REVIEW

Comparison of Hospital-at-Home and In-Hospital hospitalizations of randomized controlled studies – a systematic review and meta-analysis

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ABSTRACT

Background: Several studies demonstrated clinical and economic benefits of hospital-at-home (HaH), but using different methods, study groups, and indications, the results are unequivocal. Our systematic review and meta-analysis include only randomized-controlled studies comparing outcomes of HaH with those of regular in-patient hospitalizations.

Aim: To compare outcomes of HaH with those of regular hospitalization.

Methods: English Medical literature searches were conducted for Hospital-at-Home compared to In-Hospital hospitalization in randomized, controlled studies (RCTs). Searches were performed in PubMed, EMBASE, Scopus, and CENTRAL. Meta-analysis was performed and pooled odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated. Heterogeneity was evaluated and I^2 statistic was used to measure the proportion of inconsistency in individual studies. We also calculated a potential publication bias.

Results: 14 randomized controlled studies representing 43 sub-studies were selected according to the inclusion criteria. The odds ratio of "hospital-at-home" and "in-hospital" comparison was 0.638 95% CI 0.512 to 0.796. In the issues of clinical outcomes, HaH was found to be non-inferior than a regular hospital, but much better in patient preference with OR 0.396 95% CI 0.277 to 0.566 for worse outcomes. Heterogeneity and inconsistency were small, with no significant publication bias.

Conclusion: This meta-analysis showed that HaH may be recommended for patient hospitalization when needed, according to the specific indications and patients matching to HaH criteria.

INTRODUCTION

Hospital-at-Home (HaH) is a term that describes hospitalization at home as a substitute for regular inpatient

hospitalization. This form of hospitalization became popular recently, during the COVID-19 pandemic, following the development of new home monitoring devices, enabling remote telehealth procedures.[1] This method opens access to tertiary academic centers for remote populations and advances treatment equity. HaH became available in countries such as Australia, China, and the USA, affecting peripheral, remote populations, far away from advanced, modern services.[2-6] To be hospitalized at home the patient should be respiratory and hemodynamically stable. The decision of regular or home hospitalization may be taken according to clinical protocols, specific rules, and definitions, which may differ according to local regulations. HaH facilities provide medical care for acute conditions or exacerbation of chronic diseases and usually include monitoring, nursing, physician clinical care, diagnostic care, and treatment.

Several studies demonstrated clinical and economic benefits of HaH, but using different methods, study groups, and indications, the results are unequivocal, and further studies are needed.[7-9] Proving the non-inferiority of HaH outcomes from regular in-patient hospitalization is of utmost importance since hospitals are over-crowded with patients and HaH might be an excellent solution for relieving the pressure from the health systems. In addition, it may have the advantage of preventing nosocomial infections, falls, delirium, and many other hazards waiting for hospitalized elderly patients.[7-9]

Our systematic review and meta-analysis include only randomized-controlled studies comparing outcomes of HaH with those of regular in-patient hospitalizations. We looked at post-discharge outcomes such as mortality, readmission, admission to the emergency department, general practitioner attendance, secondary care appointments, satisfaction, preference statements, functional status, instrumental activities, living at home, and living in long-term residential care.

METHODS

Identification of Studies and Data Extraction.

We searched the PubMed, EMBASE, Scopus, and CENTRAL databases until 31.12.2023 to identify human studies written in English. The following search text and/or Medical Topic Heading (MeSH) terms were used: Virtual hospital OR Virtual Wards OR Hospital-at-Home OR HaH [All Fields] AND "In-Hospital" [MeSH Terms]. To retrieve original studies, a manual search of all review articles and editorials was also done. Hand searches included articles bibliography. This meta-analysis was performed according to the PRISMA extension statement for interventions.[10]

Selection criteria - primary endpoints

Inclusion and exclusion criteria were decided upon before starting the study investigation. Appropriate studies were included provided the following criteria were met: a. Complete articles with data that can be extracted; b. Written in English, and c. Comparing hospitalization outcomes between HAH and In-hospital. Studies that did not meet these criteria were excluded. In addition, studies of pediatric HaH, admission prevention, or not reporting outcomes, were excluded. The first screening was done by reading the titles, then the abstracts, and the whole paper.

Heterogeneity, Sensitivity, and Publication Bias

The heterogeneity of the studies was calculated using the Cochran Q test and I^2 inconsistency index, and it was considered to be present if the Q-test P value was less than 0.10. The higher the I^2, the greater the heterogeneity.[11] The sensitivity testing was

conducted by removing individual studies from the overall result. The publication bias was analyzed using a funnel plot complemented by Begg-Mazumdar and Egger statistics.[12] We also used Slim K et al. method for the evaluation of non-randomized studies' quality for the purpose of meta-analysis.[13]

Statistical analysis

We used Comprehensive meta-analysis software (Version 4, Biostat Inc., Englewood, NJ, United States). Pooled odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to compare outcomes in individual studies by using the random effects model. First, we performed a meta-analysis calculation for the 14 studies, then we separated studies into 4 groups: 1. Readmission rate (in different periods after hospitalization for individual studies), 2. Post-hospitalization admission to the emergency room, general practitioner, secondary care physician, and treatment failure, 3. Mortality rate (in different periods after hospitalization for individual studies), 4. Patients' subjective approach – satisfaction, preference, functional indexes, knowledge, self-management, not living at home, living in long-term residential care.

For the sake of unity in the direction of the meta-analysis calculation, we used only negative direction, mortality (and not survival), patient “not high satisfaction” etc.

RESULTS

A systematic review of the selected studies.[14-27]

Richards SH et al. (UK, 1998),[14] Compared the effectiveness and acceptability after randomization to early discharge to a HaH (160 patients, 68% women) with that of routine discharge from the hospital (81 patients, 72% women). Patients were from medical, orthopedic, and general surgery departments. The mortality rate was 12 out of 160 (7.5%) and 6 out of 81 (7.4%), and high satisfaction was stated by 78 out of 155 (50.3%) and 31 out of 70 (44.2%), in HaH versus in-patients, respectively. These results were not statistically significant.

Shepperd S et al. (UK, 1998),[15] Randomized patients recovering from hip replacement, knee replacement, and hysterectomy, elderly medical patients, and patients with chronic obstructive lung disease, into hospitalization in HaH (61 men, 202 women, median age 68 – 77) or inpatient hospital (58 men, 217 women, median age 70-76). Readmission rates after 3 months were 2 out of 36 (5.6%) and 1 out of 48 (2.1%); 4 out of 46 (8.7%) and 1 out of 39 (2.6%); 7 out of 108 (6.5%) and 13 out of 123 (10.6%); 13 out of 47 (27.7%) and 5 out of 42 (11.9%); 8 out of 13 (61.5%) and 6 out of 17 (35.3%), for patients recovering from hip replacement, knee replacement, and hysterectomy, elderly medical patients, and patients with COPD, respectively. Thus, the readmission rate was higher for HaH than for in-patients in most of the indications except for hysterectomy follow-up. The preferred way of hospitalization was declared by 20 out of 36 (55.6%) and 8 out of 48 (16.7%); 25 out of 46 (54.3%) and 5 out of 39 (12.8%); 32 out of 108 (29.6%) and 10 out of 123 (8.1%); 29 out of 47 (61.7%) and 8 out of 42 (19.0%), of patients recovering from hip replacement, knee replacement, and hysterectomy, elderly medical patients, and patients with COPD, respectively. Thus, patients preferred HaH on in-patient hospitalization in all the indications.

Wilson A et al. (UK, 1999),[16] Recruited 199 eligible patients, 141 of them were women, ages ranged from 33 to 102 years, a median of 84. They compared mortality and change in health status between 101 patients randomized to HaH and 96 to hospital in-patient care. Two weeks after hospitalization 26 (25.7%) and 30 (31.2%)

died; 21 (20.8%) and 16 (16.7%) were admitted to the emergency department; 9 (8.9%) and 8 (8.3%) had Barthel index of 20; and 12 (11.9%) and 7 (7.3%) had a Philadelphia geriatric morale score higher than 43, in HaH and in-patient, respectively. Better for HaH than for in-patient hospitalization.

Davies L et al. (UK, 2000),[17] Randomized patients with exacerbations of chronic obstructive pulmonary disease to HaH versus hospital care. Out of 100 patients in HaH (45 men, average age 70) and 50 patients in hospital care (30 men, average age 70) 37 (37.0%) and 17 (34.0%) were readmitted; 9 (9%) and 4 (8.0%) died, after a follow-up of 3 months, respectively. These changes were not statistically different.

Wilson A et al. (UK, 2002),[18] Asked 48 patients randomized to HaH and 35 to hospital care about their satisfaction, and got a high satisfaction rate from 47 (97.9%) and 33 (94.2%) patients, respectively (NS). The indications for hospitalization were cardiovascular or respiratory diseases.

Hernandez C et al. (Spain, 2003),[19] COPD patients, 121 HaH (117 men, mean age 71), 101 regular hospital care (98 men, mean age 71). Mortality 5 (4.1%) vs. 7 (6.9%); emergency room visits 16 (13.2%) vs. 31 (30.7%), better knowledge of the disease 70 (57.9%) vs. 27 (26.7%); and better self-management of their condition 98 (81.0%) vs. 48 (47.5%), respectively, all statistically significant and better in HaH.

Mendoza H et al. (Spain, 2009),[20] CHF patients, 37 HaH (18 men, mean age 78) 34 regular hospital care (24 men, mean age 80). All patients were studied for 1 year. No significant differences were found in baseline characteristics, including comorbidity, functional status, and health-related quality of life. Clinical outcomes were similar after initial admission and after the 12 months of follow-up. Death or re-admission due to CHF or another cardiovascular event occurred in 19 (51.4%) in HaH and in 20 (58.8%) patients of in-hospital care (NS).

Tibaldi V et al. (Italy 2009),[21] CHF patients, 48 HaH (22 men, mean age 82), 53 regular hospital care (30 men, mean age 80). Mortality was 7 (14.6%) vs. 8 (15.1%), (NS); subsequent admission to hospital 8 (16.7%) vs. 18 (34.0%), for HaH and in-patient, respectively.

Leff B et al. (USA, 2009),[22] Randomized 214 patients aged 65 and older, with exacerbation of chronic obstructive pulmonary disease, congestive heart failure, pneumonia, or cellulitis, who met previously validated HaH eligibility criteria, to HaH or regular hospital. Functional status was measured as five activities of daily living (eating, bathing, dressing, toileting, and transferring), and seven activities of instrumental activities of daily living (managing money, managing medications, preparing meals, shopping, doing light or heavy housework, using the telephone). Better results were found for 44 (61.1%) and 25 (53.2%); 46 (63.9%) and 17 (23.6%) out of 72 HaH (50 men, mean age 77) and out of 47 in-patient (35 men, mean age 76.9) patients, respectively. Thus the outcomes were significantly better for HaH.

Vianello A et al. (Italy, 2013),[23] Patients with neuromuscular disease, 26 HaH (17 men, mean age 45), 27 regular hospital care (24 men, mean age 47). Treatment failure in 8 (30.8%) vs. 13 (48.1%); mortality at 3 months 3 (11.5%)vs. 4 (14.8%), respectively. Both are not statistically significant.

Echevarria C et al. (UK, 2018),[24] Compared the outcomes of 60 COPD patients hospitalized in HaH with 58 COPD patients with the same disease severity, allocated to usual care. Death rates, readmission, one or more general practitioner attendances post-discharge, and one or more secondary care appointments, at 90 days were 1 (1.7%) and 1 (1.7%); 22 (36.7%) and 23

(39.7%); 26 (43.3%) and 30 (51.7%); 48 (80.0%) and 41 (70.7%), respectively. The stated preference for HaH was 54 (90.0%) and 51 (87.9%), respectively, all changes are not statistically significant.

Levine DM et al. (USA, 2018),[25] 9 patients were randomized to HaH (7 men, median age 65) and 11 to a regular hospital (3 men, median age 60). 30-day readmission rate, 30-day emergency department visits, primary care visit post-discharge, 30-day mortality, were 1 (11.1%) and 4 (36.4%); 1 (11.1%) and 2 (18.2%); 7 (77.8%) and 4 (36.4%); and 0 and 0, respectively. Patients suffered from any infection or exacerbation of heart failure, chronic obstructive pulmonary disease, or asthma.

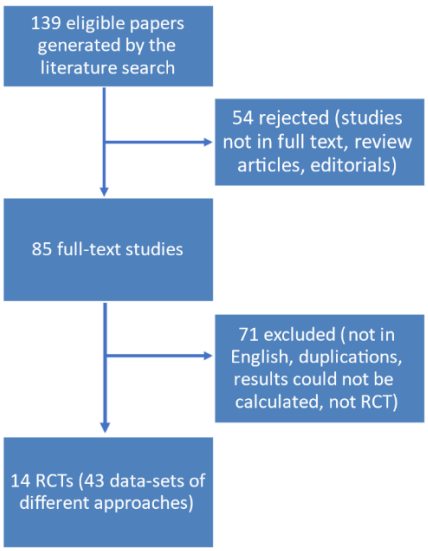
Levine DM et al. (USA, 2020),[26] Randomized 43 patients to HaH (28 men, median age 80) and 48 to a regular hospital (30 men, median age 72). They found that primary care visits within 14 days after discharge, 20-day readmission rate, and 30-day emergency department presentation in 22 (51.2%) and 19 (39.6%); 3 (7.0%) and 11 (22.9%); 3 (7.0%) and 6 (12.5%) patients, respectively. Patients suffered from selected acute conditions.

Shepperd S et al. (UK, 2021),[27] Admitted 687 geriatric patients into HaH (269 men, mean age 83.3) and 345 into a regular hospital (138 men, mean age 83.3) and compared at 6 months follow-up living at home, mortality rate, and living in long-term residential care; they found 528 (76.9%) and 247 (71.6%); 114 (16.6%) and 58 (16.8%); 37 (5.4%) and 27 (7.8%), respectively. These changes were not statistically significant.

Meta-analysis results

Our literature search revealed studies that compared outcomes of HaH and In-Hospital hospitalizations (Figure 1). 139 eligible studies were generated by the literature search. 54 studies were excluded being not in full text, review articles, and editorials. 71 additional studies were excluded being not in English, duplications, not RCT, and for using the average score and standard deviation for comparison of outcomes thus, a meta-analysis could not be performed. We were left with 14 RCTs (43 data sets) that fulfilled the inclusion criteria and compared the outcomes, published up to 31/12/2023. Altogether there were 8,169 patients, 4,784 were randomized to HaH and 3,385 to In-Hospital hospitalizations, used for comparison of the different outcomes (Figure 2a). The mean effect size is 0.638 with a 95% confidence interval (95% CI) of 0.512 to 0.796. The Z-value tests the null hypothesis that the mean effect size is 1.000. The Z-value is -3.982 with $p < 0.001$. Using a criterion alpha of 0.050, we reject this null hypothesis.

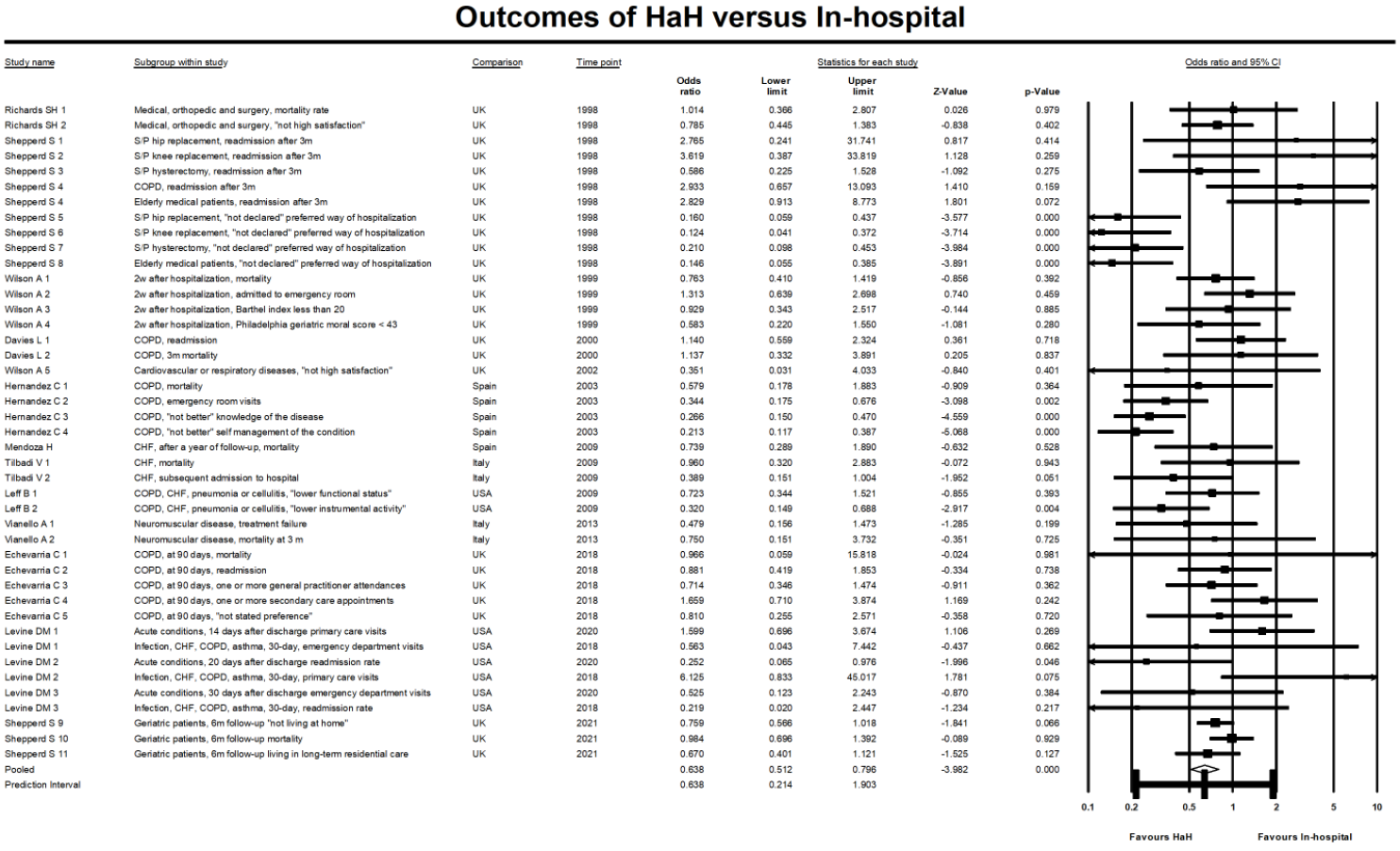
Figure 1. Flow chart of studies included in the meta-analysis.



Separately measured meta-analyses of readmission, admission to another facility, mortality, and patient preference revealed better or non-inferiority results favor HaH: OR 0.923 95%CI 0.543 to 1.571, P = NS, OR

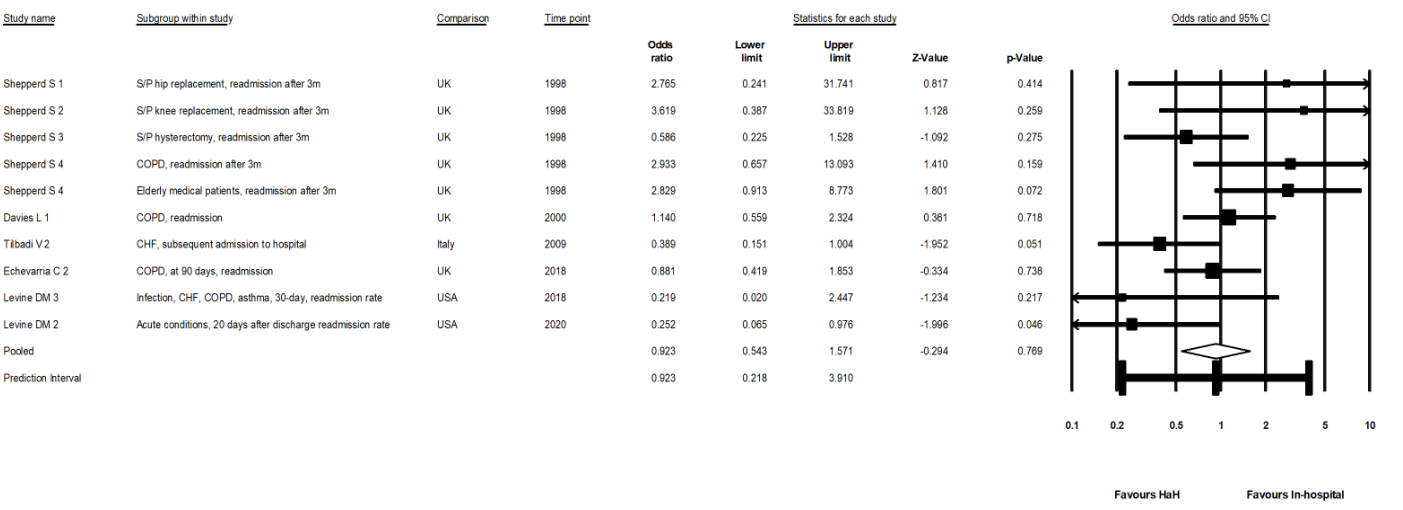
0.904 95%CI 0.545 to 1.499, P = NS, OR 0.984 95%CI 0.696 to 1.392, P = NS, and OR 0.396 95%CI 0.277 to 0.566, P < 0.0001 (Figure 2b, Figure 2c, Figure 2d, Figure 2e).

Figure 2a. Forest plot illustrating OR and 95% CI for all outcomes, comparing HaH and in-hospital.



Study name	Subgroup within study	Comparison	Time point	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value
Richards SH 1	Medical, orthopedic and surgery, mortality rate	UK	1998	1.014	0.366	2.807	0.026	0.979
Richards SH 2	Medical, orthopedic and surgery, "not high satisfaction"	UK	1998	0.785	0.445	1.383	-0.838	0.402
Shepperd S 1	S/P hip replacement, readmission after 3m	UK	1998	2.765	0.241	31.741	0.817	0.414
Shepperd S 2	S/P knee replacement, readmission after 3m	UK	1998	3.619	0.387	33.819	1.128	0.259
Shepperd S 3	S/P hysterectomy, readmission after 3m	UK	1998	0.586	0.225	1.528	-1.092	0.275
Shepperd S 4	COPD, readmission after 3m	UK	1998	2.933	0.657	13.093	1.410	0.159
Shepperd S 4	Elderly medical patients, readmission after 3m	UK	1998	2.829	0.913	8.773	1.801	0.072
Shepperd S 5	S/P hip replacement, "not declared" preferred way of hospitalization	UK	1998	0.160	0.059	0.437	-3.577	0.000
Shepperd S 6	S/P knee replacement, "not declared" preferred way of hospitalization	UK	1998	0.124	0.041	0.372	-3.714	0.000
Shepperd S 7	S/P hysterectomy, "not declared" preferred way of hospitalization	UK	1998	0.210	0.098	0.453	-3.984	0.000
Shepperd S 8	Elderly medical patients, "not declared" preferred way of hospitalization	UK	1998	0.146	0.055	0.385	-3.891	0.000
Wilson A 1	2w after hospitalization, mortality	UK	1999	0.763	0.410	1.419	-0.856	0.392
Wilson A 2	2w after hospitalization, admitted to emergency room	UK	1999	1.313	0.639	2.698	0.740	0.459
Wilson A 3	2w after hospitalization, Barthel index less than 20	UK	1999	0.929	0.343	2.517	-0.144	0.885
Wilson A 4	2w after hospitalization, Philadelphia geriatric moral score < 43	UK	1999	0.583	0.220	1.550	-1.081	0.280
Davies L 1	COPD, readmission	UK	2000	1.140	0.559	2.324	0.361	0.718
Davies L 2	COPD, 3m mortality	UK	2000	1.137	0.332	3.891	0.205	0.837
Wilson A 5	Cardiovascular or respiratory diseases, "not high satisfaction"	UK	2002	0.351	0.031	4.033	-0.840	0.401
Hernandez C 1	COPD, mortality	Spain	2003	0.579	0.178	1.883	-0.909	0.364
Hernandez C 2	COPD, emergency room visits	Spain	2003	0.344	0.175	0.676	-3.098	0.002
Hernandez C 3	COPD, "not better" knowledge of the disease	Spain	2003	0.266	0.150	0.470	-4.559	0.000
Hernandez C 4	COPD, "not better" self management of the condition	Spain	2003	0.213	0.117	0.387	-5.068	0.000
Mendoza H	CHF, after a year of follow-up, mortality	Spain	2009	0.739	0.289	1.890	-0.632	0.528
Tilbadi V 1	CHF, mortality	Italy	2009	0.960	0.320	2.883	-0.072	0.943
Tilbadi V 2	CHF, subsequent admission to hospital	Italy	2009	0.389	0.151	1.004	-1.952	0.051
Leff B 1	COPD, CHF, pneumonia or cellulitis, "lower functional status"	USA	2009	0.723	0.344	1.521	-0.855	0.393
Leff B 2	COPD, CHF, pneumonia or cellulitis, "lower instrumental activity"	USA	2009	0.320	0.149	0.688	-2.917	0.004
Vianello A 1	Neuromuscular disease, treatment failure	Italy	2013	0.479	0.156	1.473	-1.285	0.199
Vianello A 2	Neuromuscular disease, mortality at 3 m	Italy	2013	0.750	0.151	3.732	-0.351	0.725
Echevarria C 1	COPD, at 90 days, mortality	UK	2018	0.966	0.059	15.818	-0.024	0.981
Echevarria C 2	COPD, at 90 days, readmission	UK	2018	0.881	0.419	1.853	-0.334	0.738
Echevarria C 3	COPD, at 90 days, one or more general practitioner attendances	UK	2018	0.714	0.346	1.474	-0.911	0.362
Echevarria C 4	COPD, at 90 days, one or more secondary care appointments	UK	2018	1.659	0.710	3.874	1.169	0.242
Echevarria C 5	COPD, at 90 days, "not stated preference"	UK	2018	0.810	0.255	2.571	-0.358	0.720
Levine DM 1	Acute conditions, 14 days after discharge primary care visits	USA	2020	1.599	0.696	3.674	1.106	0.269
Levine DM 1	Infection, CHF, COPD, asthma, 30-day, emergency department visits	USA	2018	0.563	0.043	7.442	-0.437	0.662
Levine DM 2	Acute conditions, 20 days after discharge readmission rate	USA	2020	0.252	0.065	0.976	-1.996	0.046
Levine DM 2	Infection, CHF, COPD, asthma, 30-day, primary care visits	USA	2018	6.125	0.833	45.017	1.781	0.075
Levine DM 3	Acute conditions, 30 days after discharge emergency department visits	USA	2020	0.525	0.123	2.243	-0.870	0.384
Levine DM 3	Infection, CHF, COPD, asthma, 30-day, readmission rate	USA	2018	0.219	0.020	2.447	-1.234	0.217
Shepperd S 9	Geriatric patients, 6m follow-up "not living at home"	UK	2021	0.759	0.566	1.018	-1.841	0.066
Shepperd S 10	Geriatric patients, 6m follow-up mortality	UK	2021	0.984	0.696	1.392	-0.089	0.929
Shepperd S 11	Geriatric patients, 6m follow-up living in long-term residential care	UK	2021	0.670	0.401	1.121	-1.525	0.127
Pooled				0.638	0.512	0.796	-3.982	0.000
Prediction Interval				0.638	0.214	1.903		

Figure 2b. Forest plot illustrating OR and 95% CI for readmission comparing HaH and in-hospital.



Study name	Subgroup within study	Comparison	Time point	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value
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Echevarria C 2	COPD, at 90 days, readmission	UK	2018	0.881	0.419	1.853	-0.334	0.738
Levine DM 3	Infection, CHF, COPD, asthma, 30-day, readmission rate	USA	2018	0.219	0.020	2.447	-1.234	0.217
Levine DM 2	Acute conditions, 20 days after discharge readmission rate	USA	2020	0.252	0.065	0.976	-1.996	0.046
Pooled				0.923	0.543	1.571	-0.294	0.769
Prediction Interval				0.923	0.218	3.910		

Figure 2c. Forest plot illustrating OR and 95% CI for admission in another facility comparing HaH and in-hospital.

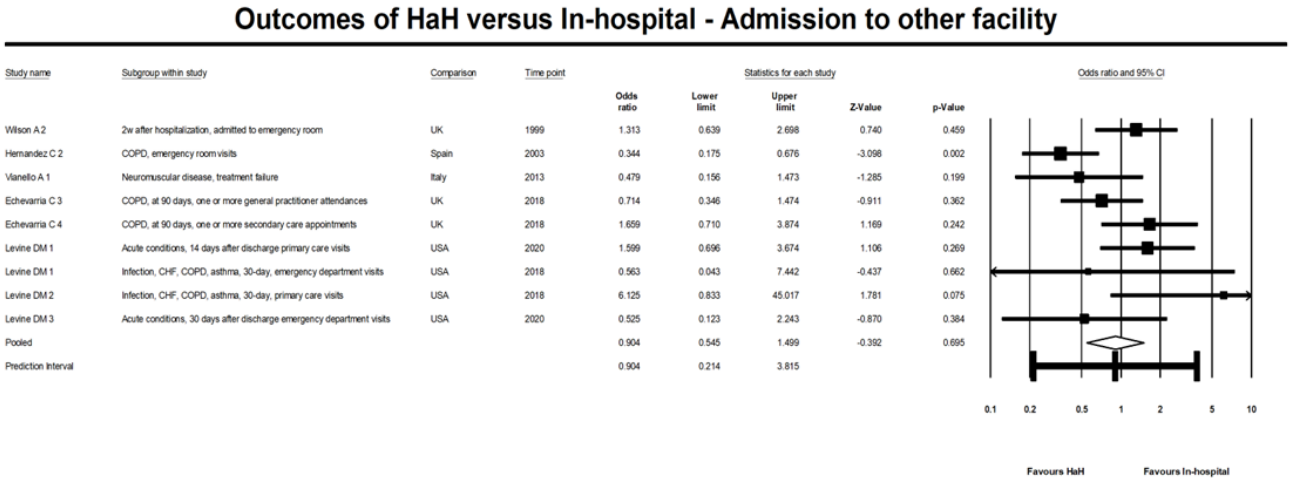


Figure 2d. Forest plot illustrating OR and 95% CI for mortality comparing HaH and in-hospital.

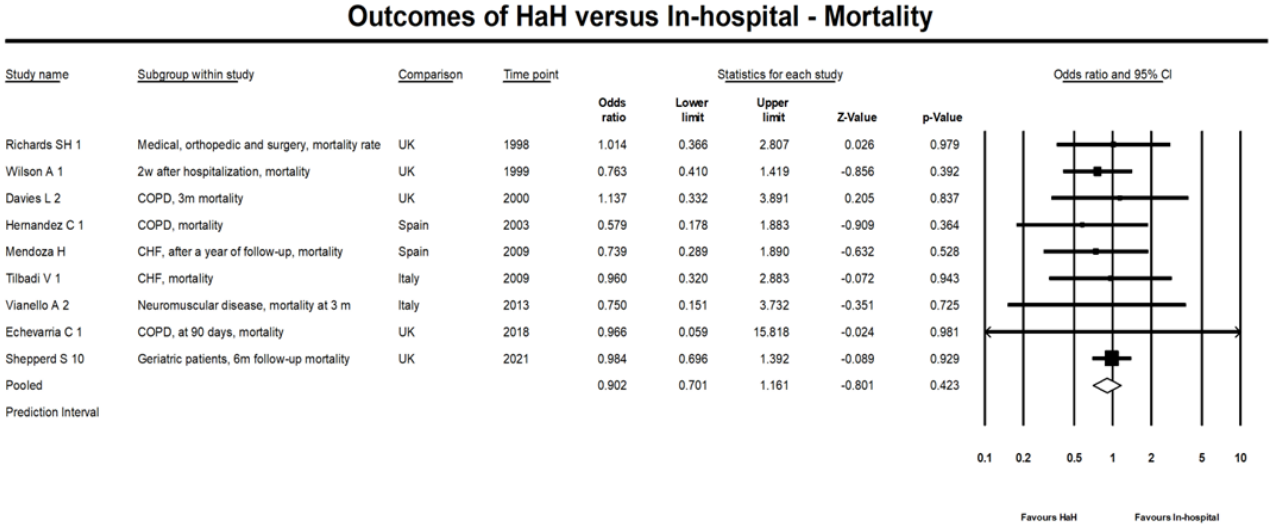


Figure 2e. Forest plot illustrating OR and 95% CI for patients' preference comparing HaH and in-hospital.

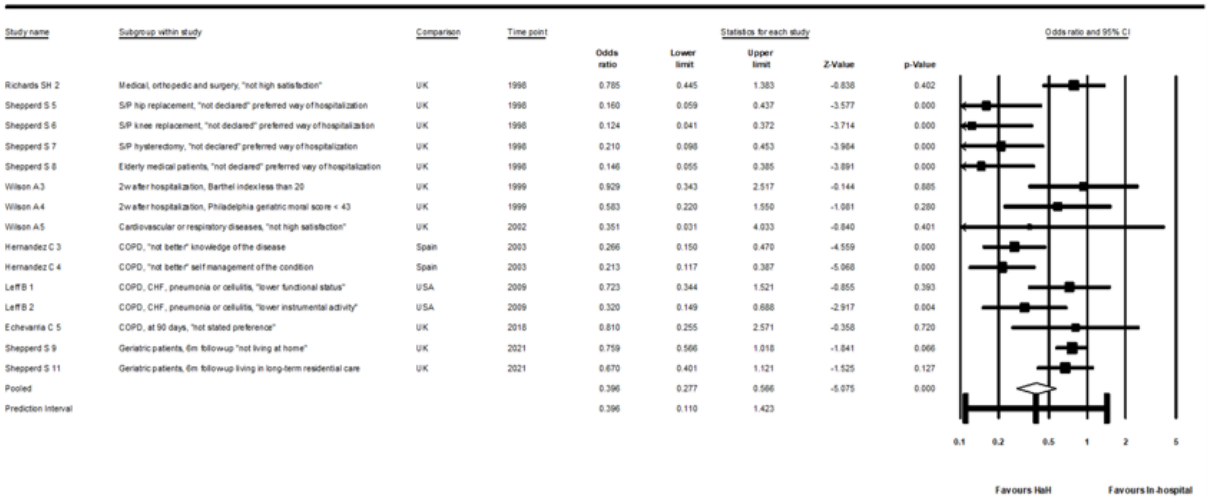
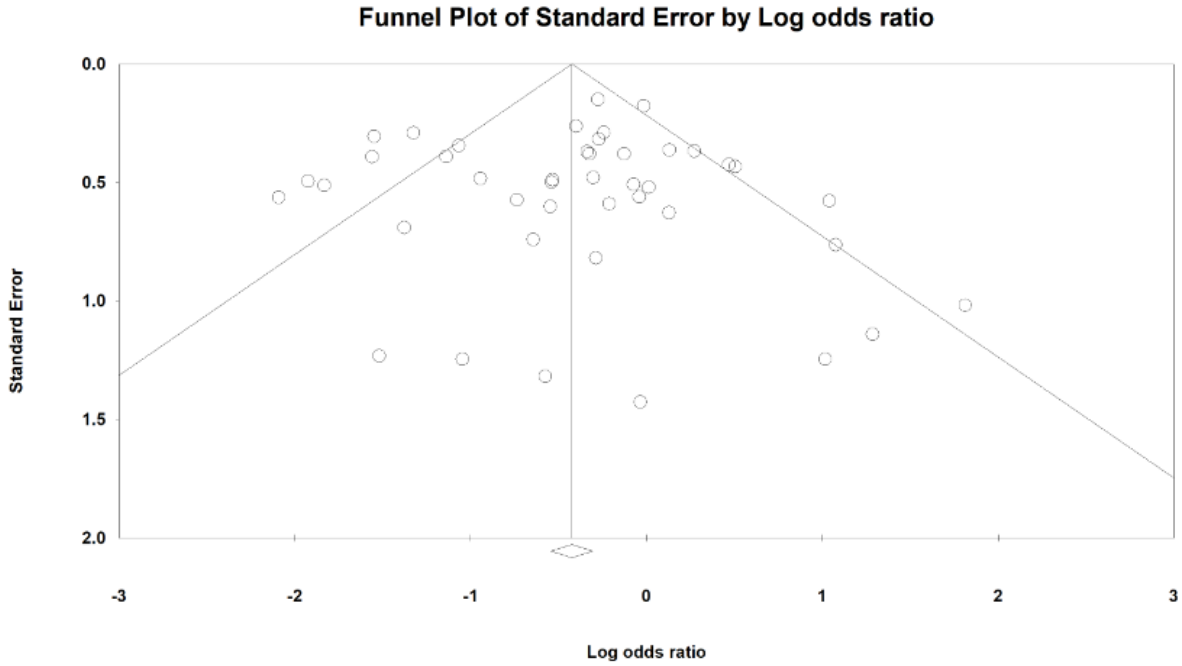


Figure 3. Funnel plot for publication bias.



The relevant funnel plot (Figure 3) is symmetric and denies a significant publication bias. The Q-value is 112.676 with 42 degrees of freedom and $p < 0.001$. Using a criterion alpha of 0.100, we can reject the null hypothesis that the true effect size is the same in all these studies. The I-squared statistic is 63%, which tells us that some 63% of the variance in observed effects reflects variance in true effects rather than sampling error. Tau-squared, the variance of true effect sizes, is 0.280 in log units. Tau, the standard deviation of true effect sizes, is 0.529 in log units. If we assume that the true effects are normally distributed (in log units), we can estimate that the prediction interval is 0.214 to 1.903. The true effect size in 95% of all comparable populations falls in this interval. The distribution of the true effect is shown in Figure 4.

We measured sensitivity by excluding individual studies and recalculating the overall meta-analysis outcome. This process was repeated for each of the studies. Deviations from the primary result were not significant with ORs varying between 0.371 95% CI 0.279 to 0.491 and 0.957 95% CI 0.820 to 1.117, the ranges of true effect were 0.142 to 0.968, and 0.820 to 1.117, respectively. In addition, we measured the studies' quality using the MINORS method (Table 1). Scores of 1 to 2 were found with a median of 1.83. Comparing studies with MINORS scores of 1 to 1.83, and 2, we found OR 0.635 95% CI 0.433 to 0.930, a range of true effect 0.139 to 2.907, and OR 0.656 95% CI 0.502 to 0.856, a range of true effect 0.257 to 1.676, respectively.

Figure 4. Distribution of true effect.

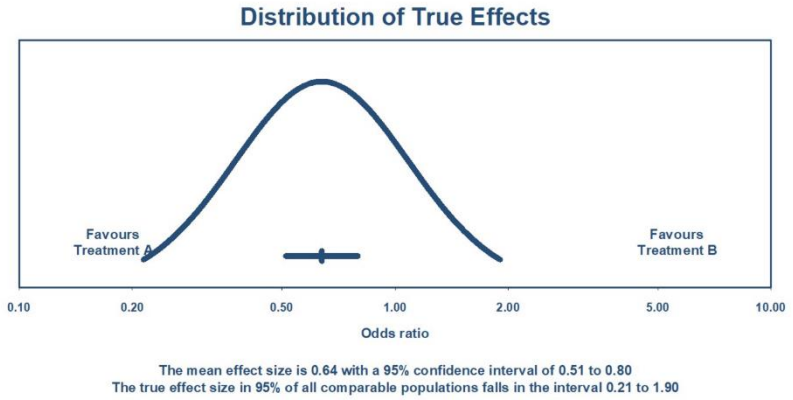


Table 1. Evaluation of MINORS quality scores.[13]

Methodological items for non-randomized studies/References	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1. **A clearly stated aim:** the question addressed should be precise and relevant in the light of available literature	2	2	2	2	2	2	2	2	2	2	2	1	2	2
2. **Inclusion of consecutive patients**: all patients potentially fit for inclusion (satisfying the criteria for inclusion) have been included in the study during the study period (no exclusion or details about the reasons for exclusion)	2	2	2	2	2	2	2	2	1	2	2	1	2	2
3. **Prospective collection of data**: data were collected according to a protocol established before the beginning of the study	2	2	2	2	2	2	2	2	2	2	2	1	2	2
4. **Endpoints appropriate to the aim of the study**: unambiguous explanation of the criteria used to evaluate the main outcome which should be in accordance with the question addressed by the study. Also, the endpoints should be assessed on an intention-to-treat basis.	2	2	2	2	2	2	2	2	2	2	2	1	2	2
5. **Unbiased assessment of the study endpoint**: blind evaluation of objective endpoints and double-blind evaluation of subjective endpoints. Otherwise the reasons for not blinding should be stated	2	2	2	2	2	2	2	2	2	2	2	1	2	2
6. **Follow-up period appropriate to the aim of the study**: the follow-up should be sufficiently long to allow the assessment of the main endpoint and possible adverse events	1	2	2	2	2	2	2	1	2	2	2	1	2	2
7. **Loss to follow up less than 5%** : all patients should be included in the follow up. Otherwise, the proportion lost to follow up should not exceed the proportion experiencing the major endpoint	1	1	1	2	2	2	2	2	2	2	2	1	2	2
8. **Prospective calculation of the study size**: information of the size of detectable difference of interest with a calculation of 95% confidence interval, according to the expected incidence of the outcome event, and information about the level for statistical significance and estimates of power when comparing the outcomes	2	2	2	2	2	2	2	2	2	2	2	1	2	2
9. **An adequate control group**: having a gold standard diagnostic test or therapeutic intervention recognized as the optimal intervention according to the available published data	0	1	2	2	2	2	2	2	1	1	2	1	2	2
10. **Contemporary groups**: control and studied group should be managed during the same time period (no historical comparison)	2	2	2	2	2	2	2	2	1	1	2	1	2	2
11. **Baseline equivalence of groups**: the groups should be similar regarding the criteria other than the studied endpoints. Absence of confounding factors that could bias the interpretation of the results	1	1	1	2	2	2	2	1	2	1	2	1	2	2
12. **Adequate statistical analyses**: whether the statistics were in accordance with the type of study with calculation of confidence intervals or relative risk	1	1	2	2	2	2	2	1	2	1	2	1	2	2
Total	32	35	38	41	42	43	44	42	43	43	48	37	50	51
Average	1.5	1.67	1.83	2	2	2	2	1.75	1.75	1.67	2	1	2	2

†The items are scored 0 (not reported), 1 (reported but inadequate) or 2 (reported and adequate). The global ideal score being 16 for non-comparative studies and 24 for comparative studies.

DISCUSSION

Our finding supports the value of HaH when compared to regular hospitalizations, looking at clinical outcomes and patient preference as well. In the clinical outcomes selected, readmission, admission to general practitioner or expert clinics, emergency department visits, and mortality, we found a significant non-inferiority, always at the direction of HaH. In the patient preference, satisfaction, functional indexes, knowledge, self-management, not living at home, and living in long-term residential care, there is a significant advantage to HaH over regular hospitalization, with OR 0.396, which is 61% higher. Since we selected only randomized controlled studies with good quality, our findings support HaH as an excellent method of patient care. A meta-analysis published in 2021, found only 9 eligible studies and described 959 participants in comparison with our meta-analysis with 14 studies (43 sub-studies) with 8169 randomized patients.[28] The main differences in our findings are non-inferiority for clinical outcomes, and significantly better patient experience. We agree that HaH interventions represent a viable substitute for an in-hospital hospitalized with chronic diseases but also with acute conditions.

Our study advantages are selecting only RCTs and examining sensitivity by two methods. We demonstrated persistent results using the MINORS score, denied publication bias, and proved the homogeneity of the studies by using the random effect model.

The main limitations of this meta-analysis are the differences in the patient's background diseases and indications for hospitalization. Patients were hospitalized because of several different indications such

as acute cardiovascular, respiratory, or infectious diseases, or exacerbation of chronic conditions, and in some studies a mix of them. We tried to stratify the results according to clinical or patient preference outcomes, and the results were influenced accordingly.

CONCLUSION

In conclusion, according to our findings, HaH is recommended for patient hospitalization when needed, according to the specific indications and patients matching HaH criteria. Patients who are more likely to benefit from HaH are those with exacerbation of chronic diseases such as COPD, CHF, CRF, and IBD, patients with acute infectious diseases such as pneumonia, UTI, and cellulitis, and patients who need further observation in continuance with in-patient hospitalization.

Notes
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