REVIEW

Comparison of Hospital-at-Home and In-Hospital hospitalizations of Congestive Heart Failure – a systematic review and meta-analysis

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ABSTRACT

Background: CHF describes patients with longstanding symptoms and signs such as breathlessness, ankle swelling, fatigue, pulmonary crackles, and peripheral edema, caused by a cardiac abnormality. Recently hospital at-home (HaH) has been offered as an alternative to traditional hospitalization, with the advantages of increased home time, reduced deconditioning, less risk of hospital-acquired infection and delirium, lower cost, and a better ability to identify social barriers.

Aim: This study aimed to compare clinical outcomes and patients' experience in HaH, with those of traditional in-patient hospitalization.

Methods: We searched the PubMed, EMBASE, Scopus, and CENTRAL databases until 31.3.2024. We selected articles that dealt with patients hospitalized because of exacerbation of CHF. This meta-analysis was performed according to the PRISMA guidelines.

Results: We found 5 studies (12 data sets) fulfilled the inclusion criteria. Altogether 480 were hospitalized in HaH, and 459 experienced In-Hospital, which were used to compare the different outcomes. The mean odd ratio (OR) is 0.562, in favor of HaH, (95%CI 0.286 to 1.105). We measured sensitivity by excluding individual studies and recalculating the overall meta-analysis outcomes, and we measured the studies' quality using the MINORS method, both were in the range of true effects.

Conclusions: HaH for worsening CHF is here to stay. Limited experience in the USA and Europe indicates that HaH has advantages, allows patients to remain at home, provides closer monitoring than outpatient care, and is not inferior to in-patient when clinical outcomes and patient preferences are measured. Yet, the limitations of HaH are not negligible and should be considered.

INTRODUCTION

Chronic heart failure (CHF) describes patients with longstanding symptoms and signs such as breathlessness, ankle swelling, fatigue, elevated jugular venous pressure, pulmonary crackles, and peripheral edema, caused by a cardiac abnormality. It is the final pathway for most cardiovascular diseases, with 600,000 new cases diagnosed in the US each year.[1] Hospitalizations are common after CHF diagnosis or worsening of signs and symptoms, with 83% hospitalized at least once, with mortality of 8%-14% at 30 days and a readmission rate of 20%-25%.[2] Recently hospital at-home (HaH) has been offered as an alternative to in-patient, traditional, hospitalization, for relatively stable patients, which theoretically has the advantages of increased home time, reduced deconditioning, less risk of hospital-acquired infection, less risk of delirium, lower cost for care provided, and better ability to identify social barriers.[3] Research demonstrating benefits to patients' quality of life (including patient preferences and satisfaction) with non-inferior or better clinical outcomes (such as readmission, and mortality) will push HaH to grow for CHF like other chronic diseases. In addition, since CHF care represents a significant burden on the health care system, HaH may be cheaper, and more cost-effective than traditional in-patient hospitalization. Some HaH programs have demonstrated 30% savings in overall costs compared to in-hospital care.[4]

There are 2 main sites for CHF referral to HaH, directly from the emergency department or from the hospital ward. In both cases, the patients should be stable hemodynamically, and suitable for HaH according to local protocol. In the last case, the patient should reach a level of relative clinical stability but is deemed still not ready for discharge. While treated with intravenous medications such as diuretics, patients should be closely monitored with telemedicine, thus clinical deterioration could be immediately observed, and an emergency team is ready for quick reaction.

In this systematic review and meta-analysis, we collected studies that compared CHF clinical outcomes and patients' experience of HaH, with those of traditional in-patient hospitalization. We looked at rehospitalization, post-hospitalization admission to the emergency room, general practitioner, secondary care physician, treatment failure; mortality; patients' subjective approach – satisfaction, preference, functional indexes, knowledge, self-management, not living at home, and long-term residential care.

METHODS

Identification of Studies and Data Extraction

We searched the PubMed, EMBASE, Scopus, and CENTRAL databases until 31.3.2024 to identify human studies written in English. The following search text and/or Medical Topic Heading (MeSH) terms were used: "CHF" OR "Chronic Heart Failure" AND "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 and searches included articles bibliographies. We selected only articles that dealt with patients hospitalized because of exacerbation of CHF. This meta-analysis was performed according to the PRISMA extension statement for interventions.[5]

Selection criteria

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 patients with acute exacerbation of CHF. Studies that did not meet these criteria were excluded.

Heterogeneity, Sensitivity, and Publication Bias

The heterogeneity of the studies was calculated using the Cochran Q test and I^2. The inconsistency index was considered present if the Q-test P value was less than 0.10. The higher the I^2, the greater the heterogeneity [6]. 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.[7] We also used Slim K et al method for the evaluation of the studies' quality for the purpose of meta-analysis.[8]

Statistical analysis

We used Comprehensive meta-analysis software (Version 4, Biostat Inc., Englewood, NJ, United States). Pooled odds ratios (ORs) and 95% confidence interval were computed. In individual studies, confidence intervals (CIs) were calculated using the random effects model to compare outcomes of CHF patients after HaH or in-hospital hospitalization. First, we performed meta-analysis calculations for all the selected studies, then we separated studies into 4 outcomes groups: readmission; post-hospitalization admission to the emergency room, visiting general practitioner, consulting secondary care physician, and treatment failure; mortality; patient subjective approach – satisfaction, preference, functional indexes, knowledge, self-management, not living at home, and living in long-term residential care. For 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.[9-13]

Mendoza H et al (Spain, 2009),[9] CHF patients, 37 HaH (18 men, mean age 78) 34 regular hospital care (24 men, mean age 80). Patients were 65 years old or older, admitted from the emergency department, and followed 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 occurred in 2 and 3 of HaH and in-patient, respectively. Re-admission due to CHF or another cardiovascular event occurred in 15 patients of HaH care and 17 in-patient hospital care. Median cost was 2541 and 4502 euros for HaH and in-hospital, respectively.

Tibaldi V et al (Italy, 2009),[10] CHF patients, 48 HaH (22 men, mean age 82), 53 regular hospital care (30 men, mean age 80). Patients who were 75 years old or older, were referred from the emergency department. Mortality was 7 vs. 8, subsequent admission to hospital 8 vs. 18, respectively. The mean cost was 1821 and 2117 euros for HaH and in-hospital, respectively.

Garcia-Soleto A et al (Spain, 2013),[11] 71 patients with acute decompensation of heart failure (65 years of age or older) were randomized for HaH (37) or inhospital (34). The functional status and health-related quality of life (HRQOL) were assessed using the Barthel Index (BI) and the EQ-5D, Short Form-36 (SF-36), and Minnesota Living with Heart Failure (MLHFQ) questionnaires, administered at admission and discharge. In 1-year follow-up readmission or deaths occurred in 20 and 2 out of 37 HaH, and 19 and 2 out of 34 in-patient. Improvement of Barthel index and EQ-5D was demonstrated in 20 and 16 out of 21 in HaH and in-patient, respectively.

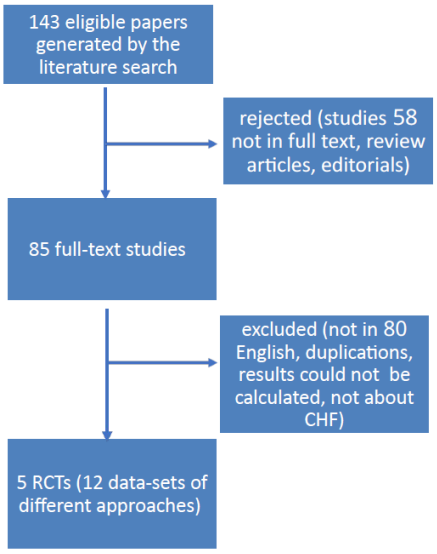
Le N et al (Canada, 2022),[12] a 9-item questionnaire on the perceived effectiveness, safety, convenience, and acceptability of a HaH model was distributed among 297 patients hospitalized for CHF at 2 academic hospitals in Ontario. The mean age was 76.2 (standard deviation, 12.3) years, 48.3% were female. 187 and 110 out of 297 patients preferred HaH or in-patients, respectively.

Helberg J et al (USA, 2023)[13] This is a non-randomized prospective case controlled of CHF patients enrolled in the HAH (40) versus admission to the hospital usual care (20). Outcomes included adverse events (5/40 HaH and 7/20 inpatient), discharge to home (38/40 HaH, 8/20 in-patient), 30-day readmission rates (4/40 HaH, 2/20 in-patient), 30-day emergency department usage (4/40 HaH, 2/20 in-patient).

Meta-analysis results

Our literature search revealed studies that compared outcomes of HaH and In-Hospital hospitalizations of patients with exacerbation of CHF (Figure 1). The literature search generated 143 eligible studies. 58 studies were excluded being not in full text, review articles, and editorials. 80 additional studies were excluded being not in English, duplications, not about CHF, 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 5 studies (12 data sets) that fulfilled the inclusion criteria and compared the outcomes, published up to 31.3.2024. Altogether there were 939 patients, 480 were hospitalized in HaH, and 459 experienced In-Hospital hospitalizations, who were used for comparison of the different outcomes (Figure 2a). The mean odd ratio (OR) is 0.562 with a 95% confidence interval (95% CI) of 0.286 to 1.105. The Z-value tests the null hypothesis that the mean effect size is 1.000. The Z-value is -1.670 with p = 0.095. Using a criterion alpha of 0.050, we cannot reject this null hypothesis. Separately measured meta-analyses of readmission, mortality, and patient preference revealed better or non-inferior results of HaH: OR 1.277 (95%CI 0.368 to 4.432, P = 0.701), OR 0.858 (95%CI 0.365 to 2.020, P = 0.725), OR 0.185 (95%CI 0.077 to 0.445, P < 0.0001), (Figure 2b, Figure 2c, Figure 2d). The relevant funnel plot (Figure 3) is symmetric and denies a significant publication bias.

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



The Q-value is 41.655 with 11 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 74%, which tells us that some 74% of the variance in observed effects reflects variance in true effects rather than sampling error. Tau-squared, the variance of true effect sizes, is 0.889 in log units. Tau, the standard deviation of true effect sizes, is 0.943 in log units. Assuming that the true effects are normally distributed (in log units), we can estimate that the prediction interval for true effect is 0.060

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

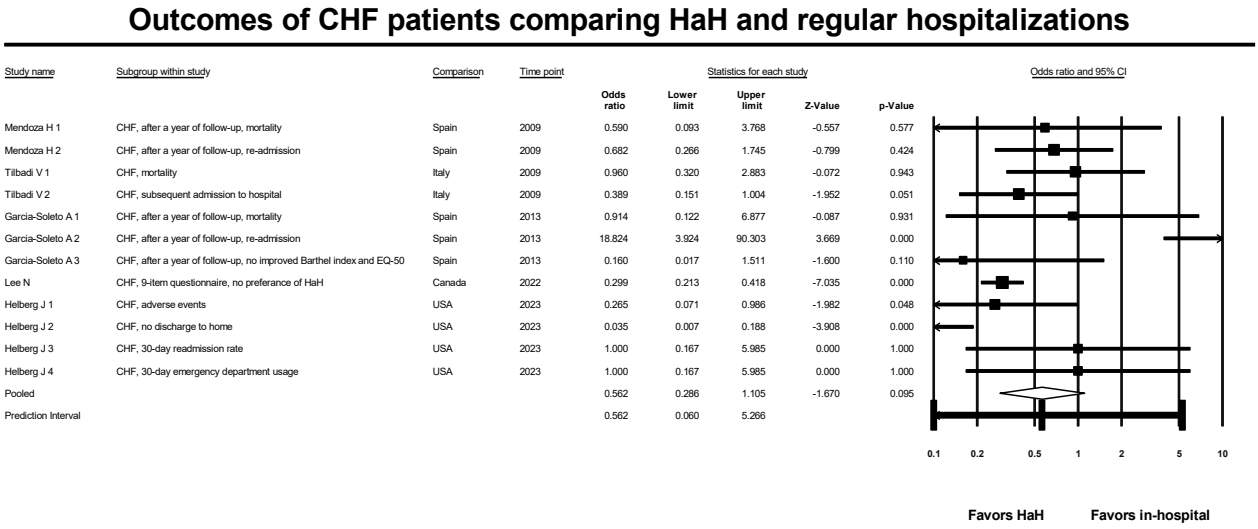


Figure 2b. Forest plot illustrating OR and 95% CI for readmission comparing HaH and in-hospital.

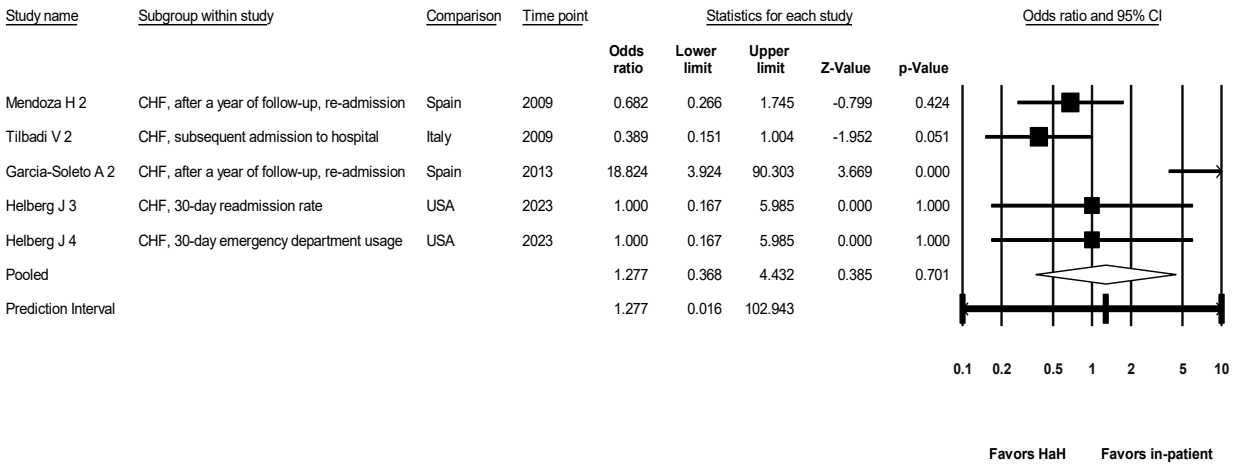


Figure 2c. Forest plot illustrating OR and 95% CI for mortality comparing HaH and in-hospital.

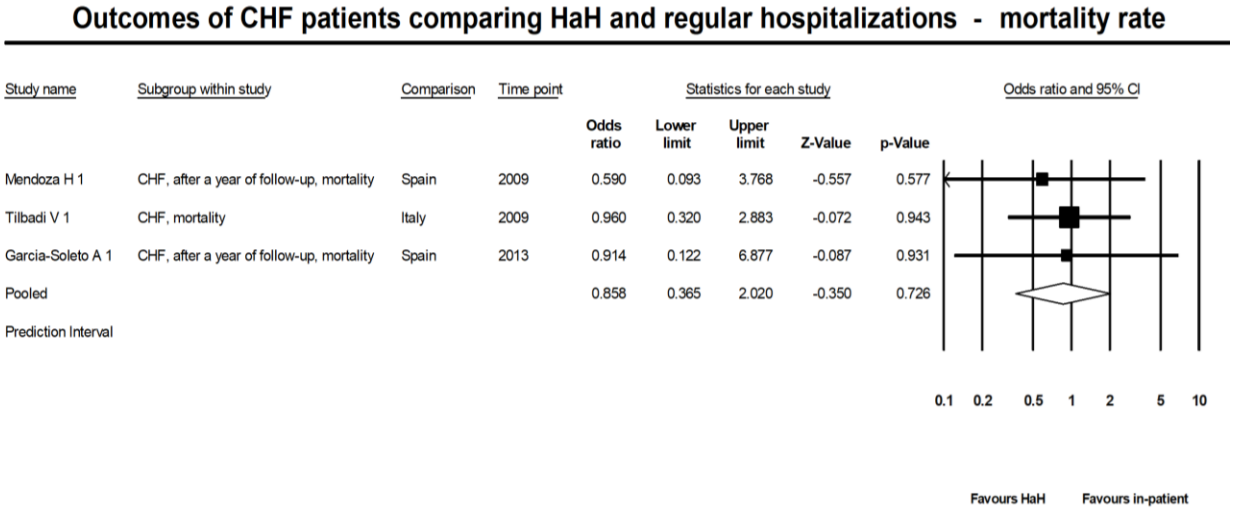
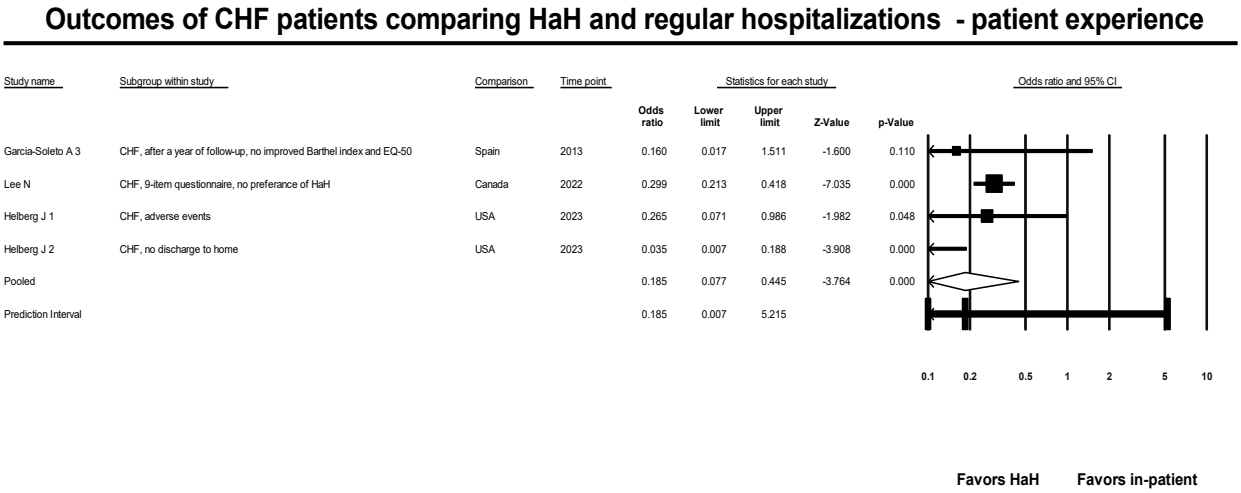


Figure 2d. Forest plot illustrating OR and 95% CI for patients' preference comparing HaH and in-hospital.



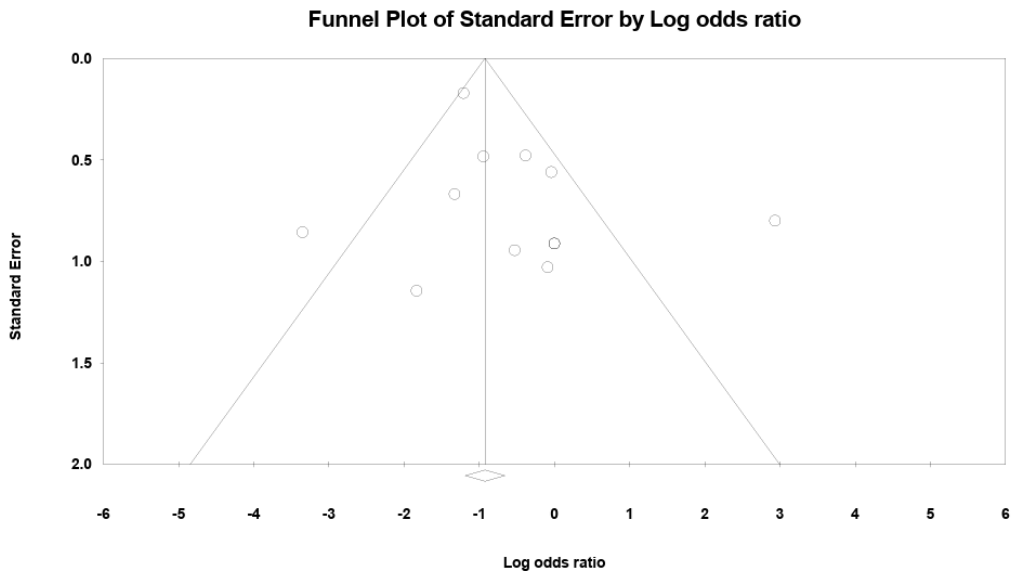
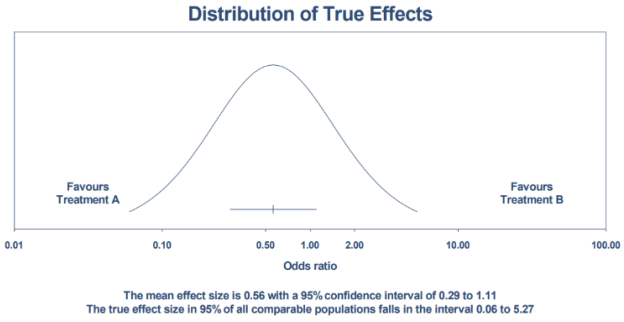


Figure 3. Funnel plot for publication bias.

to 5.266. 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.

Figure 4. Distribution of true effect.



We measured sensitivity by excluding individual studies and recalculating the overall meta-analysis outcomes. This process was repeated for each of the studies. Deviations from the primary result were not significant. Median OR was 0.59 with ORs varying between 0.035 and 18.824. The OR of papers within the lower range was 0.263 (95% CI 0.153 to 0.450), and the upper range was 1.447 (95% CI 0.547 to 3.828), both in the range of true effects.

In addition, we measured the studies' quality using the MINORS method (Table 1). Scores of 0 to 2 were found with a median of 1.4. Comparing studies with MINORS scores of 0 to 1.4, and 1.4 to 2, we found OR 0.320 (95% CI 0.149 to 0.685), and OR 0.964 (95% CI 0.327 to 2.847), respectively, in the range of true effects.

DISCUSSION

Chronic heart failure is one of the chronic diseases that is suitable for HaH such as chronic obstructive lung disease, chronic renal failure, or any other chronic disease while exacerbation needs hospitalization. Yet, since HaH is a relatively new hospitalization modality, one has to be careful to select the appropriate patients, those who are hemodynamically stable, stand in the local protocol demands, and have the appropriate social support and conditions at their homes. Good quality research is essential to establish this hospitalization modality and point toward the appropriate outcomes on one hand and manage risk and patient safety on the other hand.

Methodological items for non-randomized studies/References	Mendoza H	Tibaldi V	Garcia-Soleto A	Le N	Helberg J
1. **A clearly stated aim:** the question addressed should be precise and relevant in the light of available literature	2	2	2	1	1
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	1	1
3. **Prospective collection of data:** data were collected according to a protocol established before the beginning of the study	2	2	2	1	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	1	1
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	1	2	1	1	1
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	2	2	2	1	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	2	1	1	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	1	2	1	1	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	1	2	1	1	1
10. **Contemporary groups:** control and studied group should be managed during the same time period (no historical comparison)	1	2	1	1	1
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	2	2	1	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	2	1	1	0
Total	17	24	18	12	16
Average	1.41666667	2	1.5	1	1.3333333

†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.

Table 1. Evaluation of MINORS quality scores.

In this systematic review, we tried to collect the studies comparing outcomes of patients in HaH and in-patient hospitalization, for performing a meta-analysis and understanding the value of HaH in comparison to traditional, well-experienced, regular hospitalization. Our findings point towards better or non-inferior outcomes and patients' preferences for HaH. Readmission rates, mortality, and patient preference revealed better or non-inferior results. In addition, several studies demonstrated a significantly decreased cost when comparing HaH to regular in-patient hospitalization (9,10). In a study from Sweden,[14] 31 patients with worsening CHF were randomized, 13 to HaH and 18 to in-hospital, referred from the emergency department or the hospital ward. Total hospitalization cost was calculated. Median cost was 588 and 3277 euros, respectively. Interestingly, hospitalized patients with CHF who were randomized to HaH a week after being discharged from acute hospital care, had fewer unplanned readmissions and fewer deaths during follow-up than patients who were randomized to regular outpatient care.[15] Patient acceptance is also an essential role in establishing HaH. Of the 442 patients offered HaH, 66.7% accepted.[16] The main reasons for enrolling in HaH included being more comfortable at home (78.2%) and being near family (40.7%). Specific reasons given for refusing HaH included preferring in-hospital care (15.0%) and concern that HaH would not meet care needs (12.9%).

HaH for CHF should include IV medication (especially diuretics), physician and nurse home visits, physical or virtual with the frequency established in the clinical protocol including by a cardiologist, daily weights, oral medication administration, recording of fluid intake and urinary output, laboratory tests as needed, and possible transportation for radiology services and echocardiography. In addition, a wearable rhythm monitor and other telehealth supports are essential. An analysis of patients hospitalized for CHF with reduced ejection fraction, treated with IV diuretics, revealed that 66% had an uneventful course.[17]

Rehabilitation is one more aspect to be considered after stabilizing the worsening of CHF and can be performed virtually in HaH [18]. It was found that HaH patients had less physical deconditioning than in patients.

Limitations of HaH in CHF

No doubt HaH for CHF has limitations and is not appropriate for all patients, especially

those at risk for severe arrhythmia. It always requires a stable home environment, internet/digital connectivity, and technical support for patient transport when specific radiological examinations are needed. Patient deterioration early diagnosis should be possible, leading to patient care by the emergency team or efficient transportation to the emergency department.

Limitation of the study

Three studies included in the meta-analysis performed more than a decade ago, and only 2 studies in 2022 and 2023. This may affect the results since the Covid19 pandemic changed the HaH approach significantly. Thus, meta-analysis should be repeated in the near future to support our findings. In addition, not all the studies were randomized, controlled studies (RCTs).

CONCLUSION

HaH for worsening CHF is here to stay. Limited experience in the USA and Europe indicates that HaH has advantages, allows patients to remain at home, provides closer monitoring than outpatient care, and is not inferior to in-patient when clinical outcomes and patient preferences are measured. Yet, the limitations of HaH are not negligible and should be considered for every case.

Notes
Conflicts of Interest: None declared
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