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# Dietary protein intake in older adults undergoing cardiac surgery

Michael Goldfarb [a], Yamileth Marcano [b], Donna Schafer [b], Julia Chronopoulos [c], Victoria Hayman [c], Amanda Trnkus [c], Jonathan Afilalo [a,c,*]

[a] Division of Cardiology, Jewish General Hospital, Montreal, QC, Canada
[b] Department of Clinical Nutrition, Jewish General Hospital, Montreal, QC, Canada
[c] Centre for Clinical Epidemiology, Lady Davis Institute for Medical Research, Montreal, QC, Canada

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**Abstract** *Background:* Older adults undergoing major surgery have increased protein requirements in the postoperative period, but there are limited data describing actual protein intake following cardiac surgery.
*Methods and results:* We performed a prospective sub-study within a registry of older adults ≥60 years of age undergoing cardiac surgery at a tertiary care centre. A dietician administered a food frequency questionnaire before surgery and 1–4 months after surgery. In-hospital food intake was recorded by direct observation for 3 days in the early postoperative period. Food intake was analyzed to calculate the protein intake per kilogram of body weight per day (g/kg/d) during the three phases of care, compared to the dietary reference intake. Frailty was measured by a questionnaire and physical performance tests before surgery. There were 22 patients (8 females, 14 males; 59% frail) enrolled in the study with a mean age of 72.0 ± 7.8 years. The mean protein intake was 1.3 ± 0.5 g/kg/d, 0.7 ± 0.3 g/kg/d, and 1.3 ± 0.6 g/kg/d in the preoperative, early postoperative, and postdischarge periods, respectively ($P < 0.0001$ for early postoperative compared to other periods). Compared to the targeted dietary reference intake of 1.5 g/kg/d, there was a mean protein deficit of 0.8 g/kg/d in the early postoperative period. Only one patient (5%) met the protein dietary reference intake in the early postoperative period.
*Conclusion:* In older adults undergoing cardiac surgery, dietary protein intake was substantially lower than the recommended target in the early postoperative period. Strategies to improve protein intake, particularly in frail older patients, may be considered as a therapeutic target.


## Background and rationale

Older adults require 25–50% more dietary protein intake than younger adults to overcome the age-related decline in muscle protein synthesis and resulting risk of sarcopenia [1,2]. However, a majority of older adults do not consume the recommended protein intake in their daily diet [3]. During periods of physiological stress from critical illness, such as cardiac surgery, metabolic demands and muscle breakdown are accelerated and compounded by bedrest and poor oral intake resulting in substantial loss of muscle mass [4]. In the 6 weeks following cardiac surgery, older adults lose on average 5% of their body mass, and this is associated with a greater risk of being readmitted to hospital [5].

Nutritional society guidelines vary as to the amount of protein required in critically ill patients. The American

* Corresponding author. McGill University, Geriatric Cardiology Fellowship Program, 3755 Cote Ste Catherine Rd, E-222, Montreal, QC H3T 1E2, Canada. Fax: +514 221 3785.
*E-mail address:* jonathan.afilalo@mcgill.ca (J. Afilalo).

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Society for Parenteral and Enteral Nutrition (ASPEN) recommends a protein intake of 2.0 g per kilogram of body weight per day (g/kg/d) [6] whereas the European Society for Parenteral and Enteral Nutrition (ESPEN) recommends 1.5 g/kg/d [7]. A systematic review of protein requirements in critically ill patients suggested that these amounts may be too conservative, recommending 2.0–2.5 g/kg/d as a safe and desirable target [8]. These guidelines endorse aggressive postoperative nutritional support, including early enteral nutrition when necessary to meet the postoperative caloric and protein needs.

There are limited data describing actual protein and caloric intake in the postoperative cardiac surgery population. Practice patterns of nutritional support following cardiac surgery also likely vary considerably between centres. In addition, little is known about the impact of muscle mass loss on functional outcomes following cardiac surgery. We hypothesize that older adults do not consume an adequate amount of protein following cardiac surgery. If protein intake is indeed insufficient, improving protein consumption in older adults following cardiac surgery could be a practical and achievable therapeutic target.

## Methodology

### *Study design*

A prospective nutritional sub-study was nested within the FRAILTY registry of older adults undergoing cardiac surgery at a single tertiary care centre (Jewish General Hospital; Montreal, QC). FRAILTY is an ongoing longitudinal registry that focuses on the prognostic impact of geriatric impairments following cardiac surgery. The registry is approved by the research ethics board, and patients sign a voluntary informed consent to participate and provide information about a variety of geriatric domains including but not limited to nutritional habits.

### *Patient population*

Inclusion criteria for this sub-study were: (1) age $\geq$ 60 years at the time of surgery, (2) undergoing cardiac surgery via median sternotomy, (3) providing informed consent. The types of cardiac surgery encompassed coronary artery bypass, valve repair or replacement, or combinations thereof. Exclusion criteria were: (1) not English or French speaking, (2) moderate or severe cognitive impairment, (3) significant dysphagia or gastrointestinal condition precluding oral food intake, and (4) persistent critically ill postoperative status.

### *Dietary assessment*

A registered clinical dietician (Y.M.) administered a detailed food frequency questionnaire (FFQ) just before surgery by in-person interview, and again 1–4 months after surgery by telephone interview (Fig. S1). The FFQ was a modified version of the model used in the hospital outpatient nutrition department, to include foods that are moderate to high sources of protein. The FFQ has not been validated previously. The same dietician recorded in-hospital food intake for 3 consecutive days starting on postoperative day 2 (or when the patient was in the step-down unit and receiving oral feeds; whichever was sooner) using a detailed meal log (Fig. S2). This food log was completed by the dietician based on direct observation of the proportion of patients' consumed foods during breakfast, lunch, and dinner, and questioning of the patients' consumed foods between meals. The dietician asked the participants about barriers to food intake during the direct observation of meal intake.

The patients' food intake was analyzed for calorie and protein consumption in g/kg/d using the WinVision (Nutritek; Verdun, QC) nutrition management software with nutritional values from the 2015 Canadian Nutrient File [9]. The menu provided by the hospital was already recorded in the patient's file and by modifying the actual intake the program calculates the nutrient composition. All food items brought from home were manually added with their respective quantities.

The recommended protein requirement was calculated based on the measured preoperative body weight, or based on the ideal body weight for overweight and obese patients. A requirement of 1.2 g/kg/d during the preoperative and postdischarge periods, and 1.5 g/kg/d during the early postoperative period, was used to determine total daily protein requirements [2].

### *Clinical assessment*

Trained researchers (J.C., V.H., A.T.) administered an in-person questionnaire and series of physical performance tests to measure frailty before surgery. Physical frailty was defined as a score of $\leq$8 out of 12 on the Short Physical Performance Battery (SPPB) that encompasses 5-m gait speed test, 5 timed chair rises, and 10-s balance in tandem, semi-tandem, and side-by-side foot positions [10]. An SPPB cutoff of $\leq$8 has been used to dichotomize frailty in other studies of frail patients undergoing cardiac surgery [11]. Researchers also reviewed the patients' medical records to extract data about operative procedures.

### *Data analysis*

Distributional histograms were examined to assess distribution. Descriptive statistics are presented as the mean $\pm$ standard deviation daily protein intake during the three periods of care, and also expressed as the proportion of patients meeting the recommended protein intake values. The differences in protein intake during the three time periods was compared using the student's t test (when 2 groups) or ANOVA one-way test (when 3 or more groups). Data were analyzed using the SPSS 22.0 software package (Armonk, New York; IBM Corp).

## Results

There were 22 patients (8 females, 14 males) enrolled in the study with a mean age of 72.0 ± 7.8 years (Table 1). The type of cardiac surgery performed was isolated coronary artery bypass grafting in 15 patients (68%) and isolated or combined valve surgery in 7 patients (32%). The early postoperative nutritional assessment began on postoperative day 3.0 ± 0.6 and continued for 3 consecutive days. Eight patients completed the preoperative and early postoperative nutritional assessments but could not be reached by telephone to complete the postdischarge nutritional assessment.

Mean protein intake was 1.3 ± 0.5 g/kg/d, 0.7 ± 0.3 g/kg/d, and 1.3 ± 0.6 g/kg/d during the preoperative, early postoperative, and postdischarge periods, respectively (Fig. 1). Protein intake was significantly lower in the early postoperative period compared to the other periods ($P < 0.0001$). Compared to the targeted dietary reference intake of 1.5 g/kg/d, there was a mean protein deficit of 0.8 g/kg/d (53% of the estimated daily protein intake requirement) in the early postoperative period. Only one patient (5%) met the estimated daily protein intake requirement in the early postoperative period compared to 12 patients (55%) in the preoperative period and 6 patients (43%) in the postdischarge period.

Mean calorie intake was 2553 ± 851 kcal/d, 1211 ± 447 kcal/d, and 2395 ± 645 kcal/d during the preoperative, early postoperative, and postdischarge periods, respectively. Calorie intake was significantly lower in the early postoperative period compared to the other periods ($P < 0.0001$). The mean percentage of calories consumed from protein sources was 15%, 17%, and 11% during the preoperative, early postoperative, and postdischarge periods, respectively.

There were 13 frail (59%) and 9 (41%) non-frail patients. Protein intake was similar between the frail and non-frail patients during the preoperative (1.3 ± 0.4 g/kg/d vs. 1.4 ± 0.6 g/kg/d; $P = 0.57$), early postoperative (0.8 ± 0.4 g/kg/d vs. 0.8 ± 0.3 g/kg/d; $P = 0.70$), and postdischarge periods (1.3 ± 0.4 g/kg/d vs. 1.6 ± 0.8 g/kg/d; $P = 0.34$).

The most frequent cited barriers to food intake in the early postoperative period included low appetite in 21 patients (96%) and dislike of the food options served in 19 patients (86%) (Fig. 2). Low postoperative protein intake was not associated with patient-reported preoperative protein intake ($P = 0.42$). There were no differences in mean protein intake per kilogram of body weight in women compared to men during any of the time periods (all $P > 0.05$).

**Table 1** Clinical characteristics.

| | N = 22 |
|---|---|
| Age (years) | 72.0 ± 7.8 |
| Female (%) | 8 (35%) |
| Frailty | 13 (59%) |
| Weight (kg) | 77.3 ± 21.4 |
| Cardiac Surgery Type | |
| CABG | 15 (68%) |
| CABG + MV surgery | 2 (9%) |
| CABG + SAVR | 3 (14%) |
| MV surgery | 2 (9%) |

Abbreviations: CABG, coronary artery bypass grafting; MV, mitral valve; SAVR, surgical aortic valve replacement.

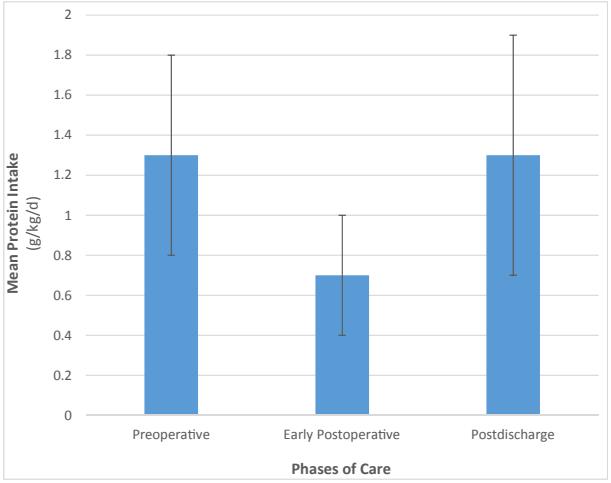


**Figure 1** Mean Protein Intake in Different Phases of Care. Abbreviations: d, day; g, gram; kg, kilograms body weight.

## Discussion

Our prospective analysis of dietary intake following cardiac surgery has shown that our population of older adults consume far less protein than is recommended to preserve muscle mass and metabolic homeostasis during the critical early postoperative period. Only one patient met the target of 1.5 g/kg/d. A number of potentially modifiable barriers were identified to improve food intake in these patients. After the first month postdischarge, dietary patterns improved and the protein intake was commensurate with the generally recommended targets.

Despite the clinical relevance of dietary behaviors in cardiac patients, there is a lack of empiric data describing actual protein and caloric intake in the perioperative cardiac surgery period. The major finding of our study is that there was vastly insufficient protein intake during the early postoperative period, accounting for 43% of the recommended daily protein requirement. Insufficient protein intake has been observed in other surgical settings. A study of older adults (mean age 84 years) undergoing hip fracture surgery found that patients consumed 50% and 80% of the calorie and protein recommended intake, respectively [12]. In this study, the protein intake requirement was calculated based on a conservative target of 1.0 g/kg/d, which is likely to underestimate the actual requirements of this older surgical population. Another study of mostly surgical patients found that 21% of older adults had a markedly reduced dietary intake less than half of the daily recommended protein requirement [13].

Insufficient protein intake is particularly deleterious for frail older patients, who have lower reserves of muscle

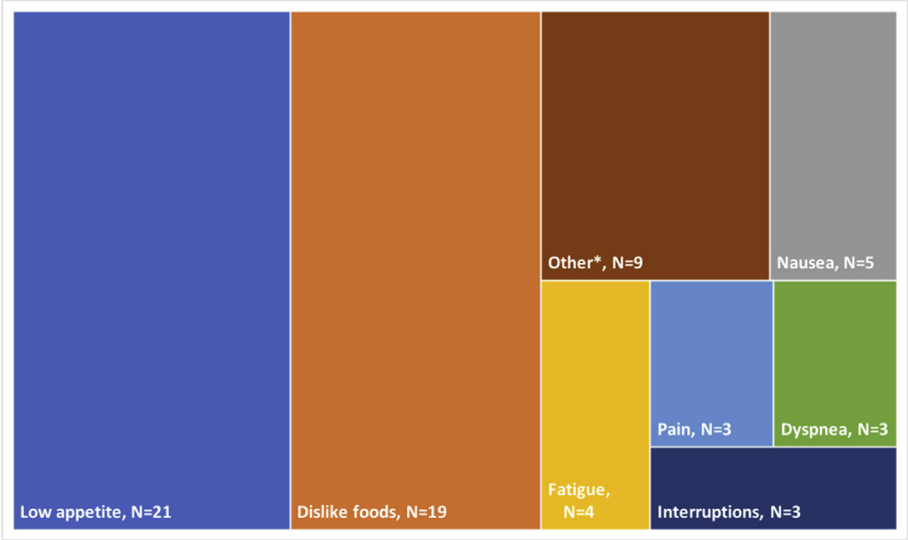


**Figure 2** Barriers to Food Intake in the Early Postoperative Period. Other* includes: discomfort due to tubes and intravenous lines, fear of constipation, missing food on tray, change in taste, late meal due to transfer, fear of high blood sugar, low food variety, cold food temperature, fear of diarrhea, difficulty chewing.

mass and strength. Frailty increases the age-related changes in protein and muscle metabolism by increasing the rate of protein catabolism and decreasing the response to anabolic factors [14]. Frail older patients require even more protein inputs during periods of severe catabolic stress and bedrest [1]. Importantly, frail older adults have shown the capacity to respond to protein supplementation and build lean mass, especially when they are malnourished [15,16]. One of the strengths of this study is that physical frailty was objectively measured with the SPPB scale, and frail patients represented 59% of our study population.

Insufficient protein intake in the early postoperative period has consistently been associated with worse outcomes. A study of patients admitted to the surgical intensive care unit found that those with a postoperative protein deficit were less likely to be discharged home [17]. A multinational nutritional study found that consuming close to the recommended protein intake was associated with 60-day survival and ventilator free days [18]. A prospective interventional study found that aggressive protein supplementation was associated with a 66% reduction in infectious complications in the surgical intensive care unit [19]. A retrospective study of 1007 postsurgical patients at 8 hospitals found that those with sufficient protein intake, defined as >60% of the recommended protein intake, had decreased length of stay and hospital costs [20]. The Nutrition Care in Canadian Hospitals (NCCH) study found that surgical patients who ate less than half of the provided food had signs of malnutrition and increased length of stay [21].

As a result of the emerging research for protein in the postsurgical diet, professional nutritional societies, such as ESPEN, advocate to start oral feeds as soon as possible after surgery [22]. In addition, surgical quality of care programs, such as Enhanced Recovery after Surgery (ERAS), include nutritional supplementation in the early postoperative period as a fundamental component of the plan to promote functional recovery after surgery. The ERAS program is designed to promote and accelerate recovery and has been shown to be beneficial and safe in older adults [23,24]. One of the core components of the ERAS program is a recommendation to liberally prescribe oral nutritional supplements in the pre- and postoperative periods [25].

Based on the metabolic, physiologic, and clinical evidence, there is a consensus amongst professional nutritional societies and experts that protein requirements are increased in older adults [26] and that they are further increased in postoperative and critically ill patients. While these experts vary on the exact target for protein intake in this setting, ranging from 1.2 to >2.0 g/kg/d [7,27], the findings of our study were not sensitive to the choice of recommended protein daily intake used. Even at the lower recommended protein daily intake of 1.2 g/kg/d, only one patient in our cohort would have met the conservative target for adequate dietary protein intake. Thus, regardless of the recommended protein daily intake level used, it is evident that a large proportion of older cardiac surgery patients are protein insufficient.

While oral nutritional supplementation with protein-rich formulations is often indicated to correct insufficient intake, there is a need to concurrently address barriers to food intake. Poor appetite was pervasive in our population, resulting from multi-factorial pathways activated during the perioperative exposure. Strategies to increase food intake in the presence of poor appetite include eating frequent smaller meals, consuming low-volume protein-rich supplements, having family members present during meal times to encourage and assist with food intake, and having family members bring in foods that the patient enjoys [28]. It is also important to ensure adequate pain

and nausea control, and minimize meal time interruptions and fasting restrictions.

There are a number of limitations to our study. This was a single-centre study that may not be generalizable to the patients treated at other centres. This study had a modest sample size by virtue of the intensive direct observation that was required to perform in-hospital dietary logs; large-scale multicenter studies are needed to adequately define the prevalence and impact of protein insufficiency in cardiac surgery patients. In addition, while early postoperative nutrition was assessed by direct observation of actual food intake, preoperative and postdischarge nutrition was assessed by FFQ, the latter is known to be prone to recall bias. The FFQ used in our study has not been validated. However, there were several measures taken to decrease the bias of overestimation of portion sizes and improve the accuracy of the dietary assessment: (1) the questionnaire was administered by a dietician; (2) the accuracy of portion sizes was prompted using standard measures (cups, spoon, hand portions); (3) the dietician asked about food consumption over the previous week (as opposed to general eating habits over a period of time); (4) we excluded patients with significant cognitive impairment; and (5) family members were encouraged to provide their input to capture more accurate data.

## Conclusions

Older patients undergoing cardiac surgery consume approximately half of the dietary protein that is recommended to maintain muscle health and metabolic homeostasis in the early postoperative period. Insufficient dietary protein intake is known to have adverse effects for recovery after surgery, particularly in frail older patients. Strategies to improve protein consumption following cardiac surgery, consisting of oral nutritional supplementation and resolution of food barriers, may be considered as a therapeutic target to prevent deconditioning and improve postoperative outcomes.

## Conflicts of interest

There are no conflict of interests to declare.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.numecd.2019.06.009.

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