identify the independent impact of each variable on the total costs, controlling for potential confounders and allowing for the evaluation of the relative importance of each factor. The variables were chosen upon significant p-values in the previous tests; collinearity was evaluated and addressed by removing variables with a variance inflation factor exceeding 10. Subsequently, the model underwent refinement, eliminating variables without statistical significance to reach the best R-squared value. All assumptions of multiple linear regression were met. Analysis was conducted through complete case data. A level of $p<0.05$ was considered statistically significant, and data analysis was carried out using SPSS, version 29.0.2.0 (IBM Corp. IBM SPSS Statistics for Windows, Armonk, NY).

Since this was a retrospective cross-sectional study there was no patient or public involvement.

Results

Descriptive statistics

This study initially involved a total of 64 patients. After applying the previously mentioned selection criteria, encompassing age above 70 years old, data on HAH costs during 2022 and complete data in clinical files, the analysis was conducted on 49 patients (this is the total population). Patients had a median (IQR) age of 86 (9) years and consisted of 31 (63.3%) female subjects, with a median (IQR) of 6 (7) days of HAH visits and 12 (19) days admitted for traditional hospitalization. Demographic data is shown in Table 1.

Table 1. Patient's demographic characteristics.

Variable	n=49 (%)
Female	31 (63.3)
Age (years)*	86 (9)
Retirees	46 (93.9)
Consultation Service †	46 (93.9)
Laboratories ‡	24 (49.0)
Patients with Palliative Care	25 (51)
Days in HAH program*	6 (7)
Days admitted in hospital*	12 (19)
Overall cost (US dollars)*	844.87 (1652.19)

*Median (Interquartile range)

† Use of the geriatric consultation service in HAH

‡ Use of laboratory studies regarding blood tests, urine tests, among others during HAH stay.

Differences in costs across diagnostic groups, procedures, and treatments

A total of 71 diagnoses were presented, which were classified into 10 groups. Among these, the grouping of infectious disorders had the highest number of patients [27 (55.1%)], followed by the groupings of cancer and muscular system disorders, where 9 (18.4%) patients were grouped into each category. Regarding the differences in costs by diagnosis grouping, the median (IQR) cost when a disease from the pulmonary disorders group was present was 2.7 times higher compared to its absence [$2,058.48 ($1,459.95) vs. $753.98 ($1,493.54), p= 0.027]. For disorders related to medical care and procedures, 3.67 times higher [$2,931.24 ($1,144.72) vs $804.77 ($1,558.18), p= 0.044], and for infectious disorders, 1.8 times higher compared to its absence [$1,319.85 ($2,125.65) vs. $726.17 ($1,198.34), p=0.052]. Differences in costs by diagnosis grouping are shown in Table 2.

Table 2. Cost differences by diagnostic grouping.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Cancer	9 (18.4%)	406.66 (2058.79)	846.39 (1391.04)	0.73
Cardiometabolic disorders	6 (12.2%)	528.12 (567.47)	848.03 (1608.56)	0.30
Urinary system disorders	7 (14.3%)	1124.27 (2340.13)	804.77 (1582.91)	0.19
Digestive system disorders	8 (16.3%)	1402.21 (2008.62)	809.97 (1516.72)	0.23
Neurogeriatric disorders	7 (14.3%)	1124.27 (1135.25)	827.33 (1740.27)	1.00
Muscular system disorders	9 (18.4%)	871.26 (1348.39)	827.33 (1536.34)	0.60
General health disorders	3 (6.1%)	2860.83 (1041.60)	804.77 (1558.18)	0.12
Disorders related to medical care and procedures	3 (6.1%)	2931.24 (1144.72)	804.77 (1558.18)	0.044
Infectious disorders	27 (55.1%)	1319.85 (2125.65)	726.17 (1198.34)	0.052
Pulmonary system disorders	3 (6.1%)	2058.48 (1459.95)	753.98 (1493.54)	0.027

*Performed using the Mann-Whitney U test

Regarding materials and medications, procedure materials were used for 46 (93.9%) patients, while intravenous solutions were used for 45 (91.8%). Antibiotics were used by 37 (75.5%) of the patients, and analgesics by 32 (65.3%) patients. The median (IQR) of the differences in costs related to medical procedures and treatments was notably higher in several categories, including laboratory studies [$1,560.14 ($2,112.62) vs. $473.05 ($969.18), p<0.001], antibiotics [$1,170.07 ($1713.84) vs. $376.01 ($543.67, p=0.003], wound care materials [$1,319.85 ($1,631.43) vs $418.61 ($666.88), p=0.010], anticoagulants [$2,976.00 ($930.91) vs. $799.62 ($1,516.72), p=0.009], neuropsychiatric drugs [$1,654.55 ($2,007.85) vs. $579.42 ($928.03), p=0.009], antacids [$1,605.67 ($1,764.16) vs $717.92 ($700.82), p=0.010], and sleep regulators [$3,231.23 ($1,654.50) vs $777.62 ($1,292.71), p<0.001]. The differences in costs related to medical procedures and treatments are detailed in Table 3.

Table 3. Differences in costs by medical procedures and treatments.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Consultation Services	46 (93.9)	859.68 (1572.55)	181.46 (114.55)	0.10
Palliative Care	25 (51)	15725,1 (35484.8)	19590.1 (31680.3)	0.92
Laboratories	24 (49.0)	1560.14 (2112.62)	473.05 (969.18)	<0.001
Antibiotics	37(75.5)	1170.07 (1713.84)	376.01 (543.67)	0.003
Wound Care Materials	33 (67.3)	1319.85 (1631.43)	418.61 (666.88)	0.010
Anticoagulants	4(8.2)	2976.00 (930.91)	799.62 (1516.72)	0.009
Neuropsychiatrics	22(44.9)	1654.55 (2007.85)	579.42 (928.03)	0.009
Antacids	23(46.9)	1605.67 (1764.16)	717.92 (700.82)	0.010
Sleep regulators	6(12.2)	3231.23 (1654.50)	777.62 (1292.71)	<0.001
Antifungals	9(18.4)	1352.56 (2029.64)	753.98 (1541.13)	0.046

Procedure materials	46(93.9)	859.68 (1572.55)	200.88 (119.71)	0.026
IV Fluids	45(91.8)	871.26 (1526.35)	303.75 (230.76)	0.020
Dietary supplements	3 (6.1)	1319. 85 (1290.96)	804.77 (1648.42)	0.23
Ointments	14(28.6)	1261.29 (1981.53)	777.62 (1565.55)	0.21
Antihypertensives	4(8.2)	1956.75 (2535.19)	844.69 (1581.41)	0.34
Analgesics	32(65.3)	1368.32 (1628.03)	713.86 (627.37)	0.046
Corticosteroids	11(22.4)	809.97 (1787.03)	857.98 (1558.18)	0.71
Hypoglycemic agents	4(8.2)	2184.83 (2359.65)	809.97 (1581.41)	0.12
Antispasmodics	11(22.4)	1703.44 (1569.41)	804.77 (1437.29)	0.30
Antiemetics	11(22.4)	1978.28 (1981.53)	753.98 (1173.05)	0.035
Diuretics	10(20.4)	2373.82 (2216.77)	799.62 (1292.71)	0.047
Cardiac drugs	1 (2%)	3199.65 (0)	827.33 (1584.46)	0.20
Statins	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Probiotics	2 (4.1%)	508.39 (221.90)	848.03 (1641.78)	0.35
Dental medications	1 (2%)	3706.24 (0)	827.33 (1548.86)	0.12
Bronchodilators	8(16.3)	2009.14 (2628.58)	777.62 (1325.11)	0.07
Mucolytics	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Nasal sprays	2 (4.1%)	2529.37 (1176.86)	809.97 (1616.64)	0.18
Laxatives	13(26.5)	2058.48 (1844.47)	680.89 (1307.80)	0.016
Thyroid hormones	2 (4.1%)	1889.54 (1310.12)	844.69 (1616.64)	0.58
Antidiarrheals	1 (2%)	334.24 (0)	846.39 (1634.83)	0.40
Antihistamines	1 (2%)	2856.19 (0)	827.33 (1584.86)	0.28
Hepatoprotectors	1 (2%)	2689.15 (0)	827.33 (1584.86)	0.36

*Performed using the Mann-Whitney U test

Main Predictors of Total Costs in the HAH Program

The results from the linear regression analysis for predicting total HAH costs showed a statistically significant positive association with disorders related to medical care and procedures β=0.333 (95%CI: 12,957.2, 52,211.2). Particularly noteworthy were the associations with sleep-regulating drugs β=0.561 (95%CI: 26,240.6, 54,044.1), laxatives β=0.330 (95%CI: 7,238.6, 27,828.0), and anticoagulants β=0.228 (95%CI: 2,527.39, 36,594.85). For more detailed information, please consult Table 4, which presents a comprehensive breakdown of these results.

Table 4. Linear regression for predicting total HAH costs.

Variable	β	Standardized β	t value	95% Confidence Interval		p-value
				Inferior	Superior	
Disorders related to medical care and procedures	32,584.2	0.333	3.35	12,957.21	52,211.20	0.002
Sleep regulators	40,142.3	0.561	5.82	26,240.57	54,044.08	<0.001
Laxatives	17,533.3	0.330	3.42	7,238.63	27,828.01	0.001
Anticoagulants	19,561.1	0.228	2.31	2,527.39	36,594.85	0.025

Corrected R^2: 0.567

Differences between Traditional Hospitalization and Hospital at Home program

In 2022, the hospital incurred a total cost of $2,206,628.26, resulting in a per capita cost of $5,716.61 in patients aged >70 years old. For the Hospital-at-Home (HAH) program, including transportation costs, the expense was $86,469.36, with a per capita cost of $1,764.68, p<0.001. The median (IQR) number of days in the HAH program was 6 (7) days, while the median (IQR) hospitalization duration for the patients in the study was 12 (19) days. Additionally, the median (IQR) percentage of days spent in the HAH program instead of traditional hospitalization was 40% (41.67).

Patients with infectious disease-related conditions incurred significantly higher per capita costs (p.c.c.) and median costs (IQR) in traditional hospitalization compared to hospital-at-home care. Specifically, the traditional hospitalization group had a p.c.c. of 126,389 and a median cost of 45,271 (142,615), while the hospital-at-home group had a p.c.c. of 32,831 and a median cost of 7,895 (39,970), with $p < 0.001$. Similarly, patients with muscular system disorders experienced significantly higher costs in traditional hospitalization, with a p.c.c. of 169,421 and a median cost of 55,884 (76,369), compared to a p.c.c. of 29,397 and a median cost of 16,915 (26,178) in hospital-at-home care ($p = 0.034$). In contrast, for patients with cancer-related conditions, there was no statistically significant difference in costs between traditional hospitalization and hospital-at-home care. The traditional hospitalization group had a p.c.c. of 58,423 and a median cost of 30,154 (26,470), compared to a p.c.c. of 30,785 and a median cost of 7,895 (39,970) in the hospital-at-home group ($p = 0.3$).

Discussion

A total of 49 patients were studied to assess the cost of HAH care. We found that the most relevant factors predicting the cost of HAH were medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants. The per capita cost of the HAH program was three times lower than traditional hospitalization, resulting in 40% of patients' days of care utilizing the HAH program instead of traditional hospitalization. Figure 1 shows a summary of the development of the study, the explanation of the findings, and the economic differences between the costs of the traditional hospitalization vs. HAH approaches, along with the potential impact of the program's implementation across multiple levels.

Figure 1 HAH program assessment and potential benefits. In the subheading "Types of variables" are described the two types of variables used for the study, then for "Phase 1" of the analysis, a univariable analysis was run to understand which variables affected the HAH

program costs and they were used to develop the Multivariable Analysis from "Phase 2", which underscores the importance of sleep regulators, laxatives, anticoagulants and disorders related to medical care and procedures. Posteriorly, the comparison to the literature was assessed and expressed in the explanation. Then, in the subheading "Difference of Hospitalization costs & Attention days", total cost and cost per capita are compared between the classic model of patients staying in the hospital versus the at-home model, and with it, the median number of days spent by the patients in each one of those. In the end, the possible impact of the HAH programs is assessed at different levels: patient, institutional and public level.

In our study, a group of diagnoses named medical and surgical care-related disorders, which was composed of sequelae of complications from medical and surgical care, significantly influenced the HAH program's overall cost. Previous research on the economic considerations of surgical care and healthcare policies found that the financial impact of complications following abdominal surgery costs escalated significantly, with minor complications leading to a doubling of costs [23]. Another study found that complicated cases result in triple the average cost. [24] This aligns with our findings as all three studies show how complications can substantially increase healthcare costs, albeit in different healthcare settings.

Aging individuals often encounter increased sleep-related issues, with approximately half of older adults expressing dissatisfaction with sleep quality [25]. [26] Sleep regulators notably impacted the HAH program's costs among the drug categories assessed in our study. A prospective observational study on the costs of insomnia revealed that medication expenses comprised the most considerable portion (69.94%) of total direct costs. At the same time, productivity loss was the primary contributor to the overall economic burden, followed by medication. [27] This finding is supported by a review indicating extensive healthcare resource utilization among patients with insomnia. [28] Our study population primarily comprised geriatric retired individuals, which nullifies the cost of productivity loss and stresses the economic

burden attributed to medication. These findings highlight the importance of addressing sleep health in geriatric care to manage costs effectively.

Constipation is a common issue within the ageing population [29], and half of the overall expenses related to this impediment are due to doctor visits, surpassing expenditures on both antihypertensive drugs and contraceptives in the UK's National Health System.[30] Similarly, we found that laxatives significantly influenced the overall cost of the HAH program. In a cost-effectiveness analysis evaluating the economic balance of medical intervention against alternative therapies for constipation, the researchers determined that laxatives are costly and not cost-effective compared to dietary management. [31] Our study exclusively enrolled patients aged 70 and above, leading to an increased number of patients requiring laxative therapy. In the elderly, the constraints posed by decreased physical activity, polypharmacy, and comorbidities make constipation prevalent and laxative use often necessary. [32]

Approximately seven million individuals globally rely on anticoagulants. These medications are commonly prescribed for health issues, including myocardial infarction, unstable angina, and acute coronary syndrome, whether in hospital or outpatient settings. [33] In our study, the cardiometabolic disorders group was not significantly expensive within the HAH program. However, anticoagulants, a medication group including apixaban, enoxaparin, and heparin, represented a significant economic burden. In a prospective cohort study of patients receiving anticoagulants for any indication in the hospital's cardiology ward, enoxaparin stood out as the costliest anticoagulant, contributing even more to the overall financial impact when factoring in the expenses associated with its monitoring [33]. This underscores the importance of carefully managing and monitoring anticoagulant therapy to optimize cost-efficiency while ensuring patient safety.

In our study, the per capita cost of the HAH program was three times lower compared to the hospital per capita cost. Specifically, for infectious disease-related conditions, the per capita cost of traditional hospitalization was approximately 3.85 times higher than that of the HAH program. Similarly, for muscular system disorders, the per capita cost in traditional hospitalization was approximately 5.76 times higher than in the HAH program. In a study describing the implementation and evaluation of a healthcare delivery model known as "Hospital at Home", the per-patient cost excluding physician fees for Hospital at Home was compared to the variable costs per case for acute care inpatients, which also excluded physician fees, resulting in an average HAH patient cost 19% lower compared to traditional hospital setting per capita cost. [6] In contrast to this study, physician fees were included for both groups, but our HAH costs remained lower. The same study explains that these savings were due primarily to shorter average hospital stays and reduced utilization of clinical tests. This supports our results since, although patients may have initially required hospitalization, further care was provided at home, resulting in patients receiving care at home through the HAH program instead of traditional hospital stay during 40% of their total period of care and probably limiting the request of laboratory studies only when necessary.

Our study has potential implications for practice. At the patient level, HAH programs could enhance convenience and safety since patients benefit from reduced stress and heightened comfort in home environments and support from family [34]. Furthermore, the reduced risk of infection, a notable advantage of home-based care, suggests improved health outcomes [35]. On an institutional level, HAH can generate cost savings by reducing bed occupancy, alleviating congestion within hospitals, and through more efficient resource management, as was needed during the pandemic of COVID-19 [36]. This is also true on a public level, as HAH models contribute to optimized healthcare delivery and disrupt the transmission of infectious diseases,

fostering healthier populations. Moreover, integrating home-based care with community services promotes synergistic benefits for the healthcare system across multiple levels.

Implementing HAH programs on a larger scale presents organizational challenges, such as establishing new departments for patient transportation logistics, medical equipment supplies chain management, and coordination with home health providers. These departments must integrate into hospitals' existing structure through changes in administrative and operational workflows. Additionally, expanding HAH programs successfully depends on developing robust training programs for healthcare providers, including training in telemedicine, remote patient monitoring, and home-based medical procedures. [1] From a public health policy perspective, scaling up HAH programs require substantial investment in healthcare infrastructure and resources. Policymakers need to create supportive frameworks and funding models to integrate HAH into the broader healthcare system, address healthcare disparities, and invest in technologies for remote care delivery in underserved areas to ensure equitable access to home-based care. [34]

While our study provides valuable insights into the cost-effectiveness of the HAH program compared with traditional hospitalization, some limitations should be considered. Firstly, the time of the study was limited to one year and involved a relatively small population size of the HAH program, limiting the statistical power and generalizability of our findings. To compensate, we used the whole population as our sample. Additionally, this is a retrospective study design; thus, we had to rely on the existing information on the medical records. Future research should consider a prospective study to understand the sustainability of the program and assess variables related to the optimization and development of logistics for the program. Although the HAH model has the potential benefit of reducing expenses and increasing patients' comfort, this conclusion was made with the per capita cost for each patient and does not imply a normal distribution for this data. Additionally, differences in eligibility criteria,

acuity levels, and diagnoses during the COVID-19 pandemic between the two populations make direct cost comparisons challenging. These factors reflect the early-stage implementation of the program, which was not designed to mirror the entirety patient profile or complexity typically seen in traditional hospital settings. Future research should aim to assess costs after the program has reached greater maturity, potentially incorporating matched cohorts or adjusted analyses to improve comparability. Before attempting to extrapolate this study's findings, it must be considered that laboratory prices were included for comparing home hospitalization and traditional hospitalization. In contrast, other studies do not take laboratory expenses as part of the HAH.

Conclusion

The results of this study suggest that the most relevant factors influencing the overall cost of the HAH program were medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants. Also, the HAH program's per capita cost is three times lower compared to the per capita cost of hospitalization, proving the cost-effectiveness of the HAH program. The results of this research underscore the significance of considering the economic factor when implementing home hospitalization programs in Mexico. It's clear that this approach doesn't just provide a financially viable substitute for the traditional hospital model but also has the potential to yield substantial savings in healthcare costs. HAH programs can play a pivotal role in advancing healthcare delivery and achieving better economic outcomes by focusing on key cost-driving factors and optimising resource allocation.

Conflict of Interest

The authors declare no financial or personal conflict of interest.

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Data Statement

Data is available upon reasonable request to the authors.

Authors' Contributorship statement

The contributions of each author to this manuscript are outlined as follows: AG-S and OIGP jointly conceptualized the study, with M.E.R-I also contributing to this phase. AG-S and OIGP developed the methodology. JSGO and AG-S worked on the software utilized in the study. The validation of the results was conducted by AG-S, OIGP, and M.E.R-I. JSGO and AG-S were responsible for the formal analysis and investigation. Resources were provided by M.E.R-I, DLVP, NDTV, MASS, and MHG. Data curation was handled by JSGO and AG-S. The original draft was written by JSGO, with OIGP assisting in this process. The manuscript was reviewed and edited by JSGO, AG-S, OIGP, and I.F.F-C. The visualizations were created by JSGO and AG-S. M.E.R-I took on the role of supervising the project. Project administration was carried out by M.E.R-I and OIGP. Funding acquisition was managed by M.E.R-I, MASS, and MHG. Finally, the guarantor is M.E.R-I.

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Figure 1. Comparative analysis of the Hospital at Home (HAH) program and traditional hospital care: This figure summarizes the study's phases, highlighting key variables influencing HAH program costs, and presents a direct comparison of total and per capita costs between HAH and traditional hospital care. It also depicts the reduction in hospitalization days and the broader impact on patient, institutional, and public levels.

Types of Variables

Medical Procedures & Treatments

Diagnostic Grouping

Univariable Analysis

Significant Variables

- Service Costs
- Laboratory Studies
- Antibiotics
- Antifungals
- Healing Materials
- Procedure Materials
- Intravenous Solutions
- Analgesics
- Anticoagulants
- Neuropsychiatrics
- Antacids
- Antiemetics
- Diuretics

- Pulmonary Disorders
- Disorders Related to Medical Care and Procedures
- Infectious Disorders

Phase 1

Multivariable Analysis

Adjusted R^2= 0.564

- Sleep Regulators
- Laxatives
- Anticoagulants
- Disorders Related to Medical Care and Procedures

Phase 2

Explanation

Relation to Literature by Variable

Above 65 years old, sleep-related issues affect 25-40%, and approximately 11.9% take medications to improve sleep. These same medications represent one of the highest direct costs associated with insomnia. [22-25]

Constipation is highly prevalent in patients over 65 years old, making laxative treatment necessary for this group. However, these treatments are known to be costly, exceeding expenditures on extensive use medications like antihypertensives. [26-27]

The economical weight caused by the anticoagulants could be related to the use of enoxaparin, which was widely used in the hospital at home patients. [30]

Complications related to procedural or surgical settings can increase the overall costs for patients, escalating from 2 to 3 times the original cost. [20,21]

Difference of Hospitalization Costs & Attention Days

Classic Model

Total Cost

$2,206,628.26

Cost Per Capita

$5,716.61

Days: 6 (7)*

At-Home Model

Total Cost

$86,469.36

Cost Per Capita

$1,764.68

Days: 12 (19)*

*Presented in Median (IQR)

Impact

Patient level

- Comfort and Convenience
- Family Involvement
- Reduced Infection Risk

Institutional level

- Reduced Bed Occupancy
- Cost Savings
- Efficiency in the management of resources.

Public level

- Cost saving by efficient resource utilization.
- Reduced transmission of infection.
- Integration with community services.

Table 1. Patient's demographic characteristics.

Variable	n=49 (%)
Female	31 (63.3)
Age (years)*	86 (9)
Retirees	46 (93.9)
Consultation Service †	46 (93.9)
Laboratories ‡	24 (49.0)
Patients with Palliative Care	25 (51)
Days in HAH program*	6 (7)
Days admitted in hospital*	12 (19)
Overall cost (US dollars)*	844.87 (1652.19)

*Median (Interquartile range)

† Use of the geriatric consultation service in HAH

‡ Use of laboratory studies regarding blood tests, urine tests, among others during HAH stay.

Table 2. Cost differences by diagnostic grouping.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Cancer	9 (18.4%)	406.66 (2058.79)	846.39 (1391.04)	0.73
Cardiometabolic disorders	6 (12.2%)	528.12 (567.47)	848.03 (1608.56)	0.30
Urinary system disorders	7 (14.3%)	1124.27 (2340.13)	804.77 (1582.91)	0.19
Digestive system disorders	8 (16.3%)	1402.21 (2008.62)	809.97 (1516.72)	0.23
Neurogeriatric disorders	7 (14.3%)	1124.27 (1135.25)	827.33 (1740.27)	1.00
Muscular system disorders	9 (18.4%)	871.26 (1348.39)	827.33 (1536.34)	0.60
General health disorders	3 (6.1%)	2860.83 (1041.60)	804.77 (1558.18)	0.12
Disorders related to medical care and procedures	3 (6.1%)	2931.24 (1144.72)	804.77 (1558.18)	0.044
Infectious disorders	27 (55.1%)	1319.85 (2125.65)	726.17 (1198.34)	0.052
Pulmonary system disorders	3 (6.1%)	2058.48 (1459.95)	753.98 (1493.54)	0.027

*Performed using the Mann-Whitney U test

Table 3. Differences in costs by medical procedures and treatments.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Consultation Services	46 (93.9)	859.68 (1572.55)	181.46 (114.55)	0.10
Palliative Care	25 (51)	15725,1 (35484.8)	19590.1 (31680.3)	0.92
Laboratories	24 (49.0)	1560.14 (2112.62)	473.05 (969.18)	<0.001
Antibiotics	37(75.5)	1170.07 (1713.84)	376.01 (543.67)	0.003
Wound Care Materials	33 (67.3)	1319.85 (1631.43)	418.61 (666.88)	0.010
Anticoagulants	4(8.2)	2976.00 (930.91)	799.62 (1516.72)	0.009
Neuropsychiatrics	22(44.9)	1654.55 (2007.85)	579.42 (928.03)	0.009
Antacids	23(46.9)	1605.67 (1764.16)	717.92 (700.82)	0.010
Sleep regulators	6(12.2)	3231.23 (1654.50)	777.62 (1292.71)	<0.001
Antifungals	9(18.4)	1352.56 (2029.64)	753.98 (1541.13)	0.046
Procedure materials	46(93.9)	859.68 (1572.55)	200.88 (119.71)	0.026
IV Fluids	45(91.8)	871.26 (1526.35)	303.75 (230.76)	0.020
Dietary supplements	3 (6.1)	1319. 85 (1290.96)	804.77 (1648.42)	0.23
Ointments	14(28.6)	1261.29 (1981.53)	777.62 (1565.55)	0.21
Antihypertensives	4(8.2)	1956.75 (2535.19)	844.69 (1581.41)	0.34
Analgesics	32(65.3)	1368.32 (1628.03)	713.86 (627.37)	0.046
Corticosteroids	11(22.4)	809.97 (1787.03)	857.98 (1558.18)	0.71
Hypoglycemic agents	4(8.2)	2184.83 (2359.65)	809.97 (1581.41)	0.12
Antispasmodics	11(22.4)	1703.44 (1569.41)	804.77 (1437.29)	0.30
Antiemetics	11(22.4)	1978.28 (1981.53)	753.98 (1173.05)	0.035
Diuretics	10(20.4)	2373.82 (2216.77)	799.62 (1292.71)	0.047
Cardiac drugs	1 (2%)	3199.65 (0)	827.33 (1584.46)	0.20
Statins	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Probiotics	2 (4.1%)	508.39 (221.90)	848.03 (1641.78)	0.35
Dental medications	1 (2%)	3706.24 (0)	827.33 (1548.86)	0.12
Bronchodilators	8(16.3)	2009.14 (2628.58)	777.62 (1325.11)	0.07
Mucolytics	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Nasal sprays	2 (4.1%)	2529.37 (1176.86)	809.97 (1616.64)	0.18
Laxatives	13(26.5)	2058.48 (1844.47)	680.89 (1307.80)	0.016
Thyroid hormones	2 (4.1%)	1889.54 (1310.12)	844.69 (1616.64)	0.58
Antidiarrheals	1 (2%)	334.24 (0)	846.39 (1634.83)	0.40
Antihistamines	1 (2%)	2856.19 (0)	827.33 (1584.86)	0.28
Hepatoprotectors	1 (2%)	2689.15 (0)	827.33 (1584.86)	0.36

*Performed using the Mann-Whitney U test

Table 4. Linear regression for predicting total HAH costs.

Variable	β	Standardized β	t value	95% Confidence Interval		p-value
				Inferior	Superior	
Disorders related to medical care and procedures	32,584.2	0.333	3.35	12,957.21	52,211.20	0.002
Sleep regulators	40,142.3	0.561	5.82	26,240.57	54,044.08	<0.001
Laxatives	17,533.3	0.330	3.42	7,238.63	27,828.01	0.001
Anticoagulants	19,561.1	0.228	2.31	2,527.39	36,594.85	0.025

Corrected R^2: 0.567

Supplemetal Materials

Table S1. Grouping of Variables

Variables	Medicines/materials/labs
Laboratories	Complete Blood Count (CBC), Cytochemical Analysis Of Peritoneal Fluid, Creatine Kinase-MB (CK-MB), Creatine Phosphokinase (CPK), Stool Test, Wound Culture, Peritoneal Fluid Culture, Throat Culture, Lactate Dehydrogenase (LDH), D-Dimer, Urine Electrolytes (Single Sample), Blood Electrolytes, Thyroid-Stimulating Hormone (TSH), Blood Culture, Thyroid-Stimulating Hormone, NT-Probnp (N-Terminal Pro B-Type Natriuretic Peptide), Urinalysis, Biochemical Profile, Thyroid Profile, Procalcitonin, C-Reactive Protein (CRP), COVID-19 PCR Test, Rapid COVID-19 Antigen Test, Rapid Influenza A + B Test, Blood Chemistry, Fecal Immunochemical Test (FIT) For Occult Blood, Prothrombin Time (PT), Partial Thromboplastin Time (PTT), Troponin I, Urine Culture, Vitamin D (25-Hydroxy).
Antibiotics	Cefixime 400 Mg Capsule/Denvar C/10, Ceftazidime 1g Ampoule/Izadima, Ceftriaxone 500mg IV/Cefaxon, Ceftriaxone 1g IM Ampoule/GI Amsa 1 Ampoule, Ceftriaxone 1g IM Ampoule/Amsa Amcef 1 Ampoule, Ceftriaxone 1g IV/Cefaxon, Ceftriaxone 1g IV/Ceftrex 1 Ampoule, Ciprofloxacin 200 Mg Ampoule/Ciprobac, Ciprofloxacin 500mg Tablet/Ciprobac C/14, Clindamycin 600 Mg Ampoule/Dalacin C, Cefepime Hydrochloride Injection/Imation C/1, Dicloxacillin 500mg Capsules/Butimaxil C/20, Ertapenem 1g Ampoule/Invanz IV, Imipenem Cilastatin 500mg IV Ampoule/GI Pisa, Levofloxacin 500mg Tablet/Evocs III C/7, Levofloxacin 500mg Tablet/Lefloxin C/7, Levofloxacin 500mg Injection/Flouning Flexova, Linezolid 2mg/Ml/Yaprinca 300ml Injection, Meropenem 1g IV Ampoule/Merrem, Meropenem 1g IV Ampoule/Pisapem C/1, Moxifloxacin 400mg Ampoule/Avelox Amp, Silver Sulfadiazine/Argental Tube 28g, Trimethoprim-Sulfamethoxazole 160/800mg/Bactropin.
Wound care materials	Antiseptic EXGERM 1 Liter For EXGERM Hands, MICROPORE Tape 1/2 3M M.1530-0, TRANSPORE Tape 1 3M M.1527-1, TRANSPORE Tape 1/2 3M M.1527-0, Chlorhexidine JBN .12% CLORHEXI-CLEAN 60M, Sterile Gauze 10x10 PROTEC, Simple Gauze 10x10cm With 200 Pieces Non-Sterile, Blue Surgical Cap TECNOL TR, Sterile MEDI-GRIP Glove 6-1/2, Sterile Latex Glove CH AMBI M.0604560383, Sterile Latex Glove MED M.064560391, Non-Sterile Latex Glove CH M.D-04340-S, Non-Sterile Latex Glove MED M.D-04341-M, Cotton/Alcohol SWABS BD M.326899, TEGADERM 10x12cm 3M M.1626W, TEGADERM 6x7cm 3M

	M.1624W, TEGADERM CHG 10x12cm REF. 1658R With 25 Pieces, Gauze Bandage 10cm LE ROY, Gauze Bandage 5cm LE ROY, Gauze Bandage 7cm LE ROY, Elastic Bandage 5cm ELASTOMEDIC, Elastic Bandage 7cm LE ROY, White Elastic Bandage 10cm LE ROY, White Elastic Bandage 5cm LE ROY.
Anticoagulants	Apixaban 2.5mg Tablets/Elicuis C/60, Enoxaparin 20mg Injection/Bolenax C/2 Ampoules, Heparin 1000 U 10ml Ampoule/Heparin Pisa.
Neuropsychiatrics	Alprazolam 0.25mg/Neupax C/30 Tablets, Alprazolam 0.50mg/Neupax C/30 Tablets, Clonazepam 2mg/Kriadex C/30 Tablets, Escitalopram 10mg Tablet/Lamobrigan C/28 SDMDU, Haloperidol 2mg/Ml Drops/Haloperil 15ml, Haloperidol 5mg/Haldol C/20 Tablets, Haloperidol 5mg Injection/Pisa C/6 Ampoules, Levetiracetam 100mg I.V./Keppra C/10 Injections, Levetiracetam 500mg Tablet/Kepra C/30, Memantine 10mg Tablet/Eutebrol 10mg C/30, Midazolam 50mg/10ml Ampoule/Relacum C/5, Paroxetine 20mg/Andepa C/20 Tablets, Pregabalin 25mg Capsule/Lyrica C/28, Pregabalin 75mg Capsule/Dismodox C/28 SDMDU, Quetiapine 100mg/Seroquel C/30 Tablets, Quetiapine 25mg/Q-Mind C/28 Tablets, Sertraline 50mg Tablet/Sertex C/28.
Antacids	Magaldrate + Dimethicone Gel / Galaver 250ml, Omeprazole 20mg Capsule / G.I. Ultra C/30, Omeprazole 40mg Injectable Solution 10ml / GI Pisa, Pantoprazole 40mg Tablet / Apotex (Efectr) C/14, Pantoprazole I.V. Ampoule / Supacid C/1.
Sleep regulators	Melatonin 3mg Tablet / Cronocaps C/30
Consultation services	Intramuscular Injection Application, Intravenous Injection Application, Urinary Catheter Application Or Change, Geriatrics Consultation, First-Time Geriatrics Consultation, Subrogated Fees, Geriatric Hospitalization At Home, Home Hospitalization By Nursing Staff, Geriatric Assessment At Home By Nurse, Geriatric Assessment At Home By Geriatrician, Home Nursing Visit.
Antifungals	Fluconazole 100mg / Diflucan C/10 Capsules, Fluconazole 100mg Injection / Flucoxan C/1, Fluconazole 150mg Capsule / Afungil C/1, Fluconazole 50ml Ampoule / Diflucan, Ketoconazole 30g Cream / Mi-Ke-Sons, Miconazole Vaginal Cream / Gynodaktarin, Nystatin 100,000 IU/Ml / Micostatin 30ml, Voriconazole 200mg Injection / Vfend Ampoule C/1.
Procedure materials	AEROCHAMBER Adult Mask TRUDELL, Sterile Water Plastic 500ml Irrigadual PISA, Sterile Injectable Water 10ml PISA, Disposable Needle 18x38mm BD M.302347, Disposable Needle 21x32mm BD M.301731, Disposable Needle 22x32mm BD M.300081, ALLEVYN ADHESIVE Dressing 12.5x12.5 Cm, Asepto Plastic Syringe AMSINO M.AS11, Round Band-Aids 7/8 C/100, Surgeon's Gown Medium BARRIER M.650101,

	Disposable Patient Gown Long Sleeve MNGA LARG TR, New Image Bag HOLLISTER M.18184, Disposable 4-Field Pack, Sterile Eye Drape BOJO01, Adult Nasal Cannula Medium REF.OPT844, Oxygen Nasal Cannula UNOMEDICAL REF.309-, Peripheral Insertion Catheter VYGON 4FR., INTROCAN SAF Catheter 20G BRAUN C.4251644, INTROCAN SAF Catheter 22G BRAUN C.4251628, INTROCAN SAF Catheter 24G BRAUN C.4251601, Peripheral Catheter 3FR. 12CM SMARTMIDLIN, CHLORAPREP 10.5ML CAT.261715, 0.9% Sodium Chloride Prefilled Syringe C/30, Extension With Microclave 15cm, FLEBOTEK 0-100 With Clave 4001968 100ml VEN, FLEBOTEK With Clave For Pump 4002759 PISA, HEMOTEK FLEBOTEK For Blood Pump PISA, PVC-Free INFUSOMAT FLEBOTEK PISA, Surgical FLEBOTEK With Clave PISA 4001967, Sterile 100ml PSU Bottle, Sterile Water Bottle 760ml With Adapter M.037-33, Disposable Cover TR, Sterile Mayo Stand Cover SIDRASA, HOME PUMP 100ml IFLOW M.C100020, I.V. START PACK With Gloves BD M.386172, KY JELLY BD M.92699, 3ml PLASTIPAK Disposable Syringe BD M.302541, 5ml PLASTIPAK Disposable Syringe BD M.302552, 10ml PLASTIPAK Disposable Syringe BD M.302560, 20ml PLASTIPAK Disposable Syringe BD, PRE-HEPARIN POSIFLUSH Syringe 3ml/100UI, PRE-FILLED POSIFLUSH Syringe 3ml/10UI, PLASTIPAK TUBERCULIN Syringe BD M.302579, Percutaneous Drainage Kit Unique 9FR. 10800, Peripheral Venipuncture Kit With Chlorhexidine, BD CONTACT-ACTIVE Lancet 21x1.8mm 366593, 2% Lidocaine 10ml Ampoule/PISACAINA C/10, HUDSON Adult Mask M.1040 WITHOUT RESERVOIR, HUDSON Adult Mask M.1060 WITH RESERVOIR, Reservoir Adult Mask 106-E UNOMEDIC, Subrogated Medical Oxygen, HOLLISTER Plates C/5 M.14804, POSIFLUSH XS BD REF.306572 Prefilled Syringe, Disposable Foot Protector PM M.SPM280, RECEPTAL 1000cc BEMIS M.7H1004R, RECEPTAL 1500cc BEMIS M.1504R, Disposable Kidney Basin LOAIZA M.H300-05, Disposable Drawer Cover TR, SILA Foley Catheter 14FR. 5cc ROCH, SILA Foley Catheter 16FR. 30cc ROCH, SILA Foley Catheter 18FR. 30cc, SILASTIC Foley Catheter 18FR. 5cc BARD, BARDIA Nelaton Catheter 16FR. M.802416, AMA K-60 14FR. Suction Catheter, Support For Venoclisis Size C SOFER, HOLLISTER Foley Catheter Holder 9781, BD Rigid Digital Thermometer M.524059, PISA Surgical Towel M.4000699, CONOX-VASO Salter Labs Connector Tube, 10 Long Suction Tube 1 AMSINO M.AS826, UROTEK ND 2LTS

	Closed System PISA, SALTER Humidifier Cup 6PSI MXSAL7600-, SURGICAL Venopack NB For Surgery PISA.
IV Fluids	DEXTROSA-HARTMAN Solution Bottle 1000ml, DEXTROSA-HARTMAN Solution Bottle 500ml PISA, DEXTROSA-NACL Solution Bottle 1000ml, DEXTROSA-NACL Solution Bottle 500ml, CS 0.9% Injectable Solution 100ml PISA, CS 0.9% Injectable Solution Bottle 1000ml, CS 0.9% Injectable Solution Bottle 250ml FLEXOVAL, CS 0.9% Injectable Solution Bottle 500ml PISA, CS 0.9% Injectable Solution Bottle 50ml PISA, DX-5 Injectable Solution Bottle 5% Glucose 50ml, DX-50 Injectable Solution Bottle 50% Glucose 50ml, HARTMAN Solution Bottle 1000ml PISA, HARTMAN Solution Bottle 500ml PISA, Sodium Chloride Solution 17.7% 10ml Ampoule PISA.
Dietary supplements	DIHEXAZINA 140ml Syrup / Viternum, Potassium Phosphate Ampoule / Potassium Phosphate / 50.
Ointments	Ac. Acexamici 5/4g Cream / Recoveron Nc, Mineral Oil Ointment / Naturalag, Triticum Vulgare With 10 Gauze / Italdermol, Triticum Vulgare Cream 30g / Italdermol.
Antihypertensives	AMLODIPINE 5mg / Pequisy C/30 Tablets, AMLODIPINE + VALSARTAN 5/160mg / Exforge C/28, ATENOLOL 100mg / Tenormin C/28 Tablets, LOSARTAN 50mg Tablets / Viopxa C/30, METOPROLOL 95mg / Lopresor R C/20 Capsules.
Analgesics	BUPRENORPHINE 10mg/Soloro Patches, BUPRENORPHINE 20mg/Transtec C/2 Patches, BUPRENORPHINE 30mg/Transtec C/4 Patches, BUPRENORPHINE 5mg/Soloro-7 C/2 Patches, CELECOXIB 200mg Capsules/G.I. Ultra C/20, DEXKETOPROFEN 25mg/10ml/Velian C/10 Sachets, DICLOFENAC 75mg/3ml Injectable Solution C/2 Genepisa, IBUPROFEN 400mg Tablets/Dolver C/10, KETOROLAC 30mg/Onemer C/3 Ampoules PISA, MORPHINE 10mg/10ml Ampoule/Graten C/5, MORPHINE 2.5mg/2.5ml Ampoule/Graten C/5, PARACETAMOL 325/37.5mg Tablet/Tafitram C/20, PARACETAMOL 500mg/Kendrick G.I. C/10 Tablets, PARACETAMOL IV 1g Ampoule/Salpifar, PARECOXIB SODIUM 40mg 0.2ml Ampoule/Dynastat.
Corticosteroids	Beclomethasone/Innovair Nexth 100/6 120d, Beclomethasone + Formoterol/Innovair 120 Doses, Budesonide 250mcg Susp/Pulmicort 2ml, Dexamethasone 8mg/2ml Ampoule/Decorex, Dexamethasone Ampoule/Alin-Depot 4mg 1x2ml.
Hypoglycemic agents	Insulin Glargine 100u/50mcg/Soliqua C/3, Insulin Glargine 300u/Ml/Toujeo 3 Pen, Insulin Lispro 3 Ml Cartridge/Humalog Mix25, Metformin 500 Mg Tablet/Dabex Xr C/30, Metformin/Sitagliptin 500/50mg Tablet Janumet C/56.
Antispasmodics	Butylhyoscine 10 Mg/ Biomesina C/10 Tablets, Butylhyoscine 20mg / Capin C/3 Ampoules, Butylhyoscine Tablets /

	Espasmotex C/ 25, Butylhyoscine/Metamizole / Busconet C/1 Ampoule.
Antiemetics	Diphenidol 40 Mg/Diphafen Amp C/2, Metoclopramide 10mg / Pramotil C/6 Amp., Ondansetron 8 Mg/ Indansen C/ 3 Amp, Ondansetron 8mg/Amal C/10 Tabs, Ondansetron 8mg/4ml Amps/ Antivon C/3.
Diuretics	Bumetanide 1 Mg / Miccil C/ 20 Tablets, Espironolactone 50 Mg / Lasilacton C/, Furosemide 20mg / Henexal C/5 Ampoules Pisa, Furosemide 40 Mg / Diurmissel C/ 20 Tablets.
Cardiac drugs	Amiodarone / Braxan C/ 20 Tablets, Isosorbide 20 Mg / Elantan C/30 Tablets.
Statins	Atorvastatin 10 Mg / Lipitor C/ 30 Tab
Probiotics	Bacillus Calsicus Ampoule / Enterogermina
Dental medications	Dexpanthenol 250ml Solution / Bexident Gums
Bronchodilators	Ipratropium Aerosol 0.02mg 10ml / Atrovent, Ipratropium Spray 10 Ml / Berodual, Ipratropium-Salbutamol / Combivent C/10 Ampoules, Ipratropium+Salbutamol 0.5/2.5mg / Fevolut 10 Ampoules, Ipratropium+Salbutamol 0.5/2.5mg / Vinza C/10 Ampoules.
Mucolytics	Acetylcysteine 600mg Tablet / Lysomucil C/20
Nasal sprays	Sodium Chloride Solution 100 Ml / Sterimar Lubnas, Sodium Chloride Solution 100ml / Nasalub Max.
Laxatives	Sodium Citrate Suspension / Microlax Enema C/4, Lactulose Syrup / Duphalac 150ml, Lactulose Syrup / Oppelver 125ml, Polyethylene Glycol 255g / Contumax 15 Sachets, Senosides A-B 187 Mg Tablet / Senokot C/60, Senosides A-B 374 Mg / Senokot F C/ 30.
Thyroid hormones	Levothyroxine 100 Mcg / Eutirox C/ 50 Tablets
Antidiarrheals	Loperamide 2 Mg / Lomotil C/ 8 Tablets, Racecadotril 10mg Sachet / Hidrasec.
Antihistamines	Loratadine 10 Mg / Gi Ultra C/20 Tablets
Hepatoprotectors	Ursodeoxycholic Acid 250 Mg / Ursofalk C/50
Consultation services	Intramuscular Injection Application, Intravenous Injection Application, Urinary Catheter Application Or Change, Geriatrics Consultation, First-Time Geriatrics Consultation, Subrogated Fees, Geriatric Hospitalization At Home, Home Hospitalization By Nursing Staff, Geriatric Assessment At Home By Nurse, Geriatric Assessment At Home By Geriatrician, Home Nursing Visit.

Table S2. Grouping of Diagnosis

Diagnosis grouping	Diagnostics
Infectious disorders	Urinary tract infection, chronic osteomyelitis, generalized sepsis, renal and perirenal abscess, urosepsis, cellulitis, fever of undetermined origin, severe sepsis without septic shock, nonspecific peritonitis, pyelonephritis, leg cellulitis, erysipelas cellulitis.
Cancer	Prostate cancer, breast cancer, metastatic cancer, malignant tumor of the lateral bladder wall, unspecified tumor, malignant lymphoma, malignant kidney tumor except renal pelvis.
Muscular system disorders	Problems related to reduced mobility (bedridden or chair-bound), polymyositis, polymyalgia rheumatica, problems related to wasting disease (frailty).
Digestive system disorders	Abdominal pain, choledocholithiasis, pancreatitis, intestinal constipation, constipation, liver cirrhosis, hepatic encephalopathy.
Urinary system disorders	Chronic kidney disease requiring dialysis, extracorporeal dialysis, hematuria, acute kidney injury, acute renal failure, non-traumatic bladder rupture, hyposmolality and hyponatremia, urolithiasis, hyperosmolality and hypernatremia
Neurogeriatric disorders	Dementia in Parkinson's disease, Alzheimer's disease, vascular dementia, subacute confusional state, coma and drowsiness stupor sleepiness unconsciousness semicoma, anxiety, unspecified delirium, delirium superimposed on dementia.
Cardiometabolic disorders	Type 2 diabetes mellitus, peripheral arterial insufficiency, chronic ischemia, subconjunctival hemorrhage, ischemic heart disease, cerebral hemorrhage, arterial hypertension, acute myocardial infarction, congestive heart failure, arterial thrombosis, heart failure.
General health disorders	Urticaria, generalized pain, hyporexia and anemia.

Disorders related to medical care and procedures	Sequelae of complications from medical and surgical care, other adverse events during medical or surgical care, and procedures for other purposes that aid in health status.
Pulmonary system disorders	Contact and exposure to COVID-19 coronavirus, nonspecific bacterial pneumonia, nonspecific pneumoconiosis, nonspecific pneumonia, pleural effusion, respiratory distress.

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Complete List of Authors:	González Ochoa, Jesús ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Garza-Silva, Arnulfo; Hospital Clínica Nova de Monterrey, Research Department González Peña, Omar; Hospital Infantil de Mexico Federico Gomez, Evidence-Based Medicine Research Unit; Universidad de Monterrey, Research and Development Directorate Romero-Ibarguengoitia, Maria Elena; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Fernández-Chau, Iván ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Villarreal Parra, Diana; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Torres Valerio, Nadia ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Sanz-Sánchez, Miguel ; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences Hughes García, Melissa; Hospital Clínica Nova de Monterrey, Research Department; Universidad de Monterrey, School of Medicine, Vice-Rectory of Health Sciences
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Cost Drivers and Feasibility of a Hospital-at-Home Program for Geriatric Care in Northeastern Mexico. A Retrospective Observational Study.

ABSTRACT

Objective: The primary objective was to evaluate factors influencing the cost of a "hospital at home" (HAH) for geriatric patients in a Northeastern Mexican hospital. Secondarily to evaluate the *per capita* global cost-effectiveness compared to traditional hospital care

Design: This retrospective analysis examined the costs incurred by geriatric patients in an HAH program from February to December 2022

Setting: We collected data from clinical records and assessed medication and procedure costs through the hospital's financial department. Costs for traditionally hospitalized patients were reviewed for comparison

Participants: Subjects both gender seventy age and older that were treated in HAH during 2022 and Hospitalized subjects with the same age and gender treated in the same period

Intervention: NA

Primary and secondary outcome measures: Primary outcome: Factors that influence costs in HAH. Secondary, global per capital cost comparison between HAH and hospital care:

Results:

We examined the expenses associated with 416 home visits to 49 patients in the HAH program. The main factors influencing the program's overall cost were medical care and procedure-related disorders (β=0.333, p=0.002), sleep-regulators (β=0.561, p<0.001), laxatives (β=0.330, p=0.001), and anticoagulants (β=0.228, p=0.025). The HAH program's per capita cost was three times lower compared to that of traditional hospital care and resulted in a 40% reduction in hospitalization days.

Conclusions:

This study highlights that the main factors influencing the HAH program's costs include medical care and procedure-related disorders, as well as medication extensively used in the elderly population. Additionally, we demonstrated the cost-effectiveness of the HAH program, which produces substantial savings and is a financially viable alternative to traditional hospital care.

Strengths and limitations

- The Hospital at Home Model (HAH) has been implemented in Mexico, representing one of the few studies conducted in Latin America.
- The study's methodology allowed for close monitoring and detailed evaluation of cost implications associated with the Hospital at Home (HAH) model.
- The capability to pinpoint cost-driving factors in the Hospital at Home (HAH) model in this study represents an opportunity for enabling targeted interventions to enhance future costs efficiency.
- This retrospective study occurred during COVID-19 pandemic; there were differences in eligibility criteria, severity in pathologies between HAH and traditional Hospitalization, so randomization or case-control design was not feasible.
- The sample size of the study is limited by the program's capacity and operational scale during the study period.

Introduction

The concept of "hospital at home" (HAH) was pioneered at John Hopkins University Schools of Medicine and Public Health in the US in 1995. [1] It refers to a patient care model that provides

necessary services directly in the individual's home rather than through hospital admission.[2] This type of program has focused on managing acute conditions such as pneumonia, cellulitis, and urinary tract infection (UTI), as well as exacerbations of chronic degenerative diseases such as chronic obstructive pulmonary disease (COPD) and heart failure. [3] This model addresses the challenge posed by the growing number of people needing medical care, surpassing hospitals' capacity to provide sufficient beds, especially during medical emergencies. Additionally, the aim is to avoid potential adverse effects associated with hospital care, such as functional decline, delirium, and iatrogenic diseases, among others. [2]

Spain and Australia have long practiced treating acute-care patients in their own residences. Other countries with publicly funded healthcare systems, such as England, Canada, and Israel, also have established home-hospital models. [1] The rising cost of hospital care, which accounts for approximately one-third of total medical expenditure in the US and results in considerable patient debt, [4] poses the question of whether these alternative models are more cost-effective. Previous studies have suggested that HAH models can contribute to cost reduction without compromising the quality of care, [5–13] but only a few have addressed the relationship between factors influencing HAH program costs and comparative budgets between traditional hospitalization and HAH. [4]

Research has been conducted on the feasibility of implementing an HAH program to reduce hospital costs, but there are still unexplored aspects that require attention. Specifically, there is a lack of knowledge about which diagnoses treated in an HAH program may generate higher expenses and affect hospital economics. Likewise, the trend of studies addressing HAH programs focuses on the care of specific and isolated diseases. [14–20] Therefore, it is worth conducting a study that explains the impact of HAH on economic outcomes in relation to a broad group of conditions.

The primary objective of this study was to evaluate factors influencing the cost of a hospital at home (HAH) model for geriatric patients in a Northeastern Mexican hospital. Secondarily to evaluate the *per capita* global cost-effectiveness compared to traditional hospital care. We hypothesize that (1) the costs associated with the HAH program are significantly influenced by specific diagnoses and medications, commonly present in geriatric care and that (2) the HAH program is more cost-effective than traditional hospital care, resulting in substantial cost savings while maintaining quality of care.

Methodology

This is a retrospective analytic cross sectional study focused on the expenses related to geriatric patients visited by an HAH geriatric program between February 2022 and December 2022. The research adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines, [21] and received approval from the local Institutional Review Board (Comité de Investigación de la Vicerrectoría de Ciencias de la Salud, Universidad de Monterrey, number: 12012023-CN-GER-CI).

Patient and Public Involvement Statement

As the study is retrospective, informed consent was not applicable; as well as, patients or the public WERE NOT involved in the design, or conduct, or reporting, or dissemination plans of our research.

Hospital Clinica Nova and the Hospital at Home Program

Hospital Clinica Nova (HCN), a small to mid-sized private hospital in northeastern Mexico, serves approximately 52,200 patients, including steelworkers from Ternium—one of Latin America's largest steel manufacturers—and their families in Monterrey, Nuevo León. Of these patients, around 10% (5,249 individuals) are aged 70 years or older.

The Hospital at Home (HAH) model at HCN provides a comprehensive service that integrates patients from various entry points, such as inpatient wards, geriatric consultations, and

emergency services, based on frequency and need. Patients eligible for this service typically include those 70 years and older with conditions like frailty syndrome, cognitive decline, mobility issues, functional deterioration, or terminal palliative (end-of-life care) needs. Referrals are authorized by the HAH team and reviewed beforehand by geriatricians, emergency care providers, and primary care physicians, following strict admission criteria.

The multidisciplinary team operates daily from 8 a.m. to 8 p.m., consisting of geriatricians, nurses, social workers, psychologists, and other specialists. Team members are assigned based on individual patient needs, with flexibility to ensure comprehensive diagnostic and therapeutic support at home. Monitoring is conducted daily in 2 to 3 shifts or as needed, with responsibility shared among the nursing staff and physicians. This includes both in-person visits and telemedicine support, such as video and phone calls, ensuring continuous supervision. Monitoring tools include vital sign tracking and instant messaging systems, allowing timely responses to patient needs. Emergency situations are managed 24/7 through direct links to urgent care services, with paramedics and ambulances available as needed, along with thorough education for family members on emergency response protocols.

In-home interventions are tailored to each patient's diagnosis and commonly include antibiotic therapy for infectious diseases, intravenous hydration, wound care, and the use of feeding and urinary catheters. Additional treatments may involve oxygen administration for patients requiring respiratory support. These interventions aim to address any acute or subacute needs identified through regular assessments. Basic laboratory tests are collected at home by nursing staff and analyzed at the hospital laboratory, while advanced imaging studies are scheduled for assisted hospital visits if necessary. This model enhances the continuity of care for acute and subacute conditions, minimizing the need for travel and hospital visits.

Hospital Clinica Nova's HAH model provides hospital-level care at home, closely following the World Hospital at Home Congress (WHAH) Congress definition through specialist-led

management, daily nursing visits, telemedicine for remote monitoring, and urgent escalation protocols. Our interventions include palliative care, wound care, and basic lab testing conducted at home, ensuring continuity of acute-level care as an alternative to traditional hospital stays. However, unlike the WHAH model's 24/7 availability, our HAH services operate daily from 8 a.m. to 8 p.m., with education to patients in case of alarm signs, and availability to reference them to the emergency room in case of needing help outside attention hours. Additionally, advanced diagnostic procedures, such as imaging, require patients to visit the hospital, as these are not yet available in-home. Our model of HAH includes taking care of both acute and subacute patients.

The inclusion criteria encompassed individuals of both genders aged over 70 who received visits from the HAH program throughout 2022 and had updated clinical records and reported costs generated by the program as of the study date. Patients who needed intensive care unit (ICU) care throughout the follow-up or died during the study were excluded. No probabilistic sampling was conducted. Data selection relied on the visits made by the HAH program within the included year. A formal sample size was not determined, as all patients from the HAH program were included in the analysis.

We examined the expenses associated with a total of 416 home visits made to 49 patients aged over 70 years of age enrolled in the HAH program during 2022. Data was gathered from the patients' clinical records, and the cost of medication and procedures was assessed by the hospital's financial and technological departments. Additionally, data on the costs and hospitalizations of patients aged 70 and older in traditional hospital settings were analyzed to calculate the per capita costs for hospitalized patients in 2022. This analysis allowed for a comparison of overall per capita costs and the cost differences associated with the most common diagnoses treated in the Hospital-at-Home program. Monetary values were converted from Mexican pesos to US dollars using an exchange rate of 1 dollar to 19.4143, as revised in

the Bank of Mexico on the day of the last visit conducted by the HAH program (December 28th, 2022). This conversion is reflected throughout this research [22].

The variables involved in this research were divided into three groups: demographic variables, those related to patients' medical procedures and treatments, and those related to patients' diagnoses. For the first group, variables include gender, age, retired work status, number of days admitted to the hospital through the follow-up, and number of days taken care of with the HAH program. The second group was composed of variables like medications, laboratory studies, provided service and procedure materials were included while the second group was composed of different diagnoses. The second group included the following variables: use of laboratory services, antibiotics, wound care materials, anticoagulants, neuropsychiatric drugs, antacids, sleep regulators, geriatric consult, antifungals, procedure materials, IV fluids, dietary supplements, ointments, antihypertensives, analgesics, corticosteroids, hypoglycemic agents, antispasmodics, antiemetics, diuretics, cardiac drugs, statins, probiotics, dental medications, bronchodilators, mucolytics, nasal sprays, laxatives, thyroid hormone replacement therapy, antidiarrheals, antihistamines, and hepatoprotective supplements. The aforementioned variables were assessed in a dichotomic manner. The grouping of the variables is shown in Table S1. Grouping of Variables from the supplemental material documents.

A total of 71 diagnoses were found, which then were categorized into different groups, including infectious disorders, cancer, muscular system disorders, digestive system disorders, urinary system disorders, neurogeriatric disorders, cardiometabolic disorders, pulmonary system disorders, general health disorders, and disorders related to medical care and procedures. Each diagnostic group was developed considering the characteristics of each diagnosis and implications regarding treatment, as well as the specific system of the human body which was affected. The aforementioned variables were assessed in a dichotomic manner,

and the categorization of the diseases is shown in Table S2. Grouping of Diagnosis from the supplemental material documents.

Data were gathered from clinical records and hospital expense records using a spreadsheet. The distribution of quantitative variables was analyzed using Shapiro-Wilk and histograms, indicating a non-normal distribution. Categorical data were expressed in frequencies and percentages, while non-normal data were described using median and interquartile ranges. A univariable analysis was conducted. The Mann-Whitney U test, a nonparametric statistical method, was applied to compare non-normal quantitative continuous data in our study. The multivariable analysis was a multiple linear regression where the dependent variable was the program's costs per patient, and the independent variables were groups of diagnosis, procedures, and drugs used by the patients. Multiple linear regression was chosen to identify the independent impact of each variable on the total costs, controlling for potential confounders and allowing for the evaluation of the relative importance of each factor. The variables were chosen upon significant p-values in the previous tests; collinearity was evaluated and addressed by removing variables with a variance inflation factor exceeding 10. Subsequently, the model underwent refinement, eliminating variables without statistical significance to reach the best R-squared value. All assumptions of multiple linear regression were met. Analysis was conducted through complete case data. A level of $p<0.05$ was considered statistically significant, and data analysis was carried out using SPSS, version 29.0.2.0 (IBM Corp. IBM SPSS Statistics for Windows, Armonk, NY).

Since this was a retrospective cross-sectional study there was no patient or public involvement.

Results

Descriptive statistics

This study initially involved a total of 64 patients. After applying the previously mentioned selection criteria, encompassing age above 70 years old, data on HAH costs during 2022 and

complete data in clinical files, the analysis was conducted on 49 patients (this is the total population). Patients had a median (IQR) age of 86 (9) years and consisted of 31 (63.3%) female subjects, with a median (IQR) of 6 (7) days of HAH visits and 12 (19) days admitted for traditional hospitalization. Demographic data is shown in Table 1.

Table 1. Patient's demographic characteristics.

Variable	n=49 (%)
Female	31 (63.3)
Age (years)*	86 (9)
Retirees	46 (93.9)
Consultation Service †	46 (93.9)
Laboratories ‡	24 (49.0)
Patients with Palliative Care	25 (51)
Days in HAH program*	6 (7)
Days admitted in hospital*	12 (19)
Overall cost (US dollars)*	844.87 (1652.19)

*Median (Interquartile range)
† Use of the geriatric consultation service in HAH
‡ Use of laboratory studies regarding blood tests, urine tests, among others during HAH stay.

Differences in costs across diagnostic groups, procedures, and treatments

A total of 71 diagnoses were presented, which were classified into 10 groups. Among these, the grouping of infectious disorders had the highest number of patients [27 (55.1%)], followed by the groupings of cancer and muscular system disorders, where 9 (18.4%) patients were grouped into each category. Regarding the differences in costs by diagnosis grouping, the median (IQR) cost when a disease from the pulmonary disorders group was present was 2.7 times higher compared to its absence [$2,058.48 ($1,459.95) vs. $753.98 ($1,493.54), p= 0.027]. For disorders related to medical care and procedures, 3.67 times higher [$2,931.24 ($1,144.72) vs $804.77 ($1,558.18), p= 0.044], and for infectious disorders, 1.8 times higher compared to its absence [$1,319.85 ($2,125.65) vs. $726.17 ($1,198.34), p=0.052]. Differences in costs by diagnosis grouping are shown in Table 2.

Table 2. Cost differences by diagnostic grouping.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Cancer	9 (18.4%)	406.66 (2058.79)	846.39 (1391.04)	0.73
Cardiometabolic disorders	6 (12.2%)	528.12 (567.47)	848.03 (1608.56)	0.30
Urinary system disorders	7 (14.3%)	1124.27 (2340.13)	804.77 (1582.91)	0.19
Digestive system disorders	8 (16.3%)	1402.21 (2008.62)	809.97 (1516.72)	0.23
Neurogeriatric disorders	7 (14.3%)	1124.27 (1135.25)	827.33 (1740.27)	1.00
Muscular system disorders	9 (18.4%)	871.26 (1348.39)	827.33 (1536.34)	0.60
General health disorders	3 (6.1%)	2860.83 (1041.60)	804.77 (1558.18)	0.12
Disorders related to medical care and procedures	3 (6.1%)	2931.24 (1144.72)	804.77 (1558.18)	0.044
Infectious disorders	27 (55.1%)	1319.85 (2125.65)	726.17 (1198.34)	0.052
Pulmonary system disorders	3 (6.1%)	2058.48 (1459.95)	753.98 (1493.54)	0.027

*Performed using the Mann-Whitney U test

Regarding materials and medications, procedure materials were used for 46 (93.9%) patients, while intravenous solutions were used for 45 (91.8%). Antibiotics were used by 37 (75.5%) of the patients, and analgesics by 32 (65.3%) patients. The median (IQR) of the differences in costs related to medical procedures and treatments was notably higher in several categories, including laboratory studies [$1,560.14 ($2,112.62) vs. $473.05 ($969.18), p<0.001], antibiotics [$1,170.07 ($1713.84) vs. $376.01 ($543.67, p=0.003], wound care materials [$1,319.85 ($1,631.43) vs $418.61 ($666.88), p=0.010], anticoagulants [$2,976.00 ($930.91) vs. $799.62 ($1,516.72), p=0.009], neuropsychiatric drugs [$1,654.55 ($2,007.85) vs. $579.42 ($928.03), p=0.009], antacids [$1,605.67 ($1,764.16) vs $717.92 ($700.82), p=0.010], and sleep regulators [$3,231.23 ($1,654.50) vs $777.62 ($1,292.71), p<0.001]. The differences in costs related to medical procedures and treatments are detailed in Table 3.

Table 3. Differences in costs by medical procedures and treatments.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Consultation Services	46 (93.9)	859.68 (1572.55)	181.46 (114.55)	0.10
Palliative Care	25 (51)	15725,1 (35484.8)	19590.1 (31680.3)	0.92
Laboratories	24 (49.0)	1560.14 (2112.62)	473.05 (969.18)	<0.001
Antibiotics	37(75.5)	1170.07 (1713.84)	376.01 (543.67)	0.003
Wound Care Materials	33 (67.3)	1319.85 (1631.43)	418.61 (666.88)	0.010
Anticoagulants	4(8.2)	2976.00 (930.91)	799.62 (1516.72)	0.009
Neuropsychiatrics	22(44.9)	1654.55 (2007.85)	579.42 (928.03)	0.009
Antacids	23(46.9)	1605.67 (1764.16)	717.92 (700.82)	0.010
Sleep regulators	6(12.2)	3231.23 (1654.50)	777.62 (1292.71)	<0.001
Antifungals	9(18.4)	1352.56 (2029.64)	753.98 (1541.13)	0.046
Procedure materials	46(93.9)	859.68 (1572.55)	200.88 (119.71)	0.026
IV Fluids	45(91.8)	871.26 (1526.35)	303.75 (230.76)	0.020

Dietary supplements	3 (6.1)	1319. 85 (1290.96)	804.77 (1648.42)	0.23
Ointments	14(28.6)	1261.29 (1981.53)	777.62 (1565.55)	0.21
Antihypertensives	4(8.2)	1956.75 (2535.19)	844.69 (1581.41)	0.34
Analgesics	32(65.3)	1368.32 (1628.03)	713.86 (627.37)	0.046
Corticosteroids	11(22.4)	809.97 (1787.03)	857.98 (1558.18)	0.71
Hypoglycemic agents	4(8.2)	2184.83 (2359.65)	809.97 (1581.41)	0.12
Antispasmodics	11(22.4)	1703.44 (1569.41)	804.77 (1437.29)	0.30
Antiemetics	11(22.4)	1978.28 (1981.53)	753.98 (1173.05)	0.035
Diuretics	10(20.4)	2373.82 (2216.77)	799.62 (1292.71)	0.047
Cardiac drugs	1 (2%)	3199.65 (0)	827.33 (1584.46)	0.20
Statins	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Probiotics	2 (4.1%)	508.39 (221.90)	848.03 (1641.78)	0.35
Dental medications	1 (2%)	3706.24 (0)	827.33 (1548.86)	0.12
Bronchodilators	8(16.3)	2009.14 (2628.58)	777.62 (1325.11)	0.07
Mucolytics	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Nasal sprays	2 (4.1%)	2529.37 (1176.86)	809.97 (1616.64)	0.18
Laxatives	13(26.5)	2058.48 (1844.47)	680.89 (1307.80)	0.016
Thyroid hormones	2 (4.1%)	1889.54 (1310.12)	844.69 (1616.64)	0.58
Antidiarrheals	1 (2%)	334.24 (0)	846.39 (1634.83)	0.40
Antihistamines	1 (2%)	2856.19 (0)	827.33 (1584.86)	0.28
Hepatoprotectors	1 (2%)	2689.15 (0)	827.33 (1584.86)	0.36

*Performed using the Mann-Whitney U test

Main Predictors of Total Costs in the HAH Program

The results from the linear regression analysis for predicting total HAH costs showed a statistically significant positive association with disorders related to medical care and procedures β=0.333 (95%CI: 12,957.2, 52,211.2). Particularly noteworthy were the associations with sleep-regulating drugs β=0.561 (95%CI: 26,240.6, 54,044.1), laxatives β=0.330 (95%CI: 7,238.6, 27,828.0), and anticoagulants β=0.228 (95%CI: 2,527.39, 36,594.85). For more detailed information, please consult Table 4, which presents a comprehensive breakdown of these results.

Table 4. Linear regression for predicting total HAH costs.

Variable	β	Standardized β	t value	95% Confidence Interval		p-value
				Inferior	Superior	
Disorders related to medical care and procedures	32,584.2	0.333	3.35	12,957.21	52,211.20	0.002
Sleep regulators	40,142.3	0.561	5.82	26,240.57	54,044.08	<0.001
Laxatives	17,533.3	0.330	3.42	7,238.63	27,828.01	0.001
Anticoagulants	19,561.1	0.228	2.31	2,527.39	36,594.85	0.025

Corrected R^2: 0.567

Differences between Traditional Hospitalization and Hospital at Home program

In 2022, the hospital incurred a total cost of $2,206,628.26, resulting in a per capita cost of $5,716.61 in patients aged >70 years old. For the Hospital-at-Home (HAH) program, including transportation costs, the expense was $86,469.36, with a per capita cost of $1,764.68, p<0.001. The median (IQR) number of days in the HAH program was 6 (7) days, while the median (IQR) hospitalization duration for the patients in the study was 12 (19) days. Additionally, the median (IQR) percentage of days spent in the HAH program instead of traditional hospitalization was 40% (41.67).

Patients with infectious disease-related conditions incurred significantly higher per capita costs (p.c.c.) and median costs (IQR) in traditional hospitalization compared to hospital-at-home care. Specifically, the traditional hospitalization group had a p.c.c. of 126,389 and a median cost of 45,271 (142,615), while the hospital-at-home group had a p.c.c. of 32,831 and a median cost of 7,895 (39,970), with $p < 0.001$. Similarly, patients with muscular system disorders experienced significantly higher costs in traditional hospitalization, with a p.c.c. of 169,421 and a median cost of 55,884 (76,369), compared to a p.c.c. of 29,397 and a median cost of 16,915 (26,178) in hospital-at-home care ($p = 0.034$). In contrast, for patients with cancer-related conditions, there was no statistically significant difference in costs between traditional hospitalization and hospital-at-home care. The traditional hospitalization group had a p.c.c. of 58,423 and a median cost of 30,154 (26,470), compared to a p.c.c. of 30,785 and a median cost of 7,895 (39,970) in the hospital-at-home group ($p = 0.3$).

Discussion

A total of 49 patients were studied to assess the cost of HAH care. We found that the most relevant factors predicting the cost of HAH were medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants. The per capita cost of the HAH program was three times lower than traditional hospitalization, resulting in 40% of patients' days of care utilizing the HAH program instead of traditional hospitalization. Figure 1 shows a summary of the development of the study, the explanation of the findings, and the economic differences between the costs of the traditional hospitalization vs. HAH approaches, along with the potential impact of the program's implementation across multiple levels.

Figure 1 HAH program assessment and potential benefits. In the subheading "Types of variables" are described the two types of variables used for the study, then for "Phase 1" of the analysis, a univariable analysis was run to understand which variables affected the HAH

program costs and they were used to develop the Multivariable Analysis from "Phase 2", which underscores the importance of sleep regulators, laxatives, anticoagulants and disorders related to medical care and procedures. Posteriorly, the comparison to the literature was assessed and expressed in the explanation. Then, in the subheading "Difference of Hospitalization costs & Attention days", total cost and cost per capita are compared between the classic model of patients staying in the hospital versus the at-home model, and with it, the median number of days spent by the patients in each one of those. In the end, the possible impact of the HAH programs are assessed at different levels: patient, institutional and public level.

In our study, a group of diagnoses named medical and surgical care-related disorders, which was composed of sequelae of complications from medical and surgical care, significantly influenced the HAH program's overall cost. Previous research on the economic considerations of surgical care and healthcare policies found that the financial impact of complications following abdominal surgery costs escalated significantly, with minor complications leading to a doubling of costs [23]. Another study found that complicated cases result in triple the average cost. [24] This aligns with our findings as all three studies show how complications can substantially increase healthcare costs, albeit in different healthcare settings.

Aging individuals often encounter increased sleep-related issues, with approximately half of older adults expressing dissatisfaction with sleep quality [25]. [26] Sleep regulators notably impacted the HAH program's costs among the drug categories assessed in our study. A prospective observational study on the costs of insomnia revealed that medication expenses comprised the most considerable portion (69.94%) of total direct costs. At the same time, productivity loss was the primary contributor to the overall economic burden, followed by medication. [27] This finding is supported by a review indicating extensive healthcare resource utilization among patients with insomnia. [28] Our study population primarily comprised geriatric retired individuals, which nullifies the cost of productivity loss and stresses the economic

burden attributed to medication. These findings highlight the importance of addressing sleep health in geriatric care to manage costs effectively.

Constipation is a common issue within the ageing population [29], and half of the overall expenses related to this impediment are due to doctor visits, surpassing expenditures on both antihypertensive drugs and contraceptives in the UK's National Health System.[30] Similarly, we found that laxatives significantly influenced the overall cost of the HAH program. In a cost-effectiveness analysis evaluating the economic balance of medical intervention against alternative therapies for constipation, the researchers determined that laxatives are costly and not cost-effective compared to dietary management. [31] Our study exclusively enrolled patients aged 70 and above, leading to an increased number of patients requiring laxative therapy. In the elderly, the constraints posed by decreased physical activity, polypharmacy, and comorbidities make constipation prevalent and laxative use often necessary. [32]

Approximately seven million individuals globally rely on anticoagulants. These medications are commonly prescribed for health issues, including myocardial infarction, unstable angina, and acute coronary syndrome, whether in hospital or outpatient settings. [33] In our study, the cardiometabolic disorders group was not significantly expensive within the HAH program. However, anticoagulants, a medication group including apixaban, enoxaparin, and heparin, represented a significant economic burden. In a prospective cohort study of patients receiving anticoagulants for any indication in the hospital's cardiology ward, enoxaparin stood out as the costliest anticoagulant, contributing even more to the overall financial impact when factoring in the expenses associated with its monitoring [33]. This underscores the importance of carefully managing and monitoring anticoagulant therapy to optimize cost-efficiency while ensuring patient safety.

In our study, the per capita cost of the HAH program was three times lower compared to the hospital per capita cost. Specifically, for infectious disease-related conditions, the per capita cost of traditional hospitalization was approximately 3.85 times higher than that of the HAH program. Similarly, for muscular system disorders, the per capita cost in traditional hospitalization was approximately 5.76 times higher than in the HAH program. In a study describing the implementation and evaluation of a healthcare delivery model known as "Hospital at Home", the per-patient cost excluding physician fees for Hospital at Home was compared to the variable costs per case for acute care inpatients, which also excluded physician fees, resulting in an average HAH patient cost 19% lower compared to traditional hospital setting per capita cost. [6] In contrast to this study, physician fees were included for both groups, but our HAH costs remained lower. The same study explains that these savings were due primarily to shorter average hospital stays and reduced utilization of clinical tests. This supports our results since, although patients may have initially required hospitalization, further care was provided at home, resulting in patients receiving care at home through the HAH program instead of traditional hospital stay during 40% of their total period of care and probably limiting the request of laboratory studies only when necessary.

Our study has potential implications for practice. At the patient level, HAH programs could enhance convenience and safety since patients benefit from reduced stress and heightened comfort in home environments and support from family [34]. Furthermore, the reduced risk of infection, a notable advantage of home-based care, suggests improved health outcomes [35]. On an institutional level, HAH can generate cost savings by reducing bed occupancy, alleviating congestion within hospitals, and through more efficient resource management, as was needed during the pandemic of COVID-19 [36]. This is also true on a public level, as HAH models contribute to optimized healthcare delivery and disrupt the transmission of infectious diseases,

fostering healthier populations. Moreover, integrating home-based care with community services promotes synergistic benefits for the healthcare system across multiple levels.

Implementing HAH programs on a larger scale presents organizational challenges, such as establishing new departments for patient transportation logistics, medical equipment supplies chain management, and coordination with home health providers. These departments must integrate into hospitals' existing structure through changes in administrative and operational workflows. Additionally, expanding HAH programs successfully depends on developing robust training programs for healthcare providers, including training in telemedicine, remote patient monitoring, and home-based medical procedures. [1] From a public health policy perspective, scaling up HAH programs require substantial investment in healthcare infrastructure and resources. Policymakers need to create supportive frameworks and funding models to integrate HAH into the broader healthcare system, address healthcare disparities, and invest in technologies for remote care delivery in underserved areas to ensure equitable access to home-based care. [34]

While our study provides valuable insights into the cost-effectiveness of the HAH program compared with traditional hospitalization, some limitations should be considered.

The sample size in our study reflects the total number of patients treated by the HAH program during the year 2022, representing the entire population served by this program within that timeframe. While we recognize that 49 patients may appear small, it is important to note that this number is limited by the program's capacity and operational scale during the study period of one year, particularly as it was still developing. Despite the small sample size and the respective nature on this study, the data provide valuable insights into the cost-effectiveness and potential benefits of the HAH program. Our findings offer a foundation for further research and contribute to the growing evidence supporting the viability of home-based care models, especially in resource-limited settings.

Future research should consider a prospective study to understand the sustainability of the program and assess variables related to the optimization and development of logistics for the program. Although the HAH model has the potential benefit of reducing expenses and increasing patients' comfort, this conclusion was made with the per capita cost for each patient and does not imply a normal distribution for this data. Additionally, differences in eligibility criteria, acuity levels, and diagnoses during the COVID-19 pandemic between the two populations make direct cost comparisons challenging. These factors reflect the early-stage implementation of the program, which was not designed to mirror the entirety patient profile or complexity typically seen in traditional hospital settings. Future research should aim to assess costs after the program has reached greater maturity, potentially incorporating matched cohorts or adjusted analyses to improve comparability. Before attempting to extrapolate this study's findings, it must be considered that laboratory prices were included for comparing home hospitalization and traditional hospitalization. In contrast, other studies do not take laboratory expenses as part of the HAH.

Conclusion

The results of this study suggest that the most relevant factors influencing the overall cost of the HAH program were medical care and procedure-related disorders, sleep regulators, laxatives, and anticoagulants. Also, the HAH program's per capita cost is three times lower compared to the per capita cost of hospitalization, proving the cost-effectiveness of the HAH program. The results of this research underscore the significance of considering the economic factor when implementing home hospitalization programs in Mexico. It's clear that this approach doesn't just provide a financially viable substitute for the traditional hospital model but also has the potential to yield substantial savings in healthcare costs. HAH programs can play a pivotal role in advancing healthcare delivery and achieving better economic outcomes by focusing on key cost-driving factors and optimising resource allocation.

Conflict of Interest

The authors declare no financial or personal conflict of interest.

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Data Statement

Data is available upon reasonable request to the authors.

Authors' Contributorship statement

The contributions of each author to this manuscript are outlined as follows: AG-S and OIGP jointly conceptualized the study, with M.E.R-I also contributing to this phase. AG-S and OIGP developed the methodology. JSGO and AG-S worked on the software utilized in the study. The validation of the results was conducted by AG-S, OIGP, and M.E.R-I. JSGO and AG-S were responsible for the formal analysis and investigation. Resources were provided by M.E.R-I, DLVP, NDTV, MASS, and MHG. Data curation was handled by JSGO and AG-S. The original draft was written by JSGO, with OIGP assisting in this process. The manuscript was reviewed and edited by JSGO, AG-S, OIGP, and I.F.F-C. The visualizations were created by JSGO and AG-S. M.E.R-I took on the role of supervising the project. Project administration was carried out by M.E.R-I and OIGP. Funding acquisition was managed by M.E.R-I, MASS, and MHG. Finally, the guarantor is M.E.R-I.

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Figure 1. Comparative analysis of the Hospital at Home (HAH) program and traditional hospital care: This figure summarizes the study's phases, highlighting key variables influencing HAH program costs, and presents a direct comparison of total and per capita costs between HAH and traditional hospital care. It also depicts the reduction in hospitalization days and the broader impact on patient, institutional, and public levels.

Types of Variables

Medical Procedures & Treatments

Diagnostic Grouping

Univariable Analysis

Significant Variables

- Service Costs
- Laboratory Studies
- Antibiotics
- Antifungals
- Healing Materials
- Procedure Materials
- Intravenous Solutions
- Analgesics
- Anticoagulants
- Neuropsychiatrics
- Antacids
- Antiemetics
- Diuretics

- Pulmonary Disorders
- Disorders Related to Medical Care and Procedures
- Infectious Disorders

Phase 1

Multivariable Analysis

Adjusted R^2= 0.564

- Sleep Regulators
- Laxatives
- Anticoagulants
- Disorders Related to Medical Care and Procedures

Phase 2

Explanation

Relation to Literature by Variable

Above 65 years old, sleep-related issues affect 25-40%, and approximately 11.9% take medications to improve sleep. These same medications represent one of the highest direct costs associated with insomnia. [22-25]

Constipation is highly prevalent in patients over 65 years old, making laxative treatment necessary for this group. However, these treatments are known to be costly, exceeding expenditures on extensive use medications like antihypertensives. [26-27]

The economical weight caused by the anticoagulants could be related to the use of enoxaparin, which was widely used in the hospital at home patients. [30]

Complications related to procedural or surgical settings can increase the overall costs for patients, escalating from 2 to 3 times the original cost. [20,21]

Difference of Hospitalization Costs & Attention Days

Classic Model

Total Cost

$2,206,628.26

Cost Per Capita

$5,716.61

Days: 6 (7)*

At-Home Model

Total Cost

$86,469.36

Cost Per Capita

$1,764.68

Days: 12 (19)*

*Presented in Median (IQR)

Impact

Patient level

- Comfort and Convenience
- Family Involvement
- Reduced Infection Risk

Institutional level

- Reduced Bed Occupancy
- Cost Savings
- Efficiency in the management of resources.

Public level

- Cost saving by efficient resource utilization.
- Reduced transmission of infection.
- Integration with community services.

Table 1. Patient's demographic characteristics.

Variable	n=49 (%)
Female	31 (63.3)
Age (years)*	86 (9)
Retirees	46 (93.9)
Consultation Service †	46 (93.9)
Laboratories ‡	24 (49.0)
Patients with Palliative Care	25 (51)
Days in HAH program*	6 (7)
Days admitted in hospital*	12 (19)
Overall cost (US dollars)*	844.87 (1652.19)

*Median (Interquartile range)

† Use of the geriatric consultation service in HAH

‡ Use of laboratory studies regarding blood tests, urine tests, among others during HAH stay.

Table 2. Cost differences by diagnostic grouping.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Cancer	9 (18.4%)	406.66 (2058.79)	846.39 (1391.04)	0.73
Cardiometabolic disorders	6 (12.2%)	528.12 (567.47)	848.03 (1608.56)	0.30
Urinary system disorders	7 (14.3%)	1124.27 (2340.13)	804.77 (1582.91)	0.19
Digestive system disorders	8 (16.3%)	1402.21 (2008.62)	809.97 (1516.72)	0.23
Neurogeriatric disorders	7 (14.3%)	1124.27 (1135.25)	827.33 (1740.27)	1.00
Muscular system disorders	9 (18.4%)	871.26 (1348.39)	827.33 (1536.34)	0.60
General health disorders	3 (6.1%)	2860.83 (1041.60)	804.77 (1558.18)	0.12
Disorders related to medical care and procedures	3 (6.1%)	2931.24 (1144.72)	804.77 (1558.18)	0.044
Infectious disorders	27 (55.1%)	1319.85 (2125.65)	726.17 (1198.34)	0.052
Pulmonary system disorders	3 (6.1%)	2058.48 (1459.95)	753.98 (1493.54)	0.027

*Performed using the Mann-Whitney U test

Table 3. Differences in costs by medical procedures and treatments.

Variables	n=49 (%)	Adjusted cost		p-value*
		Presence Median (IQR) US dollars	Absence Median (IQR) US dollars	
Consultation Services	46 (93.9)	859.68 (1572.55)	181.46 (114.55)	0.10
Palliative Care	25 (51)	15725,1 (35484.8)	19590.1 (31680.3)	0.92
Laboratories	24 (49.0)	1560.14 (2112.62)	473.05 (969.18)	<0.001
Antibiotics	37(75.5)	1170.07 (1713.84)	376.01 (543.67)	0.003
Wound Care Materials	33 (67.3)	1319.85 (1631.43)	418.61 (666.88)	0.010
Anticoagulants	4(8.2)	2976.00 (930.91)	799.62 (1516.72)	0.009
Neuropsychiatrics	22(44.9)	1654.55 (2007.85)	579.42 (928.03)	0.009
Antacids	23(46.9)	1605.67 (1764.16)	717.92 (700.82)	0.010
Sleep regulators	6(12.2)	3231.23 (1654.50)	777.62 (1292.71)	<0.001
Antifungals	9(18.4)	1352.56 (2029.64)	753.98 (1541.13)	0.046
Procedure materials	46(93.9)	859.68 (1572.55)	200.88 (119.71)	0.026
IV Fluids	45(91.8)	871.26 (1526.35)	303.75 (230.76)	0.020
Dietary supplements	3 (6.1)	1319. 85 (1290.96)	804.77 (1648.42)	0.23
Ointments	14(28.6)	1261.29 (1981.53)	777.62 (1565.55)	0.21
Antihypertensives	4(8.2)	1956.75 (2535.19)	844.69 (1581.41)	0.34
Analgesics	32(65.3)	1368.32 (1628.03)	713.86 (627.37)	0.046
Corticosteroids	11(22.4)	809.97 (1787.03)	857.98 (1558.18)	0.71
Hypoglycemic agents	4(8.2)	2184.83 (2359.65)	809.97 (1581.41)	0.12
Antispasmodics	11(22.4)	1703.44 (1569.41)	804.77 (1437.29)	0.30
Antiemetics	11(22.4)	1978.28 (1981.53)	753.98 (1173.05)	0.035
Diuretics	10(20.4)	2373.82 (2216.77)	799.62 (1292.71)	0.047
Cardiac drugs	1 (2%)	3199.65 (0)	827.33 (1584.46)	0.20
Statins	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Probiotics	2 (4.1%)	508.39 (221.90)	848.03 (1641.78)	0.35
Dental medications	1 (2%)	3706.24 (0)	827.33 (1548.86)	0.12
Bronchodilators	8(16.3)	2009.14 (2628.58)	777.62 (1325.11)	0.07
Mucolytics	1 (2%)	1124.27 (0)	827.33 (1659.86)	0.89
Nasal sprays	2 (4.1%)	2529.37 (1176.86)	809.97 (1616.64)	0.18
Laxatives	13(26.5)	2058.48 (1844.47)	680.89 (1307.80)	0.016
Thyroid hormones	2 (4.1%)	1889.54 (1310.12)	844.69 (1616.64)	0.58
Antidiarrheals	1 (2%)	334.24 (0)	846.39 (1634.83)	0.40
Antihistamines	1 (2%)	2856.19 (0)	827.33 (1584.86)	0.28
Hepatoprotectors	1 (2%)	2689.15 (0)	827.33 (1584.86)	0.36

*Performed using the Mann-Whitney U test

Table 4. Linear regression for predicting total HAH costs.

Variable	β	Standardized β	t value	95% Confidence Interval		p-value
				Inferior	Superior	
Disorders related to medical care and procedures	32,584.2	0.333	3.35	12,957.21	52,211.20	0.002
Sleep regulators	40,142.3	0.561	5.82	26,240.57	54,044.08	<0.001
Laxatives	17,533.3	0.330	3.42	7,238.63	27,828.01	0.001
Anticoagulants	19,561.1	0.228	2.31	2,527.39	36,594.85	0.025

Corrected R^2: 0.567

Supplemetal Materials

Table S1. Grouping of Variables

Variables	Medicines/materials/labs
Laboratories	Complete Blood Count (CBC), Cytochemical Analysis Of Peritoneal Fluid, Creatine Kinase-MB (CK-MB), Creatine Phosphokinase (CPK), Stool Test, Wound Culture, Peritoneal Fluid Culture, Throat Culture, Lactate Dehydrogenase (LDH), D-Dimer, Urine Electrolytes (Single Sample), Blood Electrolytes, Thyroid-Stimulating Hormone (TSH), Blood Culture, Thyroid-Stimulating Hormone, NT-Probnp (N-Terminal Pro B-Type Natriuretic Peptide), Urinalysis, Biochemical Profile, Thyroid Profile, Procalcitonin, C-Reactive Protein (CRP), COVID-19 PCR Test, Rapid COVID-19 Antigen Test, Rapid Influenza A + B Test, Blood Chemistry, Fecal Immunochemical Test (FIT) For Occult Blood, Prothrombin Time (PT), Partial Thromboplastin Time (PTT), Troponin I, Urine Culture, Vitamin D (25-Hydroxy).
Antibiotics	Cefixime 400 Mg Capsule/Denvar C/10, Ceftazidime 1g Ampoule/Izadima, Ceftriaxone 500mg IV/Cefaxon, Ceftriaxone 1g IM Ampoule/GI Amsa 1 Ampoule, Ceftriaxone 1g IM Ampoule/Amsa Amcef 1 Ampoule, Ceftriaxone 1g IV/Cefaxon, Ceftriaxone 1g IV/Ceftrex 1 Ampoule, Ciprofloxacin 200 Mg Ampoule/Ciprobac, Ciprofloxacin 500mg Tablet/Ciprobac C/14, Clindamycin 600 Mg Ampoule/Dalacin C, Cefepime Hydrochloride Injection/Imation C/1, Dicloxacillin 500mg Capsules/Butimaxil C/20, Ertapenem 1g Ampoule/Invanz IV, Imipenem Cilastatin 500mg IV Ampoule/GI Pisa, Levofloxacin 500mg Tablet/Evocs III C/7, Levofloxacin 500mg Tablet/Lefloxin C/7, Levofloxacin 500mg Injection/Flouning Flexova, Linezolid 2mg/Ml/Yaprinca 300ml Injection, Meropenem 1g IV Ampoule/Merrem, Meropenem 1g IV Ampoule/Pisapem C/1, Moxifloxacin 400mg Ampoule/Avelox Amp, Silver Sulfadiazine/Argental Tube 28g, Trimethoprim-Sulfamethoxazole 160/800mg/Bactropin.
Wound care materials	Antiseptic EXGERM 1 Liter For EXGERM Hands, MICROPORE Tape 1/2 3M M.1530-0, TRANSPORE Tape 1 3M M.1527-1, TRANSPORE Tape 1/2 3M M.1527-0, Chlorhexidine JBN .12% CLORHEXI-CLEAN 60M, Sterile Gauze 10x10 PROTEC, Simple Gauze 10x10cm With 200 Pieces Non-Sterile, Blue Surgical Cap TECNOL TR, Sterile MEDI-GRIP Glove 6-1/2, Sterile Latex Glove CH AMBI M.0604560383, Sterile Latex Glove MED M.064560391, Non-Sterile Latex Glove CH M.D-04340-S, Non-Sterile Latex Glove MED M.D-04341-M, Cotton/Alcohol SWABS BD M.326899, TEGADERM 10x12cm 3M M.1626W, TEGADERM 6x7cm 3M

	M.1624W, TEGADERM CHG 10x12cm REF. 1658R With 25 Pieces, Gauze Bandage 10cm LE ROY, Gauze Bandage 5cm LE ROY, Gauze Bandage 7cm LE ROY, Elastic Bandage 5cm ELASTOMEDIC, Elastic Bandage 7cm LE ROY, White Elastic Bandage 10cm LE ROY, White Elastic Bandage 5cm LE ROY.
Anticoagulants	Apixaban 2.5mg Tablets/Elicuis C/60, Enoxaparin 20mg Injection/Bolenax C/2 Ampoules, Heparin 1000 U 10ml Ampoule/Heparin Pisa.
Neuropsychiatrics	Alprazolam 0.25mg/Neupax C/30 Tablets, Alprazolam 0.50mg/Neupax C/30 Tablets, Clonazepam 2mg/Kriadex C/30 Tablets, Escitalopram 10mg Tablet/Lamobrigan C/28 SDMDU, Haloperidol 2mg/Ml Drops/Haloperil 15ml, Haloperidol 5mg/Haldol C/20 Tablets, Haloperidol 5mg Injection/Pisa C/6 Ampoules, Levetiracetam 100mg I.V./Keppra C/10 Injections, Levetiracetam 500mg Tablet/Kepra C/30, Memantine 10mg Tablet/Eutebrol 10mg C/30, Midazolam 50mg/10ml Ampoule/Relacum C/5, Paroxetine 20mg/Andepa C/20 Tablets, Pregabalin 25mg Capsule/Lyrica C/28, Pregabalin 75mg Capsule/Dismodox C/28 SDMDU, Quetiapine 100mg/Seroquel C/30 Tablets, Quetiapine 25mg/Q-Mind C/28 Tablets, Sertraline 50mg Tablet/Sertex C/28.
Antacids	Magaldrate + Dimethicone Gel / Galaver 250ml, Omeprazole 20mg Capsule / G.I. Ultra C/30, Omeprazole 40mg Injectable Solution 10ml / GI Pisa, Pantoprazole 40mg Tablet / Apotex (Efectr) C/14, Pantoprazole I.V. Ampoule / Supacid C/1.
Sleep regulators	Melatonin 3mg Tablet / Cronocaps C/30
Consultation services	Intramuscular Injection Application, Intravenous Injection Application, Urinary Catheter Application Or Change, Geriatrics Consultation, First-Time Geriatrics Consultation, Subrogated Fees, Geriatric Hospitalization At Home, Home Hospitalization By Nursing Staff, Geriatric Assessment At Home By Nurse, Geriatric Assessment At Home By Geriatrician, Home Nursing Visit.
Antifungals	Fluconazole 100mg / Diflucan C/10 Capsules, Fluconazole 100mg Injection / Flucoxan C/1, Fluconazole 150mg Capsule / Afungil C/1, Fluconazole 50ml Ampoule / Diflucan, Ketoconazole 30g Cream / Mi-Ke-Sons, Miconazole Vaginal Cream / Gynodaktarin, Nystatin 100,000 IU/Ml / Micostatin 30ml, Voriconazole 200mg Injection / Vfend Ampoule C/1.
Procedure materials	AEROCHAMBER Adult Mask TRUDELL, Sterile Water Plastic 500ml Irrigadual PISA, Sterile Injectable Water 10ml PISA, Disposable Needle 18x38mm BD M.302347, Disposable Needle 21x32mm BD M.301731, Disposable Needle 22x32mm BD M.300081, ALLEVYN ADHESIVE Dressing 12.5x12.5 Cm, Asepto Plastic Syringe AMSINO M.AS11, Round Band-Aids 7/8 C/100, Surgeon's Gown Medium BARRIER M.650101,

	Disposable Patient Gown Long Sleeve MNGA LARG TR, New Image Bag HOLLISTER M.18184, Disposable 4-Field Pack, Sterile Eye Drape BOJO01, Adult Nasal Cannula Medium REF.OPT844, Oxygen Nasal Cannula UNOMEDICAL REF.309-, Peripheral Insertion Catheter VYGON 4FR., INTROCAN SAF Catheter 20G BRAUN C.4251644, INTROCAN SAF Catheter 22G BRAUN C.4251628, INTROCAN SAF Catheter 24G BRAUN C.4251601, Peripheral Catheter 3FR. 12CM SMARTMIDLIN, CHLORAPREP 10.5ML CAT.261715, 0.9% Sodium Chloride Prefilled Syringe C/30, Extension With Microclave 15cm, FLEBOTEK 0-100 With Clave 4001968 100ml VEN, FLEBOTEK With Clave For Pump 4002759 PISA, HEMOTEK FLEBOTEK For Blood Pump PISA, PVC-Free INFUSOMAT FLEBOTEK PISA, Surgical FLEBOTEK With Clave PISA 4001967, Sterile 100ml PSU Bottle, Sterile Water Bottle 760ml With Adapter M.037-33, Disposable Cover TR, Sterile Mayo Stand Cover SIDRASA, HOME PUMP 100ml IFLOW M.C100020, I.V. START PACK With Gloves BD M.386172, KY JELLY BD M.92699, 3ml PLASTIPAK Disposable Syringe BD M.302541, 5ml PLASTIPAK Disposable Syringe BD M.302552, 10ml PLASTIPAK Disposable Syringe BD M.302560, 20ml PLASTIPAK Disposable Syringe BD, PRE-HEPARIN POSIFLUSH Syringe 3ml/100UI, PRE-FILLED POSIFLUSH Syringe 3ml/10UI, PLASTIPAK TUBERCULIN Syringe BD M.302579, Percutaneous Drainage Kit Unique 9FR. 10800, Peripheral Venipuncture Kit With Chlorhexidine, BD CONTACT-ACTIVE Lancet 21x1.8mm 366593, 2% Lidocaine 10ml Ampoule/PISACAINA C/10, HUDSON Adult Mask M.1040 WITHOUT RESERVOIR, HUDSON Adult Mask M.1060 WITH RESERVOIR, Reservoir Adult Mask 106-E UNOMEDIC, Subrogated Medical Oxygen, HOLLISTER Plates C/5 M.14804, POSIFLUSH XS BD REF.306572 Prefilled Syringe, Disposable Foot Protector PM M.SPM280, RECEPTAL 1000cc BEMIS M.7H1004R, RECEPTAL 1500cc BEMIS M.1504R, Disposable Kidney Basin LOAIZA M.H300-05, Disposable Drawer Cover TR, SILA Foley Catheter 14FR. 5cc ROCH, SILA Foley Catheter 16FR. 30cc ROCH, SILA Foley Catheter 18FR. 30cc, SILASTIC Foley Catheter 18FR. 5cc BARD, BARDIA Nelaton Catheter 16FR. M.802416, AMA K-60 14FR. Suction Catheter, Support For Venoclisis Size C SOFER, HOLLISTER Foley Catheter Holder 9781, BD Rigid Digital Thermometer M.524059, PISA Surgical Towel M.4000699, CONOX-VASO Salter Labs Connector Tube, 10 Long Suction Tube 1 AMSINO M.AS826, UROTEK ND 2LTS

	Closed System PISA, SALTER Humidifier Cup 6PSI MXSAL7600-, SURGICAL Venopack NB For Surgery PISA.
IV Fluids	DEXTROSA-HARTMAN Solution Bottle 1000ml, DEXTROSA-HARTMAN Solution Bottle 500ml PISA, DEXTROSA-NACL Solution Bottle 1000ml, DEXTROSA-NACL Solution Bottle 500ml, CS 0.9% Injectable Solution 100ml PISA, CS 0.9% Injectable Solution Bottle 1000ml, CS 0.9% Injectable Solution Bottle 250ml FLEXOVAL, CS 0.9% Injectable Solution Bottle 500ml PISA, CS 0.9% Injectable Solution Bottle 50ml PISA, DX-5 Injectable Solution Bottle 5% Glucose 50ml, DX-50 Injectable Solution Bottle 50% Glucose 50ml, HARTMAN Solution Bottle 1000ml PISA, HARTMAN Solution Bottle 500ml PISA, Sodium Chloride Solution 17.7% 10ml Ampoule PISA.
Dietary supplements	DIHEXAZINA 140ml Syrup / Viternum, Potassium Phosphate Ampoule / Potassium Phosphate / 50.
Ointments	Ac. Acexamici 5/4g Cream / Recoveron Nc, Mineral Oil Ointment / Naturalag, Triticum Vulgare With 10 Gauze / Italdermol, Triticum Vulgare Cream 30g / Italdermol.
Antihypertensives	AMLODIPINE 5mg / Pequisy C/30 Tablets, AMLODIPINE + VALSARTAN 5/160mg / Exforge C/28, ATENOLOL 100mg / Tenormin C/28 Tablets, LOSARTAN 50mg Tablets / Viopxa C/30, METOPROLOL 95mg / Lopresor R C/20 Capsules.
Analgesics	BUPRENORPHINE 10mg/Soloro Patches, BUPRENORPHINE 20mg/Transtec C/2 Patches, BUPRENORPHINE 30mg/Transtec C/4 Patches, BUPRENORPHINE 5mg/Soloro-7 C/2 Patches, CELECOXIB 200mg Capsules/G.I. Ultra C/20, DEXKETOPROFEN 25mg/10ml/Velian C/10 Sachets, DICLOFENAC 75mg/3ml Injectable Solution C/2 Genepisa, IBUPROFEN 400mg Tablets/Dolver C/10, KETOROLAC 30mg/Onemer C/3 Ampoules PISA, MORPHINE 10mg/10ml Ampoule/Graten C/5, MORPHINE 2.5mg/2.5ml Ampoule/Graten C/5, PARACETAMOL 325/37.5mg Tablet/Tafitram C/20, PARACETAMOL 500mg/Kendrick G.I. C/10 Tablets, PARACETAMOL IV 1g Ampoule/Salpifar, PARECOXIB SODIUM 40mg 0.2ml Ampoule/Dynastat.
Corticosteroids	Beclomethasone/Innovair Nexth 100/6 120d, Beclomethasone + Formoterol/Innovair 120 Doses, Budesonide 250mcg Susp/Pulmicort 2ml, Dexamethasone 8mg/2ml Ampoule/Decorex, Dexamethasone Ampoule/Alin-Depot 4mg 1x2ml.
Hypoglycemic agents	Insulin Glargine 100u/50mcg/Soliqua C/3, Insulin Glargine 300u/Ml/Toujeo 3 Pen, Insulin Lispro 3 Ml Cartridge/Humalog Mix25, Metformin 500 Mg Tablet/Dabex Xr C/30, Metformin/Sitagliptin 500/50mg Tablet Janumet C/56.
Antispasmodics	Butylhyoscine 10 Mg/ Biomesina C/10 Tablets, Butylhyoscine 20mg / Capin C/3 Ampoules, Butylhyoscine Tablets /

	Espasmotex C/ 25, Butylhyoscine/Metamizole / Busconet C/1 Ampoule.
Antiemetics	Diphenidol 40 Mg/Diphafen Amp C/2, Metoclopramide 10mg / Pramotil C/6 Amp., Ondansetron 8 Mg/ Indansen C/ 3 Amp, Ondansetron 8mg/Amal C/10 Tabs, Ondansetron 8mg/4ml Amps/ Antivon C/3.
Diuretics	Bumetanide 1 Mg / Miccil C/ 20 Tablets, Espironolactone 50 Mg / Lasilacton C/, Furosemide 20mg / Henexal C/5 Ampoules Pisa, Furosemide 40 Mg / Diurmissel C/ 20 Tablets.
Cardiac drugs	Amiodarone / Braxan C/ 20 Tablets, Isosorbide 20 Mg / Elantan C/30 Tablets.
Statins	Atorvastatin 10 Mg / Lipitor C/ 30 Tab
Probiotics	Bacillus Calsicus Ampoule / Enterogermina
Dental medications	Dexpanthenol 250ml Solution / Bexident Gums
Bronchodilators	Ipratropium Aerosol 0.02mg 10ml / Atrovent, Ipratropium Spray 10 Ml / Berodual, Ipratropium-Salbutamol / Combivent C/10 Ampoules, Ipratropium+Salbutamol 0.5/2.5mg / Fevolut 10 Ampoules, Ipratropium+Salbutamol 0.5/2.5mg / Vinza C/10 Ampoules.
Mucolytics	Acetylcysteine 600mg Tablet / Lysomucil C/20
Nasal sprays	Sodium Chloride Solution 100 Ml / Sterimar Lubnas, Sodium Chloride Solution 100ml / Nasalub Max.
Laxatives	Sodium Citrate Suspension / Microlax Enema C/4, Lactulose Syrup / Duphalac 150ml, Lactulose Syrup / Oppelver 125ml, Polyethylene Glycol 255g / Contumax 15 Sachets, Senosides A-B 187 Mg Tablet / Senokot C/60, Senosides A-B 374 Mg / Senokot F C/ 30.
Thyroid hormones	Levothyroxine 100 Mcg / Eutirox C/ 50 Tablets
Antidiarrheals	Loperamide 2 Mg / Lomotil C/ 8 Tablets, Racecadotril 10mg Sachet / Hidrasec.
Antihistamines	Loratadine 10 Mg / Gi Ultra C/20 Tablets
Hepatoprotectors	Ursodeoxycholic Acid 250 Mg / Ursofalk C/50
Consultation services	Intramuscular Injection Application, Intravenous Injection Application, Urinary Catheter Application Or Change, Geriatrics Consultation, First-Time Geriatrics Consultation, Subrogated Fees, Geriatric Hospitalization At Home, Home Hospitalization By Nursing Staff, Geriatric Assessment At Home By Nurse, Geriatric Assessment At Home By Geriatrician, Home Nursing Visit.

Table S2. Grouping of Diagnosis

Diagnosis grouping	Diagnostics
Infectious disorders	Urinary tract infection, chronic osteomyelitis, generalized sepsis, renal and perirenal abscess, urosepsis, cellulitis, fever of undetermined origin, severe sepsis without septic shock, nonspecific peritonitis, pyelonephritis, leg cellulitis, erysipelas cellulitis.
Cancer	Prostate cancer, breast cancer, metastatic cancer, malignant tumor of the lateral bladder wall, unspecified tumor, malignant lymphoma, malignant kidney tumor except renal pelvis.
Muscular system disorders	Problems related to reduced mobility (bedridden or chair-bound), polymyositis, polymyalgia rheumatica, problems related to wasting disease (frailty).
Digestive system disorders	Abdominal pain, choledocholithiasis, pancreatitis, intestinal constipation, constipation, liver cirrhosis, hepatic encephalopathy.
Urinary system disorders	Chronic kidney disease requiring dialysis, extracorporeal dialysis, hematuria, acute kidney injury, acute renal failure, non-traumatic bladder rupture, hyposmolality and hyponatremia, urolithiasis, hyperosmolality and hypernatremia
Neurogeriatric disorders	Dementia in Parkinson's disease, Alzheimer's disease, vascular dementia, subacute confusional state, coma and drowsiness stupor sleepiness unconsciousness semicoma, anxiety, unspecified delirium, delirium superimposed on dementia.
Cardiometabolic disorders	Type 2 diabetes mellitus, peripheral arterial insufficiency, chronic ischemia, subconjunctival hemorrhage, ischemic heart disease, cerebral hemorrhage, arterial hypertension, acute myocardial infarction, congestive heart failure, arterial thrombosis, heart failure.
General health disorders	Urticaria, generalized pain, hyporexia and anemia.

Disorders related to medical care and procedures	Sequelae of complications from medical and surgical care, other adverse events during medical or surgical care, and procedures for other purposes that aid in health status.
Pulmonary system disorders	Contact and exposure to COVID-19 coronavirus, nonspecific bacterial pneumonia, nonspecific pneumoconiosis, nonspecific pneumonia, pleural effusion, respiratory distress.