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Comprehensive Geriatric Hospital At Home: adaptation to referral and case-mix changes during the COVID-19 pandemic

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Brief summary:

Home hospitalization based on comprehensive geriatric assessment emerges as a flexible care model for older adults by responding to changing referral pathways and patient case-mixes while maintaining favorable outcomes.

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Abstract

Objectives

To describe the evolution of a Hospital at Home (HAH) based on comprehensive geriatric assessment (CGA), including its adaptability to changing case-mixes and pathways during the COVID-19 pandemic.

Design

Observational study of consecutive admissions to a combined step-up (admissions from home) and step-down (hospital discharge) HAH during three periods: pre-pandemic (2018-Feb 2020) vs. pandemic (March-Dec 2020, and Jan-Dec 2021).

Setting and participants

Participants were all consecutive patients admitted to a CGA-based HAH, located in Barcelona, Spain. Referrals followed acute events or exacerbation of chronic conditions, by either primary care (step-up) or after post-surgical discharge (step-down).

Methods

HAH intervention based on CGA and incorporated geriatric rehabilitation. Patient case-mix, functional evolution (Barthel index) and mortality were compared across periods and between pathways.

Results

HAH capacity expanded three-fold from 15 to 45 virtual beds and altogether managed 688 consecutive patients (mean age(SD)=82.5(9.6) years; 59% women).

Pandemic case-mix was slightly older (mean age=83.5 vs 82, p=0.012) than pre-pandemic, with greater mobility impairment. Across periods, step-up increased (26.1%, 40.9%, 48.2%, p<0.01) due to medical events, skin ulcers and post-acute stroke, whereas step-down decreased; multivariable models showed no differences in functional improvement or mortality. When comparing pathways, step-up featured older patients with higher comorbidity, worse functional status and lower absolute functional gain than step-down (5.6 vs 13 points of Barthel Index, p<0.01), remaining statistically significant after adjusting for covariates (p=0.003); no differences in mortality were observed.

Conclusions and Implications

A multipurpose, step-down and step-up CGA HAH expanded its activity and adapted to changing case-mixes and pathways throughout COVID-19 pandemic waves. While further quantitative and qualitative studies are needed to assess the impact of this model, our results suggest that harnessing the adaptability of HAH may help advance a paradigm shift toward more person-centered, cost-effective models of clinical care aimed at older adults.

Introduction

Western countries face population ageing, associated with progressively increasing disability and complex health and social care needs. In this scenario, the classic "reactive" healthcare model, based on urgent assessment and resolution in the acute hospital, needs to evolve towards proactive and community-based integrated health and social care[1]. Many older adults prefer to receive care and support at home, if safe and appropriate[2]. Hospital at Home (HAH) has emerged as a safe, effective, and high-quality alternative to conventional inpatient care. It has been implemented in different populations: oncology, post-surgery or trauma, or decompensation of chronic diseases. To access HAH, the patient's clinical conditions should be sufficiently stable to allow management at home with support from the family and/or informal caregivers[3]. Patients'[4] and caregivers'[5] experience with HAH is highly positive.

HAH may substitute an episode of inpatient care ("step-up" or admission avoidance pathway) or may enable an early supported discharge from the hospital ("step-down") to continue medical treatments or rehabilitation. In older adults, step-up HAH has shown comparable efficiency to conventional hospitalization, with improved delirium outcomes and a delay in institutionalization[6]. Likewise, step-down models of care have proven effective in older populations[7]. We have previously shown that an interdisciplinary HAH team that applies a comprehensive geriatric assessment (CGA) approach for older adults can offer combined step-up and step-down pathways tailored to the needs of patients, carers, and local systems[8,9]. This interdisciplinary CGA-based model overlaps with a broader suite of intermediate care services that operate at the interface between hospital and primary care[10].

The onset of the COVID-19 pandemic heightened awareness of the urgent need for innovative community-based solutions[11]. Increased demand from coronavirus

illness, exacerbations of chronic conditions and widespread deconditioning, have been overwhelming the capacity of primary care and hospitals[12-14]. The risk of COVID-19 transmission was lower for care at home than in hospital or long-term care facilities. Both issues prompted technology-enabled models of HAH for COVID-19 patients[15].

The rapid expansion and adaptation of the HAH model to the changing pandemic context has been challenging, and evidence on its performance in this scenario, besides the specific care for COVID-19 patients, is limited. Therefore, this observational study aims to describe the influence of the pandemic on referral patterns, case-mix, and outcomes of an urban interdisciplinary HAH based on comprehensive geriatric assessment and management (CGA HAH), progressively expanded during sequential waves of the COVID-19 pandemic.

Methods

Design

Study design featured a cohort of patients admitted to a combined step-up and step-down HAH during three consecutive periods: Period 1 ("Pre-pandemic"), between January 2018 (date of implementation of the first HAH team) and February 2020; Period 2 ("Pandemic 2020"), between March 2020 (the official declaration of the COVID-19 pandemic in Spain) and December 2020, including the first lockdown phase (March-May 2020); Period 3 ("Pandemic 2021"), between January and December 2021, during two subsequent waves. For the present analysis, we compared patient outcomes across successive periods and between the step-up and step-down pathways. In line with the Declaration of Helsinki of 1975, prior to the start of the study, its protocol was approved by the corresponding ethics committee, and written informed consent was obtained from all participants.

Population

Older adults (65 years and older) referred to CGA based HAH following: a) an acute event (e.g., hip fracture, stroke, COVID-19 infection or surgery); b) an exacerbation of a chronic condition (e.g., heart failure or Chronic Obstructive Pulmonary Disease (COPD), or c) an infection superimposed on a complex chronic condition such as dementia or complex multimorbidity.

The Comprehensive Geriatric Assessment Hospital at Home (CGA HAH) model

The HAH of Parc Sanitari Pere Virgili (PSPV) is part of an extensive intermediate care service network coordinated by the PSPV Hospital which serves as the reference hub for intermediate care for approximately 900,000 citizens in the

Barcelona metropolitan area of Catalonia, Spain. The network also comprises 365 intermediate care hospital beds (providing geriatric rehabilitation, subacute, long-term and palliative care), ambulatory services (geriatric day hospital, dementia and geriatric outpatients, frailty management unit in the community), and two palliative home-care teams. In addition, the two local university hospitals also provide an acute HAH service, albeit this is not specialized for older adults, and does not provide rehabilitation.

At PSPV, a first CGA HAH team was implemented in January 2018, a second team in January 2021, and a third one in October 2021. The inter-disciplinary and CGA-based functioning of the teams, as well as their governance and coordination within the local system, is detailed in Table 1. Each team manages approximately 15 patients in their own homes as a “virtual ward”, so by October 2021, the overall caseload had expanded to 45 patients. To be eligible for HAH, patients need to be hemodynamically stable and have a caregiver at home who can support the tailored plan established by HAH teams. Reimbursement of expenses is 100% public, and the reference length of stay is around six weeks.

Outcomes

Functional status is routinely assessed with the Barthel Index[16] (0-100, total to no disability in the activities of daily living) at admission and discharge. Baseline value is retrieved from patients and proxies. Primary outcomes were functional improvement (change in Barthel index between HAH admission and discharge) and mortality during the HAH episode.

Covariates

Covariates include: socio-demographic data (age, sex, living situation, formal caregiver), comorbidities (including the Charlson index[17]), diagnosis at admission and geriatric syndromes, including nutritional assessment through Mini Nutritional Assessment–Short Form [MNA-SF®][18], depressive symptoms (Geriatric Depression Scale)[19], delirium screening (CAM), sleep disturbances, walking impairment, falls in the previous six months, dysphagia, sensory deficits, urinary incontinence, constipation and polypharmacy (5+ drugs).

Statistical analysis

Characteristics of the sample are presented as mean values and standard deviation (SD) for continuous variables and absolute numbers plus percentages for categorical variables. Characteristics and outcomes of patients admitted in the different periods were compared using the ANOVA or Kruskal-Wallis test and Chi-square test. Differences between the two main care pathways (step-down and step-up) were analyzed using the chi-square test for proportions and the T-Student test or the Mann–Whitney test for continuous variables.

Variables showing a significant difference between groups (p-for-trend value <0.05) and those considered clinically relevant, or to have a potential influence on the outcomes, were included in a multivariable linear or logistic regression models to determine the adjusted effect of the pandemic period and of the care pathway on functional improvement and mortality, respectively.

All analyses were performed using Stata version 14 (StataCorp LLC, College Station, TX).

Results

Between 2018 and 2021, the CGA HAH managed 688 consecutive patients (mean age=82.5 years; SD=9.6 years, 59% women), mainly referred by acute hospitals (49%), followed by primary care (37%). Overall, 85.5% lived with family members, and 31% were already assisted by a formal caregiver (Table 2). The mean Charlson idex was 2.2, indicating moderate comorbidity, and patients were frankly disabled in the basic activities of daily living (mean Barhtel index 53.2 at admission) from a pre-event state of mild-moderate disability. After a decrease during the pandemic 2020 period, the number of admissions increased in the pandemic 2021 period, with the expansion of HAH capacity (Figure 1).

Compared to the pre-pandemic period, patients admitted during the pandemic were slightly older and had greater mobility impairment but a reduced history of falls and lower rates of delirium. The proportion of patients referred directly by primary care teams (step-up pathway) increased progressively during the pandemic (Table 2). Over time, there was a significant shift in the principal reasons for HAH: a decrease in “surgical profile” (general and orthopedic), while medical events, care of pressure and vascular ulcers and post-acute stroke increased. The team also attended a small number of acute COVID-19 patients. There was no change in the pattern of comorbidities over time. Episodes of delirium preceding the admission and falls lowered over time, whereas walking impairment and constipation increased. The length of stay increased progressively (mean(SD), days=33.0(19.3) vs 36.3(24.3) vs 38.9(21.5), p-for-trend=0.018), and there was no statistically significant difference in readmissions to the acute hospital (mean(SD)=15.0(46) vs 10.1(16) vs 14.4(32) across groups, p-for-trend=0.760). Absolute improvements in Barthel index were not different across the three waves (mean[SD] being 11.1[14.5], 9.6[12.9], 9.9[13.7]

respectively, p-for-trend=0.266), whereas there was a statistically significant increase in absolute deaths (2.6[8], 6.3[10], 7.2[16] respectively, p-for-trend=0.037). However, in the adjusted models there were no differences in functional improvement or mortality across the periods (Table 3).

Patients referred by primary care (step-up) were older, with a higher prevalence of comorbidities (cardiovascular disease, dementia, COPD) and a worse functional status pre-episode (Supplementary Table 1, available separately in Supplemental Material). When comparing step-up and step-down in the whole HAH sample, the step-up pathway showed a significantly lower functional improvement (Barthel Index, mean[SD] 5.6[13.5] vs 13.0[13.4], p- =<0.001) and an increased mortality (9.9[25] vs 2.0[9], p<0.001). In adjusted models (Table 4), functional improvement remained significantly lower for the the step-up group, whereas the difference was non-significant for mortality.

Discussion

In our experience, after a temporary reduction of referral (mainly due to step-down demand, as hospital activity shifted towards COVID-19), the HAH had expanded by 2021 to three teams to meet the increased demand. This was partially driven by an increased referral from primary care, with a corresponding shift in case-mix. Outcomes did not change across pandemic periods, although the step-up group had significantly lower functional improvement than the step-down one, partly attributable to differences in case-mix.

The reduction in step-down demand, previously the main source of referrals, is primarily explained by the shift of activity in acute care hospitals[12,13]. The subsequent increase in step-up demand is likely due to the need for alternative solutions for older adults with exacerbations of chronic diseases, when primary care was focused on managing community-dwelling COVID-19 patients and contact tracing, with a reduced follow-up of chronic multimorbid patients[14]. Our HAH model integrates a rehabilitative function, in line with the integrated transitional and intermediate care model for older adults[10], which enhances the care continuum and also explains the different length of stay, compared to the acute HAH literature. Notably, although many rehabilitation activities were temporarily interrupted at the beginning of the pandemic all over the world[21], including in Catalonia, this CGA HAH remained active, as social distancing was feasible in the patient's environment within the pandemic scenario.

At an international level, there is a growing interest in HAH research[22]. Systematic reviews suggest that both care pathways have similar or improved outcomes compared to conventional hospitalization[23]. We had previously shown, in a different population, that this CGA HAH model, combining step-up and step-down

care within the same team, was comparable to conventional hospitalization for both care pathways[8,9], also for specific processes such as stroke rehabilitation[24], with a contextual reduction of the length of stay[8,25]. In a recent large UK trial on step-up HAH, the authors found comparable outcomes in living at home and mortality at six months. Older adults were more satisfied with the HAH care, less often experienced delirium, and fewer were admitted to nursing homes[6]. Care at home is a valuable resource for managing geriatric syndromes such as delirium[26].

Patients referred during the pandemic were slightly older and showed more mobility impairment than pre-pandemic HAH patients, to which the lack of physical activity associated with social distancing measures might have contributed[27]. The lower risk of delirium could be due to lower rates of hospitalization, a significant risk factor for delirium[28], and perhaps less confidence in diagnosing delirium in primary care/home settings.

Functional impairment and mortality were not substantially different comparing the pandemic and pre-pandemic groups overall but functional improvement was lower for step-up HAH cases. These patients were generally complex with a considerably higher prevalence of cardiovascular, dementia, and cancer comorbidities that contribute to poor outcomes. We speculate that primary care physicians may preferentially refer such patients to HAH given the low benefit/risk ratio associated with conventional hospital care. However, they may also have delayed the referral because they are less aware of this care option. The observed unadjusted difference in mortality between step-up and step-down pathways is consistent with other studies[29] and probably related with the higher age and comorbidity burden of patients in the step-up pathway. A few studies have investigated the impact of HAH models on the functional status of older adults: in

general, results seem favorable[30] compared to conventional acute care, with reduced use of subsequent rehabilitation services[31]; functional outcomes appear at least not inferior to geriatric rehabilitation or bed-based intermediate care[8]. It has been suggested that HAH models might favor patients' daily physical activity, although research in this field is scarce[32].

HAH is viable for hemodynamically stable patients who do not need intensive diagnostic or treatment resources and have a caregiver who can assume responsibility for some care tasks[3]. Unless integrated health and social care systems are strengthened, the need for an informal caregiver might be an important limitation to scale up HAH. Increasing international evidence supports the cost-effectiveness of CGA HAH, compared to conventional hospitalization[33], also considering the 30-day post-acute care period[34].

This study has different limitations: first, it is difficult to assess generalizability of results because local contextual factors and relationships with primary care and after-hours providers may have influenced the HAH process and outcomes. Second, the three time periods studied might be considered arbitrary, although they were chosen to balance the need to differentiate between periods with different operational context with need to maintain a reasonable sample size in each group. Finally, we could not control for the severity/acuity of the disease at admission. Study strengths include the real-life implementation-research approach, the relatively large sample size for an innovative model of care, and careful and complete data collection across both the acute and rehabilitation phases of the intervention.

Conclusions and Implications

In conclusion, the COVID-19 pandemic has been an important catalyst in strengthening this innovative alternative model of care. Our CGA HAH teams showed an ability to rapidly adapt and evolve the service in response to the different pandemic waves, maintaining flexibility to manage changing case-mixes between the two pathways. Despite managing more complex and functionally impaired patients over time, the outcomes of HAH did not worsen significantly. CGA HAH represents a powerful evolution of traditional geriatric care and a valuable alternative to conventional hospitalization for healthcare systems. We advocate further empirical research of this model in different systems and with an evaluation of outcomes against the Quadruple Aim (health outcomes, patients and caregiver experience, experience of professionals, and costs), as harnessing the adaptability of CGA HAH may help advance a paradigm shift toward more person-centered, cost-effective models of clinical care aimed at older adults.

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421 **Legends**

422 *Figure 1*. Number of admissions to CGA HAH by month and number of confirmed
423 COVID-19 cases in Catalonia.

424

425 *Supplemental Material*: Supplementary Table 1. Baseline characteristics of patients
426 included in Geriatric HAH, comparing types of care pathway.

Table 1. Description of the HAH model according to pre-defined descriptive categories(6)

Admission avoidance hospital at home with Comprehensive Geriatric Assessment	
ORGANIZATIONAL FEATURES	
Team members	Geriatrician, Nurse, Physiotherapist, Occupational therapist, 0.5wte Social worker, Speech therapist (online), for each 15 beds.
Responsibility	Attending geriatricians and specialized nurses.
Governance structure	Under the structure of Parc Sanitari Pere Virgili intermediate care hospital (Department of Ambulatory and Home-Care Geriatrics).
Patient referral route to CGA HAH	• Acute hospital, from the emergency room or acute wards. • Subacute care unit at the intermediate care hospital. • Primary care (family medicine or nursing).
Patient assessment when admitted to CGA HAH	All the referrals must include clinical and social information. **a)** Patients admitted from an acute hospital are assessed, before admission, by a reference professional, in some cases by a geriatric nurse performing a systematic short CGA. The nurse practitioner at the HAH collects information, contacts the referring staff by phone within 12 to 24 hours of referral, and discusses with a geriatrician and social worker who assesses them at home after admission. **b)** Patients admitted from home are assessed by a geriatrician, a specialized nurse, and a social worker within 24 to 48 hours.
Comprehensive geriatric assessment (CGA)	A specialized nurse completes the initial assessment, followed by a medical assessment (<24 hours after admission). Elements include: • Clinical history and examination; list of differential diagnoses. • Assessment of medical, functional, and cognitive needs in the home environment on the day of admission, which includes screening for delirium, geriatric syndromes, dementia and depression, assessment of frailty, skin, nutrition, vision, hearing. • Review of investigations and medication review. • Socio-economic status, risk assessment and home environment. • Multi-dimensional CGA-based individualized treatment plan. • Communication with patients (or representatives) and caregivers for shared goals, decision-making and advanced care planning.
Virtual ward or board rounds	In-person care is available from 8 am to 9pm. Home visits by all team members are planned depending on individual needs. Daily visits by at least one team member (Mon to Fri). Each patient's evolution, intervention plan and discharge planning are discussed in the weekly interdisciplinary board meeting.
Out-of-hours care	9 pm to 8 am is covered by the physican on call in hospital, providing telephone advice or activating the emergency services.
SPECIFIC ROLES of TEAM MEMBERS and PARTNERS	
Geriatrician and specialty training doctors	Clinical governance, clinical review, trainees supervision, communication with the primary care team, investigations orders, drug prescription and referrals to other specialties.

Specialized nurses	• Patients' assessment at home, including activities of daily living, delirium, physical or cognitive ability, and falls. • Provision of equipment and medication • Investigations requests, extraction of blood samples. • ECG, urinary catheterization, dressings to skin lesions… • IV fluids and drugs administration. • Link with community teams for follow-up care. • Pre-discharge visits in the hospital to build trust with patients.
Physiotherapists and occupational therapists	• Functional assessment to include gait, balance, managing stairs, chest physiotherapy, exercise program, and walking aids. • Assessment and training in the activities of daily living also outside the house; equipment provision and training.
Social workers	• Social and family assessment and detection of needs. • Guidance on procedures and social resources. • Coordination with external services (i.e., primary care social worker, social services) and referral to them if necessary. • Drafting of the social report upon discharge.
Pharmacists	• Medicine reconciliation, polypharmacy, and adherence checks.
Primary care physicians and teams	• Triage referrals for CGA HAH in case of step-up pathway • Cooperates during the process if particular issues arise • Receive discharge information through Shared Health Electronic platform of Catalonia and assume care continuity

Table 2. Baseline characteristics of patients admitted to the CGA HAH, comparing pre-pandemic and pandemic periods.

	Total, n= 688	**Pre-Pandemic, n=307**	**Pandemic 2020, n=159**	**Pandemic 2021, n=222**	**p-value**
Age, mean (SD)	82.5 (9.6)	82.0 (8.8)	81.9 (10.2)	83.5 (10.2)	**0.012**
Women, % (n)	58.6 (391)	55.7 (171)	56.6 (90)	58.6 (130)	0.517
Living situation, % (n)					
Living with family	85.5 (588)	85.0 (261)	88.7 (141)	83.8 (186)	
Living with a caregiver	10.6 (73)	10.8 (33)	8.2 (13)	12.2 (27)	0.664
Nursing home	3.9 (27)	4.2 (13)	3.1 (5)	4.1 (9)	
Formal caregiver, % (n)	31.5 (216)	31.2 (95)	27.2 (43)	35.1 (78)	0.386
Source of referral, % (n)					**<0.001**
Primary care teams	36.6 (252)	26.1(80)	40.9 (65)	48.2 (107)	
Intermediate Care beds	14.1 (97)	14.0 (43)	15.7 (25)	13.1 (29)	
Acute Hospitals	49.3 (339)	59.9 (184)	43.4 (69)	38.7 (86)	
Comorbidities, % (n)					
Cardiovascular[a]	83.9 (577)	84.4(259)	83.0 (132)	83.8 (186)	0.838
Diabetes mellitus	30.9 (212)	30.9 (95)	35.9 (57)	27.3 (60)	0.402
Cerebrovascular	20.1 (138)	15.6 (48)	18.2 (29)	27.5 (61)	**0.001**
Chronic Renal Failure	29.2 (201)	29.0 (89)	30.2 (48)	28.8 (64)	0.987
Dementia or Cognitive impairment	28.2 (194)	29.6 (91)	25.8 (41)	27.9 (62)	0.624
Depression	19.6 (135)	18.9 (58)	20.1 (32)	20.3 (45)	0.684
COPD	19.3 (133)	22.2 (68)	18.9 (30)	15.8 (35)	0.066
Neoplasia	13.5 (93)	11.7 (36)	16.3 (26)	14.0 (31)	0.405
Charlson I.,mean (SD)	2.2 (1.8)	2.0 (1.7)	2.5 (2.1)	2.2 (1.8)	0.068
Diagnosis at admission, % (n)					
Post-surgery	1.7 (12)	3.6 (11)	0.6 (1)	0.0 (0)	**0.001**
Orthogeriatric	33.4 (230)	41.3 (127)	28.9 (46)	25.7 (57)	**<0.001**
Medical event[b]	50.4 (347)	47.6 (146)	57.2 (91)	49.6 (110)	0.546
Stroke	6.0 (41)	2.9 (9)	6.9 (11)	9.5 (21)	**0.002**
Skin ulcers	5.5 (38)	4.6 (14)	3.8 (6)	8.1 (18)	0.095
COVID-19	2.9 (20)	0.0 (0)	2.5 (4)	7.2 (16)	<0.001
Geriatric syndromes, % (n)					
Delirium (acute episode)	14.5 (100)	21.5 (66)	9.4 (15)	8.5 (19)	**<0.001**
Sleep disturbances	25.2 (173)	24.1 (74)	21.4 (34)	29.3 (65)	0.211
Walking impairment	39.7 (273)	21.2 (65)	54.7 (87)	54.5 (121)	**<0.001**
Falls (past 6 months)	55.8 (363)	65.3 (186)	46.4 (71)	49.8 (106)	**<0.001**
Polypharmacy[c]	62.4 (429)	65.8 (202)	61.0 (97)	58.6 (130)	0.085
Dysphagia	14.4 (99)	12.4 (38)	13.8 (22)	17.6 (39)	0.098
Malnutrition	8.6 (59)	9.5 (29)	8.8 (14)	7.2 (16)	0.371
Sensory deficits[d]	46.7 (321)	49.8 (153)	46.5 (74)	42.3 (94)	0.089
Urinary incontinence	50.4 (347)	50.8 (156)	42.8 (68)	55.4 (123)	0.386
Constipation	29.8 (205)	25.4 (78)	30.8 (49)	35.1 (78)	**0.015**
Functional assessment, means (S.D.)					
Barthel I. pre-admission	76.4 (24.9)	77.4 (23.4)	77.1 (25.9)	74.6 (26.2)	0.532
Barthel I. admission	53.2 (23.5)	52.7 (22.0)	54.8 (24.7)	52.8 (24.7)	0.788

SD: Standard Deviation.

Legend:
[a] Cardiovascular disease: Hypertension, ischemic cardiopathy, atrial fibrillation, chronic heart disease; [b] Medical event: decompensation of chronic diseases such as heart failure, chronic pulmonary disease, chronic renal failure, dehydration, pain control; [c] Polypharmacy: ≥ 5 drugs; [d] Sensory deficits: auditory or visual deficits

Table 3. Multivariable regression models, comparing the main outcomes (functional improvement and death) across the pre-pandemic and pandemic periods.

	Barthel Index improvement			**Death**		
REGRESSION MODELS	**Linear regression**			**Logistic regression**		
	ß	**95% C.I.**	**p-value**	**OR**	**95% C.I.**	**p-value**
Unadjusted						
Pre-pandemic	ref					
Pandemic 2020	-1.17	-4.20 ; 1.86	0.448	2.51	0.97 ; 6.49	0.058
Pandemic 2021	-1.19	-3.97 ; 1.56	0.395	2.90	1.22 ; 6.91	**0.016**
Adjusted						
Pre-pandemic	ref					
Pandemic 2020	-1.21	-4.38 ; 1.95	0.451	2.03	0.62 ; 6.68	0.239
Pandemic 2021	-0.94	-3.93 ; 2.03	0.534	2.26	0.75 ; 6.85	0.149
Age	-0.09	-0.22 ; 0.04	0.158	1.08	1.02 ; 1.14	**0.013**
Female	4.01	1.61 ; 6.40	**0.001**	0.86	0.38 ; 1.93	0.707
Referral from primary care	- 6.10	-8.71 ; -3.50	**<0.001**	2.98	1.21 ; 7.32	**0.017**
Stroke [a]	6.24	1.61 ; 10.94	**0.009**	1 (omitted)		
Previous walking impairment	1.40	-1.14 ; 3.95	0.278	1.91	0.85 ; 4.29	0.119
Delirium (acute episode)	-3.63	-6.86 ; -0.40	**0.028**	0.83	0.23 ; 3.04	0.790
Falls (past six months)	2.41	-0.11 ; 4.94	0.061	0.54	0.23 ; 1.25	0.149

Barthel Index improvement: Barthel I. at discharge minus Barthel I. at admission

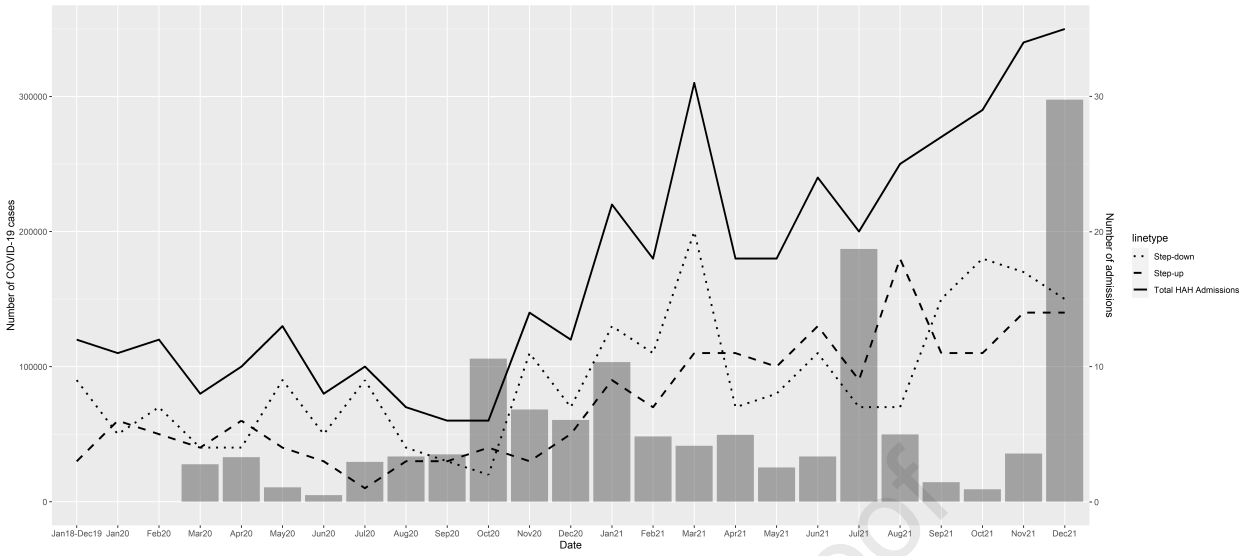
[a] Main diagnosis at admission.

Table 4. Multivariable regression models comparing the main outcomes (functional improvement and death) between step-up and step-down pathway.

	Barthel improvement			**Death**		
REGRESSION MODELS	**Linear regression**			**Logistic regression**		
	ß	**95% C.I.**	**p-value**	**OR**	**95% C.I.**	**p-value**
Unadjusted						
Step-up	ref					
Step-down	7.45	5.03 ; 9.86	**<0.001**	0.19	0.09 ; 0.42	**<0.001**
Adjusted						
Step-up	ref			ref		
Step-down	4.12	1.44 , 6.82	**0.003**	0.46	0.18 ; 1.15	0.098
Age	-0.05	-0.19 ; 0.08	0.452	1.07	1.00 ; 1.13	**0.036**
Female	2.99	0.54 ; 5.43	**0.017**	0.99	0.42 ; 2.34	0.987
Formal caregiver	-1.67	-4.37 ; 1.04	0.226	0.88	0.38 ; 2.04	0.759
Cardiovascular disease [a, b]	-1.52	-4.68 ; 1.63	0.343	1.53	0.33 ; 7.11	0.585
Dementia or Cognitive impairment [b]	1.84	-4.59 ; 0.91	0.189	0.80	0.32 ; 1.98	0.625
Orthogeriatric [c]	4.45	0.167 ; 7.24	**0.002**	0.28	0.06 ; 1.37	0.116
Falls (past six months)	1.09	-1.43 ; 3.60	0.397	0.78	0.33 ; 1.82	0.561
Barthel pre-admission	0.05	0.01 ; 0.111	**0.046**	0.98	0.97 ; 0.99	**0.028**

Barthel Index improvement: Barthel Index at discharge minus Barthel Index at admission

[a] Cardiovascular disease: Hypertension, ischemic cardiopathy, atrial fibrillation, chronic heart disease; [b] Comorbidities; [c] Main diagnosis at admission.



Supplementary Table 1. Baseline characteristics of patients included in Geriatric HAH, comparing types of care pathway.

	Total, n= 688	**Step-up, n=307**	**Step-down, n=351**	**p-value**
Age, mean (SD)	82.7 (9.2)	85.0 (8.3)	81.0 (10.0)	**<0.001**
Female, % (n)	56.5(372)	58.7 (148)	55.7 (243)	0.445
Social situation				
Living with				0.193
Family	85.2 (561)	82.9 (209)	86.9 (379)	
Caregiver	10.8 (71)	11.5 (29)	10.1 (44)	
Nursing home	4.0 (26)	5.6 (14)	3.0 (13)	
Formal caregiver, % (n)	32.4 (212)	40.6 (102)	26.3 (114)	**<0.001**
Comorbidities				
Cardiovascular[a], % (n)	83.9 (552)	88.1 (222)	81.4 (355)	**0.022**
Diabetes mellitus, % (n)	31.0 (204)	27.8 (70)	32.6 (142)	0.190
Cerebrovascular, % (n)	20.1 (132)	18.7 (47)	20.9 (91)	0.483
Chronic Renal Failure, % (n)	28.9 (190)	32.5 (82)	27.3 (119)	0.145
Dementia or Cognitive impairment, % (n)	28.4 (187)	34.5 (86)	24.8 (108)	**0.009**
Depression, % (n)	19.2 (126)	17.5 (44)	20.9 (91)	0.278
COPD, % (n)	19.9 (131)	24.6 (62)	16.3 (71)	**0.008**
Neoplasia, % (n)	13.5 (89)	11.5 (29)	14.7 (64)	0.241
Charlson Index, mean (SD)	2.2 (1.8)	2.2 (1.6)	2.2 (1.9)	0.985
Diagnosis at admission, % (n)				
Post-surgery	1.8 (12)	0.8 (2)	2.3 (10)	0.148
Orthogeriatric	32.2 (212)	13.5 (34)	45.0 (196)	**<0.001**
Medical event	51.5 (339)	70.6 (178)	38.8 (169)	**<0.001**
Stroke	6.1 (40)	4.4 (11)	6.9 (30)	0.179
Pressure/vascular ulcers	5.5 (36)	9.9 (25)	3.0 (13)	**<0.001**
COVID-19/ post-COVID-19	2.9 (19)	0.8 (2)	4.1 (18)	**0.012**
Geriatric syndromes, % (n)				
Delirium (acute episode)	14.5 (100)	12.3 (31)	15.8 (69)	0.206
Sleep disturbances	25.2 (173)	25.8 (65)	24.8 (108)	0.766
Walking impairment	39.7 (273)	39.3 (99)	39.9 (174)	0.872
Falls (past 6 months)	55.8 (363)	41.5 (95)	63.5 (268)	**<0.001**
Polypharmacy [c]	62.4 (429)	61.1 (154)	63.1 (275)	0.609
Dysphagia	14.4 (99)	17.1 (43)	12.8 (56)	0.129
Malnutrition	8.6 (59)	7.1 (18)	9.4 (41)	0.308
Sensory deficits [d]	46.7 (321)	54.0 (136)	42.4 (185)	**0.003**
Urinary incontinence	50.4 (347)	57.1 (144)	46.6 (203)	**0.007**
Constipation	29.8 (205)	31.8 (80)	28.7 125)	0.395
Functional assessment, means (S.D.)				
Barthel I. pre-admission	76.4 (24.9)	67.7 (27.8)	81.3 (21.6)	**<0.001**
Barthel I. (admission)	53.2 (23.5)	51.7 (25.9)	54.0 (21.9)	0.230

SD Standard Deviation.

[a] Cardiovascular disease: Hypertension, ischemic cardiopathy, atrial fibrillation, chronic heart disease. [b] Medical event: decompensation of chronic diseases as heart failure, chronic pulmonary disease, chronic renal failure, dehydration, pain control. [c] Polypharmacy: ≥ 5 drugs. [d] Sensorial deficits: auditive or visual deficits.