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# Cardiac surgery in the frail patient: managing the increased risks

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**Abstract**

Frailty, as a reflection of biological age rather than chronological age, has been shown to predispose cardiac surgery patients to higher in-hospital mortality, major morbidity, institutional discharge, and reduced mid-term survival. With an increasing cardiovascular risk burden and the growing adoption of minimally invasive techniques for high-risk elderly patients deemed unsuitable for open surgery, the number of frail patients presenting for cardiac interventions is set to rise over the next few years. Identifying this vulnerable group of patients using comprehensive risk scoring systems, including frailty assessment tools, as well as disability and comorbidity assessments, helps individualize management to the physiological capacity of each patient and optimize the use of limited health care resources. Perioperative nutritional supplementation, physical rehabilitation, and pharmacological agents, together with a balanced anesthetic technique, may benefit the frail patient presenting for cardiac interventions. ■ *Heart Metab*. 2018;76:18-22

**Keywords:** frailty; pathophysiology; pre-habilitation; sarcopenia

## Introduction

Frailty is a concept that describes an impaired capability of an individual to recover from pathological or iatrogenic stressors.[1] Frailty is different from disability, as disability is the impaired ability to carry out functional tasks.[2] While the elderly may be frail, the frail individual may not be elderly. The pathophysiology of frailty is believed to be attributed to immune, endocrine, and metabolic dysfunction.[3] Increased inflammatory cytokines coupled with dysregulation of energy metabolism lead to a catabolic state, giving rise to "sarcopenia." Age-related decline and chronic diseases further potentiate this catabolic state and contribute to multiorgan dysfunction, impairing the homeostatic ability of the frail patient during a period of stress.[3] *Figure 1* describes the pathophysiology of frailty.

In cardiac surgery, frail patients were found to be at an increased risk of in-hospital mortality (odds ratio, 1.8; 95% CI, 1.1-3.0) and institutional discharge (odds ratio, 6.3; 95% CI, 4.2-9.4), as well as having reduced mid-term survival (hazard ratio, 1.5; 95% CI, 1.1 2.2).[4,5] These effects of frailty were independent of age. The use of 5-meter gait speed as a single measure of frailty, independently predicted operative mortality (odds ratio, 1.11 per 0.1 m/sec decrease in gait speed; 95% CI, 1.07-1.16) as well as the composite outcome of mortality or major morbidity.[6]

## Abbreviations

**CAF:** Comprehensive Assessment of Frailty; **EuroSCORE:** European System of Cardiac Operative Risk Evaluation; **PREHAB study:** PRE-operative rehabilitation for reduction of Hospitalization After coronary Bypass and valvular surgery; **PROMM:** Predicted Risk of Mortality or Major Morbidity; **STS:** Society of Thoracic Sugeons; **TAVI:** transcatheter aortic valve implantation

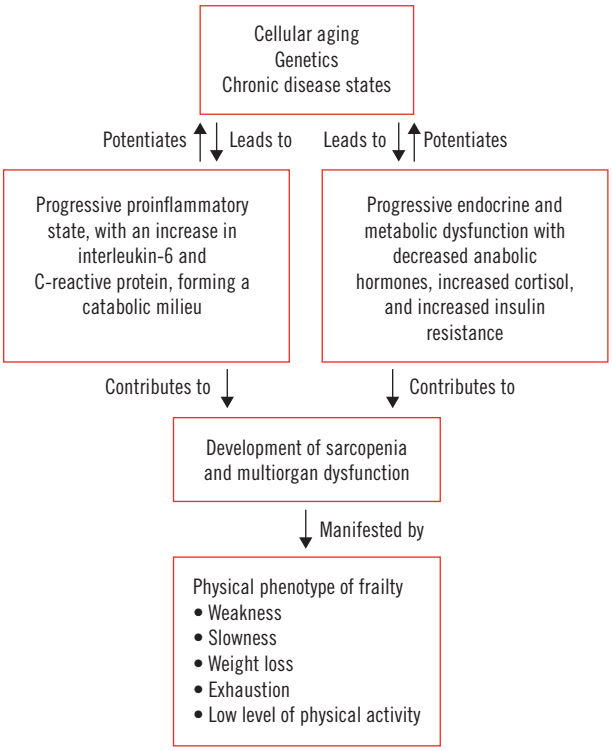


***Fig. 1*** *Flow diagram describing the pathophysiology of frailty. Cellular aging, chronic disease states, and genetic variation contribute to the development of a progressive proinflammatory state and endocrine and metabolic dysregulation. A catabolic state ensues, which further potentiates their root causes, leading to a vicious cycle and giving rise to multiorgan dysfunction and sarcopenia. The physical phenotype of frailty subsequently manifests in the form of weakness, slowness, weight loss, exhaustion, and low levels of physical activity.*

In transcatheter aortic valve implantation (TAVI) procedures, frailty was an independent predictive factor of increased late cumulative mortality risk (hazard ratio, 1.28; 95% CI, 1.10-1.49) and it was associated with poorer quality of life at 1 year.[7,8] Similar results were reported for aortic surgery, where the unadjusted 30-day/in-hospital and 1-year composite major morbidity and mortality outcomes were significantly worse for frail vs nonfrail patients.[9] In addition to poorer outcomes, the median cost for hospitalization for cardiac surgery was higher in frail patients compared with nonfrail patients, thereby increasing the economic burden on both families and societies.[10]

## Risk scoring

Traditional cardiosurgical operative risk scoring, such as the European System of Cardiac Operative Risk Evaluation (EuroSCORE) and Society of Thoracic Surgeons (STS) scores are predominantly based on a comorbidity assessment.[11-15] These scores do not consider frailty, which contribute to the physiological vulnerability of the patient.[11-15] The Comprehensive Assessment of Frailty (CAF) score developed by Sündermann et al has been found to correlate significantly with observed 30-day mortality.[16] At 1 year, a condensed version of this CAF score performed better than the STS and EuroSCORE in estimating mortality risk.[17] Scoring systems that have been described for use in the cardiac surgery population can be categorized into the domains of frailty, disability, and comorbidity.[18]

In the domain of frailty, various methods have been used for assessment, including:

- Physical phenotype, using the Fried Criteria[19];
- Physical performance, using 5-meter gait speed and handgrip strength;
- Sarcopenia, using psoas area and volume;
- Expert judgment-based tools, using the Clinical Frailty Score,[20] which is based on functional performance and independence: ranges from 1 (robust health) to 7 (complete functional dependence on others); and
- Multidimensional tools (including physical, cognitive, performance, self-rated health, psychological, social aspects), using the CAF score[16] (Fried criteria,[19] physical performance test, Clinical Frailty Score,[20] laboratory values of albumin, creatinine, and forced expiratory volume in 1 second, body mass index score), and the Edmonton Frail Scale[21] (9 domains: cognition, continence, functional independence, functional performance, general health status, mood, nutrition, social support, use of medication).

In the domain of disability, assessment tools that have been used include:

- Nagi Scale[22] (including difficulty pulling or pushing large objects, bending, crouching, kneeling, extending arms above the head, handling small objects with fingers, lifting more than 5 kg weight); and

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- Activities of Daily Living[23] (bathing, dressing, toileting, transferring, continence, feeding).

In the domain of comorbidity, scoring systems include:

- Parsonnet Score[24];
- EuroSCORE II[13]; and
- STS-PROMM (Predicted Risk Of Mortality or Major Morbidity).[14,15]

While there is significant heterogeneity in the criteria used for frailty and postoperative outcomes in the referenced studies, strong evidence exists for an association between frailty and adverse outcomes in cardiac surgery. Hence, incorporating standardized and validated scoring systems that include clinical, frailty, and disability assessments, as part of the preoperative evaluation process, will help identify patients at high risk of poor postoperative outcomes. With valid outcome estimates, the surgeons can formulate the best treatment options for their patients and help patients make informed decisions regarding their care.

## Perioperative intervention

Pre-habilitation, nutritional supplementation, and pharmacological therapies have been described,[25-27] some showing an improvement in outcomes, but evidence in the frail patient is lacking.[28,29] The length of stay in the intensive care unit and hospital were reduced after coronary artery bypass grafting surgery in low-risk patients who had been subjected to a preoperative 10-week exercise regimen; in addition, preoperative inspiratory muscle training has the potential to decrease the risk of respiratory complications.[28,29] Ongoing studies may give us clearer answers to these questions. The PREHAB study (PRE-operative rehabilitation for reduction of Hospitalization After coronary Bypass and valvular surgery), a multicenter randomized controlled trial, compared an additional 8-week exercise and education program at a certified medical fitness facility to standard of care for frail patients to determine if pre-habilitation improves 3- and 12-month clinical outcomes in elective cardiac surgery.[30]

An international multidisciplinary expert group on nutrition in cardiac surgery recommends determining nutritional risk as part of the preoperative assessment and commencing nutritional supplementation in malnourished patients at least 2 to 7 days before cardiac surgery. Postoperative nutrition should also be restarted within 24 hours of surgery and at least 80% of the target requirement achieved by the third postoperative day, with a view of adding immunomodulating components in complex or prolonged surgical procedures.[31] Current pharmacological interventions include protein and vitamin D supplementation for sarcopenia, or anabolic steroids and growth hormones to improve strength, but evidence supporting these interventions is poor.[32]

A multidisciplinary and multidimensional approach to the care of elderly patients involving geriatricians and using the Comprehensive Geriatric Assessment to evaluate functional ability, as well as physical, cognitive, and mental health has been reported.[33] Although this approach may improve postoperative outcomes and reduce postoperative length of stay in elective surgery, evidence in the cardiac surgical setting is lacking.[34,35]

## Anesthesia for the frail patient presenting for a cardiac intervention

While there are no published recommendations on anesthesia for elderly frail patients presenting specifically for cardiac surgery, it is reasonable to assume that the same principles for noncardiac surgery will apply. The recommendations from The American Geriatric Society Best Practice Report that are relevant to cardiac surgery include avoiding benzodiazepines as much as possible, selecting glycopyrrolate as the anticholinergic agent of choice, providing adequate pain control, and titrating the depth of anesthesia according to processed electroencephalogram monitoring to minimize the risk of postoperative delirium.[35] Elderly patients are also more prone to postoperative respiratory failure due to inspiratory muscle atrophy and change in lung mechanics. Preoperative counseling should include the risk of potential prolonged postoperative mechanical ventilation, especially after complex cardiac surgery.[36] In addition, altered baroreceptor and adrenoceptor responsiveness lead to increased intraoperative hemodynamic instability and unpredictable sensitivity to vasoconstrictors and inotropes commonly used in cardiac anesthetic practice. Hyperglycemia has been linked with poorer neurocognitive outcomes, among other problems, especially in predisposed elderly individuals, and the latest guidelines by the Society of Thoracic Surgeons

recommend a perioperative glucose target below 10 mmol/L.[37,38] Prudent temperature management on cardiopulmonary bypass may decrease the risk of postoperative cognitive impairment.[39] Additional care must also be taken with intraoperative patient positioning and padding of pressure points, paying special attention to skeletal deformities, such as kyphoscoliosis, especially in cardiac surgeries that are typically longer than other types of surgeries.

## Delirium in the frail patient

Delirium is one of the most common complications after cardiac surgery, occurring in up to one-fifth of the patients after cardiac surgery.[40] Postoperative delirium accounts for significant morbidity, increased rates of delayed institutional discharge, cognitive impairment, and mortality.[41,42] There is no effective treatment for delirium, hence it is important to identify at-risk patients early and have resources directed at preventive measures.[43] The Clinical Practice Guidelines that were recommended by the American Geriatric Society for managing postoperative delirium in the general surgical patient, recommend a number of pharmacological and nonpharmacological interventions.[44] The society strongly recommends that a multidisciplinary team administer nonpharmacological interventions to at-risk patients to prevent delirium. These interventions include improving sleep quality by using nonpharmacological sleep protocols and better sleep hygiene, promoting early mobility and physical rehabilitation, providing visual and hearing aids, helping with cognitive reorientation, and ensuring adequate fluid and caloric intake, bowel movement, and medication use.

## Conclusions

Going forward, there are two main challenges in managing the frail patient presenting for cardiac interventions. First, a standardized and validated method to assess frailty that is practical and reproducible by both specialists and nonspecialists needs to be created to identify at-risk patients better to facilitate appropriate risk counseling and management. Second, the types and timing of perioperative nutritional, physical, and pharmacological interventions that will improve outcomes for the frail patient need to be determined. The use of a robust risk scoring system, together with a multidisciplinary approach to nonpharmacological and pharmacological interventions, will allow for greater patient-centric care and improve medical and functional outcomes in this high-risk group of patients after cardiac intervention. ■

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