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Change in Functional Status from Preoperative to One Year Postoperative in Patients Who Have Undergone Elective Open-Heart Surgery: A Repeated-Measures Study

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Abstract

Purpose: Although patient-related factors affect surgical outcomes, preoperative functional status is not measured by any cardiac risk score. Functional status can, however, be objectively measured using validated outcome tools such as the *Late-Life Function and Disability Instrument* (LLFDI). The purpose of this study was to determine 1) if there was a change over time in functional status, as measured by the LLFDI, in patients who underwent elective cardiac surgery, and if so, 2) what specific aspect(s) of functional status changed. **Methods:** A prospective longitudinal study of one year was conducted on elective cardiac surgery patients (n = 43) using the self-reported LLFDI, which measures Disability Frequency (frequency of participation in social tasks), Disability Limitation (ability to participate in social tasks) and Function Total (ease in performing routine activities). Higher scores indicate increased function and decreased disability. LLFDI scores were compared at three times (preoperative, six-week and one-year postoperative) using repeated measures ANOVA. Post hoc pairwise comparison was conducted for specific interactions. **Results:** Both Function Total and Disability Frequency significantly changed over time ($p = 0.047$ and $p = 0.013$, respectively). Specifically, patients' function level was significantly higher one-year postoperative compared to preoperative (M difference = +3.48, SE = 1.48, $p = 0.026$). Likewise, Disability Frequency scores were significantly higher (*i.e.* more active) at one-year postoperative versus preoperative (M difference= +5.98, SE

= 2.19, p = 0.033). Disability Limitation scores were not significantly different between any time points (p > 0.05). **Conclusion:** By one-year postoperative, patients demonstrated increased ease in their routine physical activities and were more participatory in social life tasks. Individuals who underwent elective cardiac surgery took more than six weeks to detect notable improvement in functional status, which was expected with a sternotomy approach. This study provides support for the use of the LLFDI as an effective tool to capture functional status in the cardiac population. These findings may assist cardiac patients in recovery timeline expectations.

Keywords

Functional Status, Elective Cardiac Surgery, Late-Life Function and Disability Instrument

1. Introduction

Determining the efficacy of cardiac surgery involves considering several risk factors and numerous patient outcomes [1] [2] [3] [4] [5]. Mortality and morbidity risk after surgery are measures cardiac surgeons universally calculate to estimate patient outcomes [6] [7] [8] [9]. Cardiac risk scores do not include functional status [10] [11] [12] [13], despite evidence that adding this component would enhance mortality and morbidity risk prediction [14] [15] [16] [17] [18]. Varley *et al.* demonstrated one-year mortality risk was significantly reduced when preoperative frailty (*i.e.* poor functional status) was identified in elective surgery patients [18]. Moreover, poor preoperative functional mobility has been correlated to a decline in physical function after cardiac surgery [19] [20]. Researchers found functional status was more predictive of mortality than a patient's principal admitting diagnosis [21], was strongly associated with increased mortality risk among geriatric surgical populations at 2-months postoperative [22] and at 6-months postoperative [23] and had increased 90-day and 6-month mortality, respectively [21] [24], among the hospitalized elderly population.

Functional status is defined as an individual's ability to perform activities within their regular environment, an ability potentially limited by cardiac disease, perceived symptoms, and environmental, social and psychological factors [25]. Researchers have historically measured functional status using self-report questionnaires to calculate physical health, well-being, and quality of life [26]-[31]. Consensus is lacking on a standardized outcome measure to use. Self-report questionnaires such as the Short Form 36 (SF-36) and Katz Index of Independence in Activities of Daily Living (Katz ADL), have been used in several studies on "functional status," [26]-[31] however, they lack specificity, as seen by their use in research to measure quality of life [29] [30] [32], general health [13], postoperative pain [32], and functional capacity [22] [28]. While these studies may shed some light on patient recovery symptoms over time, the tools used were not validated to measure functional status, but rather health-related quality of life.

Incongruencies also exist in research concerning the time lapse until functional status improvement appears and full recovery restores following coronary artery bypass graft (CABG) surgery. Based on gaps in prospective research, Ballan *et al.* [33] recommended exploring function preoperative to six-week post-CABG surgery. Ballan *et al.* detected functional improvement at six weeks, but patient-perceived pain remained notable [33]. LaPierand Mizner [27] used several functional status measures and found patients continued to report moderate deficits in performing daily activities and function at 6 months post-CABG. Based on Katz ADL and FIM scores, Niemeyer-Guimarães, Cendoroglo, and Almada-Filho [31] found "slow recovery" in functional status at 1 month and 6 months post-CABG compared to discharge, but not back to baseline. In contrast, Barnason *et al.* [26] utilized SF-36 questionnaire and concluded baseline functional status responses were surpassed by 6 to 12 months. Hunt, Hendrata and Myles [32] detected gains in function but not patient-perceived quality of life at 12 months, while Joskowiak *et al.* [29] concluded physical and mental health status improved within the first year after cardiac surgery, both using the SF-36 tool. Without using a validated tool designed to measure function it remains unclear if significant functional gains occur in the early postoperative phase and if they surpass baseline levels by 12 months postoperative. Rigorous studies examining this very question about patient-reported functional status remain lacking [34].

One validated functional status measure is the Late-Life Function and Disability Instrument (LLFDI), a self-report questionnaire which targets a variety of physical activities and social life tasks [function component], as well as assesses participation ability and frequency in different social activities [disability component]. The LLFDI has established valid and reliable function and disability components that, when combined, yield outcome measures for functional status [27] [35]-[40]. The LLFDI has been used by LaPier *et al.* [27] [41] to assess preoperative/postoperative functional status change in cardiac surgery patients, but to date, the LLFDI has not been used to track functional status changes over time with this population.

The purpose of this study was to assess functional status changes over time among patients who underwent elective cardiac surgery using the LLFDI.

2. Methods

2.1. Study Design

A non-experimental, longitudinal design using a convenience sample was employed. Subjects were recruited from a single-center hospital, June to December 2010, after a cardiac surgeon recommended non-emergency cardiac surgery. Inclusion criteria: Subjects ≥ 18 years of age, able to communicate fluently in English, and undergoing elective cardiac surgery which involves coronary artery bypass graft as an initial or redo procedure, valve repair/replacement, or both. Exclusion criteria/termination from study: Elective cardiac surgery became emergency surgery; subject failed to return or sufficiently complete their preoperative LLFDI. Seventy-seven individuals met the eligibility criteria with enrollment of n = 43. LLFDI completed responses at all three-time points was n = 29.

Joint Institutional Review Board approval was obtained by Western Michigan University (#11-06-06) and Saint Vincent Health Center (no reference number) prior to study commencement. This study was performed in accordance with the Declaration of Helsinki [42].

2.2. Procedures

Preoperative LLFDIs were mailed to subjects within one week prior to surgery with instructions to return completed form via mail in provided de-identified envelope. All returned LLFDIs were mailed directly to the research assistants to maintain a single-blinded study. Fifty-three percent of the 77 subjects elected to remain as inpatients until cardiac surgery and their completed preoperative LLFDIs were collected in person in sealed, de-identified envelopes. LLFDIs were again mailed to subjects one week prior to their six-week and one-year post-operative surgery dates with instructions to return the completed form via mail.

2.3. Measures

2.3.1. Late-Life Function and Disability

There are two components to the LLFDI: The Function component is made up of (32) questions that start with "How much difficulty do you have?" regarding routine physical actions and activities such as unscrewing a jar lid or running a 1/2 mile [36] [37]. The higher the Function score, the more functionally able/active one is. The Disability component consists of 16 two-part questions that start with: "How often do you participate?" and "To what extent do you feel limited?" on social life tasks such as taking part in recreational activities [35] [37]. The higher the disability scores, the less disabled one is, both in frequency and limitation [35] [37]. Each question carries a different weight, and raw scores are transformed into a 0 - 100 range [35] [36]. The authors of the LLFDI also classified the scaled scores into four distinguishable subgroups based on limitation for easier clinical interpretation [35] [36]. For this study, functional status was measured using LLFDIs Function Total, Disability Frequency and Disability Limitation scores.

Demographic data on gender, race/ethnicity, and age information were collected (see **Table 1**). For this study, age groups were defined as <60 years, 60 - 69 years, and ≥70 years. Race/ethnicity was defined as Caucasian, African American, Hispanic or "other."

2.3.2. Data Analysis

Data were analyzed using the statistical package SPSS 18.0.0 (SPSS Inc., Chicago, IL). Repeated measures analyses were conducted to determine functional status changes from preoperative to 6 weeks postoperative to one year postoperative. Any significant main effects found in mean LLFDI changes were further analyzed for specific interactions using post-hoc tests with Bonferroni adjustment. Descriptive statistics were conducted on each LLFDI variable at each time to examine assumptions of normality. Non-parametric tests were conducted in addition to parametric if non-normality was identified. If results were similar, parametric test results were used.

Table 1. Study demographics compared with LLFDI validation demographics.

Study Demographics			**LLFDI Demographics**		
Preoperative	N	% of Total	L LFDI Development	N	% of Total
Gender			**Gender**		
Female	12	28%	Female	34	23%
Male	31	72%	Male	116	77%
Race/Ethnicity			**Race/Ethnicity**		
Caucasian	41	95%	Caucasian	126	84%
Hispanic	1	2%	Hispanic	8	5%
African Amer	1	2%	African Amer	11	7%
Age			**Age**		
40 - 49	1	2.3%	40 - 49	X	0%
50 - 59	9	20.9%	50 - 59	X	0%
60 - 69	17	39.5%	60 - 69	41	27.3%
70 - 79	11	25.6%	70 - 79	61	40.7%
80 - 89	5	11.7%	80 - 89	40	26.7%
Median	66		90+	8	5.3%
SD	9.739		Mean age for CABG (STS, 2010)	64.9	
Mean	66.35		LLFDI = Late Life Function and Disability Instrument		
Mode	54, 61, 62, 66				

3. Results

3.1. Baseline Demographics and Distribution

The mean age of participants was 64.9. Eighty-one percent of the subjects (n = 35) underwent an elective CABG procedure, 5 of which were performed off pump. A total of 8 subjects (19%) underwent elective valve repair or replacement surgery, including 3 subjects (7%) who underwent a combination valve/CABG procedure. All subjects received physical therapy postoperatively as inpatients and were recommended for cardiac rehabilitation upon discharge.

3.2. Repeated Measures Anova

Repeated measures ANOVA was conducted for the three LLFDI components at three points in time. Function Total was significantly affected by time, F (2, 56) = 3.232, p = 0.047, meaning patients' ability to perform routine activities improved significantly over time (Table 2). Preoperative Total Function scores (M = 62.34, SD = 8.90) were not significantly different from six-week postoperative scores (M = 62.97, SD = 8.70) but were significantly different from one-year postoperative scores (M = 65.82, SD = 10.99), as revealed by post hoc tests using Bonferroni adjustment (M difference = +3.48, SE = 1.48, p = 0.026).

Table 2. Main effect of time on functional status (LLFDI Components).

Variable	Sphericity Test	Df	F	Sig
Functional total	Sphericity Assumed	(2 56)	3.232	0.047*
Disability Frequency	Greenhouse Geisser	(1.53, 42.70)	5.494	0.013*
Disability Limitation	Sphericity Assumed	(2.56)	2.423	0.098

*p < 0.05 denotes statistical significance; LLFDI = Late Life Function and Disability Instrument.

Table 3. Functional status (LLFDI)—group mean changes over time in elective cardiac surgery patients.

Variable	Time	Mean	Std. Deviation	LLFDI Limitation Classification	Sig.
Function total	Preoperative	62.3424	8.90171	Moderate to Slight	
N = 29	6 Weeks Postoperative	62.9655	8.70044	Moderate to Slight	
	1 Year Postoperative	65.8210	10.98957	Slight	
(Pre-Op to 1 Year Post-Op)	**M Difference**	**+3.4786**	1.48 (SE)		**0.026***
Disability Frequency	Preoperative	51.8141	6.20402	Moderate to Slight	
N=29	6 Weeks Postoperative	52.9041	8.17441	Moderate to Slight	
	1 Year Postoperative	57.7921	12.48259	Slight	
(Pre-Op to 1 Year Post-Op)	**M Difference**	**+5.978**	2.19 (SE)		**0.033***
Disability Limitation	Preoperative	75.6497	14.93365	Slight	
N=29	6 Weeks Postoperative	75.6317	15.57000	Slight	
	1 Year Postoperative	81.6524	15.44953	Slight	
(Pre-Op to 1 Year Post-Op)	**M Difference**	**+6.0207**	2.55 (SE)		0.075

*p < 0.05 denotes statistical significance; The higher the mean score = the more functional, less disabled the individual; LLFDI = Late Life Function and Disability Instrument.

The sphericity assumption was violated for Disability Frequency. Utilizing the Greenhouse-Geisser correction for repeated measures ANOVA revealed significant differences over time for Disability Frequency, F (1.53, 42.70) = 5.49, p = 0.013, $\varepsilon = 0.763$, indicating subject participation in social life tasks significantly improved over time. Specifically, preoperative Disability Frequency scores (M = 51.80, SD = 6.20) were significantly lower than one-year postoperative scores (M = 57.79, SD = 12.48), which indicated that social task participation significantly increased from preoperative to one-year postoperative (M difference = +5.98, SE = 2.19, p = 0.033 (**Table 3**) as revealed by post hoc pairwise comparison tests using Bonferroni adjustment.

Disability Limitation was not significantly associated with time (p = 0.098), meaning that capabilities in performing social life tasks did not change preoperatively to postoperatively (see **Table 2**).

4. Discussion

This study's findings indicated that by one-year postoperative, individuals surpassed their preoperative functional status. These findings are consistent with a few longitudinal studies that have explored functional status changes after CABG surgery [15] [23] [28] [29]. These studies, however, differed in study duration and/or outcome measure selection and did not include either preoperative or prospective data. A few studies only tracked functional status to six months post-CABG [21] [30] [31]. Bäck *et al.* [15] captured functional mobility pre-cardiac surgery using Functional Independence Measure (FIM) scores but estimated one-year postoperative outcomes. Ko *et al.* [23] conducted a retrospective study in which preoperative functional status was derived from admission FIM scores to estimate postoperative major cardiac events and mortality risk six months following cardiac surgery and no patient-response data were collected. Joskowiak *et al.* [29] concluded "functional status" improved within the first year after cardiac surgery but examined health-related quality of life rather than function. Douki *et al.* [28] determined functional status at 18 months surpassed baseline scores, however no time points between were assessed.

Based on results from this study, no improvement in any aspect of functional status was detected at 6-week postoperative. Minimal research to date has been conducted examining functional changes this early post-surgery. Niemeyer-Guimarães *et al.* [31] explored functional status changes from preadmission to one and six-month postoperative using Katz ADL Scale and FIM scores and concluded slow recovery without return to baseline scores. Mori *et al.* [30] found of subjects post-CABG (n = 362), that 14% still had difficulty in at least one ADL at six months. These results are consistent with the findings from this study. Cardiac surgery is a major operation which typically includes sternal precautions for six weeks and this may help to explain why patients did not report significant improvement 6 weeks post-surgery.

5. Strengths and Limitations

The relatively small sample impacted the statistical power of the study, and possibly explains the inability to reach any of the standardized minimally detectable change (MDC) levels, according to a validation study by LaPier and Mizner [27] for the LLFDI tool, despite reaching statistical significance on Disability Frequency and Function Total with the data. Based on 95% confidence interval, LaPier and Mizner calculated MDC for the Disability Limitation component as 16.7 and in high contrast to 7.8 for Disability Frequency component and 4.3 for the Function component [27]. Given the wide variance in response noted for Disability Limitation, the change needed to exceed level of measurement error in order to detect meaningful change in Disability Limitation was not likely to be reached with the relatively small sample size here. Unlike the frequency to which one participates in personal and social life tasks, Disability Limitation refers to one's capability in participating. Since people participate in activities with great variance in capability, a wide range of scores is not unexpected. However, this may have reduced the power and inflated the risk of a type II error.

Although MDC was not reached, minimum clinically important difference (MCID) was reached according to Beauchamp *et al.* [43], with MCID for each LLFDI sub-group between 2 (small) and 5 (large/significant) and considered clinically meaningful to the participants. In terms of clinical relevance in this research field, this study was one of the first to collect prospective patient data on cardiac surgery recovery with respect to functional status changes from preoperative to six weeks postoperative and as far out as one-year postoperative. Further, this study used an outcome tool specifically designed to measure functional status and one tested on patients with cardiovascular disease [27] [35] [36] [38] [39] [41].

Attrition rate from consent to preoperative LLFDI was 29% (n = 22). One explanation may have been that subjects were met just after news received of cardiac surgery recommended, without much time to process information. Further, there was a small window of time (roughly two hours) to obtain informed consents before subjects were discharged home. Conducting this study at a single site with a sample of convenience without a control group limits the generalizability of the findings. Closer examination of the data revealed that all but six of the participating subjects underwent CABG surgery (n = 37) and only one of the six valve procedures was a combination valve/CABG surgery; therefore, the sub-groups were too small for comparative analysis. This research did not consider other factors that also may have influenced postoperative functional status such as whether subjects participated in cardiac rehabilitation. Tahir *et al.* [44] noted a positive correlation between cardiac rehabilitation participation and improved physical function following CABG. Future studies would benefit from exploring cardiac rehabilitation's influence on functional status changes over time and conducting a multi-center study to fully examine cardiac surgery subgroups.

6. Conclusion

Although cardiac surgery patients' difficulties with various social life tasks (disability limitation) failed to significantly improve by one-year postoperative, the extent of participation in their social life tasks (disability frequency) and their ability to perform routine physical activities (function) significantly improved over time, specifically from preoperative to one-year postoperative. For individuals and their loved ones, cardiac surgery is a serious conversation with the medical team and one that should be patient-centered [45] [46]. Having as much information as possible is of the utmost importance [45]. Understanding functional status changes over time may assist patients and their families in elective cardiac surgery decisions and with what to expect for recovery [16] [45]. American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines, published December 2023, is the first to recognize the importance of functional status and recommend its inclusion among other risk factors [47]. Cardiac risk scores have yet to include functional status and a standardized outcome tool has yet to be established [47].

Conflicts of Interest

The authors have no conflicts of interest.

References

[1] Weisel, R.D., Nussmeier, N., Newman, M.F., *et al.* (2014) Predictors of Contemporary Coronary Artery Bypass Grafting Outcomes. *The Journal of Thoracic and Cardiovascular Surgery*, **148**, 2720-2726. https://doi.org/10.1016/j.jtcvs.2014.08.018

[2] Kusu-Orkar, T.E., Kermali, M., Oguamanam, N., Bithas, C. and Harky, A. (2020) Coronary Artery Bypass Grafting: Factors Affecting Outcomes. *Journal of Cardiac Surgery*, **35**, 3503-3511. https://doi.org/10.1111/jocs.15013

[3] Jones, J.M., Loubani, M., Grant, S.W., *et al.* (2022) Cardiac Surgery in Older Patients: Hospital Outcomes during a 15-Year Period from a Complete National Series. *Interactive CardioVascular and Thoracic Surgery*, **34**, 532-539. https://doi.org/10.1093/icvts/ivab320

[4] Akins, C.W., Miller, C., Turina, M.I., *et al* (2008) Guidelines for Reporting Mortality and Morbidity after Cardiac Valve Interventions. *The Annals of Thoracic Surgery*, **85**, 1490-1495. https://doi.org/10.1016/j.athoracsur.2007.12.082

[5] Ferguson, T.B., Hammill, B.G., Peterson, E.D., DeLong, E.R. and Grover, F.L. (2002) A Decade of Change–Risk Profiles and Outcomes for Isolated Coronary Bypass Grafting Procedures, 1990-1999: A Report from the STS National Database Committee and the Duke Clinical Research Institute. *The Annals of Thoracic Surgery*, **73**, 480-490. https://doi.org/10.1016/S0003-4975(01)03339-2

[6] Shahian, D.M., O'Brien, S.M., Filardo, G., *et al.* (2009) The Society of Thoracic Surgeons 2008 Cardiac Surgery Risk Models: Part 1—Coronary Artery Bypass Grafting Surgery. *The Annals of Thoracic Surgery*, **88**, S2-S22. https://doi.org/10.1016/j.athoracsur.2009.05.053

[7] Shahian, D.M., O'Brien, S.M., Filardo, G., *et al.* (2009) The Society of Thoracic Surgeons 2008 Cardiac Surgery Risk Models, Part 3: Valve plus Coronary Artery Bypass Grafting Surgery. *The Annals of Thoracic Surgery*, **88**, S43-S62.

https://doi.org/10.1016/j.athoracsur.2009.05.055

[8] Jacobs, J.P., Shahian, D.M., Badhwar, V., *et al.* (2022) The Society of Thoracic Surgeons 2021 Adult Cardiac Surgery Risk Models for Multiple Valve Operations. *The Annals of Thoracic Surgery*, **113**, 511-518. https://doi.org/10.1016/j.athoracsur.2021.03.089

[9] Lawton, J.S., Tamis-Holland, J.E., Bangalore, S., *et al.* (2022) 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*, **145**, e4-e17. https://doi.org/10.1161/CIR.0000000000001039

[10] Nashef, S.A., Roques, F., Sharples, L.D., *et al.* (2012) EuroSCORE II. *European Journal of Cardio-Thoracic Surgery*, **41**, 734-745. https://doi.org/10.1093/ejcts/ezs043

[11] Silverborn, M., Nielsen, S., Karlsson, M., *et al.* (2023) The Performance of EuroSCORE II in CABG Patients in Relation to Sex, Age, and Surgical Risk: A Nationwide Study in 14,118 Patients. *Journal of Cardiothoracic Surgery*, **18**, Article No. 40. https://doi.org/10.1186/s13019-023-02141-4

[12] Bouabdallaoui, N., Stevens, S.R., Doenst, T., *et al.* (2018) Society of Thoracic Surgeons Risk Score and EuroSCORE-2 Appropriately Assess 30-Day Postoperative Mortality in the STICH Trial and a Contemporary Cohort of Patients with Left Ventricular Dysfunction Undergoing Surgical Revascularization. *Circulation*: *Heart Failure*, **11**, e005531. https://doi.org/10.1161/CIRCHEARTFAILURE.118.005531

[13] Sepehri, A., Beggs, T., Hassan, A., *et al.* (2014). The Impact of Frailty on Outcomes after Cardiac Surgery: A Systematic Review. *The Journal of Thoracic and Cardiovascular Surgery*, **148**, 3110-3117. https://doi.org/10.1016/j.jtcvs.2014.07.087

[14] Afilalo, J., Mottillo, S., Eisenberg, M.J., *et al.* (2012). Addition of Frailty and Disability to Cardiac Surgery Risk Scores Identifies Elderly Patients at High Risk of Mortality or Major Morbidity. *Circulation*: *Cardiovascular Quality and Outcomes*, **5**, 222-228. https://doi.org/10.1161/CIRCOUTCOMES.111.963157

[15] Bäck, C., Hornum, M., Jørgensen, M.B., Lorenzen, U.S., Olsen, P.S. and Møller, C.H. (2021) Comprehensive Assessment of Frailty Score Supplements the Existing Cardiac Surgical Risk Scores. *European Journal of Cardio-Thoracic Surgery*, **60**, 710-716. https://doi.org/10.1093/ejcts/ezab127

[16] Yanagawa, B., Graham, M.M., Afilalo, J., Hassan, A. and Arora, R.C. (2018) Frailty as a Risk Predictor in Cardiac Surgery: Beyond the Eyeball Test. J*ournal of Thoracic and Cardiovascular Surgery*, **156**, 172-176. https://doi.org/10.1016/j.jtcvs.2018.01.103

[17] Barac, Y.D., Josefson, E.K., Saute, M., Gorphil, D., Rubchevsky, V. and Aravot, D. (2019) Comprehensive Assessment of Frailty Score as a Tool to Assess Potential Recovery in Cardiac Surgery. *Journal of Thoracic and Cardiovascular Surgery*, **158**, E43-E44. https://doi.org/10.1016/j.jtcvs.2019.02.118

[18] Varley, P.R., Buchanan, D., Bilderback, A., *et al.* (2023). Association of Routine Preoperative Frailty Assessment with 1-Year Postoperative Mortality. *The Journal of American Medical Association Surgery*, **158**, 475-483. https://doi.org/10.1001/jamasurg.2022.8341

[19] Itagaki, A., Saitoh, M., Okamura, D., *et al.* (2019) Factors Related to Physical Functioning Decline after Cardiac Surgery in Older Patients: A Multicenter Retrospective Study. *Journal of Cardiology*, **74**, 279-283. https://doi.org/10.1016/j.jjcc.2019.02.020

[20] Govers, A.C., Buurman, B.M., Jue, P., de Mol, B.A., Dongelmans, D.A. and de Rooij, S.E. (2014) Functional Decline of Older Patients 1 Year after Cardiothoracic Surgery Followed by Intensive Care Admission: A Prospective Longitudinal Cohort Study. *Age and Ageing*, **43**, 575-580. https://doi.org/10.1093/ageing/afu058

[21] Inouye, S.K., Peduzzi, P.N., Robison, J.T., Hughes, J.S., Horwitz, R.I. and Concato, J. (1998) Importance of Functional Measures in Predicting Mortality among Older Hospitalized Patients. *The Journal of the American Medical Association*, **279**, 1187-1193. https://doi.org/10.1001/jama.279.15.1187

[22] Stewart, R.A.H., Szalewska, D., She, L., *et al.* (2014) Exercise Capacity and Mortality in Patients With Ischemic Left Ventricular Dysfunction Randomized to Coronary Artery Bypass Graft Surgery or Medical Therapy: An Analysis from the STICH Trial (Surgical Treatment for Ischemic Heart Failure). *Journal of the American College of Cardiology*: *Heart Failure*, **2**, 335-343. https://doi.org/10.1016/j.jchf.2014.02.009

[23] Ko, H., Ejiofor, J.I., Rydingsward, J.E., Rawn, J.D., Muehlschlegel, J.D. and Christopher, K.B. (2018) Decreased Preoperative Functional Status Is Associated with Increased Mortality Following Coronary Artery Bypass Graft Surgery. *PLOS ONE*, **13**, Article 0207883. https://doi.org/10.1371/journal.pone.0207883

[24] Robinson, T.N., Eiseman, B., Wallace, J.I., *et al.* (2009) Redefining Geriatric Preoperative Assessment Using Frailty, Disability and Co-Morbidity. *Annals of Surgery*, **250**, 449-455. https://doi.org/10.1097/SLA.0b013e3181b45598

[25] Bennett, J.A., Riegel, B., Bittner, V. and Nichols, J. (2002) Validity and Reliability of the NYHA Classes for Measuring Research Outcomes in Patients with Cardiac Disease. *Heart Lung*, **31**, 262-270. https://doi.org/10.1067/mhl.2002.124554

[26] Barnason, S., Zimmerman, L., Anderson, A., Mohr-Burt, S. and Nieveen, J. (2000) Functional Status Outcomes of Patients with a Coronary Artery Bypass Graft over Time. *Heart Lung*, **29**, 33-46. https://doi.org/10.1016/S0147-9563(00)90035-9

[27] LaPier, T.K. and Mizner, R. (2009) Outcome Measures in Cardiopulmonary Physical Therapy: Focus on the Late-Life Function and Disability Instrument (LLFDI). *Cardiopulmonary Physical Therapy Journal*, **20**, 32-35. https://doi.org/10.1097/01823246-200920020-00006

[28] Douki, Z.E., Vaezzadeh, N., Zakizad, M., Shahmohammadi, S., Sadeghi, R. and Mohammadpour, R.A. (2010) Changes in Functional Status and Functional Capacity Following Coronary Artery Bypass Surgery. *Pakistan Journal of Biological Sciences*, **13**, 330-334. https://doi.org/10.3923/pjbs.2010.330.334

[29] Joskowiak, D., Meusel, D., Kamla, C., Hagl, C. and Juchem, G. (2022) Impact of Preoperative Functional Status on Quality of Life after Cardiac Surgery. *The Thoracic and Cardiovascular Surgery*, **70**, 205-212. https://doi.org/10.1055/s-0039-1696953

[30] Mori, M., Djulbegovic, M., Hajduk, A.M., Holland, M.L., Krumholz, H.M. and Chaudhry, S.I. (2021) Changes in Functional Status and Health-Related Quality of Life in Older Adults after Surgical, Interventional, or Medical Management of Acute Myocardial Infarction. *Seminars in Thoracic and Cardiovascular Surgery*, **33**, 72-81. https://doi.org/10.1053/j.semtcvs.2020.05.001

[31] Niemeyer-Guimarães, M., Cendoroglo, M.S., and Almada-Filho, C.M. (2016). Course of Functional Status in Elderly Patients after Coronary Artery Bypass Surgery: 6-Month Follow up. *Geriatrics & Gerontology International*, **16**, 737-746. https://doi.org/10.1111/ggi.12547

[32] Hunt, J.O., Hendrata, M.V. and Myles, P.S. (2000) Quality of Life 12 Months after Coronary Artery Bypass Graft Surgery. *Heart Lung*, **269**, 401-411.

https://doi.org/10.1067/mhl.2000.110578

[33] Ballan, A. and Lee, G. (2007) A Comparative Study of Patient Perceived Quality of Life Pre and Post Coronary Artery Bypass Graft Surgery. *The Australian Journal of Advanced Nursing*, **24**, 24-28.

[34] Mori, M., Angraal, S., Chaudhry, S.I., *et al.* (2019) Characterizing Patient-Centered Postoperative Recovery after Adult Cardiac Surgery: A Systematic Review. *Journal of the American Heart Association*, **8**, e013546. https://doi.org/10.1161/JAHA.119.013546

[35] Jette, A.M., Haley, S.M., Coster, W.J., *et al.* (2002). Late Life Function and Disability Instrument: I. Development and Evaluation of the Disability Component. *The Journals of Gerontology*: *Series A*, **57**, M209-M216. https://doi.org/10.1093/gerona/57.4.M209

[36] Haley, S.M., Jette, A.M., Coster, W.J., *et al.* (2002) Late Life Function and Disability Instrument: II. Development and Evaluation of the Function Component. *The Journals of Gerontology*: *Series A*, *Biological Sciences* and *Medical Sciences*, **57**, M217-M222. https://doi.org/10.1093/gerona/57.4.M217

[37] Jette, A.M., Haley, S.M. and Kooyoomjian, J.T. (2002) Late Life Function and Disability Instrument. MA, Trustees of Boston University.

[38] Sayers, S.P., Jette, A.M., Haley, S.M., Heeren, T.C., Guralnik, J.M. and Fielding, R.A. (2004) Validation of the Late-Life Function and Disability Instrument. *Journal of the American Geriatrics Society*, **52**, 1554-1559. https://doi.org/10.1111/j.1532-5415.2004.52422.x

[39] Beauchamp, M.K., Schmidt, C.T., Pedersen, M.M., Bean, J.F. and Jette, A.M. (2014) Psychometric Properties of the Late-Life Function and Disability Instrument: A Systematic Review. *BMC Geriatrics*, **14**, Article No. 12. https://doi.org/10.1186/1471-2318-14-12

[40] Dubuc, N., Haley, S.M., Ni, P., Kooyoomjian, J.T. and Jette, A.M. (2004) Function and Disability in Late Life: Comparison of the Late-Life Function and Disability Instrument to the Short-Form-36 and the London Handicap Scale. *Disability and Rehabilitation*, **26**, 362-370. https://doi.org/10.1080/09638280410001658667

[41] LaPier, T.K. and Waitt, M. (2007) Using the Late Life Function and Disability Instrument as a Self-Report Outcome Measure in Patients with Cardiovascular Disease. *Journal of Cardiopulmonary Rehabilitation and Prevention*, **27**, 331. https://doi.org/10.1097/01.HCR.0000291340.61795.48

[42] World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. *The Journal of the American Medical Association*, **310**, 2191-2194. https://doi.org/10.1001/jama.2013.281053

[43] Beauchamp, M.K., Ward, R.E., Jette, A.M. and Bean, J.F. (2019) Meaningful Change Estimates for the Late-Life Function and Disability Instrument in Older Adults. *The Journals of Gerontology*: *Series A*, **74**, 556-559. https://doi.org/10.1093/gerona/gly230

[44] Tahir, T., Shah, J.Z., Mukhtar, H., *et al.* (2023) The Role of Cardiac Rehabilitation in Improving Postoperative Recovery and Long-Term Outcomes after Cardiac Surgery: A Systematic Review. *Journal of Population Therapeutics and Clinical Pharmacology*, **30**, 151-159. https://doi.org/10.53555/jptcp.v30i18.3057

[45] Gainer, R.A., Curran, J., Buth, K.J., David, J.G., Légaré, J.F. and Hirsch, G.M. (2017) Toward Optimal Decision Making among Vulnerable Patients Referred for Cardiac Surgery: A Qualitative Analysis of Patient and Provider Perspectives. *Medical Deci-*

sion Making, **37**, 600-610. https://doi.org/10.1177/0272989X16675338

[46] Myles, P.S. (2014) Meaningful Outcome Measures in Cardiac Surgery. *The Journal of ExtraCorporeal Technology*, **46**, 23-27. https://doi.org/10.1051/ject/201446023

[47] Virani, S.S., Newby, L.K., *et al*. (2023) 2023 AHA/ACC/ACCP/ASPC/NLA/PCNA Guideline for the Management of Patients with Chronic Coronary Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines. *Circulation*, **148**, e186. https://doi.org/10.1161/CIR.0000000000001195