Frailty and aortic valve disease

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Frailty is a common occurrence in elderly persons and is present in approximately half of the patients being screened for transcatheter aortic valve replacement (TAVR) therapy. Accurate assessment of the likelihood of benefit from intervention in the older patient with aortic stenosis is critical with both surgical aortic valve replacement and TAVR now available. Whereas risk algorithms are available that are helpful in predicting outcomes in patients undergoing surgical procedures, measures of frailty are not included in the algorithms. When considering intervention in the elderly patient, the addition of frailty assessment to determine the true risk in this population is essential to determine potential benefit. Gait speed as determined by the 5-m walk test is the most commonly used single test objective measurement of frailty in patients undergoing cardiac surgery and is an independent predictor of mortality and major morbidity. Wider application of this and other objective measures of frailty in the population undergoing TAVR is necessary to determine whether it is predictive in this population also. (J Thorac Cardiovasc Surg 2013;145:S7-10)

Frailty is a commonly encountered condition in elderly patients that needs to be considered when weighing treatment options. Although frailty is a relatively easy concept to describe, it is much more difficult to define and measure clinically. Akin to Supreme Court Justice Potter Stewart's oft-quoted pronouncement on pornography, ''I can't define it, but I know it when I see it,'' most physicians face the same conundrum when assessing frailty.[1] Clinicians often euphemistically refer to the ''eyeball test'' or ''end of the bed-o-gram'' when assessing the likelihood that a patient will survive and receive benefit from a contemplated procedure.

The ability to understand procedural risks in the frail elderly patient is necessary to guide decision making. Many risk algorithms have been developed that take into account age and comorbid medical conditions, and models based on these have been constructed that are predictive of outcomes after surgical procedures. However, defining frailty, measuring the role it plays in outcomes, and incorporating frailty parameters into risk algorithms have proved elusive.[2] Although risk increases with chronologic age and comorbidity, these factors alone are insufficient to predict outcomes and benefit. More discriminatory assessments are needed to understand why, despite equal measured risk, some individuals do well whereas others do not.

DEFINING FRAILTY IN ELDERLY PATIENTS

The elderly population is growing and living longer. In the United States today, an individual at age 80 years still has almost 9 years of life expectancy, so that treatments that can optimize the quality of remaining years of life are of great potential value.[3] However, with age comes a loss in complex adaptations across organ systems, yet substantial heterogeneity in biological aging is known.[4] Those who are least adaptive to the process of aging, we define as frail.

Frailty is formally defined as a clinical syndrome of multisystem impairment that results in a decreased physiologic reserve and an increased vulnerability to stressors.[5] The biology of frailty has been associated with shortened telomeres, cell senescence, a generalized catabolic state, and alterations in brain neurotransmitters, inflammatory, and coagulation pathways.[6] The phenotype of frailty can be described as decreased physical function associated with sarcopenia, osteopenia, and cognitive impairments.[7] Furthermore, frailty, or declines in organ and physiologic reserves, may be ''subclinical'' and apparent only in hindsight.

The prevalence of frailty in community-dwelling elders is about 15% at age 70 years and increases to 40% past age 85 years, whereupon there is no further increase.[8] Although it is rare to find frail individuals under age 70 years, prevalence never exceeds 50% even past age 90 years, because frail individuals do not survive to the oldest ages.[9] Frailty is dynamic to some degree, with frailty criteria disappearing over time in up to 20% of frail individuals, as well as developing over time in others.[8] Frailty, easy to describe as a concept, is more complicated to capture and define for several reasons. First, frailty is distinct from comorbidity and disability, both of which are commonly collected conditions. In fact, in the Cardiovascular Health Study, 27% of people with frailty had no comorbidity or disability.[5] Comorbidity and disability overlap with frailty, but disability is considered an outcome as much as a descriptor. Comorbidity—specifically the sum of noncardiac comorbidities—is a marker of advanced risk, but itself is not frailty. This suggests that aspects of frailty may be amenable to intervention. In the most frail of patients, the degree of

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Abbreviations and Acronyms

CI = confidence intervals
OR = odds ratio
PARTNER = Placement of AoRTic TraNscathetER Valve (Trial)
STS = The Society of Thoracic Surgeons
TAVR = transcatheter aortic valve replacement

debilitation can be such that the likelihood of meaningful functional recovery after a successful procedure is small. This leads to the clinical quandary of ''utility versus futility.'' The question is: can we define the degree of the vulnerability to stressors that is so great that despite a successful intervention to cure or alleviate a particular condition, long-term survival, meaningful recovery, and improved quality of life and functional outcomes are unlikely to occur?

MEASURING FRAILTY

There is no gold standard for defining frailty, and the range of available measures raises issues as to how to collect this consistently. Although the eyeball test is appealing, there is too much variability from patient to patient and from physician to physician because of lack of objectivity and varying experience. The available frailty scores are objective but are limited by lack of prospectively available data values, especially in patients undergoing surgical or interventional procedures, and capture only some aspects of frailty in selected organ systems. Moreover, it is relatively cumbersome and time-consuming in a busy clinical practice to gather sufficient information to truly capture frailty.

There are more than 20 multidimensional frailty scales in the published literature that capture aspects of slowness, weakness, low activity, exhaustion, cognitive impairment, and nutrition, among others[7,9,10] (Table 1). Geriatric impairments (falls, incontinence) have also been included in these composite scores. Physical performance assessments such as gait speed and grip strength offer advantages in that they are objective, statistically robust, and capture the integrated function of the individual. These continuous measures can be analyzed at various cut points and require no language translation, in contrast to the subjective activity questionnaires. In a pooled analysis of individual data from 9 selected cohorts studying survival in elderly persons, gait speed was associated with survival in older adults.[10]

FRAILTY IN PATIENTS WITH CARDIAC DISEASE

As one would expect, the prevalence of frailty in the elderly population with cardiac disease is great and carries prognostic significance. In a review of 9 studies encompassing 54,250 elderly patients with a mean weighted follow-up of 6.2 years, cardiovascular disease was associated with an odds ratio (OR) of 2.7 to 4.1 for prevalent frailty and an OR of 1.5 for incident frailty in those who were not frail at baseline. Gait velocity as a measure of frailty was associated with an OR of 1.6 for incident cardiovascular disease. In elderly patients with documented severe coronary artery disease or heart failure, the prevalence of frailty was 50% to 54%, and this was associated with an OR of 1.6 to 4.0 for all-cause mortality after adjusting for potential confounders.[11] The prevalence of frailty was also defined in a recent study of hospitalized older adults with severe coronary artery disease.[12] With the use of gait speed, grip strength, and chair stands, 2 frailty phenotypes (composite A and composite B) were defined in 309 consecutive inpatients aged 70 years and older with a minimum of 2-vessel coronary artery disease. This was then correlated with 6-month mortality. The prevalence of frailty was 27% for composite A versus 63% for composite B. The utility of single-item measures for identifying frailty was greatest for gait speed, followed by chair stands and grip strength. Slow gait speed ($\leq$0.65 m/s) and poor grip strength ($\leq$25 kg) were the strongest predictors of 6-month mortality.

FRAILTY IN PATIENTS WITH AORTIC STENOSIS

In the evaluation of frailty in patients with aortic stenosis, an additional question, is how much of a role does the aortic stenosis play in frailty? The implications are 2-fold. First, the patient may be too frail to survive a procedure to relieve the aortic stenosis. Second, even if the patient survives the procedure, what is the likelihood that the frailty will improve and that there will be an improved quality of life and functional outcome?

The prevalence of frailty in aortic stenosis was recently defined in a series of 102 older adults being screened for transcatheter aortic valve replacement (TAVR).[13] Sixty-three percent of patients had a slow gait speed (<0.5 m/s). There was a strong association between slow gait speed and dependent functional status, with the authors concluding that assessment of gait speed is a useful, objectively measurable risk stratification tool in this population.

In our own center, we have tested gait speed in 200 consecutive patients with aortic stenosis being screened for TAVR; 53.5% of patients, mean age 80.5 $\pm$ 8.8 years, met the criteria for frailty, with a gait speed of less than 6 seconds for the 5-m walk test. Clinicians were blinded as to the results of gait speed when evaluating these patients. Patients with normal gait speed were more often selected for surgical aortic valve replacement than those with a slower gait speed, who were more often treated with either TAVR or medical therapy. This suggests to us that gait speed may be an objective surrogate for the eyeball test.

TABLE 1. Tests for measurement of frailty in different domains

- Slowness:
  - Gait speed (walk time)
  - Get up and go
  - Chair stands
  - Balance
  - SPPB
- Weakness:
  - Grip strength
  - Calf circumference
- Low activity:
  - Physical function (SF-36 PF, DASI)
  - Inactivity
  - Minnesota Leisure Time Scale
- Exhaustion:
  - Fatigue scales (CES-D)
- Cognitive impairment:
  - MMSE
  - TICS-M
  - Dementia
  - Trails Test
  - Word Recall
  - Clock Drawing
- Nutrition:
  - Body mass index
  - Weight loss
- Other:
  - Activities of daily living
  - Falls
  - Hearing or vision impairment
  - Polypharmacy
  - Incontinence
  - Comorbidity count
  - Depression (GDS)
  - Mood disturbance

SPPB, Short Physical Performance Battery; *SF-36 PF,* Short Form–36, physical functioning; *DASI,* Duke Activity Status Index; *CES-D,* Center for Epidemiological Studies Depression Scale; *MMSE,* mini–mental state examination; *TICS-M,* Modified Telephone Interview for Cognitive Status; *GDS,* Geriatric Depression Scale.

Whether frailty as defined by gait speed is a determinant of outcomes after TAVR, however, remains to be determined.

FRAILTY IN PATIENTS UNDERGOING CARDIAC SURGERY

The use of tools for the assessment of frailty in patients undergoing cardiac surgery is increasing. In a multicenter prospective cohort of 131 elderly patients undergoing cardiac surgery at 4 tertiary care hospitals, the value of gait speed—a clinical marker for frailty—was used to improve the prediction of mortality and major morbidity.[14] Patients were eligible for the study if they were 70 years of age or older and were scheduled for coronary artery bypass and/or valve replacement or repair. Sixty (46%) patients were classified as slow walkers before cardiac surgery: they were more likely to be female (43% vs 25%; $P = .03$) and diabetic (50% vs 28%; $P = .01$). Thirty (23%) patients had the primary composite end point of mortality or major morbidity after cardiac surgery. Slow gait speed was an independent predictor of this composite end point after adjusting for The Society of Thoracic Surgeons (STS) risk score (OR, 3.05; 95% confidence interval [CI], 1.23-7.54).

These findings were subsequently amplified by another study by the same authors.[15] The study hypothesis was that cardiac surgery risk scores perform poorly in elderly patients, in part because they do not take into account frailty and disability, which are critical determinants of health status with advanced age. Combining established cardiac surgery risk scores with measures of frailty and disability could provide a more complete model for risk prediction in elderly patients undergoing cardiac surgery.

Four different frailty scales, 3 disability scales, and 5 cardiac surgery risk scores were measured in all patients. The primary outcome was the STS composite end point of in-hospital postoperative mortality or major morbidity. A total of 152 patients were enrolled, with a mean age of 75.9 ± 4.4 years; 34% were women. Depending on the scale used, 20% to 46% of patients were found to be frail, and 5% to 76% were found to have at least 1 disability. The most predictive scales in each domain were as follows: 5-m gait speed greater than 6 seconds as a measure of frailty (OR, 2.63; 95% CI, 1.17-5.90); more than 3 impairments in the Nagi scale as a measure of disability (OR, 2.98; 95% CI, 1.35-6.56), and either the Parsonnet score (OR, 1.08; 95% CI, 1.04-1.13) or the STS Predicted Risk of Mortality or Major Morbidity (STS-PROMM) (OR, 1.05; 95% CI, 1.01-1.09) as a cardiac surgery risk score.[16] The authors concluded that clinicians should use an integrative approach combining frailty, disability, and risk scores to better characterize elderly patients referred for cardiac surgery to identify those that are at increased risk.

Another recent additional ''comprehensive assessment of frailty'' was performed in 400 patients undergoing cardiac surgery, mean age 74 years.[17] The frailty score combined characteristics of the Fried criteria, patient phenotype, physical performance, and laboratory results. Patients underwent isolated coronary artery bypass grafting ($n = 90$), isolated valve surgery ($n = 128$), transcatheter valve implantation ($n = 59$), or combined procedures ($n = 123$). The primary end point was the correlation of a frailty score to 30-day mortality. There were low-to-moderate albeit significant correlations of the frailty score with the STS score and EuroSCORE ($P < .05$). There was also a significant correlation between the frailty score and observed 30-day mortality ($P < .05$). The authors concluded that a comprehensive assessment of frailty is an additional tool to evaluate elderly patients adequately before cardiac surgical interventions and that a combination of the new frailty score and the traditional scoring systems may facilitate more accurate risk scoring in elderly high-risk patients scheduled for conventional cardiac surgery or TAVR.

TABLE 2. Tests for assessment of frailty in the PARTNER Trial

1. Grip strength (<18 kg)
2. 5-m walk (>6 s)
3. Serum albumin (<3.5 mg/dL)
4. Katz ADLs (4/6 or less)

PARTNER Trial, Placement of AoRTic TraNscathetER Valve Trial; *ADLs,* activities of daily living.

Because of the shortcomings of the current risk prediction models in elderly patients undergoing cardiac surgery, and based on some of the aforementioned studies, frailty as determined by gait speed has recently been added to the STS Database (version 2.73) starting July 2011.

In the PARTNER Trial of TAVR, frailty parameters are being prospectively collected as a routine part of evaluation for entry into the trial. A frailty index is being used to classify patients as frail. For frailty to be the sole or primary reason for inoperability, 3 of 4 criteria listed in Table 2 must be fulfilled.

CONCLUSIONS

As the population ages, accurate assessment of the likelihood of benefit from intervention in the elderly is critical. This is especially true in the older patient with aortic stenosis, in whom less invasive therapeutic options have become available. The ability to distinguish those patients who are dying *of* aortic stenosis from those who are dying *with* aortic stenosis can be a perplexing clinical conundrum. The determination of ''utility versus futility,'' wherein there is the possibility of no improvement in quality of life even if the patient undergoes a successful procedure, is gaining increasing importance. Many risk algorithms are available that accurately predict outcomes after cardiac surgery. They all lose accuracy, however, when applied to the elderly population in whom other factors that are not accounted for in the various predictive models—such as frailty—predominate.

Frailty is a common occurrence in elderly persons, characterizing between 40% and 70% of the population studied. It occurs in approximately half the candidates being screened for transcatheter aortic valve therapy. Gait speed as determined by the 5-m walk test is the most commonly used single test objective measurement of frailty in patients undergoing cardiac surgery and is an independent predictor of mortality and major morbidity. Wider application of this and other measures of frailty in the population undergoing TAVR will be necessary to determine whether it is also predictive in this population undergoing this interventional procedure.

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