Early Mobilization of Older Adults in the Cardiovascular Intensive Care Unit

I. RESEARCH QUESTION
Is an early progressive mobilization program safe, feasible, and effective in older adults in the Cardiovascular Intensive Care Unit (CICU)?

II. HYPOTHESES
1. An early mobilization (EM) program is safe, feasible, and effective in older adults in a Canadian tertiary care academic CICU.
2. Level of function on CICU discharge is associated with health-related quality of life scores and functional status at longer-term follow-up.

III. SPECIFIC AIMS
Aim #1: To determine functional status and longer-term patient-centered outcomes of older adults admitted to the CICU prior to the implementation of the EM program (“pre-intervention” cohort)
Aim #2: To assess the safety and feasibility of an EM program in a Canadian academic tertiary care CICU
Aim #3: To determine the effectiveness of EM at improving the functional status of older adults during CICU admission and improving longer term patient-centered outcomes (“intervention” cohort)

IV. BACKGROUND
A. Physical Function and Impairment in Older Adults in the Critical Care Unit
Older adults (age 60 ≥ years old) comprise the majority of patients admitted to the CICU. Older adults have a higher burden of prehospital functional impairment, which is an important predictor of morbidity and mortality during and following critical care unit hospitalization. During hospitalization, older adults are at risk for rapid loss of muscle mass and strength from critical illness, immobility, and prolonged bedrest. As a result, survivors of critical illness frequently develop physical impairments, such as a reduced ability to ambulate and difficulty performing activities of daily living (ADLs), which can endure well-beyond index hospitalization. Up to 70% of older adults in the critical care unit are unable to return to prehospital levels of activity at discharge and have significant physical impairments that persist months later. The enduring physical impairments following critical care unit hospitalization can have devastating effects on the ability of older adults to maintain independence and quality of life and also results in increased morbidity and mortality.

B. Early Mobilization in the Intensive Care Unit: Opportunities and Challenges
EM describes progressive mobilization activities that start immediately upon hemodynamic and respiratory stabilization, typically within 24-48 hours of intensive care unit admission. The objectives of EM is to prevent loss of muscle function, promote rapidity in mobility recovery, and to maintain or help patients regain prehospital functional capabilities. There is evidence that EM is associated with improvements in muscle strength, physical function, and quality of life in patients admitted to critical care units. In addition, EM has also been shown to decrease critical care delirium, improve long-term cognitive outcomes, decrease critical care and hospital length of stay, reduce hospital readmissions, decrease long-term
mortality, and result in considerable cost savings.\textsuperscript{5,11-14} The safety of EM programs in critically ill patients has also been established with only rare reports of serious adverse events and catheter dislodgement. The most commonly reported complications are transient physiologic changes.\textsuperscript{15,16}

Yet despite the demonstrated effectiveness and safety in the peer-reviewed literature for EM practices in critical care units, there is evidence that actual practice is lacking.\textsuperscript{17} A recent survey of Canadian physicians working in critical care units reported that, while more than half of physicians believed that mobilization should begin as early as possible after unit admission, almost three-quarters felt that they lacked adequate knowledge or training to mobilize patients.\textsuperscript{18} In addition, the physicians noted a number of barriers to early mobilization, such as a lack of a standardized protocol and concern over patient safety. Addressing these barriers is essential to the successful implementation of an EM program.

C. Frailty in Older Adults with Cardiovascular Disease

Older adults are at increased risk of developing frailty, a syndrome characterized by sarcopenia, subclinical multi-organ dysfunction, and reduced capability of handling physiological stress.\textsuperscript{19} Sarcopenia is the age-related alteration in protein metabolism, decline in muscle mass, strength, and functional capacity. The prevalence of frailty in the critical care unit ranges from 10-40\%, depending on the population and setting.\textsuperscript{20,21} Frail older adults are more likely to have increased muscle loss during periods of acute illness and immobilization, functional decline during hospitalization, and long-term disability following discharge. Frailty in cardiovascular patients is also a strong predictor beyond the chronological age of increased morbidity, hospital and critical care unit stays, mortality, discharge to rehabilitation facilities and institutionalization, and higher rates of readmission. Early progressive mobilization activities may have an even greater impact on frail older adults than on their non-frail counterparts.

D. Knowledge gaps targeted in this proposal

Recent reviews of EM programs in the peer-reviewed literature have identified a number of evidence gaps to be directly addressed by this study.\textsuperscript{22}

1. Safety and feasibility of EM in the CICU: The majority of EM intervention studies were performed in the medical intensive care unit or in populations with low rates of primary acute cardiovascular disease and it is unknown whether the findings can be generalized to the CICU. The CICU contains a unique population of patients with primary cardiovascular disease, high illness acuity, and a considerable burden of non-cardiovascular disease.\textsuperscript{23} Barriers to mobility for cardiac patients may also differ from those of the general critical care population. To date, minimal data exist in the literature on the use of EM in acute cardiovascular populations.\textsuperscript{5,24} An expert panel from Health Quality Ontario reviewed the literature for articles assessing EM interventions in hospitalized acute heart failure patients and could not identify any relevant studies.\textsuperscript{25} A retrospective Canadian study of post-TAVR patients demonstrated a reduction in median hospital length of stay with an early discharge protocol including EM as part of a multimodal intervention strategy.\textsuperscript{26}

2. EM in older adults: Whether older adults, particularly frail older adults, benefit more from EM than younger or nonfrail older adults is uncertain. Prior EM intervention studies were composed of younger patient cohorts and there have been no studies that specifically focus on EM in older adults.\textsuperscript{24}
3. EM and patient-centered outcomes: Prior studies on the impact of EM on outcomes have focused mainly on healthcare resource outcomes (i.e., length of stay, readmission rates) and there are limited data on the effect of EM on patient-centered outcomes. The Canadian Institute for Health Research has identified patient-centered research as a priority for the healthcare system.\textsuperscript{27} Health-related quality of life and functional status are patient-centered measures that are recommended as key metrics when studying older adults with cardiovascular disease.\textsuperscript{28}

4. Lack of published nurse-driven EM protocols

Prior published EM protocols typically include intensive involvement in daily EM by physiotherapists.\textsuperscript{22, 29} However, given the limited availability of physiotherapists for 24/7 care in the critical care setting and the need for protocol generalizability, it is essential to establish a protocol that can be easily implemented by nursing staff and will provide enough details for replication.

5. Knowledge translation

There are few available tools on how to implement an EM program, particularly in an acute cardiovascular unit. A lack of written protocols or guidelines, as well as insufficient clinician knowledge, has been identified as a barrier to implementing EM in critical care units.\textsuperscript{18}

V. PRELIMINARY STUDIES

During my Cardiac Intensive Care fellowship at Cedars-Sinai Medical Center in Los Angeles, CA, I participated in the EM program and instituted frailty screening in the CICU. We used a level of function (LOF) assessment tool in the EM program that ranged from 1 to 5, where 1 was bedbound and 5 was ability to walk > 50 feet (see sidebar). Preliminary analysis of the retrospective cohort of 264 patients with acute cardiovascular disease undergoing EM showed that 90 (34.1%) patients were frail, 65 (24.6%) were vulnerable, and 109 (41.3%) were not frail. We found a moderate correlation between prehospital LOF and frailty (r = -0.580, P=0.01). Prehospital LOF was higher in nonfrail elderly than in frail elderly (mean score of 3.71±0.61 vs. 2.59±1.03; P<0.001). LOF improved in both nonfrail and frail elderly during CICU stay, however, there was greater improvement in LOF in the frail group (mean increase of 0.53 vs 0.70; P<0.01). The initial data analysis suggests that frailty status is a potential predictor of responsiveness to EM. Further analysis of this dataset is needed to identify other predictors of responsiveness to EM in the CICU.

The current mobility practices and LOF assessment for patients admitted to the CICU of the Jewish General Hospital were reviewed by a nurse educator on two separate dates as part of continuous quality improvement requested by the quality of care committee of the division of cardiology. We looked at a convenience sample of patients in the CICU on two separate dates. There were 26 patients in the analysis (mean age 71.7 years old, standard deviation (SD) ± 10.9, female 38.4% (n=10)). There were 10 patients (38.5%) who would not be initially eligible for entry into the study (see eligibility criteria below; four due to age, two on noninvasive or invasive ventilation, two with a transvenous pacemakers, and two...
who were not hemodynamically stable). For patients who were initially eligible for the study, the mean prehospital LOF was 4.7 (SD±0.6) and the mean LOF on CICU admission was 2.3 (SD±1.2). Of the eligible patients, 14 patients (87.5%) said they would agree to participate in an EM study and 12 patients (75%) were followed prior to hospitalization by a hospital-affiliated cardiologist.

VI. METHODS

Design, participants and setting

An EM program is being developed as a quality improvement project in conjunction with the Quality and Safety Committee of the Division of Cardiology at the Jewish General Hospital (JGH). For our study, we will perform a prospective, pre/post-EM intervention study in adults aged ≥60 years old admitted to the CICU at the JGH. During a 3-month period, we will prospectively enrol patients to the pre-intervention cohort. The EM intervention will then be implemented. During a 12-month period, we will prospectively enrol patients to the intervention cohort. 1 and 12 months following hospital discharge, patients in the pre-intervention and post-intervention cohorts will be contacted by phone by a member of the research team to assess for functional status and quality of life measures.

A multidisciplinary EM implementation team developed a LOF assessment tool targeted for the CICU patient population. The assessment tool was created to be easy to use, quantitative, nurse-driven, and potentially generalizable to other CICUs. The creation of the EM team and EM program was an initiative of the Quality of Care Committee in the Division of Cardiology at the Jewish General Hospital.

All patients admitted to the CICU are eligible for the EM program, except for patients meeting pre-defined hemodynamic, respiratory, neurologic, or in-dwelling device criteria. The exclusion criteria were chosen based on expert guidelines for EM safety\(^{30}\) and adapted for the acute cardiovascular patient population through collaboration with the multidisciplinary EM team.

For entry into our study, the inclusion criterion is age ≥ 60 years and exclusion criteria are CICU stays less than 24 hours and patients with prehospital LOF 0 (immobile), LOF 1 (bedbound) or 2 (can sit in chair only). Cardiac surgery patients will also be excluded. For the pre-intervention cohort, patients will be prospectively enrolled over a 3-month period by a member of the research team during CICU admission. Informed consent will be obtained by a member of the research team.

Following discharge, a member of the research team will review the medical record to extract demographic data (age, sex), comorbid illnesses, primary admission diagnosis, frailty status, adverse events during mobilization (falls, dislodgements, and injuries),
mobilization activities, length of critical care unit stay, length of hospital stay, mortality, and discharge location.

**Intervention**

On admission to the CICU, the patient’s treating nurse will assess the patient for the EM program. Patients participating in the EM program will be assessed for enrolment in our study by a member of the research team and will obtain informed consent during CICU admission (“intervention cohort”). The potential participants are likely to be competent and medically fit to be approached for informed consent as patients who are not medically fit will be excluded from the early mobilization program based on clinical factors, which include hemodynamic criteria.

The EM program consists of a progression of functional activities from LOF 0 (lowest mobility) to 5 (highest mobility). Each LOF has 3 primary activities designed to promote the patient to the next level. The nurse will begin with mobility activities based on the LOF that matches the patient’s current status. The nurse and clinical partner will attempt and/or complete each LOF activity once per shift. Physiotherapy assistance is available if required, although not obligatory. Nurses will also provide documentation and education to patients and families on how to perform and assist with certain activities. LOF, activity attempts/completion, and adverse safety events will be recorded on an EM flowsheet. The intervention will start while the patient is in the CICU and will continue until discharge from the CICU.

To introduce the EM protocol to the nursing staff, the nurse and physician champion will provide a series of in-service training sessions. Physicians routinely caring for older adults in the CICU and rotating trainees will receive education in the CICU through “Lunch and Learn” conferences. Weekly audits will be performed by the nurse champion to assess for adherence to the EM protocol. Reminders and further education will be provided if necessary. Monthly status reports will be created and disseminated to the nurses and the CICU team.

Frailty will be assessed on admission using the Clinical Frailty Scale (CFS) by the patient’s nurse or a member of the research team (Appendix B). The CFS is a simple bedside assessment tool that uses a single global judgement-based measure to assign a score from 1 (very fit) to 9 (terminally ill) with increasing scores from 5 to 8 indicating more advanced frailty. The CFS correlates with more comprehensive frailty tools, has been shown to accurately diagnose frailty in critically ill and acute cardiac populations, and provides short and long-term prognostic information.

**Post-discharge follow-up**

One month and 12-months post-discharge a member of the research team will call participants by phone to assess for health-related quality of life and functional status. The member of the research team will administer the Short-Form 36-Item Health Survey (SF-36) physical component summary score on the phone. The SF-36 is the most widely used health-related quality of life instrument and has been widely validated in cardiovascular disease. The physical component score is a subset of the SF-36 that focuses on physical functional abilities, limitations, bodily pain, and general health.

**Outcome Measures**

For effectiveness, the primary outcome will be the mean improvement in LOF during CICU admission. We will determine which covariates predict improvement in LOF (“responsiveness”) and which ones do not (“non-responsiveness”). We will assess the recovery
of physical function at 1 month and 12 months as measured by the SF-36 physical component summary score. We will compare the SF-36 scores of the highest scoring tertile of LOF on hospital discharge with the lowest scoring tertile. We will also compare hospital readmission at 30 days and discharge home vs. healthcare facility.

For safety, we will record the composite and individual components of the number of falls, injuries, and dislodgements over the total number of attempted mobility activities. The results from the intervention cohort will be compared to the pre-intervention cohort for all results.

Data Collection Procedures

Following discharge, a member of the research team will capture the following hospitalization data from the electronic medical record (Chartmaxx, Quest Diagnostics, Madison, New Jersey) for each subject: age, sex, primary admission diagnosis, comorbidities, level of function assessments, CFS score, length of CICU stay, length of hospital stay, discharge location, and referral to cardiac rehabilitation. At 1 month and 12 months post-hospital discharge, a research team member will call the patient at by phone to assess for vital status, current level of function, hospital readmission, and administer the SF-36 questionnaire.

Availability of Participants

In the fiscal year 2016-2017, there were 1,356 admissions to the JGH CICU (mean age 68 years old; 477 female (35%)). There were 1,034 patients (76.3%) age ≥ 60 years old. The mean CICU length of stay was 3.3 days and the mean hospital length of stay was 9.5 days. Only one in five patient stays was less than 24 hours in length.

From the pilot data, we conservatively estimate that about one-third of patients will not be eligible for the study and about 70% will agree to participate. We estimate that the loss of patients to 12 month follow-up will be approximately 10% as the vast majority of CICU patients are followed by hospital-affiliated cardiologists prior to admission or are assigned to one following CICU discharge. Given these estimates, approximately 75 patients are expected to be enrolled and followed during the pre-intervention period and 300 patients are expected to be enrolled and followed during the 12 month intervention period.

Data Analysis

Results for primary outcomes will be stratified by age (<80; ≥80), sex, and frailty status. Continuous data will be presented as mean ± standard deviation or median with interquartile range and between group differences will be tested with the Student’s t test and the Mann-Whitney U test, respectively. Categorical data will be presented as frequencies and percentages and will be compared using the chi-squared test or the Fisher exact test, as appropriate. Multivariable linear regression will be used to assess for predictors of mean change in LOF during CICU admission. All p values will be two-sided with values ≤ 0.05 indicating statistical significance. Statistical tests will be done using the SPSS 24.0 statistical software (IBM Corp, Armonk, New York).

VII. RESOURCE AVAILABILITY AND SUPPORT

The CICU at the JGH has 16 beds equipped for advanced hemodynamic support and 32 ward beds with telemetry available. Patients are admitted to the CICU mainly for acute primary cardiovascular disease.
The nurse champion’s role is to attend EM team meetings, provide education to nursing and clinical partners, and ensure nursing adherence to the protocol. A review of the CICU environment conducted with physiotherapists from the EM team has ensured that the CICU is already equipped with the standard equipment necessary for patient mobilization, particularly for bedbound and immobile patients, and nurses have been trained to use the equipment.

A research assistant will be based in the Division of Cardiology at the JGH and will have a dedicated space and workstation with computer access in the clinical research department. The research assistant will be responsible for obtaining informed consent, extracting data from the patient record, putting it into the database system, auditing nursing adherence to the study protocol, publishing monthly status updates, and interviewing patients by phone. Funds to support a research assistant on a part-time basis (20 hours per week) will be provided for a one-year period by the JGH’s Division of Cardiology.

The EM team has support and representation from leaders in various disciplines at the JGH including Diane Brault, the head of the CICU nursing department, Dr. Lawrence Rudski, Chief of the JGH Division of Cardiology and Director of the Integrated Cardiovascular Science Program, Dr. Jean-Francois Morin, Chief of Cardiac Surgery, and Dr. Richard Sheppard, Director of the CICU.

The JGH’s Division of Cardiology has given me approximately 50% protected research time with a salary support of $50k per annum to pursue my research program. I also receive a salary support for research of $20k per annum from the JGH’s Department of Medicine. Funds to support a research assistant on a part-time basis (20 hours per week) for a 1 year period – renewable for up to 3 years - will be provided by the cardiology division as well.

VIII. KNOWLEDGE DISSEMINATION

We will develop simple to follow instructional materials, including the detailed EM protocol and videos on how to perform the level of function assessment and mobility activities. These will be made available on a dedicated web portal.

We intend to publish the EM protocol and the study results in a peer-reviewed cardiology journal, as well as present the findings at a major national cardiology conference. Through membership in the Canadian Cardiovascular Critical Care Society, a member society of the Canadian Cardiovascular Society, the results of the study will be disseminated to healthcare professionals involved in acute cardiovascular care.

In order to gauge the value of the EM program in the CICU, we will use the Information Assessment Method (IAM), a self-administered 1-page questionnaire endorsed by the Canadian Institute for Health Research. We will distribute the professional and patient versions of the IAM to healthcare staff and to patients involved in the EM program, respectively. The IAM is used to systematically evaluate the (1) acquisition and relevance of new information, (2) practical impact, (3) expected health benefits, and (4) intent to use the information and associated barriers or facilitators. We will review the IAM responses to understand the factors associated with the EM program and to generate recommendations and feedback to the participants.

IX. POTENTIAL CHALLENGES & MITIGATION STRATEGIES

The study will attempt to directly address frequently reported barriers to EM implementation. Biweekly multidisciplinary EM team meetings and availability of the physician and nurse champion will ensure any issues that arise will be dealt with promptly.

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<th>Barriers for EM</th>
<th>Solution Strategy</th>
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Lack of knowledge and training | Education by physician and nurse champions to healthcare staff
---|---
No written protocols or guidelines | A simple, straightforward written protocol
Inadequate equipment | Standard critical care mobility equipment is available
Requirement for intensive physiotherapy involvement | Nurse-led protocol with physiotherapist consultation availability
Requirement for physician orders prior to mobilization | No requirement for physician orders prior to mobilization
Not an institutional priority | Support and involvement by hospital leadership
Concern over medical instability | Exclusion criteria based on safety parameters
Delayed recognition of suitable patients to mobilize | Screening patients on admission for EM and re-screening each shift for suitability.
Concern over dislodgement of tubes, lines or devices | Education of nursing and clinical partners on proper mobilization techniques
| Education of healthcare team of low rates of adverse events found in prior studies

X. QUALIFICATIONS
I am a clinician-scientist trained in both cardiology and experimental medicine at McGill University and critical care medicine at Cedars-Sinai Medical Center. Over the past 3 years, I have had 11 publications (10 as first author) and was a co-author on the State-of-the-Art paper on the future of the field of Cardiac Intensive Care published in the Journal of the American College of Cardiology. My primary research interest has been improving outcomes in older adults with acute cardiovascular disease. My Master’s thesis (in submission process) focused on the impact of frailty in older adults undergoing invasive cardiac interventions. I was involved with the EM program during my critical care medicine fellowship.

XI. TIMETABLE

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XII. POTENTIAL IMPACT OF THE STUDY
The proposed study will generate much needed evidence for the safety, efficacy, and feasibility of a structured EM program in older patients with acute cardiovascular disease. The simple, practical EM protocol and the knowledge translation plan are designed to educate cardiologists involved in acute care and encourage the implementation of EM programs as routine practice into CICUs.

XII. REFERENCES
Early Mobilization of Older Adults in the CICU


35. Wyrwich KW, Tierney WM, Babu AN, Kroenke K and Wolinsky FD. A Comparison of Clinically Important Differences in Health-Related Quality of Life for Patients with Chronic Lung Disease, Asthma, or Heart Disease. Health Services Research. 2005;40:577-592.


