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Predicting functional decline in older patients undergoing cardiac surgery

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Abstract

Background: a growing number of older patients undergo cardiac surgery. Some of these patients are at increased risk of post-operative functional decline, potentially leading to reduced quality of life and autonomy, and other negative health outcomes. First step in prevention is to identify patients at risk of functional decline. There are no current published tools available to predict functional decline following cardiac surgery.
Objective: to validate the identification of seniors at risk—hospitalised patients (ISAR-HP), in older patients undergoing cardiac surgery.
Design and methods: a multicenter cohort study in cardiac surgery wards of two university hospitals with follow-up 3 months after hospital admission. Inclusion criteria: consecutive cardiac surgery patients, aged ≥65. Functional decline was defined as a decline of at least one point on the Katz ADL Index at follow-up compared with preadmission status.
Results: 475 patients were included, 16% of all patients and 20% of patients ≥70+ suffered functional decline. The amended prediction model predicted functional decline using four criteria: preadmission need for daily assistance in instrumental activities of daily living, use of a walking device, need for assistance in travelling and no education after age 14. Area under the receiver operating curve for patients ≥70 it was 0.73. For the amended ISAR-HP sensitivity, specificity, positive and negative predictive values were 85, 48, 29 and 93%, respectively.
Conclusions: the amended ISAR-HP used in older cardiac surgery patients showed good discriminative values at score ≥1, supporting the generalisability of this prediction model for this patient group.

Keywords: *ISAR-HP, cardiac surgery, older patient, functional decline, prediction, older people*

Introduction

Improved cardiopulmonary bypass technology has allowed for safer procedures with reduced morbidity and mortality, even among the older patients (≥65 years) [1]. Older (≥65 years) patients account for nearly 60% of all patients receiving cardiac surgery [2]. Because of the increasing aging population [3, 4], the number of older cardiac surgery patients is estimated to rise over the next few decades.

In general, older individuals admitted to the hospital for acute health problems are at an increased risk for functional decline following discharge [5–8]. Functional decline often results in decreased autonomy, increased dependency and decreased health-related quality of life. Furthermore, functional decline is associated with prolonged length of hospital stay, greater use of health resources, increased nursing home admission and higher mortality risk [9, 10]. Functional decline is associated with complications like delirium, pressure ulcers, and depression and older cardiac surgery patients often suffer from these complications [11–15]. Identification of high-risk patients is a first step to provide tailored care for patients who would most likely benefit from preventive actions [16]. This risk assessment can then be followed by a comprehensive geriatric assessment (CGA) and targeted interventions to prevent functional decline [16, 17].

Previously, a prediction model and scorecard to assess the risk of functional decline were developed and validated for older patients acutely admitted to the general internal medical wards, the identification of seniors at risk – hospitalised patients (ISAR-HP) [18]. This prediction model

exhibited good discriminatory properties with an area under the receiver operating curve (AUC) of 0.71 (95% CI: 0.66–0.76) and good calibration expressed by a non-significant Hosmer–Lemeshow χ^2 *P*-value (0.95). At a threshold of 2, the sensitivity and specificity, and the positive and negative predictive values for the ISAR-HP scorecard were 87.1 and 39.4%, 43.1 and 85.2%, respectively [18]. The ISAR-HP could also be a valid tool for predicting high risk for functional decline in cardiac surgery patients.

The aim of this study is to validate the ISAR-HP in older cardiac surgery patients.

Methods

A multicenter prospective cohort study was conducted in two university hospitals in the Netherlands, from January 2006 to May 2007 in the first hospital and from November 2006 to April 2008 in the second hospital. Study participants included consecutive cardiac surgery patients aged ≥65, admitted for at least 48 h, interviewed within 48 h after admission but before surgery. Patients who were unable to speak or understand Dutch were excluded from the study. All patients provided informed consent, and the Institutional Review Board of the two hospitals approved the study.

Measurements

Baseline data and function were assessed by specially trained research nurses within 48 h of admission and follow-up data were obtained at 3 months following admission. Baseline data included: demographic information (age, gender and social circumstances), cognition, years of education after age six, the ISAR-HP and functional status measured using the Katz ADL Index. Follow-up functional status was assessed by telephone interview, and functional decline was defined as a decrease of at least 1 point on the Katz ADL Index between baseline and follow-up.

Measurement tools

The ISAR-HP scorecard consisted of four criteria: preadmission daily need for assistance in instrumental activities of daily living (IADL), use of a walking device, need for assistance in travelling and no education after age 14 [18]. These criteria were scored as either 0 (not present) or 1 (present), except for the use of a walking device, for which presence was scored as 2 points. In the original study, scores ≥2 indicated a high risk for functional decline.

Functional status was measured using the Katz ADL Index for six items: bathing, dressing, toileting, transferring, eating and use of incontinence materials [19]. Each item was scored as either 0 (independent) or 1 (dependent).

Analysis

Some patient data were missing for one or more of the variables. Missing data were imputed using the single linear regression method, with the addition of random error terms in the SPSS statistical software.

Percentages or means and standard deviations were calculated to describe the study population, and the discriminative value of the model was measured by the AUC. AUC, sensitivity and specificity and the positive and negative predictive values were calculated in different age groups (≥65, ≥70 and ≥75) to determine the optimal predictive use of the ISAR-HP scorecard.

Analyses were performed using the SPSS software, version 15 (Statistical Package for the Social Sciences, Inc. Chicago, IL, USA).

Results

Of 513 eligible patients, three participants refused the follow-up, eight participants were lost to follow-up, one participant was still hospitalised and not available for follow-up, 26 patients died, leaving 475 participants to be included in this study. Table 1 lists the demographic and clinical characteristics of the study population. The mean age of the participants was 73; 64% were male, 94% lived independently and 24% lived alone. Most of the participants (55%) were admitted for cardiac arterial bypass surgery, for aorta valve replacement (AVR) (23%) or a combination of these (14%). Approximately 16% of all participants and 20% of participants 70+ years of age exhibited functional decline.

The AUC of the prediction model in participants ≥65 was 0.72 (95% CI: 0.65–0.79), in participants aged ≥70 this was 0.73 (95% CI: 0.66–0.80) and in participants aged ≥75 it was 0.75 (95% CI: 0.66–0.83). An overview of the sensitivities and specificities, and the positive and negative predictive values at various thresholds is shown in Table 2. In participants aging ≥65 and using threshold 2, the sensitivity was 51% and specificity was 83%. However, assessing participants

Table 1. Demographic and clinical characteristics of patients admitted to two cardiac surgery units (*n* = 475)

Age, mean (SD)	73 (5.2)
Male, % (*n*)	64 (303)
Living situation, % (*n*) independent	94 (448)
Social situation, % (*n*) living alone	24.4 (116)
Education years after age 6, mean (SD)	9.9 (3.6)
No education after age 14% (*n*)	38.5 (183)
Memory problems (yes%)	12.2 (58)
Walking device (yes%)	13.7 (65)
Needing assistance in travelling	11.4 (54)
Preadmission functional status (2 weeks before admission), Katz score; independent % (*n*)	90 (425)
Follow-up functional status (3 months after admission), Katz score; independent % (*n*)	80 (378)
Difference in functional status at preadmission and at follow-up % (*n*)	
Between −4 and −1 = improved	3 (13)
0 = no difference	82 (388)
≥1 point = declined	16 (74)

Table 2. ISAR-HP [18]: overview of different discriminative values at various thresholds

ISAR-HP	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
Age 65 ($n = 475$)				
Threshold of 2	51	83	36	90
Threshold of 1	80	51	23	93
Age 70 ($n = 331$)				
Threshold of 2	56	82	43	88
Threshold of 1	85	48	29	93
Age 75 ($n = 187$)				
Threshold of 2	60	79	49	85
Threshold of 1	89	39	33	92

70+ years of age using threshold 1 resulted in the best sensitivity and specificity of 85 and 48%, respectively.

Discussion

The amended ISAR-HP scorecard, applied in participants aged ≥70 and using threshold ≥1, was able to identify the older patients admitted for cardiac surgery who were at greater risk for functional decline after hospitalisation (Figure 1). This prediction model uses only four predictors: preadmission daily need for assistance in IADL, use of a walking device, need for assistance in travelling and no education after age 14.

The first steps in prevention are risk assessment, potentially followed by interventions such as CGA. We preferred to be more conservative and obtain a high sensitivity, which would identify all high-risk patients but would also include several low-risk patients and generate a number of false positives. At a threshold of 2 that we used in the original instrument [18], we obtained a sensitivity of 51% for participants aged ≥65. As this was not an optimal result, we applied a threshold of 1 for participants aged ≥70 which gave the best results with a sensitivity of 85% and a specificity 48%. The corresponding positive predictive value is 29%, indicating that about three quarters of these at risk participants will not develop functional decline. As the second step for patients at risk is a geriatric assessment to prevent geriatric complications we think this relatively high number of false positives, it is acceptable. Fifty-nine percent of the participants of 70 years and older were identified as being at risk. For these patients, a CGA might be indicated. Other cut-off scores might be applicable depending upon local context and resource availability.

The AUC of 0.72 in this study was similar to that seen in the original development and validation studies in general medical settings (AUCs of 0.71 and 0.68, respectively).

However, there are several limitations of the present study that need to be addressed. To identify patients at high risk for functional decline, we advise assessing patients 70+ years of age using a threshold of one. The original development and validation study assessed patients 65+ years of age using a threshold of 2 [18]. Thus, differences observed between the two studies might be due to the difference in incidence of functional decline (35% in the development and validation study versus 16% in this study).

We also excluded any deceased patients from our analysis ($n = 26$) because we did not want to confound the prediction model of functional decline with mortality; it is possible that some of these patients may have had functional decline and their exclusion may have affected the results. The ISAR-HP scorecard also predicted mortality with a sensitivity of 92%.

ISAR-HP

Identification of Seniors At Risk – Hospitalised Patients

	YES	NO
1. Before hospital admission, did you need assistance for IADL (e.g., assistance in housekeeping, preparing meals, shopping, etc.) on a regular basis?	1	0
2. Do you use a walking device (e.g., a cane, rollator, walking frame, crutches, etc.)?	2	0
3. Do you need assistance for traveling?	1	0
4. Did you continue education after age 14?	0	1
Total score		

Total score ≥1 = patient at risk for functional decline

Figure 1. Amended scorecard: identification of seniors at risk—hospitalised patients (ISAR-HP).

Conclusion

Of 475 older cardiac surgery participants examined, we found that 20% of participants ≥70 years suffered from functional decline when comparing the functional status 3 months after hospital admission with that at preadmission. The functional decline after hospital admission can be predicted using a four-variable model at a threshold of ≥1 for patients 70+ years of age. The ISAR-HP scorecard for this

model is convenient for clinical use because of the small number of items that need to be assessed. For those patients who are at risk, we advise to assess the geriatric risks which should be followed by targeted interventions to prevent complications and functional decline.

Key points

- Increasing numbers of older people are undergoing cardiac surgery, some of whom are at risk of post-operative functional decline.
- There are no valid risk prediction tools to identify those likely to experience functional decline.
- The amended ISAR-HP was able to accurately identify those at risk of functional decline following cardiac surgery.

Conflicts of interest

None declared.

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References

1. Bacchetta MD, Ko W, Girardi LN, *et al*. Outcomes of cardiac surgery in nonagenarians: a 10-year experience. Ann Thorac Surg 2003; 75: 1215–20.
2. Northrup WF III, Emery RW, Nicoloff DM, Lillehei TJ, Holter AR, Blake DP. Opposite trends in coronary artery and valve surgery in a large multisurgeon practice, 1979–1999. Ann Thorac Surg 2004; 77: 488–95.
3. Department of Economic and Social Affairs, United Nations. Population Ageing and Development 2012. 2012;ST/ESA/SER.A/323.
4. Kinsella K, He W. An Aging World: 2008, international population reports. 2009; International Population Reports, P95/09–1.
5. Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, Burant CJ, Landefeld CS. Loss of independence in activities of daily living in older adults hospitalised with medical illnesses: increased vulnerability with age. J Am Geriatr Soc 2003; 51: 451–8.
6. Boyd CM, Landefeld CS, Counsell SR, Palmer RM, Fortinsky RHKresevic D, Burant C, Covinsky KE. Recovery of activities of daily living in older adults after hospitalization for acute medical illness. J Am Geriatr Soc 2008; 56: 2171–9.
7. Gill TM, Allore HG, Holford TR, Guo Z. Hospitalization, restricted activity, and the development of disability among older persons. JAMA 2004; 292: 2115–24.
8. Creditor MC. Hazards of hospitalization of the elderly. Ann Intern Med 1993; 118: 219–23.
9. Miller EA, Weissert WG. Predicting elderly people's risk for nursing home placement, hospitalization, functional impairment, and mortality: a synthesis. Med Care Res Rev 1026; 57: 259–97.
10. Covinsky KE, Justice AC, Rosenthal GE, Palmer RM, Landefeld CS. Measuring prognosis and case mix in hospitalised elders. The importance of functional status. J Gen Intern Med 1997; 12: 203–8.
11. Balas MC, Happ MB, Yang W, Chelluri L, Richmond T. Outcomes associated with delirium in older patients in surgical ICUs. Chest 2009; 135: 18–25.
12. McCusker J, Cole M, Dendukuri N, Belzile E, Primeau F. Delirium in older medical inpatients and subsequent cognitive and functional status: a prospective study. CMAJ 2001; 165: 575–83.
13. Kazmierski J, Kowman M, Banach M *et al*. Preoperative predictors of delirium after cardiac surgery: a preliminary study. Gen Hosp Psychiatry 2006; 28: 536–8.
14. Blumenthal JA, Lett HS, Babyak MA *et al*. Depression as a risk factor for mortality after coronary artery bypass surgery. Lancet 2003; 362: 604–9.
15. Feuchtinger J, Halfens R, Dassen T. Pressure ulcer risk assessment immediately after cardiac surgery – does it make a difference? A comparison of three pressure ulcer risk assessment instruments within a cardiac surgery population. Nurs Crit Care 2007; 12: 42–9.
16. Ferrucci L, Guralnik JM, Studenski S, Fried LP, Cutler GB Jr, Walston JD. Designing randomized, controlled trials aimed at preventing or delaying functional decline and disability in frail, older persons: a consensus report. J Am Geriatr Soc 2004; 52: 625–34.
17. Ellis G, Langhorne P. Comprehensive geriatric assessment for older hospital patients. Br Med Bull 2004; 71: 45–59.
18. Hoogerduijn JG, Buurman BM, Korevaar JC, Grobbee DE, de Rooij SE, Schuurmans MJ. The prediction of functional decline in older hospitalised patients. Age Ageing 2012; 41: 381–7.
19. Katz S, Ford A, Moskowitz R, Jackson B, Jaffe M. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychsocial function. JAMA 1963; 185: 914–9.

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