Frailty as a risk predictor in cardiac surgery: Beyond the eyeball test

Bobby Yanagawa, MD, PhD, FRCSC,^a Michelle M. Graham, MD,^b Jonathan Afilalo, MD,^c Ansar Hassan, MD,^d and Rakesh C. Arora, MD, PhD^{e,f}

From the ^aDivisions of Cardiac Surgery, St Michael's Hospital, University of Toronto, Toronto, Ontario, Canada;

^bDivision of Cardiology, University of Alberta and Mazankowski Alberta Heart Institute Edmonton, Edmonton, Alberta, Canada; ^cDivision of Cardiology and Centre for Clinical Epidemiology, Jewish General Hospital, McGill University, Montreal, Quebec, Canada; ^dDalhousie Medicine New Brunswick, Saint John, New Brunswick, Canada; Cardiovascular Research New Brunswick, New Brunswick Heart Centre, Saint John Regional Hospital, Saint John, New Brunswick, Canada; ^eSection of Cardiac Surgery, Department of Surgery, Max Rady College of Medicine, University of Manitoba, Winnipeg, Manitoba, Canada; and ^fCardiac Sciences Program, St Boniface Hospital, Winnipeg, Manitoba, Canada.

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Address for reprints: Bobby Yanagawa, MD, PhD, FRCSC, Division of Cardiac Surgery, St Michael's Hospital, 30

Bond St, 8th Floor, Bond Wing, Toronto, ON M5B 1W8 Canada (E-mail: YanagawaB@smh.ca).

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Three-strikes model of frailty. Adapted with permission.⁵

Central Message

Frailty is an outcome modifier in cardiac surgery.

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Over the past 50 years, there have been dramatic improvements in cardiac surgical processes and outcomes that allow for procedures to be performed safely on older and sicker patients. In the current era of cardiac surgery, more than half of cases are being performed in patients aged 75 years and older, and 25% to 50% of these aged patients can be considered “frail.”^{1,2}

Successful surgical correction of cardiac disease has the potential to restore biologic function and provide substantial benefit even for older adult patients.^{3,4} However, conventional cardiac surgery is associated with substantial iatrogenic stress, which can affect outcomes. Frail patients are vulnerable in that they are more susceptible to the complexity of surgical process, are at greater risk for complications after surgery, and are less likely to recover function postoperatively (Figure 1).⁵

WHAT IS FRAILTY AND IS IT A RISK PREDICTOR IN CARDIAC SURGERY?

Frailty is a syndrome characterized by vulnerability to stressors due to loss of physiologic reserve. The phenotype of frailty encompasses the patient factors of exhaustion, malnutrition, wasting, weakness, slowness, and inactivity.⁶ Often seen in the older adult, frailty is an important but still underused determinant of treatment outcome in cardiac surgery. The literature has largely focused on the biological or physical aspects of frailty as a risk factor; however, more recently, there is greater appreciation for the psychologic and social aspects of frailty, which may also result in negative postoperative outcomes.^{7,8}

Chronological age is inextricably linked to frailty but should not be the sole determinant in determining operative vulnerability or assignment of treatment futility. Younger

patients can also be frail. In fact, the Canadian Health Measures Study determined that the prevalence of frailty was 2% to 5% in those aged 18 to 34 years, 4% to 6% in those aged 35 to 49 years, 7% to 12% in those aged 50 to 64 years, and 8% to 20% in those aged 65+ years.⁹ We tend to associate frailty with low body mass index because obese patients tend to have greater metabolic reserve and can cope better with catabolic stimuli seen in chronically advanced heart failure and acutely in cardiac surgery; this is referred to as the “obesity paradox.”¹⁰ However, obese patients also can be frail, a phenomenon referred to as “sarcopenic obesity.” Sarcopenia is an age-associated decline in skeletal muscle that when coupled with obesity can beget frailty, disability, and adverse cardiovascular outcomes linked to metabolic syndrome.¹¹ The major issue is the low muscle mass, associated with low metabolic reserve and poor coping with catabolic stimuli, and not the excess fat mass.

There are now ample data to support the notion that frailty is a risk predictor for poor outcomes after cardiac surgery. A recent systematic review demonstrated the association between frailty and adverse outcomes, which was particularly true for older patients undergoing transcatheter aortic valve replacement (TAVR).¹² Frailty was also associated with a 3-fold increase in mortality among older adult patients in a multicenter prospective database.¹³ Not surprisingly, frailty is also independently associated with prolonged length of stay, need for critical care resources, discharge to specialized facilities, and readmission to the

FIGURE 1. Three-strikes model of frailty. Adapted with permission from Arora RC, Djaiani G, Rudolph JL. Detection, prevention, and management of delirium in the critically ill cardiac patient and patients who undergo cardiac procedures. *Can J Cardiol.* 2017;33:80-7.

hospital, suggesting an even higher surgery-related health-care cost burden.

HOW DO WE MEASURE FRAILITY?

Traditionally, surgical teams have evaluated frailty by the end-of-bed “eyeball test.” “Eyeballing,” although of some value, is subjective and tends to be inconsistent with poor inter-rater reliability.¹⁴ By way of analogy, one cannot judge the state of a car by simply examining the outward appearance alone. One needs to open the hood and take a look at the engine for a proper evaluation. To facilitate a more granular examination of the preoperative older adult, there are more than 20 different validated objective assessment tools for frailty, but at present there is no widely accepted, standardized measure for cardiac surgical patients.

There are 2 broad types of frailty assessment tools: phenotypic and index-based tools. A phenotype describes a set of observable characteristics. For example, the Fried frailty phenotype defines 5 key domains: slow gait speed, weak handgrip strength, unintentional weight loss, and questionnaire-based assessments of low physical activity and exhaustion.⁶ Fried and colleagues conceptualize frailty as a distinct biologic syndrome and as such, does not include medical comorbid conditions. Those with impairment in 3 or more of the 5 domains are considered frail. An index-based approach, on the other hand, conceptualizes frailty in terms of the numeric count of deficits, which can be loosely defined as age-related conditions, signs, symptoms, or disabilities that are associated with poor prognosis.¹⁵ Although 92 candidate deficits were originally identified to assess the frailty index, it was subsequently determined that as few as 30 provide sufficient resolution for effective measurement. There are also single

performance measures such as the chair rise test, timed up and go test, and others, which can be rapidly performed in a clinical setting.

The optimal frailty assessment for cardiac surgical patients should have high predictive ability, be quick and easy to perform (or calculate), and, if a performance measure, be practical for most patients awaiting surgery. Several assessments have been shown to be predictive for clinical outcomes in patients undergoing cardiac surgery.^{16,17} Afilalo and colleagues¹⁸ found that slow preoperative gait speed had a 2- to 3-fold increased risk predictive ability beyond the Society of Thoracic Surgery-Predicted Risk of Mortality or Major Morbidity and European System for Cardiac Operative Risk Evaluation (euroSCORE). Afilalo and colleagues¹⁹ recently performed a prospective, multi-center study of head-to-head comparison of frailty assessments in elderly patients undergoing TAVR versus surgical aortic valve replacement to determine which frailty assessment optimally predicted all-cause mortality and disability. The 4-item Essential Frailty Toolset (encompassing lower-extremity weakness, cognitive impairment, anemia, and hypoalbuminemia) best predicted mortality, disability at 1 year, and death at 30 days.

The Clinical Frailty Scale (CFS) is another practical instrument that could be used at the bedside to initiate the process of frailty screening by the perioperative team. The CFS, a tool born from a mathematical accumulation of deficit model of frailty, can function as a standardized eyeball test for determining frailty status based on a categorized, subjective clinical judgment of the evaluator and may be a reasonable first choice in making frailty assessments.²⁰ Frailty status as defined by a CFS score greater than 4 could serve as an indication to a clinician to initiate frailty-targeted management (Table 1).

TABLE 1. The Canadian Study of Health and Aging Clinical Frailty Scale

Score	Description
1	Very fit: robust, active, energetic, well motivated, and fit; these people commonly exercise regularly and are in the most fit group for their age
2	Well: without active disease, but less fit than people in category 1
3	Well, with treated comorbid disease: disease symptoms are well controlled compared with category 4
4	Apparently vulnerable: although not frankly dependent, these people commonly report being “slowed up” or having disease symptoms
5	Mildly frail: with limited dependence on others for instrumental activities of daily living
6	Moderately frail: help is needed with both instrumental and noninstrumental activities of daily living
7	Severely frail: completely dependent on others for the activities of daily living or terminally ill

CAN FRAILTY ASSESSMENT HELP TO DETERMINE WHETHER THERE IS A NET CLINICAL BENEFIT OF SURGERY?

Incorporating health priorities near the end of life has long been a part of decision-making for patients who undergo certain cardiac procedures. Innovations in percutaneous coronary intervention, TAVR, and transcatheter mitral interventions have intensified interest in frailty more broadly. For instance, frailty has become a key selection criterion for use of TAVR versus surgical aortic valve replacement. Gradients of frailty also became relevant to select those who would most benefit. The incorporation of frailty should be part of the patient evaluation process to better conceptualize discussion of desired outcomes facilitating shared decision-making and palliative care discussion within a value-based healthcare paradigm.

HOW CAN RISK SCORES INCORPORATE FRAILTY MEASURES?

It is clear that we need improved decision tools for surgical treatment of the frail. The 2 major scoring systems that are commonly used to predict the risk of negative outcomes after cardiac surgery are the Society of Thoracic Surgery-Predicted Risk of Mortality or Major Morbidity and the euroSCORE II. The euroSCORE II typically overestimates perioperative risk, whereas the Society of Thoracic Surgeons score underestimates perioperative risk in frail patients.^{21,22} The exhaustive list of variables entered into the models does not include frailty. Although these tools have incorporated age, both models, in their current iteration, focus on “traditional” physiology variables and thus provide information limited to the patient’s physiologic vulnerability. It is becoming increasingly evident that a

more comprehensive assessment that involves the psychologic and social frailty assessments as part of their algorithm is necessary for the contemporary cardiac surgery patient.

To this point, the Society of Thoracic Surgeons has included 5-m gait speed as a marker of frailty in their most recent iteration of the adult cardiac surgery database (Version 2.73). Greater incorporation of frailty assessment into clinical databases and clinical risk scores for cardiac surgery patients will provide surgeons and their patients with important information about risk and assist with shared decision-making, as well as arming health economists with information to plan healthcare costs. With the aging cardiac surgery demographic, it is necessary for registries to include measures of frailty to permit longitudinal analysis of outcomes after intervention decisions in the frail older adult. It is equally necessary for clinical trials to collect measures of frailty to catalyze comparative effectiveness research testing the differential risks and benefits of interventions in frail versus nonfrail patients. The goal is to ensure patients not only survive after cardiac surgery but also thrive as well, with the maintenance of acceptable health-related quality of life and functional independence.²³ Indeed, a question that the cardiac surgery community must start to consider is whether poor outcomes in the frail older adult should serve as a quality metric of a cardiac surgical program.

CAN WE “DEFRAIL” THE OLDER ADULT CARDIAC SURGERY PATIENT?

Beyond frailty assessments, identification of at-risk frail individuals and the evaluation of risk versus benefit in these patients, consideration must be given to how frail patients may be better prepared for their procedure. Frail patients will benefit from earlier identification and mitigation of patient vulnerabilities with a targeted strategy to improve nutritional status and functional capacity.⁵ For elective patients, identification of frailty may trigger the initiation of preoperative rehabilitation or “prehab.” Building on work by Arthur and colleagues,²⁴ a small pilot randomized controlled trial of prehab (n = 7) versus standard care (n = 8), including exercise and education classes for 60 minutes/day, twice weekly for at least 4 weeks versus standard care (n = 8) was carried out for patients undergoing coronary artery bypass grafting and valvular surgery.²⁵ Patients in the prehab group experienced improvement in walk distance and gait speed compared with baseline and higher enrolment in cardiac rehabilitation when compared with the standard care group.

Pre-operative Rehabilitation for Reduction of Hospitalization After Coronary Bypass and Valvular Surgery is a multicentre, randomized, open end point, controlled trial using assessor blinding and intent-to-treat analysis that is currently under way to better examine the effect of prehab

in the setting of frailty ([ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT02219815) NCT02219815). Frail, older adult cardiac surgical patients are being recruited and randomized to receive standard of care versus an 8-week exercise and education intervention at a certified medical fitness facility (2 times per week; aerobic exercise at 40%-60% of heart rate reserve). The primary outcome of the trial is the proportion of patients requiring a hospital length of stay greater than 7 days. Yet another initiative is the Protein and Exercise to Reverse Frailty in OldeR Men and women undergoing Transcatheter Aortic Valve Replacement. This is a multicenter randomized clinical trial of a home-based exercise program and protein-rich nutritional supplement versus usual lifestyle counseling for patients aged 70 years or more with evidence of physical frailty undergoing TAVR ([ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT03522454) Identifier: NCT03522454). The primary end point is improvement in frailty as determined by the Short Physical Performance Battery score 3 months postprocedure.

INTERDISCIPLINARY TEAM

In some cases, the level of frailty may be excessive for open surgery, which may warrant consideration for a less-invasive minimally invasive surgical approach or hybrid or interventional procedure. Alternatively, a given patient may not receive any benefit from intervention because it may accomplish neither mortality benefit nor symptom relief. At present, the cut-point of frailty being “too high” is unclear, and we advocate for an Interdisciplinary Team-based approach. For elective patients, a geriatrics specialist can help to identify vulnerable patients, correct reversible frailty-related preoperative patient characteristics, and help the team better care for such patients in the postoperative period. Other key members of the interdisciplinary team may include physiotherapists, nutritionists, and social workers.

AN ECONOMIC ARGUMENT

Healthcare systems will have to plan for the large increase in aging among the world's population. By the year 2050, it is estimated that the population of those aged 65 years will grow to 2 billion. Care of the frail and older adult consumes a disproportionate and increasing proportion of our healthcare dollars. A recent report highlighted an approximately 30% increase in hospitalization cost associated with cardiac surgery in frail patients.²⁶ The fact that cardiac surgery in frail patients is more costly in and of itself is not surprising, given that the older adult is more prone to longer intensive care unit stays, greater rates of complications, greater blood product use, and higher likelihood of transfer to rehabilitation and other nonhome facilities, as well as hospital readmission and homecare services, all of which drive excess costs.

An often-pondered economic question is whether undertaking cardiac surgery procedure in frail patients is an

appropriate use of our limited healthcare dollars. To answer this question, we need to better understand the direct and indirect costs associated with nonoperative (medical and interventional) management of such frail patients, including costs of increased follow-up care, recurrent hospitalizations, and so forth that may result from the inadequate resolution of the primary problem. A recent and important investigation by Gainer and colleagues²⁷ identified 5 main themes that are important to the frail older adult and their caregivers (educational barriers, educational facilitators, patient autonomy and perceived autonomy, patient and family expectations of care, and decision-making advocates) that are likely impactful to the frail older adult and their caregivers. A consistent barrier within each of these themes is the perception of a time constraint in the current consent process. These findings have been observed in both cardiac and noncardiac patient populations for whom the development of decision aids or the implementation of a decisional “coach” has been advocated to facilitate a shared-decision making process in patients with chronic conditions facing decisions involving invasive, preference-sensitive therapy options.²⁸ As stated by Gainer and colleagues,²⁷ “given ...the trend toward older and frail patients referred for complex cardiac procedures, the need for an effective shared decision making process is compelling...” for the modern perioperative cardiac surgery team.

CONCLUSIONS

It is increasingly clear that the cardiac surgery community needs to actively participate in initiatives that address the perioperative management of the vulnerable, frail patient to improve our outcomes. This needs to be in the form of implementation of routine frailty assessments and targeted treatment of frail patients, knowledge translation, and the launch of high-quality clinical trials to de-frail our patients. Ultimately, we need to develop better tools with long-term outcome measures to assess the potential recovery trajectories of frail patients to facilitate better informed shared decision-making with the patient and caregivers. The Essential Frailty Toolset and CFS are 2 such practical, evidence-based scales of frailty. Frailty assessment may be used to help guide patient selection and shared decision making for surgery, as well as informing future studies of preoperative and postoperative interventions aimed at improving outcomes in frail patients at highest risk of adverse sequelae for all cardiovascular interventions.

Conflict of Interest Statement

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