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Development and Real-World Implementation of a Frailty-Informed Cardiogeriatric Decision Algorithm for Older Adults with Heart Failure: a Single-Centre Service

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Abstract

Background

Heart failure (HF) in older adults is frequently accompanied by frailty, multimorbidity, cognitive impairment, and functional vulnerability, making standard disease-centred pathways difficult to apply in routine practice. Although frailty-informed care and age-friendly principles are increasingly advocated, detailed real-world descriptions of operational cardiogeriatric service models remain scarce. We therefore describe the development and implementation of a hospital-based cardiogeriatric decision algorithm for older adults with HF, integrating frailty stratification and the 4Ms framework.

Methods

This study is a descriptive, single-centre service development report conducted in the Department of Cardiogeriatrics at Hôpital La Porte Verte, Versailles, France. Its aim was not to evaluate effectiveness, but to describe the rationale, structure, implementation process, and operationalization of a real-world decision algorithm for older adults with HF. The model was informed by heart failure guidelines, frailty-based clinical reasoning, and the Age-Friendly Health Systems 4Ms framework. It incorporated frailty stratification, comprehensive geriatric assessment, advanced practice nurse coordination, day-hospital management, telemonitoring, therapeutic education, and supportive or palliative care when appropriate.

Results

From 2023 onwards, the decision algorithm was progressively embedded into routine inpatient, outpatient, day-hospital, and telemonitoring practice. It provided a shared multidisciplinary framework for aligning therapeutic intensity with frailty status, functional reserve, cognitive status, and patient priorities. In practice, the algorithm supported profile-adapted therapeutic orientation across inpatient, ambulatory, and supportive care settings, while helping structure coordination between cardiology, geriatrics, nursing teams, and community care. This report does not present a formal comparative evaluation of clinical outcomes; its findings should therefore be interpreted as descriptive and hypothesis-generating.

Conclusions

This single-centre experience describes a pragmatic and age-friendly cardiogeriatric decision algorithm for older adults with HF and complex care needs. By integrating frailty assessment, the 4Ms framework, and coordinated multidisciplinary care into routine practice, the model offers a transferable organisational approach for clinicians managing older patients with HF. Formal evaluation is now needed to assess implementation outcomes, patient-centred outcomes, and scalability.

Introduction

Heart failure (HF) is the leading cause of hospitalization among older adults, with prevalence and complexity rising sharply after age 75 years [1, 2]. Older HF patients are far from homogeneous: some remain robust and tolerate guideline-directed medical therapy (GDMT) and invasive interventions [1, 2], whereas others present with frailty, cognitive impairment, or dependency, requiring tailored management [3–6]. At the extreme, very frail or dependent patients may benefit more from comfort-oriented or palliative approaches than from aggressive escalation [3–5].

Despite the availability of effective GDMT, elderly patients remain underrepresented in clinical trials [1, 2], and evidence supporting profile-adapted HF strategies is limited [3, 4, 8, 9]. Hospitalization—the default response to decompensation—carries high risks of delirium, malnutrition, functional decline, and long-term disability [10, 11].

This heterogeneity underscores the need for pragmatic, profile-based algorithms integrating geriatric and cardiologic principles [12]. Such models are consistent with the Age-Friendly Health Systems (AFHS) framework, which organizes care around the *4 Ms*: *What Matters*, *Medication*, *Mentation*, and *Mobility* [13–15]. Implementing these principles in HF care can improve personalization, coordination, and safety for older adults [16].

While individual components such as frailty assessment, ambulatory diuretic care, telemonitoring, and palliative integration have each been described separately in the literature, real-world descriptions of decision algorithms that operationally integrate these components to guide profile-adapted management in older adults with HF remain limited. We therefore report the development and implementation of a single-centre cardiogeriatric decision algorithm for older adults with HF, designed to integrate frailty stratification, the 4Ms framework, and profile-adapted therapeutic orientation within routine care. Our aim is not to evaluate effectiveness, but to provide a transparent description of the decision algorithm, its implementation, and its perceived practical value in routine care.

Methods

Design and Setting

This study is a descriptive, single-centre, real-world report of the development and implementation of a frailty-informed cardiogeriatric decision algorithm in routine practice. It was conducted at *Hôpital La Porte Verte*, a tertiary cardiogeriatric facility serving an aging population. The initiative was developed by a multidisciplinary team including cardiologists, geriatricians, advanced practice nurses (APNs), and telemonitoring specialists.

Algorithm Development

The figure presents the cardiogeriatric algorithm implemented at *Hôpital La Porte Verte (Versailles, France)*.

Based on ESC and AHA guidelines [1, 2], frailty and multimorbidity literature [3, 4, 8, 9, 17, 18], and the AFHS "4 Ms" framework [13–15], the team developed a profile-stratified decision algorithm (Fig. 1) categorizing older HF patients as:

- Fit/robust – candidates for full GDMT, structured titration, and advanced interventions (TAVI, MitraClip, device therapy) [1, 2];
- Frail (non-palliative) – requiring cautious therapy adjustment, slower titration, ambulatory diuretic or iron infusions, and reinforced education [4, 17, 19–21];
- Palliative frail – prioritizing comfort, simplified regimens, and early palliative involvement [3, 5, 18].

Each pathway integrates the 4 Ms [13–15]:

What Matters – shared decision-making on care goals;

Medication – periodic medication review and deprescribing;

Mentation – cognitive and mood screening;

Mobility – functional assessment guiding rehabilitation and discharge planning.

Operationally, the algorithm was intended to support four successive decision steps: (1) identification of frailty profile and clinical complexity; (2) integration of age-friendly domains using the 4Ms framework; (3) selection of therapeutic intensity and care setting; and (4) reassessment over time according to clinical evolution, functional reserve, and patient goals.

Rather than functioning as a rigid protocol, the algorithm was designed as a structured decision-support framework to guide multidisciplinary reasoning in routine practice.

Implementation process

The algorithm was developed and implemented through an iterative multidisciplinary process within the Department of Cardiogeriatrics at Hôpital La Porte Verte. The initial algorithm was designed by the local cardiogeriatric team, drawing on routine clinical experience, HF guidelines, frailty-informed decision-making, and age-friendly care principles. It was progressively refined through repeated discussions involving cardiologists, geriatricians, advanced practice nurses, nursing staff, and telemonitoring professionals.

Implementation relied on the gradual integration of the algorithm into routine inpatient, outpatient, and day-hospital workflows rather than on a single formal launch. The algorithm was introduced as a shared clinical framework to support therapeutic stratification, referral to ambulatory care options, and

coordination across care settings. Its operational use was reinforced through multidisciplinary exchanges, case-based discussions, and repeated alignment of practices between hospital-based and community-based professionals.

During deployment, the pathway was adjusted pragmatically according to clinical feedback and organisational constraints.

Barriers and facilitators

Implementation of the pathway was influenced by several contextual facilitators and barriers identified during routine use. Key facilitators included the presence of a pre-existing cardiogeriatric structure, the involvement of advanced practice nurses, access to day-hospital activity, the availability of a telemonitoring platform, and an established multidisciplinary culture within the service. These elements supported the progressive integration of frailty-informed decision-making and age-friendly principles into routine HF care.

The main barriers were related to the complexity of real-world care trajectories. These included coordination across multiple settings, time constraints in daily practice, heterogeneity of patient profiles and levels of frailty, and variable availability of community-based resources after discharge. Additional challenges arose from the need to align treatment intensity with functional status, cognitive status, patient priorities, and evolving care goals. These factors required pragmatic adaptation of the pathway during implementation.

Operationalization of the decision algorithm

The operational structure of the decision algorithm is summarized in Table 1 and illustrated in Fig. 1, which presents the Hôpital La Porte Verte algorithm integrating frailty profiles into cardiovascular management.

Table 1
Operational structure of the cardiogeriatric decision algorithm for older adults with heart failure

Frailty profile	Typical clinical features	4Ms and therapeutic orientation	Operational modalities (care setting, APN, telemonitoring)	Triggers for reassessment / palliative shift
Fit / robust	Preserved autonomy; compensated comorbidity burden; good adherence potential; low cognitive vulnerability; expected tolerance of GDMT and invasive evaluation if indicated	What Matters: preserve independence and prognosis-oriented care. Medication: optimize and titrate GDMT. Mentation: identify subtle barriers to adherence. Mobility: preserve function during treatment intensification. Orientation: full GDMT optimization, structured titration, and evaluation for advanced interventions when indicated.	Care setting: outpatient clinic, day-hospital if needed, conventional hospitalization if acute instability. APN: coordinate titration, reinforce education and adherence, monitor tolerance, liaise with cardiology, geriatrics, and community care. Telemonitoring: detect early congestion or intolerance during optimization and secure ambulatory follow-up.	Functional decline; recurrent decompensation; emerging cognitive impairment; treatment intolerance; change in patient goals.
Frail (non-palliative)	Reduced physiological reserve; multimorbidity; mobility limitation; nutritional vulnerability; possible mild cognitive impairment; increased iatrogenic risk	What Matters: balance symptom relief, autonomy, and treatment burden. Medication: cautious adjustment, deprescribing when appropriate, avoid overtreatment. Mentation: assess cognition, mood, and caregiver support. Mobility: protect transfers, gait, and rehabilitation potential. Orientation:	Care setting: day-hospital, outpatient follow-up, short hospitalization if needed, home/community-supported care when feasible. APN: central coordination, geriatric assessment, patient/caregiver education, organize transitions, detect warning signs, align team decisions. Telemonitoring: monitor symptoms and weight, identify early decompensation, trigger APN contact and ambulatory response.	Recurrent HF episodes; progressive functional loss; worsening cognition; increasing dependency; poor tolerance of active treatment; repeated inability to return to baseline.

Frailty profile	Typical clinical features	4Ms and therapeutic orientation	Operational modalities (care setting, APN, telemonitoring)	Triggers for reassessment / palliative shift
		profile-adapted treatment, slower titration, simplified but active HF management, ambulatory IV diuretics or iron when appropriate, avoid unnecessary escalation while maintaining therapeutic intent.		
Palliative frail	Advanced frailty or dependency; major functional limitation; severe cognitive vulnerability and/or institutionalization; high symptom burden; limited expected benefit from intensive escalation	What Matters: comfort, dignity, place of care, caregiver reassurance. Medication: simplify regimens and deprescribe non-beneficial drugs. Mentation: address distress, cognition, and communication capacity. Mobility: prioritize comfort and avoid burdensome interventions. Orientation: comfort-oriented management, symptom relief, treatment simplification, early palliative integration, avoid low-benefit escalation, goal-concordant care planning.	Care setting: home, nursing home, teleconsultation/remote support, hospitalization only if consistent with goals of care. APN: support care planning, coordinate with family, primary care, nursing home, and palliative teams, ensure continuity, anticipate crises. Telemonitoring: selective use for symptom surveillance and avoidance of burdensome transfers when aligned with goals of care.	Refractory symptoms; repeated decompensation with poor recovery; worsening dependency; inability to tolerate or benefit from active HF therapies; explicit shift toward comfort-focused care.

Since 2023, the algorithm has been embedded into standard care through:

- Day-hospital programs for IV diuretics, iron therapy, and GDMT, coordinated within the cardiogeriatric pathway [20, 21];
- Comprehensive geriatric assessment addressing frailty, cognition, nutrition, and mobility [19, 22];
- Telemonitoring with Satelia® Cardio, including daily symptom and weight reports, with APN follow-up to prevent emergency admissions [23, 24];
- Therapeutic education for patients and caregivers on adherence and early warning signs [25];
- Coordination with national transition programs (PRADO) and community care teams for continuity [26].

The figure illustrates the sequential logic of the algorithm: initial multidimensional assessment, integration of the 4Ms framework, identification of frailty profile, selection of profile-adapted therapeutic orientation, activation of operational care modalities, and longitudinal reassessment according to clinical evolution, functional reserve, cognition, treatment tolerance, and patient goals. Advanced practice nurses support implementation across all stages through geriatric assessment, care coordination, education, and anticipatory follow-up.

This article aims to describe the development and implementation of a hospital-based integrated model rather than to evaluate its impact. A formal assessment of clinical and organizational outcomes is planned in the next phase of the project.

Ethical approval

was not required, as this was a service-development project without patient-level data analysis.

Results

Illustrative use of the decision algorithm

Since 2023, the decision algorithm has been used in routine cardiogeriatric practice to stratify older adults with HF according to frailty profile and to guide therapeutic orientation across inpatient, ambulatory, and supportive care settings.

The following illustrative cases show how the algorithm was used to support different therapeutic decisions according to frailty profile, functional reserve, and care goals.

- A fit 80-year-old independent patient underwent structured day-hospital titration of ACE inhibitors, β-blockers, and SGLT2 inhibitors, supported by telemonitoring to ensure safety and adherence [1, 2, 23].
- A frail 88-year-old with limited mobility benefited from ambulatory intravenous diuretics, caregiver education, and coordinated follow-up with primary care [20, 25].

- A palliative 92-year-old nursing-home resident was managed with simplified regimens focused on comfort, symptom relief, and continuity of care through teleconsultations [3, 5, 18].

These illustrative uses suggest that the algorithm provided a shared framework for profile-based decision-making across diverse clinical situations. No formal comparative assessment was performed, and observations are reported descriptively.

Contextual evidence supporting algorithm-guided management options

The following published data relate to individual care components that informed or supported algorithm-guided management options within the local cardiogeriatric model and should not be interpreted as outcome evaluation of the algorithm itself.

Preliminary observational data from related care programs provide contextual support for this approach. In the DOME-HF study, elderly patients (mean age 88 years) managed via a diuretic day hospital achieved acceptable 90-day outcomes, with 20% HF rehospitalization and 7.5% all-cause mortality despite advanced frailty [20]. The TeleSAT study reported associations between structured telemonitoring and lower rates of potentially avoidable admissions in routine care [23]. Within the present algorithm-guided model, telemonitoring was used to support earlier identification of clinical worsening and outpatient follow-up [23, 24]. Qualitative feedback from professionals and patients also suggested improved understanding of treatment and greater confidence in disease self-management [25].

These component-level observations support the clinical plausibility and operational relevance of the algorithm-guided approach, but they do not constitute formal outcome evaluation of the algorithm itself.

Discussion

This report describes the development and real-world implementation of a cardiogeriatric decision algorithm designed to adapt HF management to frailty profile, functional status, cognitive vulnerability, and patient priorities in older adults. What this report adds is the description of a frailty-informed decision algorithm, rather than a single intervention or care component. The novelty lies in showing how age-friendly principles, therapeutic stratification, ambulatory options, and palliative integration can be combined within one operational decision framework for older adults with HF.

Its main contribution is not the isolated description of day-hospital care, telemonitoring, or palliative integration, but the operational integration of these components into a unified decision-support framework. Unlike our previous publications focusing on individual components of cardiogeriatric care, the present report describes the overall decision architecture, implementation logic, and routine use of this algorithm within an age-friendly model of care.

Robust individuals may be considered for full GDMT and invasive procedures when appropriate, whereas very frail patients can be managed with simplified strategies that prioritize safety and comfort. This approach facilitates early identification of frailty, personalization of care, and attention to clinical situations commonly associated with potentially avoidable hospitalizations—three priorities in contemporary geriatric medicine [4, 6, 7, 10, 12]. Rather than considering older adults as a homogeneous group, the algorithm explicitly acknowledges heterogeneity within the ageing HF population. Robust patients may tolerate comprehensive GDMT, frail patients often require cautious titration and tailored interventions, and very frail or dependent individuals generally benefit from simplified, comfort-oriented management [3, 4]. This stratified reasoning reflects the clinical reality of multimorbidity and vulnerability among older HF patients and is consistent with ESC/HFA and AHA recommendations emphasizing individualized care [1, 2].

By distinguishing between non-palliative and palliative frailty, the model supports avoidance of both overtreatment and therapeutic neglect, promoting goal-concordant care aligned with patients' priorities, physiological reserve, and quality-of-life objectives [5, 18]. Integration of palliative principles into cardiology pathways is increasingly recognized as an important component of advanced HF management in older adults [5].

Integration of the "4 Ms" Framework

A key conceptual contribution of this model lies in the operationalization of the Age-Friendly Health System "4 Ms" framework within routine HF care [13–15]. Each dimension is incorporated into the algorithm as a practical clinical process:

- **What Matters**: shared decision-making ensures that clinical goals reflect each patient's values, life context, and autonomy.
- **Medication**: structured medication review and deprescribing reduce polypharmacy and adverse drug events, a critical issue in frail older adults [19, 27, 28].
- **Mentation**: systematic screening for cognitive and mood disorders informs both adherence strategies and caregiver engagement [11].
- **Mobility**: evaluation of gait, balance, and autonomy supports rehabilitation, fall prevention, and safe transitions of care [10, 19].

Embedding the 4 Ms within HF management shifts the focus from disease-centred decision-making toward age-friendly, person-centred care. This framework supports multidisciplinary coordination and is consistent with international standards promoted by the Institute for Healthcare Improvement for age-friendly health systems [13–16].

Role of Advanced Practice Nurses

A central operational element of this model is the coordinating role of APNs across the continuum of care. Within this model, APNs play a key operational role in implementing the decision algorithm across

settings by supporting geriatric assessment, education, monitoring, and coordination [23–25]. Their role supports early identification of clinical changes, caregiver engagement, and continuity between hospital-based and community care. By linking cardiology and geriatrics, APNs fulfil an integrative function described in age-friendly and integrated-care frameworks [11, 13–15].

Organizational and Policy Implications

From an organizational perspective, this model addresses clinical and operational determinants commonly associated with fragmented care, including delayed reassessment, poor coordination, and limited continuity between settings. By structuring frailty-based stratification, APN coordination, and telemonitoring, the model supports coherent care trajectories and clearer role distribution within multidisciplinary teams. Qualitative feedback suggested improved professional collaboration and perceived clarity of care pathways.

Although developed within the French healthcare system, the core components of the model—frailty stratification, nurse-led coordination, and telemonitoring-supported follow-up—are potentially transferable to other settings, including those without formal day-hospital structures. Adaptation may be feasible across diverse health systems facing increasing challenges related to ageing and multimorbidity [29–31].

Core requirements for implementation include frailty assessment and coordinated follow-up, ideally supported by advanced practice nurses or equivalent roles. Other components, such as telemonitoring or day-hospital facilities, may be adapted to local resources. This flexibility supports transferability across different healthcare systems.

Limitations and Future Perspectives

This work has several limitations inherent to its design. It represents a single-centre, descriptive implementation study without a comparative or interventional design, and no formal statistical evaluation of clinical outcomes was performed. The primary objective was to document the structure, feasibility, and reproducibility of an integrated cardiogeriatric framework rather than to demonstrate effectiveness.

Nevertheless, qualitative observations and routine practice indicators suggest improved coordination, anticipatory clinical management, and patient understanding of treatment. The model was developed through iterative multidisciplinary consensus involving cardiologists, geriatricians, APNs, and telemonitoring specialists and refined during real-world implementation, supporting its practical relevance.

Future multicentre studies are needed to quantitatively assess clinical outcomes, functional trajectories, patient-reported outcomes, and cost-effectiveness, and to evaluate scalability within broader age-friendly and integrated care initiatives [13–16, 31].

Broader implications

This cardiogeriatric algorithm illustrates the feasibility of embedding geriatric principles, APN leadership, and the 4 Ms framework within structured HF pathways. It offers a pragmatic bridge between guideline recommendations and routine clinical practice for complex older adults. By integrating frailty assessment, multidisciplinary collaboration, and person-centred priorities into hospital-based care, this initiative aligns with the WHO Framework on Integrated People-Centred Health Services [31] and the European Joint Action on Frailty [32].

Overall, this experience suggests that hospital-based cardiogeriatric services may serve as practical environments for developing age-friendly models of care that support coherence, equity, and continuity across the care continuum. These findings should be interpreted as descriptive and hypothesis-generating.

Conclusion

The cardiogeriatric algorithm implemented at Hôpital La Porte Verte represents a pragmatic, Age-Friendly Health System–aligned decision algorithm for managing HF in older adults. By integrating frailty assessment, APN-led coordination, telemonitoring, and the 4 Ms within a unified framework, it operationalizes age-friendly principles into routine cardiology care. This report describes a pragmatic single-centre cardiogeriatric decision algorithm intended to help operationalise guideline principles in the care of older adults with HF.

Abbreviations

AFHS: Age-Friendly Health Systems

AHA: American Heart Association

APN: Advanced Practice Nurse

DOME-HF: Diuretic Outpatient Management for the Elderly with Heart Failure

ESC: European Society of Cardiology

GDMT: Guideline-Directed Medical Therapy

HF: Heart failure

TAVI : Transcatheter Aortic Valve Implantation

Declarations

Ethical approval and consent to participate

This article describes an organizational innovation and does not involve research on human participants or animals. Ethical approval was therefore not required.

Clinical trial number: not applicable.

Consent for publication

Not applicable. The manuscript does not include any individual person's data in any form (images, videos, or identifiable details).

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author (*R.E.*) on reasonable request. Due to patient privacy restrictions, data are not publicly available.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Figures

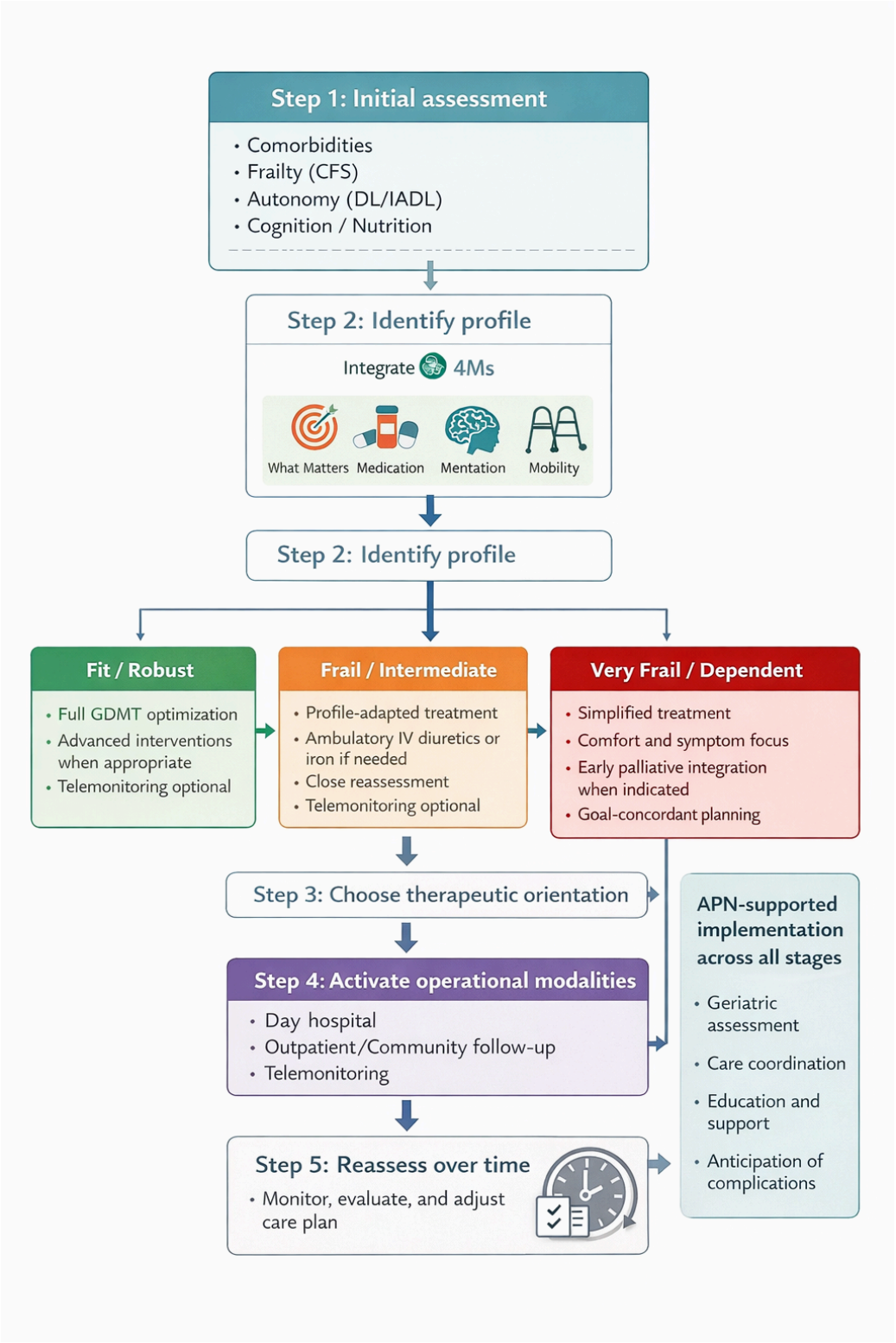


Figure 1

Frailty-informed cardiogeriatric decision algorithm for older adults with heart failure

The figure illustrates the sequential logic of the algorithm: initial multidimensional assessment, integration of the 4Ms framework, identification of frailty profile, selection of profile-adapted therapeutic orientation, activation of operational care modalities, and longitudinal reassessment according to clinical evolution,

functional reserve, cognition, treatment tolerance, and patient goals. Advanced practice nurses support implementation across all stages through geriatric assessment, care coordination, education, and anticipatory follow-up.