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Evaluation of Frailty in Older Adults With Cardiovascular Disease:

Incorporating Physical Performance Measures

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Abstract

Rapid growth in the numbers of older adults with cardiovascular disease (CVD) is raising awareness and concern of the impact that common geriatric syndromes such as frailty may have on clinical outcomes, health-related quality of life, and rising economic burden associated with healthcare. Increasingly, frailty is recognized to be a highly prevalent and important risk factor that is associated with adverse cardiovascular outcomes. A limitation of previous studies in patients with CVD has been the lack of a consistent definition and measures to evaluate frailty. In this review, building upon the work of Fried and colleagues, a definition of frailty is provided that is applicable for evaluating frailty in older adults with CVD. Simple, well-established performance-based measures widely used in comprehensive geriatric assessment are recommended that can be readily implemented by nurses in most practice settings. The limited studies conducted in older adults with CVD have shown physical performance measures to be highly predictive of clinical outcomes. Implications for practice and areas for future research are described for the growing numbers of elderly cardiac patients who are frail frailty and at risk for disability.

Keywords

cardiovascular disease; elderly; frailty; physical performance–based measures

Over the past 2 decades, the demographic trend in the United States and in cardiovascular disease (CVD) has shifted to one of predominately older adults (>65 years).[1] An aging demographic is supported by evidence that adults 80 years and older are the fastest growing segment of the population.[2] Rapid growth in the numbers of older adults with CVD is raising awareness and concern of the impact common geriatric syndromes such as frailty may have on clinical outcomes, health-related quality of life (HRQOL), and the rising economic burden associated with healthcare.[3–9] Frailty is a heightened vulnerability to stressors in the presence of low physiological reserve and is increasingly recognized to be a significant predictor of adverse outcomes and poor HRQOL in older patients with CVD. Frailty has multiple manifestations with no 1 symptom diagnostic or essential in its presentation, which has led to difficulties defining, identifying, and managing this complex syndrome.[10–13] Greater attention of the link between frailty, CVD, and the risk for poor clinical outcomes has prompted a recent call by the American Heart Association for a better understanding of frailty and its relation to cardiac care in older adults.[14,15]

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Weakness, slower movement, and limitation in the ability to perform routine physical activities often signal the onset of frailty.[10,11,16–19] In older adults, performance measures are well established and commonly used as part of the geriatric assessment to evaluate change in physical function. Performance measures represent aspects of physical function that are associated with routine daily activities that are important for maintaining independence in older adults.[17,20,21] These measures integrate multiple dimensions of health and aging, such as disease processes, nutritional status, cardiorespiratory fitness, and psychological state, and provide a global assessment of physical function. Although performance measures are widely used in comprehensive geriatric assessment, their use has been very limited in older adults with CVD.[14] Recent studies indicate, however, that they are practical, are safe to administer, and provide valuable insight regarding older adults who are most vulnerable for adverse events and outcomes in cardiac care settings.[14,15,22–31]

Among older cardiac patients, frailty is reported to be a significant and an independent predictor of functional decline, more frequent and lengthier hospital stays, poorer surgical outcomes, placement in a long-term care facility, and higher mortality rates.[22–31] For example, in older patients undergoing cardiac surgery, slow gait speed (<0.65 m/s) was a significant predictor of adverse outcomes and provided additional information that enhanced the accuracy of traditional risk assessment models for cardiovascular surgery.[24] Among elderly patients hospitalized with heart failure (HF), lower scores on a short battery of performance tests administered during hospitalization was associated with longer hospital stays and more frequent readmissions and mortality over a 30-month follow-up period.[22] Although few studies have reported the use of performance measures to evaluate frailty in older patients with CVD, evidence suggests that they may improve risk assessment of clinical outcomes in this population.[29–31] Early detection of frailty may be a window of opportunity for intervention and a key factor for improving clinical outcomes in elderly patients with CVD.[10,12,13,32]

In this review, Fried et al's[10] definition of frailty is proposed along with evidence of the close association increasingly reported between CVD and frailty. Using Fried et al's[10] definition and criteria, simple, objective physical performance measures that can be administered in 5 to 10 minutes are recommended for assessment of frailty across practice settings. Commonly used self-report questionnaires are also included that may enhance evaluation of frailty. Finally, implications for practice are discussed for the increasing number of frail, elderly cardiac patients as well as recommendations for improving clinical outcomes for this growing population.

Frailty: Definition and Age-Related Factors

Defining Frailty

Two main phenotypes of frailty have been described in the geriatric literature: physical frailty and a broader, multidomain phenotype that incorporates psychological, social, and cognitive domains[10,18] Although frailty is considered by most experts to be a dynamic process, there is a lack of consensus on the definition of frailty, despite 20 instruments currently available to measure it.[33] Rockwood et al[34,35] used a multidomain approach and defined frailty as a proportion of accumulated deficits (impaired continence, walking, cognition, and activity of daily living [ADL] disability). Others describe frailty as vulnerability in at least 2 domains including physical, nutritive, cognitive, and sensory,[36] whereas others suggest that gait speed or handgrip strength alone is the most robust indicator of frailty.[37]

The physical frailty phenotype developed by Fried and colleagues is based on their work in 2 large epidemiological studies, the Cardiovascular Health Study (CHS) and the Women's

Health and Aging Studies, and is the most widely cited and tested definition.[10] The American Geriatrics Society/National Institute on Aging on Research conference on a Research Agenda on Frailty in Older Adults has recently adopted the Fried et al phenotype of frailty because of its consistent, relatively simple approach that yields high predictive ability compared to other definitions.[38] The definition of physical frailty includes 5 measurable items: shrinking or weight loss, weak grip strength, slow gait speed, exhaustion, and low-energy expenditure (Table 1). Participants are classified as frail if they meet 3 or more of the 5 criteria, as intermediate or prefrail if they meet 1 or 2 of the 5 criteria, and as nonfrail if they meet none of the criteria. Using the Fried et al criteria,[10] the prevalence of frailty was 7% in the CHS (4317 community-dwelling adults aged 65 years and older), 30% in the subgroup aged 80 years and older, and 25% in the Women's Health and Aging Studies (1002 community-dwelling women aged 65 years and older).[39] Other larger and more recent epidemiological studies have reported similar rates of frailty using the this physical phenotype.[40]

Among participants in the CHS, frailty increased with age and was significantly higher in women than in men, which is consistent with other studies, including older patients with CVD.[24] Frailty was also more prevalent in African Americans, those with lower education and income, poorer health status, and higher comorbidity and disability. Fried et al's physical phenotype independently predicted future health events over a 3-year period including falls, worsening mobility, hospitalization, and death. In addition, participants who were prefrail showed a higher risk of becoming frail over the next 3 to 4 years compared with those who were nonfrail. Evidence that prefrail status is progressive and leads to frailty has important implications for early restorative and preventative interventions.[10,32,38]

Application in Clinical Practice Settings

Fried et al's definition of frailty is recommended for clinical practice because it has shown wide application across diverse populations and has consistently identified a profile of high-risk, adverse outcomes in older adults with CVD. The Fried et al criteria can be completed in 15 to 20 minutes and are easy to interpret, which make it practical as an assessment tool in acute settings, during routinely scheduled clinic visits or as an outcome to measure intervention response.[13,23,38–41]

A major criticism of the Fried et al model is the emphasis on the physical dimensions of frailty.[12,38] Whereas other factors such as cognitive impairment and mood states are well-established risks for poor health status, the Fried et al definition considers both as comorbid conditions that confound frailty.[10,42] A recent study, however, reported the predictive ability of the Fried et al definition was significantly improved with the addition of the Mini Mental Status Evaluation.[43] Frail persons with cognitive impairment at baseline were significantly more likely to develop disability in ADLs and instrumental ADLs (IADLs) over a 4-year follow-up period. Notably, cognitive decline was not associated with the development of ADL disability or mortality among nonfrail participants.[40] Because the Mini Mental Status Evaluation is an easily administered self-report instrument, including it as a secondary measure may enhance risk assessment because cognitive decline is a common feature in certain cardiovascular disorders such as HF.[44] Other investigators have also included additional biomarkers associated with frailty and CVD such as C-reactive protein, brain natriuretic peptide, interleukin 6, and tumor necrosis alpha, but the findings are inconclusive.[23,45,46] As research in frailty evolves, improved assessment measures will likely emerge to further enhance the predictive ability of the Fried et al definition and inform targets for future interventions.

The Link Between Frailty and CVD

Evidence of a strong bidirectional relationship between frailty and CVD has been established in a number of large epidemiological studies and more recently in clinical research.[10,22–31,47–53] A recent systematic review by Afilalo et al[14] provides an in-depth review of the epidemiological evidence that link CVD and frailty. Fried et al's definition of frailty is associated with a 2- to 3-time greater probability of developing CVD.[10,39] In addition, frailty is associated with higher rates of mortality in patients with established CVD that is independent of other common risk factors including age, New York Heart Association (NYHA) functional class, and comorbidity. For example, among CHS participants who were diagnosed as frail, only 12% were alive at the 7-year follow-up compared with 43% of nonfrail participants. In addition, participants who were older and had a history of CVD or HF also had a 7.5 greater probability of death during the 7-year follow-up period.[10,47] The strong link between frailty, inflammatory biomarkers, and coagulation processes also has an equally strong association in CVD. These underlying physiological mechanisms may, in part, explain the similarities and close link consistently reported between frailty and CVD.[10,14,47]

Several recent reports among hospitalized patients also point to frailty as a strong predictor of poor clinical outcomes. Among patients who had cardiac surgery,[26] those categorized as frail were more likely to experience higher in-hospital mortality and had a 6-fold greater probability of requiring long-term care after discharge. In another study,[27] of patients (mean age 80 years) undergoing cardiac surgery, Fried et al's criteria predicted with similar accuracy 30-day mortality rates as traditional cardiac surgery risk models. Several studies[14,26,27] now suggest that frailty scores may enhance traditional risk models for cardiac surgery and may derive the greatest clinical benefit when a combined approach is used in older patients.

Older adults with HF in both inpatient and outpatient settings are more likely to be frail.[53–56] A recent study reported (mean age, 80 years) that 39% of older adults with HF had a mobility disability defined as requiring assistance (from a device, such as a cane or a walker, or from another person) or being unable to walk, which significantly increased risk for mortality.[53] In addition, older individuals with HF have a higher number of comorbid conditions, on average 4 to 5, which also place them at higher risk for physical function decline and disability.[54]

The strong association between frailty, CVD, and risk for adverse clinical outcomes is receiving wider attention as supportive evidence from clinical investigations becomes increasingly available. Future studies are needed to test the validity of the Fried et al definition[10] and establish which frailty index or performance measures have the greatest clinical utility in older patients with CVD.[14]

Measurement of Frailty

Currently, there are no gold standard instruments for evaluating risk for frailty. Self-report, performance measures, or a combination of both is used to quantify physical function and risk for frailty in the Fried et al definition.[10] From a clinical perspective, measuring physical function and identifying change over time are critical because declining physical capabilities are a strong predictor of future health outcomes, frailty, disability, and mortality across a wide number of chronic illnesses, including CVD. There are both advantages and limitations for self-report and performancebased measures.[20,57,58]

Self-report questionnaires can denote capabilities for a wide range of physical activities.[59] A major advantage of self-report questionnaires is their ease of administration and practicality in both clinical and research applications. Self-report, however, is subjective and may be confounded by mood, inaccurate judgment of physical capabilities, cognitive impairment, misinterpretation of what is being asked by the respondent, or social desirability. Previous studies have shown that agreement between self-reported physical function and objective performance-based measures is generally weak.[20,57] The presence of ceiling and floor effects in higher functioning adults is also reported using self-report. Another important disadvantage of many self-report instruments is their lack of sensitivity for detecting small changes in physical function that may be clinically significant.[59]

The Fried et al definition[10] uses self-report responses from the Center for Epidemiological Studies-Depression scale[60] and the Minnesota Leisure Time Activities Questionnaire (short version)[61] to measure exhaustion and level of physical activity, respectively. Several studies, including the Frailty Intervention Trial,[41] have incorporated simple modifications to evaluate physical activity level. For example, participants were considered physically inactive in the past year if they performed no physical activity, spent most of the time sitting, or rarely had a short walk (or other nondemanding physical activity); this modified physical activity criteria were strongly correlated with physiological measures of muscle mass. Using the modified criteria for physical activity, 8.8% of older adults (mean age, 75 years) were considered frail in conjunction with the other measures, and this is similar with the findings from the CHS.[45] The use of disease-specific questionnaires such as the Kansas City Cardiomyopathy Questionnaire[62] for older patients with HF or physical function subscales[63] such as the medical Outcomes Study short form-36 is also potentially useful as measures of physical activity and is an area for further research.

In geriatric assessment, basic activities of daily living (BADL) and IADL questionnaires are routinely administered to evaluate risk for frailty and disability and are applicable in older patients with CVD.[64] The Lawton-Brody scale is a well-validated instrument and indicates whether older adults are able to perform 8 IADLs such as using a telephone, being responsible for their own medication, managing money, having the ability to use public or private transport, shopping, grooming, doing housework, and doing laundry.[65] For assessment of BADLs, the Katz ADL scale (bathing, dressing, transferring from bed to chair, toileting, and feeding) can be used.[66] If respondents indicate that they are unable to perform 1 or more activities without help, they are considered as having an IADL or ADL disability or a combination of both.[64,65] Modifications in IADL performance are frequently reported in older adults with CVD and are more prevalent in women than men and in certain disorders such as HF.[67,68] Among patients with HF, a recent study found they were more likely to have at least 1 and, in some cases, greater than 4 ADL and IADL impairments; the number of limitations among patients with HF was significantly higher than those with CAD or without HF or CVD.[54] Higher risk older patients, such as those with HF, should be evaluated routinely for change in self-reported ability to perform daily activities, which may help identify risk for frailty and onset of disability.[13,14,24]

Performance-based measures objectively evaluate different domains of physical function and have been shown to identify frailty in older adults with CVD.[17,20,21] Administering a performance-based measure requires an individual to perform a task in a standardized manner using preestablished criteria, which often include time, number of repetitions, or a combination of both. Performance-based tests have a number of advantages including the following: (1) direct assessment of physical function reduces the risk of bias associated with perceptions and mood, (2) standardized administration and scoring increases reliability across measurements, and (3) greater sensitivity to clinical change than self-report.[20,21,57] Performancebased measures also have several limitations. One major limitation of performance-based measures is the use of a simulated environment. In older adults, the use of a simulated environment may lead to either overestimation or underestimation of physical function capabilities simply because of the structure or context of the test. Some performance-based measures are too time-consuming; require sophisticated equipment, space, or trained personnel; and are difficult to score or interpret any of which make them impractical in most clinical practice settings.

The performance-based measures included in this review have previously demonstrated excellent psychometric properties as well as sensitivity for change that is clinically meaningful. Minimal detectable change (MDC), a threshold score that is associated with patient status change, is important for interpreting level of risk for frailty and is included for each instrument.[69,70] The single-item measures (gait speed, handgrip strength) were selected because they are part of Fried et al's criteria[10] and are widely used to screen for frailty in older adults.[20,64] Fried et al's cut points for gait speed and handgrip have been used effectively in a number of studies as a threshold for determining frailty, including older patients with CVD.[13,14,23] In addition, the selected performance measures can be administered in less than 10 minutes; require little training, equipment, or space; and can be readily implemented by nurses in most practice settings.[20] The multi-item performance measure, the Short Physical Performance Battery (SPPB),[17,71] can also be administered in 10 minutes or less and includes balance and chair rises. The SPPB is not part of the Fried et al criteria but may provide additional information concerning risk for falls and lower extremity strength that may be beneficial to evaluate in some patients.[20] Both the single-item and multi-item instruments also have a scoring system that is transparent and easy to interpret. The selected measures have been tested in several large epidemiological studies, which have included substantial numbers of older adults with CVD.[71] Recently, these performance measures have been tested in elderly patients with CVD and therefore are appropriate outcomes to consider in this population.[10,22–31]

Gait Speed

Preferred gait speed is simple, easily measured and interpreted, and increasingly considered an important ''vital sign'' for older adults.[72,73] Excellent testretest reliability for gait speed is reported in adults older than 55 years and in the frail elderly. The advantages of gait speed include excellent reliability, validity, and responsiveness, which make it a useful screening instrument for frailty in acute and outpatient settings.[20,24,57,71]

Few studies have reported gait speed in older patients with CVD. Afilalo and colleagues[24] evaluated 131 patients with a mean age of 76 years scheduled for cardiac surgery. Using the Fried et al[10] cut point of 0.65 m/s for gait speed, 50% of the sample was frail. Slow gait speed was significantly more common in women than in men (43% vs. 25%) and in patients with diabetes (50% vs 28%) and was associated with a 3-fold greater likelihood of morbidity and mortality after surgery. Older women had a much higher risk (8-fold) of poor outcomes postoperatively than men. Slower walkers also were twice as likely to be hospitalized longer or to be discharged to a long-term healthcare facility.

Purser et al[23] compared 2 frailty phenotypes, physical and multidimensional, in 309 hospitalized patients aged 70 years and older with ischemic heart disease. Gait speed was the most significant single-item measure for detecting frailty followed by chair-stands (number of times rising from chair in 30 seconds) and handgrip strength. Slow gait speed (≤0.65 m/s) and poor grip strength (≤25 kg) were stronger predictors of 6-month mortality than either composite score on the frailty indexes. Notably, the multidimensional frailty composite score[34,35] categorized patients frail almost 2.5 times more often than Fried et al's[10] phenotype.

Specific thresholds for gait speed are useful for identifying older adults with CVD who are at greater risk for poor clinical outcomes.[69,74–76] Currently, a gait speed threshold of 1 m/s is widely used as a clinical cut point for identifying frailty in older adults. Other evidence indicates, however, that this gait speed threshold may be too slow to detect early functional decline, especially among higher functioning patients. A clinical threshold between 0.6 and 0.8 m/s has been proposed as more definitive.[75] In 2 studies of older adults hospitalized with CVD, a gait speed of 0.65 m/s, which is consistent with Fried et al's criteria,[10] was associated with frailty and poor clinical outcomes.[24,30] For physically active and higher functioning older adults, a gait speed of 0.5 seconds may be more predictive of early change in physical function. Perera et al[69] recently reported MDC values for gait speed that reflected both small 0. 05 m/s and substantial 0.1 m/s changes, respectively. These MDC values may be particularly useful for monitoring change over time in patients with CVD.[69,75,76]

Six-Minute Walk

Boxer et al[28] recently reported a 300-m or less walk distance was a significant predictor of frailty in patients with HF. A comparison of gait speed with the 6-minute walk (6MWT) may clarify which is the most beneficial as a predictor of clinical outcomes. An advantage of gait speed over the 6MWT is less space and time required, and frail elderly patients are more likely to finish a 4-m versus 6MWT. Gait speed in these older patients may provide more definitive information about physical function capability than the 6MWT. In addition, 6MWT is often more difficult to interpret in older patients because of multiple comorbidities and functional limitations.[77,78] A change in 6MWT distance of 20 and 50 m was recently reported to represent a small and substantial MDC, respectively, in older adults.[69] This is consistent with the 50- to 54-m change in the 6MWT often cited as clinically meaningful distance change in patient status with cardiopulmonary disease.[79]

Handgrip Strength

Handgrip strength is simple, is easily measured, and provides an approximation of overall muscle strength; frail older adults have weaker grip strength than those who are nonfrail.[80] Age, gender, and body mass index influence handgrip strength.[81,82] Men have higher handgrip strength than women, and a decline in strength occurs around 40 years old in both genders. Handgrip strength is also highly correlated with peak V02, adverse clinical events, and outcomes such as falls, disability, prolonged hospital stays, and reduced HRQOL in older adults.[73,80]

Handgrip strength has not been widely reported or used as an outcome measure in older patients with CVD.[83,84] In the largest study of patients with CVD (N = 1960),[84] handgrip strength was on average 4% to 5% lower than in healthy, gender, and age-matched populations. Factors that were significantly correlated with handgrip strength in patients with CAD included gender, peak VO2, and age. Following a program of cardiac rehabilitation, handgrip strength increased approximately 5% over baseline values and men showed greater improvement than women did. Whether improvement in handgrip strength is associated with better clinical outcomes is an area for further investigation. The cut points used in the Fried et al model adjusted for age, gender, and body mass index have shown high predictability for detecting frailty in older adults.[10] In patients with CVD and HF, these handgrip cut points also identified risks for poor outcomes and death in several studies and should be tested in future studies. For example, Purser et al[23] found among patients hospitalized with CAD that those with handgrip strengths of 25 kg or less had almost a 3-fold greater likelihood of death over a 6-month period. In another study of HF patients, a handgrip of 32 kg and lower peak Vo2 were associated with poorer survival.[85] Monitoring handgrip strength at scheduled intervals may help identify older patients with CVD at higher risk of becoming frail, as some studies have shown, particularly among those who have a decline of 1.5 to 2 kg over a 1-year period.[86,87]

Short Physical Performance Battery

The SPPB[17,71] is a well-established and validated measure of lower extremity performance designed to simulate routine physical activities. Three areas of lower extremity function are evaluated using the SPPB including static balance, gait speed, and getting in and out of a chair. These tasks are essential for independent living and therefore an important outcome measure for patients with CVD.

Both total and subscale scores can be calculated for the SPPB, with total scores ranging from 0 to 12 (with 0 indicating poor function and 12 indicating excellent function).[71] A score of 10 or lower on the SPPB is considered the cut point for mobility impairment. In subjects older than 65 years living in the community, the risk of death and disability increased by 7% to 9% for every 1-point reduction in SPPB score.[17] The MDC values range from 0.54 to 1.34 points for the SPPB, which suggests that a change in physical performance of 1 to 2 points is a clinically meaningful change.[69] In frail African Americans, a MDC value of 3 points was recently reported to be indicative of a change in status.[81]

Three studies have evaluated outcomes using the SPPB as a risk assessment of frailty in older adults with HF. The study by Di Bari et al[25] was 1 of the first to compare SPPB scores and the 6MWT distance (6MWD) in older adults with and without HF. Participants with HF had significantly lower SPPB scores and 6MWD, which were predictive of higher mortality than those without HF. Recently, Chiarantini et al[22] evaluated the ability of the SPPB to predict long-term survival of older patients (n = 157; mean age, 80 years) discharged from the hospital after an HF exacerbation. The mean SPPB score was 4.5, which varied significantly by NYHA class (class I: 7.4 ± 1.1, class II: 5.0 ± 0.5, class III: 4.8 ± 0.5, class IV: 2.3 ± 0.7; $P < .001$). Mortality increased with worsening physical performance; compared with a SPPB score of 9 to 12, scores of 0, 1 to 4, and 5 to 8 were associated with mortality risks of 6.06, 4.78, and 1.95, respectively. Among the 30% (N=47) of participants who scored 0 on the SPPB, 47% were NYHA class IV and 74% were unable to perform any of the 3 tests on the SPPB. Administering the SPPB took an average of 10 to 15 minutes, and there were no adverse events reported in these frail, elderly hospitalized HF patients.

The SPPB has also been used in other populations of older adults to predict outcomes before, during, or after hospitalization. Valpato et al[30] used the SPPB to assess older adults (mean age was 78 years) admitted to the hospital with a diagnosis of HF (64%), pneumonia (13%), chronic obstructive pulmonary disease (16%), or minor stroke (6.6%) at admission (baseline) and discharge. The mean (SD) baseline SPPB score was 6.0 (2.7) and was inversely correlated with age, severity of disease, and the ability to perform activities of daily living 2 weeks before hospital admission. The SPPB score increased by 1 point on average during hospitalization and was significantly associated with length of hospitalization; those with lower SPPB scores had longer stays. In a follow-up analysis,[29] a repeat SPPB test was conducted 1 month after hospitalization and telephone follow-up used to identify patterns of functional decline and hospitalization over a 1-year period. Participants with the lowest SPPB quartile scores at hospital discharge (0Y4) had a 5-fold greater risk of rehospitalization or death than those in the highest quartile (8Y12). Patients with early decline in SPPB scores 1 month after hospital discharge had greater limitations in performing activities of daily living and a significantly greater probability of being re-hospitalized or dying during the 1-year follow-up period. Use of the SPPB after hospital discharge or at the first follow-up outpatient visit may be beneficial for targeting further intervention or the need for more frequent follow-up care.[29,30]

Because the SPPB can be completed in 10 minutes or less, the full SPPB is recommended over gait speed alone, especially if there is evidence of lower extremity weakness or balance difficulties.[20] Detailed instructions for completing the SPPB and scoring are provided in

Table 2. The instructions and information about the SPPB can also be downloaded along with normative data free of charge for clinical use at www.grc.nia.nih.gov/branches/ledb/sppb/index.htm.

Implications for Practice

Estimates are that expenditures for the treatment of heart disease will have a 46% increase by 2025 largely because of the rise in numbers of older adults with CVD.[82] Frailty, a prevalent syndrome in older adults with CVD, is also anticipated to dramatically increase over the next several decades.[1–3] Identifying those at risk for frailty is important for improving patient outcomes and may provide a window of opportunity to prevent or slow the progression to disability. The physical phenotype developed by Fried et al improves risk assessment in elderly cardiac patients and is practical and applicable in most practice settings.13,14,23 In previous studies, patients with CVD who were identified as frail had a significantly higher probability of adverse outcomes, greater health resource utilization, and increased mortality.[22–31] Because CVD and frailty often co-occur in older adults, coordinated management is essential; guidelines are needed that address comprehensive management of CVD and geriatric syndromes. Healthcare systems that include a coordinated, multidisciplinary approach to managing frail older adults with CVD will optimize patient outcomes and reduce the enormous economic burden associated with cardiovascular care. [82,88]

Frail elderly patients with CVD are vulnerable and more likely to experience physical function decline and dependence in activities of daily living after hospitalization. Hospitalization in a frail older adult with CVD is a significant predictor of new onset disability.[22,29,89] Frailty has important implications for prevention and rehabilitation efforts associated with hospitalization. Few studies, however, have examined frailty prevention in hospitalized older patients, and none have examined it in patients with CVD. Positive results are reported for improving physical function and delaying onset of frailty, which may be applicable to older patients with CVD. For example, among older adults with either slow walking speed or inability to rise from a chair without using their hands, an intervention that used a combination of balance and strength training was able to prevent further decline in physical function among older adults residing in community settings.[90,91] Similar interventions may have applications to hospitalized older adults with CVD.[10] Although the benefits of exercise in older adults and in CVD are well established,[92] little is known about exercise as a strategy to prevent frailty before, during, or after hospitalization and is an area for future research.[93,94]

Use of performance measures preoperatively may alert clinicians to the level of risk among some older cardiac patients as well as special needs postoperatively. For example, in frail patients, postoperative care that is tailored to risk level may lower rates of complications. Lowering rates of postoperative complications in older patients is an important target because complications increase 30-day mortality by 26% in those 80 years and older.[31] Older women with CVD have higher rates of frailty and experience poorer outcomes after cardiac surgery.[23,24,26,27] Factors shown to contribute to greater risk for frailty in older women include being widowed and living alone, having a lower in socioeconomic status and higher rates of depression, which are associated with poorer nutritional status and physical inactivity all of which accelerate the onset of frailty and progression to disability.[39,51]

Older patients have reduced exercise tolerance because of coexisting age-related declines and CVD. Patients with HF are at particular risk because of the 50 to 75 reduction in aerobic capacity and the peripheral musculoskeletal changes that further decrease muscle mass and exercise tolerance. A recent study found that older adults who have an active lifestyle were less likely to become frail versus those who were sedentary.[94] A recent systematic review also found exercise may prevent frailty and onset of disability in older adults, but the findings are inconclusive because of the multiple approaches and doses of exercise reported; there was also no evidence that nutritional therapies were effective as a preventative strategy for frailty.[91] The interest in nutritional therapies revolve around protein supplementation as a strategy to mitigate loss of muscle mass associated with aging and are an area of ongoing research. Far fewer exercise trials have been conducted in older patients with CVD, but the results are favorable with similar benefits are reported as younger patients.[92] Supervised exercise programs such as cardiac rehabilitation have been associated with significant improvement in physical function in patients with CVD. These programs, however, are often not available or practical for many elderly patients especially women because of lack of availability, transportation difficulties, or cost constraints. For these reasons, home-based exercise programs that include both aerobic and resistance exercise components are increasingly recommended. Recent systematic reviews indicate that home-based exercise programs can be as effective for improving clinical outcomes as supervised programs.[95,96]

Aerobic or endurance exercise leads to improved physical performance and HRQOL and may increase the probability of older adults remaining independent. Progressive aerobic training can significantly increase aerobic capacity of older adults with CVD by at 2 to 3 mL/kg/minute or more, potentially increasing physiological reserve and providing a larger margin of safety that may delay the onset of frailty. Although some benefits accrue from low-intensity exercise, progression from low to moderate intensity is recommended to maximize the health benefits of exercise.[92]

Performance measures should be incorporated to periodically evaluate exercise progress in older patients with CVD. Traditional CVD measures such as the 6MWT should be used along with performance measures such as gait speed to determine response to exercise. Peak oxygen consumption is typically not required for older adults beginning a program of progressive low to moderate exercise such as walking.[92] Older adults with CVD should be advised on how to monitor their rate of exertion during exercise. The 10-point Borg Rate of Perceived Exertion scale provides an easy and convenient method to measure the level of exercise intensity; patients should be advised to keep their Rate of Perceived Exertion[97] between 3 and 5. The talk test is another tool that may be used to evaluate the intensity of aerobic activity. The general room of thumb is that patients should be able to talk or carry on a conversation during exercise. If it becomes difficult to talk, older adults should be advised to lower the intensity level or exertion during exercise. Selfmonitoring heart rate and blood pressure and using pedometers to track exercise such as walking have been shown to be beneficial for improving motivation, depressive symptoms, and exercise self-efficacy in older adults.[98–100]

Resistance exercise increases muscle strength using some form of resistance, such as light weights or elastic bands. Resistance exercise increases muscle mass, lowers the risk for falls, and is associated with maintaining independence in older adults. The amount of resistance and number of repetitions vary, but in general, 2 to 3 sets of 10 to 12 repetitions are regarded as the optimal dose for increasing muscle strength. As strength increases, the amount of resistance should also increase. Strength training should not be performed on consecutive days to give the muscles time to rest and recover between sessions. Lower extremity muscles are particularly important for mobility and independence. Balance and flexibility exercises should also be encouraged several times per week. To determine the most appropriate design and exercise modalities (type, intensity, frequency, and duration of exercise) that prevent loss of function and onset of frailty, randomized trials are needed to compare different training protocols.[92]

Performance measures may serve as another vital sign in older adults with CVD to monitor changes in physical function. Gait speed, in particular, may be valuable as a screening tool for frailty in older cardiac patients as previous studies have demonstrated. Performance measures in clinical settings require staff time but little training, space, equipment, or risk. Selfreport questionnaires may use less staff time if self-administered, but depending on the selection, some may require time to administer and score.[20] As performance measures become more common in cardiac care settings, MDC thresholds should be identified based on the specific characteristics of the population.[69] From an economic perspective, there is a need to establish which combination of performance and self-report measures provides the most useful clinical information for the cost in patients with CVD.[20,82]

Although the number of studies is quite limited that address or measure frailty in older patients with CVD, the definition and criteria developed by Fried and colleagues[10] have successfully identified frailty and prefrailty in this population. It is less clear whether these criteria will be applicable in higher functioning older patients with little or no comorbidity or in younger patients with advanced CVD as a risk assessment tool. As evidence in the application to CVD grows, newer predictive models that build upon the Fried et al criteria will emerge and be may be useful for identifying frailty sooner as a strategy to avoid the enormous clinical and economic consequences.

Conclusion

Interventions to identify and prevent frailty in older adults with CVD will become increasingly important as the population ages. Although curative treatments for frailty are currently unavailable, interdisciplinary interventions such as exercise and comprehensive geriatric assessment may improve outcomes in older patients with CVD.[41] Information gained from objective, simple, inexpensive physical performance measures, when used in combination with self-report and health information, may enhance the ability to evaluate change in physical function that signal onset of frailty.[20,23] The high morbidity and mortality associated with frailty indicate that it should be a priority for future research as a strategy to improve clinical outcomes, enhance HRQOL, and lower healthcare costs in this growing population of frail, older cardiac patients.[82]

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Clinical Pearls

- Frailty is prevalent among older adults with cardiovascular disease (CVD) but often goes unrecognized, which places them at high risk for poor clinical outcomes including more frequent and lengthier hospital stays, poorer surgical outcomes, placement in a long-term care facility, and higher mortality rates.
- Simple and easy-to-administer performance-based measures may improve risk assessment and clinical outcomes in older patients with CVD.
- Monitoring physical function changes at regular intervals may help identify elderly patients at risk for frailty who may be more amenable to intervention.
- Aerobic and resistance exercise is recommended for older adults and has been shown to slow the progress of frailty and onset of disability.
- An interdisciplinary team approach is needed to meet the complex care needs of aging patients with CVD in the future.

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Table 1

Fried et al[10] Criteria for the Definition of Frailty

Criteria	Methods	Cutoff			
Shrinking (ie, weight loss)	Self-report of unintentional weight loss	≥10 lb or 4.5 kg over the past year			
		At least 5% loss of the previous year's body weight on examination with scales			
Weakness (ie, low grip strength)	Grip strength of the dominant hand (mean of 3 serial measurements) adjusted for gender and body mass index (BMI)	BMI—male	Cutoff, kg	BMI—female	Cutoff, kg
		≤24	≤29	≤23	≤17
		24–26	≤30	23–26	≤17.3
		26–28	≤30	26–29	≤18
		>28	≤32	>29	≤21
Exhaustion	Evaluation of 2 statements from the Center for Epidemiological Studies-Depression scale	*(a)* I felt everything I did was an effort			
		(b) I could not get going			
		Criterion is positive if at least 1 condition was present for 3 days or more during the past week.			
Slow gait speed	Timed walk over 4.57 m or 15 ft at usual pace	Height—male, cm	Cutoffs	Height—female	Cutoffs
		≤173	≥7 s (0.65 m/s)	≤159	≥7 s (0.65 m/s)
		>173	≥6 s (0.76 m/s)	>159	≥6 s (0.76 m/s)
Low-energy expenditure	Physical activities over past 2 weeks using the Minnesota Leisure Time Activities Questionnaire (short version)	Male		Female	
	Weekly tasks are converted to equivalent kilocalories of expenditure	≤383 kcal/week		≤270 kcal/week	

One point is scored for each criterion, with a score of 3 or higher defined as frail.

Table 2

Scoring for the Short Physical Performance Battery

Patient ID: ___________________		
Date: ________________________		
Balance Score		
Unable to hold side-by-side stance for > 9 seconds		0 point
Side-by-side stance for 10 seconds but unable to hold semitandem for 10 seconds		1 point
Semitandem for 10 seconds, unable to hold full tandem for > 2 seconds		2 points
Full tandem for 3– 9 seconds		3 points
Full tandem for 10 seconds		4 points
Walk score (4 m or 13.12 ft)		
Unable to walk		0 point
If time is more than 8.70 seconds		1 point
If time is 6.21– 8.70 seconds	Time 1: _____	2 points
If time is 4.82–6.20 seconds		3 points
If time is <4.82 seconds	Time 2: _____	4 points
Chair stand score		
If the participant was unable to complete the 5 chair stands		0 point
If chair stand time is 16.7 seconds or more		1 point
If chair stand time is 13.7–16.6 seconds		2 points
If chair stand time is 1 1.2–13.6 seconds		3 points
If chair stand time is 11.1 seconds or less	Time: _____	4 points
Total score		

Source: Guralnik JM, Simonsick EM, Ferrucci L, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol*; 1994;49:M85–M94.