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REVIEW

# State of the Art in Measuring Frailty in Patients With Heart Failure: from Diagnosis to Advanced Heart Failure

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## Abstract

**Purpose of Review** This review aims to present the current state of the art in measuring frailty in patients with heart failure (HF), covering the entire spectrum from diagnosis to advanced stages of the disease. Frailty is a critical factor that significantly impacts outcomes in heart failure, and accurate assessment is essential for guiding treatment and improving prognosis.

**Recent Findings** Frailty is increasingly recognized as a key determinant of morbidity and mortality in HF patients. Various tools are available for assessing frailty, but there is no consensus on the optimal method. The assessment of frailty needs to be multidimensional, incorporating physical, cognitive, and social domains. Early detection of frailty, coupled with personalized interventions, has the potential to improve patient outcomes.

**Summary** Integrating routine frailty assessments into the clinical care of heart failure patients is essential for optimizing treatment. Future research should focus on standardizing frailty assessment tools and integrating innovative technologies, such as artificial intelligence, to enhance the precision and applicability of these assessments in clinical practice.

**Keywords** Frailty · Heart failure · Assessment tools · Multidimensional approach · Personalized care

**Abbreviations**

| | |
|---|---|
| HF | Heart Failure |
| FS | Frailty Syndrome |
| LVAD | Left Ventricular Assist Device |
| OHT | Orthotopic Heart Transplantation |
| AI | Artificial Intelligence |
| ML | Machine Learning |
| TFI | Tilburg Frailty Indicator |
| EFS | Edmonton Frail Scale |
| GDMT | Guideline-Directed Medical Therapy |

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## Introduction

Frailty is a syndrome characterized by a significant decline in the function and reserve of multiple physiological systems, resulting in reduced homeostatic tolerance to stressors and an increased vulnerability to adverse outcomes. Traditionally, frailty has been considered a proxy for accelerated aging, reflecting the cumulative impact of age-related impairments across various physiological systems. However, the progression of functional decline associated with aging can vary significantly among individuals. As a result, frailty is now recognized as a distinct biological syndrome that accounts for this variability, rather than being solely an indicator of aging [1–4].

Frailty often coexists with heart failure (HF), as the two conditions share common pathophysiological pathways, including a high burden of comorbidities, frequent hospitalizations, and age-related sarcopenia. These shared factors

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accelerate functional decline and exacerbate the clinical challenges faced by HF patients [5]. When present together, frailty and HF are associated with significantly worse clinical outcomes and diminished quality of life, highlighting the need for a more comprehensive and integrated approach to their management. Consequently, there is growing emphasis on incorporating frailty assessments into prognostic models and treatment strategies for HF to improve outcomes and tailor care to the patient's needs [6].

The aim of this review is to recent advancements in the assessment of frailty in HF patients, spanning all stages of the disease, from early diagnosis to advanced stages. Additionally, it evaluates the clinical utility of existing frailty assessment tools and identifies future directions for standardizing these methods and integrating them into routine HF care.

## What is the Clinical Impact of Frailty on Heart Failure Patients?

Frailty has a profound clinical impact on patients with HF, influencing both the progression of the disease and the effectiveness of treatment. Frailty is highly prevalent in HF patients, with studies showing it affects up to 90% of those with preserved ejection fraction (HFpEF) and 60% of those with HFrEF [7]. This prevalence is further exacerbated by the presence of comorbidities such as diabetes, COPD, and renal failure, which independently contribute to worse outcomes in HF patients [8]. Frailty condition is closely associated with worse clinical outcomes, including a significantly higher risk of all-cause mortality and hospitalizations, particularly in the presence of comorbidities such as diabetes, COPD, and renal failure, which amplify the adverse impact of frailty on recovery and resilience. Specifically, frail HF patients face a 1.5- to 2-fold increased risk of these adverse outcomes compared to non-frail patients, largely due to their diminished ability to recover from acute stressors [8–10].

The coexistence of frailty and sarcopenia, which is the loss of muscle mass and strength, exacerbates the negative prognosis in HF patients. Sarcopenia is approximately 20% more prevalent in HF patients, further increasing their vulnerability to poor outcomes such as frequent hospital readmissions and higher mortality rates [4, 11]. The combination of these conditions leads to a cycle of declining health, where frailty accelerates the progression of HF, and worsening heart failure, in turn, exacerbates frailty.

Several landmark trials have assessed the impact of frailty on the outcomes of HF therapies. In the PARADIGM-HF trial, frailty was associated with worse outcomes, yet patients derived significant benefits from sacubitril/valsartan, including reductions in cardiovascular death and HF hospitalizations [9, 12]. Similarly, the DAPA-HF trial demonstrated that dapagliflozin effectively reduced the risk of worsening HF and cardiovascular death in both frail and non-frail patients with HFrEF, as confirmed by a prespecified analysis [12]. Subgroup analyses of DAPA-HF have also shown that dapagliflozin is effective in reducing adverse outcomes in patients with diabetes and chronic kidney disease, which are common comorbidities in HF patients with frailty, further underscoring its utility in complex clinical scenarios. In the DELIVER trial, dapagliflozin was also effective in frail patients with HFpEF, highlighting the consistent benefits of SGLT2 inhibitors across different frailty strata [13]. The TOPCAT trial, which focused on HFpEF patients, further underscored the importance of addressing frailty. Subsequent analyses of the TOPCAT dataset used a frailty index derived from clinical, laboratory, and self-reported variables, demonstrating that frail individuals had significantly higher event rates, including cardiovascular mortality and HF hospitalizations [8]. However, the benefits of spironolactone were not diminished by frailty status, suggesting its utility across frailty levels. These findings emphasize the need for targeted strategies to manage frailty in HFpEF patients while ensuring access to evidence-based therapies.

An additional challenge in managing frail HF patients is polypharmacy - the concurrent use of multiple medications - which is prevalent due to the necessity of addressing various comorbidities. While guideline-directed medical therapy (GDMT) is essential for improving outcomes, the complexity of multiple drug regimens can lead to decreased adherence, increased risk of adverse drug reactions, and drug-drug interactions. To mitigate these risks, regular medication reviews are recommended to assess the necessity, effectiveness, and potential harms of each drug. Deprescribing, a systematic process of identifying and discontinuing medications where the risks outweigh the benefits, can be beneficial in reducing medication burden. Employing tools such as the Beers Criteria [14] and the STOPP/START [15] criteria can aid clinicians in identifying potentially inappropriate medications and optimizing pharmacotherapy. Additionally, simplifying dosing regimens, involving patients in shared decision-making, and providing education on the importance of adherence are strategies that can enhance medication adherence and overall treatment efficacy [16].

Moreover, frailty complicates the management of heart failure. Frail patients are often perceived as being at higher risk of adverse effects from standard HF treatments, leading to the underutilization or suboptimal dosing of guideline-directed medical therapies (GDMT). Despite these concerns, evidence indicates that many treatments, such as angiotensin receptor-neprilysin inhibitors (ARNI) and sodium-glucose co-transporter-2 (SGLT2) inhibitors, are

effective across different levels of frailty. For example, analyses from trials like DAPA-HF and DELIVER demonstrate that dapagliflozin effectively reduces the risk of worsening HF and cardiovascular death in frail patients, similar to its effects in non-frail patients [12, 13, 17]. Therefore, frailty should not be a barrier to the application of these life-saving therapies. Addressing frailty in HF patients through comprehensive management strategies is crucial for improving outcomes and should involve careful consideration of both frailty and sarcopenia, as well as the management of common comorbidities such as diabetes, COPD, and renal failure, which substantially influence prognosis and treatment effectiveness.

## Is Frailty Prevention Possible in Patients With Heart Failure?

In consideration of the clinical relevance of FS in HF, there remains an open question as to whether HF-related frailty can be reversed by efficacious therapeutic interventions. It is recommended that, in clinical practice, any intervention strategy aimed at preventing or reversing frailty should be undertaken, as this is essential to improve outcomes [18]. Given the multifactorial nature of frailty in HF, a comprehensive and individualized approach is required to address both physiological and functional impairments. Effective management should encompass not only pharmacological treatment but also lifestyle modifications, rehabilitation programs, and nutritional support.

Recent studies [] have highlighted the pivotal role of cardiac rehabilitation (CR) as a key intervention in preventing and reversing frailty in HF patients [19]. Frailty affects approximately 40–50% of HF patients referred to CR and is associated with worse clinical outcomes, including higher rates of hospitalization and mortality. However, structured CR programs integrating aerobic and resistance exercise, nutritional optimization, psychosocial support, and cognitive training have demonstrated significant benefits in enhancing physical performance – notably in including grip strength, gait speed, and six-minute walk distance (6MWD) – as well as reducing frailty burden, and improving overall prognosis [20, 21]. Notably, tailored interventions, including personalized rehabilitation and prehabilitation strategies, appear particularly effective for patients with greater frailty at baseline. While short-term improvements in frailty and functional capacity following CR are well-documented, emerging evidence suggests that these benefits can persist beyond program completion, contributing to long-term improvements in functional status and quality of life. Nonetheless, CR adherence remains a major challenge, particularly among frail individuals, underscoring the need for adaptive rehabilitation models to enhance participation and optimize long-term outcomes. Given the variability in frailty assessment methods and the limited number of randomized controlled trials, further research is needed to refine rehabilitation protocols and establish standardized approaches for managing frailty in HF [19].

These findings reinforce the growing body of evidence supporting the role of rehabilitation in frailty management across different stages of heart failure. While CR programs have demonstrated effectiveness in improving frailty and functional outcomes in stable HF patients, the potential for early rehabilitation interventions in acute settings, such as during hospitalization for acute decompensated HF (ADHF), is increasingly being recognized. Recent evidence underscores the significance of early rehabilitation strategies in mitigating frailty among HF patients [22]. The findings revealed that participants who engaged in the structured rehabilitation program experienced notable improvements in functional capacity, mobility, and frailty status, especially those identified as frail upon admission. This study highlights the potential of early, comprehensive rehabilitation interventions to reverse frailty and promote recovery in the heart failure population. It also emphasizes the importance of incorporating personalized rehabilitation approaches into standard heart failure care protocols to optimize patient outcomes.

While early rehabilitation interventions show promise in mitigating frailty among HF patients, long-term management strategies, including advanced medical therapies and structured rehabilitation programs, are essential for sustained improvement. Despite a lack of extensive research, evidence suggests that frailty and its associated risks can be reversed through the implementation of advanced therapies (e.g., LVAD, OHT) [10] and/or cardiac rehabilitation programmes [23, 24]. A consensus statement from the International Society for Heart & Lung Transplantation (ISHLT) [18] recommends the investigation of frailty in patients with advanced HF, as well as the development of strategies for the assessment and treatment of this condition. Despite the limited number of studies that have examined the reversibility of frailty in the context of advanced medical procedures (LVAD or OHT), the most significant improvement was observed more than three months following surgery [25–27]. It is important to note that not all frail patients exhibited improvement. Therefore, further research and observation are necessary to identify the baseline factors that predict improvement in frailty following the interventions used. It is suggested that younger patients with fewer comorbidities and age-related declines may benefit the most. Non-surgical interventions, including exercise and nutritional support, must be approached on an individual basis, with a tailored treatment plan developed for each patient. It is recommended that these interventions be considered for those

undergoing advanced surgery, as well as for those not. In the context of frailty, interventions designed to enhance physical function tend to prioritise the promotion of key domains, including mobility, balance, strength, and endurance [18].

Beyond medical and rehabilitative interventions, addressing nutritional deficiencies is a fundamental aspect of comprehensive frailty management in HF, given its significant impact on functional capacity and disease progression. Patients with HF are at an increased risk of developing nutritional deficiencies as a result of the accompanying symptoms, including early satiety, persistent dyspnoea, dietary restrictions or the presence of other comorbidities [28]. In a multicentre, randomised, controlled trial [29] noted that the implemented nutritional intervention in patients with HF and malnutrition over a 12-month period was associated with a reduced risk of mortality from any cause and a reduced risk of readmission due to HF decompensation. It must be acknowledged that there is still an absence of comprehensive, well-designed clinical trials in this field.

A comprehensive approach to frailty management in heart failure requires a multifaceted strategy combining early rehabilitation, advanced therapies, and personalized interventions, including structured exercise and nutritional support. Optimizing these therapeutic components while identifying patient-specific predictors of frailty reversal remains essential to improving long-term functional outcomes and overall prognosis.

## Monitoring Frailty from Heart Failure Onset to Disease Progression

Frailty syndrome is a reversible, multidimensional syndrome recognised at all stages of HF from onset to disease progression. Physiological changes associated with heart failure - such as reduced cardiac output, chronic inflammation and neurohormonal activation - can accelerate the onset of frailty. In turn, frailty amplifies the effects of heart failure by reducing the patient's ability to cope with stressors, leading to a vicious cycle of worsening health. Frailty syndrome may worsen HF outcomes, while HF-related stress may contribute to the progression of frailty syndrome, which in itself suggests the need to assess frailty at any stage of heart failure [30, 31].

Various factors influence the trajectory of frailty in patients with HF. Monitoring frailty from the onset of heart failure to its progression provides valuable information that can guide personalised treatment strategies to mitigate the impact of frailty on patient outcomes and quality of life [28].

Implementing routine assessment of frailty, including physical capacity using objective measures, can also help identify patients at risk of frailty, providing the opportunity to develop patient-centered interventions. Recognition of the condition preceding frailty in patients with HF is crucial for timely implementation of rehabilitation measures. The 2022 consensus of many cardiological societies proposes a model for assessing frailty in patients with cardiovascular disease in which **if** the presence of a frailty syndrome is identified after screening, or the patient has an overt form of frailty, a more detailed assessment of the specific deficit or a comprehensive geriatric assessment is indicated. A key element of this model is the identification of domains of frailty, their components in order to provide a personalized response to the specific needs of patients [32].

Figure 1 illustrates the trajectory of heart failure and indicates that frailty should be assessed at multiple time points throughout the HF trajectory [33]. Assessment of frailty syndrome in the heart failure trajectory is crucial for timely interventions and optimal management of the disease. Several key time points for assessing frailty in patients with heart failure are described below.

## Initial Assessment

Assessing frailty at the time of diagnosis of heart failure provides insight into the patient's baseline functional status but also into their mental state, cognition and allows us to establish their social resources. Importantly, early assessment for frailty allows for the identification.

of patients at increased risk, and the consideration of frailty in disease management [28, 34].

## During Routine Follow-Up Visits

Regular frailty assessments during routine follow-up visits are important. This is essential as frailty can change over time due to disease progression, response to treatment or changes in health status. Periodic reassessment allows monitoring of changes and promotes individualisation of care for patients with HF [32].

## At Admission to the Hospital

For patients admitted with acute HF, screening for frailty should be included in the initial assessment. This may identify those at increased risk of complications, longer hospital stay and readmissions. Although assessment of frailty may be limited in people with cardiovascular instability, a tool such as the Clinical Frailty Scale can be used effectively for rapid and initial assessment of frailty on admission to hospital [35, 36].

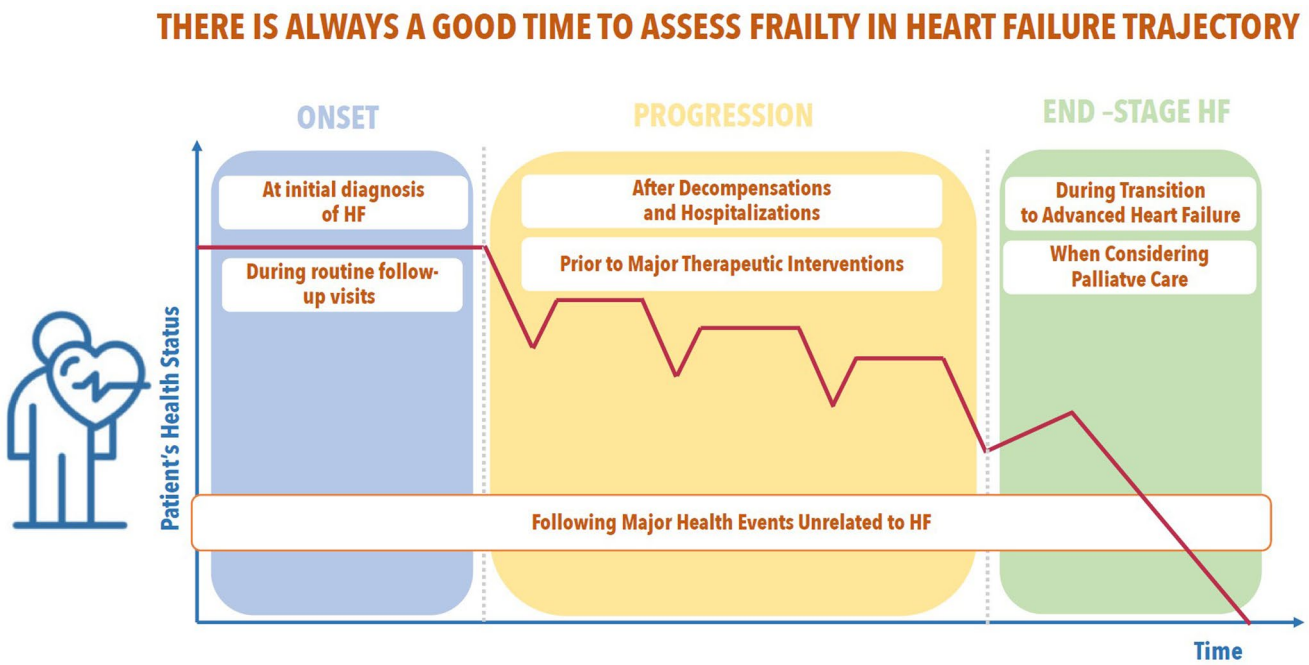


**Fig. 1** Assessment of frailty syndrome in the heart failure trajectory

### At Discharge and After Hospitalizations

Worsening heart failure symptoms often lead to a rapid decline in functional capacity and can induce or worsen frailty. An in-depth, comprehensive assessment of frailty at discharge, or as written above during routine follow-up visits, is key to understanding the impact on frailty and planning rehabilitation [37].

## Prior to Major Therapeutic Interventions

A comprehensive frailty assessment prior to significant interventions such as surgery, implantation of devices or **initiation of** advanced therapies is essential to carry out a risk-benefit analysis. A frailty assessment does not in itself determine eligibility for treatment, but provides information on patient vulnerability and potential risks [33]. Moreover, a similar approach applies to decisions regarding Cardiac Implantable Electronic Devices (CIEDs), such as implantable cardioverter-defibrillators (ICDs) or cardiac resynchronisation therapy (CRT) [38]. Integrating frailty assessment into the decision-making process can help clinicians weigh procedural risks, the potential for improved survival, and the patient's capacity for post-procedural recovery [39, 40]. In addition, many CIEDs now offer remote monitoring capabilities that, when combined with regular frailty assessments, enable earlier detection of clinical deterioration and more responsive interventions to mitigate HF-related complications. Such an integrated approach ensures that both the risks and benefits of device therapy are thoroughly evaluated in the context of the patient's overall vulnerability [38, 39, 41].

## Following Major Health Events Unrelated to Heart Failure

Adverse health events such as strokes, infections, or fractures can exacerbate frailty and affect the treatment of heart failure, hence, it becomes important to assess frailty after an event in order to understand the new baseline [33].

### Transition to Advanced HF

When patients approach advanced stages of heart failure and are eligible for treatments such.

as left ventricular assist devices or heart transplantation, the assessment of frailty becomes critical, influencing treatment decisions, including palliative care considerations. Weakness at this stage is associated with a significant increase in mortality and hospitalisation. Continuous monitoring through both clinical assessment and advanced techniques (e.g. wearable devices and telemonitoring) is essential to manage the complex interaction between frailty and heart failure. In addition, a focus on multi-domain assessments of frailty, including physical, cognitive and psychosocial aspects, becomes important at this stage [32, 42].

## End of Life Care

In the context of palliative care, vulnerability assessment is essential to understand the patient's overall health status and to guide end-of-life care decisions. This assessment can help tailor interventions that focus on quality of life rather than aggressive treatments. Part of the assessment at this stage should be a focus on quality of life measures and patient preferences in the context of frailty [42].

An expanded approach to palliative and end-of-life care in HF requires a comprehensive, multidisciplinary strategy that goes beyond symptom control. Early integration of palliative care in the management of advanced HF has been shown to improve patient outcomes by addressing complex physical, psychosocial, and spiritual needs [43, 44]. Key elements include regular assessment of distressing symptoms (e.g., pain, dyspnea), addressing the psychological impact of progressive disease, and supporting both patients and their caregivers [45].

A pivotal component of palliative care is advance care planning, which involves proactive discussions about treatment goals, patient preferences, and potential decisions regarding deactivation of CIEDs in end-of-life settings [46, 47]. Such conversations should be patient-centered, taking into account personal values and cultural beliefs, and should involve the patient's family or other support networks as appropriate. By clarifying expectations and wishes ahead of time, healthcare providers can tailor interventions that maintain dignity, relieve suffering, and uphold what the patient perceives as quality of life [45].

Moreover, the presence of frailty at this stage underscores the importance of individualized interventions that consider not only physical limitations but also nutritional, cognitive, and social vulnerabilities. By adopting a holistic and interdisciplinary approach—engaging cardiologists, palliative care specialists, nurses, social workers, and mental health professionals—it becomes possible to ensure that end-of-life care decisions are both medically appropriate and aligned with patient-centered goals [48].

The link between the trajectory of heart failure and frailty underscores the importance of continuous monitoring throughout the disease course. Frailty is a critical but often overlooked aspect of heart failure that significantly affects patient outcomes. Monitoring frailty from the onset of heart failure to its progression provides invaluable insight into the patient's overall health status and helps guide personalised treatment strategies. By combining clinical assessments, functional testing, biomarkers and advanced monitoring technologies, healthcare professionals can better manage frailty in heart failure patients, ultimately improving survival rates and quality of life. Continuous monitoring and management of frailty should be integrated into guideline-based clinical management of heart failure patients, ensuring that interventions are timely, appropriate and holistic.

## Inpatient vs. Outpatient Frailty Evaluation in Heart Failure

HF has two very distinct clinical presentations: outpatients with chronic HF and inpatients with acute HF [49]. A key challenge is determining whether frailty should be assessed in inpatient or outpatient settings, as each approach has its own advantages and disadvantages that must be tailored to the patient's needs [7, 50].

Frailty evaluation in a hospital setting often occurs during hospitalization due to an exacerbation of heart failure [7, 51]. In this situation, patients are under continuous observation, allowing for close monitoring of their health status [33]. Inpatient settings also offer access to advanced diagnostic tools, enabling a comprehensive assessment of the patient [52]. However, frailty evaluation in the hospital may not accurately reflect the patient's condition in a home environment, where stress levels and activity patterns differ. Furthermore, hospitalization itself can influence the evaluation results, for example, by causing deconditioning due to immobility [53]. When assessing frailty in patients with acute heart failure, an in-depth evaluation of the frailty syndrome should be performed once severe symptoms and decompensation have resolved.

On the other hand, frailty assessment in an outpatient setting can provide a more realistic picture of the patient's daily functioning [54]. Patients are evaluated in their natural environment, which helps to better understand how they cope with daily challenges [2, 55]. Outpatient frailty evaluation can also include a longer observation period, which is beneficial for monitoring disease progression and treatment efficacy [56]. However, in outpatient settings, there is no immediate access to advanced diagnostic tools, and patients may not report all symptoms, making a complete assessment more challenging [52].

Effective frailty assessment in HF requires seamless cooperation between healthcare providers across different care settings, including hospitals, outpatient clinics, and community health services. Transmural collaboration ensures that frailty evaluation and management are not confined to a single care setting but are instead integrated into a patient-centered care continuum. This approach facilitates the sharing of critical health information, enabling more accurate assessments and coordinated care strategies tailored to the patient's evolving needs [57].

For instance, during transitions from inpatient to outpatient care, multidisciplinary teams - including cardiologists, geriatricians, physiotherapists, and social workers - can collaboratively address frailty-related challenges. This may

involve preparing patients for discharge, ensuring they have access to outpatient follow-up, and implementing interventions that address both medical and social determinants of health. Regular communication between care providers helps monitor disease progression and adjust treatment plans, improving patient outcomes and quality of life.

The decision of whether to assess frailty in an inpatient or outpatient setting should depend on the patient's condition and the goals of the evaluation. If the aim is a rapid and accurate diagnosis in the context of disease exacerbation, inpatient evaluation may be more appropriate [7, 51]. However, for assessing long-term stability and patient functioning, outpatient evaluation may provide more valuable insights [54]. In practice, a combination of both methods may be the most effective, allowing for a comprehensive picture of the patient's condition [50].

## Which Tools are Leading the Way in Frailty Assessment?

The observed global trend of an aging population has led to increased interest in the phenomenon of frailty. The observed correlation between HF and FS highlights the necessity for screening for frailty in patients with HF, and vice versa. The early identification of individuals with pre-frail or frail status could potentially allow for the implementation of targeted therapeutic interventions, which may help to reduce the risk of frailty progression and improve patient outcomes [58]. It is crucial to have access to appropriate frailty assessment tools that can facilitate optimization of the therapeutic process. Despite extensive research, there is still no consensus on the most appropriate tool for identifying frailty in the literature. Currently, a variety of assessment methods are in use, which take into account various physical, psychological and social aspects [59].

One of the most effective ways to prevent the consequences of frailty has become early detection through the use of various tools. A number of tools are now available to help assess frailty syndrome. However, not all of them are useful in clinical practice because their use requires a lot of time and the use of other diagnostic tools. It is therefore necessary that the choice of the appropriate tool is made in accordance with the individual patient's specific clinical conditions, and with due consideration of their medical history. It is important to emphasize that a good tool aimed at the diagnosis of frailty syndrome should also be characterized by its time of using and ease of application in clinical practice. The available literature points out that an ideal frailty screening tool should be able to accurately identify frailty, predict the response of frail patients to potential therapies, be simple and easy to apply, and have a low cost. Additionally, it is recommended that preliminary screening be conducted as soon as possible following the patient's admission to the hospital. This should be performed by a physician or nurse, as it allows the formulation of an individualized plan of care, which can be implemented during the hospital stay, as well as in outpatient settings [60].

It should also be pointed out that different diagnostic tools may focus on different components of frailty. For example, the Fried criteria focus on the physical phenotype of frailty, while Rockwood et al. point to a multidimensional model [51, 61].

The available literature indicates that one of the fastest tools that can be used in clinical practice, acute care and community is the FRAIL scale. The FRAIL scale is a short five-question assessment which can be administered by health professionals and caregivers [62]. Moreover, it has been shown that The FRAIL scale is a valid predictor of mortality [63].

One of the first tools developed to determine the phenotype of frailty was Fried's Frailty Phenotype, which included five composite measures: unintentional weight loss, exhaustion, low physical activity, weakness, and walking speed [4]. The instrument is useful for assessing the presence of frailty; however, the need to measure grip strength using a dynamometer can be a hindrance in clinical practice.

The Edmonton Frail Scale (EFS) was developed to be practical and applicable in a community or bedside setting. It can be administered in a very short time and has the following domains: Cognition, General health status, Functional independence, Social support, Medication use, Nutrition, Mood, Continence, and Functional performance [64].

Another tool is the Tilburg Frailty Indicator (TFI) which is the most widely used tool in cardiovascular diseases. The TFI is composed of two parts, part A evaluates "determinants of frailty and diseases", and part B about the "presence of frailty" that generates a final score. Part B includes three domains (physical, psychological, and social) and a total of 15 items. A total score $\geq 5$ is set as the threshold for frailty [65].

The Clinical Frailty Scale (CFS) is a measure of frailty based on clinical judgment. It has been designed to grade the severity of frailty following a comprehensive geriatric assessment. Each point on its scale has a visual chart and a written description of frailty to assist the classification process [51].

A screening programme in heart failure patients should be regarded as a comprehensive process, rather than a single test. The process typically begins with the identification of an eligible population and progresses through the implementation of interventions, the provision of treatment and the monitoring of results. Table 1 presents a comprehensive selection of validated frailty assessment tools applicable in

**Table 1** Validated frailty assessment tools in heart failure management

| Test name | Frailty type | Main components/scopes of assessment | Aplication | Cut-off Score & Interpretation | Estimated Time to Complete | Strengths & Limitations |
|---|---|---|---|---|---|---|
| Fried's Frailty Phenotype [4] | Physical phenotype of frailty | Five components: weight loss, exhaustion, low physical activity, slowness, weakness | Assessing frailty in a physical context | Frail: ≥3 criteria; Pre-frail: 1–2 criteria | ~10–15 min | **Strengths**: Well-established, validated; **Limitations**: Requires physical performance testing |
| FRAIL Scale [62] | General, rapid assessment | 5 self-reported items (Fatigue, Resistance, Ambulation, Illnesses, Loss of weight) | Quick screening in clinical/community settings | Frail: ≥3; Pre-frail: 1–2 | ~2–5 min | **Strengths**: Simple, quick; **Limitations**: Subjective, may not capture all frailty domains |
| Edmonton Frail Scale (EFS) [64] | Multidimensional | Cognitive status, General health, Functional independence, Social support, Medication use, Nutrition, Mood, Continence, Functioning | Practical, bedside tool | Frail: ≥8/17 | ~5–10 min | **Strengths**: Covers multiple domains; **Limitations**: Less specific to HF |
| Tilburg Frailty Indicator (TFI) [65] | Multidimensional | Physical, mental, social frailty components | Particularly used in CVD & HF | Frail: ≥5/15 | ~10 min | **Strengths**: Comprehensive; **Limitations**: Self-reported, requires questionnaire completion |
| Clinical Frailty Scale (CFS) [51] | Clinical judgment-based | Visual scale (1–9) based on clinician assessment | Used in geriatrics & HF | Frail: ≥5 | ~1–2 min | **Strengths**: Simple, widely used; **Limitations**: Subjective, requires clinical expertise |
| Rockwood Frailty Index [66] | Multidimensional | Up to 70 variables, covering physical, mental, and social aspects | Used mainly in research | Frail: Index > 0.25 | ~Varies (detailed) | **Strengths**: Highly comprehensive; **Limitations**: Time-consuming |

patients with heart failure, facilitating early identification and tailored management strategies.

The available literature also indicates the importance of Comprehensive Geriatric Assessment (CGA) which is particularly valuable in managing patients with HF, who often exhibit a complex interplay of chronic diseases, age-related physiological changes, and social factors. The main elements of the CGA encompass several critical evaluations, for example comorbidity, polypharmacy, activities of daily living, cognitive function and mood disorders, CGA also include an evaluation of nutritional health, alongside an assessment of sarcopenia and mobility. The assessment also considers living conditions, social support systems and frailty syndrome [67] CGA identifies factors that may increase the risk of hospitalization and mortality, enabling healthcare providers to take proactive measures. In the study of Yuguchi et al. it has been shown that CGA carried out by using The Clinical Frailty Scale (CFS) might aid in effectively identifying older patients with heart failure (HF) and frailty who would then reap maximum benefits from the CGA [68]. CGA plays a crucial role in the nuanced management of heart failure among older adults, enhancing care by addressing the comprehensive needs of this vulnerable population. By implementing CGA, healthcare providers can significantly improve health outcomes and quality of life for heart failure patients.

## The Importance of a Multidimensional Approach in Measuring and Managing Frailty in Heart Failure

Frailty syndrome is increasingly recognized as a crucial determinant of morbidity and mortality in HF patients, necessitating the adoption of innovative, multidimensional approaches for its prevention and diagnosis. Traditional methods, which often rely on physical tests and self-reporting tools, may not adequately capture the multifaceted nature of frailty, which includes physical, cognitive, and social components. These components interact dynamically, underscoring the need for more sophisticated assessment tools that integrate these dimensions to enable more personalized and effective patient care strategies [69, 70]. Additionally, most studies on frailty in advanced heart failure focus primarily on physical aspects, such as handgrip strength, gait speed, or physical exhaustion, while cognitive and social components remain underexplored [18].

### The Role of Multidimensional Screening in Frailty Assessment

A multidimensional approach to screening involves assessing frailty across physical, cognitive, and social domains, recognizing that these dimensions collectively influence patient outcomes. Physical assessments often include tools

like the Fried Frailty Phenotype or the Short Physical Performance Battery (SPPB), which evaluate strength, endurance, and mobility. However, these measures are insufficient when used in isolation, as frailty also encompasses cognitive and social factors.

Cognitive decline, for instance, is a key marker of frailty that is often overlooked in traditional screening methods. Including tools like the Montreal Cognitive Assessment (MoCA) or Mini-Mental State Examination (MMSE) can help identify early signs of cognitive impairment. Cognitive frailty, a concept that combines physical frailty with cognitive decline, has been linked to worse outcomes in HF patients, including higher rates of rehospitalization and mortality [71, 72].This underscores the importance of integrating cognitive assessments into routine frailty screening, particularly for patients undergoing interventions like cardiac surgery.

Social factors, such as isolation, lack of caregiver support, and low socioeconomic status, further complicate the management of frailty. Screening for social vulnerability can be conducted using tools like the Lubben Social Network Scale or the Gijón Social-Familial Assessment Scale. These assessments provide critical insights into a patient's living conditions, access to care, and potential barriers to adherence to treatment regimens. Addressing social vulnerabilities is essential for crafting comprehensive care plans beyond medical interventions to include social support mechanisms [72, 73].

### Frailty in Cardiac Surgery

Cardiac surgery provides a compelling example of the importance of a multidimensional approach to frailty assessment. In this context, frailty is a significant predictor of perioperative risk, yet it is often not integrated into standard risk models such as EuroSCORE II or the STS risk score. Identifying frailty during the perioperative period is essential not only for tailoring treatment strategies but also for optimizing the use of clinical resources. Rather than serving as a contraindication to surgery, recognizing frailty should be viewed as an opportunity to better prepare patients, thereby improving surgical outcomes [70].

Integrating cognitive and social assessments into the perioperative evaluation process can enhance decision-making. For example, preoperative interventions addressing cognitive decline, such as targeted cognitive training or caregiver education, may help mitigate risks. Similarly, evaluating social vulnerabilities can ensure that patients receive adequate support during recovery, leading to better adherence to postoperative care protocols [70, 72].

### Cognitive Decline and Frailty in Heart Failure

Cognitive decline is increasingly recognized as both a contributor to and a consequence of frailty in HF patients. Chronic heart failure is associated with cerebral hypoperfusion and neuroinflammation, which may accelerate cognitive impairment. This, in turn, can hinder a patient's ability to adhere to complex medication regimens, recognize symptoms of worsening HF, or effectively communicate with healthcare providers [71, 72].

Interventions aimed at preserving cognitive function should be prioritized in the management of frailty. Cognitive training programs, physical exercise, and nutritional support have shown promise in mitigating cognitive decline and improving overall frailty scores. These interventions can be tailored to individual patient needs, particularly for those identified as high-risk during preoperative assessments for cardiac surgery [72].

### The Socioeconomic and Social Context of Frailty in HF Patients

Frailty does not occur in isolation but is deeply influenced by the socioeconomic and social context of HF patients. Low-income individuals, for example, often face challenges such as limited access to healthcare, poor nutrition, and inadequate housing, all of which contribute to the progression of frailty. Moreover, social isolation—a common issue among older adults with HF—can exacerbate physical and cognitive decline, creating a vicious cycle that is difficult to break [72, 73].

Addressing these issues requires a multidimensional strategy that includes both clinical and community-based interventions. Social prescribing, which involves linking patients to community resources such as exercise programs, nutritional counseling, or peer support groups, has emerged as an effective approach to mitigating the social determinants of frailty. Additionally, policies aimed at reducing healthcare disparities and improving access to affordable treatments are crucial for managing frailty in vulnerable populations [73].

### The Role of Artificial Intelligence in Multidimensional Frailty Assessment

The advent of artificial intelligence (AI) and machine learning (ML) further enhances the assessment and management of frailty in HF patients. These technologies can analyze large datasets to identify patterns and predict frailty, offering personalized insights that can improve both diagnosis and treatment. Research highlights the potential of AI-driven tools in identifying frailty and optimizing treatment

strategies by integrating physical, cognitive, and social dimensions into patient management. When combined with multidimensional assessment tools, AI-driven models can revolutionize how frailty is managed in clinical settings, particularly in high-risk scenarios like cardiac surgery. This integrated approach improves the accuracy of risk assessments and ensures that treatment strategies are appropriately tailored, ultimately enhancing patient outcomes and quality of life [18, 69].

By adopting a multidimensional approach to frailty assessment, supported by advanced AI techniques, healthcare providers can better manage frailty in HF patients, particularly those undergoing cardiac surgery. This strategy is crucial for improving prognosis, optimizing treatment, and enhancing these vulnerable patients' overall quality of life.

## Challenges and Future Perspectives in Measuring Frailty in Patients With Heart Failure

Frailty is a crucial prognostic factor in patients with heart failure (HF), influencing outcomes such as mortality, hospitalization, and quality of life [7]. However, the accurate measurement of frailty in this population remains a significant challenge. This challenge stems from the heterogeneity of available assessment tools, the complexity of integrating frailty assessments into clinical practice, and the limited applicability of existing measures across diverse healthcare settings. Although the recognition of frailty's impact on HF is growing, substantial barriers hinder the effective implementation of frailty measurement tools in routine clinical care.

### Heterogeneity of Assessment Tools

One of the primary challenges is the lack of a universally accepted frailty assessment tool. Traditional methods, such as the Frailty Phenotype by Fried, focus on physical indicators like grip strength, walking speed, and weight loss. While these measures are well-validated and correlate with adverse outcomes in HF patients, they are not routinely assessed in clinical settings, making them impractical for widespread use [74]. On the other hand, deficit accumulation models, such as the Frailty Index, offer an alternative by utilizing data already present in medical records. These models are potentially more feasible for large-scale use; however, they also have limitations, including the reliance on the quality and completeness of medical record data [4].

### Data Quality and Feasibility

Another significant challenge is the variability in the quality of data used for frailty assessment. Traditional frailty measurements often require specialized equipment, such as dynamometers for grip strength, which may not be readily available in all clinical settings [75]. Furthermore, these assessments typically require manual data collection, increasing the likelihood of human error and making it resource-intensive, especially in busy healthcare environments [75].

### Emerging Role of Artificial Intelligence and Machine Learning

Given these challenges, there is growing interest in leveraging routinely collected healthcare data and integrating new technologies, such as artificial intelligence (AI), to enhance frailty measurement. Recent studies have demonstrated the potential of AI, particularly machine learning (ML), in predicting frailty syndrome in patients with HF. These AI models can integrate data from various sources, such as electronic health records, and have shown promise in identifying frailty risk factors that are clinically relevant [69]. However, the effectiveness of these models is still limited by data quality, and further research is required to validate these approaches and ensure their applicability in clinical practice [7]. In addition, real-world implementation of AI-driven solutions involves overcoming challenges related to healthcare infrastructure compatibility, data interoperability, and user acceptance among clinicians [69]. Moreover, ML algorithms could potentially incorporate *real-time monitoring* (e.g., wearable sensors or telemonitoring) to detect subtle changes associated with the progression of frailty, thereby facilitating earlier therapeutic interventions [69]. Nonetheless, prospective studies are needed to confirm these models' predictive accuracy and to assess their cost-effectiveness and ease of adoption in diverse HF populations.

### Implementation Challenges and Future Directions

Looking to the future, a key area of research will be the development of tools that are both accurate and practical for use in diverse clinical settings. AI-based models that can integrate data from various sources, including real-time patient monitoring, hold promise for improving frailty assessment [69]. However, further research is required to validate these approaches and ensure their applicability in everyday clinical practice. Standardization of frailty assessment tools and guidelines will be critical to ensuring consistency across healthcare settings and improving patient outcomes [7]. Moreover, integrating frailty assessments into routine HF care will require substantial educational efforts to equip healthcare providers with the knowledge

and resources necessary to accurately assess and manage frailty in their patients [76].

In summary, future progress will depend on the prospective validation of AI/ML-based frailty assessments across various HF populations, alongside efforts to improve data quality and ensure consistent data collection protocols. Equally important is the development of user-friendly interfaces that integrate seamlessly into clinical workflows, as well as the enhancement of educational programs so that healthcare professionals can confidently interpret AI-generated frailty metrics and translate them into timely, patient-centered interventions. By addressing these aspects, future innovations in AI and ML can substantially enhance the accuracy and feasibility of frailty assessment, ultimately improving patient outcomes in HF.

## Conclusions

Frailty is a critical factor in heart failure, influencing patient outcomes across the disease spectrum from diagnosis to advanced stages. The accurate measurement of frailty is essential for guiding treatment decisions and improving prognosis. While multiple tools are available for assessing frailty, there is no consensus on the optimal method for heart failure patients.

A multidimensional approach that includes physical, cognitive, and social domains is crucial for a comprehensive evaluation. Throughout the course of heart failure, early identification of frailty and continuous monitoring can significantly enhance patient care. Future research should focus on refining and standardizing frailty assessment tools to ensure they are effectively integrated into clinical practice.

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## References

1. Dent E, Hanlon P, Sim M, Jylhävä J, Liu Z, Vetrano DL, et al. Recent developments in frailty identification, management, risk factors and prevention: A narrative review of leading journals in geriatrics and gerontology. Ageing Res Rev. 2023;91:102082.
2. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet Lond Engl. 2013;381(9868):752–62.
3. Afilalo J, Alexander KP, Mack MJ, Maurer MS, Green P, Allen LA, et al. Frailty assessment in the cardiovascular care of older adults. J Am Coll Cardiol. 2014;63(8):747–62.
4. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol Ser A. 2001;56(3):M146–57.
5. Vitale C, Uchmanowicz I. Frailty in patients with heart failure. Eur Heart J Suppl J Eur Soc Cardiol. 2019;21(Suppl L):L12–6.
6. Vitale C, Jankowska E, Hill L, Piepoli M, Doehner W, Anker SD, et al. Heart failure Association/European society of cardiology position paper on frailty in patients with heart failure. Eur J Heart Fail. 2019;21(11):1299–305.
7. Talha KM, Pandey A, Fudim M, Butler J, Anker SD, Khan MS. Frailty and heart failure: State-of-the-art review. J Cachexia Sarcopenia Muscle. 2023;14(5):1959–72.
8. Sanders NA, Supiano MA, Lewis EF, Liu J, Claggett B, Pfeffer MA, et al. The frailty syndrome and outcomes in the TOPCAT trial. Eur J Heart Fail. 2018;20(11):1570–7.
9. Dewan P, Jackson A, Jhund PS, Shen L, Ferreira JP, Petrie MC, et al. The prevalence and importance of frailty in heart failure with reduced ejection fraction - an analysis of PARADIGM-HF and ATMOSPHERE. Eur J Heart Fail. 2020;22(11):2123–33.
10. Yang X, Lupón J, Vidán MT, Ferguson C, Gastelurrutia P, Newton PJ, et al. Impact of frailty on mortality and hospitalization in chronic heart failure: A systematic review and Meta-Analysis. J Am Heart Assoc. 2018;7(23):e008251.
11. Streng KW, Hillege HL, Ter Maaten JM, van Veldhuisen DJ, Dickstein K, Ng LL, et al. Clinical implications of low estimated protein intake in patients with heart failure. J Cachexia Sarcopenia Muscle. 2022;13(3):1762–70.
12. Butt JH, Dewan P, Merkely B, Belohlávek J, Drożdż J, Kitakaze M, et al. Efficacy and safety of Dapagliflozin according to frailty in heart failure with reduced ejection fraction: A post hoc analysis of the DAPA-HF trial. Ann Intern Med. 2022;175(6):820–30.
13. Butt JH, Jhund PS, Belohlávek J, de Boer RA, Chiang CE, Desai AS, et al. Efficacy and safety of Dapagliflozin according to frailty in patients with heart failure: A prespecified analysis of the DELIVER trial. Circulation. 2022;146(16):1210–24.
14. Panel B. The 2019 AGSBCUE. American geriatrics society 2019 updated AGS beers Criteria® for potentially

inappropriate medication use in older adults. J Am Geriatr Soc. 2019;67(4):674–94.
15. O'Mahony D, O'Sullivan D, Byrne S, O'Connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. Age Ageing. 2015;44(2):213–8.
16. Tersalvi G, Beltrani V, Peronti M, Furlan L, Foy A, Biasco L. Deprescribing strategies in older patients with heart failure. Intern Emerg Med. 2024;1–11.
17. Greene SJ, Choi S, Lippmann SJ, Mentz RJ, Greiner MA, Hardy NC, et al. Clinical effectiveness of Sacubitril/Valsartan among patients hospitalized for heart failure with reduced ejection fraction. J Am Heart Assoc. 2021;10(16):e021459.
18. Denfeld QE, Jha SR, Fung E, Jaarsma T, Maurer MS, Reeves GR, et al. Assessing and managing frailty in advanced heart failure: an international society for heart and lung transplantation consensus statement. J Heart Lung Transpl. 2024;43(1):1–27.
19. MacEachern E, Quach J, Giacomantonio N, Theou O, Hillier T, Abel-Adegbite I, et al. Cardiac rehabilitation and frailty: a systematic review and meta-analysis. Eur J Prev Cardiol. 2024;31(16):1960–76.
20. Hillier T, MacEachern E, Kehler DS, Giacomantonio N. Contribution of individual and cumulative frailty-related health deficits on cardiac rehabilitation completion. BMC Geriatr. 2023;23(1):34.
21. Quach J, Kehler DS, Giacomantonio N, McArthur C, Blanchard C, Firth W, et al. Association of admission frailty and frailty changes during cardiac rehabilitation with 5-year outcomes. Eur J Prev Cardiol. 2023;30(9):807–19.
22. Pandey A, Kitzman DW, Nelson MB, Pastva AM, Duncan P, Whellan DJ, et al. Frailty and effects of a multidomain physical rehabilitation intervention among older patients hospitalized for acute heart failure: A secondary analysis of a randomized clinical trial. JAMA Cardiol. 2023;8(2):167–76.
23. Aili SR, Lo P, Villanueva JE, Joshi Y, Emmanuel S, Macdonald PS. Prevention and reversal of frailty in heart Failure - A systematic review. Circ J Off J Jpn Circ Soc. 2021;86(1):14–22.
24. Kitzman DW, Whellan DJ, Duncan P, Pastva AM, Mentz RJ, Reeves GR, et al. Physical rehabilitation for older patients hospitalized for heart failure. N Engl J Med. 2021;385(3):203–16.
25. Jha SR, Hannu MK, Newton PJ, Wilhelm K, Hayward CS, Jabbour A, et al. Reversibility of frailty after Bridge-to-Transplant ventricular assist device implantation or heart transplantation. Transpl Direct. 2017;3(7):e167.
26. Maurer MS, Horn E, Reyentovich A, Dickson VV, Pinney S, Goldwater D, et al. Can a left ventricular assist device in individuals with advanced systolic heart failure improve or reverse frailty?? J Am Geriatr Soc. 2017;65(11):2383–90.
27. Chung CJ, Wu C, Jones M, Kato TS, Dam TT, Givens RC, et al. Reduced handgrip strength as a marker of frailty predicts clinical outcomes in patients with heart failure undergoing ventricular assist device placement. J Card Fail. 2014;20(5):310–5.
28. Pandey A, Kitzman D, Reeves G. Frailty is intertwined with heart failure: mechanisms, prevalence, prognosis, assessment, and management. JACC Heart Fail. 2019;7(12):1001–11.
29. Gámez-López AL, Bonilla-Palomas JL, Anguita-Sánchez M, Moreno-Conde M, López-Ibáñez C, Alhambra-Expósito R, et al. Rationale and design of PICNIC study: nutritional intervention program in hospitalized patients with heart failure who are malnourished. Rev Esp Cardiol Engl Ed. 2014;67(4):277–82.
30. Joyce E. Frailty in advanced heart failure. Heart Fail Clin. 2016;12(3):363–74.
31. Chen MA. Frailty and cardiovascular disease: potential role of gait speed in surgical risk stratification in older adults. J Geriatr Cardiol JGC. 2015;12(1):44–56.
32. Richter D, Guasti L, Walker D, Lambrinou E, Lionis C, Abreu A, et al. Frailty in cardiology: definition, assessment and clinical implications for general cardiology. A consensus document of the Council for cardiology practice (CCP), association for acute cardio vascular care (ACVC), association of cardiovascular nursing and allied professions (ACNAP), European association of preventive cardiology (EAPC), European heart rhythm association (EHRA), Council on valvular heart diseases (VHD), Council on hypertension (CHT), Council of cardio-Oncology (CCO), working group (WG) aorta and peripheral vascular diseases, WG e-Cardiology, WG thrombosis, of the European society of cardiology, European primary care cardiology society (EPCCS). Eur J Prev Cardiol. 2022;29(1):216–27.
33. Wleklik M, Denfeld Q, Czapla M, Jankowska EA, Piepoli MF, Uchmanowicz I. A patient with heart failure, who is frail: how does this affect therapeutic decisions? Cardiol J. 2023;30(5):825–31.
34. Finn M, Green P. The influence of frailty on outcomes in cardiovascular disease. Rev Esp Cardiol Engl Ed. 2015;68(8):653–6.
35. Laddu DR, Ozemek C, Sabbahi A, Severin R, Phillips SA, Arena R. Prioritizing movement to address the frailty phenotype in heart failure. Prog Cardiovasc Dis. 2021;67:26–32.
36. Sze S, Pellicori P, Zhang J, Weston J, Clark AL. Identification of frailty in chronic heart failure. JACC Heart Fail. 2019;7(4):291–302.
37. Chokshi NBK, Karmakar B, Pathan SK, Joshi V, Gohel DM, Coulshed DS, et al. A systematic review of frailty scores used in heart failure patients. Heart Lung Circ. 2023;32(4):441–53.
38. Fumagalli S, Potpara TS, Bjerregaard Larsen T, Haugaa KH, Dobreanu D, Proclemer A, et al. Frailty syndrome: an emerging clinical problem in the everyday management of clinical arrhythmias. The results of the European heart rhythm association survey. EP Eur. 2017;19(11):1896–902.
39. Albakri A, Orkaby A, Rosenberg MA. Feasibility of frailty assessment integrated with cardiac implantable electronic device clinic Follow-up: A pilot investigation. Gerontol Geriatr Med. 2021;7:2333721420987342.
40. Mlynarski R, Mlynarska A, Joniec M, Gladysz-Wanha S, Honkowicz M, Stachanczyk J, et al. Predictors of early cardiac implantable electronic device lead dislodgement in the elderly. Int J Environ Res Public Health. 2022;19(22):14766.
41. Ahmed FZ, Sammut-Powell C, Kwok CS, Tay T, Motwani M, Martin GP, et al. Remote monitoring data from cardiac implantable electronic devices predicts all-cause mortality. EP Eur. 2022;24(2):245–55.
42. Lehto HR, Jain N, Bernacki RE, Landzberg MJ, Desai AS, Orkaby AR. Feasibility of frailty screening among patients with advanced heart failure. BMJ Open Qual. 2023;12(4):e002430.
43. Barrett TA, MacEwan SR, Melnyk HL, Volney J, Singer J, Di Tosto G, et al. The role of palliative care in heart failure, part 1: referring provider perspectives about opportunities in advanced cardiac therapies. J Palliat Med. 2023;26(12):1671–7.
44. McConnell T, Burden J, Duddy C, Hill L, Howie C, Jones B, et al. Integrating palliative care and heart failure: a protocol for a realist synthesis (PalliatHeartSynthesis). BMJ Open. 2022;12(1):e058848.
45. Lee JH, Hwang KK. End-of-Life care for End-stage heart failure patients. Korean Circ J. 2022;52(9):659–79.
46. Hill L, Prager Geller T, Baruah R, Beattie JM, Boyne J, de Stoutz N, et al. Integration of a palliative approach into heart failure care: a European society of cardiology heart failure association position paper. Eur J Heart Fail. 2020;22(12):2327–39.
47. Oliveira T, Ferreira Monteiro N, Cipriano P. Deactivation of cardiac implantable electronic devices in palliative patients: when and how. Med Clínica. 2024;163(10):512–6.
48. Riley JP, Beattie JM. Palliative care in heart failure: facts and numbers. ESC Heart Fail. 2017;4(2):81–7.
49. Boureau AS, Annweiler C, Belmin J, Bouleti C, Chacornac M, Chuzeville M, et al. Practical management of frailty in older

patients with heart failure: statement from a panel of multidisciplinary experts on behalf the heart failure working group of the French society of cardiology and on behalf French society of geriatrics and gerontology. ESC Heart Fail. 2022;9(6):4053–63.
50. Buck HG, Riegel B. The impact of frailty on health related quality of life in heart failure. Eur J Cardiovasc Nurs. 2011;10(3):159–66.
51. Rockwood K, Song X, MacKnight C, Bergman H, Hogan DB, McDowell I, et al. A global clinical measure of fitness and frailty in elderly people. CMAJ Can Med Assoc J J Assoc Medicale Can. 2005;173(5):489–95.
52. Matsue Y, Kamiya K, Saito H, Saito K, Ogasahara Y, Maekawa E, et al. Prevalence and prognostic impact of the coexistence of multiple frailty domains in elderly patients with heart failure: the FRAGILE-HF cohort study. Eur J Heart Fail. 2020;22(11):2112–9.
53. Chen Y, Almirall-Sánchez A, Mockler D, Adrion E, Domínguez-Vivero C, Romero-Ortuño R. Hospital-associated deconditioning: not only physical, but also cognitive. Int J Geriatr Psychiatry. 2022;37(3).
54. Vidán MT, Blaya-Novakova V, Sánchez E, Ortiz J, Serra-Rexach JA, Bueno H. Prevalence and prognostic impact of frailty and its components in non-dependent elderly patients with heart failure. Eur J Heart Fail. 2016;18(7):869–75.
55. Uchmanowicz I, Nessler J, Gobbens R, Gackowski A, Kurpas D, Straburzynska-Migaj E, et al. Coexisting Frailty Heart Fail Front Physiol. 2019;10:791.
56. Pandey A, Kitzman D, Whellan DJ, Duncan PW, Mentz RJ, Pastva AM, et al. Frailty among older decompensated heart failure patients: prevalence, association with Patient-Centered outcomes, and efficient detection methods. JACC Heart Fail. 2019;7(12):1079–88.
57. Fritsche G, Schoonenboom N, Van der Kroon H, Douma CE, Van der Dussen J, Verlaan MNE, et al. The effect of regional transmural agreements on the information transfer of frail older patients. BMC Geriatr. 2023;23(1):787.
58. Uchmanowicz I, Młynarska A, Lisiak M, Kałużna-Oleksy M, Wleklik M, Chudiak A, et al. Heart failure and problems with frailty syndrome: why it is time to care about frailty syndrome in heart failure. Card Fail Rev. 2019;5(1):37–43.
59. Deng Y, Sato N. Global frailty screening tools: review and application of frailty screening tools from 2001 to 2023. Intractable Rare Dis Res. 2024;13(1):1–11.
60. McDonagh J, Martin L, Ferguson C, Jha SR, Macdonald PS, Davidson PM, et al. Frailty assessment instruments in heart failure: A systematic review. Eur J Cardiovasc Nurs. 2018;17(1):23–35.
61. Rodríguez-Mañas L, Féart C, Mann G, Viña J, Chatterji S, Chodzko-Zajko W, et al. Searching for an operational definition of frailty: a Delphi method based consensus statement: the frailty operative definition-consensus conference project. J Gerontol Biol Sci Med Sci. 2013;68(1):62–7.
62. Morley JE, Malmstrom TK, Miller DK. A simple frailty questionnaire (FRAIL) predicts outcomes in middle aged African Americans. J Nutr Health Aging. 2012;16(7):601–8.
63. Thompson MQ, Theou O, Tucker GR, Adams RJ, Visvanathan R. FRAIL scale: predictive validity and diagnostic test accuracy. Australas J Ageing. 2020;39(4):e529–36.
64. Rolfson DB, Majumdar SR, Tsuyuki RT, Tahir A, Rockwood K. Validity and reliability of the Edmonton frail scale. Age Ageing. 2006;35(5):526–9.
65. Gobbens RJJ, van Assen MALM, Luijkx KG, Wijnen-Sponselee MT, Schols JMGA. The Tilburg frailty indicator: psychometric properties. J Am Med Dir Assoc. 2010;11(5):344–55.
66. Moorhouse P, Rockwood K. Frailty and its quantitative clinical evaluation. J R Coll Physicians Edinb. 2012;42(4):333–40.
67. Brunetti E, Lucà F, Presta R, Marchionni N, Boccanelli A, Ungar A, et al. A comprehensive geriatric workup and frailty assessment in older patients with severe aortic stenosis. J Clin Med. 2024;13(14):4169.
68. Yuguchi T, Nakajima K, Takaoka H, Shimokawa T. Usefulness of clinical frailty scale for comprehensive geriatric assessment of older heart failure patients. Circ Rep 6(4):127–33.
69. Szczepanowski R, Uchmanowicz I, Pasieczna-Dixit AH, Sobecki J, Katarzyniak R, Kołaczek G, et al. Application of machine learning in predicting frailty syndrome in patients with heart failure. Adv Clin Exp Med Off Organ Wroclaw Med Univ. 2024;33(3):309–15.
70. Wleklik M, Czapla M, Denfeld Q, Przybylski R, Reczuch K, Uchmanowicz I. The how and why of assessing frailty syndrome in cardiac surgery. Adv Clin Exp Med. 2022;31(10):1061–4.
71. Szczepanowski R, Uchmanowicz I, Pasieczna-Dixit AH, Sobecki J, Katarzyniak R, Kołaczek G, et al. Application of machine learning in predicting frailty syndrome in patients with heart failure. Adv Clin Exp Med. 2024;33(3):309–15.
72. Pasieczna AH, Szczepanowski R, Sobecki J, Katarzyniak R, Uchmanowicz I, Gobbens RJJ, et al. Importance analysis of psychosociological variables in frailty syndrome in heart failure patients using machine learning approach. Sci Rep. 2023;13(1):7782.
73. Karunananthan S, Rahgozar A, Hakimjavadi R, Yan H, Dalsania KA, Bergman H, et al. Use of artificial intelligence in the identification and management of frailty: A scoping review protocol. BMJ Open. 2023;13(12):e076918.
74. McNallan SM, Chamberlain AM, Gerber Y, Singh M, Kane RL, Weston SA, et al. Measuring frailty in heart failure: a community perspective. Am Heart J. 2013;166(4):768–74.
75. Soong JTY. Frailty measurement in routinely collected data: challenges and benefits. Lancet Healthy Longev. 2021;2(3):e117–8.
76. McNallan SM, Singh M, Chamberlain AM, Kane RL, Dunlay SM, Redfield MM, et al. Frailty and healthcare utilization among patients with heart failure in the community. JACC Heart Fail. 2013;1(2):135–41.