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Preventing Hospital-Associated Disability: Effects of the Hospital Early Structured Mobilization (HESM) Program on Function and Survival in Older Adults

Fabrizio Turrini

f.turrini@ausl.mo.it

Internal Medicine - Ramazzini Hospital, Carpi https://orcid.org/0000-0002-4782-6980

Giovanni Esposito

Internal Medicine - Ramazzini Hospital, Carpi

Veronica Zanni

Rehabilitation Service - Ramazzini Hospital, Carpi

Ada Tamborelli

Rehabilitation Service - Ramazzini Hospital, Carpi

Giuseppe Palladino

Internal Medicine - Ramazzini Hospital, Carpi

Laura Davoli

Internal Medicine - Ramazzini Hospital, Carpi

Emma Rossi

Internal Medicine - Ramazzini Hospital, Carpi

Rocco Amendolara

Research and Innovatio - Local Health Agency of Modena

Luca Golinelli

Patient Safety - Local Health Agency of Modena

Chiara Benatti

Internal Medicine - Ramazzini Hospital, Carpi

Research Article

Keywords:

Posted Date: November 3rd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11308880/v1

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Abstract

Background

Hospital-associated disability is common in older medical inpatients. Evidence for structured early mobilization pathways remains limited.

Aim

To evaluate whether the Hospital Early Structured Mobilization (HESM) pathway was associated with improved functional outcomes and 90-day survival.

Design

Single-centre quasi-experimental before-and-after cohort study.

Methods

We included 600 discharged-alive patients aged ≥ 65 years admitted to an internal medicine ward in Italy, 300 before and 300 after HESM implementation. HESM was an interdisciplinary, protocolised early mobilization pathway integrated into routine care. The primary outcome was clinically meaningful functional worsening at discharge, defined as an increase of ≥ 1 point in modified Rankin Scale and/or a decrease of ≥ 20 points in modified Barthel Index. Ninety-day mortality and safety were assessed using multivariable logistic and Cox regression.

Results

Functional worsening occurred in 149/300 patients before and 89/300 after implementation (49.7% vs 29.7%; absolute risk reduction 20.0 percentage points, 95% CI 12.3–27.7; number needed to treat 5). Modified Rankin Scale worsening decreased from 46.3% to 27.3%, and Barthel Index decline from 25.0% to 15.3%. HESM was associated with lower odds of functional worsening (adjusted OR 0.46, 95% CI 0.32–0.65). Ninety-day mortality decreased from 20.7% to 11.7% and remained lower after adjustment (HR 0.53, 95% CI 0.35–0.80). Falls were infrequent and similar.

Conclusions

HESM was associated with less functional decline and lower 90-day mortality. These findings support mobility-focused care pathways, although residual confounding cannot be excluded.

Introduction

Hospital-associated disability is a frequent and clinically important consequence of acute hospitalization in older adults. Even short hospital stays may lead to immobility, deconditioning, and loss of independence, with consequences that extend beyond the acute illness itself. Low mobility during hospitalization has been associated with subsequent decline in activities of daily living, new institutionalization, and mortality, reinforcing the clinical relevance of mobility as a modifiable target in older inpatients. (1–4).

Early mobilization is a plausible strategy to reduce this risk, but its implementation in general medical wards remains inconsistent. Conceptual models focused on preservation of autonomy, including Orem's Self-Care Deficit Nursing Theory, support care strategies aimed at maintaining or restoring self-care capacity during acute illness (5–7).

We therefore implemented a structured, interdisciplinary early mobilization pathway for older adults admitted to an acute medical ward and evaluated whether its introduction was associated with better functional outcomes, improved in-hospital care processes, and lower 90-day mortality after discharge.

Materials and methods

Study design and setting

We conducted a single-centre, quasi-experimental before–after study in an internal medicine ward of an acute care hospital in Italy. The evaluation was embedded in a service-improvement programme for older inpatients and examined the introduction of a structured early mobilization pathway delivered by an interdisciplinary team. Patients were assigned to the pre-implementation phase (usual care) or post-implementation phase (after protocol implementation) according to calendar time. Enrolment covered routine ward activity between February 2024 and March 2025. Consecutive, non-probability sampling was used. In the absence of robust preliminary data for a formal sample size calculation, a feasibility target of 300 patients per phase was prespecified.

Participants

Eligible participants were consecutive patients admitted to the internal medicine ward who were aged 65 years or older, had a premorbid modified Rankin Scale (mRS) score of 4 or lower (8, 9), a Modified Early Warning Score (MEWS) below 5 at enrolment (10), and provided written informed consent. Exclusion criteria were a formal medical indication for strict bed rest, an end-of-life clinical condition, an internal medicine diagnosis with a primary rehabilitative indication, or lack of consent or impossibility of obtaining it. Baseline variables collected at enrolment were age, sex, MEWS, premorbid mRS, and premorbid modified Barthel Index (MBI) (11).

All consecutive eligible patients were included. Patients who died during hospitalisation were included in safety analyses but, because discharge functional status and post-discharge outcomes could not be assessed, were excluded from analyses of functional trajectories and 90-day post-discharge outcomes. The final analytic cohort therefore comprised 600 patients, with 300 patients in each phase.

Intervention

The Hospitalized Early Structured Mobilization (HESM) protocol is a multicomponent, documented, and auditable pathway designed to deliver early, progressive mobilization in older inpatients under internal medicine care. The intervention was designed to preserve functional autonomy and reduce the adverse consequences of immobility during hospitalization (12).

Within the first 24 hours after admission, patients underwent joint functional and clinical assessment by a physician, nurse, physiotherapist, and healthcare assistant, followed by an individualized mobilization plan integrated into routine nursing care. Mobilization began once clinical stability had been achieved, guided by MEWS. The protocol specified progressive, goal-directed targets, including active or assisted in-bed exercises, sitting out of bed, standing balance, transfers, and hallway ambulation, with safety checks before each session. At least two mobilization sessions per day were planned, with additional mobility embedded into routine care activities such as meals in a chair, toileting, and short walks. Daily brief team huddles were used to review progress and set next-day goals, and mobilization activity and patient response were recorded for audit. Environmental supports, including armchairs, walkers, and non-slip footwear, were made available at the bedside.

During the pre-implementation phase, patients received usual care without this structured mobilization bundle. During the post-implementation phase, the intervention was delivered in a single 21-bed ward section because of staffing requirements; bed allocation was primarily determined by bed availability, and medical staff rotated across ward sections. Additional operational details of the HESM pathway, including progression criteria, safety checks, bedside equipment, and daily documentation procedures, are provided in the supplementary appendix.

Outcomes

The primary objective was to evaluate the effectiveness and safety of a structured early mobilization strategy in older medical inpatients.

The primary functional outcome was clinically meaningful functional worsening at discharge, defined as either an increase of at least 1 point in mRS from premorbid status to discharge or a decrease of at least 20 points in MBI. A 1-point change in mRS reflects a clinically relevant shift in global disability, while changes of about 15–20 points in MBI have been reported to represent a minimal clinically important difference in functional independence. Functional decline during hospitalization has also been associated with institutionalization and post-acute care needs in older adults (13–15). Additional

primary outcomes were post-discharge survival, defined as time from hospital discharge to death or administrative censoring at 90 days, and mobilization safety, defined as adverse events temporally related to mobilization, including falls, haemodynamic instability, or escalation of care. Falls were identified through routine hospital incident reporting supplemented by chart review, and severity was classified according to documented clinical consequences.

Secondary outcomes were delirium during admission, urinary catheter use at discharge, prescription of assistive devices at discharge, transfer to a post-acute care setting, institutionalization at discharge, and length of stay. Delirium was identified through routine clinical documentation and structured chart review; no standardized delirium screening instrument was mandated by protocol. Chart-based identification of delirium has previously been described and validated against standardized clinical assessment (16, 17). Functional outcomes were prioritized because the intervention specifically targeted preservation of autonomy and self-care capacity, whereas mortality and safety outcomes were included to provide a broader assessment of clinical impact.

Data sources

Study variables were derived from routinely collected demographic, clinical, functional, and outcome data in the hospital electronic medical record.

Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics (version 19; IBM Corp., Armonk, NY, USA). Continuous variables are reported as mean (standard deviation) or median (interquartile range), as appropriate, and categorical variables as counts and percentages. Between-group comparisons used χ^2 or Fisher's exact test for categorical variables and Student's t test or Mann–Whitney U test for continuous variables, as appropriate. Length of stay was compared using the Mann–Whitney U test.

Factors associated with functional worsening at discharge were examined using univariable and multivariable logistic regression models including prespecified enrolment covariates; results are reported as odds ratios with 95% confidence intervals. Model assumptions were assessed by examining linearity of continuous predictors and potential multicollinearity among covariates.

Time-to-event analyses for 90-day all-cause mortality used Cox proportional hazards models, with time zero defined as hospital discharge and censoring at 90 days. The primary survival model included age, sex, dementia, delirium during hospitalization, and study phase. Proportional hazards assumptions were assessed analytically, and Kaplan-Meier curves were used to visualize survival, with between-phase comparisons by log-rank test. To explore whether discharge functional outcomes and care processes might contribute to the observed phase-mortality association, we performed prespecified exploratory analyses by stratifying Kaplan-Meier curves according to functional worsening and urinary catheter use at discharge, and by fitting sequential Cox models adding these variables to the primary model.

Sensitivity analyses addressed temporal and baseline confounding using binomial interrupted time-series models based primarily on 15-day discharge blocks, with exploratory analyses using 30-day blocks, June 2024 as the intervention point, Cox models additionally adjusted for discharge season, and propensity score weighting with stabilized inverse probability of treatment weights derived from baseline covariates. Covariate balance was assessed using standardized mean differences. This study is reported in accordance with the STROBE guideline (18). The completed STROBE checklist is provided in Supplementary Appendix 2. Additional details on variable definitions, propensity score weighting, covariate balance, and interrupted time-series models are provided in Supplementary Table 1 and Supplementary Appendix 3.

Patient and public involvement

Patients and members of the public were not involved in the design, conduct, reporting, or dissemination plans of this study.

Ethics approval

The study protocol, consent form, and data-protection procedures were approved by the Territorial Ethics Committee of Area Vasta Emilia Nord (CET-AVEN), Emilia-Romagna, Italy (approval No 688/2023). All participants gave written informed consent before inclusion. Data were pseudonymized and handled in accordance with Good Clinical Practice and the principles of the Declaration of Helsinki.

Results

Study population. A total of 600 discharged-alive patients were included in the final analytic cohort, with 300 patients in each phase. In-hospital deaths occurred in 15 patients in phase 1 and 10 patients in phase 2. These patients were excluded from analyses of functional trajectories and post-discharge survival because they did not survive to discharge, but were retained in the safety assessment. The pre-implementation cohort was accrued from February through June 2024, whereas the post-implementation cohort was accrued from June 2024 through early March 2025, June 2024 represented a transition month. Because patients were allocated to ward sections primarily according to bed availability and physicians rotated across sections, systematic differences in baseline case-mix between sections were unlikely (Fig. 1).

Overall, the intervention was delivered in a mean of 86% of planned opportunities (3715 of 4320 planned sessions). Missed sessions were mainly attributable to diagnostic tests or procedures, transient clinical instability, need for closer clinical monitoring, ongoing therapeutic adjustment, or patient refusal.

The mean age of the study population was 81.7 (SD 7.7) years, and 318/600 (53.0%) were women. Baseline demographic and clinical characteristics were broadly similar between phases, although dementia was more common in the post-implementation group (24.3% v 16.3%, p = 0.015) (Table 1).

Baseline illness severity was similar, with MEWS values of 2.1 (SD 1.3) before implementation and 1.9 (SD 1.2) after implementation (p = 0.088). Urinary catheter use at admission was infrequent and similar between groups (3.0% v 3.3%, p = 0.816). Premorbid functional status was also similar, with median mRS 2 [IQR 1–3] in both groups (p = 0.317) and median MBI 88 [IQR 56–100] before implementation and 88 [63–99] after implementation (p = 0.935). Primary admission diagnoses were similarly distributed between phases (p = 0.744), with respiratory diseases the most common category.

Table 1
Baseline demographic and clinical characteristics

Characteristic	**Overall**	**Pre (n = 300)**	**Post (n = 300)**	**p-value**
Age, years (mean ± SD)	81.7 ± 7.7	81.7 ± 8.0	81.6 ± 7.4	0.953
MEWS at admission (mean ± SD)	2.0 ± 1.2	2.1 ± 1.3	1.9 ± 1.2	0.088
Female, n (%)	318 (53.0%)	154 (51.3%)	164 (54.7%)	0.413
Dementia, n (%)	122 (20.3%)	49 (16.3%)	73 (24.3%)	0.015
Urinary catheter at admission, n (%)	19 (3.2%)	9 (3.0%)	10 (3.3%)	0.816
Urinary catheter positioned during hospitalization, n (%)	315 (52.5%)	158 (52.7%)	157 (52.3%)	0.935
Primary admission diagnosis (overall distribution)				0.744
Respiratory diseases	244 (40.7%)	116 (38.7%)	128 (42.7%)	
Circulatory diseases	105 (17.5%)	58 (19.3%)	47 (15.7%)	
Digestive diseases	46 (7.7%)	26 (8.7%)	20 (6.7%)	
Genitourinary diseases	42 (7.0%)	19 (6.3%)	23 (7.7%)	
Hematologic diseases	33 (5.5%)	20 (6.7%)	13 (4.3%)	
Psychiatric disorders	34 (5.7%)	15 (5.0%)	19 (6.3%)	
Musculoskeletal diseases	15 (2.5%)	7 (2.3%)	8 (2.7%)	
Nervous system diseases	7 (1.2%)	3 (1.0%)	4 (1.3%)	
Other diagnoses	74 (12.3%)	36 (12.0%)	38 (12.7%)	

Implementation of the structured early mobilization pathway was associated with improved functional trajectories (Table 2). Worsening in mRS occurred in 139/300 (46.3%) patients before implementation and 82/300 (27.3%) after implementation (p < 0.001). Decline in MBI occurred in 75/300 (25.0%) and

46/300 (15.3%), respectively (p = 0.003). Overall, any clinically meaningful functional worsening occurred in 149/300 (49.7%) patients before implementation and 89/300 (29.7%) after implementation (p < 0.001), corresponding to an absolute risk reduction of 20.0 percentage points (95% CI 12.3 to 27.7) and a number needed to treat of 5.

Table 2
Outcomes

Outcome	Pre (n = 300)	Post (n = 300)	RR (95% CI)	p-value
mRS worsening	139 (46.3%)	82 (27.3%)	0.59 (0.47–0.74)	< 0.001
Barthel decline	75 (25.0%)	46 (15.3%)	0.61 (0.44–0.85)	0.003
Any functional worsening	149 (49.7%)	89 (29.7%)	0.60 (0.49–0.74)	< 0.001
Delirium	33 (11.0%)	40 (13.3%)	1.21 (0.79–1.87)	0.382
Assistive devices	9 (3.0%)	13 (4.3%)	1.44 (0.63–3.33)	0.385
Urinary catheter at discharge	81 (27.0%)	55 (18.3%)	0.68 (0.50–0.92)	0.011
Transfer to long-term care	17 (5.7%)	6 (2.0%)	0.35 (0.14–0.88)	0.019
90-day readmission	54 (18.0%)	41 (13.7%)	0.76 (0.52–1.10)	0.146
90-day mortality	62 (20.7%)	35 (11.7%)	0.56 (0.39–0.83)	0.003

Hospital care processes showed a generally favourable pattern. Delirium during admission did not differ significantly between phases (11.0% v 13.3%, p = 0.382). Urinary catheter use at discharge was lower after implementation (55/300, 18.3%) than before implementation (81/300, 27.0%; p = 0.011). Transfer to long-term care was also less frequent in the post-implementation phase (6/300, 2.0%) than in the pre-implementation phase (17/300, 5.7%; p = 0.019). Ninety-day readmission did not differ significantly between phases (18.0% v 13.7%, p = 0.146). Median length of stay was similar between groups (7 [IQR 5–9] v 7 [5–10] days; p = 0.078).

Falls were infrequent and similar between phases (4/300, 1.3% before implementation v 6/300, 2.0% after implementation; Fisher exact p = 0.752). In-hospital deaths in the safety population were 15/315 (4.8%) in phase 1 and 10/310 (3.2%) in phase 2 (Fisher exact p = 0.415).

In logistic regression analyses of the composite endpoint of any functional worsening, the post-implementation phase was associated with lower odds of worsening in both univariable analysis (OR 0.43, 95% CI 0.31 to 0.60; p < 0.001) and multivariable analysis adjusted for prespecified enrolment covariates (adjusted OR 0.46, 95% CI 0.32 to 0.65; p < 0.001) (Table 3A and 3B).

Post-discharge 90-day mortality occurred in 62/300 (20.7%) patients before implementation and 35/300 (11.7%) after implementation (p = 0.003). In multivariable Cox proportional hazards analysis adjusted for age, sex, dementia, and delirium during hospitalization, the post-implementation phase was associated

with lower hazard of 90-day death (HR 0.53, 95% CI 0.35 to 0.80; p = 0.003) (Table 4A). Kaplan-Meier curves showed separation between phases (log-rank p = 0.003) (Fig. 2). When any functional worsening was added to the Cox model, the phase estimate was attenuated but remained statistically significant (HR 0.60, 95% CI 0.39 to 0.91; p = 0.017). Further adjustment for urinary catheter use at discharge yielded an HR of 0.63 (95% CI 0.41 to 0.97; p = 0.035) (Table 4B). Likelihood ratio testing showed improved model fit after addition of functional worsening (p = 0.002) and after further addition of urinary catheter use at discharge (p < 0.001).

Sensitivity analyses were broadly consistent with the primary findings. Additional adjustment of the Cox model for discharge season yielded a persistent association between the post-implementation phase and lower 90-day mortality (HR 0.56, 95% CI 0.37 to 0.86; p = 0.008). A propensity score-weighted Cox model using stabilized inverse probability of treatment weights derived from baseline covariates also confirmed lower 90-day mortality in the post-implementation phase (weighted HR 0.56, 95% CI 0.37 to 0.86; p = 0.007).

Interrupted time-series analyses using binomial segmented models showed favourable post-implementation slope changes for any functional worsening using both 15-day and 30-day discharge blocks. For 90-day mortality, the change was directionally favourable with 15-day blocks and reached statistical significance in exploratory 30-day block analyses. No significant ITS signal was observed for urinary catheter use at discharge. Overall, the sensitivity analyses supported the robustness of the association between HESM implementation and improved functional and survival outcomes, while showing no consistent time-series effect on urinary catheter use.

Discussion

Principal findings

In this quasi-experimental study of older adults admitted to an internal medicine ward, implementation of a structured early mobilization pathway was associated with improved functional outcomes at discharge, more favourable in-hospital care processes, and lower 90-day mortality. The magnitude of the association was clinically relevant for both disability-related and survival outcomes, and findings were consistent across several analytical approaches, including adjusted regression models, interrupted time-series analyses, and propensity score–weighted analyses. These data support the view that preservation of functional status is not simply a secondary outcome of acute medical care, but a clinically important determinant of prognosis in older hospitalized adults.

Strengths and weaknesses of the study

This study has several strengths. It evaluated a structured, interdisciplinary mobilization strategy embedded in routine practice, making the findings directly relevant to real-world care. The intervention was protocolized, auditable, and delivered with high adherence, and the main outcomes were patient-centred and clinically meaningful. In addition, the consistency of the results across sensitivity analyses

reduces, although does not remove, concern that the findings were driven entirely by baseline imbalance or temporal variation.

The limitations are also important. The before–after design is inherently vulnerable to temporal confounding, and causal inference cannot be established. Although no major concurrent organizational changes were identified during the study period, unmeasured factors may still have influenced the observed differences. The study was conducted in a single centre, which may limit generalizability. Residual confounding also remains possible, particularly with respect to comorbidity burden, frailty dimensions not captured in the dataset, and treatment-limitation preferences. Delirium was identified through chart-based methods rather than systematic bedside screening, which may have led to some misclassification.

Strengths and weaknesses in relation to other studies

Our findings are consistent with evidence from other settings in which early mobilization is already considered a core element of good clinical practice. In hip fracture care, early surgery combined with structured mobilization has been associated with fewer complications, shorter recovery, and better outcomes (19). Similar principles apply in postoperative orthopaedic and cardiovascular care, where earlier mobilization is increasingly regarded as standard practice (20, 21). In intensive care settings, early mobility programmes have been associated with improved muscle strength, less delirium, and shorter lengths of stay (22, 23). Mobilization nevertheless remains underprioritized in many hospital environments, despite broad recognition of its clinical importance (24).

Compared with previous work, the main contribution of the present study is that it extends this evidence base to the general internal medicine ward, where data are more limited and implementation barriers are often greater. Rather than testing a narrowly defined rehabilitation intervention, this study evaluated a structured care pathway integrated into daily ward practice. This makes the results especially relevant to hospitals seeking scalable, service-level strategies to reduce hospital-associated disability.

Meaning of the study: possible explanations and implications for clinicians and policymakers

Several mechanisms may explain these findings. Early mobilization may reduce the rapid deconditioning associated with bed rest, preserve balance and muscle strength, and help maintain the patient's ability to perform basic activities of daily living. The observed reductions in urinary catheter use and institutionalization are also clinically coherent and may represent downstream consequences of better functional preservation. The attenuation of the mortality association after adjustment for functional worsening and catheter use is consistent with the possibility that these factors lie on part of the pathway linking mobilization to survival, although formal causal mediation cannot be inferred from this design.

The favourable safety profile is also important. Length of stay did not increase, falls were infrequent, and no serious adverse events attributable to mobilization were reported. This is consistent with previous literature suggesting that, when delivered by trained staff and guided by structured criteria, early

mobilization is safe even in medically complex patients (25). These findings should reassure clinicians and administrators that promoting mobility does not necessarily come at the cost of increased risk.

From a clinical and organizational perspective, the findings support the prioritization of mobility as a core therapeutic objective in older medical inpatients. In many hospitals, the increasing technological and administrative burden of care can displace basic practices that preserve autonomy, such as getting patients out of bed, helping them transfer safely, or encouraging walking. Our results suggest that a simple, structured, person-centred mobilization pathway may yield meaningful benefits in outcomes that matter directly to patients and health systems.

Unanswered questions and future research

Further research is needed to confirm these findings in multicentre studies and, where feasible, randomized or cluster-randomized designs. Future work should clarify which components of mobilization pathways are most effective, how best to measure mobility exposure during admission, and whether the observed associations translate into longer-term gains in independence, quality of life, and healthcare utilization. More detailed assessment of frailty, delirium, and post-discharge trajectories would also strengthen understanding of the mechanisms involved.

Conclusion

Implementation of HESM was associated with less functional worsening at discharge and with lower observed 90-day mortality after discharge in older medical inpatients. These findings support structured early mobilization as a clinically relevant strategy to reduce hospital-associated disability, the possible survival benefit is attracting but requires confirmation in multicentre studies.

Declarations

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, Fabrizio Turrini used OpenAI's ChatGPT to assist with language editing, formatting of tables and supplementary materials, checking internal consistency between the manuscript text, tables, figures and supplementary appendices, and supporting the preparation of graphical material from author-provided data. The author reviewed and edited the output as needed and takes full responsibility for the content of the published article.

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Table 3 and 4

Table 3 and 4 are available in the Supplementary Files section.

Figures

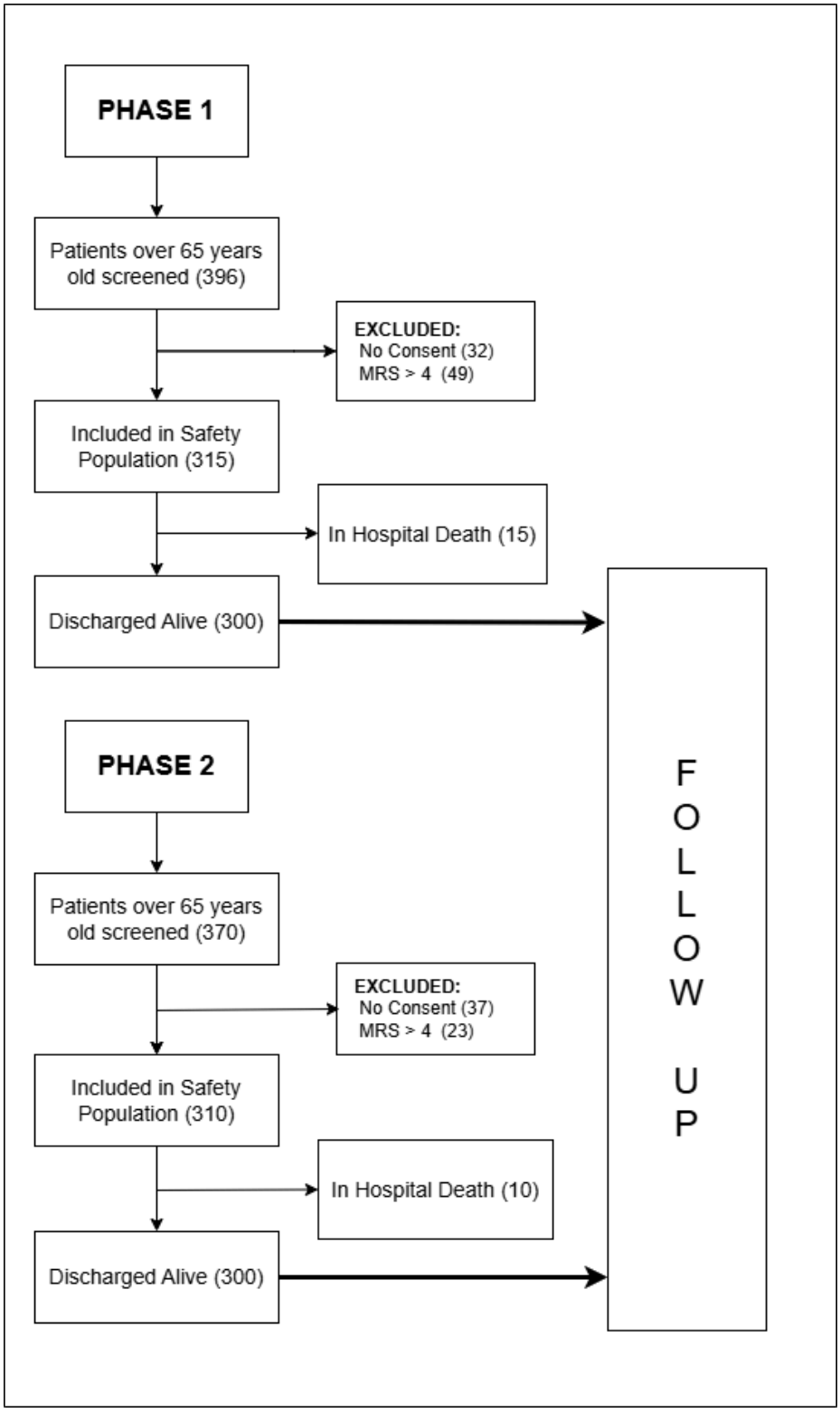
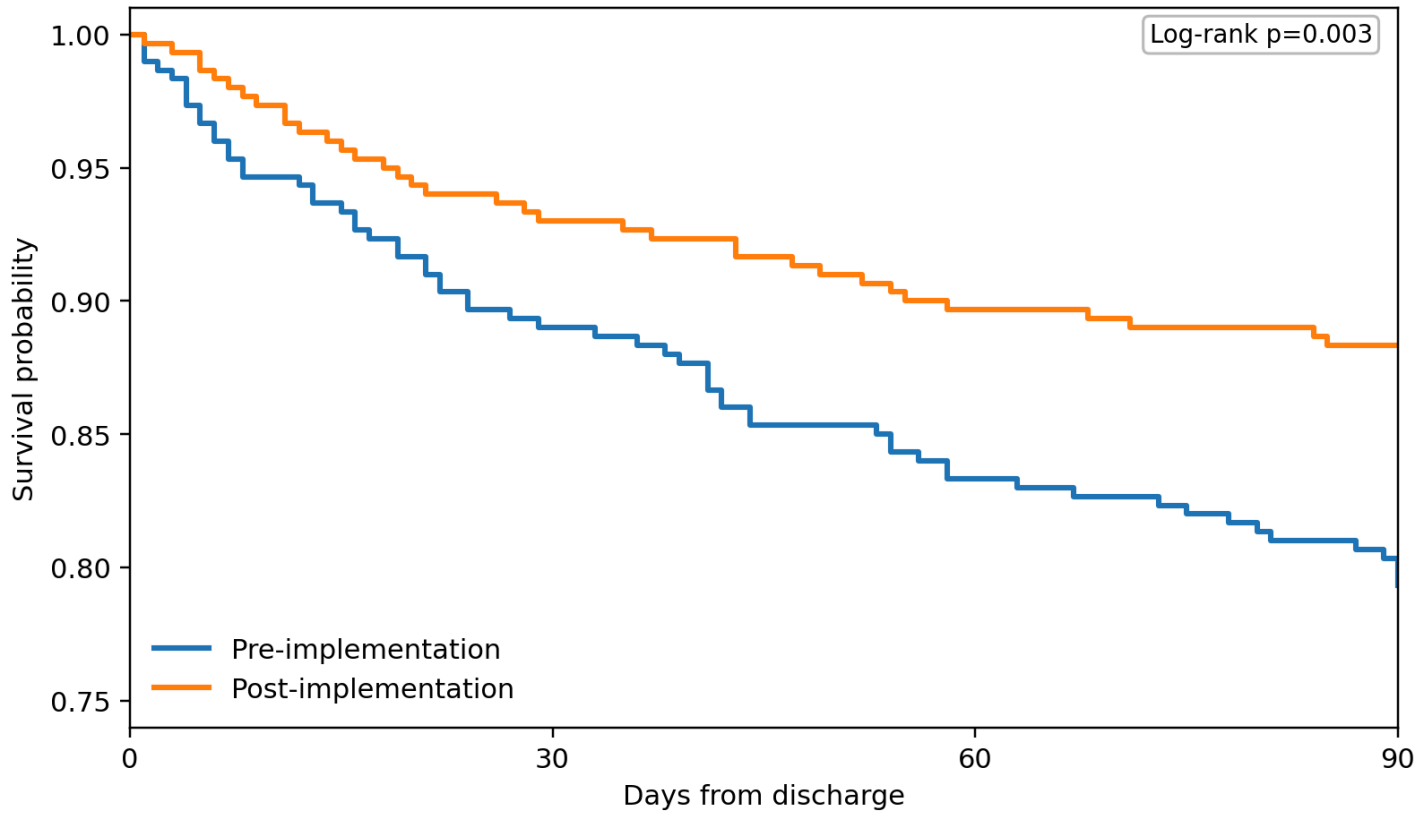


Figure 1

Study flow diagram

Flow diagram showing patient screening, exclusions, safety population, and discharged-alive, analytic cohort before and after implementation of the HESM pathway.



Number at risk

Pre	300	267	250	241
Post	300	279	269	265

Figure 2

Ninety-day post-discharge survival according to study phase

Kaplan-Meier survival curves comparing 90-day post-discharge survival before and after implementation of the HESM pathway. The post-implementation curve remains above the pre-implementation curve, indicating higher survival after implementation.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- HESMgraphicalabstract.png
- SupplementaryAppendix1.docx
- SupplementaryAppendix2.docx
- SupplementaryAppendix3.docx
- Table3and4.docx