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SHORT REPORT

Preoperative Cognitive Screening Predicts Postoperative Ambulatory Recovery: A Pilot Study

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Purpose: Cardiac surgery patients are older adults at risk for postoperative physical impairment. We hypothesize that screening for mild cognitive impairment (MCI) using the Montreal Cognitive Assessment (MoCA) may identify patients at risk for delayed physical recovery.

Patients and Methods: This is a single center prospective cohort pilot study of patients undergoing elective cardiac surgery. Patients were screened preoperatively for MCI using the MoCA full version 8.1, with scores < 26 defined as a positive screen for MCI. Daily step count, as a practical measure of physical function, was continuously recorded from the preoperative period (baseline) through postoperative day 50 using a commercially available activity tracker.

Results: Eighteen patients met inclusion criteria. Eight (44%) screened positive for MCI and 10 (56%) screened non-impaired (NI). Baseline characteristics and operative outcomes were similar between the MCI and NI cohorts. The MCI cohort did not achieve their preoperative daily step count by postoperative day 50, whereas the NI cohort did so by postoperative day 37. There was a difference in median [IQR] postoperative daily step count (MCI: 3662[2292–5704] vs NI: 4497[2532–9216]; $p < 0.001$).

Conclusion: In a cohort of patients older than 60 undergoing cardiac surgery, a preoperative screen for MCI delayed postoperative physical recovery. A brief preoperative cognitive screen tool may identify patients who could benefit from early intervention for recovery of physical function.

Keywords: ambulation, postoperative recovery, cardiac surgery, cognitive impairment, MoCA

Introduction

As longevity increases, the number of older adults undergoing surgery is increasing.[1,2] Hundreds of thousands of adults older than 60 years make up more than half of patients undergoing cardiac surgery in the United States.[3] Older age is a risk factor for impaired mobility after surgery and other associated postoperative complications, including delirium.[4,5] Multiple studies have demonstrated that postoperative ambulation positively impacts surgical outcomes and is associated with improved cognitive health including rates of delirium and dementia.[6–11] Identifying older adults at risk for impaired postoperative mobility preoperatively could enable targeted interventions to enhance ambulation recovery and reduce morbidity.

The Montreal Cognitive Assessment (MoCA) is a validated screening tool to identify patients at risk for mild cognitive impairment (MCI).[12] The full version MoCA was developed as a point of care test that can be administered in

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approximately ten minutes by a trained health-care professional after completion of a one-hour course.[12] For these reasons, the MoCA was chosen as a feasible screening exam that can be easily administered without significant resources in a busy surgery clinic. Patients undergoing elective cardiac surgery with cardiopulmonary bypass represent an ideal model to examine how cognitive impairment before elective surgery impacts pre- and post-operative daily step count recovery in older adults as 1) the average patient is 60 years or older, community-dwelling and functionally independent and 2) factors impacting mobility and cognitive impairment can be assessed prospectively with the potential to intervene both before and soon after surgery to prevent or minimize postoperative impairment in mobility.

In this study, we seek to determine how preoperative potential MCI is related to preoperative daily step count and postoperative ambulatory recovery. We perform preoperative screening for MCI using the MoCA and track preoperative and postoperative daily steps continuously for 50 days after cardiac surgery. We hypothesize that patients who screened positive for MCI preoperatively will return to their baseline slower, increasing their risk for complications.

Materials and Methods

We performed a single center, prospective pilot study of patients ≥ 60 years old undergoing planned (elective, non-emergent) coronary and/or valve surgery with cardiopulmonary bypass. Exclusion criteria included patients with a pre-existing clinical diagnosis of dementia in the medical record, non-ambulatory patients or those without a smartphone. Data collection and analysis were conducted from September 2023 through August 2024. Study procedures were approved by Colorado Multiple Institutional Review Board (#23-1394) and comply with the Declaration of Helsinki.

After recruitment and written informed consent, participants were provided with and instructed to wear a commercially available activity tracker (Vivofit 4; Garmin Ltd, Schaffhausen, Switzerland) on their wrist. The activity tracker is validated to track steps with <2% deviation from the gold standard of video observation.[13] Additionally, this tracker has a long battery life that does not require charging, allowing participants to continuously wear it for the duration of the study. Baseline daily step count was recorded for up to 30 days preoperatively. Daily step data from three particular days were not included in data analysis as these days did not have a full day of data collection: 1) day the watch was provided, 2) day of surgery, and 3) day the watch was returned. Postoperatively, daily steps were recorded for up to 50 days beginning on postoperative day one. The activity trackers did not require charging and patients were encouraged to wear the activity tracker day and night if able.[14] Data from the watch was downloaded for each participant by syncing it with the Garmin Connect app (Garmin Ltd, Schaffhausen, Switzerland) on their smartphone.

After enrollment, patients were screened for MCI using the MoCA version 8.1. Using standard interpretation, participants scoring ≥ 26 were categorized as non-impaired (NI), while those scoring < 26 were categorized as screening positive for MCI.[12] Operative and postoperative outcomes including operative approach, operative times, requirement of postoperative mechanical circulatory support, hospital length of stay, participation in cardiac rehabilitation, readmission, discharge destination and return to regular activities were obtained from chart review after return of the activity tracker.

Microsoft Excel (Microsoft, Redmond, WA, USA), the R Project for Statistical Computing (The R Foundation, Vienna, Austria) and REDCap (The REDCap Consortium, Nashville, TN, USA) were used for data management and analysis. Categorical variables were compared using Fisher Exact Test ($n < 5$) or Chi Squared Test ($n \geq 5$). Nonparametric continuous variables (steps per day) were compared using the Wilcoxon rank sum test. P values < 0.05 were considered statistically significant.

Results

Twenty-one patients were enrolled and 18 were included in the analysis. Three patients withdrew from the study (one patient had a stroke, one patient voluntarily withdrew, one patient did not have surgery). Preoperative MoCA identified eight patients (44%) who screened positive for MCI and ten patients (56%) who were screened as NI. For the purpose of this research, we classify these patients into MCI and NI cohorts, although the MoCA is only a screening tool and not diagnostic. Preoperative characteristics including demographics are described in Table 1. There was no difference in baseline demographics or comorbidities. There was no difference in median [IQR] preoperative baseline steps (MCI: 7490 [4942–9763] vs NI: 8099 [6197–11,139]; $p = 0.08$).

Table 1 Baseline Characteristics, Operative Variables and Postoperative Outcomes

	Mild Cognitive Impairment (n = 8)	Non-Impaired (n = 10)	*P* Value
Baseline Characteristics			
Median baseline daily step count	7490 [4942–9763]	8099 [6197–11139]	0.08
Montreal Cognitive Assessment	23 [22–24]	27 [27–28]	<0.001
Age (years)	68 [63–73]	66 [60–68]	0.57
Male Sex	4 (50%)	7 (70%)	0.63
Body Mass Index	25.2 [22.8–25.2]	25.1 [24.0–26.2]	0.32
Coronary Artery Disease	1 (13%)	1 (10%)	>0.99
Valvular Disease	8 (100%)	9 (90%)	>0.99
Ejection Fraction < 50%	0 (0%)	0 (0%)	>0.99
Hypertension	0 (0%)	2 (20%)	0.48
Diabetes Mellitus	0 (0%)	0 (0%)	>0.99
Stroke	1 (13%)	1 (10%)	>0.99
Chronic Kidney Disease	1 (13%)	0 (0%)	0.44
Operative Variables			
Surgery Type			
Valve repair/replacement	7 (88%)	9 (90%)	0.71
Coronary artery bypass	0 (0%)	1 (10%)	
Myxoma excision	1 (11%)	0 (0%)	
Minimally invasive approach	8 (100%)	7 (70%)	0.22
Bypass time (minutes)	135 [111–169]	127 [119–156]	0.83
Cross clamp time (minutes)	84 [66–105]	83 [76–109]	0.56
Extubated in operating room	6 (75%)	8 (80%)	>0.99
Postoperative MCS	0 (0%)	0 (0%)	>0.99
Postoperative Outcomes			
CAM positive during admission	1 (13%)	1 (10%)	>0.99
Length of stay (days)	4 [3–4]	4 [3–5]	0.54
30-day Readmission[a]	0 (0%)	2 (20%)	0.48
Discharged Home	8 (100%)	10 (100%)	>0.99
Cardiac rehabilitation initiated	4 (50%)	5 (50%)	>0.99
30-day Return to driving	7 (88%)	7 (70%)	>0.99
30-day Return to regular activity or work	5 (63%)	4 (40%)	0.64
Median daily step count from postoperative day 0 to 50	3662 [2292–5704]	4497 [2532–9216]	<0.001

Notes: [a]Readmission reasons: Syncope and pneumothorax. Continuous variables reported as median [IQR]; Categorical variables reported as number (percent).

Abbreviations: MCS, Mechanical Circulatory Support; CAM, Confusion Assessment Method.

Operative and postoperative variables were compared between the NI and MCI cohorts, described in Table 1. There were no differences in operative approach (sternotomy versus sternotomy-sparing), cardiopulmonary bypass or aortic cross clamp times, operating room extubation rates, need for postoperative mechanical circulatory support, postoperative delirium (as determined by a positive Confusion Assessment Method for Intensive Care Unit [CAM-ICU] assessment) or hospital length of stay.

Postoperative ambulatory recovery is represented graphically for the MCI (Figure 1A) and NI (Figure 1B) cohorts. Daily step counts were positively correlated with postoperative day, showing an increasing trend with increasing postoperative day. The MCI cohort did not reach their preoperative baseline by postoperative day 50. The NI cohort

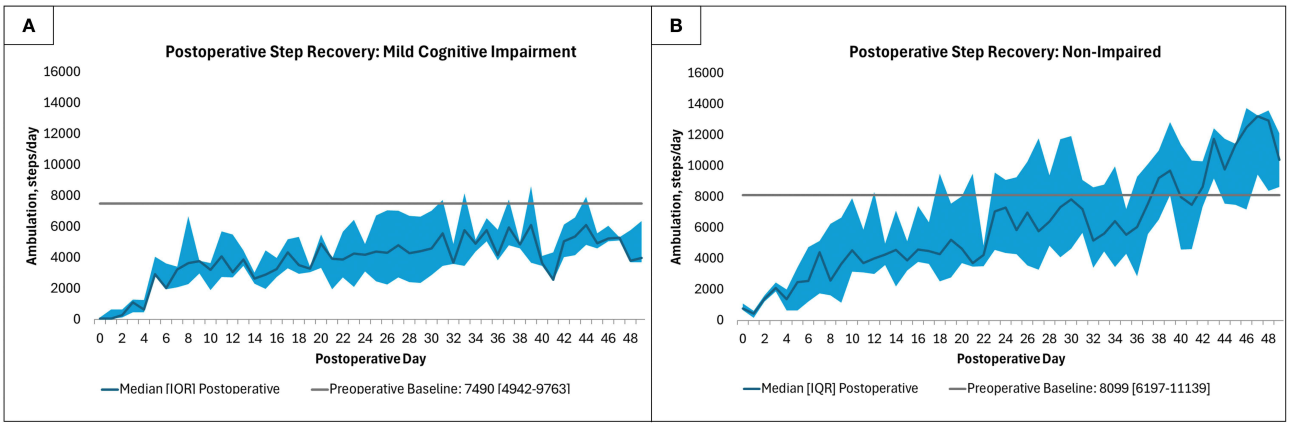

Figure 1 Postoperative step recovery was significantly delayed in (**A**) patients who screened positive for mild cognitive impairment before surgery, compared with (**B**) patients who had a normal cognitive screen before surgery, $p < 0.001$.

reached their postoperative baseline by postoperative day 37. A comparison of median [IQR] postoperative daily step count by cohort revealed a statistical difference (MCI: 3662 [2292–5704] vs NI: 4497 [2532–9216]; $p < 0.001$).

There was no difference in evaluated postoperative metrics including hospital length of stay, participation in cardiac rehabilitation, readmission, discharge destination or return to preoperative activities at 30 days postoperative, Table 1.

Discussion

Our data demonstrate that older patients who screen positive for MCI during preoperative assessment for cardiac surgery have delayed ambulation recovery after cardiac surgery compared with their counterparts who do not screen positive for cognitive impairment. Patients without cognitive impairment returned to their preoperative baseline daily step count by postoperative day 37 and then subsequently exceed their preoperative baseline. Impaired mobility demonstrated within the potential MCI cohort is a risk factor for several postoperative complications, which has been demonstrated across surgical subspecialties.[15–19] While we did not detect a difference in postoperative metrics within our cohort, this may be due to the study being underpowered for these outcomes. With a larger sample size, differences in these outcomes may become apparent. Additionally, despite not detecting a difference in clinical outcomes, predicting the postoperative ambulation recovery of patients may better help set patient expectations in the preoperative setting. Realistic expectations has been shown to improve patient satisfaction postoperatively.[20]

There is an aging population of patients undergoing cardiac surgery with a current median age of 63 years.[21] As cardiac surgery operative mortality has improved, a call to action has been issued to widen the focus from survival, to optimizing the physical function and cognitive recovery of older adults.[22,23] It is increasingly important for the perioperative care of older adults to integrate multidisciplinary recommendations from geriatricians and rehabilitation providers. Older adults undergoing cardiac surgery represent a population of community-dwelling, functionally independent adults at increased risk for undiagnosed MCI as evidenced by 44% of our cohort screening positive. We have demonstrated these patients have a stunted postoperative ambulatory recovery compared with their counterparts despite otherwise similar preoperative and operative characteristics. MCI as a risk factor can be rapidly detected in the presurgical or primary care setting with administration of a 10-minute MoCA. Furthermore, any health-care professional can become certified to administer the MoCA and implement this screening test in a busy, preoperative clinic visit. A positive screen for cognitive impairment with the MoCA may help identify patients, in a resource-limited setting, who will most benefit from early, targeted intervention for recovery of physical function after surgery and neurocognitive follow-up. Alternatively, preoperative cognitive training for this at risk group may have a positive impact on preoperative MCI or potentially on postoperative physiologic outcomes.

We recognize the limitations of our study and the results presented herein should be interpreted in the context of these limitations. Postoperative complications were low in this cohort of patients undergoing elective cardiac surgery, however future studies need to examine whether delayed ambulation is associated with longer term deficits in physical function,

postoperative cognitive impairment, patient reported outcomes, or increased health-care utilization. Furthermore, with evidence demonstrating delirium impacts ambulation recovery, future studies should examine how preoperative MoCA may be associated with postoperative delirium, cognitive function and ambulation recovery. Future work will also examine if this relationship between preoperative cognitive impairment and postoperative ambulatory recovery is similar with older adults receiving other types of surgery, and whether short and longer term complications are impacted. This study is also a single center, single surgeon pilot cohort and should be expanded to allow for better generalizability. Future work will evaluate interventions and resources that can be allocated for patients with MCI to aid in their postoperative functional and cognitive recovery. Daily step counts serve as a unique surrogate for preoperative function and are a modifiable variable, pre and postoperatively.[24] Wearing an activity tracker as a primary intervention or as part of a broader physical activity intervention can increase daily step counts in older adults including those with cardiovascular disease.[25–27] Lastly, median baseline daily step count is approaching statistical significance between the two cohorts, which may impact the significance of differences in postoperative ambulation recovery, although this will require a larger cohort to investigate.

Conclusion

In a cohort of patients older than 60 years undergoing elective cardiac surgery, a high proportion (44%) screened positive for MCI. Preoperative screening for MCI using the MoCA can identify patients at risk for impaired functional recovery after cardiac surgery. Early intervention and resources for these patients may help prevent postoperative complications.

Abbreviations

MCI, mild cognitive impairment; MoCA, Montreal Cognitive Assessment; NI, non-impaired; IQR, interquartile range; CAM-ICU, confusion assessment method for intensive care unit; MCS, mechanical circulatory support.

Data Sharing Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval and Informed Consent

This work was approved by Colorado Multiple Institutional Review Board (#23-1394). This study complies with the Declaration of Helsinki.

Consent to Participate

All participants provided written informed consent for participation in the study.

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The work herein was presented at the 62nd Annual Meeting of the Eastern Cardiothoracic Surgical Society (2024).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted and agree to be accountable for all aspects of the work.

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