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Original Article

Sedentary Time in Older Adults With Acute Cardiovascular Disease

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ABSTRACT

Background: Older adults may be subject to prolonged bedrest during hospitalization for acute cardiovascular disease, which can contribute to poor functional outcomes posthospitalization. Our objective was to describe mobility status in hospitalized older adults with acute cardiovascular disease.

Methods: Patients aged ≥ 60 years old in the cardiac intensive care unit and cardiovascular ward at a tertiary care academic centre in Montréal, Québec were prospectively enrolled from April 2019 to March 2020. Activity levels were measured with the ActiGraph GT9X

RÉSUMÉ

Introduction : Les personnes âgées hospitalisées en raison d'une maladie cardiovasculaire en phase aiguë peuvent être sujettes à un alitement prolongé qui peut contribuer à des résultats fonctionnels médiocres après l'hospitalisation. Notre objectif était de décrire l'état de mobilité des personnes âgées hospitalisées en raison d'une maladie cardiovasculaire en phase aiguë.

Méthodes : Nous avons inscrit de façon prospective les patients de ≥ 60 ans de l'unité des soins intensifs cardiaques et de l'unité de cardiologie d'un centre universitaire de soins tertiaires à Montréal, au

Older adults often endure prolonged periods of bedrest during hospitalization because of acute illness, physician prescription, medical tests, and lack of medical support staff.[1,2] People with acute cardiovascular disease, such as ischemic heart disease, atrial fibrillation, and heart failure, are particularly subject to lengthy periods of bedrest because of the need for invasive monitoring as well as the concern for electrical and hemodynamic instability.[3] Bedrest is associated with poor outcomes such as pressure ulcers, edema, and increased length of hospital stay.[1,2,4] Bedrest also results in the loss of muscle mass and strength, leading to functional decline that remains well beyond the index hospitalization period.[5,6] Following hospitalization there is a transient period of vulnerability, known as posthospitalization syndrome, when the hospital-acquired deconditioning leads to impaired functional ability and increases the risk of hospital readmission.[5,7]

Structured mobilization programs designed to increase physical activity may decrease sedentary time during acute care hospitalization and may affect posthospitalization functional outcomes.[8] Older adults may prioritize their independence as well as functional measures such as mobility and maintenance of quality of life over standard clinical outcomes.[9]

There are limited data describing the amount of sedentary time that older adults with cardiovascular disease spend during an acute care hospitalization. Actigraphy devices equipped with accelerometers can track time spent in varying mobility positions and estimate metabolic expenditure during hospitalization.[10] Actigraphy has been shown to provide accurate and valid data on the mobility status of critically ill inpatients.[11] Thus, our objectives were to describe the time older adults spend in sedentary positions during hospitalization for acute cardiovascular disease and to explore the association between sedentary time and posthospitalization person-centred outcomes. Data from this study can be used to design interventions aimed to reduce in-hospital sedentary behaviour, which could then improve posthospitalization outcomes in older adults with acute cardiovascular disease.

Methods

Study design, participants, and setting

Patients aged ≥ 60 years admitted to the cardiovascular intensive care unit (CICU) or cardiovascular ward were prospectively enrolled in an observational cohort study at the Jewish General Hospital, a tertiary care academic centre in Montréal, Canada, from April 1, 2019, to March 1, 2020. Exclusion criteria were projected hospital stay ≤ 24 hours,

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Ethics Statement: This study was approved by the institutional research ethics board.

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Link 3-axis accelerometer (ActiGraph, Pensacola, FL). Sedentary was defined as lying in bed or in a sitting position. Health-related quality of life (HRQOL) was measured with the Short-Form 36 (SF-36) questionnaire by telephone at 1 month posthospitalization. The primary outcome was percentage of sedentary time during hospitalization.

Results: There were 35 patients included in the analysis (75.7 ± 6.9 years old; 45.7% female; 22.9% ischemic heart disease; 20.0% heart failure). Patients spent 91.2% ± 5.5 in a sedentary position during their hospital stay. Mean steps per minute were 1.0 ± 1.2, and mean kcals consumed per day were 116.6 ± 124.5. In the multivariable analysis, a higher percentage of sedentary time and lower steps per minute were each associated with lower total SF-36 scores at 1-month posthospitalization (both $P < 0.05$).

Conclusions: Older adults with acute cardiovascular disease may be sedentary for a large part of their hospital stay. Increased sedentary time is associated with worse self-reported posthospital HRQOL. Future studies are needed to determine whether interventions to increase activity during hospitalization improve posthospital HRQOL and functional outcomes.

Québec, d'avril 2019 à mars 2020. Nous avons mesuré les niveaux d'activité physique à l'aide de l'accéléromètre ActiGraph GT9X Link 3-axis (ActiGraph, Pensacola, Floride, É.-U.). Nous avons défini la sédentarité par le fait d'être couché au lit ou en position assise. Nous avons mesuré la qualité de vie liée à la santé (QVLS) à l'aide du questionnaire SF-36 (Short Form-36) par téléphone un mois après l'hospitalisation. Le critère de jugement principal était le pourcentage de temps sédentaire durant l'hospitalisation.

Résultats : Dans l'analyse, on comptait 35 patients (75,7 ± 6,9 ans; 45,7 % de femmes; 22,9 % atteints d'une cardiopathie ischémique; 20,0 % atteints d'insuffisance cardiaque). Les patients passaient 91,2 % ± 5,5 en position sédentaire durant leur séjour à l'hôpital. Les pas moyens par minute étaient de 1,0 ± 1,2, et les kcal moyennes consommées par jour étaient de 116,6 ± 124,5. Dans l'analyse multivariée, un pourcentage plus élevé de temps sédentaire et un nombre inférieur de pas par minute étaient chacun associés à des scores totaux plus faibles au SF-36 un mois après l'hospitalisation ($P < 0,05$, pour les deux).

Conclusions : Les personnes âgées atteintes d'une maladie cardiovasculaire en phase aiguë se retrouvent sédentaires pendant une grande partie de leur séjour à l'hôpital. L'augmentation du temps sédentaire est associée à une plus mauvaise QVLS après l'hospitalisation selon les personnes âgées interrogées. Des études ultérieures sont nécessaires pour déterminer si les interventions pour accroître l'activité physique durant l'hospitalisation améliorent la QVLS et les résultats fonctionnels après l'hospitalisation.

patients with poor prehospital level of function (LOF) status (defined as levels 0, 1, or 2), or a scheduled cardiac surgery during the index hospitalization. All patients from this observational cohort were enrolled in the early mobility (EM) program. All participating subjects signed written informed consent forms before enrollment in the study.

The early mobility program

The early mobility (EM) program is a pragmatic, nurse-driven mobilization program in which patients are mobilized as soon as hemodynamic stability is achieved, typically within the first day or 2 following unit arrival. The EM program has been previously shown to be safe and feasible people with acute cardiovascular disease.[12,13] Mobility is measured in the EM program using the validated LOF Mobility Scale, which ranges from 0 (bed mobility) to 5 (able to walk > 20 meters).[12] Bedside nurses assess the prehospital and admission LOF score upon unit arrival and then subsequently twice daily. Prehospital LOF status is determined by nurses through patient history or by contacting the family. Patients undergo morning and evening activities as specified by their current LOF status. Nurses document contraindications to mobilization, adverse events, activities performed, and the LOF. Adverse events were defined as life threatening (cardiac arrest or severe respiratory distress), major (syncope, falls, line displacement, health care personnel injury, persistent chest pain, or hypotension), or minor (transient, self-resolving hemodynamic, arrhythmic or respiratory events).

Study variables and outcome measures

The primary outcome was percentage of sedentary time during hospital stay. Secondary outcomes were total step counts, steps per minute, kcal consumption per day, and Short-Form (SF)-36 scores at 1-month and 12-months post-hospitalization. The SF-36 Health Survey is a 36-item health-related quality of life (HRQOL) survey self-reported by patients. It is the most widely used HRQOL instrument, is feasible to administer in-person and by phone, and has been validated in older patient populations.[14] Covariates of interest included age, sex, primary admission diagnosis, length of unit stay and LOF scores at 3 intervals (prehospital, admission, and unit discharge). Additional outcomes of interest were in-hospital mortality, 30-day hospital readmission, and discharge destination.

Study instruments

Patients enrolled in the study were outfitted with a 3-axis accelerometer and inclinometer: the ActiGraph GT9X Link Bluetooth Activity Monitor (ActiGraph, Pensacola, FL). The ActiGraph GT9X Link is a small portable activity device weighing 14 grams and measuring 3.5 x 3.5 x 1 cm that is fastened to a belt that on patients' thighs or waists.[15] A member of the research team swaps out the devices daily to charge and transfer data, sterilizing with isopropyl alcohol in between. The device and the accompanying ActiLife software defines sedentary as lying down or in a sitting position.[16] The device has been shown to provide accurate and reliable long-term data of time spent in mobility positions (standing, sitting, lying), time spent in activity intensities (sedentary, moderate, light, vigourous), step counts, steps per minute and kcal per day consumption in acute care inpatients.[11] Through Bluetooth technology, the ActiGraph GT9X Link devices connect to the ActiLife software to extract the data.[17]

Table 1. Cohort characteristics

Variable	Number in cohort N = 35
Demographic	
Age (years)	75.7 ± 6.9
Female (%)	16 (45.7%)
Primary admission diagnosis	
Ischemic heart disease	8 (22.9%)
Heart failure	7 (20.0%)
Atrial fibrillation	6 (17.1%)
Other cardiovascular disease	4 (11.4%)
Valvular disease	9 (25.7%)
Clinical outcomes	
CICU length of stay, days	3.0 (1.0 to 5.0)
Hospital length of stay, days	11.0 (5.0 to 23.0)
In-hospital death	0 (0.0%)
30-day hospital readmission	4 (11.4%)
Discharge destination	
Home	33 (94.3%)
Rehabilitation or acute-care hospital	2 (5.7%)
Long-term care facility	0 (0.0%)
Mobility	
Prehospital LOF	4.6 ± 0.6
CICU admission LOF	3.3 ± 1.3
CICU discharge LOF	3.9 ± 0.8
Adverse events	3
Number of activities completed	791
Contraindications	9 (25.6%)

Continuous variables are included as mean ± standard deviation. Categorical variables are included as number (percentage). CICU length of stay and hospital length of stay in days reported as median.

CICU, cardiovascular intensive care unit; LOF, level of function.

Data collection

The following data were obtained from the electronic medical records of each subject: age, sex, primary admission diagnosis, length of CICU or cardiovascular ward hospital stay, discharge destination, vital status at discharge and at 30 days, and mobility metrics (LOF scores, contraindications to mobilization, total activities completed, adverse events). Primary admission diagnosis was codified into the following categories: ischemic heart disease, heart failure, atrial fibrillation, other arrhythmia, other cardiovascular disease, other noncardiovascular disease, and valvular disease. Discharge destination was defined as home, rehabilitation facility or acute care hospital, or long-term care facility. HRQOL was ascertained at 1 and 12 months by a member of the research team administering the SF-36 Health Survey by telephone.

Data analysis

Continuous variables are summarized as mean ± standard deviation, with between-group differences tested using the Student's *t*-test. Categorical variables are summarized as frequencies and percentages. Length of stay in the CICU and hospital in days are reported as median values with interquartile ranges. Comparisons were done using the χ^2 test or Fisher exact test, where appropriate. Bivariate Pearson's correlation was performed to correlate step counts with mobility activities and percentage of sedentary time. A multivariable linear regression model was used to determine the predictor variables of age, sex, primary admission diagnosis, and mobility levels, with the total SF-36 score at 1-month. A P value of ≤ 0.05 was considered to be statistically significant. Data analysis was done using the SPSS 24.0 statistical software (IBM Corp, Armonk, NY).

Results

There were 35 patients included in this analysis (Table 1). The mean age was 75.7 ± 6.9 years old, and 16 patients were female (45.7%). The median length of stay was 3.0 days in the CICU and 11.0 days in the hospital. The majority of patients were discharged home (n = 33; 94.3%). There were 4 patients (11.4%) readmitted to the hospital within 30 days. There were 3 adverse events (3 events per 791 activities; 0.4%). All (n = 3) were minor and transient. There were no patient falls.

Patients spent 91.2% ± 5.5 of their time during hospital stay in a sedentary position, 7.5% ± 4.8 in moderate activity, and 0.8% ± 1.9 in vigourous activity. The average percentage of sedentary time during hospital stay ranged from 80.0% to 100% (Fig. 1). The percentage of sedentary time was highest during the first day of CICU stay (95.7% ± 0.0008; n = 2) and decreased by the third day of hospital day (89.5% ± 0.06; n = 19; Fig. 2). The mean kcals burned per day was 116.6 ± 124.5, peaking on day 3, with 92.6 kcals per day burned. The mean overall step count during the hospitalization period was 5965.3 ± 8091.4, and mean steps per minute was 1.0 ± 1.2. Peak mean step counts for patients occurred on day 6 of their hospital stay with 1792.4 steps. Patients with a hospital stay more than 7 days tended to be more sedentary throughout their entire CICU stays compared with patients with CICU length of stays less than 7 days (Fig. 3).

Steps per minute and percentage of mobility activities completed by patients were correlated with one another ($P = 0.05$; $r = -0.04$) and negatively associated with percentage of sedentary time ($P = 0.01$; $r = -0.8$). There was no correlation between sedentary time and readmission within 30 days

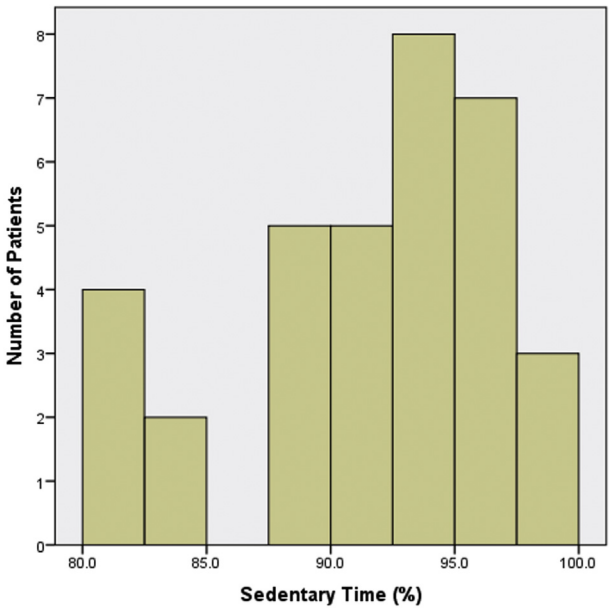
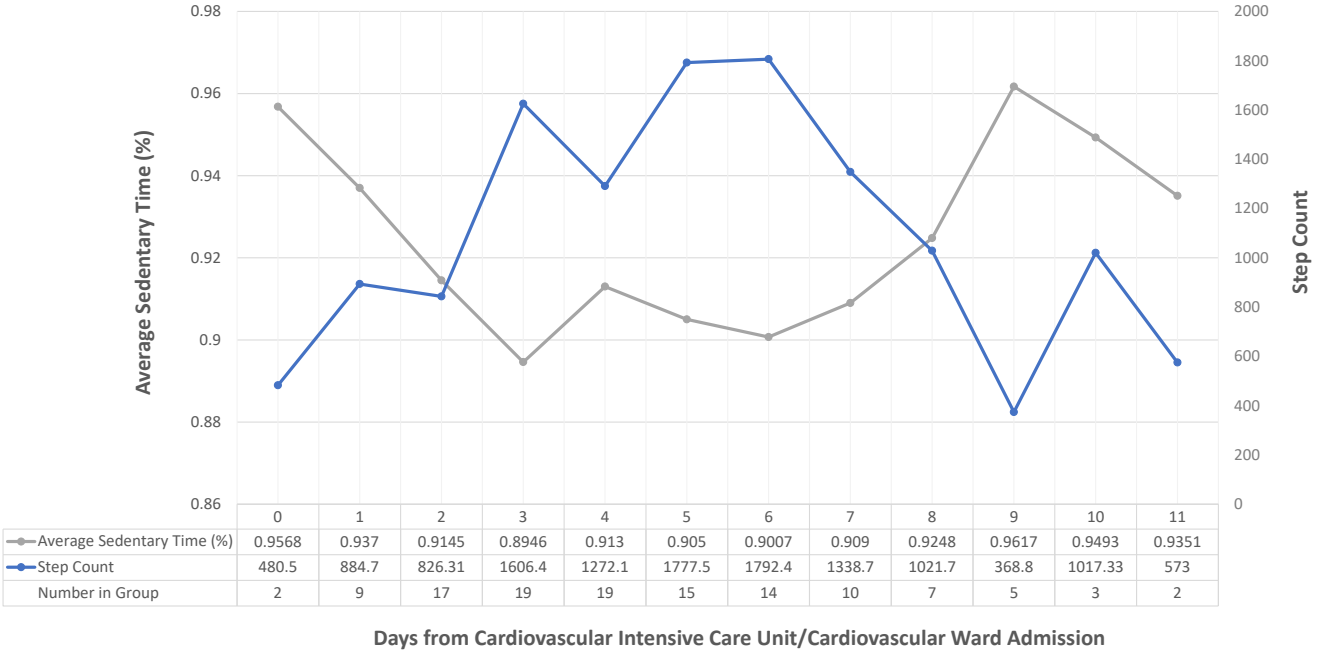


Figure 1. Percentage of sedentary time in people with acute cardiovascular disease.



	0	1	2	3	4	5	6	7	8	9	10	11
Average Sedentary Time (%)	0.9568	0.937	0.9145	0.8946	0.913	0.905	0.9007	0.909	0.9248	0.9617	0.9493	0.9351
Step Count	480.5	884.7	826.31	1606.4	1272.1	1777.5	1792.4	1338.7	1021.7	368.8	1017.33	573
Number in Group	2	9	17	19	19	15	14	10	7	5	3	2

Figure 2. Distribution of sedentary time and step count during unit stay.

($P = 0.93$; $r = -0.016$). The mean SF-36 scores were 60.0 ± 21.9 and 67.7 ± 20.7 at 1 and 12 months, respectively. There was a difference in mean SF-36 score at 1 month by length of stay but not by sex or primary admission diagnosis (Table 2).

In the multivariable regression analysis, prehospital LOF was significantly associated with a total SF-36 score at 1 month, with percentage of sedentary time significantly associated with poor total SF-36 score at 1-month (Table 3; $P = 0.02$).

When steps per minute was added to the multivariable model and percentage of sedentary time was removed, steps per minute was an independent predictor of total SF-36 score at 1 month ($P = 0.003$). There was no significant difference between average sedentary time by diagnosis (P = 0.3), as well as average sedentary time difference by sex (P = 0.5). When the average sedentary time was split by quartile (quartile 1 had the least sedentary time; quartile 4 had the most sedentary time), there was a 30.6-point difference in total SF-36 scores between the first and fourth quartiles ($P = 0.02$; Supplemental Fig. S1).

Discussion

Key findings

Our study found that older adults with acute cardiovascular disease spend, on average, more than 90% of their hospital stay in sedentary positions. Patients were most sedentary during the first day of CICU admission. Patients who had a hospital stay greater than 1 week tended to remain more sedentary throughout the entirety of their stays compared with patients with hospital stays of less than 1 week. The EM program was safe, with no major adverse events. Older patients who were more sedentary had significantly poorer HRQOL measurements at 1 month. Functional status before hospitalization was also associated with HRQOL outcomes at 1 month.

Sedentary time and patient outcomes

Previous studies in medical cohorts have explored the duration of time spent in bed. Brown et al. found that patients in a general medical unit spent 83% of their time lying in bed.[1] Another study in older medical patients wearing accelerometers found that they spent a median of 17 hours per day (70.8%) in sedentary positions.[18] Our study found that older adults with acute cardiovascular disease spent an average of 21.6 hours per day (90%) in sedentary positions despite participation in mobility programs. The increased average sedentary time in our study may reflect a more acutely ill cohort, the nature of people with acute cardiovascular disease, or, less likely, inadequate opportunities for mobility. Our findings suggest that more is needed to be done within mobility programs to reduce the amount of sedentary time in older adults with acute cardiovascular disease.

There is also evidence that much of the time spent in bed may be involuntary and unnecessary; a study of acute hospitalized patients found that 33% of patients had involuntary bedrest ordered and that 60% of bedrest episodes had no documented medical indication.[4] Increased time spent in bedrest during hospitalization has been associated with increased risk of hospital-associated pneumonia, lower cardiac output, longer hospital length of stay, and increased likelihood of institutionalization.[1,4] Low mobility during acute hospitalization is associated with a decline in the ability to perform activities of daily living and greater functional decline following hospital discharge.[7] In-hospital deconditioning puts patients at greater risk for falls during and following hospitalization, which can prolong length of stay, affect discharge location, and lead to readmission.[5] Approximately 1 in 9 patients in our study required hospital readmission with 30 days of discharge.

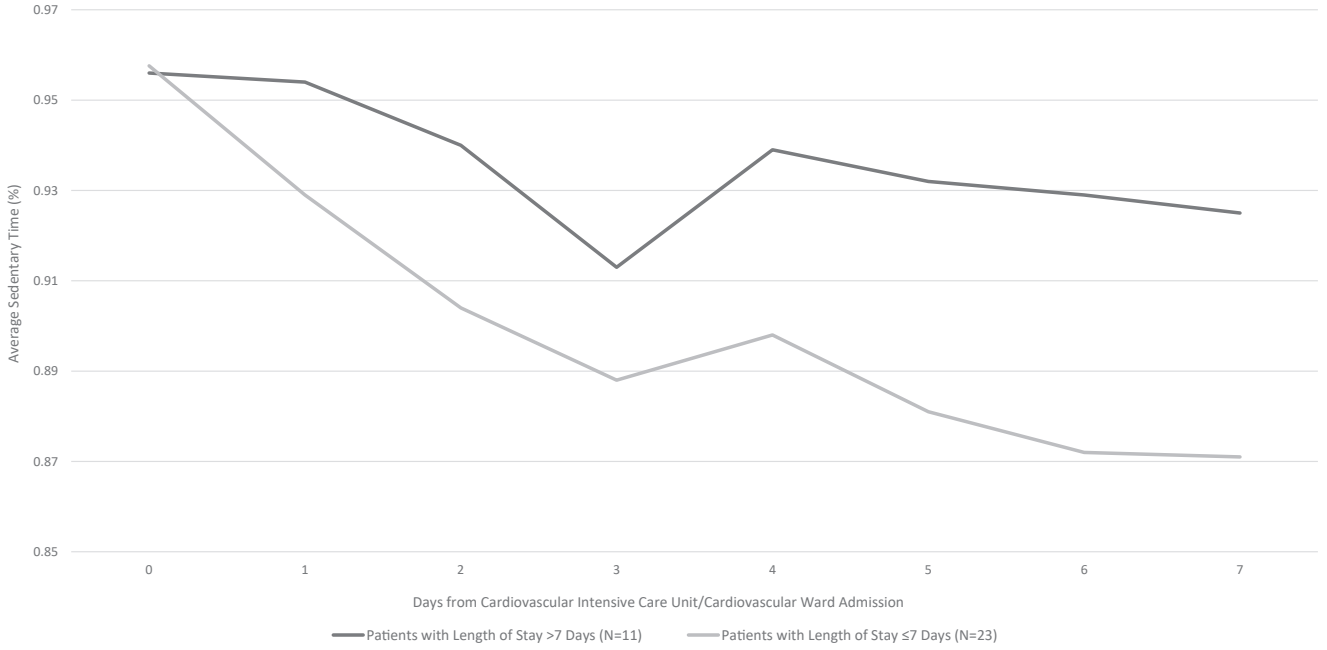


Figure 3. Average sedentary time split by 1-week hospital length of stay.

Although the mean duration of CICU admission in our study was only 3 days, the overall mean hospital length of stay was 11 days. This time represents a considerable opportunity to prevent deconditioning during the typical hospital stay for acute cardiovascular disease. The frequency of discharge to rehabilitation facility or other in-patient setting was quite low in our study (5.7%). In contrast, a recent study by Semsar-Kazerooni et al., of patients with acute cardiovascular disease undergoing EM reported 9.6% of interventional and 12.2% of preintervention patients discharged to a rehabilitation or acute-care hospital.[13] A low rate of discharge to inpatient rehabilitation may represent either a "less sick" selected patient population or improved recovery while in hospital.

Health care providers may emphasize treatment of the acute illness that burden patients at the expense of the in-hospital stressors of low immobility and increased sedentary time.[5] These stressors can decompensate patients, leading to a transient period of vulnerability in the 30-day period following hospital discharge, known as posthospitalization syndrome.[5] Addressing the immobility of patients during their hospital stays by reducing sedentary time has the potential to mediate this contributor to posthospitalization syndrome and improve functional outcomes. A recent study by Baldwin, observing 40 adults requiring mechanical ventilation in the intensive care unit, reported better physical function and muscle strength in patients who spent increased time sitting upright and sit to stand, had longer sessions of upright bouts, and decreased time sitting.[19] In a cohort of 100 hospitalized older medical patients, Brown and colleagues found that addressing mobility barriers and assistance with ambulation twice daily prevented loss of community mobility 1 month following hospital discharge.[7] Moreover, with each 10% increase in hospital lying time, Floegel et al. observed an associated 0.7-second longer time required to complete a timed up and go test for patients at 30 days, whereas an additional 1000 steps per day was associated with a higher short-performance battery score at 30 days.[20] With more than 90% of patients in our study spending their hospital stay in sedentary positions, the findings from these previous studies reflect the possible detrimental impact of sedentary time upon the functional status and physical strength and functioning of patients.

Given that posthospitalization syndrome leaves patients physically deconditioned and ill prepared to mitigate the stressors posthospitalization, describing in-hospital sedentary time of older adults with cardiovascular disease is a relevant metric to assess. There are also limited data on the association between in-hospital sedentary time and posthospitalization person-centred outcomes. Our study found that the percentage of sedentary time was predictive of 1-month post-hospitalization HRQOL. This indicates that patients that spend more time in the lying or sitting positions during their acute hospitalizations were more likely to have worse self-

Table 2. Mean Short-Form 36 (SF-36) score at 1-month

	Mean SF-36 score at 1 month	*P* value
Overall (n = 28)	60.0 ± 21.9	
Sex		0.59
Female (n = 14)	57.5 ± 15.8	
Male (n = 14)	62.3 ± 27.1	
Primary admission diagnosis		0.54
Acute coronary syndrome (n = 8)	67.8 ± 23.3	
Heart failure (n = 4)	51.8 ± 30.6	
Atrial fibrillation (n = 5)	55.0 ± 13.8	
Length of stay		0.04
< 7 days (n = 7)	74.5 ± 10.2	
≥ 7 days (n = 21)	55.2 ± 22.7	

Table 3. Multivariable linear regression

Variable	Regression coefficient	95% CI	*P* value
Age	−0.3	−1.3 to 0.7	0.6
Sex	−1.4	−14.5 to 11.6	0.82
LOF prehospital	18.2	7.3 to 29.0	0.002
Sedentary percentage time	−1.5	−2.9 to −0.2	0.02

CI, confidence interval; LOF, level of function.

reported HRQOL at 1 month following their hospital discharges.

Interventions to decrease the percentage of sedentary time present a clinically relevant and modifiable target for improving postdischarge HRQOL. Care programs designed to promote mobility during acute-care hospitalization may prevent the persistent functional impairment that many patients experience after discharge. In a general medical inpatient cohort, Hoyer and colleagues reported that a mobility intervention improved mobility status and reduced hospital length of stay.[21] The improvement in mobility status was sustained 4 months following completion of the mobility intervention.[21] EM has also been shown to be safe, feasible, and effective in older adults with acute cardiovascular disease.[22] In addition to reducing in hospital sedentary time, EM may also improve mood and cognitive outcomes as well as reduce the functional decline associated with posthospitalization syndrome.[23] However, the bulk of the current evidence base for mobility programs is for mechanically ventilated patients in critical care units. There is a need for studies exploring the role of mobility intervention delivery in acute, but noncritically ill populations, such as in acute cardiovascular care. Future randomized clinical studies can be used to ascertain the effectiveness of an EM program at decreasing sedentary time and measuring important posthospitalization clinical and patient-centred outcomes in older adults with acute cardiovascular disease.

Prolonged bedrest following acute myocardial infarction and heart failure was historically used to reduce cardiac workload and prevent further acute cardiac events. However, there is an increasing body of evidence suggesting that earlier mobilization and reduced bedrest is both safe and feasible in this population.[13] The minimum length of time that people with acute cardiovascular conditions should remain in bed has not been defined. There are, at present, no major cardiovascular professional society guideline recommendations for the duration of bedrest following myocardial infarction or heart failure.[24] There is a need to establish guidelines for the safe initiation of mobilization in acute cardiac patients. Hospitalizations for heart failure and atrial fibrillation, which are—on average—longer than those for acute myocardial infarction, present a great opportunity for earlier mobilization. However, older adults with acute myocardial infarction have longer lengths of stay and are more at risk for functional decline compared with their younger counterparts and may also benefit from earlier mobilization and decreased amount of sedentary time during hospitalization.

Limitations

There are a few limitations for this study. First, the small sample size and single-site nature of the study reduces the generalizability to other health care regions and settings. The recruitment period of our study was limited by the onset of the COVID pandemic and institutional restrictions on participant recruitment for research. Caution should be used when interpreting the results of the regression analysis given the overall low number of participants. Further studies with larger numbers of participants are needed to confirm our findings and better understand the impact of contemporary mobility practices. Second, all patients enrolled in this study had received the EM program, and no control group exists. Thus, whether an EM program, compared with usual mobility care, decreases the time spent in a sedentary position cannot be determined from the current study. The type of mobility intervention offered (ie, 1 vs 3 sessions per day, family member involvement) also may have impact on the amount of time spent in sedentary positions. These evidence gaps should be explored in future studies.

Conclusions

Older adults with acute cardiovascular disease may remain sedentary for a large portion of their stays in the CICU. Increased sedentary time was associated with poor posthospital HRQOL at 1 month. Future studies are required to determine whether interventional programs designed to promote mobility and decrease bedrest affect sedentary time during hospital stay—compared with usual care—promote posthospital HRQOL and improve functional status.

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Disclosures

The authors have no conflicts of interest to disclose.

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Supplementary Material

To access the supplementary material accompanying this article, visit *CJC Open* at https://www.cjcopen.ca/and at https://doi.org/10.1016/j.cjco.2021.10.008.