MAYO CLINIC

REVIEW

Comprehensive Geriatric Assessment in the Management of Older Patients With Cardiovascular Disease

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Abstract

Cardiovascular disease (CVD) disproportionately affects older adults. It is expected that by 2030, one in five people in the United States will be older than 65 years. Individuals with CVD now live longer due, in part, to current prevention and treatment approaches. Addressing the needs of older individuals requires inclusion and assessment of frailty, multimorbidity, depression, quality of life, and cognition. Despite the conceptual relevance and prognostic importance of these factors, they are seldom formally evaluated in clinical practice. Further, although these constructs coexist with traditional cardiovascular risk factors, their exact prevalence and prognostic impact remain largely unknown. Development of the right decision tools, which include these variables, can facilitate patient-centered care for older adults. These gaps in knowledge hinder optimal care use and underscore the need to rigorously evaluate the optimal constructs for providing care to older adults. In this review, we describe available tools to examine the prognostic role of age-related factors in patients with CVD.

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INTRODUCTION

Improving the care of older adults effectively requires inclusion and assessment of key constructs that are prevalent in this population and that affect their outcomes. They include evaluation of frailty, comorbid conditions or multimorbidity, depression, quality of life (QOL), activities of daily living (ADL), instrumental activities of daily living, and cognition.[1-3] Despite their conceptual relevance and prognostic importance, they are rarely evaluated in clinical practice. Further, although frailty, multimorbidity, depression, poor health status, and cognition coexist with traditional cardiovascular risk factors, their exact prevalence, prognostic impact, and association with cardiovascular risk factors remain largely unknown. It is unclear to what extent their formal and objective evaluation will, or should, affect clinical decision-making in older adults with complex conditions who may not have better outcomes with more invasive treatments, but such research is sorely needed. A foundation of investigating these important considerations is a comprehensive understanding of the conceptual framework for evaluating these domains and outcomes. In this review, we describe information on available tools to examine frailty, multimorbidity, QOL, depression, and cognition and study their prognostic role in patients with cardiovascular disease (CVD).

FRAILTY

Frailty is a multidimensional syndrome characterized by a heightened susceptibility to perturbations in the body's homeostatic systems.[4] Robust individuals have a buffer in cellular structure and function, and this redundancy helps an individual weather

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ARTICLE HIGHLIGHTS

- This review informs the readers on unique consideration in caring for older adults.
- It elaborates on common problems, including frailty, depression, quality of life, cognition, and multimorbidity, that are relevant to both physicians and patients, particularly the growing older adult population.
- We outline strategies to identify these constructs in both acute and stable clinical settings.

periods of stress and illness such as those experienced with acute myocardial infarction (MI) or exacerbation of congestive heart failure (Figure 1).[5] Erosion of this buffer can lead to frailty, which is associated with inflammation, sarcopenia, loss of appetite and weight, weakness, diminished physical activity, and low levels of testosterone and vitamin D.[6–9] Frailty overlaps with, but is distinct from, related concepts of multimorbidity, depression, poor QOL, cognitive decline, and dependency in ADL such as bathing, dressing, continence, and feeding.[10]

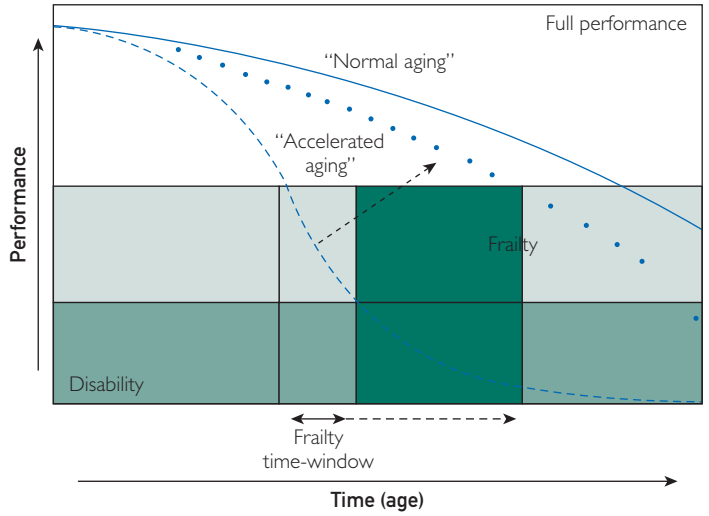

FIGURE 1. Trajectories of physical, cognitive, social, or quality of life functioning with aging. Individuals with high performance have good functional reserve and can weather illnesses such as acute MI or worsening HF with relative ease. However, for frail individuals, the trajectory is steeper, and homeostatic disruption caused by illness leads to adverse health outcomes, including disability and death. Treatment of the presenting illness and recognition and effective treatment of frailty can potentially reduce the rate of functional decline and improve performance (arrow). Modified with permission from Ferrucci et al.[11]

Prevalence of Frailty

The prevalence of frailty increases with age and is higher among women and residents of long-term care facilities.[12-14] Frailty is estimated to affect 20% of patients aged 65 years or older who are undergoing percutaneous coronary intervention (PCI) and 27% of patients aged 70 years or older who are undergoing cardiac catheterization.[15,16] Frailty is highly prevalent among patients undergoing transcatheter aortic valve replacement.[17,18]

Estimates of the prevalence of frailty vary among patients with CVD because different instruments are used in different patient subgroups.[19] However, the prevalence of frailty is generally believed to be higher among patients with CVD than in those without CVD.[20]

Measurement of Frailty

Several simple tools that use some or all of the key criteria can facilitate a frailty assessment (Table 1). Poor gait speed (walking 5 to 10 meters at normal speed) is associated with adverse outcomes. This test is simple and reproducible but requires patients to be able to walk.[13,21-24] Grip strength, assessed with a dynamometer (Jamar, Patterson Medical, Illinois), can be used in patients with immobility, although joint osteoarthritis or other causes of hand pain can hamper its usefulness and accuracy.[25,26] The Short Physical Performance Battery, functional reach, and Up and Go tests assess a participant's physical performance by measuring balance, gait speed, and time taken to rise from a chair.[27,28] The Fried scale measures frailty on the basis of five criteria: unintentional weight loss in the past year, slow gait speed, weakness (assessed by grip strength), self-reported low physical activity, and exhaustion.[12] For day-to-day assessment of frailty, simple screening tools perform equally well as more comprehensive methods.[29] A brief

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TABLE 1. Questionnaires and Simple Measurement Tools to Measure Frailty

Common tests for frailty	Components assessed
Fried	Unintentional weight loss >10 lbs in the past year, slow gait speed, poor grip strength, exhaustion, slow self-reported physical activity
Rockwood	Calculations of deficits based on symptoms, signs, and lab measurement
FRAIL questionnaire	Fatigue; Resistance: Inability to climb a flight of stairs; Ambulation: Inability to walk ≥1 block; Illness ≥5; Loss of weight in 6 months >5 lb
Grip strength	Reduced grip strength
Gait speed	Slow gait speed
EFT	Time required to stand from a seated position without using the arms; cognition by MMSE, low albumin, and low hemoglobin
Balance	Side by side, tandem, semitandem balance, as well as gait speed, chair stand

EFT = essential frailty toolset; MMSE = Mini-Mental State Examination.

four-item scale, the Essential Frailty Toolset, encompasses lower-extremity weakness, cognitive impairment, anemia, and hypoalbuminemia; this method outperformed other frailty scales in older adults undergoing aortic valve replacement.[18]

Rockwood et al[5,30] assessed frailty by quantifying deficits in a range of health areas based on symptoms, signs, disabilities, and number of chronic diseases. Some items are self-reported (eg, "help with tasks"), whereas others are tests (eg, Mini-Mental State Examination), clinical evaluation (eg, hypertension), or laboratory measurement (eg, hemoglobin, serum albumin). Each clinically recognized deficit that is insufficiently repaired can negatively affect prognosis. Deficits are reported as the proportion of deficits associated with worse prognosis over the total number of deficits present. Other tools define frailty as a combination of the various components, including deficits, low hemoglobin or albumin, and dependency in ADL.[21,31-34]

The 2013 consensus statement on frailty recommends screening all persons aged 70 years or older and those with significant (>5 lb) annual unintentional weight loss. The FRAIL questionnaire is a good screening tool to assess frailty, but the Fried criteria, Rockwood frailty scale (useful in immobile or moribund patients), and gait speed are more established tools (Table 1).[35]

Frailty and Prognosis

Frailty is associated with poor long-term survival. Among 628 patients aged 65 years or older, the 3-year mortality rate after PCI was higher for frail patients (Fried criteria) than nonfrail patients (28% vs 6%, respectively).[16] The Targeted Platelet Inhibition to Clarify the Optimal Strategy to Medically Manage Acute Coronary Syndromes trial included 4671 patients (25% prefrail and 5% frail using Fried criteria) aged older than 65 years who presented with an acute coronary syndrome. In that study, frail participants had a higher rate of adverse cardiovascular events.[36] Poor physical performance is predictive of worse outcomes in patients with heart failure (HF).[37] Among 448 residents of Minnesota with HF, frailty over a mean follow-up period of 2.0 ± 1.1 years was associated with a 65% increase in risk of hospitalization and almost double the risk (92%) of emergency department visits.[38] Frailty is also predictive of postoperative morbidity and mortality. Frail patients referred for cardiac surgery have higher needs for rehabilitation and institutional care.[39,40] Similar results were reported for patients who underwent transcatheter aortic valve replacement.[39,41-43]

DEPRESSION IN CVD

Nearly 1 in 10 Medicare beneficiaries evaluated in primary care practices have depression. Specific patient subgroups such as those with multimorbidity, loss of independence, or limited social support are particularly vulnerable.[44,45] The precise association between depression and CVD is unclear whether depressive symptoms precede and

affect outcomes of patients with CVD or whether depressive symptoms predict prognosis in patients with previously established CVD.

Prevalence of Depression in CVD

Depression is approximately three times more common in patients after an acute MI, and 15% to 20% of these patients meet the criteria for major depression[46-49]; and higher estimates of depression are noted in patients with HF.[50,51] Prevalence of depression in the outpatient setting is less well studied, but major depression and elevated depressive symptoms are more common among community dwellers with heart disease than among individuals without CVD.[46,51] In a national survey of 30,801 adults, 12-month prevalence of major depression was seen among 9.3% with some cardiac disease and was almost twice as high when compared with those without comorbidity (4.8%).[52]

Importance of Depression in Patients With CVD

Findings of a systematic review support etiologic and prognostic roles for depression in the setting of CVD.[50] In addition, depression complicates patient care as it interferes with medication compliance, affects self-care, increases ambulatory visits, and negatively impacts QOL.[53] This interaction of depression with patient care is particularly relevant in patients with CVD as nonadherence to guideline-directed medical therapy may lead to adverse consequences. MI depressive symptoms can be associated with other mood disturbances (eg, anxiety) or substance abuse, which also are associated with adverse cardiac outcomes. Importantly, similar to many health conditions, depression is not a binary (present/absent) condition; the severity of depressive symptoms has a dose-dependent effect on cardiac outcomes.[54]

Depressive symptoms alter the autonomic nervous system, activate the hypothalamic-pituitary-adrenal axis, and worsen the prothrombotic milieu — all factors implicated in the pathogenesis of CVD.[53,55,56] Beyond the plausible biologic underpinnings, depression poses clinical challenges by affecting medication adherence, participation in cardiac rehabilitation, and self-care, Table 2.[57,58]

Depression and HF

High prevalence (up to 40%) of depression and medication nonadherence has a synergistic effect on cardiac event-free survival in patients with HF that led to the development of pathways to identify and treat elevated depressive symptoms.[51,59] In the randomized Sertraline Against Depression and Heart Disease in Chronic Heart Failure trial, the selective serotonin reuptake inhibitor sertraline did not improve short-term outcomes compared with a placebo.[60] Similarly, no difference was observed at 2 years in depressive symptoms or clinical outcomes with antidepressants in the Effect of Escitalopram on All-Cause Mortality and Hospitalization in Patients With Heart Failure and Depression trial that compared escitalopram with placebo in patients with systolic HF (average ejection fraction, 35%) and major depression.[61] With these negative studies, the design of the trials for depressive symptoms in HF has shifted toward multidisciplinary team management with focus on rehabilitation and preservation of function.[62-64]

TABLE 2. Shared Biologic and Clinical Factors for Depression and Cardiovascular Disease

Biologic
Impaired microvascular function
Elevated proinflammatory cytokines (C-reactive protein, interleukin-6, fibrinogen)
Genetic susceptibility
Clinical
Reduced aerobic physical activity (lower participation rates in cardiac rehabilitation)
Less medication compliance
Substance abuse
Psychosocial support system challenges
Reduced health status (quality of life, symptom burden, functional impairment)
Increased use of health care resources (ambulatory care visits, hospitalization)

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Current guidelines have endorsed depression screening and treatment,[53] but robust data supporting improvements in survival and ischemic outcomes are lacking. A systematic review that described 11 studies about screening accuracy and six depression treatment trials observed modest reduction in symptoms of depression with either pharmacotherapy or cognitive behavioral therapy (effect size, 0.20-0.38; r (2), 1%-4%), with no improvement in survival or clinical outcomes. Supplementation of antidepressants with cognitive behavioral therapy in patients with MI and depression versus usual care in the Enhanced Recovery in Coronary Heart Disease Patients (ENRICHD) trial did not result in any difference in event-free survival (75.5% vs 74.7%, respectively).[65] Current American Heart Association (AHA) recommendations are to administer the Patient Health Questionnaire (Table 3), with any affirmative response requiring additional screening questions or referring to a qualified mental health professional.[53]

Gaps still remain in the identification of depression suggesting opportunities for improvement in the education and training and in better alignment of the care plan with the patient's primary physician or mental health specialist. The positive effects of treatment on medication adherence and QOL and their safety record from randomized MI trials have allowed patients with CVD to benefit from various treatment options for depression. Cognitive behavioral therapy can be used in addition to or instead of pharmacotherapy for treatment of depressive symptoms.[63,67] The advantage of aerobic activity was observed with exercise training compared with usual care in patients with HF (hazard ratio, 0.89; 95% CI, 0.81-0.99; P=.03).[68] Further research is needed to better understand the effects of positive lifestyle changes such as exercise, self-care, medication, and treatment adherence on outcomes and QOL for patients with CVD and elevated depressive symptoms.

Factors that may confound proper diagnosis and treatment in older adults include a perception by some that depression comes with aging. Coexisting geriatric syndromes, such as cognitive impairment and polypharmacy, should be considered because these factors may mask or modify depressive symptoms and make diagnosis more challenging. Older patients with coronary artery disease and comorbidities who are identified as having depression may benefit from the collaborative effort of a care team that includes internists, mental health specialists, geriatricians, cardiovascular specialists, and physical therapists.

TABLE 3. Patient Health Questionnaire-2: Over the Past 2 Weeks, How Often Have You Been Bothered by Any of the Following Problems?[66]

1.	Little interest or pleasure in doing things.
2.	Feeling down, depressed, or hopeless.

MULTIMORBIDITY AND CVD

A patient with multimorbidity (or comorbidity) is defined as having two or more concurrent, medically diagnosed diseases lasting for longer than 1 year. Distinctions must be made between cardiovascular and noncardiovascular comorbid conditions and also between frailty and comorbidity because they differ in their pathophysiologic, therapeutic, and prognostic underpinnings.[16,69] In current clinical practice, a single-disease treatment model is used for CVD. However, recent efforts have embraced a patient-centered approach that systematically integrates multimorbidity into care models.[70] Higher co-prevalence and weak association of comorbid conditions with traditional cardiovascular risk factors highlights the need for their separate assessment.

Prevalence of Multimorbidity

The prevalence of comorbid conditions increases with age and is associated with worse outcomes, including mortality.[18] More than 70% of adults have CVD by the age of 70 years, and more than two-thirds also have non-CVD comorbidities.[71] The number of comorbidities also increases with age and is associated with higher health care costs, greater disability, and increased mortality

risk.[14,69,72] Among Medicare beneficiaries, more than one-half of beneficiaries younger than 65 years but more than 80% of those aged 85 years and older have multimorbidity. The 2010 US population census estimates that the number among the population older than 70 years is 46 million. Of these, 32 million are estimated to have CVD, meaning that a large population of patients (21.5 million) will have CVD plus other comorbidities (2010 census).

Importance of Multimorbidity

CVD is a disease of older adults, such that coexisting multimorbidity is expected to affect outcomes. Older patients are also affected by the overlapping pathophysiologic signals of disease development (eg, inflammation and stress) and the complex interactions of CVD and multimorbidity (eg, disease-disease, disease-drug, and drug-drug) (Figure 2). For example, achievement of blood pressure goals with diuretics or vasodilators in an older adult with autonomic dysfunction can lead to falls due to unsafe orthostatic hypotension. Therapeutic competition, in which the therapy for one condition adversely affects a comorbid condition or its treatment, has been described in more than 20% of cases in older adults.[73]

Models commonly used to evaluate multimorbidity include the Charlson index[74] and the coronary artery disease–specific index.[75] These models provide prognostic information on long-term survival in patients with CVD. The importance of multimorbidity in predicting post-MI was underscored by the Cardiovascular Cooperative Project and patients with MI from Olmsted County, Minnesota.[76,77]

We showed significant improvement in the discriminant accuracy of the Mayo Clinic Risk Score with the addition of the coronary artery disease-specific index, which underscores the importance of comorbid conditions in determining long-term survival after the index PCI.[78]

Greater effort is needed to analyze the multimorbidity and concomitant CVD to ensure practical and effective care that is congruent with patient values and improves symptoms, morbidity, or mortality. This goal can be achieved by including geriatric patients in randomized clinical trials to further improve identification of the best treatment modalities for CVD in this highly comorbid population, as seen in the recent Drug-eluting Stents in the Elderly Patients with Coronary Artery Disease (SENIOR) trial.[79]

COGNITION AND CVD

Cognitive dysfunction is common among older patients with CVD. Deterioration of various domains of cognition affects the patient's self-care and ability to cope with treatment regimens, thereby modifying symptoms and health behaviors.[80] Such patients often present with symptoms of executive-function deficits such as forgetting names and lists, having word-finding difficulties, and struggling to perform instrumental activities of daily living. Although patients with CVD and cognitive impairment do not typically meet the criteria for dementia, they can have considerable functional debilitation that worsens QOL. Thus, clinicians must be aware of the cognition trajectory and available tools to examine cognitive function.

The ABCs of Cognition Among Patients With CVD

The fundamental determinants of cognitive dysfunction among older patients are termed the ABCs, and they consist of atherosclerotic risk factors, baseline vulnerability of older adults, and cardiac stressors.

Atherosclerotic Risk Factors — The "A". A strong link has long been established among atherosclerotic diseases, CVD, and vascular risk factors such as hypertension, diabetes mellitus, and dyslipidemia.[81–83] The association between these risk factors and cerebrovascular diseases, including cognitive decline and dementia, are equally consistent.[84–87] Older adults are less frequently recognized as having a higher risk of CVD and a simultaneous incremental risk of cognitive impairment (Figure 3).[80,88] Lyall et al[89] evaluated nearly a half million patients with CVD, hypertension, and diabetes

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The Seattle Angina Questionnaire-7

1. The following is a list of activities that people often do during the week. Although for some people with several medical problems it is difficult to determine what it is that limits them, please go over the activities listed below and indicate how much limitation you have had **due to chest pain, chest tightness or angina** over the past 4 weeks.

Place an X in one box on each line.

Activity	Extremely limited	Quite a bit limited	Moderately limited	Slightly limited	Not at all limited	Limited for other reasons or did not do the activity
a. Walking indoors on level ground	☐	☐	☐	☐	☐	☐
b. Gardening, vacuuming or carrying groceries	☐	☐	☐	☐	☐	☐
c. Lifting or moving heavy objects (e.g. furniture, children)	☐	☐	☐	☐	☐	☐

2. Over the past 4 weeks, on average, how many times have you had chest pain, chest tightness or angina?
I have had **chest pain, chest tightness or angina…**

4 or more times per day	1-3 times per day	3 or more times per week but not every day	1-2 times per week	Less than once a week	None over the past 4 weeks
☐	☐	☐	☐	☐	☐

3. Over the past 4 weeks, on average, how many times have you had to take nitroglycerin (nitroglycerin tablets or spray) for your **chest pain, chest tightness or angina?**
I have taken **nitroglycerin…**

4 or more times per day	1-3 times per day	3 or more times per week but not every day	1-2 times per week	Less than once a week	None over the past 4 weeks
☐	☐	☐	☐	☐	☐

4. Over the past 4 weeks, how much has your **chest pain, chest tightness or angina** limited your enjoyment of life?
I have taken **nitroglycerin…**

It has **extremely** limited my enjoyment of life	It has limited my enjoyment of life **quite a bit**	It has **moderately** limited my enjoyment of life	It has **slightly** limited my enjoyment of life	Completely satisfied
☐	☐	☐	☐	☐

5. If you had to spend the rest of your life with your **chest pain, chest tightness or angina** the way it is right now, how would you feel about this?

Not satisfied at all	Mostly dissatisfied	Somewhat satisfied	Mostly satisfied	Completely satisfied
☐	☐	☐	☐	☐

FIGURE 2. The short version of the Seattle Angina Questionnaire has 5 questions about limitations in daily activities, presence of recent angina, and its impact on quality of life and frequency of use of nitroglycerine. This type of questionnaire is disease-specific, easy to use, provides reproducible results, and accurately describes the patients' perspectives of their health status.[171]

mellitus and observed a significant incremental association between these factors and cognitive decline. Patients with CVD in the cardiac-care setting frequently have concomitant vascular risk factors, and such patients are likely to have a concurrent underlying cognitive decline.[89] Despite the exponential increase in the prevalence of CVD risk factors,[90] the importance of concomitant cognitive decline is often overlooked, and declines generally are attributed to senile degenerative processes.

Baseline vulnerabilities — The "B". The prevalence of cognitive dysfunction is 12% to 18% among community-dwelling adults aged 65 years or older,[91–93] and it is 25% among those aged 80 to 89 years.[94] However, the dysfunction is often subtle (characterized as mild cognitive impairment [MCI]) and may affect only a single cognitive sphere (memory or attention),[95] leaving other cognitive capacities relatively preserved and functional activities such as ADL intact. The prevalence of MCI is high (16%-35%) among patients with CVD.[96–99] Patridge et al[100]

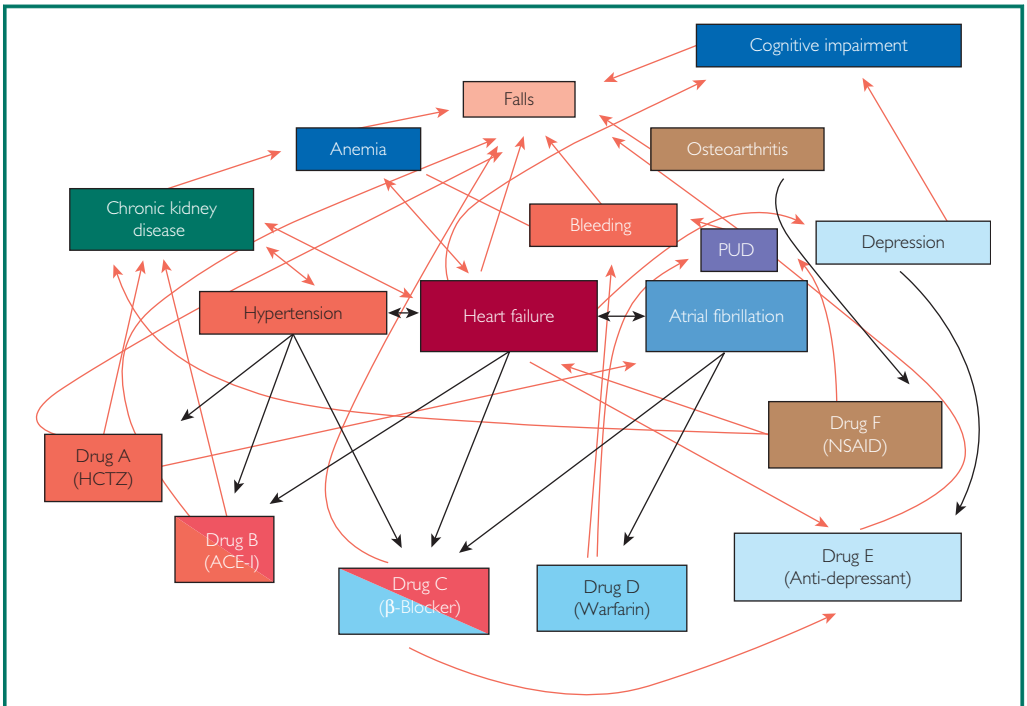

FIGURE 3. Interplay of vascular risk factors, cardiovascular disease (CVD), and presence of cognitive impairment. ACE-I = angiotensin converting enzyme inhibitor; HCTZ = hydrochlorothiazide; NSAID = nonsteroidal anti-inflammatory drug; PUD = peptic ulcer disease.

assessed 114 patients undergoing vascular surgery, and reported that 68% had MCI (score <24). Importantly, nearly 90% of patients with abnormal scores preoperatively were previously unrecognized. Similar results were obtained in a cross-sectional study by Harkness et al[101]; they evaluated 44 patients with HF (age >65 years) and detected cognitive impairment in more than 70% of patients. In a study of 23 patients with previous MI and moderate to severe HF, one of four patients had cognitive impairment.[102]

In addition to cognitive decline with age,[18] frailty also has been consistently associated with cognitive decline[103–105] and heightens the patients' baseline vulnerability and worsens outcomes (including higher mortality, delirium, and cognitive decline) after stressor events.[106,107]

Greater knowledge about patient's cognitive status can aid in choosing treatment options that may safeguard mental function and identify at-risk patients who will benefit from preventive measures for cognitive decline.

Cardiac Disease and Cardiac Surgery-Related Stressors — The "C". Patients with cardiac disease have additional risk of cerebrovascular insults. Cardiac stressors such as acute coronary syndrome, HF exacerbation, or open-heart surgery may alter cardiac output, and the resultant hemodynamic instability may disrupt cerebrovascular blood flow (ie, cerebral hypoperfusion) and ultimately increase the risk of stroke and MCI.[108] Saczynski et al[108] evaluated survivors of acute coronary syndrome (N=1521) during hospitalization and at 1 month after hospital discharge; 16% and 11% reported cognitive impairment during hospitalization and at 1 month following discharge. Notably, 4% had newly developed cognitive impairment after the acute coronary insult.[108] Vogels et al[109] compared the risk of cognitive impairment of a pooled sample of patients with HF (n=2937) and healthy individuals (n=14,848). Patients with HF were 60% more likely to have cognitive impairment compared with healthy controls.

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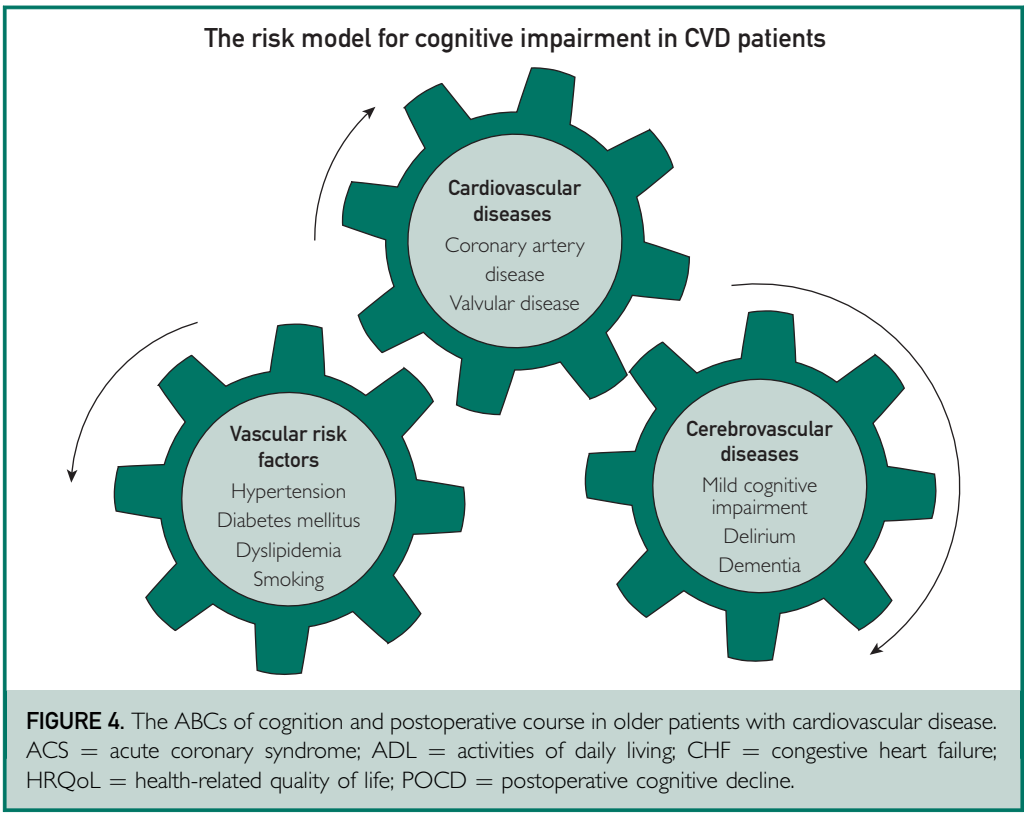

FIGURE 4. The ABCs of cognition and postoperative course in older patients with cardiovascular disease. ACS = acute coronary syndrome; ADL = activities of daily living; CHF = congestive heart failure; HRQoL = health-related quality of life; POCD = postoperative cognitive decline.

Importantly, cognitive deficiency negatively affects patients' self-care and decision-making capacity,[110] especially regarding choices about their health care and adherence to complex treatment.[111]

Older patients with CVD undergoing cardiac surgery are exposed to perioperative stressors (eg, surgical trauma, hypotension, and cardiopulmonary bypass) that increase the risk of postoperative cognitive dysfunction.[112,113]

Older patients with CVD and preoperative cognitive impairment (including MCI) have higher risks of postoperative delirium, a longer hospital stay, long-term dementia, and dependency in personal ADL.[114–118] Postoperative cognitive impairment occurs in two distinct categories (Figure 4). First is delirium, an acute form of brain dysfunction that occurs within days, characterized by fluctuating mental status, inattention, and either disorganized thinking or an altered level of consciousness.[112,119,120] The second is postoperative cognitive decline (POCD) that occurs over weeks; POCD ranges from subtle memory problems and difficulty multitasking to more pronounced learning difficulties and noncompliance with multistep procedures.[121]

Currently, delirium is estimated to affect at least one in five patients after cardiac surgery,[122] and it is associated with a higher probability of death, morbidity, falls, cognitive decline, and loss of functional independence.[123–125] Cognitive decline occurs in 50% to 80% of patients within 1 week, in 30% to 50% of patients after 8 to 10 weeks, and at a lower prevalence at 3 to 5 years.[126] It is linked to prolonged hospital stays, death, loss in ADL, and worsened QOL.[118,127,128]

There is equipoise of evidence about the long-term recovery after perioperative cognitive impairment. Prior studies have reported recovery with improvement in the overall health status[125,129–132]; however, these may have biases of repeated testing-learning effects and the absence of nonsurgical controls.[130]

The Clinical Implications of Cognitive Impairment Among CVD Patients

Cognitive status can regress from baseline after perioperative stress, and the ensuing cognitive dysfunction, including delirium and cognitive decline, can result in worse short- and long-term outcomes. Deteriorated cognition impedes ADL and decreases QOL after hospital discharge, and these aspects may not recover to baseline levels (Figure 5). Thus, it is imperative to assess cognitive impairment in older adults with more routine cognitive screenings, particularly when CVD risk factors and homeostatic stressors are involved.

Preoperative Risk Stratification and Tools to Evaluate Perioperative Cognition

Routine cognitive evaluations (Table 4) are constrained by 1) heterogeneity in the available assessment tools, 2) variations in how cognitive impairment is defined, and 3) limited expertise and lack of clinical feasibility of potentially time-intensive tools.

The most widely used tool for cognitive impairment assessment is the Mini-Mental State Examination (MMSE).[134] However, the time- and expertise-intensive aspects of the test make it less practical for routine perioperative use. The Mini-Cog tool is clinically feasible perioperatively (typically administered in 2-3 minutes), and has high sensitivity (99%) and specificity (93%); however, it is limited to areas of memory and executive function, making it less relevant for certain individuals. Another less time-consuming strategy is the Montreal Cognitive Assessment (MoCA) tool.[142] This comprehensive test evaluates multiple domains of cognition and has 90% sensitivity and 50% specificity for detecting MCI.[142]

Several reports have provided insights into patient-related risk factors associated with postoperative delirium. Rudolph et al[135] studied 231 patients and identified four risk factors for postoperative delirium after cardiac surgery: pre-existing cognitive impairment (low MMSE score), prior cerebrovascular event, low albumin, and pre-existing depression. McPherson et al[146] reported 200 patients undergoing cardiac surgery who received benzodiazepine at

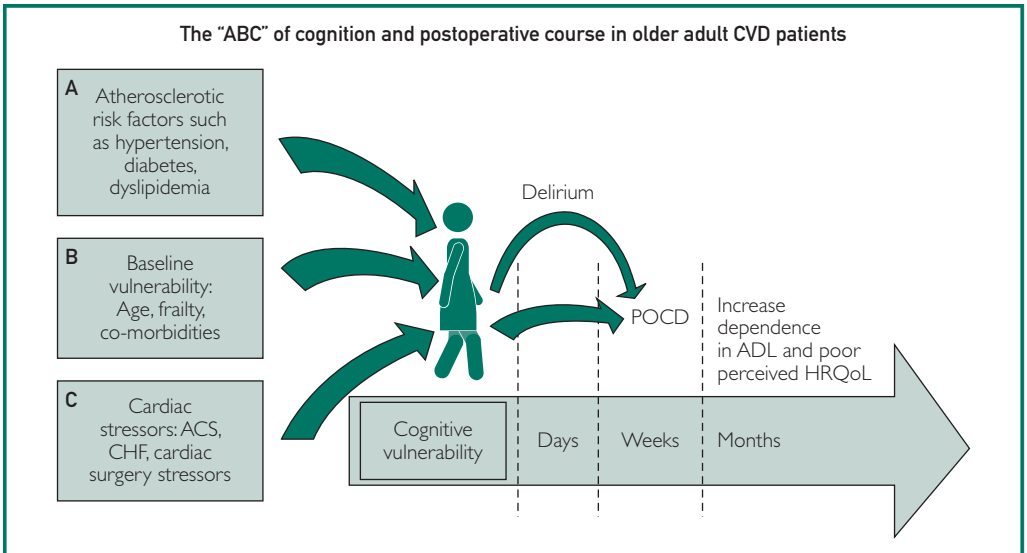

FIGURE 5. The short version of the Seattle Angina Questionnaire has seven questions about limitations in daily activities, presence of recent angina, and its impact on quality of life and frequency of use of nitroglycerine. This type of questionnaire is disease-specific, easy to use, provides reproducible results, and accurately describes the patients' perspectives of their health status.[73] ACS = acute coronary syndrome; ADL = activities of daily living; CHF = congestive heart failure; HRQoL = health-related quality of life; POCD = postoperative cognitive decline.

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TABLE 4. Summary of Neuropsychological and Cognitive Assessment Tools Used Perioperatively[a]

Tool name and description	Cognitive domain assessed	Study	Cohort	Operative phase (pre/post)	Prognostic value/ impact
Mini-Cog[136]					
3-Item recall and clock drawing	Quick screen (1-2 min) for cognitive assessment; memory and executive function	Robinson, 2009[137]	Multiple; including cardiac	Preop, Postop: daily CAM-ICU	Pre-existing CI (Mini-Cog <2) was the strongest predictor of the development of postoperative delirium
		Robinson, 2009[138]	Multiple; including cardiac surgery	Preop, Postop: 6 month	Pre-existing CI (Mini-Cog <2) was significantly associated with postoperative 6-month mortality
CAM-ICU[139]					
4-Item objective assessment tool	Assesses content of consciousness; delirium	Robinson, 2009[138]	Multiple; including cardiac surgery	Preop, Postop: 6 month	Postoperative delirium identified using CAM-ICU was associated with increased 6-month mortality rate
MMSE[140]					
A battery of 20 individual tests	Visual-spatial representation, recall, and executive function	Veliz-Reissmüller, 2007[140]	Cardiac surgery	Preop, Postop	Patients with lower preoperative MMSE scores had higher risk of postop delirium
Stroop Neuropsychological Screening test[141]					
Reading a list of color names printed in incongruous colors	Attention, concentration, and executive function	Miller, 2001[96]	CABG	Preop: 3 days; Postop: 6 days, 6 months	Pre-existing CI was significantly associated with postoperative CI at postoperative day 6 and 6 months later
MoCA[142]					
Cognitive screening instrument	Memory, language, executive functions, visuospatial skills, calculation, abstraction, attention, concentration, and orientation	Partridge, 2014[100]	Vascular surgery	Preop	MoCA was quick and feasible CI (MoCA <24) was newly identified in 60.5% of patients aged >60 years, Preoperative CI (MoCA <24) was predictive of a longer length of stay
Other cognitive screening tests not validated in a cardiac surgery setting [Enter] 6-Item screener (6-IS)[143]					
3-Item recall, 3-Item temporal orientation	Quick screen (<1 min) for cognitive impairment;	Callahan, 2002[143]	Community dwellers >65 years		Comparable sensitivity and specificity with MMSE

Continued on next page

TABLE 4. Continued

Tool name and description	Cognitive domain assessed	Study	Cohort	Operative phase (pre/post)	Prognostic value/ impact
	memory and orientation				
8-Item screener[144]					
3-Item recall and attention/ calculation exercise	Quick screen (<2 min) for cognitive impairment; memory and attention	Chan, 2011[144]	Community dwellers >60 years	…	High sensitivity (94.9%) and (59.1%) specificity
6-Item Cognitive Impairment Test[145]					
3-Item orientation, 5-Item recall, and 2-Item attention	Quick screen (< 2 min) for cognitive impairment; orientation, memory, and attention	Brooke, 1999[145]	Community dwellers >70 years		Comparable sensitivity and specificity with MMSE

[a]CABG = coronary artery bypass grafting; CAM- ICU = Confusion Assessment Method for the Intensive Care Unit; CI = cognitive impairment; MMSE = Mini-Mental State Examination; MoCA = Montreal Cognitive Assessment; preop = preoperative; postop = postoperative; TAVI = transcatheter aortic valve implantation. Adapted with permission from Long et al,[133] Folstein et al,[134] and Rudolph et al.[135]

admission and had a three-fold increase in the risk of delirium. In addition to drugs, interventions precluding mobilization had a 2.5- to 3-times higher risk of delirium. Katznelson et al[147] recognized that in the absence of a systematic screening tool, delirium may be overlooked in 50% to 70% of patients after cardiac surgery.

Call for Action

In 2015, the American Geriatric Society recommended health care professionals to routinely assess patients for delirium risk factors, including age older than 65 years, chronic cognitive decline or dementia, poor vision or hearing, severe illness, and presence of infection.[120] Although this guideline is a useful starting point, extensive research on cognitive variation indicates that numerous potential mechanisms for delirium exist, and a large, multicenter dataset is needed to confirm modifiable risk factors associated with delirium for patients with CVD.

QOL AS A FOCUS OF CARDIOVASCULAR CARE IN OLDER ADULTS

Although guidelines for treating patients with CVD emphasize the primary goals of improving survival and optimizing QOL,[148,149] most scientific inquiries into CVD treatments have focused on extending life, rather than optimizing patients' health status: their symptoms, function, and QOL. However, for older adults, health status is often more important than longevity.[150] It is thus necessary to explicitly elicit and understand older patients' treatment goals because some patients may choose to trade a substantial portion of their longevity for improved QOL.[151]

Measurement of QOL

A recent scientific statement from the AHA emphasized three components of patient health status: symptom burden, functional status, and health-related QOL,[152] where QOL refers to the difference between actual and desired symptoms and function.[152] Importantly, the ideal method of assessing patients' health status is to have the patients themselves complete surveys about their overall health. Whereas generic measures may be useful for capturing the impact of the totality of patients' comorbidities, disease-specific measures are particularly useful for assessing the impact of CVD on patients' health, as well as their response to treatments. To accurately reflect a patient's

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health status, questionnaires undergo rigorous psychometric testing to ensure their validity, reliability, and responsiveness, and to determine how best to interpret either cross-sectional differences or changes in scores.[153] The latter is particularly important when interpreting clinical trials[154] and using patient-reported outcome measures as markers of health care quality or as tools in delivering care.

Surveys

As noted above, general health status surveys quantify overall physical and mental function status and well-being of the patient, as impacted by not only their CVD, but also by the totality of the their comorbidities. Examples of general health status surveys include the Short-Form 36[155] or a shorter version (SF-12), the Patient-Reported Outcomes Measurement Information System,[156] and the EuroQol 5-Dimension.[157] Because these surveys assess overall health, they can be used for any disease and are useful for comparing health status across different diseases. However, in CVD, care teams are often considering treatments, such as PCI, to address disease-specific symptoms. In this case, generic health surveys may not sensitively capture the clinical benefit of a specific treatment because they do not measure the cardinal symptoms or impacts of CVD.[158] Disease-specific questionnaires, such as the Kansas City Cardiomyopathy Questionnaire (KCCQ),[159] Seattle Angina Questionnaire (SAQ),[160] the Atrial Fibrillation Effect on Quality of Life for patients with atrial fibrillation,[161] the MacNew Heart Disease Health-Related Quality of Life questionnaire,[162] the Stroke impact Scale and Stroke-Specific Quality of Life scale for stroke patients,[163,164] and the Peripheral Artery Questionnaire for patients with peripheral arterial disease, more sensitively define the health of patients with CVD and their response to treatment.[165] To support the use of patient-reported outcomes in clinical care, efforts are being made to shorten the original instruments, while preserving their psychometric characteristics. For example, the 19-item SAQ[160] and the 23-item KCCQ[159] have been shortened to 7- and 12-item instruments,[166,167] respectively (the shortened SAQ is shown in Figure 5). These shortened versions offer the opportunity to integrate patient-reported outcomes into clinical care, and the surveys more accurately and reliably measure the frequency of angina, for example, than clinician interviews[168]; further, they are much more reproducible than many techniques used to assess the severity of coronary disease.[169,170,166] Recently, the SAQ and KCCQ have been endorsed by the International Consortium on Health Outcomes Measurement in their comprehensive assessments of health care value.[171]

Importance of QOL Assessment

Accurately measuring health status is particularly important in the care of older adults with CVD. For example, older patients often have better health status than younger patients, but are much more sensitive to a deterioration in function.[172] Without explicitly measuring health status, these important differences in outcomes for older adults can be missed. In fact, the recent AHA Scientific Statement underscores the importance of health status measurement for various applications.[152]

Given that patients' health status is often the strongest predictor of adverse outcomes, the primary benefits of many cardiovascular treatments, such as PCI in stable ischemic heart disease, are to improve patients' health status.[173,174] Formally assessing health status should therefore become an integral component of clinical care and research. With the development of new treatments for older adults (eg, percutaneous valve replacement), the principal outcome of interest is often QOL.[43,175,176–179] Although the use of formal health status assessments as endpoints in clinical trials is of unquestionable importance and is becoming more common, the real future of providing better care for patients with CVD is to use these measures to translate[21] the results of clinical trials into tools that can apply the evidence to individual patients. This approach

recognizes the heterogeneity of treatment benefit, which may be strongly influenced by age, and challenges trialists to leverage their data to make these tools available to practicing clinicians.[180,181] As an example, the Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) trial compared PCI plus optimal medical therapy with optimal medical therapy alone and built models of health status outcomes to support shared medical decision-making.[182] A similar tool was developed to define health status benefits of cardiac resynchronization therapy by using the Minnesota Living with Heart Failure Questionnaire.[183] This tool requires knowing only the patient's age, QRS duration, and baseline health status to predict the health status benefits at 3 or 12 months after treatment. Importantly, older age is associated with an increased likelihood of a large QOL benefit from treatment and considering these QOL benefits may be very helpful in selecting patients for cardiac resynchronization. Observational registries can also be used to build similar tools. By using tools that include patients' predicted health status and periprocedural risks, older adults in particular may better calibrate their expectations and have increased satisfaction with care.

In summary, the field of health status measurement has evolved from the creation of assessment tools to their application in quantifying important patient-centered outcomes in clinical trials to the development of novel tools that can predict patient-centered outcomes after treatment. What is needed currently is the integration of these measures into clinical care so that the potential benefits can be fully realized for patients. Emerging efforts by the International Consortium on Health Outcomes Measurement and the Centers for Medicare and Medicaid Services to transform patient-reported outcome measures into tools for quantifying health care quality are important steps toward mandating their use in clinical care.[184–187] However, the ability of clinicians to learn how to use these measures in clinical practice remains a barrier, particularly in the care of older adults who most value treatments that improve their symptoms, function, and QOL.

WHY CONDUCT COMPREHENSIVE GERIATRIC ASSESSMENTS?

The prevalence of domains discussed in this review increases with age and we recommend their routine screening in patients 65 years of age or older. Evaluation of younger patients with multimorbidity could be considered. This is supported by several observations. First, highly prevalent frailty, poor cognition and QOL, depression, and multimorbidity identify at-risk older adults whose long-term survival is significantly lower as compared with individuals with preserved functioning. Frail patients undergoing PCI had five-fold higher long-term mortality as compared with those without frailty. Similar observations were noted in a patient with multimorbidity.[16,77,78] The prognostic influence of individual components is known, but prognostic information incurred from measurement of all domains is not well studied. Second, the tests developed to measure them are noninvasive, less time-consuming, and can be administered by allied health staff or health care professional. Third, these variables become the foundation of shared decision-making. For example, a frail patient with poor QOL who lives in a nursing home with limited ADL may decide against a very invasive and higher risk procedure as the prognosis is poor despite successful interventions such as aortic valve replacement or high-risk PCI. On the other hand, such complex treatments can be offered to an older adult who is highly functional. In a prior study, we showed that addition of QOL, multimorbidity, and frailty correctly reclassified patients undergoing PCI to a higher risk category.[16] Therefore, it is important to include them in the decision-making before embarking on high-risk procedures.

Current single-disease patient care paradigms, clinical trials, and guidelines ignore the complexities associated with comprehensive geriatric assessments (CGAs). Inclusion of a CGA recognizes patient-led and

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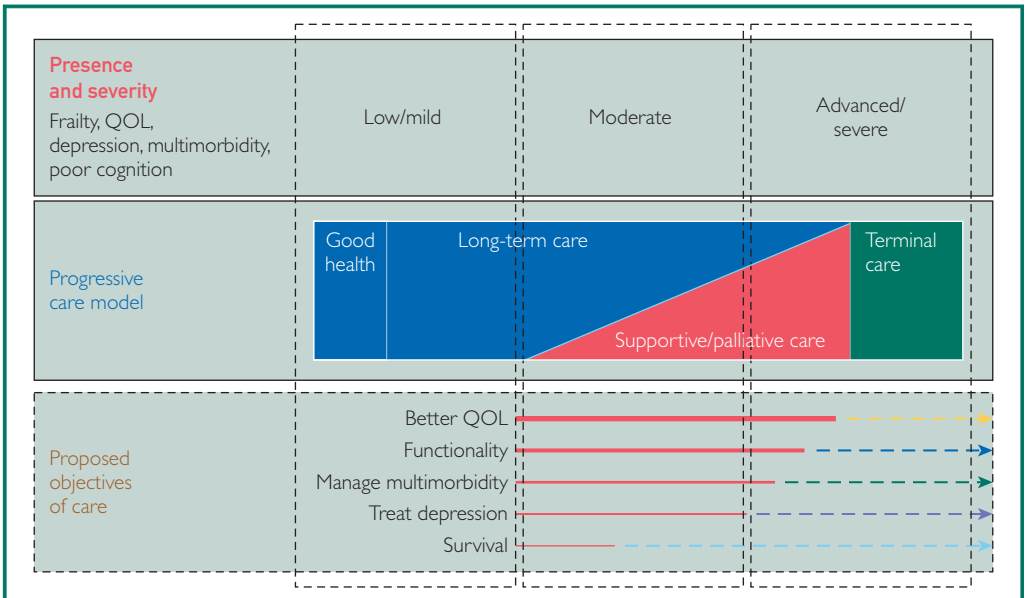

FIGURE 6. This model illustrates the importance of determining the presence and severity of comprehensive geriatric assessment when determining a patient's objectives for care. For example, a patient with no or mild frailty who is cognitively intact and without depression or multimorbidity will enjoy good health and can live independently. For such a patient, the goal of care with any treatment is to improve survival, maintain functionality, and further improve quality of life. However, with increasing severity of these constructs (eg, a patient with advanced frailty and multimorbidity), the model of care transitions from long-term care to supportive or palliative care, and the objectives of care shift from improvement in survival to provision of better quality of life and functionality. Modified with permission from Porter.[187]
QOL = quality of life.

patient-driven broad and interconnected goals as the fundamental drivers of management (Figure 6). Assessment of these variables in clinical practice is heterogeneous, likely because of time constraints, unfamiliarity, care provided by multiple providers, and marked disparities between provider-assessed and patient-reported health. The varying clinical interpretations of CGAs and their limited feasibility in clinical practice are additional barriers to their widespread acceptance.

We propose modifying the existing patient-reported health status paradigm. In this new model, dimensions of risk (eg, frailty and cognition) are added to an existing health status domain, and key instruments for their measurement are used. The patient's current health is a prognostic marker for future adverse events. Many of the components included in CGAs are modifiable and may be useful in targeting health care resources. For example, home health, rehabilitation, and case or disease management can be targeted when seeking to improve QOL, frailty, comorbidity, poor cognition, or depression.

CGA can quantify accurately the patient's risk over and above that measured by traditional cardiovascular risk factors. Components of the CGA are complementary to the medical history, physical examination, and routine diagnostic tests. The information obtained from a CGA can evaluate QOL, judge procedural appropriateness, and lay the foundation for shared decision-making. In addition, a longitudinal assessment may be useful for clinical monitoring. For example, in the Eplerenone Post-AMI Heart Failure Efficacy and Survival trial, each five-point decline in the KCCQ overall summary score was associated with

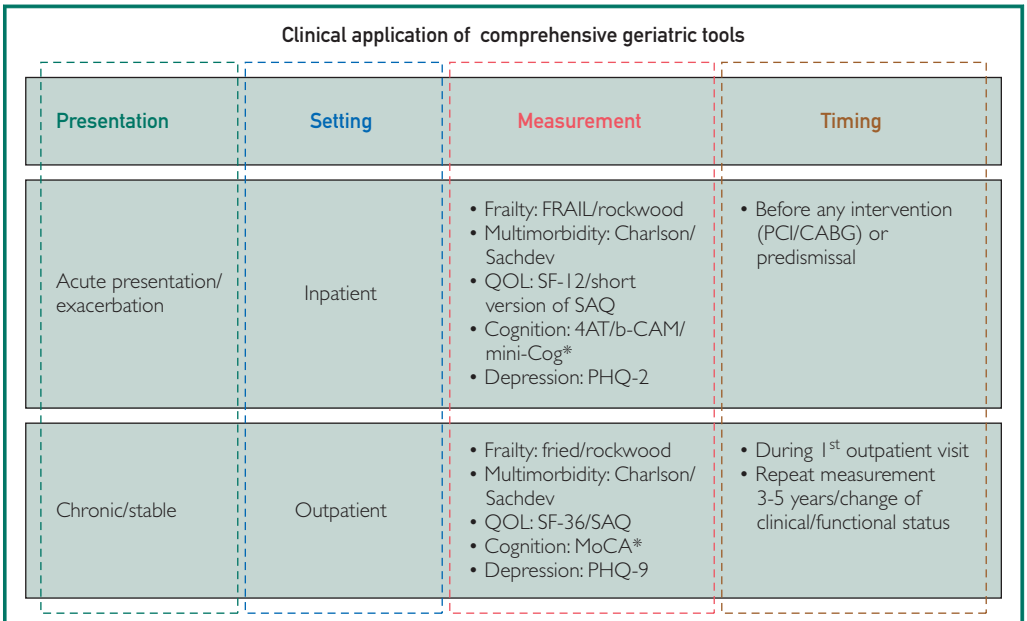

FIGURE 7. Comprehensive geriatric assessment can largely be based on the acuity and setting of patient's presentation. When a patient presents with myocardial infarction, heart failure worsening, or an arrhythmic event, focus should be on data extraction from hospital records and simpler screening tests with minimal participant burden. For example, shorter versions of questionnaires for depression and QOL and screening questionnaires (FRAIL) for frailty will suffice. In addition, hospital records should be used to assess multimorbidity and to calculate deficits for the Rockwood's frailty criteria. More elaborate tests/questionnaires can be used during outpatient evaluation such as Fried criteria for frailty, longer versions of questionnaires for quality of life (Seattle Angina Questionnaire or Short-Form 36). During inpatient setting, the measurement by trained allied health staff should be done before discharge and entered into patient's records or before a major decision needs to be made for surgery or complex coronary intervention. Patients with significant impairment in multiple domains should be referred to a geriatrician. *There is no one extensively validated cognitive assessment tool to be applied for the acute setting. However, screening tools assessing delirium (eg, 4AT)[188] and other shorter cognitive assessment tool (eg, Mini-Cog) will allow a brief cognition assessment (ie, a neuro "vital signs" measure), identifying cognitive vulnerability and guiding future treatment would be of value. Similarly, in the in/outpatient setting, the MoCA tool, validated for geriatric patients, has comparable accuracy to MMSE and is less intensive to administer, may be of value. CABG = coronary artery bypass graft; CAM = Confusion Assessment Method; MMSE = Mini-Mental State Examination; MoCA = Montreal Cognitive Assessment; PCI = percutaneous coronary intervention; PHQ = patient health questionnaire; QOL = quality of life; SAQ = Seattle Angina Questionnaire.

subsequent adverse cardiovascular events (hazard ratio, 1.11; 95% CI, 1.05-.1.07) after adjusting for traditional cardiovascular risk factors.[188]

Clinical Framework for CGA

Type of CGA (Figure 7) is largely determined by the acuity and setting of patient's presentation. When patient presents with MI, HF worsening, or arrhythmic event, focus should be on data extraction from hospital records and simpler screening tests with minimal participant burden. For example, shorter versions of questionnaires for depression and QOL and screening questionnaires (FRAIL) for frailty will suffice. In addition, hospital records may be used to assess multimorbidity and to calculate deficits for the Rockwood's frailty criteria. More elaborate tests/questionnaires can be used during outpatient/research evaluation such as Fried criteria for frailty, longer versions of questionnaires for QOL (SAQ or Short Form−36). During inpatient setting, the measurement by trained allied health staff should be done before discharge and

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entered into patient's records or before a major decision needs to be made for surgery or complex coronary intervention. Patients with significant impairment in multiple domains should be referred to a geriatrician.

CONCLUSION

This review underscores the principal tenet of health care endorsed by the AHA, to help people live longer and better lives by improving survival and health. Measurement and management of patient-centered issues provide essential additional information about risk and prognosis such that patient preferences and shared decision-making take the center stage in the management of older persons with CVD.

Abbreviations and Acronyms: **ADL** = activities of daily living; **CVD** = cardiovascular disease; **HF** = heart failure; **KCCQ** = Kansas City Cardiomyopathy Questionnaire; **MI** = myocardial infarction; **PCI** = percutaneous coronary intervention; **QOL** = quality of life; **SAQ** = Seattle Angina Questionnaire

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