

**Early mobility to improVE health outcomes following cardiac surgery (EVE) Clinical Feasibility
Trial Development**

by

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Abstract

There is a know-do gap between the generation of research knowledge and its use in clinical healthcare. Implementation science research focuses on closing the know-do gap by investigating interventions that support the uptake of research knowledge into clinical practice. When practices, such as early mobility in the cardiac surgery intensive care unit (CSIUC) are shown to be effective and efficacious, research should shift to focus on how these practices can be implemented into clinical practice. One approach to implementation science is intervention mapping, a multi-step, theory-informed process for co-developing an intervention, an implementation plan, and an evaluation plan. There are six steps in intervention mapping: 1) a needs assessment exploring the behaviour targeted for change through a review of the literature and contextually through qualitative and quantitative means, 2) identifying performance objectives, 3) selecting theory-based methods for behaviour change, 4) creating an intervention, 5) planning for intervention implementation, and 6) evaluating the intervention. This dissertation shares the process of intervention mapping applied to early mobility in the CSICU. First, an overview of implementation science, integrated knowledge translation, intervention mapping, my guiding worldview and positionality, patient engagement in research, arts-based research methods, and the current state of early mobility literature are shared to provide context for the dissertation. Chapters 2-7 describe the research that formed the needs assessment, the first step of intervention mapping. The needs assessment includes a review of the literature (Chapter 2), a quantitative exploration of the current state of early mobility in the CSICU using behaviour mapping (Chapter 3), a qualitative exploration of clinicians' perspectives of early mobility through interpretive description (Chapter 4), and then the lived experience of early mobility in the CSICU is explored with patients and care partners through body mapping and virtual engagement works (Chapters 5-7). The findings of the needs assessment generated performance objectives which were aligned with two theoretical methods for behaviour change to support intervention development (Chapter 8). An implementation and an evaluation plan were developed (Chapter 8). The intervention was implemented and evaluated through repeated behaviour mapping

(Chapter 9). Finally, the work is synthesized, discussed in the context of existing literature, and its impact explored (Chapter 10). Overall, this dissertation makes a novel contribution to implementation science literature. It provides an example of how an implementation science approach of early mobility in the CSICU can be used to move research findings into practice. The thesis also demonstrates that novel approaches to research, such as patient engagement and arts-based research methods, uncover important knowledge that can be used to inform early mobility intervention development for the CSICU. Finally, this dissertation shares that implementation science research guided by a pragmatist worldview can engage people with lived experience and clinicians and use the literature to develop an educational intervention to support clinicians in engaging in early mobility behaviours to change patient early mobility in the CSICU.

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Abbreviations

ABM- Arts-based research methods

CABG- Coronary artery bypass grafting

CS- Cardiac surgery

EVE- Early mobility to improVE health outcomes following cardiac surgery

GRIPP2 - Guidance for Reporting Involvement of Patients and the Public version 2

ICU- Intensive care unit

iKT-Integrated knowledge translation

IQR – interquartile range

PEP- PWLE engagement panel

PER- Patient engagement in research

PICS- Post-intensive care syndrome

PPI- Patient and public involvement

PWLE- People with lived experience

SBH- St Boniface Hospital

SOP- Standard operating procedure

SPOR- Strategy for Patient-Oriented Research

Q– quartile

Chapter 1 : Overview and Research Approaches

Implementation Science, Integrated Knowledge Translation, and Intervention Mapping

The intent of clinical research is to produce knowledge to improve health outcomes.¹ Interventions are commonly developed by research teams in isolation from patient and clinical partners. This limits the ability to integrate knowledge from these experts into interventions, potentially limiting their use outside a research setting. This is evident in the know-do gap between the creation of new research evidence (the “know”) and its clinical use (the “do”).¹⁻³ It is estimated that up to 60% of decisions on general medical services are made with low-quality evidence.² Even when high-quality evidence exists, when examining the impact 15 years after its publication, it is only used in approximately 60% of patients.¹ To close the know-do gap, an implementation science approach is required to operationalize integrated knowledge translation (iKT) and support the development of interventions that are feasible in the clinical context. Implementation science research moves away from examining the impact of the intervention on a health issue and instead examines the process of integrating research evidence into clinical care to improve health outcomes.^{4,5} Evidence generated through implementation science research identifies barriers and enablers to using research evidence, as well as strategies to overcome barriers.^{4,6} iKT improves the applicability of research findings by involving knowledge users (people with lived experience [PWLE] and clinicians) throughout the research process as equal partners with researchers.³

The scope of and factors contributing to the know-do gap suggest that interventions need to be developed differently to both generate and apply research evidence into clinical care.¹⁻³ This is because integrating interventions into clinical practice requires changes in clinicians' behaviours. Behaviour change is complex; it does not occur simply through the publication of primary research, reviews, or the creation of best practice guidelines. It is common for research teams to create and test interventions in clinical research without the input from clinicians and PWLE of the health issue. These interventions

may be feasible to deliver in a research environment; however, they are often not designed to be incorporated into clinical care. In this way, clinical factors are not adequately considered in the design of interventions. Co-developing interventions using an iKT approach with clinicians and PWLE may enhance their clinical utility and, thus, their uptake into clinical practice.^{7,8} There is also a lack of consideration of the lived experience in intervention design. Incorporating PWLE in research teams helps align clinical research with the priorities of those receiving healthcare. Together, clinicians and PWLE can support researchers in developing interventions that can be used clinically to integrate research findings into practice.

One way of operationalizing iKT and using an implementation science approach is intervention mapping. Intervention mapping is a systematic method of designing, implementing, and evaluating interventions targeted at changing behaviours.⁹⁻¹¹ With origins in health education,⁹ intervention mapping has been successfully applied in healthcare.¹⁰ The goal of using intervention mapping is to create and implement interventions that are aligned with clinical needs and can be incorporated into clinical care. An intervention can be proven to be effective, but it must be used to see the effect. Intervention mapping supports the delivery of the intervention with fidelity and its sustainability beyond the research project.

There are six steps in intervention mapping: 1) a needs assessment exploring the behaviour targeted for change through a review of the literature and contextually through qualitative and quantitative means, 2) identifying performance objectives, 3) selecting theory-based methods for behaviour change, 4) creating an intervention, 5) planning for intervention implementation, and 6) evaluating the intervention.^{9,10} In step one, qualitative and quantitative research methods are used to analyze the needs of the people whose behaviours are being targeted for change.^{9,10} This needs assessment is often multi-faceted and includes a robust scoping or other literature review, along with qualitative exploratory research to understand the context within which the behaviour is performed.^{9,10} In step two, the needs identified in step one are reframed into performance objectives.^{9,10} These are

actionable, measurable statements that describe the targeted behaviour changes.^{9,10} In step three, a theory is selected to support the use of evidence-informed methods for behaviour change. The Theoretical Domains Framework was selected as the guiding behaviour change framework for this dissertation (see Figure 1.1 for a visual overview).¹² The Theoretical Domains Framework consists of 12 domains that influence behaviour and behaviour change, reflecting a broad range of potential barriers and supports. It provides a range of implementation strategies to change clinical practice.¹² In addition, Behaviour Change Techniques were used to provide theory-informed methods for behaviour change.¹³ The Theoretical Domains Framework supports identifying the domain within which the behaviour exists, and the Behaviour Change Techniques support identifying how to influence the behaviour within each domain.¹³ Together, these frameworks and theories provide robust, evidence-informed methods to support behaviour change. Next, the Behaviour Change Techniques identified are matched with the identified performance objectives from step two.^{9,10} This provided theory-informed methods to achieve the performance objectives.^{9,10} In step four, the intervention to address the performance objectives is developed.^{9,10} As intervention mapping is a way to operationalize implementation science, the intervention focuses on changing behaviours to integrate research knowledge into practice rather than on the research knowledge itself.^{9,10} In step five, an implementation plan is developed for the intervention.^{9,10} Finally, step six involves developing an evaluation plan for the intervention.^{9,10} This evaluation focuses on the performance objectives identified in step two and whether or not the intervention was successful in changing behaviours to meet these objectives.^{9,10}

This dissertation follows this six-step process, with researchers, clinicians, and PWLE working together to co-develop an early mobilization intervention designed for feasible delivery in the cardiac surgery intensive care unit (CSICU). Chapters 2, 3, 4, 6, and 7 cover step 1, sharing a scoping review of early mobility in the ICU following cardiac surgery (Chapter 2), a quantitative study describing current mobility practices in the CSICU (Chapter 3) a qualitative exploration of early mobility perceptions, barriers, and facilitators with CSICU clinicians (Chapter 4), and an arts-based qualitative exploration of

the experience of early mobility of patients and care partners (Chapters 6 & 7). Steps 2-6 are covered in Chapter 8. The intervention was then implemented and evaluated as described in Chapter 9. Overall, this dissertation demonstrates how to integrate clinical and lived experiences throughout the research process and to use these experiences to develop and test a clinical intervention.

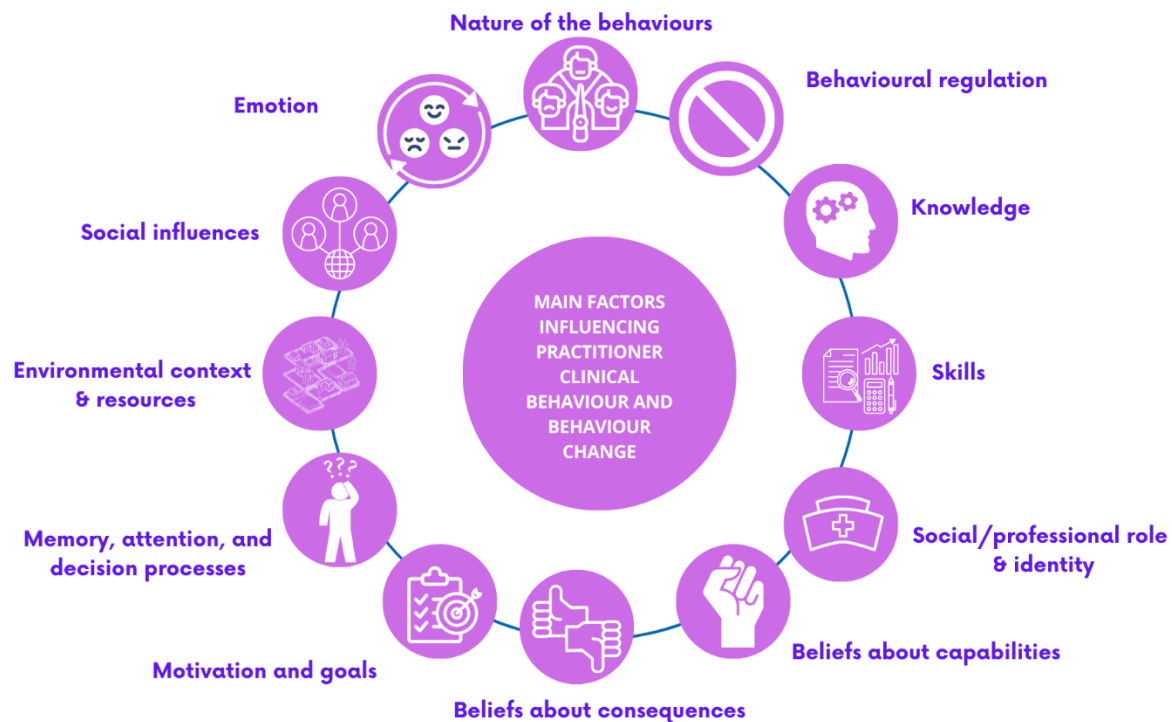


Figure 1.1. Visual overview of the Theoretical Domains Framework

Guiding Worldview and Positionality

Worldviews are the perspective through which researchers see, understand, and approach experiences and problems.¹⁴ Worldviews have assumptions that guide how questions are asked, what is considered evidence, and what potential solutions exist to solve problems.¹⁴ Understanding the worldview underlying this research is important as it impacts the questions asked, the methods used to answer questions, and the knowledge available to inform the research. Historically, health research was guided by the biomedical worldviews of positivism and postpositivism.¹⁴⁻¹⁷ Positivism supports a

deductive approach, where complex phenomena can be understood by exploring specific events.^{15,18} Causal relationships are explored between events through the derivation and testing of hypotheses to produce theories.^{18,19} Through a positivist worldview, knowledge is available to be discovered through rigorous experimentation and measurement and, once discovered, can be universally applied regardless of context.^{15,18,19} Knowledge is shared by researchers with other researchers, who will build upon the body of knowledge and continue the cycle.¹⁵ The positivist worldview leaves no room for subjectivity, as experiments, if conducted objectively and rigorously, produce results independent of the researcher.¹⁵ If newly discovered knowledge does not support previously developed theories, either the theories or the new knowledge are wrong.^{15,18}

Diverging from positivism, where knowledge is infallible, postpositivism purports that truth can be determined through objective research, which can be based on fallible knowledge.^{15,20} The fallibility of knowledge can be understood when considering context.¹⁵ By setting limits to the phenomenon being studied, truth can be determined.^{15,20} In health research, these limits are the inclusion and exclusion criteria of the quantitative studies that researchers guided by a postpositivist worldview believe explain and predict objective truth.^{15,20} Similar to positivism, researchers guided by a postpositivist worldview value rigour and objective knowledge that is separate from reality.^{15,20}

While research conducted through the positivist and postpositivist worldviews has provided life-saving evidence, such as insulin,¹ reflection is required to understand their limitations and where alternative worldviews may be beneficial.²¹ The assumption of a single reality removes the possibility that an experience may be interpreted differently by people of different backgrounds, cultures, socioeconomic statuses, or genders.¹⁵⁻¹⁷ This assumption of a single reality needs to be challenged. An alternative worldview that incorporates the lived experience of patients and their care partners as a source of knowledge to guide research is required.²²⁻²⁴ Pragmatism is an alternative worldview that can be used to include the lived experience throughout the research process.

Research through a pragmatic worldview can use mixed methods approaches. The main requirement of a pragmatic worldview is that the research aims to produce logical research findings that are relevant to the population and rational for the research.^{18,25,26} In this worldview, the research question drives the choice of research design and methodology.^{18,25,26} The separation of the question from the assumptions of positivism, postpositivism, and constructivism is key to the pragmatic worldview.²⁶ Rather than being defined by how one knows and whether reality is subjective or objective, a pragmatic worldview is defined by the requirement to conduct research driven by the purpose.²⁶ See Figure 1.2 for an overview of positivism, post-positivism, and pragmatism.

Positivism	Post-positivism	Pragmatism
Deductive	Deductive	Deductive or inductive
Cause and effect	Cause and effect	Relevant questions and methods
Acontextual knowledge available to be discovered	Contextual knowledge available to be discovered	Contextual knowledge derived from experience
One reality	One reality	Many realities
Research conducted on people with lived experience	Research conducted on people with lived experience	Research conducted with people with lived experience

Figure 1.2. Overview of positivism, post-positivism, and pragmatism.

Pragmatism Underlying this Thesis

The research question guiding this doctoral thesis is informed by PWLE and clinicians and, thus, is relevant to the target populations. The goal of this doctoral research is to produce findings relevant to PWLE and clinicians to support clinical care through both verbal and aesthetically shared knowledge. The research described below also employs a variety of methods that align with the research question. The requirement to experience something to understand it underlies the research described below. Engaging PWLE throughout the work as research collaborators and consulting a broader group of PWLE at specific points brings the experiential knowledge that they hold to inform this research.

Positionality

In qualitative research, the researcher influences how data are interpreted based on who they are, their background, and their underlying assumptions.²⁷ These elements will also impact my approach to research design and knowledge translation for all aspects of this doctoral work. As such, sharing my positionality is essential to provide insights into these elements. I will begin by discussing my epistemological, ontological, and axiological approaches to research. This will be followed by sharing my relevant personal clinical experience that informs the proposed research.

Epistemological, Ontological, and Axiological Approach

Epistemology asks how one knows.¹⁶ To answer this, I use the framework of Carper's Ways of Knowing: empirical, personal, ethical, and aesthetic knowledge.²⁸ Empirical is the easiest, I know through journal articles and conference presentations, through positivist and post-positivist research sharing the truth that has been uncovered.²⁸ Through self-reflection and years of practice, I have the personal knowledge that allows me to connect to others and quickly form a therapeutic relationship.²⁸ Shifting this relationship to focus on research rather than care delivery will take mindfulness in the future. Ethical knowledge drives my research because I want to change the way we do things to the way things ought to be done.²⁸ Could aesthetic knowledge be more than just how care is delivered and the art of

nursing?²⁸ Are the “abstracted particulars”²⁸ Carper mentions not a possible form of art used to convey that which can’t be shared in words?

I believe that truth is subjective and is not “out there” to be discovered.²⁹ I would label my epistemological stance to align closely with a pragmatist view that there is no single truth to know; rather, knowledge is something co-created through experiences.^{18,29} How I understand something depends on my previous experiences and my interactions with those around me.^{18,29} I am not isolated; rather, I am influenced by the world around me and my experiences within it.^{18,29} I believe that people create knowledge, and that it is influenced by their perspectives, beliefs, and experiences.²⁹ I also believe that knowledge is fallible and context-dependent.²⁹

Ontology describes the nature of reality.¹⁶ I believe in constructionism, that reality is a social construct.³⁰ The interactions we have with others create a shared understanding and experience.³⁰ I believe in multiple realities and that there is no definite truth but rather a subjective experience.³¹ Interactions with others can be through words or actions, but language is also a social construct.³⁰ How do you describe something that doesn’t have a word invented yet to describe it? How do you describe an emotion to someone else? Art can fill this gap, it is a way to express what can’t be put into words or to share or evoke emotion to help a reader feel the information.³¹ Art-based research is demystified and approachable by recognizing what I would be trying to understand by using an arts-based methodology.

My axiology, or values,¹⁶ include honesty, compassion, empathy, learning, quality of life. I note that these are mostly relational. My values seem to focus on my existence in a social world where I interact with others and reflect how I approach these interactions. When I reflect on what I value in research, it is the “so what”, the rationale shared of how this work will impact the population. By longitudinally studying biomarkers in women who have yet to be diagnosed with cardiac diseases, we will gain a deeper understanding of women’s heart health and sex-specific biomarkers of disease. By understanding the experience of cardiac pain, we will be better able to understand the experience of pain

and improve our ability to assess pain. Simply put, I value research that adds value to those receiving care.

My research approach and axiological stance reflect my epistemological and ontological stances. I believe in multiple ways of knowing and in both objective and subjective knowledge. I believe that we exist in a reality that is co-created with others and is perceived, interpreted, and understood based on previous experiences. I value how relationships with others occur and how they are approached. In research, I value asking questions that can impact patients and providing tangible outcomes that can be applied in practice or future research. It makes sense that I want to approach research through patient engagement and with a toolkit that allows me to ask questions and seek to co-create knowledge in the best way to find a meaningful answer.

Personal Clinical Experience

I graduated with a Bachelor of Medical Sciences, Honours Specialization Medical Sciences degree in 2008. My areas of focus were physiology, anatomy, microbiology, and immunology. I completed the Compressed Timeframe Bachelor of Science in Nursing degree in 2011 with distinction. I have been a practicing nurse since 2011, initially in a small town in southern Ontario, then at a tertiary ICU in southern Ontario. I have been in cardiac care since I moved to Winnipeg in 2013. From 2013-2015, I worked as a clinical practice nurse in the CSICU at St Boniface Hospital (SBH). I was the continuing education instructor for cardiology from 2015-2021 when I became a clinical nurse specialist for cardiac sciences.

My CSICU clinical experience was the foundation for this study. While thinking about our CSICU and patient outcomes, I wondered if there were interventions that clinical practice nurses could implement to improve health outcomes. I connected with my current advisors, and this question grew to encompass the concept of post-intensive care syndrome (PICS), an engaged research approach, arts-based research methods, and early mobility. Recognizing the interdisciplinary team that cares for patients in the CSICU, approaching this question with an interdisciplinary research team seemed a logical way to

improve the relevance of the research. My thesis advisory committee consists of 4 members, all with doctorate degrees: a kinesiologist, a cardiac surgeon/intensivist, a nurse with research expertise in PER, and a nurse with research expertise in ABMs. Together, we are approaching clinical trial development through a pragmatist worldview, engaging PWLE and clinicians to ensure their experience, and thus knowledge, is integrated throughout the intervention. This approach reflects the goal of generating an early mobility intervention that can be delivered by members of the CSICU healthcare team that will support improved patient care in the CSICU. The lived and clinical expertise will be leveraged to overcome barriers to implementing the intervention, and thus, improve the success of integrating an intervention into daily patient care. The strength of my committee and of this work is the innovative approach to intervention development to address cardiac surgery (CS) PICS focused on early mobility.

I have not worked clinically with patients in the CSICU or across the broader CS journey since 2018 and, due to operational changes within the healthcare system, have no formal affiliation with the CSICU at present. I have no formal power over the CSICU or the staff, only relationships with decision-makers, such as the program director and medical directors, that can be leveraged for support. Many of the current CSICU clinical staff began their positions after my departure and others know me as a co-worker as I have never had a formal leadership role in the CSICU. This personal clinical experience and description of my connection to the CSICU are shared to provide perspective on the intersection of my clinical and research interests and to clarify the scope of my power from an ethical perspective.

Patient Engagement in Research

Patient engagement in research (PER) is an approach that facilitates the integration of lived expertise into the research process.^{2,32} In this active, collaborative approach, researchers and patients work together to contribute equally to the generation and conduct of research addressing issues and outcomes important to patients.^{2,32} The goal of PER is to produce evidence relevant to healthcare users, PWLE, to reduce the know-do gap.^{2,32} In this active and collaborative approach, researchers and PWLE come together to contribute knowledge equally to generate and conduct research.^{2,32} This collaboration

can occur across a spectrum of levels of engagement, from the one-off engagement of PWLE to inform research decisions to empowering PWLE to lead research as principal investigators.³³ PWLE can also be involved at any stage of research, from the conceptualization and prioritization of research topics to study design and execution to knowledge translation.^{34,35} The critical aspect of PER is that PWLE contribute their lived expertise to the decision-making about a study rather than as data to be analyzed by researchers.³⁶ Positioning PWLE as equal partners with researchers throughout the investigative process expands the available evidence base.^{21,37} This is because additional, unique perspectives and sources of knowledge from PWLE are integrated throughout the research process. This can align researcher priorities with those of PWLE and provide novel ways of thinking about and intervening on a research question.²

The operationalization of PER must be individualized to the project, research team, PWLE and organizational contexts.³⁸ Several reviews have highlighted the diversity in models and frameworks guiding PER, supporting such individualization.³⁸⁻⁴⁰ A recent scoping review aligned the elements of PER into six conceptual categories (principles, foundational components, contexts, actions, outcomes, and organizational levels) and five domains (intrapersonal, interpersonal, process, environmental, and health systems and outcomes) that can be used as a toolbox to consider when planning and operationalizing a study using PER approach.³⁸ This individualization extends to the level of engagement of PWLE. They can be engaged at many levels, from “inform,” one-off engagement to inform research decisions, to “empower,” research led by PWLE as principal investigators.³³ The selected level must align with the engagement goal, the research team's readiness to engage, the PWLE's availability and willingness to engage, and the time available to complete the project.⁴¹ PWLE should be meaningfully and actively engaged, as perceived through the research environment, expectations from the research team, available supports, and the valuing of skills and perspectives.⁴² Engagement can occur in person or virtually.^{43,44} Each presents challenges to overcome to ensure PWLE, such as the need to travel or use technology.^{32,44} These should be considered and discussed with the PWLE partners when planning

engagement activities.^{32,44} Finally, an evaluation of engagement should be included when using a PER approach.⁴⁵ The evaluation can consist of the outcomes and impacts of PER on the study, the PWLE, and the research team.^{41,45} The outcomes of PER are the unique contribution of PWLE to the research and can be described quantitatively or qualitatively.⁴⁵ The impacts of PER on the research and the research team, including PWLE, can be explored through evaluation tools such as the Public and Patient Engagement Evaluation Tool.⁴⁶

Pragmatism and Patient Engagement in Research

A pragmatic worldview supports the use of PER as a research approach. There are several key elements of a pragmatic worldview that support the shift from studying people seen in positivism and postpositivism to engaging them in research. Researchers who adopt a pragmatic worldview believe that knowledge is derived from experience and is inherently contextual.^{24,26} This suggests that for researchers to understand a problem, PWLE are required as part of the investigative team. For example, the perspective of an ICU stay from a healthcare provider may differ significantly from that of an ICU patient or their care partner. For research to truly be directed at improving outcomes of patients and care partners in the ICU, one must understand the experience and, thus, engage them in research. Researchers who adopt a pragmatic worldview also focus on producing relevant research findings,^{18,25,26} suggesting an understanding of what is and is not relevant to the population of interest. Asking a research question applicable to a population should require knowledge of and input from the population. Designing an intervention to tackle a problem identified by a population requires measurement to determine efficacy. If the intervention does not address an issue relevant to the population or the outcome measures do not address patient-identified outcomes, the knowledge generated is not relevant. Researchers who adopt a pragmatic worldview use the best approach possible to gain knowledge,^{18,25,26} which opens the figurative door to including patients and care partners in research design and leveraging their lived expertise. PWLE can be engaged in novel ways to inform projects and share their critical lived experiential knowledge.

Rather than being forced to research a population, research from a pragmatic worldview allows barriers to be broken down and PWLE to engage in conducting research.

Arts-Based Research Methods

Arts-based research methods (ABMs) use art to delve into knowledge that is difficult to be put into words.^{31,47} Both evocative and provocative, ABMs elicit emotion and feeling along with empirical knowledge.⁴⁷ ABMs can be used throughout the research process for data collection, analysis, and dissemination.⁴⁷ A variety of ABMs are available for use, including, but not limited to, photo elicitation,⁴⁷⁻⁵² poetry,^{47,52,53} theater,^{47,52,54} dance,^{47,55} and visual art.⁴⁷ Specifically for knowledge translation, ABMs are evocative tools⁵³ and their use is supported by the Canadian Institutes for Health Research.⁵⁶

The dominance of the use of words for PER, either through verbal or written expression,³⁴ limits the knowledge shared to that which can be put into words. PER is missing knowledge that is difficult to put into words, which is the aesthetic knowledge that ABMs elicit.³¹ This aesthetic knowledge broadens the incomplete epistemologies⁵⁷ that dominate current PER. Using ABMs allows PWLE to share their knowledge and insights in the manner they wish and stimulate dialogue.⁴⁷ Art can have multiple meanings,⁴⁷ leading to richer dialogue and deeper understanding of issues being discussed. Using the art created by participants when sharing research results provides a deeper understanding of the perspectives of the participants, as their knowledge is shared directly through their art.⁵⁸⁻⁶² Using ABMs for PER reduces the power imbalances that inherently exist in research.⁶³ Using ABMs for PER can also reduce the perception of tokenism that can plague PER projects.⁶⁴ The use of ABMs shifts engagement from a checkbox towards empowering PWLE and using the research to share the art created in a meaningful way.⁶⁴

There are many arts-based research methods available to use with PER, including visual art, poetry, music, digital storytelling, and body mapping.⁶⁵ In particular, body mapping supports exploring experiences, emotions, and feelings of a physical event.⁶⁶⁻⁷⁰ Body mapping can be used to engage PWLE

to walk through a healthcare experience so they can relive it and provide insights meant to generate future research questions and outcome measures. Body mapping involves creating a life-size tracing of a body, in the position of the PWLE's choosing, which is then filled in based on reflection on questions shared in a workshop.⁶⁶⁻⁷⁰ The lived experience is shared in a manner of the PWLE's choosing, including through the use of symbols, emotions, and stories that represent their experience of their body.^{68,70} This ABM was first used in research in the early 2000s, investigating the experiences of people from South Africa living with human immunodeficiency viruses.^{66,67,69,71} Since this project, body mapping has been used to investigate sources of strength and support for people in treatment for problematic alcohol and other drug use,⁶⁷ drugged bodies and injecting drugs,⁷¹ with youth exploring how sexual and reproductive health relates to their social situation,⁶⁹ the experiences of women with mental health disorders or psychosocial distress,⁷² with marginalized women,⁶⁸ and body image and premenstrual changes to eating and exercise practice.⁷⁰

Body mapping projects follow a similar process. First, a group of participants come together in a focus group-style setting to create their individual body maps;^{67-69,72} however, this can also be done in one-on-one sessions.⁷⁰ Participants can choose the position that their body will be traced onto the paper^{68,69} or can use a pre-prepared outline.^{68,70} Participants are asked to fill in the body map related to their perceptions or experiences of the research topic, guided by probing questions,^{67-70,72} using a variety of materials such as paper, pens, markers, and even magazines to clip images from.^{69,70} These sessions are audio-recorded, and researchers may take field notes.^{67-70,72} Following the creation of the body maps, participants share an explanation of what they have depicted on their body maps in interview or focus group sessions.^{67-70,72} This combination of creativity and reflection^{67-70,72} leads to a deeper, embodied self-awareness and understanding of identity.⁶⁸ Participants are in control of what and how they share their experience through any artistic method they choose.^{69,70} Guided reflection among all team members^{67-70,72} creates a shared vulnerability and space for aesthetic knowledge co-creation.^{31,47}

Pragmatism and Arts-Based Research Methods

The use of ABM for PER aligns with a pragmatist worldview. Positivism and postpositivism do not value subjective^{16,29} or aesthetic knowledge⁴⁷ and can be viewed as oppressive.⁷³ By challenging and rejecting the limitations set on what constitutes knowledge by these worldviews through the use of a pragmatist worldview, ABMs become anti-oppressive and emancipatory.⁷³ ABMs shift power from the researcher back to the participant, as they are inherently participatory.^{47,74} ABMs are problem-focused rather than restrained by a philosophical underpinning or adherence to rules.^{47,75} Dialogue is integral to PER, as patients and care partners share and reflect on their experiences.⁷⁵ ABMs facilitate dialogue and help build relationships among diverse team members.⁴⁷ This relationship building can help to balance the power between researchers and PWLE which is also integral to PER.⁷⁵ The idea of *energeia*, that action is required to create art,³¹ aligns with the idea that knowledge is derived from action.²⁶ To ask a research question relevant to a population^{18,25} requires an understanding of the experience of the population. Experience is personal and includes an aesthetic epistemology to understand the sensory, embodied, and emotional ways of knowing³¹ is required to truly understand and know.

Early Mobility Evidence

For patients undergoing CS, mobilization within the first 24 hours post-operatively supports improved health outcomes, particularly among patients with baseline symptoms of poor physical functioning,^{76–78 76–7876–78} a condition with which aging patients are at significant risk.^{79,80} Early mobility is poorly defined in the literature, with no consistent definition found. In general, early mobility after CS is used as a “catch-all” phrase to describe the intentional movement of patients. These movements, or modes of early mobility, can include range of motion activities in bed, sitting at the side of the bed, getting out of bed to a chair, marching, ambulating, and cycling.^{81,82} Some of these modes of early mobility have been explored for safety, specifically getting out of bed to a chair, ambulation, and cycling.^{83–85} These modes have been found to be safe for patients undergoing CS in the intensive care unit (ICU), with studies reporting minimal adverse events and hemodynamic stability with mobilization

12 hours postoperatively.^{83–85} Both the ICU Liberation Bundle⁸⁶ and the Enhanced Recovery After Surgery CS guidelines⁸⁷ advocate for the early mobility of patients in the ICU. Despite being safe and recommended, the integration of early mobility into CSICU clinical care is inconsistent.⁷ This may relate to the way early mobility interventions have been developed. A brief overview of the early mobility literature related to these three aspects is provided below. An in-depth literature review of early mobility interventions can be found in Chapter 2.

Early mobility positively impacts respiratory outcomes such as pleural effusions and atelectasis,⁸⁸ but a mixed impact is reported on ICU and hospital length of stay. Some studies cited reduced length of stay,^{89,90} others cited no impact on length of stay,^{78,82} and one cited increased ICU length of stay and no impact on hospital length of stay.⁷⁶ A reduction in hospital mortality has been reported, ranging from 2% to 4.2%.⁸² There are indications that early mobility may reduce the incidence of depression and anxiety in ICU patients.⁹¹ The impacts of early mobility interventions explored in CS patients have been focused to physical outcomes, including a six-minute walk test,⁷⁷ functional status,^{76,78} independence with activities of daily living at ICU and hospital discharge,⁷⁶ and the ability to mobilize.⁷⁸ One study reported fewer deep vein thromboses, pneumonia, and dysrhythmias in the group receiving early mobility compared to the control group.⁸⁹ While these are promising findings, there have not been investigations of early mobility interventions among CSICU patients on longer-term impacts on symptoms of cognition and mental health in patients with a prolonged ICU and hospital length of stay. For patients with a prolonged ICU length of stay, the constellation of short and long-term impacts on physical and mental health and cognitive function are collectively known as post-intensive care syndrome (PICS).⁹² This syndrome is discussed in detail below.

Early mobility, whether through range of motion activities, sitting at the side of the bed, getting out of bed to a chair, marching, ambulating, or cycling has been reported as safe for patients in the postoperative phased of care in the CSICU, with studies reporting minimal adverse events and hemodynamic stability with mobilization 12 hours postoperatively.^{83–85} An observational study exploring

the hemodynamic effects of mobilizing post-CS to a chair measured central venous oxygenation and arterial lactate five minutes before mobilization, after 10 minutes of sitting in a chair, and 10 minutes after returning to bed.⁸³ This study found that central venous oxygenation dropped a clinically insignificant amount after 10 minutes of sitting in a chair, from 64% to 59%, then returned to 62% 10 minutes after returning to bed. Arterial lactate rose a clinically insignificant amount after 10 minutes of sitting in a chair, from 1.4 mmol/L to 1.8 mmol/L and remained elevated at 1.9 mmol/L 10 minutes after returning to bed.⁸³ This is unsurprising, as oxygen demand would increase with mobility, reducing central venous oxygenation and increasing arterial lactate⁹³ and these patients did not have a compensatory increase in blood pressure or heart rate during mobilization.⁸³ The slower return of arterial lactate to baseline is also unsurprising as arterial lactate would take longer to recover to a resting state than central venous oxygenation.⁹³ Importantly, only 17% of patients experienced a drop in mean arterial blood pressure of more than 10% of their baseline, which required primarily minor intervention.⁸³ Interventions included a median of 500mL of fluid to treat their hypotension (78% of these hypotensive patients) and a low dose of vasopressor (22% of hypotensive patients).⁸³ Nausea was noted in 13% of patients and arrhythmias in 5.6% of patients.⁸³ The median ICU length of stay was 24.75 hours, the ICU readmission rate was 1%, and the 28-day mortality rate was 3.77%, with one death attributed to mesenteric ischemia and the other to multiple organ dysfunction due to heparin-induced thrombocytopenia type II.⁸³ These findings suggest that the changes in arterial lactate noted during mobility did not lead to adverse outcomes.⁸³ This study demonstrates the clinical safety of getting patients out of bed to a chair the morning after CS, despite hemodynamic changes that may occur.⁸³ Though less detailed, the safety of early mobility via cycle ergometer has also been reported.⁸⁴ This study reported no hemodynamic instability in the mobility group.⁸⁴ There were also no reports of mediastinitis or sternal/ saphenous wound dehiscence in the mobility group.⁸⁴ The hemodynamic safety of cycling is supported by another study that reported hypotension in only 1.5% of the cycling sessions completed in the study.⁸⁵ No saphenous wound complications were noted through visual inspection before, during, and after cycling.⁸⁵

Both the ICU Liberation Bundle⁸⁶ and the Enhanced Recovery After Surgery CS guideline⁸⁷ both advocate for the early mobility of patients in the ICU. The ICU Liberation Bundle shares the ICU-specific assessments suggested to support determining the activity goal of the patient.⁸⁶ This bundle also suggests steps to support safe mobilization of ICU patients, including considering lines, monitoring hemodynamics, and having multiple people involved for assistance with equipment.⁸⁶ Criteria for when to stop mobility are also suggested.⁸⁶ The Enhanced Recovery After Surgery CS guideline is less specific, only suggesting that early mobility is an essential component.⁸⁷ This guideline provides no other information and refers users to their local staff with expertise in early cardiac rehabilitation and physical therapy.⁸⁷ Thus, the recommendations from both organizations exist but provide little guidance on the operationalization of early mobility in the CSICU.

Post-Intensive Care Syndrome

PICS is a new or worsening deterioration in a patient's cognitive, mental, and/ or physical health after a stay in an ICU.⁹² Cognitive health outcomes of PICS are impairments in memory, attention, executive function, mental processing speed, and visuospatial ability.⁹² Mental health outcomes of PICS include anxiety, depression, and post-traumatic stress disorder.⁹² Physical health outcomes of PICS include muscle atrophy and reduced functional capacity.⁹² It is common to have outcomes co-occur among these three areas of health, suggesting relationships among the outcomes.^{94,95}

Risk factors for developing PICS include, but are not limited to, older age, postoperative delirium, and prolonged mechanical ventilation,⁹² which are demonstrated by the current population of patients who have undergone a CS procedure.^{79,80,96} With the aging Canadian population,⁹⁷ more older adults are undergoing CS.⁷⁹ Older patients experience prolonged post-operative CSICU stays⁸⁰ and higher rates of delirium⁹⁶ compared to younger patients. Patients with prolonged post-operative CSICU stays experience longer mechanical ventilation time compared to patients without prolonged post-operative stays.⁷⁹ Older patients with prolonged post-operative CSICU stays are at higher risk for symptoms of PICS, including reduced cognitive function (cognitive health),^{96,98} anxiety and depression (mental health),⁹⁶ reduced

health-related quality of life (physical and mental health),⁹⁹ and poorer functional survival, defined as post-hospital admission to a long-term care facility (physical health).^{79,80}

PICS research has been more commonly studied in a medical-surgical ICU environment for acute respiratory distress syndrome or sepsis.¹⁰⁰ A 2014 stakeholder meeting noted that CSICU viewpoints might diverge from existing PICS viewpoints.¹⁰⁰ Despite this recognition and the fact that CS patients exhibit risk factors and are at higher risk for the adverse patient-centred outcomes of PICS, CS patients continue to be underrepresented¹⁰¹ or excluded⁹⁴ from PICS research. Research is needed to explore interventions that prevent PICS in older patients, aiming to optimize health outcomes following CS.

Current CS PICS Intervention Research

A wide variety of interventions directed at preventing CS PICS have been published. These include massage,^{102–105} acupressure,^{106,107} music therapy,¹⁰⁸ saffron,¹⁰⁹ humanized care,¹¹⁰ ICU diaries,¹¹¹ sleep promotion,¹¹² head cooling,¹¹³ medication,^{114–122} education,^{123–125} remote ischemic preconditioning,¹²⁶ cognitive behavioural therapy,¹²⁷ isolated impaired fasting glucose,¹²⁸ and continuous nursing.¹²⁹ Only two studies used physical activity interventions,^{85,130} one with a rehabilitative focus¹³⁰ and the other with a preventive focus using early mobility.⁸⁵ The majority of these studies (14 of 30) investigated the cognitive domain of CS PICS,^{105,113–122,125,126,128,130} with 10 investigating the mental health domain of CS PICS,^{102,103,106–108,112,123,124,127,129} and one the physical domain of PICS.⁸⁵ Three studies investigated both the mental and physical domains of CS PICS^{104,110,129} and one investigated both the mental and cognitive domains of CS PICS.¹⁰⁹ No studies investigated all three domains of CS PICS. An overview of these studies, including the results, can be found in Appendix A.

Most of the teams conducting the intervention trials had homogeneous clinical backgrounds. Twenty-two studies included physicians on the research teams,^{85,102,108–111,113,114,116–122,124–126,128–130} with cardiac surgeons and anaesthesiologists being the dominant sub-specialties. Nurses led or participated in 12 of the 30 studies.^{102–107,112,118,123,124,127} The studies investigating physical activity interventions included a physiotherapist and either a rehabilitation scientist or exercise physiologist on the research

teams.^{85,130} None of the teams conducting intervention trials explicitly described integrating clinicians or PWLE in intervention development. While the researchers may also be clinicians in some cases, broadening the clinical insights available by integrating clinicians whose role is only to deliver patient care is still missing from these teams. This provides an opportunity to demonstrate how to incorporate both clinical and lived expertise into intervention development for this emerging field of research.

Overview of the Research

This introduction has shared what is known related to early mobility, PICS, PER, ABMs, and intervention development. This is summarized below the checkmark in Figure 1.3. There are many important questions that remain or grow from this existing knowledge. Some of these questions are summarized below the question mark in Figure 1.3 and are explored in this dissertation as described below.

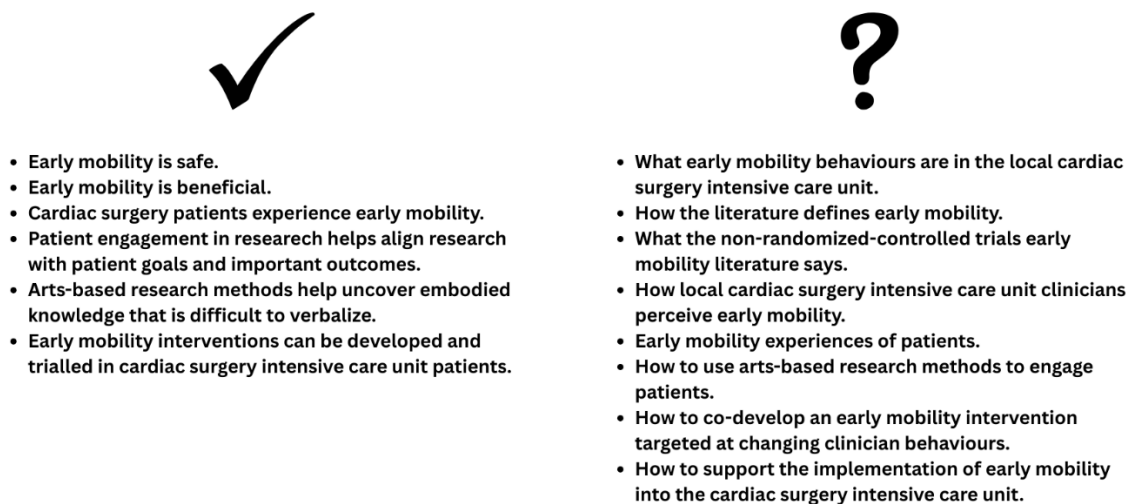


Figure 1.3. Overview of what is known and not known prior to this dissertation.

This doctoral thesis aimed to co-create and feasibility test an early mobility intervention informed by clinicians, PWLE, and the literature. This occurred through four studies using multiple research methods, all conducted by an interdisciplinary research team that includes PhD, clinician, and PWLE

researchers. First, a scoping review of published early mobility interventions (Chapter 2) was conducted. It aimed to map the CSICU early mobility literature to understand the extent, range, and nature of the extant literature. Chapter 3 is an observational study using behaviour mapping to understand the current state of early mobility in the CSICU. The objective of this project was to gain an understanding of the current state of early mobility in the CSICU. Chapter 4 is a qualitative study aimed at understanding clinicians' perspectives of early mobility through focus group discussions. Chapter 5 describes the methods used to engage PWLE in exploring their embodied knowledge through body mapping and then continuing engagement in virtual consultation workshops to co-create a definition of early mobility and identify and prioritize barriers, facilitators, and outcome and experience measures for early mobility intervention research. Chapter 6 is a study exploring PWLE experiences with early mobility through the ABM of body mapping. The early mobility definition and prioritized barriers and facilitators to early mobility, along with outcome and experience measures to evaluate future early mobility interventions, are found in Chapter 7. Chapter 8 describes the development of the early mobility intervention through intervention mapping. Chapter 9 describes the evaluation of the early mobility intervention through behaviour changes in clinicians. Chapter 10 summarizes the conclusions and contributions that this dissertation makes to the field, including perspectives about how the research informs future research and clinical care. Overall, this dissertation aimed to generate high-quality, clinical- and lived-experience-informed evidence to support the integration of early mobility interventions into CSICU clinical care. This dissertation addresses key gaps in CSICU clinical care through a co-development process that recognizes the value of clinical and lived experiences.

Format of the Thesis

This thesis is a grouped manuscript style of thesis, also referred to as a sandwich thesis by the University of Manitoba Faculty of Graduate Studies. This thesis style consists of a collection of published or publishable papers along with an introductory and a concluding chapter. The thesis must be a unified document with the papers all contributing to the overall theme of the research and work of the thesis.

Multi-authored papers can be included in a sandwich thesis if there is an explanation of the nature and extent of the contributions of all authors and the candidate writes unique text to describe the chapter. To support consistency throughout this thesis, the chapters that are published or publishable papers (Chapters 3-8) all follow the same format. For each chapter of that style, there is a section titled **Preface to the Manuscript**, which shares information about the justification for the research described in the chapter as well as how the chapter contents build the overall story of the thesis. The next section is titled **Manuscript Status**, where the study of the paper (submitted, under review, under revision, etc.) is shared. The next section lists the **Authors** of the paper with the **Contributions of Authors** described. The **Manuscript** is then shared. If the paper is published, the link to the paper on the journal website is provided to allow for access to the most up-to-date version of the paper as they move through the publication process and to adhere to copyright. If the paper is not yet published, the text of the paper has been inserted into the thesis, formatted for the intended journal of publication. Finally, the last section is titled **Brief Discussion of the Manuscript**, where I discuss the manuscript findings, the impact the findings have had to date, and tie the findings into the overall story of the thesis.

Manuscripts that have been drafted but are not yet published have been cited as journal articles throughout this dissertation. These manuscripts follow the same referencing style as a journal article; however, in the reference list, they will indicate the step in the publishing process they are at. For example, the manuscripts in Chapters 5-7 have been submitted for consideration of publication. This is noted beside the journal name. Manuscripts that have been accepted have also been cited as journal articles throughout this dissertation. As noted above, the link to the paper on the journal website is provided to allow for access to the most up-to-date version of the paper as they move through the publication process and to adhere to copyright. Cited works in all other chapters are referenced in sequential order and identified in the reference list at the end of this thesis.

Chapter 2 : Scoping Review of Early Mobility in the Intensive Care Unit Following Cardiac Surgery

Preface to the Manuscript

Step one of intervention mapping is to conduct a needs assessment exploring the behaviour targeted for change through a review of the literature and contextually through qualitative and quantitative means.^{9,10} This chapter presents the literature review portion of the needs assessment. A scoping review was conducted to broadly explore the early mobility literature, as existing reviews focused only on randomized controlled trials.^{77,82,90} Not including pilot studies, quality improvement studies, and grey literature in the needs assessment, limits the breadth of understanding of the state of the literature.

Manuscript Status

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Contributions of Authors

This review, the research question, and approach was conceptualized by Drs. Arora, Duhamel, Schultz, and O’Keefe-McCarthy and me. The research question was refined by Jacqueline Hay, April Gregora, Kathy Smith, and me. The search strategy was co-developed among Jacqueline Hay, Caroline Monnin, April Gregora, Kathy Smith, and me. Caroline Monnin executed the original and updated

searches, exported the results to EndNote, deduplicated the records, and imported them into Covidence. Jacqueline Hay, April Gregora, Kathy Smith, and I iteratively determined inclusion and exclusion criteria and performed full-text screening. Jacqueline Hay and I independently conducted the title and abstract screening and extraction in Covidence. As the first author, I drafted the original manuscript and revised it based on author and reviewer feedback. Jacqueline Hay and I co-developed figures to support knowledge translation. All authors provided academic or clinical expertise and reviewed, revised, and approved the manuscript.



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Review article

Scoping review of early mobility in the intensive care unit following cardiac surgery



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ABSTRACT

Introduction: Early mobility in the intensive care unit (ICU) within 24 h following cardiac surgery (CS) is guideline-recommended, safe, and supports improved patient outcomes. The evolution of early mobility following CS research has not been explored. Prior reviews have not included non-randomized controlled trials nor assessed the quality of intervention reporting using standard guidelines.

Objective: This scoping review addresses these gaps and maps CS ICU early mobility literature to understand the extent, range, and nature of the extant literature.

Design: The databases Medline, Embase, PsycINFO, Scopus, CINAHL, ClinicalTrials.org, and CS association websites were searched from inception to January 2025. Extracted details included early mobility definitions and modes, outcome measures, alignment of intervention reporting with the Consensus of Exercise Reporting Template (CERT), and the inclusion of sex/gender in results/discussions.

Results: A total of 109 studies were included. 43 studies defined early mobility, ranging from the day of surgery to within 2 weeks post-operatively. Many early mobility modes were noted, most commonly ambulation. Primary outcomes varied, with hospital length of stay and pulmonary function the most often studied. There was a consistent lack of reporting of CERT items. Only two studies presented findings disaggregated by sex/gender, and only 13 studies considered sex/gender in the discussion.

Conclusions: There is heterogeneity in the extant CS ICU early mobility literature, specifically in early mobility definitions and modes, outcome measures, quality of intervention reporting, and consideration of sex/gender. Improvements to research design and reporting should be encouraged to support the advancement of the science.

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1. Introduction

Early mobility in the intensive care unit (ICU) following cardiac surgery (CS) can be defined as any active movement soon after surgery, and most often starts on the day of surgery or first post-operative day [1,2]. Active movements, or modes of early mobility,

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can include sitting, standing, actively moving from bed to a chair, marching on the spot, ambulation, cycling, or other active exercises [1,2]. Engaging in early mobility supports improved physical functioning outcomes and may reduce ICU and hospital length of stay [3,4]. This diversity in early mobility modes, start time post-CS, and outcomes suggests that early mobility can be tailored to clinical resources and integrated into CS ICU clinical care. There is, however, a lack of integration of early mobility into CS ICU clinical care [2,5], which may be in part due to the inconsistent and incomplete reporting of early mobility intervention studies.

A 2022 systematic review of early mobility interventions in the CS ICU by Borges and colleagues [1] assessed only randomized controlled trials. A broader review that includes pilot studies [6], quality improvement studies [5,7], and grey literature would enrich the current evidence related to early mobility in the CS ICU. No review has explored early mobility research reporting over time to discern evolution and make recommendations for advancing the field. Incomplete reporting may also impede advancement, future replication, and use in clinical practice as the time, resources, and methodologies are ambiguous [8]. Currently, the transparency and clarity of reporting of early mobility interventions are unknown, as the alignment of reporting with a standard guideline, such as the Consensus on Exercise Reporting Template (CERT) [8,9] and Sex and Gender Equality in Research (SAGER) [10,11] guidelines, has yet to be explored. This scoping review aims to fill these gaps in the literature by mapping the extant CS ICU early mobility literature in adults undergoing coronary artery bypass grafting, cardiac valve surgery, or combination surgery to understand the extent, range, nature, and quality of reporting of early mobility interventions explored across time using any study methodology. The reporting of this scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews [12]. See Appendix A (Table A1) for the checklist.

2. Methods

The protocol for this scoping review was published in Open Science Framework (<https://doi.org/10.17605/OSF.IO/JVGH2>) [13] and follows Arksey and O'Malley's six-stage framework [14] with adaptations from Levac et al. [15]. As the adaptations from Levac et al. [15] require consultation, two people with lived experience were engaged at the level of collaboration [16], defined as equally partnering in each aspect of the research [16] and operationalized by including the people with lived experience partners as members of the research team and co-authors who were actively involved in all aspects of the review.

A nurse with CS ICU experience (EKP), a clinical exercise physiologist (JLH), a research librarian (CM), and two people with lived experience partners (AG and KS) co-developed the peer-reviewed search strategy [17]. The search was executed in December 2023 in MEDLINE (Ovid) and translated to Embase (Ovid), PsycINFO (Ovid), Scopus, and CINAHL with Full Text (EBSCOhost) (see Appendix B (Tables B1–B5) for full search details) and updated in January 2025. A mix of controlled vocabulary (i.e., MeSH) and keywords informed the development of the search strategy. The main search concepts were comprised of terms related to early mobility, CS, and the ICU. Subject headings (i.e., MeSH) such as early ambulation, cardiac surgical procedures, and intensive care units were also included. To locate grey literature, the librarian searched registries (i.e., CENTRAL) and CS association websites (i.e., Canadian Society of Cardiac Surgeons). All records were exported into EndNote (version x20; Clarivate Analytics, Philadelphia, PA, USA), duplicates were removed [18], and the remaining records were imported into Covidence (Melbourne, Australia).

EKP, JLH, AG, and KS iteratively determined inclusion and exclusion criteria [14,15]. Inclusion criteria were articles written in English, adult patients 18 years of age or older, undergoing coronary artery bypass grafting, cardiac valve surgery, or a combination of the two, interventions where mobility occurred in the ICU, and where the protocol for early mobility is reported. Exclusion criteria were patients under the age of 18, non-CS or CS other than coronary artery bypass grafting, cardiac valve surgery, or a combination of the two, interventions where mobility did not occur in the ICU, systematic or scoping reviews or meta-analyses, and opinion, descriptive, or qualitative research designs not describing an early mobility intervention. Two reviewers (EKP and JLH) independently conducted the title and abstract screening in Covidence [14,15]. Following this, EKP, JLH, AG, and KS each screened 20 articles for full-text review and then met to ensure consistency and understanding. The inclusion and exclusion criteria and reasons for rejection were shared among team members in a summary sheet developed by JLH to support full-text screening. Two of the four reviewers reviewed each study for full-text for inclusion. Any disagreements were resolved through discussion among the four reviewers [14,15]. If agreement was not possible, an additional reviewer (TAD) was included to resolve the disagreement.

Extraction was performed by EKP and JLH in Covidence [15]. Disagreements were resolved through discussion. The charting template was co-developed iteratively with the people with lived experience partners [14,15]. Author, year, country of origin, aim or purpose, population characteristics (age, sex, gender, types of CS, etc.), study design (randomized controlled trials, pilot study, quality improvement, etc.), inclusion and exclusion criteria, and primary outcome measure were charted. Early mobility mode, the definition of early mobility, inclusion, exclusion, stopping criteria, comparators, and an overview of the protocol guided by the CERT checklist were also extracted [8,9]. In alignment with the SAGER guidelines, the charting included a limited number of items, including if the results were disaggregated by sex/gender (6b) and if the implications or generalizability of the findings based on sex/gender were discussed (7a) [10]. As others have done [19], we extracted the proportion of female/male participants and the terminology (male or female, man or woman, or both) used to refer to participants. To explore the reporting of the interventions, the reporting of each CERT item (1–16) was classified as 'Yes,' 'No,' 'Unsure,' or 'Not Applicable,' as others have done [20]. Items were classified as not applicable to the intervention for several reasons [20]. Since the interventions of interest are based in the CS ICU, most often item 8 (home program elements) was 'Not applicable' [20]. Additionally, protocol and implementation studies that described the intervention but not the outcomes were assessed as 'Not Applicable' for items 11 (adverse events) and 16 (fidelity) [20]. The remaining items relate to what materials (item 1), which providers (item 2), how the intervention is delivered (items 3–7, 9, 10), where the intervention is delivered (item 12), the dose of the intervention (item 13), and any tailoring of the intervention (items 14 & 15) [8,9].

3. Results

The search yielded 4667 studies. A hand search of the reference lists of systematic reviews yielded 7 additional studies for title and abstract review. A total of 790 duplicates were removed in EndNote, and an additional 30 duplicates were removed in Covidence manually ($n = 10$) or automatically ($n = 20$). The titles and abstracts of 3854 remaining studies were reviewed for inclusion, and 3493 were excluded. The full texts of the remaining 361 studies were reviewed, and 249 were excluded. The most

common reasons for exclusion were the study not describing the protocol for early mobility ($n = 98$), the study being a systematic or scoping review or meta-analysis ($n = 49$), and early mobility not beginning in the CS ICU ($n = 31$). Data were extracted from 109 studies. See Fig. 1 for the PRISMA diagram.

3.1. Overview of included studies

A summary of the included studies is provided in Table 1. The included studies used a variety of study designs, including randomized controlled trials ($n = 64$) [21–84], observational ($n = 27$) [2,85–110], other experimental trials ($n = 10$) [6,111–

119], quality improvement ($n = 5$) [5,120–123], case series ($n = 1$) [124], qualitative ($n = 1$) [125], and feasibility ($n = 1$) [126]. Participants included patients undergoing only CABG ($n = 47$) [22,28,31–33,37–49,53–58,60–62,66–72,77,80,81,90,96,105,108, 112–114,117,122,124], only valve surgery ($n = 12$) [23,26,36,50, 59,75,76,78,85,95,107,123], CABG or valve surgery ($n = 4$) [25,79,101,106], and combined surgery ($n = 43$) [2,5,6,21,24,27, 29,30,34,35,51,52,63–65,73,74,82,22–84,86–89,91–94,97–100, 102–104,109–111,115,116,118,119,125]. Three studies did not report the type of CS that the participants underwent [120,121, 126]. Studies were conducted worldwide from 1983 [22] to 2024 [2,23,79,22–84,87,108,86–110,118,119, 122,123,125], with

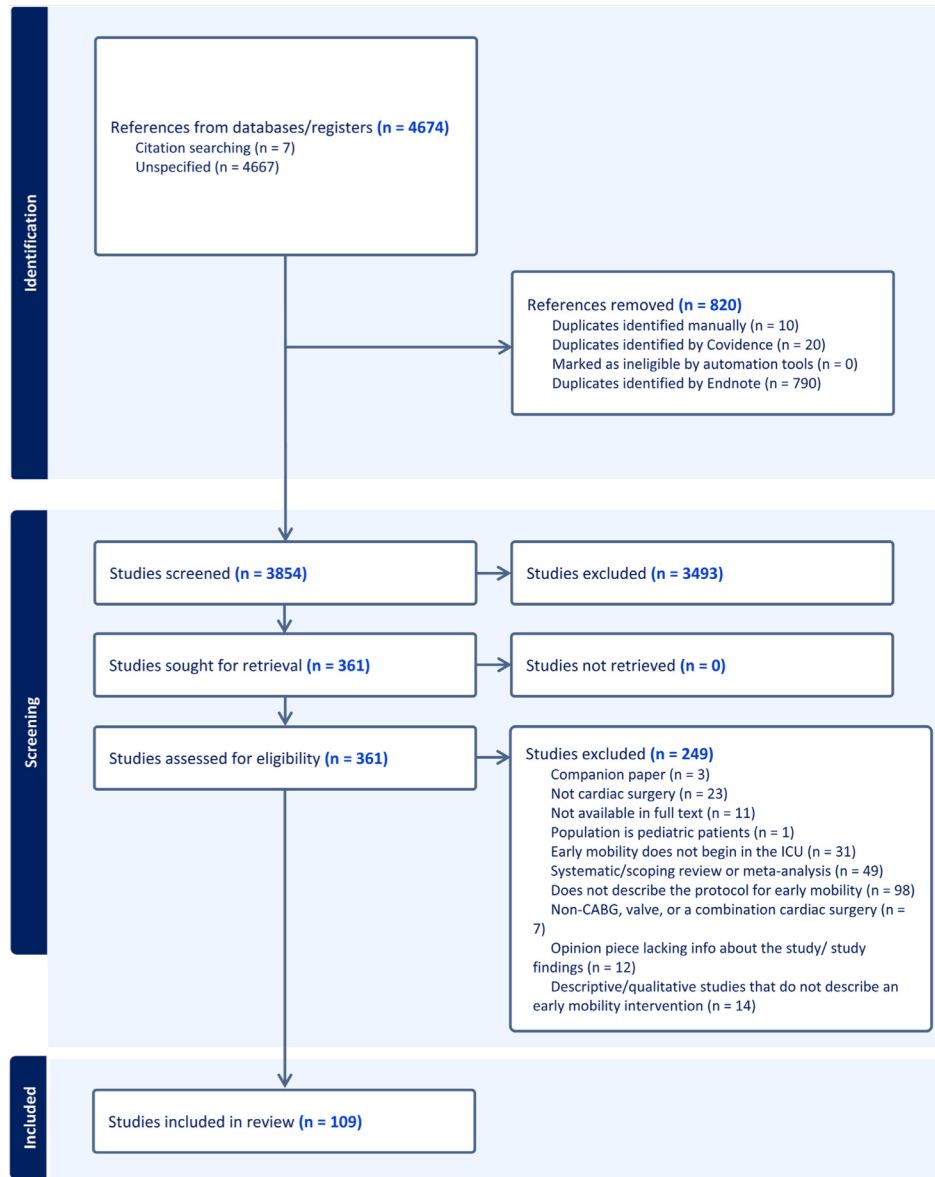


Fig. 1. Prisma diagram.

Table 1
Overview of included studies.

Year	Author	Country	Study design	Surgeries included (CABG, V, CABG&V)	Mode of early mobility in ICU	Comparator (Usual care, none)	Were sex and/or gender considered (Yes, No, Results, Discussion)
1983	Dull	United States	RCT	CABG	Active ROM, sit, stand all with incentive spirometer	Active ROM, sit, stand	Yes, discussion
1989	Jenkins	UK	RCT	CABG	Ambulate with breathing exercises	Ambulate	n/a
1991	Waite	United States	Non-randomised experimental study	CABG&V	Stand	None	No
1996	Griffith	United States	Non-randomised QJ	NR	Ambulate	None	No
1996	Jesurum	United States	Non-randomised experimental study	CABG	To chair, ADLs	None	n/a
1996	Johnson	Canada	RCT	V	Dangle	Breathing only	Yes, discussion
1999	Nickerson	United States	Prospective cohort study	CABG&V	Ambulate	None	Yes, discussion
2002	Priestley	Australia	RCT	CABG	Ambulate	None	No
2003	Brasher	Australia	RCT	CABG&V	Ambulate and to chair	Breathing exercises	No
2004	van der Peijl	Netherlands	RCT	CABG	Active ROM & to chair	Active ROM & to chair	No
2006	Kirkeby-Garstad	Norway	Crossover RCT	CABG	Cycle	None	No
2006	Kirkeby-Garstad	Norway	QJ	NR	To chair & march	None	No
2006	Savci	Turkey	RCT	CABG	Active ROM with incentive spirometry	Active ROM	n/a
2008	Herdy	Brazil	RCT	CABG	Ambulate	None unless PT consulted	No
2008	Hirschhorn	Australia	RCT	CABG	Ambulate	Usual care	Yes, discussion
2009	Stein	Brazil	RCT	CABG	Active ROM & ambulate	Usual care	No
2010	Izumi	Japan	Retrospective pre-post intervention survey	CABG&V	Ambulate	None	No
2010	Mendes	Brazil	RCT	CABG	Active ROM & march	Usual care	No
2012	Hirschhorn	Australia	RCT	CABG	Cycle	Ambulate	Yes, discussion
2013	Cacau	Brazil	RCT	CABG&V	Virtual reality	Usual care	No
2013	Saitoh	Japan	Retrospective cohort	CABG or V	Ambulate	None	No
2014	Mendes	Brazil	Prospective cohort study	CABG	Ambulate	None	No
2014	Pantoni	Brazil	Non-randomised experimental study	CABG	Active ROM	None	No
2014	Sturgess	Australia	Non-randomised experimental study	CABG&V	Ambulate & thoracic exercises	Ambulate	No
2015	Tashiro	Japan	RCT	Off pump CABG	Mobilization with adaptive servo-ventilation	Mobilization without adaptive servo-ventilation	No
2015	Winkelmann	Brazil	Retrospective cohort	CABG or V	Active ROM, stand, ambulate	None	No
2015	Ximenes	Brazil	RCT	CABG	Resistance training	Active ROM	No
2015	Nozawa	Brazil	RCT	CABG&V	March	To chair	n/a
2016	Borges	Brazil	RCT	CABG	Cycle	Usual care	No
2016	Cassina	Switzerland	Cohort study	CABG&V	To chair	None	No
2016	da Costa Torres	Brazil	RCT	CABG	Ambulate & cycle	Usual care	n/a
2016	Dedichen	Norway	Cohort study	CABG	Cycle	None	No
2016	Dong	China	RCT	CABG	Ambulate	Ambulate post-ICU	No
2016	Fleming	UK	Cohort study	CABG&V	To chair	None	No
2016	Floyd	United States	Retrospective descriptive comparative	CABG&V	Ambulate	None	Yes, discussion
2016	Højskov	Denmark	RCT	CABG	Cycle	Usual care	No

Table 1 (Continued)

Year	Author	Country	Study design	Surgeries included (CABG, V, CABG&V)	Mode of early mobility in ICU	Comparator (Usual care, none)	Were sex and/or gender considered (Yes, No, Results, Discussion)
2016	Pantoni	Brazil	RCT	CABG	Amalgate with CPAP	Amalgate	No
2017	Hong	Australia	RCT	CABG using LIMA	Amalgate	Amalgate	No
2017	Moradian	Iran	RCT	CABG	Amalgate	Usual care	No
2017	Mungovan	Australia	Prospective cohort study	CABG&V	Amalgate	None	Yes, results & discussion
2017	Tariq	Pakistan	RCT	CABG&V	To chair	Amalgate POD1	No
2017	Turky	Egypt	RCT	CABG	To chair & amalgate	Usual care	Yes, discussion
2018	Kitamura	Japan	RCT	CABG&V	Neuromuscular stimulation	Cycle	No
2018	Rocha	Brazil	RCT	V	Cycle	Usual care	n/a
2019	Arai	Japan	Cohort study	CABG&V	Amalgate	None	No
2019	Højskov	Denmark	RCT	CABG	Cycle	Usual care	No
2019	Itagaki	Japan	Cohort study	CABG&V	Amalgate	None	Yes, discussion
2019	Kato	Japan	Cross sectional study	V	Amalgate	None	No
2019	Yayla	Turkey	Quasi-experimental	CABG&V	To chair & amalgate	Usual care	No
2019	Zanini	Brazil	RCT	CABG	Active ROM, to chair, march	Active ROM, to chair	No
2020	Boyd	Australia	Cross sectional study	CABG&V	Dangle	None	No
2020	Chen	China	Non-randomised experimental study	Off pump CABG	Amalgate	None	No
2020	Cui	China	RCT	Off pump CABG	Amalgate (day 2 or 3)	Amalgate (day 2 or 3)	No
2020	Dima	Canada	Feasibility	NR	Amalgate	None	n/a
2020	Gama Lordello	Brazil	RCT	CABG&V	Cycle	Usual care	No
2020	Kose	Turkey	Quasi-experimental	CABG&V	Amalgate	None	No
2020	Kubitz	Germany	Cross sectional study	Minimally invasive V	Amalgate	None	No
2020	Ratajska	Poland	RCT	CABG	Active ROM	None	No
2020	Ribeiro	Brazil	RCT	CABG	Cycle, Wii sports	Cycle/ ROM	No
2020	Shirvani	Iran	RCT	CABG	Amalgate	Usual care	No
2020	Takroni	Saudi Arabia	RCT	V	Active ROM, sit, to chair, amalgate	Active ROM, sit, to chair, amalgate	No
2020	Windmoller	Brazil	RCT	CABG	Cycle, amalgate, stand, stretch	Stand, stretch	No
2020	Goswami	Austria	RCT	CABG or V	Stand with vibration	Stand	n/a
2020	Macaire	Vietnam	RCT	V	Sit in bed	Sit in bed	n/a
2021	Afxonidis	Greece	RCT	CABG&V	To chair	Usual care	No
2021	Chen	China	RCT	V	Amalgate	Usual care	No
2021	Cordeiro	Brazil	Cohort study	V	Cycle, to chair	Cycle, to chair	No
2021	Jacob	Qatar	QI	CABG&V	Amalgate	None	n/a
2021	Newman	Canada	Non-randomised experimental study	CABG&V	Cycle	None	No
2021	Saitoh	Japan	Cohort study	CABG&V	Amalgate	None	n/a
2021	Sousa	Brazil	Prospective cohort	CABG&V	Stand & respiratory training	Stand	No
2021	Vitomskiy	Ukraine	RCT	CABG&V	Strengthening and functional exercises, active assistive moving techniques	Usual care	n/a
2021	Chatzitheodorou	Greece	RCT	CABG&V	Amalgate with CPAP	Amalgate	n/a
2021	Obaid	Pakistan	RCT	CABG	Neuromuscular stimulation	Usual care	No
2022	Cerqueira	Brazil	RCT	CABG&V	Amalgate, hand grip strength	Usual care	No
2022	Elbel	Brazil	RCT	CABG	Paddling + march	March	No
2022	Hamid	Pakistan	RCT	CABG&V			No

Table 1 (Continued)

Year	Author	Country	Study design	Surgeries included (CABG, V, CABG&V)	Mode of early mobility in ICU	Comparator (Usual care, none)	Were sex and/or gender considered (Yes, No, Results, Discussion)
2022	Han	China	RCT	CABG	Anbulate	NR	No
2022	Salenger	United States	Retrospective interrupted time series	CABG&V	Anbulate	None	No
2022	Surendran	Qatar	Case series	CABG	Anbulate & cycle	None	n/a
2022	Xue	China	RCT	V	Anbulate	Usual care	No
2023	Allahbakhshian	Iran	RCT	CABG	Anbulate/ march	Usual care	No
2023	Alsubaiei	Saudi Arabia	Quasi-experimental	CABG	Anbulate	None	No
2023	Bano	Pakistan	RCT	CABG	Cycle	Usual care	No
2023	Esmealy	Iran	RCT	CABG	Passive and active ROM, sit, to chair, ambulate	Chest physio, sit, to chair, ambulate	No
2023	Ghichi Moghaddam	Iran	RCT	CABG	Virtual reality	Usual care	No
2023	Md Ali	Malaysia	RCT	CABG&V	Anbulate	Usual care	n/a
2023	Morisawa	Japan	Prospective cohort study	CABG&V	Anbulate	None	Yes, discussion
2023	Obafemi Takino	United States	Cohort study	CABG&V	Anbulate	Usual care	No
2023		Japan	RCT	CABG&V	Anbulate & neuromuscular stimulation	Ambulate & sham	No
2023	Tsuchikawa Zhou	Japan	Cohort study	CABG	Anbulate	None	No
2023		China	RCT	V	Active ROM, sit, stand, balance training, and ambulate	Usual care	n/a
2024	Ahmad	Egypt	RCT	V	Cycling	Usual care	No
2024	Awaludin	Indonesia	Cross sectional study	CABG&V + spetal defect closure	Active ROM	NR	No
2024	Ceylan	Iraq	RCT	CABG or V	Active ROM, sit	Breathing exercises	No
2024	Chen	China	Retrospective cohort	CABG & V	Passive and active ROM, sit, resistance, to chair, ambulate	Usual care	No
2024	Cook	United States	QI	CABG	To chair	n/a	No
2024	Cordeiro	Brazil	RCT	CABG	Cycle	Ambulate	No
2024	Ibrahim Ahmad	Egypt	Quasi-experimental	CABG&V	Sit, to chair	Usual care	No
2024	Ma	China	RCT	CABG	Active ROM, ambulate	DB&C, ambulate	No
2024	Phillips	Canada	Observational	CABG&V	Sit, to chair, ROM, ambulate	n/a	No
2024	Schmid	Germany	QI	V	Anbulate, stairs, cycling, ADLs, exercises while lying, sitting, or standing	n/a	n/a
2024	Silva	Brazil	Observational	CABG	Sit, to chair, ambulate active and passive ROM, sit, stand, ambulate	n/a	No
2024	Takahashi	Japan	Retrospective cohort	CABG&V	ROM, sit, stand, ambulate	n/a	No
2024	Ünver Wang	Turkey	Qualitative RCT	CABG&V	Anbulate	n/a	n/a
2024	Yang	China	Non-randomised experimental study	CABG&V	Passive ROM, sit, stand, ambulate, to chair	Usual care	No
2024	Yuenyongchaiwat	Thailand	RCT	CABG&V	Active ROM, sit, ambulate	Usual care	No
2024	Sen	Turkey	RCT	CABG&V	Active ROM via virtual reality, sit, stand, ambulate	Active ROM, sit, stand, ambulate	n/a
2024	\$				Active and passive ROM, to chair	Sit, to chair	n/a

Legend: RCT = randomised controlled trial; * = Study terminated; \$ = Clinical Trial; CABG = coronary artery bypass grafting; V = valve surgery; NR = not reported; ROM = range of motion; QI = quality improvement.

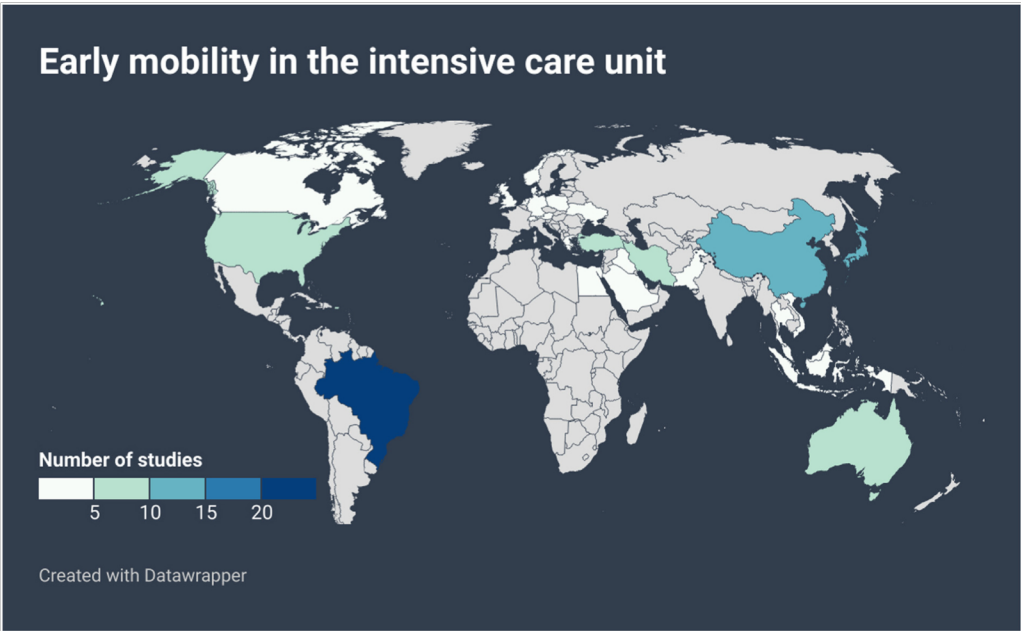


Fig. 2. Choropleth of location of included studies.

the highest volume conducted in Brazil ($n = 23$) [21,27,33,35,38, 40,43,53,55,58,59,62,68–70,73,80,85,96,104,106,108,114]. See Fig. 2 for a choropleth map visualizing the density of publications

by country. One clinical trial was stopped early but the reason was not reported [28]. As seen in Fig. 3, the volume of studies have increased over time. Of note, 54% of the included studies were

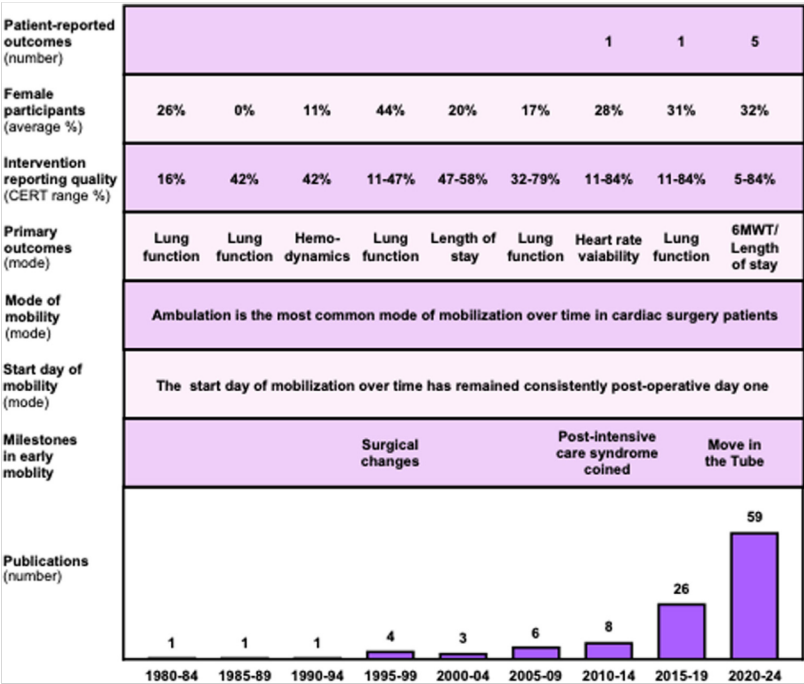


Fig. 3. Summary of key elements of studies over time.

published from 2020 to 2024 [2,5,6,21,23–26,28–32,35–37,40–42,52,57,58,60,64,68,74, 76–85,87,89,95,97,100,102–105,108,86–110,112,116,112–119, 122–124,124–126].

3.2. Early mobility definitions

The definitions of early mobility can be found in Table 2. Only 43 studies included definitions of early mobility [2,5,6,21–23,25–27,30–34,36,37,41,51,55,60,64–67,69,71,72,74,76–78,81,84,87,88,91,94,96,105,119,122,125,126], defined as post-operative day 1 by 44% [27,34,36,55,60,64,65,67,69,71,72,74, 76,77,87,88,91,94,96]. The longest period defined by one study was within 2 weeks post-operatively [119]. Two studies used patient-condition-specific definitions of clinical [23] or hemodynamic and respiratory stability [126] rather than relating early to a post-operative time. Four studies defined early as three [5], four [22,26], to six [2] hours following extubation, regardless of when extubation occurred post-operatively. Two studies defined early as two [60] to six [27] hours following extubation, which occurred on post-operative day one. All other studies tied the definition of early to post-operative days zero to seven [6,21,25,30–34,36,37,41, 51,55,60,64–67,69,71,72,74,76–78,81,87,88,91,94,96,105,119, 122,125]. See Fig. 4 for a visual of the proportion of studies defining early as post-operative days zero to five.

3.3. Intervention description

A variety of modes of early mobility were used (Table 1). Modes ranged from active range of motion [2,22,53,57,61,62,67,70,75,77–79,81–84,87,96,106,109,110,114,119], to getting to a chair [2,30,34,65,66,75,77,82,84–86,91,108,110,111,113,118,120,122], to ambulation [2,5,28,31,36,37,39,41,43,45,48,52,55,56,60,78, 81,82,88,92–105,107–109,112,116,119,121,125,126], to cycling [6,21,23,32,33,44,46,47,59,72,90]. Some studies used a combination of these modes, such as ambulation and getting to a chair [34,75,108–110], cycling and getting to a chair [85], and ambulation and cycling [38,124]. Novel modes of mobility included playing Wii Sports, such as boxing [58] and virtual reality-based mobilization [42,73,83]. Three studies approached the mode of mobility by incorporating functional exercises [24] and activities of daily living [113,123] into their protocols.

3.4. Quality of intervention reporting

No study reported all items of the CERT (Fig. 5). Interventions often described CERT item 3 if the exercises were performed in a group or individually (79%), CERT item 4 if the exercise was supervised (77%), and CERT item 2 the qualifications of the providers (74%). However, few studies reported CERT item 8, a

Table 2
Definitions of early mobility found in the literature.

Year	Author	Country	Definition of early mobility used
2021	Afxonidis	Greece	POD0
2024	Ahmad	Egypt	In the ICU upon confirmation of patient clinical stability
2023	Allahbakhshian	Iran	POD0
2019	Arai	Japan	POD1
2024	Awaludin	Indonesia	POD1
2023	Bano	Pakistan	POD0
2016	Borges	Brazil	POD0 within 24 h
2003	Brasher	Australia	POD1 morning
2021	Chen	China	POD0–5
2024	Cook	United States	POD0
2020	Cui	China	Within first 3 POD
2020	Dima	Canada	Immediately with hemodynamic and respiratory stability
1983	Dull	United States	Within 4 h after extubation
2023	Esmealy	Iran	POD1
2016	Fleming	UK	POD1 morning
2020	Gama Lordello	Brazil	First 24 h post-operative
2020	Goswami	Austria	First 48 h post-operative hours
2022	Han	China	Within 7 POD
2010	Izumi	Japan	POD1
2021	Jacob	Qatar	Within 3 h of extubation
2006	Kirkeby-Garstad	Norway	POD1
2018	Kitamura	Japan	48 h post-operative
2021	Ma	Saudi Arabia	POD2–5
2020	Macaire	Vietnam	4 h after extubation
2014	Mendes	Brazil	POD1
2021	Newman	Canada	3–4 days after ICU admission
2015	Nozawa	Brazil	6 h post extubation on POD1
2016	Pantoni	Brazil	POD1
2024	Phillips	Canada	6 h post-extubation
2024	Sen	Turkey	Within 12 h post-extubation
2020	Shirvani	Iran	2 h after extubation on POD1
2023	Takino	Japan	POD1
2017	Tariq	Pakistan	POD0–1
2015	Tashiro	Japan	POD1
2023	Tsuchikawa	Japan	POD3
2017	Turky	Egypt	POD2
2024	Ünver	Turkey	Within 24 h post-operative
2004	van der Peijl	Netherlands	POD1
2021	Vitomskyi	Ukraine	POD1
2015	Ximenes	Brazil	POD1
2022	Xue	China	POD1
2024	Yang	China	Within 2 weeks post-operative
2023	Zhou	China	Within 24 h post-operative

Legend: POD = post-operative day.

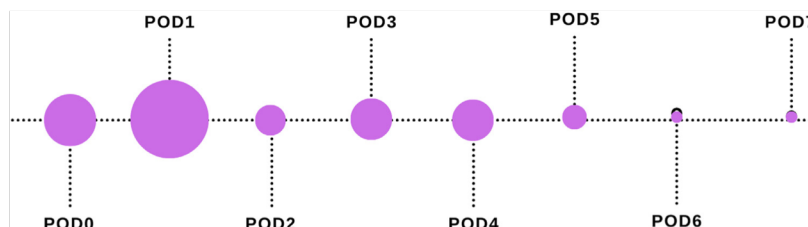


Fig. 4. Proportion of studies defining early mobility by post-operative day.

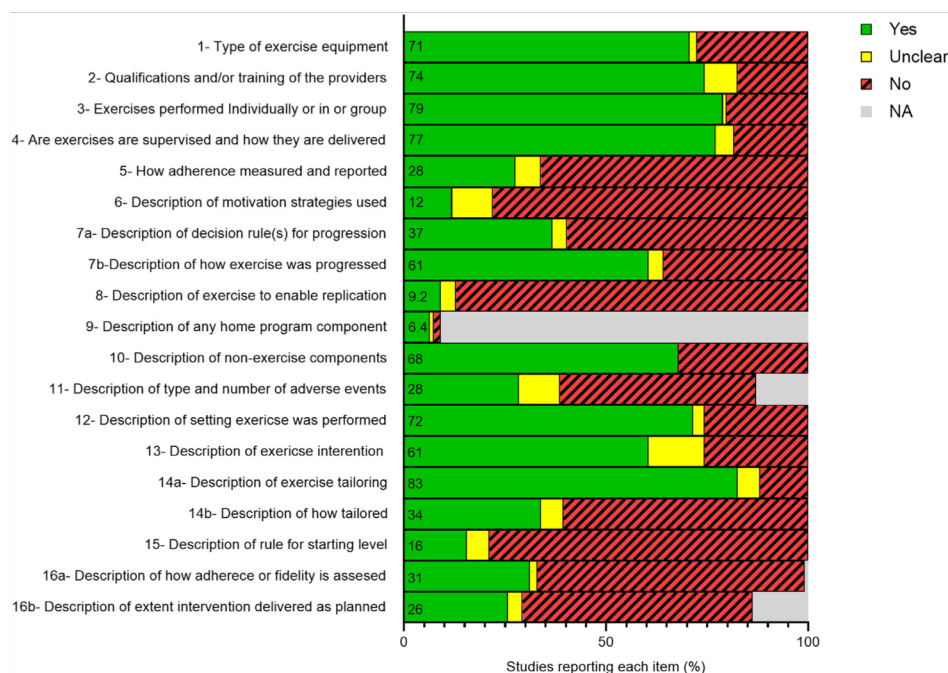


Fig. 5. Summary of intervention reporting quality by each item of the CERT.

detailed description to enable replication (9.2%), CERT item 15, the rule for determining the starting level of exercises (16%), and CERT item 6 if motivation strategies were used (12%). Notably, while most interventions were delivered face-to-face, individually, by nurses and physiotherapists, eight studies mentioned the support or engagement of family members [5,37,78,82,99,100,113,122]. While the reporting of items of the CERT has improved over time, there remains a significant range in reporting among studies (Fig. 5).

3.5. Outcomes

There was significant heterogeneity, with 28 primary outcome categories reported across the 109 studies (Table 3). Six studies had an unclear primary outcome measure [33,46,57,83,103,109], two were quality improvement projects with multiple process, balance, and outcome measures [5,121], one described implementation without evaluation [123], one was observational [2], and one was a case study [124] that did not specify a primary outcome measure. Hospital length of stay ($n = 17$) [24,26,30,34,37,43,56,73,75,84,91,92,99,106,111,112,122], pulmonary function ($n = 16$)

[22,28,39,49,50,54,55,61,62,66,69,74,82,113,118,119], the 6-minute walk test ($n = 13$) [23,32,35,38,40,44,45,47,68,70,80,98,117], hemodynamic measurements ($n = 12$) [25,65,71,72,77,86,89,90,110,115,116,120], heart rate variability ($n = 5$) [53,58,59,96,114], and functional outcomes [41,67,79,85,102] were most often studied. Few studies focused on mortality and readmission ($n = 3$) [97,100,105]. Patient-reported outcome measures (PROMs) were the primary outcome measures in seven studies [29,41,42,48,63,87,102]. The PROMs used included the Kihon Checklist [102], Barthel Index [41], quality of life via the Short Form-36 [29], self-efficacy via the Cardiovascular Management Self-Efficacy Questionnaire [42], and pain via a visual analog scale [48,63,87]. Fig. 6 provides a visualization of the eight most common primary outcome measures used.

3.6. Sex and gender considerations

Five studies did not report sex or gender [5,29,90,113,122], and five were conducted only in males/men [49,61,66,72,117]. Of the mixed sex/gender studies, the proportion of female/women participants ranged from 10.4% [44] to 67.7% [23], with an average

Table 3
Primary outcomes found in the literature.

Year	Author	Primary outcome
		Hospital length of stay
2021	Afxonidis	Length of hospital and ICU stay
2003	Brasher	Post-operative length of stay
2013	Cacau	Hospital length of stay and 6MWT
2021	Chatzitheodorou	Length of postoperative hospital stay
2020	Chen	Length of post-operative stay
2020	Cui	Postoperative hospital length of stay
2024	Cook	Hospital length of stay
2016	Fleming	Length of stay
2016	Floyd	ICU length of stay
2008	Herd	ICU and hospital length of stay
2020	Macaire	ICU length of stay
1999	Nickerson	Length of stay
2002	Priestley	Length of stay
2015	Winkelmann	Hospital length of stay
2019	Yayla	Hospital length of stay
2024	Sen	Hospital length of stay in ICU
2024	Takroni	Hospital and ICU length of stay
		Pulmonary function
1983	Dull	Pulmonary function test changes
1989	Jenkins	Lung function
1996	Johnson	Atelectasis
2017	Moradian	Pulmonary complications via oxygenation
2016	Pantoni	Breathing pattern variables, exercise time in seconds, dyspnea/leg effort ratings, and peripheral oxygen saturation
2006	Savci	Atelectasis
2009	Stein	Pulmonary function
2017	Turky	Changes in alveolar-arterial gradient and inspiratory muscle power
2021	Obaid	Arterial blood gases
2021	Vitomskyi	Forced Vital Capacity
2015	Ximenes	Functional capacity
2024	Wang	Length of time of intubation
2024	Yang	FEV1
1996	Jesurum	Time to extubation
2016	Dong	Duration of mechanical ventilation
2024	Ibrahim Ahmad	Atelectasis
		6-minute walk test
2024	Ahmad	Physical functional capacity via the 6MWT
2023	Bano	Distance walked in the 6MWT
2022	Cerqueira	6-minute walk test distance
2016	da Costa Torres	6-minute walk test distance
2022	Eibel	Functional capacity by 6MWT
2012	Hirschhorn	6-minute walk test distance
2008	Hirschhorn	6-minute walk test distance
2019	Højskov	Physical function via 6MWT
2017	Mungovan	6-minute walk test distance
2020	Windmoller	6-minute walk test distance
2024	Cordeiro	6-minute walk test
2019	Zanini	Functional capacity via 6MWT
2023	Alsubaiei	6-minute walk test
		Hemodynamic measurements
2020	Boyd	Hemodynamic measurements
2016	Cassina	Safety profile via a decrease in mean arterial pressure of >10% or the presence of supraventricular or ventricular arrhythmias
2016	Dedichen	Left ventricular dysfunction
2006	Kirkeby-Garstad	Cardiac index and venous oxygen changes with a change in posture
2006	Kirkeby-Garstad	Composite of heart rate and stroke volume
2020	Kose	Pulse, blood pressure, respiratory rate, body temperature, & oxygenation
2017	Tariq	Hemodynamic parameters
2015	Tashiro	Hemodynamic parameters
1991	Waite	Venous oxygenation
2023	Esmealy	improvement in arterial blood oxygen saturation
2024	Chen	Left ventricular ejection fraction, stroke volume
2020	Goswami	heart rate, systolic blood pressure, diastolic blood pressure during sit to stand test
		Heart rate variability
2010	Mendes	Mean heart rate and heart rate variability
2014	Mendes	Heart rate variability
2014	Pantoni	Heart rate variability and R-R intervals
2020	Ribeiro	Heart rate variability

Table 3 (Continued)

Year	Author	Primary outcome
2018	Rocha	Heart rate variability & oxidative stress
		Functional outcomes
2021	Cordeiro	Functional independence and Perme ICU Mobility Score Scales
2004	van der Peijl	Functional level
2021	Saitoh	Functional status via the Kihon Checklist
2022	Han	Functional independence via Barthel index (activities of daily living)
2024	Ceylan	International Physical Activity Questionnaire
		Days to walk
2019	Arai	100 m walking in 7 days
2013	Saitoh	Achievement of 100-m walk within 8 postoperative days
2010	Izumi	The number of days required to walk more than 100 m without assistance
2019	Kato	Rate of delay of early rehab (based on time to 100 m walk which based on the article is ~POD5)
		Mortality and or readmission
2023	Morisawa	Composite of cardiovascular-related readmission (HF, CAD, arrhythmias, and surgical site infection)
2023	Obafemi	30-day mortality and morbidity (urinary tract infection, ventilator-acquired pneumonia, wound infections)
2023	Tsuchikawa	Cardiac event-free survival
		Adverse events
2021	Sousa	Incidence of physiological abnormalities or adverse events
2024	Silva	Complications with ambulation
2024	Ma	Lower limb complications
		Pain
2024	Awaludin	Visual analog scale
2017	Hong	A minimum of 20 mm difference in visual analog scale pain score between groups
2014	Sturgess	Sternal, anterior chest, thoracic, and shoulder pain
		Cognitive outcomes
2023	Allahbakhshian	Cognitive function via the mini-mental state exam
2020	Shirvani	Post-operative delirium
		Feasibility
2020	Kubitz	Feasibility
2021	Newman	Feasibility
		Other
2019	Itagaki	Gait speed
2023	Md Ali	Change in the unsupported upper limb exercise test
2023	Takino	Isometric knee extension strength
2020	Dima	Level of Function Mobility Scale
2020	Gama Lordello	Number of steps recorded on the pedometer over three days
2022	Hamid	Quality of life via the Short Form-36
2023	Ghlich	Self-efficacy via Cardiovascular Management
		Self-Efficacy Questionnaire
2021	Chen	Timed up and go
2018	Kitamura	Urinary markers of skeletal muscle breakdown
2015	Nozawa	Volume of drainage fluids pre-and-post intervention
2022	Xue	Short Physical Performance Battery
2023	Zhou	Composite score: all cause mortality, complications and HLOS > 7 days
		Unclear
2023	Yuenyongchaiwat	
2024	Takahasi	
2022	Salenger	
2020	Ratajska	
2016	Højskov	
2016	Borges	
		Quality Improvement
2024	Schmid	Implementation focus
2021	Jacob	Process and balance measures
1996	Griffith	Process and balance measures
		Case study
2022	Surandian	
		Observational
2024	Phillips	

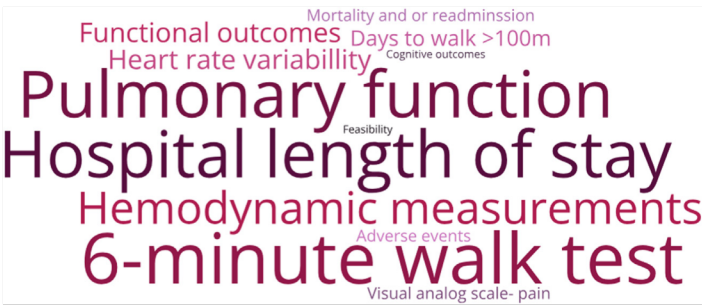


Fig. 6. Word cloud of common primary outcomes.

inclusion of 31.3%. Two studies presented data disaggregated by sex or gender [21,98], and one analyzed the results by sex [98]. Only 13 of the included studies considered sex or gender in the discussion [22,44,45,47,50,66,79,92,93,97–99,117]. Six studies discussed their sex and gender findings and related them to findings in existing literature [45,50,79,97,99,117]. The terms males and men, females and women, and sex and gender were used interchangeably in many of these articles [22,44,45,50,79,92,93,97–99,117]. No definition of sex or gender was provided in any article, nor were the ways sex or gender were assessed identified [22,44,45,47,50,66,79,92,93,97–99,117].

4. Discussion

Through this scoping review, we identified 109 studies of early mobility in the CS ICU. The included studies used a variety of designs and included patients undergoing CABG, valve, or combined surgeries. The definitions of early mobility ranged from the day of to seven days post-CS. Post-operative day one was the most common definition of early mobility found. Most studies used ambulation as the mode of early mobility. Using a combination of modes and focusing on functional activities or activities of daily living was less commonly seen. Most study protocols were described too poorly to allow for replication. Quality of reporting was not noted to improve over time despite the creation of reporting guidelines. A range of outcome measures were found to be used with minimal integration of PROMs and PREMs. Results were rarely reported and/ or discussed disaggregated by sex and gender. An overview of the key findings and suggestions for future research is discussed below and summarized in Table 4.

4.1. Early mobility definitions

While early mobility has been demonstrated to be safe [4,6,21,86,111,127], the inconsistent definition of early mobility

by post-operative day presents a significant problem in both research and clinical applications. From a research perspective, the results of a meta-analysis of timing, mode, and outcomes would be highly heterogeneous, limiting the ability to determine the best method of early mobility for improved patient health outcomes. Clinically, the diversity in definitions has been reported as a barrier to early mobility, leaving CS ICU healthcare providers uncertain about when to commence early mobility [5,82]. This leads to a more restrictive practice [5,82] that may negatively impact patient outcomes. Tying early mobility interventions to a post-operative time point excludes the ability to consider important patient-related factors. Moving forward, defining early mobility should focus on a patient-centric approach, which should be initiated unless patients meet specific contraindications. This approach to early mobility would reflect the diverse patients undergoing CS [5,6]. Patient-centric definitions for early mobility do exist, such as the definition used in the Trial of Early Activity and Mobilization Study [128]. Early mobility was defined as “any active exercise where the patients could assist with the activity using their own muscle strength and control that occurred while the patient was receiving invasive ventilation” [128]. Such a definition could be tailored to the CS ICU population to support more consistency and support research and clinical applications of early mobility.

4.2. Interventions

The goals of undergoing cardiac surgery are to reduce symptoms, improve quality of life, and increase survival [129]. Said another way, cardiac surgery aims to correct cardiac structures to support patients returning home and living their lives. Peri-operative care should also aim to support patients returning home. Therefore, the modes of mobility used in interventions should be functional or align with activities of daily living, particularly for the individual. Only three studies incorporated functional exercises [24] or activities of daily living [113,123] into their early mobility interventions. Twelve studies used cycling

Table 4
Key findings and suggestions for future research.

Key findings	Suggestions for future research
Diverse definitions of early mobility	Co-create a patient-centric early mobility definition based less on post-operative time and more on patient condition
Lack of integration of functional activities into early mobility interventions	Refocus early mobility interventions on preparing patients to be confident in caring for themselves at home and include activities of daily living.
Diverse outcome measures	Use a core outcome set to evaluate early mobility interventions.
Lack of patient voice in outcome measures	Integrate patient-reported outcome and experience measures into a core outcome set.
Incomplete reporting of early mobility interventions	Report all elements of early mobility interventions as guided by a standard reporting guideline such as the Consensus on Exercise Reporting Template to support transparency and reproducibility.
Consistency in Early Mobility Research Over 40 Years	Explore novel methods for intervention development, such as intervention mapping, to improve integration into CS ICU clinical care.

[6,21,23,32,33,44,46,47,59,72,80,90] as the mode of mobility. While cycling is touted as safe for patients who are mechanically ventilated [130], ambulation of mechanically ventilated patients has also been shown to be safe [131]. Cycling is not a functional movement that is used daily by most people, while ambulation is. Future research should explore integrating activities of daily living, such as brushing teeth, dressing, and going to the toilet, in early mobility interventions. These activities of daily living could progress to less assistance throughout the ICU and hospital stay. For example, a patient could transition from brushing their teeth in bed to walking to and leaning over a sink. This would allow them to develop physical functioning and balance to enhance confidence in their ability to care for themselves successfully at home.

4.3. Outcomes

As we described earlier, the heterogeneity in timing reduces the ability to compare intervention efficacy between early mobility trials. In addition, there is also a lack of inclusion of PROMs and patient-reported experience measures (PREMs) in the outcomes evaluated in early mobility research. Including outcomes reported by patients (PROMs) and their experience (PREMs) supports understanding early mobility interventions from the point of view of the person living through the intervention and the health issue [132]. These measures provide important information to consider alongside other outcome measures to determine the efficacy of the intervention. For example, if a patient has improvement in their 6-minute walk test distance but reports minimal improvement in their physical functioning, the efficacy of the intervention should be questioned.

In the future, researchers should consider using a core outcome set to evaluate early mobility interventions. One option is the Physical Rehabilitation Core Outcomes in Critical Illness (PRACTICE) core outcome set for trials of physical rehabilitation after critical illness, developed with researchers, clinicians, patients, and care partners [133]. The outcome set includes physical function, activities of daily living, survival, frailty, exercise capacity, cognitive function, emotional and mental well-being, and health-related quality of life; however, it does not provide specific assessment tools for each of these outcomes [133]. This is a limitation, as the assessment tools selected by researchers may differ and may investigate different aspects of an outcome [134]. For example, our scoping review noted that 14 different tools were used to measure cognitive health issues in the CS ICU [135]. Each tool defines cognitive health very differently, from motor speed and strength (Grooved Pegboard Test) to verbal ability and executive control (Category and Letter Fluency) to mild cognitive impairment (Montreal Cognitive Exam) [135]. These diverse definitions continue to limit the ability to compare early mobility intervention effectiveness [135]. Expanding the PRACTICE core outcome set to provide specific assessment tools, similar to the outpatient post-intensive care syndrome core outcome set [136], would align the assessments of outcomes with the definitions used in the study and support the robust and consistent evaluation of early mobility interventions.

The PRACTICE core outcome set includes PROMs such as health-related quality of life [132,133]. There are many generic and cardiac-specific PROMs [132] that should be included in the process of creating future core outcome sets. Including PREMs, such as satisfaction with the care experience [132], would also facilitate a holistic evaluation of early mobility interventions and reflect that healthcare is a service experienced by patients [137]. The patient's experience of an intervention should be taken into account in evaluation, as if the intervention is beneficial but the experience is poor, patients may decline to participate, reducing the effectiveness of the intervention [137].

4.4. Enhancing reporting to advance science

The lack of integration of early mobility into clinical practice [5] may be in part related to incomplete and unclear reporting of the interventions [9]. Clear reporting of intervention would support investigations of the implementation of early mobility interventions into clinical practice. Following relevant reporting guidelines supports reporting the minimum essential elements related to the specific guideline [9,11]. Only seven of the included studies predate the SAGER guidelines [22,43–45,50,92,99], which were published in 2016 [11]. Despite this, there was minimal integration of these guidelines into study reporting, with only 13 studies including sex or gender in the results or discussion [22,44,45,47,50,66,79,92,93,97–99,117]. Integrating the SAGER guidelines will also enhance reporting and advance the science of early mobility, permitting intersectional approaches that facilitate understanding of biological and gender-related impacts on the intervention [11]. Similarly, the CERT guidelines were published in 2016 [8,9]. Again, only seven studies predate the CERT guidelines [22,43–45,50,92,99]. Despite this, intervention reporting aligned with the CERT guidelines was low, limiting the replication and understanding of costs and resources needed to integrate interventions into clinical practice [8,9].

Blanco and colleagues described several interventions available to improve adherence to reporting guidelines [138]. Providing training, making reporting guidelines accessible, encouraging adherence throughout the research process, checking adherence when submitting manuscripts for publication, and involving experts in reporting guideline development are all methods to enhance adherence [138]. For example, many publishers, editorial groups, and other organizations support reporting of health research, many of the EQUATOR network reporting guidelines [139]. More publishers, editorial groups, and other organizations should be encouraged to mandate that studies follow the relevant reporting guidelines to improve the reliability and value of health research [138,140].

4.5. Consistency in early mobility research over 40 years

The consistency in early mobility research over a 40-year period and the lack of integration of early mobility into CS ICU clinical care [2,5] suggest advancements in early mobility research and knowledge translations are needed. One possibility is to use intervention mapping, a systematic, theory-driven method to design and develop behaviour-based interventions to promote behaviour change [141]. Intervention mapping has not been used in the CS ICU early mobility literature thus far. This method develops interventions by exploring the literature and collecting data from the target population to verify the empirical data and add clinical and lived knowledge and experience [141]. Following this, barriers and facilitators to the behaviour are identified, reframed into performance objectives, and then linked to determinants of change [141]. The performance objectives and determinants of change are mapped into a matrix [141] using the Theoretical Domains Framework [142]. The Theoretical Domains Framework consists of 12 domains that influence behaviour and behaviour change that reflect a broad range of potential barriers and support a range of implementation strategies to change clinical practice [142]. Next, Behaviour Change Techniques [143] are identified from the existing literature. The Behaviour Change Techniques identified are matched with the identified performance objectives and determinants of change [141]. This provides theory-informed methods to achieve the performance objectives and determinants of change [141]. The Behaviour Change Techniques are aligned under the 12 domains of the Theoretical Domains Framework to support operationalization [142]. Intervention mapping has been successfully used in many

studies, including those involving mobility [144–146] and located in critical care [147].

5. Strengths and limitations

Our study has several strengths. While scoping reviews do not need to include a quality assessment [14,15], two were embedded using the CERT and aspects of the SAGER guidelines. This supports an understanding of the current quality of the literature in a guideline-directed manner. We also explored trends over time, and our broad definition of early mobility mapped a significant amount of literature spanning 1983–2024. Finally, this review includes literature from around the globe, providing a geographically diverse description of the current state of the literature. A limitation of this scoping review is that we only included early mobility interventions in the cardiac surgery ICU; we did not include studies occurring after ICU discharge.

6. Conclusion

The existing CS ICU early mobility literature has significant heterogeneity in early mobility definitions and outcome measures used. There is a dominance of ambulation and cycling interventions; however, most studies have not reported the intervention in sufficient detail to permit replication. Sex and gender have been poorly considered in the execution and reporting of early mobility intervention studies. Future research must overcome these pervasive issues to support the integration of early mobility interventions into clinical care. Such integration will support the provision of optimal patient care and optimal patient outcomes following CS.

Informed consent and patient details

The authors declare that this report does not contain any personal information that could lead to the identification of the patient(s).

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Declaration of competing interest

The authors declare that they have no known competing financial or personal relationships that could be viewed as influencing the work reported in this paper.

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Appendix A

Table A1
Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for scoping reviews (PRISMA-ScR) checklist.

Section	Item	PRISMA-ScR checklist item	Reported on page #
Title			
Title	1	Identify the report as a scoping review.	1
Abstract			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	3
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5–6
Methods			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	6
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6–7
Information sources ^a	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6–7
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	supplemental
Selection of sources of evidence ^b	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5–6
Data charting process ^c	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	7–8
Critical appraisal of individual sources of evidence ^d	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	n/a
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7–8

Table A1 (Continued)

Section	Item	PRISMA-ScR checklist item	Reported on page #
Results			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	8–9
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	8–9
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	n/a
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	9–13
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9–13
Discussion			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	13–18
Limitations	20	Discuss the limitations of the scoping review process.	18–19
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	19
Funding			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	2

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*. 2018;169:467–473. doi: 10.7326/M18-0850.

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

^a Where sources of evidence (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

^b A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

^c The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

^d The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

Appendix B

Table B1

Medline.

Database: Medline	
Platform: Ovid	
Date Searched: December 14, 2023	
Number of records: 2288	
#	Searches
1	Early Ambulation/
2	((mobilization or ambulatory) adj3 (early or accelerat*)),tw,kf.
3	exercise/ or exp swimming/ or exp walking/ or exp warm-up exercise/
4	exp Exercise Therapy/or exp Exercise Test/
5	((exercise* or movement* or motion* or physical* or stretch* or rehab* or activit* or active* or walk* or march* or aerobic* or swim* or sit or sitting* or stand or standing or cycle or cycling or spin*) adj5 (early or accelerat*)),tw,kf.
6	((Accelerometer* or wearable* or VR or virtual or digital or smartwatch* or iwatch or fitbit or pedometer* or gaming) adj7 (early or accelerat*)),tw,kf.
7	or/1–6 [Early Mobilization]
8	intensive care units/ or coronary care units/
9	(intensive care or postop* or post-op* or icu or coronary care or critical care or post-surg* or postsurg* or post procedur*)),tw,kf.
10	or/8–9 [ICU]
11	exp cardiac surgical procedures/ or exp cardiovascular surgical procedures/
12	(heart* or cardiac* or cardiothoracic* or cardio thoracic* or cardiovascular* or arter* or aort* or atria* or valve* or tricuspid* or mitral* or coronary* or type a or endocarditis or maze*),tw,kw.
13	(annuloplast* or CABG or bypass or by-pass or myocardial revascularization* or mammary artery),tw,kw.
14	or/11–13 [Cardiac Surgery]
15	7 and 10 and 14
16	limit 15 to english language
17	16 not ((exp infant/ or exp child/ or adolescent/) not exp adult/)

Table B2

Embase.

Database: Embase	
Platform: Ovid	
Date Searched: December 14, 2023	
Number of records: 1383	
#	Searches
1	mobilization/
2	((mobilization or ambulatory) adj3 (early or accelerat*)),tw,kf.
3	((exercise* or movement* or motion* or physical* or stretch* or rehab* or activit* or active* or walk* or march* or aerobic* or swim* or sit or sitting* or stand or standing or cycle or cycling or spin*) adj5 (early or accelerat*)),tw,kf.
4	((Accelerometer* or wearable* or VR or virtual or digital or smartwatch* or iwatch or fitbit or pedometer* or gaming) adj7 (early or accelerat*)),tw,kf.
5	or/1–4 [Early Mobility Search]
6	intensive care unit/ or coronary care unit/
7	(intensive care or postop* or post-op* or icu or coronary care or critical care or post-surg* or postsurg* or post procedur*)),tw,kf.
8	or/6–7 [ICU]
9	exp heart surgery/ or exp cardiovascular surgery/
10	(heart* or cardiac* or cardiothoracic* or cardio thoracic* or cardiovascular* or arter* or aort* or atria* or valve* or tricuspid* or mitral* or coronary* or type a or endocarditis or maze*)),tw,kw.
11	(annuloplast* or CABG or bypass or by-pass or myocardial revasculari?ation* or mammary artery),tw,kw.
12	or/9–11 [Cardiac Surgery]
13	5 and 8 and 12
14	limit 13 to english language
15	14 not (exp juvenile/ not exp adult/)
16	limit 15 to embase status

Table B3

PsycINFO.

Database: PsycINFO	
Platform: Ovid	
Date Searched: December 14, 2023	
Number of records: 18	
#	Searches
1	((mobilization or ambulatory) adj3 (early or accelerat*)),tw.
2	((exercise* or movement* or motion* or physical* or stretch* or rehab* or activit* or active* or walk* or march* or aerobic* or swim* or sit or sitting* or stand or standing or cycle or cycling or spin*) adj5 (early or accelerat*)),tw.
3	((Accelerometer* or wearable* or VR or virtual or digital or smartwatch* or iwatch or fitbit or pedometer* or gaming) adj7 (early or accelerat*)),tw.
4	(intensive care or postop* or post-op* or icu or coronary care or critical care or post-surg* or postsurg* or post procedur*)),tw.
5	(heart* or cardiac* or cardiothoracic* or cardio thoracic* or cardiovascular* or arter* or aort* or atria* or valve* or tricuspid* or mitral* or coronary* or type a or endocarditis or maze*)),tw.
6	(annuloplast* or CABG or bypass or by-pass or myocardial revasculari?ation* or mammary artery),tw.
7	1 or 2 or 3
8	4 and 5 and 7
9	limit 8 to english language

Table B4

Scopus.

Database: Scopus	
Date Searched: December 15, 2023	
Number of records: 91	
Searches	
(TITLE-ABS-KEY (((mobilization OR mobilization OR ambulatory OR exercise* OR movement OR motion* OR physical* OR activit* OR active OR rehab OR stretch* OR walk* OR march* OR aerobic* OR swim* OR sit OR sitting OR stand OR standing OR cycle OR spin) W/7 (early OR accelerat*))) AND TITLE-ABS-KEY ((intensive AND care OR postop* OR post-op* OR icu OR coronary AND care OR critical AND care OR post-surg* OR postsurg* OR post AND procedur*)) AND TITLE-ABS-KEY ((heart* OR cardiac* OR cardiothoracic* OR cardio AND thoracic* OR cardiovascular* OR arter* OR aort* OR atria* OR valve* OR tricuspid* OR mitral* OR coronary* OR (type a) OR endocarditis OR maze*)))).	

Table B5
Cinahl.

	Database: Cinahl with Full Text
	Platform: EbscoHOST
	Date Searched: December 15, 2023
	Number of records: 568
	Searches
S1	(MH "Early Ambulation")
S2	TI (((mobili?ation or ambulatory) W3 (early or accelerat*))) OR AB (((mobili?ation or ambulatory) W3 (early or accelerat*)))
S3	(MH "Exercise+") OR (MH "Exercise Test")
S4	(MH "Therapeutic Exercise")
S5	TI (((exercise* or movement* or motion* or physical* or stretch* or rehab* or activit* or active* or walk* or march* or aerobic* or swim* or sit or sitting* or stand or standing or cycle or cycling or spin*) W5 (early or accelerat*))) OR AB (((exercise* or movement* or motion* or physical* or stretch* or rehab* or activit* or active* or walk* or march* or aerobic* or swim* or sit or sitting* or stand or standing or cycle or cycling or spin*) W5 (early or accelerat*)))
S6	TI (((Accelerometer* or wearable* or VR or virtual or digital or smartwatch* or iwatch or fitbit or pedometer* or gaming) W7 (early or accelerat*))) OR AB (((Accelerometer* or wearable* or VR or virtual or digital or smartwatch* or iwatch or fitbit or pedometer* or gaming) W7 (early or accelerat*)))
S7	S1 OR S2 OR S3 OR S4 OR S5 OR S6
S8	(MH "Intensive Care Units") OR (MH "Critical Care")
S9	TI (((intensive care or postop* or post-op* or icu or coronary care or critical care or post-surg* or postsurg* or post procedur*)) OR AB (((intensive care or postop* or post-op* or icu or coronary care or critical care or post-surg* or postsurg* or post procedur*))
S10	S8 OR S9
S11	(MH "Cardiac Surgery")
S12	TI (((heart* or cardiac* or cardiothoracic* or cardio thoracic* or cardiovascular* or arter* or aort* or atria* or valve* or tricuspid* or mitral* or coronary* or "type a" or endocarditis or maze*)) OR AB (((heart* or cardiac* or cardiothoracic* or cardio thoracic* or cardiovascular* or arter* or aort* or atria* or valve* or tricuspid* or mitral* or coronary* or "type a" or endocarditis or maze*))
S13	TI (((annuloplast* or CABG or bypass or by-pass or myocardial revasculari?ation* or mammary artery)) OR AB (((annuloplast* or CABG or bypass or by-pass or myocardial revasculari?ation* or mammary artery))
S14	S11 OR S12 OR S13
S15	S7 AND S10 AND S14

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Glossary

Early mobility: Any active movement soon after surgery, and most often starts on the day of surgery or the first post-operative day
Active movement: Sitting, standing, actively moving from bed to a chair, marching on the spot, ambulation, cycling, or other active exercises

Brief Discussion of the Manuscript

The results of this scoping review led me to think about the poor clarity of reporting of interventions and to review the existing early mobility protocol in the CSICU. I noticed gaps in that protocol that are consistent with those found in the literature. For example, a lack of motivation strategies, a description of exercise that does not enable replication, a lack of a rule for the starting level of activity, and a lack of clarity on rules for the progression of exercise. These gaps provided ideas for educational needs for the intervention ultimately developed, and for elements to consider in future early mobility intervention protocols for this CSICU. This review sparked my consideration of the essential elements required in an early mobility definition that informs future research and clinical care. The early mobility definition ultimately created is based on the work reported in Chapters 6 and 7. Finally, this review began my thinking about including functional activities in early mobility interventions. This was something discussed with a care partner in the body mapping workshops reported in Chapter 6. When reviewing the results of this scoping review, I noted the dominance of one mode of mobility in protocols and the lack of consideration of the need to prepare patients to return to their lives after hospital discharge. I closely read the few included articles that included functional movements and began to consider how functional movements could be included in early mobility protocols.

Chapter 3 : Mobility in a Cardiac Surgery Intensive Care Unit: A Behaviour Mapping Study

Preface to the Manuscript

The first step in intervention mapping is to quantitatively and qualitatively explore the behavioural and environmental aspects of the behaviour targeted for change.^{9,10} This study is the quantitative investigation of early mobility practice in our CSICU. This observational study aimed to understand the current state of early mobility in the local CSICU.

Manuscript Status

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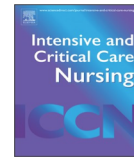
Contributions of Authors

Drs. Arora and Duhamel and I conceptualized the study. Dr. Ashe identified the methodology and provided methodological expertise. Drs. Schultz and O’Keefe-McCarthy supported the creation of the data collection and analysis plan. Data were collected by Mudra Dave and me. I performed data analysis. As first author, I drafted the original manuscript and revised it based on feedback from the authors and reviewers. All authors contributed academic expertise to the project and the manuscript. Dr. Duhamel provided funding for the project.



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Research Article

Mobility in a cardiac surgery intensive care unit: A behaviour mapping study

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ABSTRACT

Purpose: Mobilization within 24 h post-cardiac surgery (CS) supports improved patient health outcomes. Despite being safe and recommended, it is unknown how much mobility takes place post-CS in the intensive care unit (ICU). Behaviour mapping was used to describe patterns of patients' mobility in one CS ICU.**Materials and methods:** Behaviour mapping gathers information on behaviour regularly over a time period. Two authors observed one CS ICU over a sixteen-hour period (0630–2230 h) on four days. Observers collected data on patients' mobility mode, location, and support at 15-minute intervals. Data aggregated into four-hour time blocks is described.**Results:** A total of 1342 observations were collected over four days: 487 of mode, 485 of location, and 370 of support. Sitting in a chair was observed 430 of 487 observations, 10-fold more than any other mode of mobility. Mobility within the ICU room was observed in 448 of 485 observations. Family support for mobility was observed in 178 of 370 observations. The most common time block for mobilization was from 0630 to 1030, with 488 of 1342 observations.**Conclusions:** Research is required to support the integration of early mobility beyond sitting in a chair supported by more team members into local CS ICU clinical care.**Implications for clinical practice:** The existence of early mobility protocols does not mean that they are operational in the CS ICU. Integration of these protocols into CS ICU clinical care requires collaboration among researchers and clinicians.

Introduction

Background/rationale

Mobility within the first 24 h post-cardiac surgery while in the intensive care unit (ICU) supports improved health outcomes, specifically with symptoms of poor physical functioning [1–3]. These are symptoms that aging CS patients are at significant risk of [4,5]. Early mobility can broadly be defined as any active mobilization activity (sitting, standing, actively moving from bed to a chair, marching on the

spot, ambulation, cycling, or other active exercises) occurring as soon as possible following CS during the ICU stay [6]. Early mobility is safe for CS patients in the ICU, with studies reporting minimal adverse events and hemodynamic stability with mobilization 12 h post-operatively [7–12]. Both the ICU Liberation Bundle [13] and the Enhanced Recovery After Surgery CS guidelines [14] advocate for the early mobility of patients in the ICU. Despite being safe and recommended, it has been suggested that early mobility is poorly integrated into CS ICU clinical care [15].

Studies have utilized surveys of the perceived practices of healthcare

Abbreviations: CS, cardiac surgery; ICU, intensive care unit; IQR, interquartile range; POD, post-operative day.

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providers [16,17], accelerometers on patients [18,19] and staff-reports [18] to describe early mobility. The validity and reliability of survey questions can impact the data collected [20,21] and may misrepresent the current state of early mobility. Nonresponse and self-report bias may impact survey results and self-report data [21], leading to misrepresentation of the current state of early mobility. While accelerometers worn by patients provide an accurate representation of mobility, data lacks the context of who is supporting the mobilization and the mode of mobilization. There is a lack of direct observation studies or studies describing the current state of early mobility. Observing early mobility occurring in the CS ICU is a way to overcome these potential misrepresentations and add to the literature describing the current state of early mobility.

Objective

The objective was to use behaviour mapping to describe patterns of patients' mobility in one CS ICU to understand their mobility patterns early after admission to the unit. A hypothesis is not provided as it is not used in descriptive studies [22].

Materials and methods

Study design

This was a cross-sectional observational study using behaviour mapping. In behaviour mapping, the type, frequency, and location of behaviour are documented at regular intervals [23,24]. This provides data on the types of behaviour along with the context of the behaviour, including who supports the behaviour and where it occurs [23]. This additional contextual information is not available through other methods, such as the use of accelerometers [23]. The data are collected by a researcher travelling through the hospital unit of interest following a predetermined pattern at random or regular intervals [23,24]. The pattern and interval are co-developed among researchers and clinical experts to ensure the desired data are obtained [23,24]. A standard operating procedure is developed to support consistent patterns and intervals of travel and documentation of data of interest [23,24]. For reporting of this study, the Strengthening the Reporting of Observational Studies in Epidemiology statement was followed [25] (see the [Supplemental File](#)).

Setting

Following ethical approvals (HE2023-0351 and RRC/2023/2145), this project occurred in the CS ICU at St Boniface Hospital in Winnipeg, Manitoba. St Boniface Hospital is the only site in the province that provides cardiac care. It has a catchment area of 1.6 million people. An average of 21 cardiac surgeries are performed each week, with the majority being coronary artery bypass grafting, valve replacement, or a combination of the two. Other CS performed include thoracic aortic and ventricular assist device (both short-term and durable) implantation. All patients are cared for in the CS ICU following surgery. The median length of stay (LOS) in the CS ICU was 1.84 days (interquartile range [IQR] 0.92–3.83) in 2021 and 1.89 days [IQR 0.93–3.86] in 2022, with an average of 8.75 patients admitted per day in 2021 (standard deviation [SD] 2.18) and 9.13 in 2022 (SD 1.9). This unit has 13 beds, a baseline 1:1 nurse-to-patient ratio, and a charge nurse (totalling 14 nurses around the clock). The unit is also staffed by three healthcare aides, one physiotherapist, and two physiotherapy assistants who, along with nurses, support mobility. Generally, healthcare aides and nurses support patients in bed mobility, transferring to a chair, and ambulation, while physiotherapists and physiotherapy assistants provide education on post-operative mobility considerations (following a Keep Your Move in a Tube model [26]) along with individualized mobility programs for patients who stay longer in the CS ICU post-operatively. Medical

coverage is provided by an intensivist around the clock, with a cardiac anaesthesiologist providing support for 10 h each day.

According to the clinical expertise of one CS ICU nurse and one CS ICU physiotherapist at the study site, most mobilization occurs between the hours of 0630 and 2230. This relates to the availability of physiotherapists and physiotherapy assistants and an attempt to promote sleep by promoting relaxation and a quiet environment. A standard order set is used for all patients who undergo coronary artery bypass grafting, valve replacement, or a combination of the two and includes a pre-selected consult to physiotherapy and a preselected order to follow the early mobility protocol (Table 1). There is a variety of equipment available to support mobilization, including 4-wheeled walkers, wheelchairs, portable oxygen, recliners, and a bed cycle ergometer.

Participants

Data collection occurred on four days, including 2 weekdays (a Wednesday and a Friday) and 2 weekend days (a Saturday and a Sunday) over a sixteen-hour period each day that reflects the most frequent time for mobilization (0630–2230 h). On the days selected for data collection, observations were recorded for all patients admitted to the CS ICU and staff working on the unit. If the curtains were drawn and a room was not visible, privacy was respected, and an observation at that location did not occur. Identifying data about patients, families, or healthcare providers was not collected, as the intent of behaviour mapping is to understand the current state of the behaviour at the unit level [23]. All patients, families, and healthcare providers were observed; there were no inclusion or exclusion criteria. The early mobility protocol is used for all patients unless they meet contraindications to mobility, including being on extracorporeal membrane oxygenation, having a lumbar drain in situ, or having an open chest.

Variables/data sources

Variables of interest specific to early mobility included the mode of activity (bed exercises, sitting at the side of the bed, sitting in a chair, ambulating, and cycling), where they were being active in their (bed, room, or hallway), and who was supporting their mobilization (nurse, healthcare aide, physiotherapist, physiotherapy assistant, or family). Patients in the CS ICU cannot mobilize independently due to the need to provide equipment for in-bed mobilization and the need for assistance with monitoring equipment and medical devices (intravenous lines,

Table 1
Early mobility protocol in the local CS ICU.

Post-operative day	Mobility recommendations
Post-operative day 0	Deep breathing & supported coughing (DB & C) q1h while awake. Dangle within 6 h post-op. Positioning side-to-side q2h using sternal precautions. Up in chair within 12–24 hr post-op.
Post-operative day 1	DB & C q1h while awake & continue during the hospital stay. Transfer with sternal precautions & continue during the hospital stay. Sit up in chair – 2 times & PRN. Range of Motion (ROM) exercises (foot/ankle, hip/knee & unilateral shoulder flexion) 2–3 times daily & continue during the hospital stay. Walk with assistance: 2–3 times if on CSIU; 1–2 times if on ICCS
Post-operative day 2	Sit up in chair for all meals & PRN & continue during the hospital stay. Promote ROM, energy conservation & education. Walk with assistance in hall 4–6 times assisted.
Post-operative day 3	Walk in hall 4–6 times either assisted or unassisted. Climb 1 flight of stairs (12 steps) with staff if appropriate & continue during the hospital stay.
Post-operative day 4	Transfer unassisted with sternal precautions. Walk unassisted in hall 4–6 times.

urinary catheters, or temporary pacing boxes) when mobilizing. Adverse events, defined as events with the potential for patient harm, were noted if observed. Due to the short, 15-second observations, the frequency of the mobility occurrences was not identified. Examples of potential adverse events include patient falls and patients slipping. The observers were not observing the hemodynamic monitors to identify changes in hemodynamic status.

Each hour, the number of patients admitted to the CS ICU, the number of patients with a mobility contraindication, the number of nurses, the nurse-to-patient ratios, and the number of nurses without an assignment were documented. This data was collected to support developing an understanding of the context of the CS ICU and the mobility observed. Contraindications to mobility included being on extracorporeal membrane oxygenation, having a lumbar drain in situ, or having an open chest.

Two authors (EKP and MGD) determined the travel pattern through the CS ICU with the CS ICU healthcare team (Fig. 1). The frequency of travel through the pre-determined path through the clinical was every 15 min with a 15-second pause at each of the nine observation points [23]. No patient rooms were entered for observation. If the curtains were drawn and a room was not visible from the hallway, privacy was respected, and an observation at that location did not occur. Per the research ethics board, informed consent was not required as no identifiable information about individual people was collected. To avoid influencing behaviour, patients, care partners, and staff were not notified of the observation periods. If patients, care partners, or staff enquired about the observation, they were informed that the mobility of patients was being observed to understand the current state.

Two authors collected data in consecutive eight-hour shifts (0630–1430, 1431–2230) to avoid fatigue. One of the observers (EKP) was a health professional, and the other (MGD) was a Master of Science student experienced in data collection in the CS ICU. A standard operating procedure was created to follow to mitigate inter-rater agreement issues. The two authors then conducted behaviour mapping simultaneously for three hours to determine inter-rater agreement. If inter-rater agreement was low, the standard operating procedure would be revised and simultaneous behaviour mapping would be repeated until inter-rater agreement exceeded 80 %.

The specific observation days were selected in collaboration with the CS ICU manager to observe a diverse group of staff members. This was done to reduce the potential for biased observations of a group of staff and increase the potential for observation of a broader number of staff. If observations had occurred on consecutive days, the same staff members could be observed repeatedly and others not at all due to staff rotations. Since the aim of this behaviour mapping study was to describe early mobility at the CS ICU unit level and not of a particular group of staff, selecting observation days that increased the diversity of staff observed was an important step.

Statistical methods

Microsoft Excel version 16.90 was used for data analysis. Percent agreement and Cohen's kappa [21,23] were used to determine the inter-rater agreement. A percent agreement of 80 % or greater and a Cohen's kappa of greater than 0.8 were considered excellent agreement [21,23] and were required to proceed with the data collection observations.

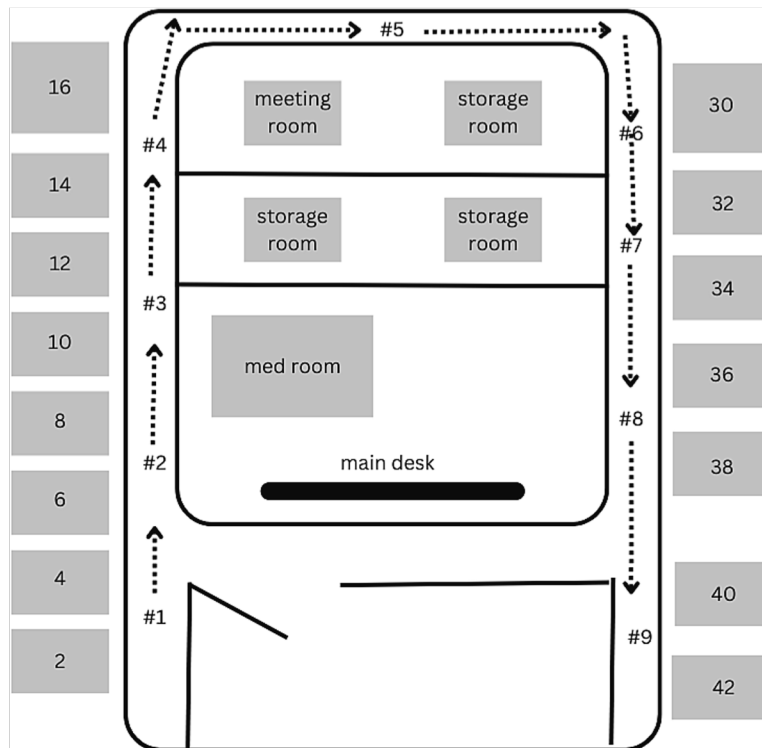


Fig. 1. Layout of the local CS ICU and the route for observations. Patient rooms are denoted by grey boxes with room numbers (2, 4, 6 and so on) along the periphery of the figure. The door to enter the CS ICU is located across from the main desk. Behind the main desk is a medication room which connects to a hall where there is access to 2 storage rooms. The storage rooms also connect to another hall that houses a meeting room and a 3rd storage room. The route for observations is denoted by dashed arrows with stops located outside of patient rooms (#1, #2, and so on).

Observation data were summed into four-hour time blocks (i.e. 0630–1030, 1031–1430, 1431–1830, and 1830–2230) for each observation day and summed for each time block across all observation days. The median number of patients admitted to the CS ICU, the number of patients with a contraindication to mobility, the number of nurses, and the number of nurses without an assignment on each observation day were calculated along with the IQR. The nurse-to-patient ratios were noted as the number of patients each nurse was assigned to care for. For example, 1:1 would be one nurse for one patient and 1:2 would be one nurse for two patients.

Results

Data collection was performed, and the inter-rater agreement was acceptable for all variables. Specifically, the percent agreement for the mode of activity was 100 %, with a Cohen's kappa of 1. The percent agreement for the location of activity was 97.3 %, with a Cohen's kappa of 0.789. This related to 1 disagreement, so a repetition was not performed and the 97.3 % agreement was accepted. The percent agreement for the identity of who was supporting the patient's mobilization was 96 %, with a Cohen's kappa of 0.938. The percent agreement for the hourly data collected was 100 %, with a Cohen's kappa of 1.

Across the four observation days, a median of 9 (IQR 8–13) patients were cared for in the CS ICU. The median number of patients with contraindications to mobility was 0 (IQR 0–2). The median number of nurses was 9 (IQR 7.5–12), and the median number of nurses without a patient to care for was 0 (0–3). On one observation day (Wednesday), the nurse-to-patient ratio was consistently 1:1 across the entire observation period. On other observation days, it was 1:2 7 times (Sunday), 15 times (Saturday), and 27 times (Friday), with the latter two observation days having 2–3 nurses with 2 patients for several hours. The nurse-to-patient ratio never exceeded 1:2.

A total of 1342 observations were made over the four observation days. The 15-minute data for all observation days is provided in Table 2. Sitting in a chair was the most frequent mode of mobility, with a total of 430 of 487 observations. The second most frequent mode of mobility was ambulation, with 18 of 487 observations. Eight mobilizations were classified as “other”, all noted to be placing the patient's bed into chair position. There were no observations of patients marching or cycling in bed. The patient's CS ICU room was the most frequent location for mobility, with 448 of 485 observations. The hall was the next most frequent location for mobility but not frequently observed, with only 27 of 485 observations of patients sitting in a chair (wheelchair) or ambulating. The bed was the least frequent location for mobility, with 10 of 485 observations. Family was the most frequent support for

mobility, with 178 of 370 observations. This included family assisting the healthcare team in patient mobility or being present with the patient while they ambulated, sat in a chair, or performed another mode of mobility. A nurse was the next most frequent support for mobility, with 142 of 370 observations. This included assisting the patient with mobility or assessing them while mobilizing by sitting in a chair. One unknown professional was noted to support a mobilization. This professional was later determined to be a physician. Physiotherapists were only observed to support mobilization a total of six times across all observation days.

The 0630–1030 time block saw the most mobilizations of any mode, with 194 of 487. A total of 189 of these mobilizations occurred in the patient's ICU room. The 1031–1430 time block saw a total of 135 of 487 mobilizations, with 124 of these again occurring in the patient's CS ICU room. The highest number of supports for mobilization (nurse, physiotherapy, family, etc) occurred in the 1031–1430 time block, with 133 observations. This was driven by the support of the family with 82 observations. This support included actively assisting the healthcare team in mobilizing the patient and being present with the patient while they sat in a chair or performed another mode of mobility.

Throughout the observation periods, no adverse events were observed. For example, no patients fell or slipped; no staff or families were observed acting or reacting in a way that suggested concerns for patient safety. Adverse events could have been missed due to the short observation time of 15 s.

Discussion

Through behaviour mapping, patients were observed mobilizing by sitting in a chair 10-fold more than any other mode of mobility. Mobilization occurred most frequently in the patient's ICU room, supported by their family. The most common time block for mobilization was 0630–1030. These observations add to the existing self-report, accelerometer, and survey data by providing contextual information related to early mobility.

Contextual information uncovered through behaviour mapping

In this study, mobilization was most frequently observed during the time period of 0630–1030. To our knowledge, these specific findings of mobilization time of day are novel. Previous work reported factors such as frequency of mobilization (e.g., daily, twice daily), however, we could not locate information on “when” most mobilization takes place post-operatively [9,27]. There are reports of accelerometer-based studies which only provided an overall number of minutes per day post-

Table 2
15-minute data summed for all observation days.

		0630–1030	1031–1430	1431–1830	1831–2230	Total
Mode of Mobility	Active range of motion of lower or upper extremities	0	1	1	0	2
	Sitting at the side of the bed	10	4	0	3	17
	Sitting in a chair	179	120	87	44	430
	Standing	3	4	1	4	12
	Marching	0	0	0	0	0
	Ambulating	2	6	9	1	18
	Cycling	0	0	0	0	0
	Other	0	0	8	0	8
	Total for time block	194	135	106	52	487
	Bed	0	1	9	0	10
Location of Mobility	Room	189	124	87	48	448
	Hall	2	16	9	0	27
	Total for time block	191	141	105	48	485
	Nurse	57	39	36	10	142
Support for Mobility	Physiotherapist	1	4	1	0	6
	Healthcare aid	25	8	10	0	43
	Family	19	82	48	29	179
	Unknown	1	0	0	0	1
	Total for time block	103	133	95	39	370

operative [18] or post-ICU discharge [19]. Further, survey data have not previously reported the time of day of mobilization [16,17]. An advantage of direct observation (e.g., behaviour mapping) is the ability to provide important contextual information, such as time of day, missing from other methods of exploring and describing behaviours [23]. Contextually, the observed mobility occurred at one point when clinical nurses would be performing physical assessments of their patients. In this CS ICU, physical assessments are performed by clinical nurses at 0400, 0800, 1200, 1600, 2000, and 2400. Physical assessments can occur in bed or a chair. The 0630–1030 reflects when patients are helped out of bed to a chair for breakfast; however, patients are supposed to be in the chair for every meal per the early mobility protocol (see Table 1). Two other time blocks include lunch (1031–1430) and dinner (1431–1830) mealtimes and the same number of mobilizations to a chair are not noted. Thus, the mobilizations observed cannot be tied to physical assessments or mealtimes. It is also unknown if mobilizations observed were driven by the early mobility protocol (Table 1) or patient request for mobilization. Further investigation using methods that explore the intent behind the time of mobility is required to understand the rationale for this time block being the most common.

The high number of supports of family during the 1031–1430 time block also requires further investigation. Family members have reported interest in supporting mobilization [28]. Despite this interest, family members are rarely discussed as supporting mobilization in the literature. One study mentioned that family members could support mobilization after the patient left the CS ICU [29]. A quality improvement project included patient and family education materials that included information about activity mobilization [15]. A future study should explore the choices of families in being at the bedside supporting their loved one and their perceived value of taking time off with the roles they play in the CS ICU. The timing of family support of mobility should also be explored. There are no visiting hours in this CS ICU, so family support cannot be tied to this time block. During this time block, one may expect family would not be at the bedside but rather would be at work. Further investigation is required to understand this novel contextual information.

According to the local early mobility protocol (Table 1), with a median length of stay in the local CS ICU of 1.84 days (IQR 0.92–3.83) in 2021 and 1.89 days (IQR 0.93–3.86) in 2022, a variety of modes of mobility should be occurring and should have been observed. The most common mode of mobility observed was sitting in a chair. There was not equal emphasis on the entire protocol, as evidenced by the lack of observations of other modes of mobility. For example, patients should be ambulating between 2 times post-operative day 1 (POD1) to six times daily by POD2 while in the ICU. The amount of ambulation observed in the current study is not aligned with this early mobility protocol, as there were fewer observations of ambulation than would be expected if patients were mobilized per the early mobility protocol. For example, if each of the median of nine patients admitted to the CS ICU were all on the POD1 step of the early mobility protocol and if each were ambulated once on each observation day, there would be 32 observations of ambulation total. There were only 18 observations of ambulation in this study, 44 % fewer than suggested by the protocol. Even when considering patients with mobility contraindications (median = 0, IQR 0–2), the number of observations of ambulation in the current study suggests that the presence of an early mobility protocol is insufficient to ensure the operationalization of early mobilization as defined by the local early mobility protocol.

Fidelity to early mobility protocols is rarely reported in the extant literature. This limits the understanding of the true effect of mobilization and removes the opportunity to explore how to improve fidelity in the future. Fidelity was discussed by one group of authors, who noted six reasons for not completing a session of early mobility [11]. These included insufficient staff, patients being discharged from the CS ICU, patients refusing to participate, patients achieving the walking milestone in the ICU, meeting the study exemption criteria, and being

incompatible with the equipment [11]. These reasons provide the opportunity to improve the alignment of practices with protocols. For example, reasons for refusal to participate could be explored and methods to overcome these could be developed.

The number of observations of patients sitting in a chair in the present study was 10-fold higher than any other mode of mobility. Sitting in a chair is not the mode of mobility described in the ICU Liberation bundle [13]. Rather, this bundle describes the steps to ambulate a patient [13]. The Enhanced Recovery after Surgery CS guidelines [14] do not indicate a mode of mobility. The local early mobility protocol indicates a range of modes of mobility that patients progress through, with sitting indicated less frequently than ambulation (Table 1). The Canadian 24-Hour Movement Guidelines may inform the ICU Liberation protocol and the local early mobility protocol [30]. The Canadian 24-Hour Movement Guidelines recommend limiting sedentary time by breaking prolonged periods of time spent sitting [30]. This recommendation aligns with the understanding that energy expenditure increases while standing versus sitting or lying in bed [31]. The benefits of sitting remain significant in critically ill patients in the ICU. Several studies have noted that ICU patients sitting in a chair have better respiratory outcomes (e.g., improved arterial blood oxygenation and tidal volume) [32,33]. Contrarily, a previous study found that in mechanically ventilated patients, the muscles associated with respiration (e.g., sternocleidomastoid) and their function did not improve by the chair-sitting exercise [34]. Despite these findings, it was noted that their findings do not justify the need to decrease any physical therapy-related exercises (i.e., mobilization practices) [34]. Thus, sitting for prolonged periods without breaks of ambulation or other forms of mobility to reduce sedentary time may not provide the mobility benefits desired.

Healthcare team members supporting mobility

The lack of observations of physiotherapists supporting mobilizations (6 of 370) may align with current clinical practice. Historically, physiotherapy referrals were common for all patients post-operatively to support optimal patient outcomes [16,17]. Clinical practice has moved away from referrals occurring for every patient, with studies reporting that physiotherapists assess and treat only patients with “special needs”, which are not defined in the study, [16] and that physiotherapists and nurses share the responsibility for early mobilization [17]. While there is poor reporting of who delivers early mobility protocols in studies, this shift is also seen in studies, with physiotherapists alone delivering interventions more than a decade ago [35] to mobilization being a shared responsibility between nurses and physiotherapists more recently [2]. A recent quality improvement study reported that a multidisciplinary mobility team of physicians, physiotherapists, nurses, respiratory therapists and occupational therapists supported safe patient mobilization [15]. This reliance on the multidisciplinary team [15] and the dominance of nursing noted in the current study may reflect staff schedules. A survey of physiotherapists in Sweden noted that physiotherapists saw patients on weekends less frequently than they did on weekdays [16]. No physiotherapists worked evenings, so patients were never seen on those shifts [16]. Nurses are at the bedside 24 h per day, every day of the week and weekend. This increased frequency of interaction with patients, along with the culture shift from physiotherapists caring for every patient post-operatively, [16,17] may, in part, explain the practices observed in this study.

Barriers to early mobility

The lack of observed ambulation compared to sitting in a chair also aligns with literature exploring barriers to mobilization. In one study, nurse-to-patient ratios and receiving training on mobilizations were found to support the operationalization of mobilization [36]. These authors found that physiotherapists reported fewer barriers to mobilization than nurses [36]. In the current study, nurses support

mobilization more frequently than all other ICU staff. This may be in part due to the shift schedules of each profession. Nurses are at the bedside 24 h per day. Physiotherapists are typically not available evenings, nights, and weekends. Healthcare aides, however, are also available 24 h per day, suggesting they should be more involved in mobilization. This observation suggests a need to explore how physiotherapists overcome barriers to mobilization perceived by other healthcare professionals. This may support integrating all ICU staff in mobility and increasing ambulation.

Despite family members being interested in being involved with mobilization [28], family members being interested in supporting mobilization can also be perceived as a barrier [36]. This does not align with the findings of the current study, as family members were the most frequent support for mobilization. This support included assisting the patient to the chair and supporting them in sitting in a chair through their presence in the room. This involvement aligns with the active end of the opportunities for patient and family engagement in the cardiac intensive care unit spectrum [37]. A deeper exploration of this perceived barrier is warranted to further understand and ultimately overcome this barrier and strategies to engage this valuable group in support of early mobility. A recent scoping review of reviews found that none of the 33 reviews included family engagement in early mobility interventions [38]. A quality improvement study shared how they shifted the philosophy of care within the ICU to value family participation in care [39]. Once valued, they shared the three steps they used to successfully integrate family into active participation in early mobility in the ICU [39]. These steps are *inviting* family to participate, *educating* family on the importance of early mobility and the early mobility goals of the ICU, and *supporting* family in participating in early mobility at whatever level they are comfortable [39]. This is an example of how to overcome this barrier in a way that can be tailored to each ICU context.

Of the various modes of mobility possible in the local CS ICU, cycling was not a mode of mobility used despite the presence of a bed cycle ergometer in the unit. This is despite good nurse-to-patient ratios, which were noted to be a barrier to using cycling as a mode of early mobility in the CS ICU [40]. The lack of clear benefits of cycling [10,41] may in part underlie its lack of use. Additionally, confidence in cycling [40] and providing opportunities, motivation, and capability [42], may be required in the local CS ICU to support the use of cycling as a mode of early mobility when appropriate. Education, training, enablement, modelling, and incentives can foster opportunities, motivation, and capability [42]. Research is required to explore how to support changing the behaviours of ICU staff in integrating cycling as a mode of mobility.

Comparing the current findings to mobility survey data

The frequency of ambulation reported in survey data [16,17] far exceeds the ambulation observed in the current study. One study reported that on POD1, 97 % (28 of 29) of physiotherapists sat patients at the side of the bed or in a chair, 93 % supported patients to stand, 28 % ambulated patients in their room, 28 % ambulated patients in the hall, and 0 % assisted patients in climbing stairs [16]. On POD2, 52 % sat patients at the side of the bed or in a chair, 55 % supported patients to stand, 79 % ambulated patients in their room, 66 % ambulated patients in the hall, and 0 % assisted patients in climbing stairs [16]. These activities were reported to occur between one and three times each day [16]. Another study reported that one to two times on POD1, 6 % of physiotherapists engaged patients in bed mobility only, 94 % sat patients at the side of the bed, 11 % supported patients to stand, 50 % sat patients up to a chair, 22 % ambulated patients in their room, 6 % ambulated patients in the hall [17]. Two to five times on POD2, 17 % ambulated patients in their room, 50 % ambulated patients in the hall, and 33 % ambulated patients an unknown distance [17]. This discrepancy of survey reports and observed mobilization leads to the question of how the survey questions were designed and if the survey data is reporting protocols or actual practice. The wording of these surveys

requests the reporting of the routine care of a post-operative patient with an uncomplicated post-operative course [16,17], which may have led to the reporting of mobility protocols and not actual practice. These surveys were also administered to physiotherapists [16,17], who, in the current study, were not found to support mobilization frequently. Together, the wording and respondents may lead to a misrepresentation of the actual state of early mobility in the CS ICU. Future research directly observing early mobility in the CS ICU is recommended to provide an understanding of the current state of early mobility.

Comparing the current findings to accelerometer data

Accelerometer data is available to inform the current state of early mobility in the CS ICU. It is possible to compare the observations in the current study to the accelerometer data to provide a more wholesome understanding of the current state of early mobility in the CS ICU. The median CS ICU length of stay of 1.84 (2021) to 1.89 days (2022) suggests comparing the current findings to POD2 data in the accelerometer literature is appropriate. One study reported a low number of steps across three accelerometers for POD2, with 37.5 steps for a FitBit (worn on the wrist), 254 steps for a StepWatch (worn on the ankle), and 392 020 activity counts for an ActiGraph (worn on the wrist) [18]. Nurse-reported activity was also included via a validated scale, the Johns Hopkins Highest Level of Mobility scale [18]. This nurse-reported activity did not include an accelerometer but was used as another form of measurement of early mobility [18]. The scale reported that on POD2 patients walked greater than or equal to 10 feet, or a score of 7 on the scale [18]. While the steps, activity count, and the highest level of mobility score increased from POD2 to POD5, the changes were not statistically significant [18]. Clinical significance was not reported [18]. Another study found that, even by POD7, the majority of the time, patients were lying or sitting [16]. These findings, along with the current study's findings, suggest that there is less ambulation occurring in practice than is reported in survey data [16,17]. Future researchers should consider this when designing studies exploring early mobility in the CS ICU.

Limitations

This behaviour mapping study has several limitations to consider. Any mobility that occurred between the observation periods is not included in data collection and analysis in behaviour mapping. This may lead to an under-representation of the current state of early mobility post-cardiac surgery. As with any observational study, the presence of research staff performing observations may have changed staff behaviour and increased mobilization [23]. This limitation was considered in the planning of the study and led to longer (i.e. 16-hour long), less frequent observations. The rationale for this decision was that over a longer observation period, staff were more likely to return to their usual routine of care than if the observations lasted only several hours. As only one CS ICU was included, this limitation is attributed to the fact that one site conducts all CS in the jurisdiction. Similar studies are needed in CS ICUs across multiple jurisdictions to determine the broader current state of early mobility practice.

Conclusion

This observational study using behaviour mapping found that sitting in a chair in the ICU room, supported by family, was the most frequent mode, location, and support for early mobility while in the CS ICU. Ambulation was observed 10-fold less than sitting in a chair, and cycling was not observed at all. The findings diverge from existing survey data of reported practices and provide a more nuanced perspective of the current state of early mobility than accelerometer data. Despite safety and guideline recommendations, the study highlights that early mobility beyond sitting in a chair remains underutilized in local clinical care.

Further research is needed to facilitate the integration of broader early mobility activities, particularly ambulation and cycling, within CS ICU protocols while identifying and addressing barriers to these underutilized forms of mobility to align practice more closely with recommendations and potentially improve outcomes for the aging CS ICU patient population.

Ethics

Ethics approvals were sought and obtained from the University of Manitoba Research Ethics Board and the St Boniface Hospital Research Review Committee.

CRedit authorship contribution statement

Emily K. Phillips: Writing – review & editing, Writing – original draft, Project administration, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Mudra G. Dave:** . **Maureen C. Ashe:** Writing – review & editing, Writing – original draft, Methodology. **Annette S.H. Schultz:** . **Sheila O’Keefe-McCarthy:** Writing – review & editing, Supervision, Conceptualization. **Rakesh C. Arora:** Writing – review & editing, Supervision. **Todd A. Duhamel:** Writing – review & editing, Supervision, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.iccn.2024.103918>.

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Brief Discussion of the Manuscript

This study is another component of the needs assessment, the first step in intervention mapping.^{9,10} Understanding the current state of early mobility in this CSICU is imperative, as it also provides a grounding for a future intervention. It provides context to the current state and helps to frame performance objectives in step two of intervention mapping. For example, if a lack of a clear early mobility definition in the literature or in the clinical setting and the inconsistent clinician education related to early mobility are likely contributing to the practices of CSICU clinicians, then performance objectives could include a clear early mobility definition and consistent clinician education related to early mobility. These are complex issues to overcome, as behaviour change is complex. It is easier to overcome, however, than uninformed or unengaged clinicians. Using an implementation science approach such as intervention mapping to support the use of the existing early mobility research more consistently may lead to improved and more consistent early mobility behaviours in this CSICU.

Chapter 4 : Perspectives of Early Mobility in the Cardiac Surgery Intensive Care Unit: An Interpretive Description Study

Preface to the Manuscript

This published manuscript is the qualitative investigation of early mobility practice in the local CSICU to support the first step of intervention mapping. To change behaviours, we need to understand the perceptions of clinicians so that we can effectively plan an intervention that aligns with these. For example, if there is a perception that early mobility takes too long, we can provide information and coaching on the actual time invested and the benefits of this time to shift this perception and support the behaviour of early mobility. We also need to understand the clinicians' perspectives of barriers and facilitators related to supporting patients engage in early mobility. Identified barriers need to be overcome and facilitators leveraged to support behaviour change of clinicians. For example, if a barrier is a clinician not knowing how to use a piece of equipment required to mobilize a patient successfully, education for the clinician can be delivered to overcome this barrier. While perceptions, barriers, and facilitators are available in the extant literature, they can be context-specific. For this reason, undertaking this qualitative study with the local CSICU clinicians was necessary to move this dissertation research and the intervention mapping process forward.

Manuscript Status

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Contributions of Authors

This study was conceptualized by Drs. Arora, Duhamel and I. Drs. Schultz and O’Keefe-McCarthy provided methodological expertise. Amy Abegglen and I facilitated focus groups and individual interviews. Amy Abegglen, Jacqueline Hay, and I performed data analysis. April Gregora, Kathy Smith, Carly Shaski, Gavin Bozek, Sarah Gilchrist, and Dr. Fagan provided lived and clinical expertise to inform data analysis. Jacqueline Hay supported the creation and revision of the main figure. As the first author, I drafted the original manuscript and revised it based on feedback from authors and reviewers. All authors reviewed, revised, and approved the final manuscript.



Perspectives of early mobility in the cardiac surgery intensive care unit: an interpretive description study

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Abstract

Objective: Early mobility after cardiac surgery in the intensive care unit improves patient outcomes, yet implementation by clinicians remains inconsistent. To inform interventions to increase adoption, this study sought to explore clinicians' perspectives on the definition of early mobility in the cardiac surgery intensive care unit and describe perceived barriers and facilitators to implementation.

Design: This qualitative study was guided by interpretive description.

Setting: A tertiary hospital that performs 1000 cardiac surgeries annually.

Participants: A total of 26 clinicians, including nurses, physicians, healthcare aides, respiratory therapists, and physiotherapists, participated.

Main Measures: The nine focus groups and four individual interviews were audio-recorded, transcribed verbatim, and analyzed using thematic analysis.

Results: Three themes and 13 categories were created from the data: (1) Incongruent operationalization and conceptualization (across micro, meso, and macro levels), (2) uncertainty, and (3) inconsistency in mobilization practices. Themes were rooted in ambiguous definitions of "early" and "mobility," discrepancy between conceptualization and implementation of timing, varied interpretations of success, and

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perceived safety concerns. In addition, 4 barriers and 4 facilitators were identified and categorized into patient-care and clinician-related.

Conclusion: Developing early mobility protocols and education informed by clinicians may enhance its implementation in the cardiac surgery intensive care unit. Incorporating the perspectives of clinicians into early mobility protocol development is essential to support behaviour change and provide this beneficial care.

Keywords

Qualitative, cardiac surgery, intensive care, early mobilization, early rehabilitation, barriers, facilitators

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Introduction

Early mobility is any active movement immediately after a specific event,^{1–3} such as cardiac surgery. Active movements include sitting, standing, getting out of bed to a chair, ambulation, or cycling.^{1,2} Early mobility in the intensive care unit after cardiac surgery is recommended, safe, and beneficial;^{4–9} however, it is inconsistently integrated into care.^{2,10} This may, in part, be related to the lack of engagement with cardiac surgery intensive care unit clinicians. Research teams thus far appear to be dominated by academic physicians, physiotherapists, and nurses.^{11–14} None of these teams has explicitly described if their work included or was being informed by practicing cardiac surgery intensive care unit clinicians. Practical expertise of cardiac surgery intensive care unit clinicians is needed to support the successful development and integration of early mobility interventions into clinical practice.^{10,15}

Clinician feedback is key because integrating early mobility into clinical practice requires a behaviour change.¹⁰ Behaviour change is complex but can be planned through intervention mapping, a systematic method of developing, implementing, and evaluating interventions targeted at changing behaviours.^{16,17} Intervention mapping originated in health education¹⁶ and has been successfully applied in healthcare.¹⁷ For this reason, we are using intervention mapping to develop, implement, and evaluate an intervention to integrate early mobility into cardiac surgery intensive care unit clinical care. The first step in intervention mapping involves

exploring the behavioural and environmental aspects of the behaviour targeted for change through qualitative and quantitative means.^{16,17} We previously completed a quantitative investigation of early mobility practice in our cardiac surgery intensive care unit.² We found that sitting in a chair was observed 10 times more frequently than any other mode of mobility.² Mobility was supported more frequently by family, either through direct assistance with mobility, alongside the healthcare team, or by being present with the patient while they sat in a chair.² Nurses, physiotherapists, and physicians were the healthcare providers observed supporting mobility.² These valuable insights into mobility practices would benefit from being supplemented by qualitative data. Understanding why mobility occurs as observed is as important as understanding the current state of mobility.^{10,15} Also, understanding the healthcare team's perceived barriers and facilitators to early mobility is important, as behaviours are difficult to change if barriers are not removed, but change can be supported through leveraging facilitators.^{16,17} Therefore, this study aimed to gain insight into the perspectives of cardiac surgery intensive care unit clinicians on early mobility through qualitative methods. The research questions were: What are the perspectives of healthcare providers on early mobility in the cardiac surgery intensive care unit? How do they think about early mobility? How do they operationalize early mobility? What additional barriers and facilitators to early mobility do they perceive?

Methods

Approvals were obtained from both the University of Manitoba Research Ethics Board (HE2024-0036) and the St Boniface Hospital Research Review Committee (RRC/2024/2159) prior to the commencement of the study. All participants reviewed and signed a consent form prior to participating in a focus group. Participants were made aware that consent was an ongoing process, and they could withdraw consent until data analysis began, at which point it was no longer possible to remove their data from the study. No person withdrew their consent.

Our study was guided by interpretive description because the objective was grounded in the cardiac surgery intensive care unit, the area of clinical practice of the first author (EKP).¹⁸ Unlike other qualitative methodologies that require the researcher not to use their clinical expertise in data analysis, a strength of interpretive description is that it values this expertise as a means to explore clinical research questions inductively.¹⁸ Moving from the specific to the general, data are first described. Interpretation occurs through understanding qualitative data through a socially constructed reality that includes clinical expertise.¹⁸ The reporting of this work follows the Standards for Reporting Qualitative Research.¹⁹ See the Supplemental Materials for the checklist. See the Supplemental Materials for details on the guiding research paradigm and researcher characteristics and reflexivity.

Context and sampling strategy

The cardiac surgery intensive care unit at St Boniface Hospital, a tertiary hospital in Winnipeg, Manitoba, Canada and the setting of this study, has been described in detail elsewhere.² Briefly, St Boniface Hospital is the only hospital in the province of Manitoba where cardiac surgeries are performed. Around 1000 are performed annually, with the majority being coronary artery bypass grafting, valve surgery, or a combination of the two.² Thoracic aortic and short-term and durable ventricular assist device implantation surgeries are also performed.² There are 13 beds in this cardiac

surgery intensive care unit. Staff who support mobility include nurses, healthcare aides, physiotherapists, and physiotherapy assistants.²

The sample size was driven by information power.²⁰ The cross-case analysis and lack of guiding theory were balanced by the narrow aim and dense sample specificity of the study, leading to high information power and a moderate required sample size.²⁰ We aimed to recruit 30 clinicians from the cardiac surgery intensive care unit, including physicians, nurses, physiotherapists, healthcare aides, respiratory therapists, and perfusionists, through a combination of purposive and convenience sampling.²¹ We targeted the specific clinician groups to attempt to gain representation from each through purposive sampling by sharing the recruitment materials with each group.²¹ Within each clinician group, we included participants who volunteered to participate in the study through convenience sampling.²¹ The inclusion criteria were clinicians currently working in the cardiac surgery intensive care unit with at least two years of experience.

The sample size was confirmed with data adequacy, as constant comparative analysis allowed for the recognition of alignment of data with the emerging themes and categories.²¹ Passive recruitment occurred through sharing study information on notices in the unit and through an email from the cardiac surgery intensive care unit manager. Interested clinicians contacted EKP directly to determine a mutually agreeable time to participate. Recruitment occurred from June to July 2024. After signing the consent form, participants received an honorarium (\$25 gift card).

Data collection and analysis

Demographic information was collected, including age, self-identified sex, years of experience in the cardiac surgery intensive care unit, and profession. Nine audio-recorded facilitated focus groups of 2–4 clinicians and four individual interviews were conducted to explore experiences with early mobility, including barriers and facilitators. Individual interviews were conducted with participants who could not attend a focus group session but wished to participate in the study. The focus groups and interviews lasted 30–90 min and were conducted

in person at a mutually convenient time and place. Focus groups and interviews were conducted using a semi-structured guide (Supplemental Table 1). The facilitators/ interviewers (EKP and AA) documented perceptions of the focus group and interview processes, focusing on theoretical insights and methodological issues, in reflective journals used as another data source.

The audio recordings were transcribed verbatim to produce 13 transcripts (9 focus group transcripts and 4 individual interview transcripts). Transcripts and reflective journals were analysed using thematic analysis.²² Specifically, EKP, AA, and JLH (the coders) first read the transcripts several times to gain familiarity.²² The coders met in person and analysed the first transcript together. Each coder independently read and analysed two transcripts and then met to compare and contrast their coding.¹⁸ Coding continued with each coder reading and analysing two additional transcripts. Coders independently analysed the same transcripts (i.e., EKP and JLH analysed transcript #3 and #8, and JLH and AA analysed transcript #5) to support the analysis of transcripts from diverse perspectives.²²

Initial codes were generated by grouping responses together based on similarities.²² These initial codes were reviewed, and themes were created by conceptualizing the relationships among the codes.²² The themes and codes were shared for review and revision by the broader research team, including clinical partners (CS and GB).²² The themes and codes were then named and defined in a coding scheme.²² Memoing was used to create an audit trail and allow for transparency on coding decisions.¹⁸

Barriers and facilitators to early mobility beyond the themes created above were also inductively analysed. This analysis focused on identifying barriers and facilitators in a qualitative manner to ensure the breadth of these was made explicit. This differs from other approaches that are deductive, as these approaches may limit what barriers and facilitators are identified through the use of pre-existing frameworks. The interview guide included questions about what barriers and facilitators to early mobility participants perceive. We then reviewed the transcripts again, specifically looking for other barriers and facilitators mentioned throughout the

discussions or those that were identified through the coder's clinical and professional backgrounds, particularly in relation to early mobility and supporting behaviour change. We inductively analysed all identified barriers and facilitators in the same manner that codes were created, moving from initial codes through revisions, then naming them, and finally creating a coding scheme.²² The barriers and facilitators were categorized as patient-specific, clinician-specific, and unit-specific. This categorization occurred to support organizing the barriers and facilitators in a manner that supports their use in the development of future interventions. This analysis did not explore relationships among barriers, facilitators, and the themes created from the discussions. Rather, we only sought to identify the breadth of barriers and facilitators perceived by participants. The goal of identifying barriers and facilitators was to explicitly share these so that they can be considered in the development of future interventions. Memoing was again used to create an audit trail and allow for transparency on decisions.¹⁸

Credibility

As appropriate for the methodology of interpretive description, credibility was evaluated rather than trustworthiness through the evaluation criteria described by Thorne.¹⁸ These criteria include integrity, representative credibility, interpretive authority, and transparent analytic logic.¹⁸ The integrity of this study is rooted in the epistemological approach.¹⁸ The findings have representative credibility because they relate to early mobility in the cardiac surgery intensive care unit based on data sourced from healthcare providers in the cardiac surgery intensive care unit. Multiple team members independently analysed and compared coding to address interpretive authority.¹⁸ Finally, creating an audit trail and facilitating reflection on coding decisions via memoing ensured transparent analytic logic.¹⁸

Results

A total of 26 healthcare providers participated in focus groups ($n = 22$) or individual interviews ($n = 4$). All who volunteered to participate were eligible.

See Supplemental Table 2 for the participant demographics. We were able to achieve representation from most identified clinician groups through purposive convenience sampling. Seventeen participants were nurses, three were healthcare aides, two were physicians, two were respiratory therapists, and two were physiotherapists. Nineteen of the participants identified themselves as female (not shown in Supplemental Table 2 to support anonymity). The median age of the participants was 40 years (interquartile range [IQR] 34 to 51). The median years of experience in the cardiac surgery intensive care unit was 8 (IQR 3 to 13).

Three themes and 13 categories were created from the data. Incongruent Operationalization and Conceptualization of Early Mobility was the first theme, supported by categories grouped at the micro (clinician), meso (unit), and macro (hospital) levels. These incongruencies lead to the next theme, Uncertainty. This theme was supported by the categories Getting Hurt and Following the Protocol. The final theme of Inconsistent Mobilization Practices is supported by the categories It Depends... and Rationale. These themes and categories are described below and visualized in Figure 1.

Four barriers and four facilitators to early mobility were identified. These are organized as patient care-related (n=2 barriers, n=1 facilitator) and clinician-specific (n=2 barriers, n=3 facilitators). The barriers and facilitators generated are shared in Supplemental Table 6.

Incongruent operationalization and conceptualization

How clinicians described the operationalization (“doing”) of early mobility did not align with their conceptualization (“thinking”) of early mobility. This was noted through the incongruencies in definitions provided compared to how these were described when discussing a successful mobilization or barriers and facilitators to early mobility. This theme is broken down into the micro (clinician), meso (unit), and macro (hospital) levels. This theme is summarized below with details and participant quotations available in Supplemental Table 3.

There are five incongruencies at the micro level: mobility definition, timing, priority, safety, and defining success. For example, the operationalization of mobility as sitting at the side of the bed is incongruent with how mobility is conceptualized, as a wide range of movements. As well, six hours post-operative was a consistent time for operationalization of “early”, however, this time does not align with the conceptualization of early. At the meso level, three incongruencies exist: who can mobilize, culture, and family support. For example, when operationalizing early mobility, clinicians considered the presence of cardiac surgery intensive care unit-specific staff as a requirement; yet, this was not the case when early mobility was conceptualized. At the macro level, the incongruency relates to staffing. Early mobility is not operationalized even when there are two clinicians (one-eighth to one-seventh of the clinicians on each shift), which is the conceptualized requirement for early mobility.

Uncertainty

Clinicians are uncertain how to mobilize patients due to the incongruencies between the conceptualization and operationalization of early mobility. This theme comprised two categories: getting hurt and not following the protocol. This theme is summarized below with details and participant quotations available in Supplemental Table 4.

Clinicians described immobility as the preference to reduce the risk of getting hurt. Not engaging the family more actively than pushing a wheelchair was shared as a way to keep them and the patient safe. Clinicians also described being uncertain of whether to mobilize a patient before the six-hour mark when the patient wished to move.

Inconsistent mobilization practices

Uncertainty ultimately leads to the theme of Inconsistent Mobilization Practices, which comprises two categories: it depends... and rationales. The categories are summarized below with details and participant quotations available in Supplemental Table 5. In it depends..., clinicians argued with themselves about engaging in early mobility as their incongruent

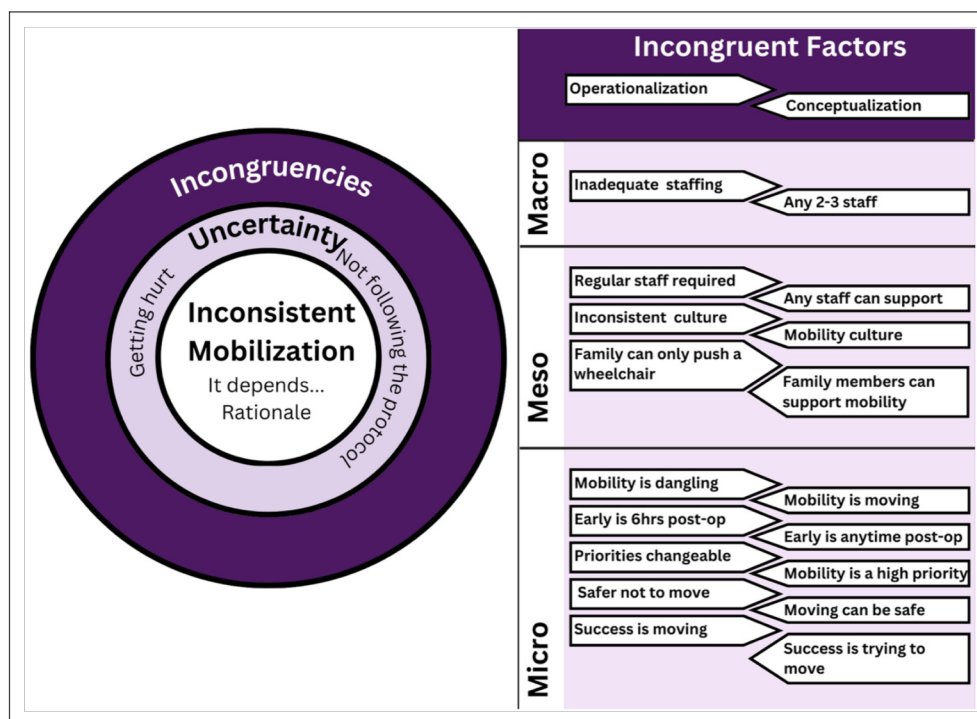


Figure 1. A visual overview of the themes and categories leading to inconsistent mobility.

conceptualizations, operationalizations, and uncertainties came together. They either talked themselves into mobilizing or out of mobilizing based on where the internal argument ended. Mobility depends on the arguments clinicians use to justify their early mobility practices. The uncertainty can also lead to a lack of action by clinicians as they make rationales for not mobilizing their patients. In this way, clinicians provide a rationale for their inconsistent mobility practices.

Barriers and facilitators to early mobility

Four barriers to early mobility were identified, along with four facilitators. These are in addition to the themes and categories already described. The barriers and facilitators are grouped as patient care-related and clinician-related to support their future use in changing behaviours and supporting early mobility practices. See Supplemental Table 6

for an overview of the barriers and facilitators with details and participant quotations.

Two barriers were grouped as patient care-related: the number and location of intravenous lines and continuous renal replacement therapy. The facilitator grouped as patient care-related were the adjunct patient care elements of massage, pain control, deep breathing and coughing. These were thought to facilitate early mobility by helping patients move better. The participants believed that massage would relax tense muscles and improve blood flow which would help mobility. Participants were clear that they did not think deep breathing and coughing was early mobility but that it was important for patients to be able to breathe to be able to move.

Two barriers were grouped as clinician-related: lack of knowledge of the bed bike and prioritizing discharge education over mobilizing patients. A discussion about prioritization is shared in Supplemental

Table 6 and highlights how patients who require the most support for mobility are prioritized behind patients who are leaving the cardiac surgery intensive care unit due to the focus on patient flow out of the intensive care unit. This leads to patients not being mobilized and remaining in the intensive care unit for longer periods of time. Three facilitators were grouped as clinician-related: experience as a healthcare provider, familiarity with the team, and conceptualization of mobility as key to recovery and discharge. Experience was not tied to years working in the intensive care unit but rather working in healthcare in general. Participants tied experience to recognizing the deconditioning that can happen to patients and to how quickly a healthcare provider will begin to mobilize a patient. Reframing early mobility from a safety issue that requires mitigation to conceptualizing it as key in recovery and discharge supports early mobility practices. Participants believe this facilitates prioritizing early mobility. This reframing of early mobility was shared by one participant as impactful and something that will change their healthcare practices.

Discussion

This interpretive description study explored perspectives of early mobility and barriers and facilitators to early mobility using focus groups and individual interviews. An incongruent operationalization (“doing” of early mobility) and conceptualization (“thinking” of early mobility) of micro, meso, and macro-level elements were found to lead to uncertainty, which culminates in inconsistent mobilization practices. Four additional barriers and four additional facilitators of early mobility were identified. These are important additional considerations when seeking to change clinician behaviours related to early mobility. They are groups as patient care-related and clinician-related to support their use.

These findings present a novel understanding of clinicians’ perspectives of early mobility and present unique barriers and facilitators to early mobility. These findings may help integrate early mobility into cardiac surgery intensive care unit clinical care by advancing our collective insight into the underlying reasons for non-uptake. The

perspectives, barriers, and facilitators are multifaceted and diverse, suggesting that interventions to support the integration of early mobility into clinical practice also need to be multifaceted and diverse. This aligns with the complexity of behaviour change and the process of intervention mapping.^{16,17} Interventions can be co-developed to target specific incongruencies or barriers and, together, they may lead to behaviour change. A combination of education, mobility champions, and protocols may be required to support overcoming identified incongruencies and barriers and leveraging facilitators. Together, these components would provide clarity and consistent conceptualizations of early mobility and would provide guidance to support aligned and consistent operationalization of early mobility.

Providing education may support consistent conceptualizations of early mobility. For example, education about the risks of bedrest could be shared to overcome the safety concerns and the preference to keep patients immobile to keep them safe. Studies such as the revisited Dallas Bed Rest Study could be shared to demonstrate the impacts of prolonged bed rest on healthy individuals.²³ Discussions about the effects of bed rest on the population of patients undergoing cardiac surgery could occur to generate an understanding that bed rest must be perceived as unsafe and incongruent with healing and maintaining a good quality of life after cardiac surgery. Education for cardiac surgery intensive care unit clinicians about early mobility, the benefits, and the outcomes of implemented early mobility programs has been shown to build a culture of mobility and sustain successful implementation.^{10,24} This education must occur for new staff and existing staff.^{10,24} Educating patients and families preoperatively about the importance of early mobility adds to the culture of mobility.^{10,24} One team took this further and provided families with three tangible ways to actively participate in early mobility with their loved one while in the cardiac surgery intensive care unit.²⁴ Families were involved in reinforcing the importance of early mobility, motivating patients through coaching or cheerleading, and providing support and encouragement for mobility.²⁴ Education could also support the prioritization of mobility. Sharing that in one study, the first

mobilization took a median of 10 min and an average of 20 min²⁵ may help cardiac surgery intensive care unit clinicians plan for early mobility throughout their shifts. Early mobility must be reframed to be equally regarded as important as titrating medications, diagnostic tests, and other “medical” care to support its prioritization by cardiac surgery intensive care unit clinicians.

More than education is required to overcome the incongruencies and barriers identified. Engaging an interdisciplinary team to champion early mobility within a cardiac surgery intensive care unit has been found to support behaviour change and improve mobility practices in other studies.^{10,24} These champions support the development and integration of early mobility intervention elements in the cardiac surgery intensive care unit and can help communicate outcomes to their fellow healthcare providers.^{10,24} Communicating outcomes, such as the number of patients eligible for early mobility who were mobilized according to the intervention, is important to successful behaviour change as it supports culture change.¹⁰ When a behaviour is expected and this expectation is communicated and reinforced, it becomes part of the cultural routine of the cardiac surgery intensive care unit.²⁴

Operationalization and barriers identified could be removed through the creation of early mobility protocols that provide specific definitions and criteria to support clarity. For example, protocols that clearly define early mobility and outline a time to begin mobility that focuses on patient factors rather than time from extubation could help overcome the incongruencies of mobility definition, time, and defining success. One quality improvement project focused on increasing early mobility in the cardiac surgery intensive care unit shared a clear goal of early mobility: to perform safe, progressive mobility based on a patient assessment and to ambulate patients at least three times each day.²⁴ This definition includes a mode of mobility but also centres the cardiac surgery intensive care unit team around a shared goal to support operationalization. Teams can identify when mobility is successful by measuring when they have achieved the goal of early mobility. Adding patient-specific inclusion and exclusion criteria for when to start mobility is

common²⁶ and allows cardiac surgery intensive care unit staff to use their critical thinking and judgment in applying an early mobility protocol, tailoring it to the unique patient context. This would also overcome many of the patient-specific barriers identified in this study. Concerns related to the safety of early mobility could be addressed through protocol elements such as monitoring suggestions, possible adverse events and potential solutions, and criteria for ceasing mobilization would help explicitly guide staff and remove interpersonal differences. One study found that these elements were only included in just over half of the early mobility protocols studied.²⁶

This work has several strengths and limitations. One strength is the inclusion of a variety of cardiac surgery intensive care unit clinicians. This reflects the population of clinicians who support early mobility in this cardiac surgery intensive care unit.² Another strength is the diversity of the research team. As described above, the team has diverse research, lived, and clinical expertise which supports a deep, rich, and multi-faceted analysis. Finally, a limitation is that this study was conducted at one site within one intensive care unit. This limits the transferability and generalization of the findings. Other sites would need to confirm and likely revise the findings before applying them to their institutions.

In conclusion, the incongruence between the operationalization and conceptualization of early mobility leads to uncertainty and inconsistent mobility practices. The successful integration of early mobility into cardiac surgery intensive care unit clinical care may require protocols and education to address incongruencies and barriers. In this way, incorporating the perspectives of clinicians into early mobility protocol development is essential to support behaviour change and provide this beneficial care.

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Ethical statement

Approvals were obtained from both the University of Manitoba Research Ethics Board (HE2024-0036) and the St Boniface Hospital Research Review Committee (RRC/2024/2159) prior to the commencement of the study. All participants reviewed and signed a consent form prior to participating in a focus group. Participants were made aware that consent was an ongoing process, and they could withdraw consent until data analysis began, at which point it was no longer possible to remove their data from the study. No person withdrew their consent.

Authors' contributions

EKP conceptualized the study, collected, analyzed, and interpreted data and drafted the manuscript. AA collected, analyzed, and interpreted data and drafted a section of the manuscript. JLH analyzed and interpreted data, supported manuscript revision, and created the figure. AG, KS, CS, GB, SG, AF, AMC, MCA, ASHS, SOM, RCA, and TAD supported data analysis and revisions of the manuscript and figure. All authors read and approved the final manuscript.

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Conflicts of interest

The authors report no conflicts of interest.

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Brief Discussion of the Manuscript

Through an implementation science lens, understanding the multifaceted and diverse ways in which clinicians make decisions about early mobility, along with the perceived barriers and facilitators, positions researchers to develop interventions that support early mobility integration.¹³³ These interventions also need to be multifaceted and diverse, targeting clinician conceptualization and behaviour.¹³³ The research described in this chapter is another part of the needs assessment that is the first step of intervention mapping.^{9,10} This study adds valuable information for the intervention mapping process. It uncovered tangible elements of clinicians' perceptions that can be targeted to support behaviour change. For example, providing a clear definition of early mobility may help align how early mobility is conceptualized and operationalized.¹³³ The results of this study also provide context for the behaviours observed in the study in Chapter 3.¹³² The inconsistent mobilization and less ambulation than predicted by the early mobility protocol observed in Chapter 3¹³² can be at least partially explained by the incongruences between how clinicians conceptualize and operationalize mobility described in this study.¹³³ These examples are integrated into the early mobility intervention described in Chapter 8.

Chapter 5 : Early mobility to improve health outcomes following cardiac surgery (EVE)

Clinical Trial Development: Engagement Methods Using Body Mapping and Virtual Consensus Building

Preface to the Manuscript

This chapter details a model of a participatory approach to guiding research directions based on lived/living experiences through body mapping and subsequent virtual consultation workshops. This chapter also describes how the model is applied to the lived experience of early mobility in the CSICU, providing researchers with a tangible application. We use early mobility in the CSICU in the manuscript to provide a case example of how the model can be applied, to provide a tangible example of the model in action. Using ABMs to engage PWLE in research is new and different for most researchers, so we believe sharing a tangible example is helpful in understanding the model. Due to the volume of knowledge generated, the findings of this work were reported in two separate manuscripts, which are presented in Chapters 6 and 7.

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Contributions of Authors

Drs. O’Keefe-McCarthy and Chudyk and I conceptualized this paper after having conducted the workshops described in Chapters 7 and 8. As the first author, I drafted the original manuscript. I shared early drafts with the workshop facilitators, Dr. O’Keefe-McCarthy, April Gregora, Kathy Smith, and

Jacqueline Hay, who provided feedback on missing elements from the workshops and what they perceived to be key elements to highlight. I revised the manuscript further based on feedback and conversations with Drs. O’Keefe-McCarthy and Chudyk. The manuscript was then shared with the broader authorship group, including two PWLEs (April Gregora and Kathy Smith), who all reviewed, revised, and approved the final manuscript.

Manuscript

Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Trial

Development: Engagement Methods Using Body Mapping and Virtual Consensus Building

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Abstract

In health research, patient engagement in research is increasingly recognized to enhance healthcare and facilitate the translation of findings into practice. This occurs through integrating the knowledge, perspectives, and priorities of people with living/lived experience (PWLE) who receive or support those receiving care. Current approaches to PER emphasize verbal methods, where the thoughts and opinions of PWLE are shared in advisory groups, one-on-one or research group meetings, and town halls. While valuable, these methods often limit the expression of complex experiences, senses, and emotions that are difficult to articulate in words. Arts-based research methods involve individuals creating art, allowing for the exploration of embodied knowledge. Various types of art can be employed, including visual art, poetry, music, digital storytelling, and body mapping. Body mapping is an emerging arts-based research method that involves PWLE creating a life-sized tracing of their body in a position of their choice. The tracing is then filled based on reflections on guided questions about their healthcare experience using self-selected types of visual art and words. While body mapping is a promising approach to generating future research questions and outcome measures, guidance related to its operationalization is lacking. This paper describes a model of a participatory approach to guiding research directions based on lived/living experiences through body mapping and subsequent virtual consultation workshops. The use of the model to explore the lived experience of early mobility after cardiac surgery while in the intensive care unit is used throughout as a case example. This model improves the accessibility of arts-based research methods for researchers engaging patients. In this way, researchers have more tools in their toolkit to broaden the types of knowledge that can be used to guide research and improve healthcare.

Keywords

1. PER
2. Patient Involvement and Engagement
3. Patient and public involvement
4. Patient engagement in research

5. Patient-oriented research
6. Body mapping
7. Arts-based research methods

1. Introduction

Patient engagement in research (PER) is the meaningful and active engagement of people with lived experience (PWLE) of a health issue in research as members of the research team.^{2,135,136} In health research, PER is internationally recognized as important in generating knowledge to improve healthcare systems.^{2,135,136} PWLE can be engaged at any stage of research in grant development, intervention and outcome design, recruitment and data collection, analysis and interpretation³⁵ and contribute their unique lived/living expertise to the clinical knowledge of clinicians and the scientific expertise of researchers.² Therein, their lived/living experience is integrated throughout the research process and used to inform and guide decisions, shifting health research to better align with the priorities of those receiving healthcare, which can also help overcome the lack of translation of research findings into clinical practice.^{2,135,136}

The dominant methods for PER, advisory groups, one-on-one or group meetings, and public or town halls, rely heavily on verbal communication.^{65,137} Verbal approaches limit the knowledge available to that which can be verbalized, such as thoughts and opinions,^{138,139} and exclude embodied knowledge, including senses, expressions, and emotions, that cannot adequately be put into words.^{65,140,141} Arts-based research methods have individuals create art to explore embodied knowledge.^{65,140,141} Removing the limitations of verbal expression allows for a richer sharing, understanding, and leveraging of the lived/living experience.^{65,140,141} Arts-based research methods are inherently participatory, offering PWLE the flexibility to choose how and what type of knowledge is shared.¹⁴⁰

Our research group recently published a narrative review exploring arts-based research methods used for PER, including how they can be used, at which research stages, at which engagement levels, and how they impacted the research.⁶⁵ There are many arts-based research methods available for PER to access embodied knowledge, including visual art, poetry, music, digital storytelling, and body mapping.⁶⁵ In particular, body mapping supports exploring the senses, emotions, and feelings of an experience.^{66–70} Body mapping can be used to engage PWLE to walk through a healthcare experience so they can relive

it and access embodied knowledge to generate future research questions and outcome measures. PWLE create a life-sized tracing of their body in the position of their choosing.^{66–70} This body map is then filled in based on reflections to guided questions posed by the research team with paint, markers, crayons, collages, or words in whatever way is meaningful to PWLE to recreate their experience of a healthcare event.^{66–70}

Although the current PER literature supports the integration of body mapping conceptually,⁶⁵ models for operationalizing it into PER are lacking, which is a barrier to its use. Establishing models would increase the accessibility of body mapping for PER, in addition to improving the accessibility of PER for arts-based researchers to enable the generation and use of multiple sources of embodied knowledge to produce research aligned with lived experiences.⁶⁵

Previous investigations have largely been limited to the utilization of body mapping for data collection and some analysis only.^{66–70} We extend this existing knowledge base by providing a participatory approach to guiding research directions based on lived/living experiences through body mapping. This article describes a case study that can serve as a model for operationalizing the integration of arts-based practices to engage PWLE in research, detailing how researchers and PWLE can collaborate to create body maps, analyze them together, and co-synthesize the data produced to generate future research questions and outcome measures. Thus, it presents an arts-based participatory approach to data collection, analysis, synthesis, and prioritization driven by the lived/living experience. We used this model to successfully explore embodied knowledge of the lived experience of early mobility after cardiac surgery while in the intensive care unit (**See Box 1**). This is the first article in a three-part series that describes a two-phased workshop to develop a PWLE-informed early mobility intervention for use in the cardiac surgery intensive care unit (CS ICU). The following two articles describe the findings of a study that employed this model to co-create an understanding of the embodied experience of mobility in the CS ICU, co-create a definition of early mobility, identify barriers and facilitators to early mobility, and prioritize outcome and experience measures for use in future intervention research. This work is part of

the Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Feasibility Trial Development study.

Box 1: Information About the Case Example

Post-intensive care syndrome (PICS) is a new or further deterioration in cognitive, mental, and/or physical health after admission to the intensive care unit (ICU).⁹² Between 16% to 99% of patients demonstrate symptoms of PICS in the cardiac surgery (CS) ICU.¹⁴² Interventions aimed at preventing PICS are required to support optimal health outcomes for these patients. Early mobility interventions in the CS ICU improve physical health outcomes,^{76–78} are safe,^{82–85,89,90} and are a guideline recommendation.^{86,87}

Despite an increasing research focus on early mobility in the last decade,¹⁴³ there remains a lack of integration of early mobility into CS ICU clinical care.^{7,132} Research teams investigating early mobility interventions thus far have been dominated by physicians, nurses, and physiotherapists, with rehabilitation scientists and exercise physiologists less frequently involved.¹⁴³ None of the research teams have included PWLE of CS. A team approach is required, with collaboration among clinicians, PWLE, and researchers, to develop early mobility interventions and support selecting outcomes relevant to PWLE. The research this model was used for begins to address these knowledge gaps to improve CS ICU patient care by exploring the embodied lived experience of early mobility in the CS ICU. The objectives of the study underlying this model were: 1) co-create an understanding of the experience of mobility in the CS ICU, 2) co-create a definition of early mobility, 3) identify barriers and facilitators to early mobility, and 4) select outcome and experience measures for use in future early mobility intervention research.

2. Methods

The described model involves a sequential series of co-facilitated workshops to co-create, co-analyze, and co-synthesize body maps and discuss and prioritize experiences shared during the co-analysis to generate future research questions and outcome measures. Reporting of patient engagement in this work follows the updated Guidelines for Reporting Involvement of Patients and the Public (GRIPP-2) long form (see Appendix 5.1).⁴⁵ This work was conducted in alignment with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2.¹⁴⁴ Institutional review board approvals for the case study exemplar were obtained in March 2024 from the University of Manitoba Research Ethics Board 1 (HE2024-0035) and the St Boniface Hospital Research Review

Committee (RRC/2024/2158). All PWLE reviewed and signed a consent form prior to participating in the workshops of the described case study. PWLE were made aware that consent was an ongoing process, and they could withdraw consent until data analysis began, at which point it was no longer possible to remove their data from the study. No PWLE withdrew their consent.

2.1 Patient Engagement in this Paper

The approach to engaging PWLE is informed by the Canadian Institutes of Health Research's Strategy for Patient-Oriented Research Framework³² and our research teams' previous work.^{38,138,139,145} The PWLE research team members, AG and KS, collaborated³³ through the entire project and were involved in conceptualization, development and conducting the case study exemplar, which originated our model. Additionally, AG and KS supported drafting the initial version of this paper and helped revise subsequent versions. As noted in previous work by members of the research team, the engagement of AG and KS in the conduct of the case study exemplar "helped to bridge the divide" between clinician and academic research team members and the workshop PWLE.¹⁴⁵

2.2 Overview of the Model

The model's overarching purpose is to guide research directions and outcome measures through the co-creation, co-analysis, and co-synthesis of body maps pertaining to the healthcare experience under study. The first step involves identifying the research direction(s) (and underlying research question[s]) to be addressed by the process. **Workshop 1 (co-creation)** involves three in-person sessions in which PWLE create and discuss body maps of the healthcare experience under study. The research team then collates discussions to support co-analysis and the determination of outcome measures. **Workshop 2 (co-analysis and co-synthesis)** involves one virtual session in which PWLE discuss and develop PWLE-informed recommendations on the research directions under study, potentially including related barriers and facilitators, along with outcome and experience measures. In **Workshop 3 (co-synthesis and prioritization)**, the recommendations (and/or their underlying facets such as barriers and facilitators) and the outcome and experience measures are prioritized using the nominal group technique.^{139,146–150}

Two rounds of prioritization occur, with a discussion between rounds focused on the initial prioritization from least agreement to most agreement.^{139,146–150} **Figure 5.1** shows a visual overview of the model. **Table 5.1** provides an overview of the goals and outputs of the workshops that comprise the model. Each workshop built on the prior, generating and interpreting knowledge simultaneously and collaboratively.

	SESSION 1	SESSION 2	SESSION 3
Workshop 1: Creation of Body Maps	Introduction to the research study and body mapping Provide opportunity for entire PEP to meet to support group dynamics In person x 3 hours All people with lived experience	Creation of body maps In person x 3 hours People with lived experience split into 2 groups	Sharing and co-analysis of body maps In person x 3 hours People with lived experience split into 2 groups
Workshop 2: co-creation of definition of early mobility, discussion of barriers, facilitators, and outcome and experience measures	Group discussion to co-create a definition of early mobility, identify barriers and facilitators to early mobility, and explore outcome and experience measures to evaluate early mobility interventions Virtual x 4 hours		
Workshop 3: prioritization of barriers, facilitators, and outcome and experience measures	Nominal group technique used to prioritize identified barriers & facilitators to early mobility along with outcome and experience measures to evaluate early mobility interventions in future research Virtual x 2 hours		

Figure 5.1. Visual overview of the workshops and sessions.

Table 5.1 Goal and desired outputs of each workshop.

Workshop number	Goal	Desired outputs
Workshop 1: Creation and Description		
1	Session 1	Develop group dynamics
		Introduce research questions
		Introduce body mapping
	Session 2	Create body maps
	Session 3	Present body maps
Workshop 2: Co-analysis and Synthesis		
2		Co-create a definition of early mobility
		Identify barriers & facilitators to early mobility, and PROMs & PREMs
Workshop 3: Co-synthesis/ Prioritization and Recommendations		
3	Prioritize barriers & facilitators to early mobility, and PROMs & PREMs	Prioritize list of barriers & facilitators to early mobility, and PROMs & PREMs

2.3 PWLE recruitment

The suggested sample size is 8-12 participants, which aligns with recommendations for optimal group size to facilitate discussion and participation.¹⁵¹ Recruitment can occur through multiple avenues, such as patient and family advisory councils, databases of patients who have consented to be contacted for future research, or through networks of PWLE research team members. Inclusion and exclusion criteria should be developed that reflect the lived/living experience of interest. For example, limiting recruitment to people who have undergone certain procedure types may be important if these procedure types lead to differences in the living/lived experience of interest. Equity, diversity, and inclusion (EDI) considerations should also reflect the living/lived experience of interest. Exploring the living/lived experience based on different EDI factors in separate studies may be beneficial in guiding research directions. Thoughtful reflection should be used when considering inclusion and exclusion criteria and EDI.

Each participant should be compensated for their time. The Strategy for Patient-Oriented Research Recommendations on Patient Engagement Compensation can be used to guide compensation

¹⁵². These recommendations suggest \$25 per hour for engagement up to four hours at a time.¹⁵² The time commitment should include the time required to complete all workshop sessions and preparatory work. Research teams should check with their local ethics review board as to whether ethics approval is required for workshop participation, especially if they intend to publish on the process and/or its findings. See **Box 2** for an example of recruitment used for the case exemplar.

Box 2: Recruitment in the Case Example

We recruited 10 participants in alignment with recommendations for group size to facilitate discussion and participation ¹⁵¹. Participants included patients and their care partners (family or friends). The inclusion of care partners was suggested by AG and KS, who shared the difficulty of remembering the ICU hospitalization and the key role care partners play in helping to piece together memories of the time. Patients and care partners were recruited from a database of patients who have undergone CS at St Boniface Hospital in Winnipeg, MB and who agreed to be contacted for future research. Inclusion criteria were adults over 18 who have undergone or had a loved one undergo elective or semi-urgent outpatient coronary artery bypass grafting, valve CS, or a combination of the two at St Boniface Hospital in the last five years, cognitively able to participate in a consultation workshop, had access to the internet and an electronic device, were willing to reflect on personal experiences relating to CS and share these in a group setting, could speak and read English, and consent to be recorded. Each participant was compensated \$475 for their time. This amount was based on the Strategy for Patient-Oriented Research Recommendations on Patient Engagement Compensation.¹⁵² These recommendations suggest \$25 per hour for engagement up to four hours at a time.¹⁵² We estimated that 19 hours would be required to complete all workshop sessions (which total 15.5 hours) and preparatory work. All participants provided written informed consent prior to workshop participation. All in-person sessions were held at St Boniface Hospital in the same building that houses the CS ICU. Locating the study as such was intentional to elicit thoughts and emotions through the familiar environment.

2.4 Detailed model description (See Box 3 for an overview of the model from the case exemplar)

2.4.1 Preparation

A standard operating procedure (SOP) should be created ahead of the workshops to guide each session (see Table 5.2). The SOP can be pretested by having research team members create their body maps. These are valuable examples for PWLE to understand the request. This also allows inexperienced facilitators to gain more familiarity with body mapping. Finally, this allows the SOP to be piloted to

ensure the instructions are clear and each facilitator has a clear understanding of their roles (see Appendix 5.2). See **Box 3** for an overview of the model from the case exemplar.

Table 5.2 Items to include in the standard operating procedure

Item	Description
Overall goal of the workshops	-The overarching goal of research, likely specifying the future research questions and outcome measures of interest
Goals and outputs of each workshop and its sessions	-The sub-goals of each session that together culminate in the overall goal -Outputs can be tangible, such as a body map, or co-developed knowledge, such as a definition of early mobility
List of materials that will be provided to participants before each workshop (Materials should be provided to participants at least one week in advance of a session to support adequate time to reflect and determine which elements of their experience they would like to share and how they would like to share them)	-Any documents that will be shared, such as a map to the workshop location, a list of suggested attire, and questions that will be posed at the workshops for the participants to consider -A questionnaire should be given to participants to complete ahead of time to identify any accessibility and other needs -Minimal information about body mapping can be provided prior to the workshop sessions with the assurance that examples will be provided and there is no correct way to create a body map.
Detailed plan for each workshop session	-From welcomes and introductions to the activities of each session -May outline the time each section will take, and which facilitator is responsible to lead each section

2.5 In-person Workshop Overview and Key Considerations

2.5.1 Workshop 1

Workshop 1 consists of three in-person sessions. The in-person format is important for creating and sharing body maps as it allows facilitators to appropriately support each PWLE. It also allows the research team to provide all art supplies feasibly, rather than sharing these through home delivery or mail. It is recommended that the group of PWLE be broken into two groups, such as a morning and an afternoon group, for Sessions 2 and 3. This ensures facilitators can provide appropriate support to each

PWLE as they create and discuss their body maps. Each session is approximately 4 hours long. This provides adequate time to build relationships and trust and learn about body mapping (Session 1), create a body map (Session 2) and provides each PWLE approximately thirty minutes (assuming 6 PWLEs in each group) to present their body map and for the group to take a break (Session 3).

2.5.1.1 Session 1- Relationship building

The goals of Workshop 1 Session 1 are to build relationships among PWLE and research team members, to introduce the arts-based research method of body mapping, and to support PWLE in exploring their experiences, emotions, and feelings related to the healthcare experience under study. The session begins with introductions and an icebreaker activity, preferably aimed at sharing meaning and experiences and highlighting how each person brings a unique perspective to the same question. For example, an icebreaker activity could involve having every attendee share a small item that is important to them and explain its significance. In the next activity, the group takes turns sharing words to describe their physical, mental, and emotional experiences and feelings related to the healthcare experience under study. A session facilitator writes these in coloured marker on a large sheet of paper posted in the room. This activity is meant to help PWLE create their body maps by reminding them of the feelings they may want to depict on their body map. The research teams' example body maps are then shown to PWLE. These provide a tangible example of what PWLE will be creating. Sharing multiple body maps is beneficial because it demonstrates that there is no "right way" to create one. Instead of creating body maps, the research team could share examples from the literature. Finally, PWLE are shown the art supplies available for creating their body maps. They are then asked to think about the position they want their body in on their map, what colours they want to use to depict their experiences, and what images they want to use to depict their experiences (for example, how will they depict feeling unsteady on their feet or feeling confused). A key consideration for Session 1 is ensuring enough time to support team building through the introductions. Based on our experience with the case exemplar, we recommend 5

minutes per person, which may seem like a lot but helps support the establishment of a cohesive group that works well together and supports one another over the following workshops and sessions.

2.5.1.2 Session 2 – Creating body maps

The goal of Workshop 1 Session 2 is to create body maps. Facilitators (one per PWLE) support PWLE in tracing an outline of their bodies and help them reflect on their experiences, emotions, and feelings about the research direction/question being addressed. This supports PWLE to fill in the body maps to depict. Facilitators support reflection by talking to them about their relevant experiences and feelings and how to potentially depict them. They also work with PWLE to create a title for their body map. A key consideration for Session 2 is to provide PWLE the space to request as much or as little facilitator support as possible. Some PWLE will come with a vision of their body map and may want very little support. Others may be unsure of how to start creating their body map, or how to fill in specific details, and need encouragement and understanding that there is no wrong way to express ideas.

2.5.1.3 Session 3 - Begin co-analysis

In Workshop 1 Session 3, the goals are for each PWLE to share their body map with the group and to begin co-analyzing it using compositional interpretation.¹⁵³ The body maps should all be displayed on one wall, with one brought forward for sharing at a time. This allows PWLE to listen to the questions being posed and reflect on their body map to support their discussion. The body map being shared is taped on the wall between the PWLE and one facilitator who leads the discussions. To introduce the PWLE to what the discussion could look like, at least one PWLE research team member should discuss their body map to reduce uncertainty/increase comfort with the process. The PWLE team member could create this body map outside of the workshop or during Workshop 1 Session 1. PWLE are then asked to volunteer to discuss and co-analyze their body maps using compositional interpretation.¹⁵³ With this analysis approach, the content, colour, spatial organization, light, and expressive content of the body map are co-analyzed through a facilitated discussion.¹⁵³ The analysis of the content of the image includes discussing what is shown and what symbols or icons are used.¹⁵³ When analyzing colour, the dominant

hue, colour saturation, the lightness or darkness of colours, the harmony of the colours used, and what is stressed with colour are investigated/discussed.¹⁵³ Spatial organization looks within the image at the direction of lines. If the image is static or dynamic and beyond the image to include the point of view the image is created from,¹⁵³ while the analysis of light explores the use of light to highlight elements of the image.¹⁵³ Finally, the co-analysis of the expressive content of the image is the emotive effect of the image.¹⁵³ These elements are what the facilitator focuses on discussing to ensure the correct interpretation of their meaning for PWLE. This co-analysis ensures the meaning intended by PWLE is captured, rather than the research team's interpretation of the body map.

PWLEs' presentations of their body maps and ensuing conversations can be video recorded along with a video recording of the other PWLE watching the discussions. The video recordings can be used to support preparation for Workshop 2 and for future secondary data analysis. Video recordings allow for the consideration of body language, facial expressions, and gestures at specific body map locations that would be missed with using audio recordings alone.

A key consideration is to allow the discussion to follow the PWLE's direction. Each experience is unique, so different prompts and questions are required to truly explore each. Potential probing questions to explore the body maps include asking about why specific colours and images were used. This exploration of the thought and meaning attached by each PWLE to their body map is the beginning of participatory data analysis as participants are engaged in exploring the meaning of the data they created (i.e., their body map).

2.6 Virtual Workshops

2.6.1 Preparation for Workshop 2

In preparation for Workshop 2, the research team summarizes the experiences shared during the co-analysis of the body maps (from Workshop 1, Session 3). It provides recommendations on the research directions under study, including barriers and facilitators identified by PWLE. The recordings of the body map discussions can be used to guide the creation of the summaries as required. Summaries should rely

on the words PWLE used and not an interpretation of them. For example, if a PWLE described “seeing things,” this phrase should be used and not changed to “hallucinations.” The summaries can simply list the experiences shared; these do not need to be grouped by themes or analyzed in any way. The goal of the summaries is to expose all PWLE to the experiences of members of the group they were not part of due to the group's division. As well, an overview of any relevant research directions or outcome measures that may not be familiar to PWLE should be shared. For example, an overview of outcome and experience measures explaining each and providing examples can support PWLE in understanding the workshop content and allow them to reflect and prepare for the workshop.

2.6.2 Workshop 2 goal and overview/ key considerations

Workshop 2 is held approximately one week after Workshop 1 to allow for the generation of the summaries described above. The workshop is approximately four hours long. Further co-analysis and co-synthesis of the experiences depicted in the body maps are the goals of the workshop. These goals are met through facilitated discussions, each focused on a subset of the research directions (and/or their underlying barriers and facilitators) and on outcome measures.

The experiences depicted in the body maps are discussed to more deeply co-analyze and co-synthesize a unified experience as guided by the PWLE. Co-analysis begins using the summary of the research directions to guide the discussion. Experiences are discussed to explore their meaning, similarities, and differences. Co-synthesis occurs through the crafting a narrative that weaves shared experiences into a cohesive story. PWLE then generate outcome and experience measures related to the guiding research directions through a discussion where PWLE share what outcome and experience measures are important in evaluating the research direction of interest. Co-synthesis again occurs when the research team and PWLE group common outcome and experience measures. Specific tools are not necessarily discussed, as the focus is on understanding the meaning of the outcomes and experiences discussed. If part of the research direction, barriers and facilitators described in the body maps are discussed, and PWLE can add to them. Co-analysis begins by exploring the meaning of the barriers and

facilitators to PWLE. This supports co-synthesis by supporting the research team and PWLE in grouping common barriers and facilitators together.

There is one key consideration for Workshop 2: technological support. One facilitator should be designated for this role. They will collaborate with PWLE to ensure they can fully access the virtual platform, including the ability to mute and unmute their microphone.

2.6.3 Preparation for Workshop 3

Following Workshop 2, a survey listing the research directions (including barriers and facilitators if relevant), as well as the outcome and experience measures, is created. This survey will be used in Workshop 3 for PWLE to prioritize the recommendations. It can be pilot tested with the facilitators to ensure it functions as intended by the team.

2.6.4 Workshop 3 - Prioritize research direction

Workshop 3 occurs approximately 2 weeks following the previous workshop to allow for reflection, survey creation, and testing. It is approximately 2.5 hours long to support time for prioritization and discussion. The goal of Workshop 3 is to prioritize the research directions (including barriers and facilitators if relevant) and the outcome and experience measures using the nominal group technique.^{139,146–150} At the start of the virtual workshop, the prioritization survey is emailed to the PWLE. The PWLE are instructed to complete the survey independently in a given time period (typically less than 30 minutes to facilitate discussion and subsequent re-prioritization). All responses are anonymous. After all PWLE complete the survey or the allotted time to complete the survey has run out, the responses are reviewed by the research team to support the upcoming group discussion. Using survey software that analyzes and ranks the responses, such as Microsoft Forms, is ideal. The research team's review focuses on the ranking of responses and the identification of the most agreed and least agreed upon responses.^{139,146–150} For example, if a research direction is ranked highly by all PWLE, it would be widely accepted. If some PWLE ranked a research direction high and others ranked it low, it would be less agreed upon.

When all PWLE have rejoined, a discussion occurs that begins with the least agreed-upon research directions. PWLE discuss how and why they prioritized these research directions in relation to others. This discussion may lead to rephrasing research directions for clarity or consistency with the lived experience and combining similar research directions. The discussion moves to the most agreed-upon research directions, which usually require minimal editing. This process occurs again for the outcome and experience measures, as well as barriers and facilitators if relevant.

As these discussions occur, a research team member simultaneously creates a second survey. This survey captures all the changes (e.g., rephrased or combined research directions) from the discussions of the first survey results. After the first survey discussion is complete, or there are approximately 30 minutes left in the workshop, the second survey is shared with PWLE to complete, following instructions similar to the first survey. Time permitting, the findings of the second survey are shared with the PWLE, after which the workshop ends.

There are two key considerations for Workshop 3. The first is technological support. This role was again assigned to a single facilitator, who also supported the creation and revision of the second survey. The second is using a survey platform, such as Microsoft Forms, that automatically analyzes responses. This allowed the facilitators to review the prioritizations and quickly identify where responses aligned and diverged. If such software is not used, more time will be required for this Workshop to allow facilitators to analyze the responses and reach agreement.

Box 3: Overview of the Model Actioned in the Case Example
Workshop 1 The words generated by PWLE of their physical, mental, and emotional experiences and feelings related to early mobility in the CSICU were recorded and posted in the workshop room throughout the 3 session days to allow PWLE and facilitators to reflect on them. Probing questions used to explore the body maps included asking why specific colours were used (for example, why red was used for pain or why bright colours were included) and why specific images were used (for example, why dumbbells were included or why rabbits were included). Preparation for Workshop 2 This is the summary shared with PWLE prior to Workshop 2:

Summary of Body Mapping June 4-6, 2024

Experience of early mobility

- Foggy/ fuzzy memory
- Start with a body scan – am I alive, am I in pain, am I ok?
- Being able to move means survived surgery!
- Lots of tubes and IVs and things to manage
- Lots of pain, mostly not from the surgery (not chest or leg)
- Frustration with not being independent
- Knew would be tough to do but necessary part of recovery
- Want to get home so this is an important early step
- Need encouragement and help to mobilize (related to pain, lack of motivation, all the lines and tubes)
- Keeping a positive attitude helps
- Easy to feel embarrassed or awkward

Early definition

- Day of surgery
- 5-6 hours after surgery
- Day after surgery
- 2 days after surgery
- Not until out of ICU
- Person specific! Tie to assessments and meeting milestones rather than a specific timeframe

Mobility definition

- Sit and stand at the side of the bed
- Sit in a chair/ commode
- Move arms and legs in bed
- Walk

Barriers to early mobility

- Brain “fuzziness”
- Weakness
- Fear
- Unclear source of pain
- “Paraphernalia”
- Poor sleep/ food/ appetite
- Lack of energy

Facilitators of early mobility

- Positive attitude
- Being encouraged/ forced/ helped
- IV pole
- Messaging that mobility means getting out of “this world” (hospital) and back to your world
- Education about comorbidities interacting and causing unclear discomfort
- Seeing others moving and leaving hospital
- Education about post-operative care

- Being given a choice of when to mobilize
- Being given repeated reminders to mobilize
- Good food
- Confidence in team and system due to team explanation and history of success of program

Workshop 2

In Workshop 2, PWLE discussed the definitions of early, ranging from the day of surgery to not until out of ICU. PWLE came to the consensus that the definition of early needs to be person-specific and tied to patient assessments rather than a specific post-operative timeframe. PWLE then discussed the definition of mobility, which ranged from sitting and standing at the side of the bed to ambulation. PWLE came to the consensus that mobility needs to be defined on a spectrum of activities that reflect how they need to move to go home. They then generated barriers, facilitators, and outcome and experience measures, as shown below. Outcome measures were grouped into cognitive, mental, and physical outcomes to align with the components of PICS.

Barriers

- Brain “fuzziness”
- Weakness
- Fear
- Unclear source of pain
- “Paraphernalia”
- Poor sleep/ food/ appetite
- Felt not like self, uncertain of what capable of, not weak necessarily, not sure if can do what being asked to do

Facilitators

- Positive attitude
- Being encouraged/ forced/ helped
- IV pole
- Messaging that mobility means getting out of “this world” (hospital) and back to your world
- Education about comorbidities interacting and causing unclear discomfort
- Seeing others moving and leaving hospital
- Education about post-operative care
- Being given a choice of when to mobilize
- Being given repeated reminders to mobilize
- Good food
- Confidence in team and system due to team explanation and history of success of program
- No pain (MICS)
- Staff – kindness, supportive
- Engaging with family and friends

Outcome Measures

- Physical
 - Light-headedness/ dizzy
 - SOB
 - Confidence in moving (related to packing and incisions) re bleeding or bumping it
 - No remember doing ADLs in ICU (they did it all), on CSIU they brought stuff to the chair to do there, felt good to go do it ‘for real’ in the bathroom

- Cognitive
 - Do you feel foggy?
 - Do you feel confused?
 - Are you seeing anything strange/ odd/ hallucinating?
 - Care partner question for sure – do they seem confused/ are they hallucinating
- Mental
 - No symptoms
 - Are you focused on the positive or the negative?

Experience Measures

- Care and attention from nurses and doctors
 - MD coming into see even when not working
 - Making feel like you matter
 - Nurses being attentive and helpful not making feel like a burden
 - Not being made to feel like a bother when ringing for help

Preparation for Workshop 3

The barriers, facilitators, and outcome and experience measures were used to create a survey in Microsoft Forms by EKP. This survey was sent to JLH, AG, and KS to pilot test and ensure instructions for completion were clear.

Workshop 3

The group discussion led to several wording changes in the survey, which improved the agreement when the second survey was shared.

Post-Workshops

Upon completion of all workshops, the prioritized recommendations for research directions can inform future research. See Box 4 for an example of how experiences can inform future research. The prioritized outcome and experience measures can also inform the evaluation of future research. The outcome and experience measures identified provide a roadmap for the evaluation components that are important to PWLE. These could be incorporated as primary and secondary outcome measures in future research. If relevant, barriers and facilitators can be used to identify areas of focus to support the implementation of future interventions. See Box 5 for an example of how barriers and facilitators identified using this model are being used to inform future intervention development and implementation. Finally, narrative inquiry can be conducted using video recordings of the body map facilitated discussion. This deeper analysis can compensate for the shortcomings of compositional interpretation, specifically the lack of consideration for the production of the image and its interpretation by a broader audience.²⁸

A narrative inquiry approach allows for data and investigator triangulation and the inclusion of interpretation by multiple research team members, along with the image creator. This analysis can include PWLE to support the findings, retaining the lens of embodied knowledge of their lived/living experience. The findings from a narrative inquiry should be used alongside the co-analyzed and co-synthesized findings to drive/inform future research directions.

Box 4: Post-Workshops

In the case example, the experiences are being incorporated into the development of an early mobility intervention. For example, the extent of brain “fuzziness” and the experience of early mobility meaning survival and moving towards getting home is being incorporated into education about supporting early mobility in the CS ICU. The top three barriers and facilitators are also being incorporated into the developing early mobility intervention. The outcome and experience measures identified will be used to guide the development of the evaluation of this early mobility intervention.

The shortcomings of compositional interpretation were balanced through narrative inquiry¹⁴⁰ of the transcripts of the workshop discussions and participant observation¹⁵⁴ of the videos of the body map presentations. Narrative inquiry focuses analysis on plotlines, thematic structures, and social and cultural references, rather than on the smaller scope of words and phrases as in other qualitative methodologies.¹⁵⁵ It allows for richer descriptions of shared experiences.¹⁴⁰ Narrative inquiry follows the typical thematic analysis process of developing codes, identifying patterns among codes, and organizing the codes into categories and themes.¹⁵⁵ To ensure that PWLE’s gestures and body language were analyzed, the videos of PWLE presenting their body maps and of the other PWLE watching the presentations were used as sources of data. Participant observation aimed to incorporate tone of voice and facial expression with the body maps and discussions with PWLE. This non-verbal communication accounts for over 90% of the communication of emotions,¹⁵⁶ so using participant observation of the videos supported a richer analysis.

3. Discussion

In this article, a participatory model for patient and care partner engagement was introduced that extends Oravec et al.’s 2022 model (integrating patient perspectives in research) with the addition of arts-based practices to maximize polyvocality to ensure that research-informed interventions are directly relevant to those with lived experiences. We assert that using arts-based participatory approaches to design research questions, conduct data collection or perform analysis and synthesis assists in operationalizing the collective voice of all team members effectively. In our model, data were collected

and analyzed through the creation and discussion of body maps that depict the experience, emotions, and feelings related to a research question. The initial analysis was then synthesized through virtual workshops to generate tangible and novel contributions to the extant body of literature and current practice(s). This model is novel, as there is a lack of guidance for using arts-based research methods beyond data collection for PER.⁶⁵

This model builds upon an existing model for integrating patient experiences into research analysis and interpretation.¹⁴⁵ It describes a process to generate and prioritize the embodied experience of a research question.¹⁴⁵ The research question of the case example of the model described in this article focuses on embodied knowledge concerning senses, experience, emotions, and feelings, which are less easily put into words.^{65,140,141,157} Different research methods exist to explore different research questions.^{158,159} The research method should align with the research question.^{158,159} Therefore, a variety of research methods must exist and be accessible to researchers. The current model offers access to a research method that can be used to explore research questions centred on the embodied knowledge of lived experience, senses, emotions, and feelings rather than thoughts and opinions.

Integrating lived experience into CS research is valuable and has been demonstrated in several studies. One example is the development of a mobile health application to support enhanced recovery protocols.⁴³ Engaging PWLE led to key design and content elements that would have been missed without their engagement.⁴³ Tailoring the design and content to the needs of PWLE is logical, as the end users of the mobile health application. Similarly, there is logic in engaging people who have undergone CS to determine care preferences and outcomes. PWLE have preferences and prioritized outcomes that both align with and diverge from clinicians and researchers.¹³⁸ For example, a scoping review and virtual consultation workshop identified 140 patient and caregiver preferences and 19 outcomes.¹³⁸ The workshop participants generated 21% of the patient and 66% of the caregiver preferences included in the study results.¹³⁸ Said another way, one-fifth to two-thirds of lived experience preferences were missing from the literature prior to this publication. Similarly, 22% of the patient outcomes and 100% of the

caregiver outcomes were generated from the workshop.¹³⁸ Including PWLE adds value to cardiac surgery research by ensuring that research aligns with the priorities of PWLE, the end users of cardiac surgery. Finally, there are 22 enhanced recovery recommendations following cardiac surgery.^{87,139} Implementing so many recommendations simultaneously is challenging for many cardiac surgery centers, particularly when they are implemented all at once.¹³⁹ Using the nominal group technique, PWLE identified the priority recommendations for pre-operative, intra-operative, and post-operative time points.¹³⁹ This supports aligning clinical care with the priorities of the end users of healthcare, PWLE.¹³⁹ Expanding engagement from perspectives, thoughts, and opinions to include senses, experiences, emotions, and feelings will further align cardiac surgery research with the end users of cardiac surgery and further improve the care they receive. The model described in this article provides such a participatory methodology.

3.1 Key Considerations

3.1.1 Time

The workshops in the model described in this article were completed over a 4-week period. This amount of time was required to allow for the collation of the initial analysis from Workshop 1 and to support institutional ethical requirements. When planning for PER, realistic timelines are required as meaningful engagement does extend the time to complete research.¹⁶⁰ This time investment is well spent when the research results better align with the end users of the research, PWLE.

3.1.2 Money

The model described in this article includes compensation of PWLE for their time. This requires funding. Suggestions for compensation and differentiating compensation from reimbursement exist.¹⁵² These should be reviewed before submitting a grant to ensure the budget accurately reflects the compensation suggested.¹⁶¹ It is also important to discuss compensation options with PWLE. Compensation can impact income level and may lead to issues with social support services.¹⁶² Early and

open conversations about the amount and form of compensation are required to ensure that compensation is not a barrier to engagement.

3.1.3 Safeguards to Reliving an Experience

Exploring experiences, emotions, and feelings through arts-based methods can cause participants emotional stress.⁶⁵ Appropriate supports are required for PWLE who struggle with reliving their experiences, emotions, and feelings.⁶⁵ Art therapy has been used to support people in healing from traumatizing experiences, so the process of using art for engagement may be both stressful and cathartic.⁶⁵ Regardless, open communication among facilitators and PWLE is required to support PWLE while reliving their experiences, emotions, and feelings.

4. Conclusion

Ensuring maximal buy-in from the ultimate end user of research-informed interventions impacting/affecting patients' and care partners' lives requires creative methods to engage PWLE in research. Engaging PWLE is integral to generating research evidence that aligns with patient and care partner priorities and generating knowledge to improve healthcare systems.^{2,135,136} Verbal methods for PER are valuable to learn thoughts and opinions.^{138,139} Exploring the layered complexities of embodied knowledge (senses, experiences, emotions, and feelings) of a health-related issue requires different methods, arts-based methods, such as body mapping.^{65,140,141,157} Using novel methods required an understanding of the process. This article describes the process of using an arts-based participatory methodology for data collection, analysis, and synthesis. Co-creating body maps, co-analysis, and co-synthesis of the data leads to tangible and novel contributions to the literature that focus on embodied knowledge of the senses, experiences, emotions, and feelings of PWLE. These can be used to improve the healthcare system.^{2,135,136}

List of Abbreviations

CS- cardiac surgery

ICU- intensive care unit

PER- patient engagement in research

PWLE – people with lived experience

Declarations

Ethics approval and consent to participate

Institutional review board approvals for the case study exemplar were obtained in March 2024 (HE2024-0035 and RRC/2024/2158). All PWLE reviewed and signed a consent form prior to participating in the workshops of the described case study. PWLE were made aware that consent was an ongoing process, and they could withdraw consent until data analysis began, at which point it was no longer possible to remove their data from the study. No PWLE withdrew their consent.

Consent for publication

Not applicable.

Availability of data and materials

Data are available from the corresponding author upon reasonable request.

Competing interests

RCA has received honoraria from Edwards Lifesciences, Medtronic, Serb Pharmaceuticals, HLS Therapeutics and Bioporto. RCA has also served on the Advisory Board for Alexion and Renibus Therapeutics Inc. None of these are relevant to this manuscript. The other authors declare no competing interests.

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Authors' contributions

SOM, AMC, and EKP conceptualized this manuscript. EKP drafted and revised the manuscript. SOM, AMC, AG, KS, and JLH provided initial feedback on missing elements from the workshops and what they perceived to be key elements to highlight. All other authors reviewed, revised, and approved the final version of the manuscript.

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None.

Appendix 5.1

Table 5.3. Guidelines for Reporting Involvement of Patients and the Public Checklist

Section and topic	Item	Reported on page No
Section 1: Abstract of paper		
1a: Aim	Report the aim of the study	n/a
1b: Methods	Describe the methods used by which patients and the public were involved	n/a
1c: Results	Report the impacts and outcomes of PPI in the study	n/a
1d: Conclusions	Summarise the main conclusions of the study	n/a
1e: Keywords	Include PPI, "patient and public involvement," or alternative terms as keywords	n/a
Section 2: Background to paper		
2a: Definition	Report the definition of PPI used in the study and how it links to comparable studies	7-8
2b: Theoretical underpinnings	Report the theoretical rationale and any theoretical influences relating to PPI in the study	7-8
2c: Concepts and theory development	Report any conceptual models or influences used in the study	n/a
Section 3: Aims of paper		
3: Aim	Report the aim of the study	16
Section 4: Methods of paper		
4a: Design	Provide a clear description of methods by which patients and the public were involved	18-20
4b: People involved	Provide a description of patients, carers, and the public involved with the PPI activity in the study	17
4c: Stages of involvement	Report on how PPI is used at different stages of the study	18
4d: Level or nature of involvement	Report the level or nature of PPI used at various stages of the study	18
Section 5: Capture or measurement of PPI impact		

5a: Qualitative evidence of impact	If applicable, report the methods used to qualitatively explore the impact of PPI in the study	20
5b: Quantitative evidence of impact	If applicable, report the methods used to quantitatively measure or assess the impact of PPI	20
5c: Robustness of measure	If applicable, report the rigour of the method used to capture or measure the impact of PPI	n/a
Section 6: Economic assessment		
6: Economic assessment	If applicable, report the method used for an economic assessment of PPI	n/a
Section 7: Study results		
7a: Outcomes of PPI	Report the results of PPI in the study, including both positive and negative outcomes	n/a
7b: Impacts of PPI	Report the positive and negative impacts that PPI has had on the research, the individuals involved (including patients and researchers), and wider impacts	n/a
7c: Context of PPI	Report the influence of any contextual factors that enabled or hindered the process or impact of PPI	n/a
7d: Process of PPI	Report the influence of any process factors, that enabled or hindered the impact of PPI	n/a
7ei: Theory development	Report any conceptual or theoretical development in PPI that have emerged	n/a
7eii: Theory development	Report testing of theoretical models, if any	n/a
7f: Measurement	If applicable, report all aspects of instrument development and testing (eg, validity, reliability, feasibility, acceptability, responsiveness, interpretability, appropriateness, precision)	n/a
7g: Economic assessment	Report any information on the costs or benefit of PPI	n/a
Section 8: Discussion and conclusions		
8a: Outcomes	Comment on how PPI influenced the study overall. Describe positive and negative effects	n/a
8b: Impacts	Comment on the different impacts of PPI identified in this study and how they contribute to new knowledge	n/a
8c: Definition	Comment on the definition of PPI used (reported in the Background section) and whether or not you would suggest any changes	n/a

8d: Theoretical underpinnings	Comment on any way your study adds to the theoretical development of PPI	n/a
8e: Context	Comment on how context factors influenced PPI in the study	n/a
8f: Process	Comment on how process factors influenced PPI in the study	n/a
8g: Measurement and capture of PPI impact	If applicable, comment on how well PPI impact was evaluated or measured in the study	n/a
8h: Economic assessment	If applicable, discuss any aspects of the economic cost or benefit of PPI, particularly any suggestions for future economic modelling.	n/a
8i: Reflections/critical perspective	Comment critically on the study, reflecting on the things that went well and those that did not, so that others can learn from this study	n/a

PPI=patient and public involvement

Appendix 5.2

Understanding the Lived Experience of Early Mobility Using Body Mapping Standard Operating Procedure

Background & Objectives

There is a lack of literature sharing the experience of early mobility of patients and their care partners following cardiac surgery (CS) in the intensive care unit (ICU). This silencing of their experiences limits our understanding and capacity to produce research aligned with their experiences and address their health needs. From a pragmatist worldview, this also means that critical knowledge is missing, as experience is required to know.^{24,26} The lack of definition of early mobility in the CS ICU provides the opportunity to produce a definition co-informed by people with lived experience (PWLE), clinicians, researchers, and the literature. Successful early mobilization requires an understanding of barriers and facilitators perceived by PWLE so these can be integrated into the implementation of the intervention and support feasibility, acceptability, and fidelity. Finally, outcome measures used to evaluate early mobility interventions should include outcome and experience measures. The overall goals of this workshop are to co-create with PWLE partners: 1) an understanding of the experience of mobility in the CS ICU, 2) a definition of early mobility, 3) identify of barriers and facilitators to early mobility, and 4) select outcome and experience measures. See Table 5.4 for an overview of the goal and output of each workshop.

Table 5.4. Overview of Workshop Goals and Outputs

Workshop Number	Goal	Output
1	Create and co-analyze body maps	Body maps Videos of discussions of body maps
2	Co-create a definition of early mobility Generate a list of barriers, facilitators, outcome, and experience measures	Definition of early mobility List of barriers, facilitators, outcome and experience measures
3	Prioritize barriers, facilitators, outcome, and experience measures	Prioritized barriers, facilitators, outcome, and experience measures

People Involved

We will form a PWLE engagement panel of 8-12 patients and care partners to align with recommendations for group size to facilitate discussion and participation.¹⁵¹ The inclusion of care partners was suggested by the current PWLE study partners, who shared the difficulty of remembering the ICU hospitalization and the key role their care partners play in helping them to piece together memories of the time. Patients and care partners will be recruited from the Patient and Family Advisory Councils at St Boniface Hospital (SBH) and the Winnipeg Regional Health Authority, a growing body of previous cardiac patients and care partners from SBH who have participated in previous panels, and a database of past CS patients agreeable to further consultation. Inclusion criteria will be older adults over the age of 65 who have undergone or adults over the age of 18 who have had a loved one undergo elective or semi-urgent outpatient CABG, valve CS, or a combination of the two at SBH in the last five years, are cognitively able to participate in consultation workshop, have access to the internet and an electronic device, are willing to reflect on personal experiences relating to CS and share these in a group setting, can speak and read English, and consent to be recorded.

Administrative Considerations

Team Members & Roles

- Facilitators: Emily, Sheila, April, Kathy

- Technology Support: Jacqueline

Equipment/ Supplies

- Room with large tables
- Paper 6 feet long x 3 feet wide
- Writing paper
- Pens
- Pencils
- Coloured construction paper
- Markers
- Crayons
- Pencil crayons
- Paint
- Paint brushes
- Scissors
- Glue
- Tape
- Sticky notes
- Letter stencils
- Magazines
- Audio recorder(s)

Process

Body mapping involves creating a life-size tracing of a body, in the position of the person's choosing, which is then filled in based on reflections to questions shared in the workshop.^{66–70} The body maps can be filled in with paint, markers, crayons, collage, or words in whatever way is meaningful to

the PWLE creating the body map.^{66–70} This diversity in how reflections are shared supports the shift in power from researchers to PWLE, as PWLE determine how they will share their knowledge.^{66–70} The combination of creativity and reflection^{67–70,72} leads to a deeper, embodied self-awareness and understanding of identity and knowledge created.⁶⁸

Preparatory Work

Prior to the formal workshops, the consent form will be shared, either a physical or electronic copy. The consent form will be signed prior to the commencement of the first session of the first workshop. Demographic information will be collected at this time, including age, self-identified ethnicity, and CS history.⁴³ As recommended,^{163,164} participants will be asked about assigned sex at birth and their gender identity. To examine gender as a continuous variable, PWLE will complete the validated GENESIS-PRAXY Gender Questionnaire.¹⁶⁵

Workshop 1 (3 x 3-hour long sessions)

To reduce the group size and to maximize the time for each PWLE to share their experience, the larger PEP will be split in half and each half will attend one of two body mapping workshops. These workshops will occur over 3 consecutive days. In each workshop, PWLE will be asked to share their experiences of early mobility and reflect on what that experience felt like through the creation of a body map. Following the creation of the body maps, participants will be asked to share an explanation of what they have depicted on their body maps in a video-recorded group discussion.^{67–70,72} This process will provide an understanding of the experience of PWLE of early mobility and will begin to co-create a definition of early mobility.

Session 1 Agenda

Welcome, land acknowledgement, and meeting overview (5 min activity) (5 mins total) *Led by Emily*

Recording reminder: Remind everyone they're being recorded

Land acknowledgement: On behalf of all of us here today living on the land of the Indigenous people, we would like to acknowledge that the University of Manitoba campuses are located on the original lands

of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Introductions (5 min activity) (10 mins total) *Led by April & Sheila*

Initiated by Emily, then everyone introduces themselves moving counter-clockwise

You were asked to bring a small item that is important to you – can you show us that item and share why you picked it?

Following introduction share insights on how each person has a different important item and rationale for that favourite which reflects the diversity of our thoughts and experiences. This exercise also started our journey in putting meaning into an item which is embodiment in action and is what we are doing together!

Creating a Safe and Creative Space and housekeeping (5 min activity) (15 mins total) *Led by Kathy*

Confidentiality, no “right” answers, listening to others, not speaking over each other

Location of bathrooms

Supports available as required

Presentation (10 min activity) (25 mins total) *Led by Emily*

Why are we here, what are we doing, what do we hope to achieve, why it’s important

Talk about CS program and approach – not researching you but engaging you to 1) co-create an understanding of the experience of mobility in the CS ICU, 2) a definition of early mobility, 3) identify of barriers and facilitators to early mobility, and 4) select PROMs and PREMs.

Target endpoints – today and overall

Joint ownership of study findings. Possibilities include authorship through a group name or specific name listed in the acknowledgements. After the study, can share name and contact info of participants who are

interested in potential future collaborations as well as to further explore the ideas we come up with through this workshop.

Activity #1: Reflections on Early Mobility (60 min activity) (85 mins total)

QUESTION: We ask you to think back to your time in ICU, which may be a bit fuzzy and even overwhelming. When you reflect on the experience, we ask you to focus in on your first experiences of mobilization – can you tell us about that experience and what was happening?

Prompts (always try to get at the why behind answers):

What do you remember thinking?

How did you feel physically?

How did you feel mentally?

How did you feel emotionally?

What words would you use to describe mobilizing?

What stood out to you?

PWLE will reflect on the above questions and begin to determine what they wish to share about their experience. This can occur through writing, drawing, conversation recorded on audio recorder or another way that is meaningful to the PWLE.

BREAK (10 min activity) (95 mins total)

Activity # 2: Body Mapping Planning (60 min activity) (155 mins total)

Question: Next, we want to explore how to move these stories into body maps. To support our work tomorrow, we ask you to first consider the position of your body. What position do you want your arms in? Beside your torso, by your head? What about your legs? How do you want to share your reflections via your body map? What images come to mind when you reflect on your experience?

Prompts (always try to get at the why behind answers):

What position do you want your body to be in?

What colours do you want to use?

What textures do you want to use?

How will you explain the meaning of what you share via a legend?

What supplies do you need that are not available?

BREAK (10 min activity) (165 mins total)

Group check-in (10 min activity) (175 mins total) *led by Sheila*

How is everyone feeling after the reflections?

Are there any ah-ha moments that you wish to share?

If you wish, you can draw your initial response to planning body mapping.

Closing remarks and evaluation (5 min activity) (180 mins total) *led by April & Kathy*

Thank all for their time and reflections

Share plan for next day

Debrief

Once all PWLE have left, the facilitators will debrief and reflect on the questions posed in Figure 5.2.

These learnings will be applied to future meetings.

Session 2 Agenda

Welcome, land acknowledgement, and meeting overview (10 min activity) (10 mins total) *Led by Emily*

Recording reminder: Remind everyone they're being recorded

Land acknowledgement: On behalf of all of us here today living on the land of the Indigenous people, we would like to acknowledge that the University of Manitoba campuses are located on the original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Activity: Body Map Creation (155 min activity) (165 mins total)

QUESTION: Based on your reflections and planning from yesterday, how do you want your body positioned to show your experience of early mobility in the CS ICU?

Facilitators and PWLE to help with tracing the outline of bodies.

All art supplies requested will be available.

Breaks throughout as required.

Group check-in (10 min activity) (175 mins total) *led by Sheila*

How is everyone feeling after the reflections?

Are there any ah-ha moments that you wish to share?

From yesterday's work and your body mapping creation, is there anything in this process that intrigues you, surprises you, and is concerning to you...Why?

Closing remarks and evaluation (5 min activity) (180 mins total) *led by Kathy & April*

Thank all for their time and reflections

Share plan for next day

Debrief

Once all PWLE have left, the facilitators will debrief and reflect on the questions posed in Figure 5.2.

These learnings will be applied to future meetings.

Session 3 Agenda

Welcome, land acknowledgement, and meeting overview (5 min activity) (5 mins total) *Led by Emily*

Recording reminder: Remind everyone they're being video-recorded

Land acknowledgement: On behalf of all of us here today living on the land of the Indigenous people, we would like to acknowledge that the University of Manitoba campuses are located on the original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of

the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Activity: Sharing Body Maps (125 min activity) (130 mins total) (107mprove.20 min/ PWLE)

QUESTION: Can you show and explain your body map to us?

BREAK (10 min activity) (140 mins total)

Group discussion (30 min activity) (150 mins total) *led by Sheila*

Bringing it all together: what final thoughts and reflections would folks like to share after hearing from the whole group today?

Closing remarks and evaluation (5 min activity) (180 mins total) *led by April & Kathy*

Debrief

Once all panel members have left, the facilitators and the rest of the research team will debrief and reflect on the questions posed in Figure 5.2. These learnings will be applied to future meetings.

Workshop 2 (4 hours)

Audio-recorded group discussions with all PWLE will continue virtually on MS Teams to refine the co-created definition of early mobility, identify barriers and facilitators to early mobility, and select outcome and experience measures to support intervention evaluation.

Materials Provided to Participants

To facilitate group discussions and share the experiences of early mobility among PWLE who attended each body mapping session, the PWLE will be presented with summaries from the body mapping workshop and an overview of outcome and experience measures. These will be generated from the discussions from Workshop 1 Session 3.

Agenda

Welcome, land acknowledgement, and meeting overview (5 min activity) (5 mins total) *Led by Emily*

Recording reminder: Remind everyone they're being recorded

Land acknowledgement: On behalf of all of us here today living on the land of the Indigenous people, we would like to acknowledge that the University of Manitoba campuses are located on the original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation. We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Introductions (5 min activity) (10 mins total)

Initiated by Emily, then everyone introduces themselves moving counter-clockwise

Please tell us your name and a boring detail about yourself.

Ground rules (5 min activity) (15 mins total) *Led by April?*

During our meetings, please:

Arrive at least five minutes early so that we can start and end on time.

Keep your audio muted until you are ready to speak.

In order to ensure that everyone has room to express themselves, please raise a “virtual” hand or wave your actual hand (if your camera is on) to get a facilitator’s attention if you’d like to say something.

Speak up! We want to hear from everyone.

Share the airtime. We want to ensure that everyone has the opportunity to speak.

Be respectful of others’ viewpoints.

If someone says something that you disagree with, instead of telling them that they’re wrong, ask the questions of why they think it works (e.g., “Help me understand – how would that work or how has that worked for you?”).

Actively participate.

Keep to the topic under discussion as we have limited time together.

Respect confidentiality where appropriate.

Let us know when you do not want to answer a question or share an experience.

Avoid use of chat function

Did we miss anything???

Presentation (10 min activity) (25 mins total) *Led by Emily*

Why are we here, what are we doing, what do we hope to achieve, why it's important

Share overview of body mapping and main takeaways

Target endpoints – today and overall

Joint ownership of study findings. Possibilities include authorship through a group name or specific name listed in the acknowledgements. After the study, can share name and contact info of participants who are interested in potential future collaborations as well as to further explore the ideas we come up with through this workshop

Activity #1: What Early Mobility Means and How It Should Be Defined (60 min activity) (85 mins total)

QUESTION: What does “early mobility” mean you?

Prompts (always try to get at the why behind answers):

When does it start?

What does it look like?

What does it feel like?

How would you explain early mobility to another patient?

Suggested approach to ensure that the group doesn't get stuck on one point: round-robin format – ask everyone to state two to three ideas, next person indicate the ideas that they agreed with (have facilitator put checks beside them), and then add any others that haven't already been shared. Next round, everyone will have the opportunity to build upon any of the ideas that have been shared. Then will go to open sharing format (box analogy – start with outlining edges, then shading details in).

BREAK (10 min activity) (95 mins total)

Activity # 2: Barriers and Facilitators (60 min activity) (155 mins total)

QUESTION: Based on our previous discussion about what early mobility is, what are the barriers to early mobility? What about facilitators?

Prompts (always try to get at the why behind answers):

Why is this a barrier?

Why is this a facilitator?

Is the opposite true? Would the opposite of a barrier be a facilitator?

Suggested approach to ensure that the group doesn't get stuck on one point: round-robin format – ask everyone to state two to three ideas, next person indicate the ideas that they agreed with (have facilitator put checks beside them), and then add any others that haven't already been shared. Next round, everyone will have the opportunity to build upon any of the ideas that have been shared. Then will go to open sharing format (box analogy – start with outlining edges, then shading details in).

BREAK (10 min activity) (165 mins total)

Activity # 3: Outcome and Experience Measures (60 min activity) (225 mins total)

QUESTION: What outcome and experience measures are important when we evaluate early mobility research?

Prompts (always try to get at the why behind answers):

Does it cover everything you felt/ experienced?

How would you explain the importance of that outcome/ experience to a researcher?

What does that outcome mean to you?

What does that experience measure mean to you?

Suggested approach to ensure that the group doesn't get stuck on one point: round-robin format – ask everyone to state two to three ideas, next person indicate the ideas that they agreed with (have facilitator put checks beside them), and then add any others that haven't already been shared. Next round, everyone will have the opportunity to build upon any of the ideas that have been shared. Then will go to open sharing format (box analogy – start with outlining edges, then shading details in).

Closing remarks and evaluation (5 min activity) (230 mins total) *Facilitated by*

Debrief

Once all PWLE have left, the facilitators and rest of the research team will debrief and reflect on the questions posed in Figure 5.2. These learnings will be applied to future meetings.

Workshop 3 (2.5 hours)

Following these discussions, we will begin the refinement towards prioritizing barriers and facilitators along with selecting outcome and experience measures. Consensus techniques will be used to prioritize the barriers, facilitators, and outcome and experience measures. Similar to a project completed by members of my committee,¹⁴⁵ a thematic summary of the PWLE-identified barriers, facilitators, and outcome and experience measures will be presented and a modified Delphi technique^{166,167} will be used to prioritize the barriers and facilitators and then the outcome and experience measures. This virtual session will use an online survey to allow for the anonymity of responses.^{166,167} Two rounds of prioritization will occur via Google Forms with a discussion between focused on the initial prioritization from least agreement to most agreement.¹⁴⁵

Materials Provided to Participants

The research team will generate a thematic summary of barriers, facilitators, and outcome and experience measures based on the transcript from the group discussion.

Agenda

Welcome, land acknowledgement, and meeting overview (5 min activity) (5 mins total) *Led by Emily*

Recording reminder: Remind everyone they're being recorded

Land acknowledgement: On behalf of all of us here today living on the land of the Indigenous people, we would like to acknowledge that the University of Manitoba campuses are located on the original lands of Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of

the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

Ground rules (5 min activity) (10 mins total) *Led by Kathy*

During our meetings, please:

Arrive at least five minutes early so that we can start and end on time.

Keep your audio muted until you are ready to speak.

In order to ensure that everyone has room to express themselves, please raise a “virtual” hand or wave your actual hand (if your camera is on) to get a facilitator’s attention if you’d like to say something.

Speak up! We want to hear from everyone.

Share the airtime. We want to ensure that everyone has the opportunity to speak.

Be respectful of others’ viewpoints.

If someone says something that you disagree with, instead of telling them that they’re wrong, ask the questions of why they think it works (e.g., “Help me understand – how would that work or how has that worked for you?”).

Actively participate.

Keep to the topic under discussion as we have limited time together.

Respect confidentiality where appropriate.

Let us know when you do not want to answer a question or share an experience.

Avoid use of chat function

Did we miss anything???

Activity #1: Prioritization of Barriers and Facilitators (20 min activity) (35 mins total)

REQUEST: Using the Google Forms link emailed to you, please prioritize the barriers and then the facilitators from most to least important.

Brief analysis of responses (10 min activity) (45 min total) by the research team

Group discussion (20 min activity) (65 mins total) *led by Emily*

Beginning with the least agreed-upon barriers, why are these not important? Why are others more important?

Beginning with the least agreed-upon facilitators, why are these not important? Why are others more important?

Activity #2: Re-Prioritization of Barriers and Facilitators (20 min activity) (85 mins total)

REQUEST: Using the Google Forms link emailed to you, please prioritize the barriers and then the facilitators from most to least important.

BREAK (10 min activity) (95 mins total)

Activity #3: Prioritization of Outcome and Experience Measures (20 min activity) (105 mins total)

REQUEST: Using the Google Forms link emailed to you, please prioritize the outcome and then the experience measures from most to least important.

Brief analysis of responses (10 min activity) (115 min total) by the research team

Group discussion (20 min activity) (135 mins total) *led by Emily*

Beginning with the least agreed-upon outcome measures, why are these not important? Why are others more important?

Beginning with the least agreed-upon experience measures, why are these not important? Why are others more important?

Activity #3: Prioritization of Outcome and Experience Measures (20 min activity) (155 mins total)

REQUEST: Using the Google Forms link emailed to you, please prioritize the outcome and then the experience measures from most to least important.

Closing remarks and evaluation (5 min activity) (160 mins total) *led by April*

Debrief

Once all PWLE have left, the facilitators and rest of the research team will debrief and reflect on the questions posed in Figure 5.2. These learnings will be applied to future meetings.

Debriefing

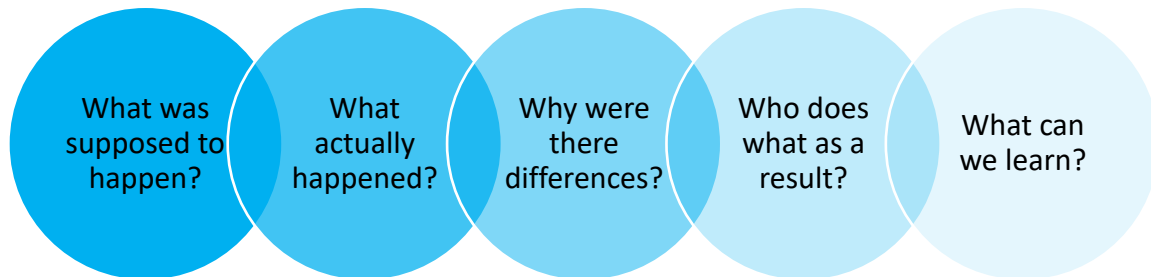


Figure 5.2. After action review. Modified from: <https://workshopbank.com/after-action-review-aar>

Brief Discussion of the Manuscript

Guidance on how to use ABMs to engage PWLE in research is lacking, limiting researchers' ability to use powerful approaches in engagement research. The manuscript that is embedded in this chapter provides a detailed description of the methods as a model to guide other researchers in the future. Rather than summarizing the methods used in the three half-day, in-person workshops and two 4-hour-long virtual workshops in sections of the findings manuscripts, I sought to describe the preparation for each workshop, the goals of each workshop, and how these were achieved. By splitting the reporting of the preparation and goals of each workshop away from the reporting of the results gained through the approach provides researchers with a model to use in their own studies. Describing how we applied the model to our own work provides a tangible example that helps researchers understand how to apply it. We also provide guidance on how to engage PWLE throughout the research process. We describe how data were co-analyzed and co-synthesized with PWLE during the workshops and how a deeper analysis of the recordings of the body map presentations can also include PWLE. This supports researchers in engaging in a meaningful way beyond only data collection.

Chapter 6 : Early mobility to improve health outcomes following cardiac surgery (EVE)

Clinical Trial Development: Findings from Workshop 1 – Embodied Experiences of Early Mobility

Preface to the Manuscript

This manuscript continues the needs assessment, the first step in intervention mapping.^{9,10} Although PWLE experiences are not explicitly included in intervention mapping literature, the worldview guiding this research, pragmatism, values these experiences. As noted in Chapter 1, through a pragmatic worldview, knowledge is derived from experience and is contextual.^{24,26} For a problem to be understood, the experiences of PWLE are required. PWLE may not be driving early mobility behaviours in the CSICU, however, they are participating in these behaviours. For this reason, their experiences should be considered alongside those of clinicians and the literature.

Manuscript Status

Under revision for publication in *Frontiers in Rehabilitation Sciences*.¹⁶⁸ The author original manuscript version is included in this thesis document.

Authors

Emily K. Phillips, Jacqueline L. Hay, April Gregora, Kathy Smith, Anna M. Chudyk, Carly Shaski, Gavin Bozek, Sarah Gilchrist, Andrew Fagan, Maureen C. Ashe, Annette S. H. Schultz, Rakesh C. Arora, MD, Todd A. Duhamel, & Sheila O’Keefe-McCarthy.

Contributions of Authors

This study was conceptualized by Drs. Duhamel, Arora, Schultz, and O’Keefe-McCarthy and me as part of the engagement plan for my dissertation. Dr. O’Keefe-McCarthy and I conceptualized the methods used in study and analyzed the data. Jacqueline L. Hay, April Gregora, Kathy Smith, Dr. O’Keefe-McCarthy, and I planned and facilitated the workshop sessions and began data analysis. Carly Shaski, Gavin Bozek, Sarah Gilchrist, and Dr. Fagan provided clinical expertise to inform data analysis.

Jacqueline Hay supported the creation and revision of the main figure. As the first author, I drafted the original manuscript and revised it based on feedback from authors and reviewers. All authors reviewed, revised, and approved the final manuscript.

Manuscript

Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Trial

Development: Findings from Workshop 1 – Embodied Experiences of Early Mobility

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Abstract

Using arts-based research methods to engage people with lived experience (PWLE) supports the exploration of embodied knowledge, including senses, expressions, emotions, and significant meaning. Understanding embodied experiences may support closing the know-do gap. The experiences of PWLE are missing from the early mobility literature after cardiac surgery (CS), which may explain why it is poorly integrated into clinical care. This article describes the findings of a study arts-based research method (body mapping) to explore the embodied knowledge of early mobility in the CS intensive care unit (ICU). Body mapping involves participants creating a life-size tracing of a body in a position of their choice. The tracing is then filled with various art media, reflecting participants' lived experiences in response to the questions posed by the researchers. Three workshop sessions were held during which 1) the project, team, and body mapping process were introduced; 2) participants created body maps; and 3) body maps and the participants' experiences were discussed and co-analyzed by participants and researchers using compositional interpretation. Video recordings of the discussions and co-analysis were further analyzed using narrative inquiry and participant observation to build on the initial analysis. Eight patients and two care partners participated. Body mapping and compositional interpretation uncovered previously unknown embodied knowledge, including emotions and feelings, which were presented alongside medical equipment. Further analysis uncovered the significant impact of mobility on patients following CS, highlighting the importance of being seen as a person rather than just a patient. Also uncovered were the positive emotions associated with early mobility in the CSICU and the need to feel mentally prepared for mobility post-CS. Engaging PWLE using arts-based research methods uncovered embodied experiences related to early mobility that were missing from the literature. These embodied experiences can inform novel interventions or approaches to enhance clinical care and research, thereby supporting successful mobilization and potentially improving patient health outcomes.

Keywords

1. Cardiac surgery
2. Intensive care
3. Early mobility
4. Patient and public involvement
5. Patient engagement in research
6. Arts-based research methods

Body mappin

5. 1. Introduction

In patient engagement in research (PER), people with lived experience (PWLE) of the health issue being studied are meaningfully and actively involved throughout the research process.^{32,135,136} Internationally, PER is recognized as important in generating knowledge to improve the healthcare system.^{32,135,136} Verbal communication methods have dominated PER thus far.^{65,137} This dominance limits the knowledge available to the research process to that which can be put into words. Arts-based research methods, which utilize various forms of art throughout the research process, offer an alternative approach to broaden the knowledge gained from PWLE.⁶⁵ Using arts-based research methods for PER can elicit embodied knowledge, which cannot be conveyed through words alone.^{65,140,141,157,169} Embodied knowledge can be defined as knowledge gained from and residing in the body.¹⁴¹ It includes elements of senses, expressions, emotions, and significant meaning.^{65,140,141,157,169} A narrative review explored how arts-based research methods have been used for PER and shared artistic methods, research stages, levels of engagement, and impacts, along with examples of how to use various artistic methods for PER.⁶⁵ Using arts-based research methods for this purpose has been associated with a deeper understanding of the lived experience through their embodied knowledge.⁶⁵ Arts-based research methods were further noted to be a decolonizing approach to conducting research and an effective way to flatten the power dynamic between PWLE and researchers and to reduce the sense of tokenism that can occur in PER.⁶⁵

Understanding the experiences of PWLE and integrating these into interventions may align the conceptualization and understanding of phenomena among researchers, clinicians, and patients and support closing the know-do gap.^{2,32} The know-do gap is the disconnect between research production and its translation into clinical care.¹⁻³ For example, research findings are often applied to only 60% of patients 15 years after publication.¹ A specific example for this study is the concept of early mobilization following cardiac surgery (CS) while in the intensive care unit (ICU). Early mobility interventions have been associated with improvements in patients' physical health outcomes following cardiac surgery.⁷⁶⁻⁷⁸ They have also been shown to be safe for patients after cardiac surgery in the intensive care unit (ICU)^{82-85,89,90} and are a guideline recommendation.^{86,87} Despite its benefits, safety, and recommendations, integration of early mobility into CSICU clinical care is inconsistent.^{7,132} Importantly, experiences of PWLEs regarding early mobility in the CSICU are largely absent from the current literature. This limits the ability to understand and incorporate this valuable source of knowledge into interventions to align conceptualization among stakeholders and support their use in clinical care. Using arts-based research methods to explore experiences with early mobility in the CSICU would provide embodied knowledge of experiences to help close this know-do gap by allowing for alignment of the conceptualization and understanding of early mobility among researchers, clinicians, and patients.^{2,32}

A prospective study, using the arts-based research method of body mapping^{66-68,70,170} to engage PWLE who have undergone cardiac surgery and been admitted to a CSICU, was undertaken. Bodies are an essential source of knowledge.¹⁴¹ Body mapping involves each person creating a life-size tracing of a body in the position of their choosing.^{66-68,70,170} Each tracing is then filled in based on personal reflections on questions posed in the workshop.^{66-68,70,170} Their body map can be filled in with paint, markers, crayons, collages, or words in whatever way is meaningful to the PWLE, creating the body map. The final step is for each PWLE to describe their body map and the meaning behind their chosen representation of their experience.^{66-68,70,170} This diversity in how reflections are shared supports the shift in power from researchers to PWLE, as PWLE determine how they will share their knowledge.^{66-68,70,170}

The combination of creativity and reflection^{67,68,70,72,170} leads to a deeper, embodied self-awareness and understanding of identity within a lived experience.⁶⁸

Body mapping reduces the power imbalance between researchers and PWLEs and the sense of tokenism that can exist in PER,⁶⁸ thereby fostering collaboration and meaningful engagement.⁶⁵ PWLE control what and how they share their experience, as there is no “right way” to create a body map.^{70,170} For example, PWLE can position their bodies how they wish, use or exclude anatomic features, and use photographs, words, colours, and their placement to tell their story.^{70,72} PWLE can collaborate and make body maps together or create them individually.¹⁷¹ Finally, body maps can include multiple, smaller bodies depicting several aspects of an experience or story.⁷¹ This expressive freedom supports PWLE in owning both their experience and how it is shared.⁶⁵ By co-analyzing the body maps, as this study did, PWLE also co-own the interpretation of their experience and how it is shared.⁶⁵ A similar process has been used in other body mapping studies and has helped uncover and more deeply explore conflicting feelings around gender.¹⁷⁰ In this way, sharing body maps through guided reflection and discussion among all team members creates a space for co-creating transformative embodied knowledge, which is deeper and more holistic than a discussion alone.^{31,47} By inviting PWLE to share their experiences through body mapping, the experience of early mobility in the CSICU flows from embodied knowledge and meaning of mobility as they lived/experienced it.

The objective of this research was to co-create an embodied understanding of mobility in the CSICU. This is the second article in a three-part series that describes a two-phase study to develop a PWLE-informed understanding of early mobility in the CSICU. The methods are reported in an article that shares our novel workshop model.¹³⁴ Phase 2, reported in a separate article, employed two didactic consultation workshops and the use of nominal group technique to co-create a definition of early mobility, identify barriers and facilitators to early mobility, and select outcome and experience measures for use in future intervention research.¹⁷² Collectively, this work is part of the Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Feasibility Trial Development study.

2. Methods

2.1 Research Design

This work engages PWLE as co-producers of research using an arts-based research method (body mapping). Reporting of this work follows the updated Guidelines for Reporting Involvement of Patients and the Public (GRIPP-2) long form.⁴⁵ See Appendix 6.1 for the checklist.

2.2 Context

This study occurred at St Boniface Hospital, a tertiary hospital in Winnipeg, Manitoba, Canada (detailed elsewhere).¹³² All CS (~1000 annually) in Manitoba are performed at this site, with the majority of procedures including coronary artery bypass grafting (CABG), valve surgery, or a combination of the two.¹³²

2.3 PWLE Recruitment

PWLE were recruited from a database of previous CS patients who had consented to be contacted for future research. Inclusion criteria were adults over 18 who have undergone or had a loved one undergo outpatient coronary artery bypass grafting, valve, or a coronary artery bypass grafting and valve procedure in the last five years, cognitively able to participate in consultation workshop, had access to the internet and an electronic device, were willing to reflect on personal experiences relating to CS and share these in a group setting, and consent to be recorded.

2.4 Equity, Diversity, and Inclusion Considerations

The small group size and the database of patients willing to be contacted for future research limited the potential diversity of our study. Due to this constraint, diversity was prioritized in 1) self-identified gender, 2) patients and care partners, and 3) urban and rural representation. We prompted inclusion through confidential, personalized discussions with each participant prior to the first workshop session, where any required supports were identified. For example, we met one participant in the parking lot with a wheelchair and assisted them to the workshop location due to mobility restrictions. In this way, we supported equitable access to the workshop sessions to promote the ability to participate as required.

PWLE demographics were collected at the beginning of Workshop 1 Session 1 using a questionnaire. Demographics collected included age, their self-identified ethnicity, whether they are a patient or care partner, length of stay in CS ICU post-cardiac surgery, type of cardiac surgery (valve, CABG, valve and CABG, or other), and the year they underwent cardiac surgery:

2.5 Research Paradigm

Engaging PWLE in research requires researchers to believe that reality can differ across experiences and contexts, and to ask questions and seek results relevant to the population of interest.⁶⁵ Such beliefs align with a pragmatic worldview, through which this study was conducted.^{18,25,26} Through such a worldview, knowledge is contextual and is derived from experience.^{24,26} This requires engaging PWLE throughout the research process and privileging their embodied knowledge. Research through a pragmatic worldview also focuses on producing research findings relevant to research users.^{18,25,26} This aligns with the tenets of PER.² Within this worldview, the best approach to gaining knowledge is preferred over reliance on a specific research methodology.^{18,25,26} This supports the use of arts-based research methods for PER, as they can elicit embodied knowledge.⁶⁵

2.6 Researcher Characteristics and Reflexivity

Our diverse research team included a former CS patient (AG), a care partner of someone who had previously undergone CS (KS), a registered nurse who formally worked in the CSICU and doctoral candidate (EKP), a current CSICU registered nurse (CS), a program director with clinical expertise as a critical care nurse (SG), two cardiac surgeon/intensivists (AF & RCA), a patient-oriented researcher (AMC), a physiotherapist with expertise in early mobility (MCA), a clinical exercise physiologist and doctoral candidate with exercise intervention development experience (JLH), a nurse scientist with research expertise in engaged research approaches (ASHS), a nurse scientist with expertise in critical care and arts-based research methods (SOM), and a PhD kinesiology professor (TAD).

Several research team mem'ers' CSICU experiences and roles are provided to clarify the intersection of personal, clinical, and research interests that led to this study, which are important when

considering the power differential from an ethical perspective. EKP has not worked clinically with patients in the CSICU or across the broader CS journey since 2018. RCA has not worked clinically in the CSICU at the study site since 2021. AF and CS currently work clinically in the CSICU. For this reason, they supported only the analysis of de-identified emerging themes to reduce potential power issues and bias.

2.7 Patient Engagement Approach

The approach to engaging PWLE was informed by the Canadian Institutes of Health Research Strategy for Patient-Oriented Research Framework³² and team members' PWLE-engaged scoping review methods and consultation workshops.^{38,138} We engaged 10 PWLE to align with recommendations for group size to facilitate discussion and participation.¹⁵¹ The inclusion of care partners was suggested by the PWLE co-authors, who shared the difficulty of remembering the ICU hospitalization and the key role care partners play in helping to piece together memories of the time.

2.7.1 Levels and Stages of Engagement

A multi-level engagement approach was used. The levels of engagement are defined by the International Association for Public Participation's Spectrum of Public Participation.³³ This spectrum defines engagement along a continuum of increasing impact on research decision-making, from "inform" to "empower".³³ Two PWLE (AG and KS) were engaged at the level of collaborate,³³ which is in the middle of the spectrum and is described as "to partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution".³³ These PWLE partners contributed expertise as members of the research team at all stages of the research through meetings, developing the body mapping workshop plan, co-facilitating the workshops, and co-analyzing the workshop findings.¹³⁷ Additionally, the PWLE that participated in the body mapping workshops were also engaged at the level of consult, which is described as gaining public feedback,³³ during data collection and analysis.¹³⁷ Engaging PWLE at multiple levels enabled this work to be fulsomely guided by lived experiences. Collaborating with PWLE as members of the research team ensured the design and

conduct of the study were informed by lived experiences. Consulting additional PWLE included a broader range of perspectives to inform the study objectives than including only the PWLE partners. It also supported data collection and analysis led by PWLE.

2.8 PWLE Compensation

The levels of engagement informed the compensation provided.¹⁵² Compensation is described for both phases of this study. The PWLE collaborators (AG and KS) were compensated \$25 per hour for their time co-facilitating and co-analyzing. They each dedicated 40 hours to this study, including preparatory time, leading to compensation of \$1000 each. The PWLE consultants were also compensated \$25 per hour for their time. They each dedicated 15 hours to the study, and an additional 4 hours of preparatory time were included, resulting in compensation of \$475 per person. All out-of-pocket expenses were reimbursed, including mileage and transportation.¹⁵²

2.9 Ethical Considerations

This work was conducted in alignment with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2.¹⁴⁴ Institutional review board approvals for the case study exemplar were obtained in March 2024 from the University of Manitoba Research Ethics Board 1 (HE2024-0035) and the St Boniface Hospital Research Review Committee (RRC/2024/2158). All PWLE reviewed and signed a consent form prior to participating in the workshops. PWLE were made aware that consent was an ongoing process, and they could withdraw consent until data analysis began, at which point it was no longer possible to remove their data from the study. No PWLE withdrew their consent.

2.10 Body Mapping

Body maps were created and partially co-analyzed over three three-hour-long in-person workshop sessions in June 2024 (Figure 6.1). These workshops have been described in detail elsewhere.¹³⁴ Briefly, in the first session, PWLE were introduced to one another, the workshop facilitators (SOM, EKP, JLH, AG, and KS), the project, and body mapping. This occurred through facilitated in-person discussions and the sharing of mobility experiences from the PWLE perspective post-CS. All PWLE attended the first

session. For the second and third sessions, PWLE were split into two groups of five to allow the facilitators to support them appropriately. In the second session, body maps were created. The third session involved PWLE sharing their body maps and experiences in a facilitated video and audio-recorded discussion with other PWLE and the workshop facilitators. This is when the analysis of the body maps began. This collaborative process aimed to begin creating a story from the experiences shared by PWLE.¹⁴⁰ Each PWLE was asked to talk about their journey with early mobility in the CSICU and about what they included on their body map. They were asked to reflect on their choices for how they represented their experiences through images, textures, colours, and words. Finally, they were asked what the title of their body map was and why. These recordings were transcribed to allow for a deeper analysis of discussions that included the PWLE collaborators (AG and KS).

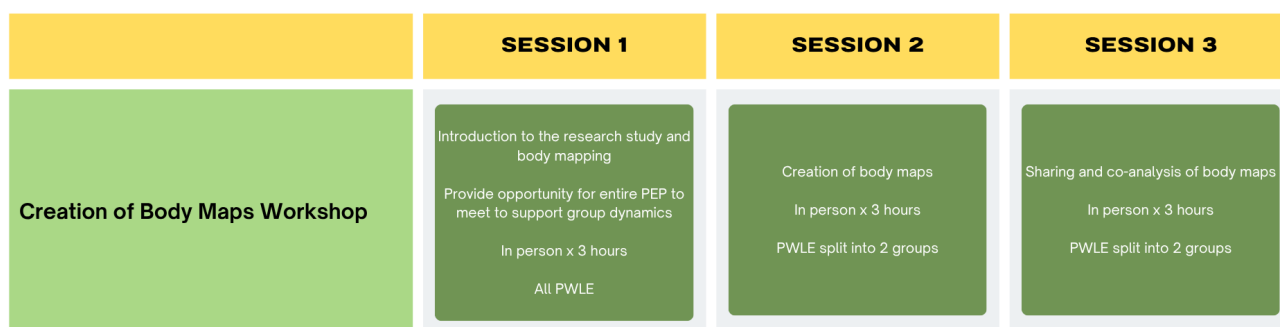


Figure 6.1. Overview of the 3 sessions of the workshop.

2.11 Data Analysis

PWLE demographics were described conventionally using frequencies and proportions for categorical variables. Analysis strategies for the body maps included compositional interpretation, a visual analysis of the body maps,¹⁵³ participant observation, noting the body language, reactions, and expressions in the video recordings,¹⁵⁴ and narrative inquiry, an analysis of the stories shared in the transcripts,¹⁴⁰ further described below. Multiple strategies were used due to the shortcomings of

compositional interpretation.¹⁵³ These shortcomings were balanced through narrative inquiry of the transcripts of the workshop discussions and participant observation of the videos of the body map presentations. The data analysis approach enabled data and investigator triangulation, as two research team members independently analyzed the data (EKP and SOM). This approach also involved exploring the production of the image through the inclusion of PWLE in data analysis, as well as the interpretations provided by multiple research team members, including the body map author. Finally, analyzing data in this way presents the embodied experiences through compositional interpretation and the interpreted results through narrative inquiry and participant observation. In this way, we shared the embodied experiences directly through the PWLE's art and provided a rich analysis of the art and discussions.

2.11.1 Compositional Interpretation

Body map analysis began during session three using compositional interpretation, which focuses on the image created and its impact through content, colour, spatial organization, light, and expressive content.¹⁵³ The analysis of colour includes the dominant hue, the colour saturation, the value, or lightness or darkness of colours, whether the colours are harmonious, and what is stressed with colour.¹⁵³ Analysis of the content of the image includes describing what is shown and what symbols or icons are used.¹⁵³ The analysis of spatial organization looks within the image at the direction of lines and if the image is static or dynamic and expands beyond the image to include the point of view the image is created from.¹⁵³ The light is the use of light to highlight elements of the image.¹⁵³ Finally, the expressive content of the image is the emotive effect of the image, what emotions the image makes one feel.¹⁵³ These elements were included in the questions that guided the conversations where PWLE shared their body maps. The PWLE were asked why certain colours were chosen, what symbols represented, why they positioned their body in the manner they chose for their body map and so on.

Following the third session, the facilitators, including the PWLE collaborators, discussed the body map presentations and reviewed the photographs of the body maps. One PWLE co-author (AG) created a table outlining the elements of each body map and the meaning placed on them by the PWLE.

The other facilitators expanded this table and the first author (EKP) categorized the expanded table into the elements of compositional interpretation. Light was not included in the compositional interpretation as no body maps included this element. The analysis then expanded to include the discussions that occurred when presenting the body maps.

2.11.2 Narrative Inquiry

Narrative inquiry focuses analysis on a larger scope of data, including plotlines, thematic structures, and social and cultural references rather than on the smaller scope of words and phrases more common in other qualitative methodologies.¹⁵⁵ Rather than the more commonly used thematic analysis, narrative inquiry of workshop discussions allows for exploration and richer descriptions of shared experiences.¹⁴⁰ First, two research team members (SOM and EKP) each read and reread the transcripts of the recordings of the PWLE discussing their body maps to gain familiarity. They then independently coded the same four transcripts and discussed the emerging narratives. The remaining four transcripts were then coded and a final discussion of the emerging narratives occurred. The emerging narratives were organized in a table that included names, descriptions, and examples of the narratives. At this point, an overall structure was unclear, as the analysis was not yet complete.

2.11.3 Participant Observation

To ensure that PWLE's gestures and body language were captured and analyzed, the videos of PWLE presenting their body maps and of the other PWLE watching the presentations were also analyzed. This analysis aimed to tie together the art created and the words used to describe the art. Nonverbal communication is important to consider, especially when PWLE are communicating emotions and experiences¹⁵⁶. Elements missing from transcripts, such as tone of voice and facial expression, account for over 90% of communication of emotions¹⁵⁶, so exploring these using participant observation of the videos supports a rich analysis.

Analysis of videos of PWLE discussing their body maps was guided by Spradley's nine dimensions of descriptive observations (Table 6.1).¹⁵⁴ See Figure 6.2 for an overview of this process.

First, a table was created with each dimension. Then, two research team members (SOM and EKP) together watched a video of a PWLE presenting their body map and simultaneously but independently analyzed it based on the elements of each dimension. For example, the room visible on the video was described under Space, and PWLE's gestures while discussing their body map were noted under Activities. As noted by Spradley, each of the nine dimensions is not important in every observation or situation.¹⁵⁴ In these observations, the Space, Objects, Acts, Events, Time, and Goals were consistent and were only noted in the initial video. The focus of observations was on Activities and Feelings. Next, they compared and discussed their observations. They then repeated this process with a second video. They then asynchronously watched and analyzed the remaining six videos. They met to discuss their analyses and the themes arising from their observations. They then repeated this process with the videos of the other PWLE watching a body map being presented. These observations were compared to the themes generated through narrative inquiry and helped to clarify the narrative produced.

Table 6.1. The nine dimensions of participant observation, adapted based on Spradley¹⁵⁴

Number	Label	Description
1	Space	The physical place where the observation occurred
2	Actors	The people /participants involved
3	Activities	A set of related acts that participants perform
4	Objects	Physical things present in the observation
5	Acts	Single actions participants perform
6	Events	Related activities participants perform
7	Timing	The sequence of acts or activities
8	Goal	What are participants trying to accomplish
9	Feeling	The emotions expressed

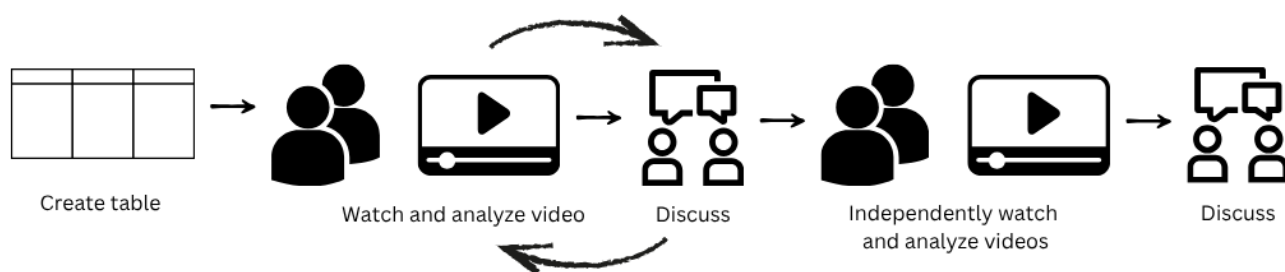


Figure 6.2. Overview of the process of participant observation.

Finally, the first author (EKP) conceptualized the structure of the overall narrative of the experiences of early mobility by combining the findings of the three analyses. The compositional interpretation was also reviewed, and some wording was updated to reflect the overall narrative. These elements were shared with the authors and refined and clarified based on feedback and discussion.

3. Results

A total of 10 PWLE, consisting of 8 patients and 2 care partners, participated in this study. We recruited 4 females/women and 6 males/men. The PWLE included one male/man care partner, one female/women care partner, 3 female/women patients, and 5 male/men patients. Demographic information can be seen in Table 6.2. The PWLE included 2 people self-identifying as Métis, of which 1 also self-identified as Ojibwe. 2 PWLE declined to share their self-identified ethnicity. The ages of the PWLE ranged from 59 to 82, with a median of 69 (interquartile range [IQR] 61-82). Their median CSICU length of stay was 5 days (IQR 3-30).

3.1 Compositional Interpretation

The compositional interpretation of the body maps is shared as three components: colour and content, spatial organization, and expressive content. The complete compositional interpretation can be found in Table 6.3. An overview is described below. Two examples of body maps can be seen in Figures 6.3 and 6.4.

3.1.1 Colour

Vivid colours dominated all the body maps, such as rich reds and saturated black. Several of the body maps included vivid yellows, pinks, blues, and greens. The colours were harmonious both within each body map and among all the body maps. Colours were used to stress pain, happiness, joy, and depression and pieces of equipment, such as chest tubes and intravenous lines.

3.1.2 Content

The content of the body maps included lines and tubes, brain fog, attitude, pain, dizziness or instability, being happy to be alive, and hallucinations. These were expressed mainly through symbols and icons. For example, pipe cleaners were used to depict lines and tubes. Cotton balls and question marks around the head were used to depict brain fog. Pain was depicted in several ways, such as scissors stabbing the lower back (P6) and red lines on the legs (P10). Rocks on the ground depicted a sense of instability (P6).

3.1.3 Spatial Organization

All body maps were organized anatomically with lines following a typical body shape. Three were sitting, all facing left, while five were standing or lying flat; it is not possible to differentiate between the two positions. One body map (P9) has arms in two positions, crossed across the chest and at the sides. This body map also included a large heart. This was described by P9 as both the pillow they used to splint their chest and as symbolic of his large heart that took everything from CS and recovered. All PWLE stated that their body map was their experience, but their experience is from the perspective of another looking at them, rather than from their perspective internally.

3.1.4 Expressive Content

Four key emotions were noted in the body maps: joy, pain, sadness, and confusion. On the body map of P8, joy was expressed using bright, vivid colours and the inclusion of heart stickers around the words “Happy to be Alive.” Pain was expressed with vivid and saturated reds and blacks, the use of squiggly lines, and the word pain. Sadness was expressed in one body map, P6, by black around the head. Finally, confusion was expressed using cotton balls or question marks around the head.

Table 6.2. Demographics of PWLE participants

Participant ID	Age	Sex assigned at birth	Self-identified Gender	Self-identified ethnicity	Role (Patient or care partner)	ICU LOS	Type of CS	Year of CS
P1	82	Male	Man	Irish	Patient	5 days	CABG + Valve	2021
P2	68	Male	Man	n/a	Patient	Unknown???	Valve	2022
P4	60	Female	Woman	White	Patient	6 days	CABG + Valve	2023
P5	63	Male	Man	Metis	Care Partner	6 days	CABG + Valve	2023
P6	70	Male	Man	Participant left blank	Patient	30 days	CABG	2023
P7	59	Female	Woman	Caucasian	Patient	3 days	Valve	2022
P8	80	Female	Woman	Canadian-French	Patient	7 days	valve	2023
P9	75	Male	Man	white/Caucasian	Patient	3 days	CABG	2023
P10	73	Male	Man	CDN	Patient	5 days	CABG	2023
P11	60	Female	Woman	Metis/Ojibwe	Care Partner	3 days	CABG	2023

Table 6.3. Compositional Interpretation of the Body Maps of the Lived Experience of Early Mobility After Cardiac Surgery

Content and Colour							Spatial Organization	Expressive Content
	Lines/ Tubes	Brain Fog	Attitude	Pain	Dizziness/ stability	Happy to be alive	Hallucinations	
All								From perspective of another but describing their experience
P1	Pipe cleaner	Written	Written	Unclear				Laying face up on back
P2		Cotton balls/ zzzzzz		Back: dark red lines, blue coils Gout: red areas	Holding onto IV pole			Laying face up on back Pain Confusion
P4/5	Pipe cleaner	Cotton balls				Background of bright colours, sun, happy face		Sitting facing left Joy
P6	Pipe cleaner	Cotton balls/ ????	Negative/ depressed: black around head	Red scissors in back	Black rocks and light blue waves under feet			Sitting facing left Pain Confusion Sadness

P7	Drawn in blue			Background (red heart, coloured flowers, sun, words)	Glued on bunnies	Laying face up on back, body cut out from rectangular paper	Pain Confusion
P8	Pipe cleaner			Back: squiggly red lines leading to back with pain written	Written in thought bubbles, heart stickers	Laying face up on back	Joy Pain
P9/11		?? Around head	Positive: written in bold words			Laying face up on back Arms in 2 positions Heart very large	Joy Confusion
P10	Dra'n	X's' & O's in ink		Legs: red squiggly lines		Sitting facing left	Confusion Pain

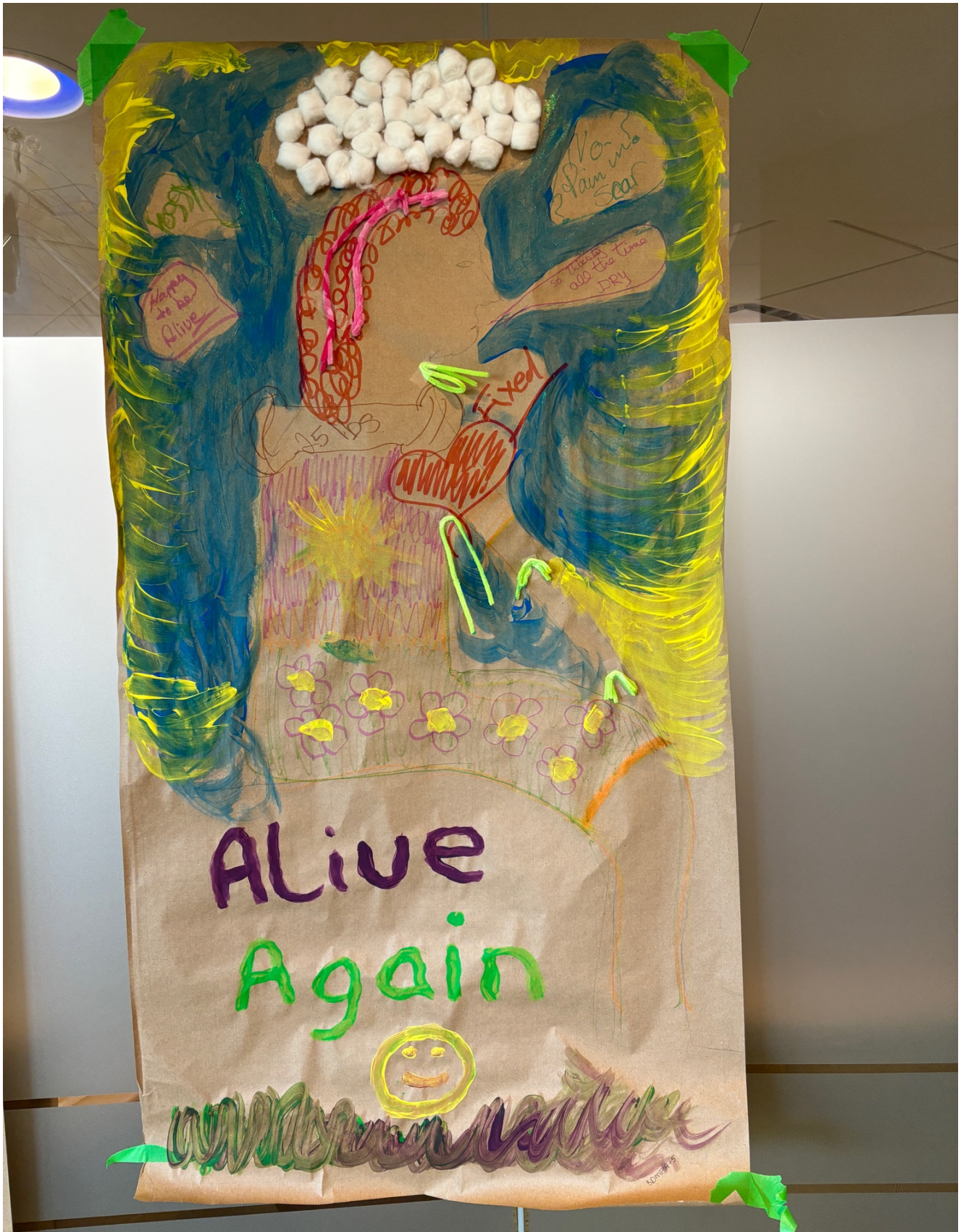


Figure 6.3. Body map of P4/5.

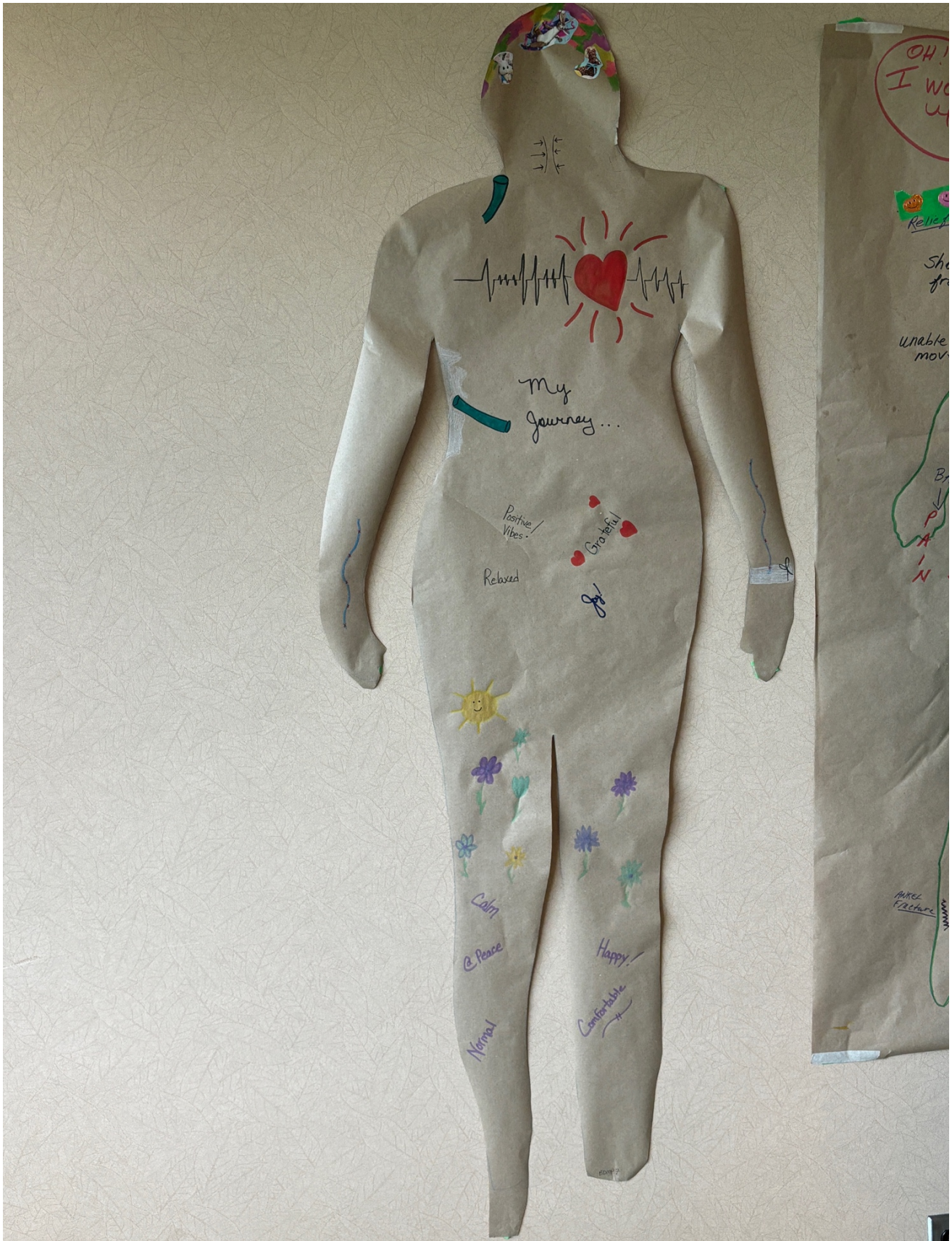


Figure 6.4. Body map of P7.

3.2 Embodied Experiences of Early Mobility

Five themes and twelve categories were generated from the three data sources. The themes are Making Meaning of Movement, the Paradox of Movement, Moving Through the Emotions, Person-First, and Attitude. These themes and the corresponding categories are described below. Quotations are included as exemplars to illustrate the themes. The quotations are taken from the PWLE's descriptions and explanations of their personal body maps. They are unedited. See Figure 6.5 for a visual overview of the themes and categories.

3.2.1 Making Meaning of Mobility

The theme of Meaning Making of Mobility was generated by PWLEs, who described mobility as more than just moving post-operatively. Three categories comprise this theme: movement means I survived, move to get home, and motivation to move. These categories are summarized below with details and participant quotations available in Table 6.4. Mobility was regarded a sign of survival. PWLE extended our current understanding of mobility and discussed it in relation to what their lives at home required of them. PWLE described what motivated them to move. These motivations related to what was important to them.

3.2.2 The Paradox of Movement

This theme was generated the categories of tensions around moving and symptoms. These categories are summarized below with details and participant quotations in Table 6.5. This paradox simultaneously pushed PWLE to mobilize and pulled them toward sedentary behaviour. The tensions around moving arise from knowing that one needs to move post-CS, but moving is problematic because ICU equipment and healthcare provider support are required. Symptoms were described through art on the body maps and through conversations, including difficulty sleeping, depression, difficulty swallowing, hallucinations, wobbly on feet, pain/ discomfort, fuzziness/ grogginess/ confusion. These symptoms led PWLE to avoid early mobility. See Table 6.3 for an overview of how symptoms were depicted on body maps.

3.2.3 Moving Through the Emotions

Mobility after CS was explained as an emotional experience. Three categories fall under this theme: being restricted, happy to be alive, and redefining self. These categories are summarized below with details and participant quotations available in Table 6.6. PWLE described oscillating from being frustrated and embarrassed about being restricted by medical equipment to being happy to be alive and taking this opportunity to redefine themselves through mobility. PWLE figuratively moved through these emotions while moving after CS. Furthermore, these emotions were driven by or stemmed from mobility.

3.2.4 Attitude

PWLE noted the importance of their attitude and how this impacted how they understood the value of early mobility after surgery and their willingness to be open to knowledge, support, and assistance from others. Two categories fall under this theme: positive attitude and if you know, you can endure. These categories are summarized below with details and participant quotations available in Table 6.7. PWLE shared that their attitudes were driving factors in moving after CS, either driving them to move or to be sedentary. Being prepared for CS by knowing what to expect post-CS was important to PWLE. This helped them mentally plan for their recovery which helped them endure the recovery process and the symptoms they experienced.

3.2.5 Person-First

Being seen, understood, and treated like an individual rather than another surgical patient helped to get PWLE moving. This theme includes the categories of individualized care and support and kindness from care partners and healthcare providers. These categories are summarized below with details and participant quotations available in Table 6.8. Since recovery requires a team of multidisciplinary healthcare providers, family, and friends, each team member needs to see, understand, and treat the patient as an individual to motivate them to move.

Table 6.4. Theme 1: Making Meaning of Mobility

Category	Explanation	Example
Movement means I survived	Movement while waking following CS was perceived as an immediate sign that PWLE had survived their CS. PWLE frequently described waking from surgery and, before opening their eyes, moving their hands and feet to ensure they were alive.	“Once I kinda woke up so to say, I moved my hands, arms, legs and I feel OK, I can...Everything is working yeah” (P1).
	Moving in the CSICU was a sign to PWLE that they had survived their cardiac journey. They could feel that the limitations on their bodies due to their cardiac issues were resolving. This signalled to them that they survived and could reclaim their lives and their identities through movement.	The title of P4/5’s body map, “Alive Again” (Figure 7.3).
Moving to get home	Multiple meanings were attached to the ability to move post-CS. For some, it was linked to being able to live the life they chose and that <i>movement</i> within that context was an integral part of living that life.	“I...I knew that was going to help me get out of there faster and try to get back to my regular life” (P2).
	Another PWLE tied moving to the pragmatics of getting home	“Well...to get washed yourself and do all that that was a big treat. And then starting with the walker because people walked with me with the walker until I navigated it. And I felt OK, this isn't so bad and I'm in the house but it's only a bungalow and I thought I should be able to manage” (P8).

Motivation to move	Motivation was deeper than practicalities and being able to complete activities of daily living. It aligned with their personalities, their quirks, or their perceptions of a reward. These motivations were powerful tools to encourage and support mobility in the CSICU.	“...when I was in the ICU with the walker and...I did...the nurses were help me walk down the hall 30 or 40 feet yeah but every day I’d go farther and then when I found out there was ice cream that you can take, then I went all the way around the ice cream.” (P10).
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Table 6.5. Theme 2: The Paradox of Movement

Category	Explanation	Example
Tensions around moving	The tensions around moving arise from knowing that one needs to move post-CS, but moving is problematic because ICU equipment and healthcare provider support are required for previously independent people.	“2 nurses come over to get you out of bed because of all these tubes and paraphernalia. They had to get this out and I'm only moving from here to where you're sitting at the sit in the chair...” (P1).
	PWLE perceived that the effort required to support them in getting out of bed was potentially higher than the benefits. This caused tension for them as they recognized the value of mobility in their recovery.	“I'm glad I got kicked out of bed...I find that the more I get forced to get up the better I feel.” (P2).
Symptoms	Symptoms experienced post CS led PWLE to avoid early mobility.	“You know, everything is fuzzy. Everyone said it is. Everybody, when you first wake up even...even all through that that first evening, that first night and for me anyway, until the next day, it was still...you were still foggy...” (P4). “Maybe little depressions on the ground for instability. When I first stood up after this, I was a little bit unstable I had to use the walker. I used a walker to get to the chair” (P6).

“Then when I did try to move, that's what this is about was the back pain. I could not get over the back pain, it took over all the other pain really” (P8).

Table 6.6. Theme 3: Moving Through the Emotions

Category	Explanation	Example
Being restricted	Not being able to move freely, even in bed, due to feeling restricted, was frustrating for PWLE. This sense of being restricted seemed to move beyond the physical. The embarrassment and frustration that PWLE felt was seen and heard through participant observation.	“You know, you can't move very much, you can't roll over this way to relieve your back, roll that way, you need help sitting up exactly help moving, going to chair or going to the bathroom. You need help. A little bit of frustration and embarrassment.” (P6). This PWLE was gesturing side to side more aggressively than in other parts of the conversation when talking about rolling. Their tone of voice changed to be harsher and halting. When this PWLE said embarrassed, their eyebrows came together, and their voice softened. In this way, they both described and embodied the emotions of frustration and embarrassment which were tied to mobility.
Happy to be alive	Feelings of happiness at being alive after CS co-existed with negative emotions. PWLE discussed how symptoms that previously negatively impacted them were now gone. “It”...it's my...my freedom of...of having...living again” (P4). This PWLE tied being able to get up and walk to being alive. Tying mobility to being happy to be alive is also seen in the Compositional Analysis of the body maps. For example, the background of bright colours, sun, and a happy face in P4/5 and the	

red heart, coloured flowers, sun, and words on the body map of P7.
See Figures 7.3 and 7.4.

Redefining self	Moving after CS made many PWLE pause and redefine themselves. They reflected on how the differences in moving after CS impacted them beyond mobility and how this carried through into their lives. Changes in how they move cause them to pause and reflect and apply the changes to redefine themselves mentally as well as physically.	“Yeah it slowed me down. I don't...well, I still do things in a hurry, but not as fast as I used to...it did make me stop you realize that, you know, you don't have to rush everything. But that it really didn't have so much to do with my heart, like it wasn't a physical condition it was more of a mental...a mental condition” (P9/11).
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Table 6.7. Theme 4: Attitude

Category	Explanation	Example
Positive attitude	Having a positive attitude towards early mobility was key to PWLE.	“...went in with the, you know, my attitude is you have to have a good attitude. I believe the staff, you know doctors and the nurses and whatnot, they have attitude to come and care for you, you know. They don't know you, you don't know them, but if you win with a positive attitude, everything's gonna work out fine. That usually does, so 'hat's important” (P1). This is also seen in the title of P1's body map, “Attitude is Everything.” The value of a positive attitude was noted in participant observation. As P1 shared their body map and discussed the above quote, P2 nodded emphatically in agreement.
If you know, you can endure	Knowing what to expect related to early mobility helped PWLE prepare for it.	“I was informed of that (pain from surgery when moving). I was aware of that there was a period of time, which wasn't that long, that I know I'd have to endure and I could. I felt I could overcome

it. I was aware of it ahead of time and as expected, so big deal. That was of no surprise and then I was prepared for it” (P2).

Knowing what to expect went beyond symptoms and included knowing about the importance of mobility.

“I knew I had to start moving. If you don't move, you lose it” (P8).

It also related to how mobility was key to being discharged from the hospital: “My attitude was, I want you to check off all the boxes so I can go home...if I have to be mobile, I’ll be mobile, if I have to do this, I’ll do that...” (P2).

Table 6.8. Theme 5: Person-First

Category	Explanation	Example
Individualized care		
Recognizing the patient as a person and how mobility impacts their life was an important way to individualize care and support early mobility.		
Individualized care also included how post-CS care needed to be tailored to the type of surgery done, for example alternative access. “It's (movement) a priority for me. I live on acreage, I have to maintain, and if I can't maintain it then, you know, my whole lifestyle is going to change so...so I was fighting to maintain a lifestyle. That wasn't looking too good with the situation I was in...” (P2).		
“Everybody assumed I had the, chest (open sternotomy), so everyone was like ‘cross your arms cross your arms,’ and I was like no, I don't have that” (P7).		

Support and kindness from healthcare providers and care partners

A simple gesture that recognizes the patient as a person was supportive in helping PWLE get moving after surgery.

“That's Hector, the orderly, yeah. Horrible food and the nurses told me you know what, Hector can make you real coffee and Hector brought me coffee in the morning and it was so good, it was real good coffee. Anyways so that that's my ode to all of the caregivers” (P10 describing why he included a cup of coffee on his body map).

Care partners, such as family, were also important sources of support and kindness. They could help remind patients of what was waiting for them at home.

“She (their care partner) was there being positive and she would just talk about home and the cat, so you know, the normal things that we were doing...so that was very helpful and in and making sure that I move forward to... that was a key part” (P9).

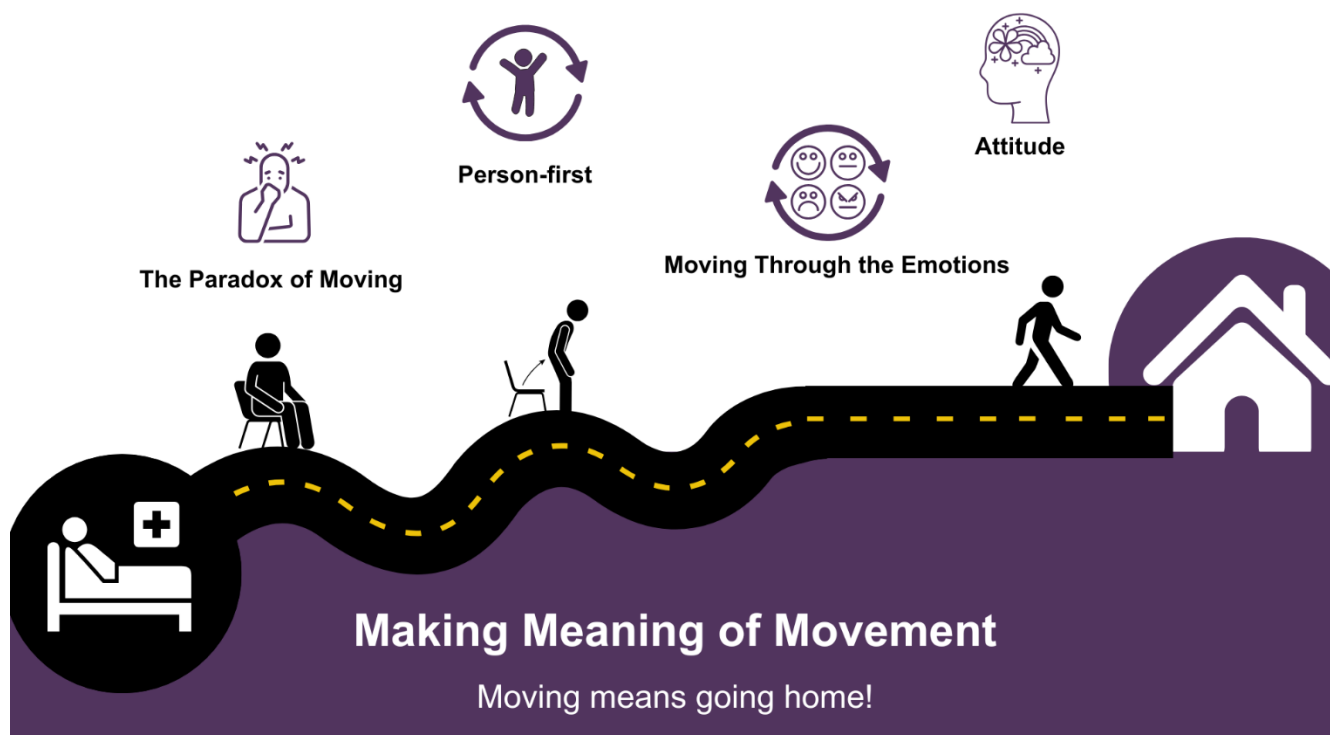


Figure 6.5. The themes developed to understand the embodied experience of early mobility in the cardiac surgery intensive care unit

4. Discussion

Exploring the embodied experience of early mobility in the CSICU through PWLE engagement in creating body maps uncovered novel elements of the experience previously missing from the literature. The use of an arts-based research method for PER allowed PWLE to share their early mobility experiences in a personal way, conveying their senses, positive and negative emotions, and feelings alongside their medical equipment and surgical wounds. A narrative inquiry of the stories shared about body maps yielded five themes and 12 categories. Several of these are novel findings that describe previously missing components of the embodied experience of early mobility that paradoxically push patients towards mobilizing and pull them towards being sedentary. This paradox more fulsomely describes the experience of early mobility in the CSICU, which may support clinicians and researchers in better supporting early mobility practices in the CSICU. Finally, the positive impact of using an arts-

based research method for PER and the benefits that PWLE shared about the engagement process using an arts-based research method suggest that such approaches should be considered in future research to support engagement.

4.1 Body Mapping and Compositional Interpretation

To our knowledge, this is one of the first studies to use body mapping to explore experiences of early mobility in the CSICU. Body mapping was first used in research in the early 2000s, investigating the experiences of people from South Africa living with HIV.^{66,67,71,170} Since then, body mapping has been used to examine sources of strength and support for people in treatment for problematic alcohol and other drug use,⁶⁷ drugged bodies and injecting drugs,⁷¹ with youth exploring how sexual and reproductive health relates to their social situation,¹⁷⁰ the experiences of women with mental health disorders or psychosocial distress,⁷² with marginalized women,⁶⁸ and body image and premenstrual changes to eating and exercise practice.⁷⁰

The use of compositional interpretation to analyze body maps is a novel contribution to the literature. The existing body mapping literature has used a variety of analytical methodologies. Critical visual narrative analysis has been used to explore body map production and related discussions.¹⁷¹ An analysis of symbols, including their placement and descriptions, using coding software has also occurred.¹⁷³ Analysis focused on transcripts of the discussions relating to body maps is much more common. Some authors use body maps to triangulate such an analysis.^{70,170,174} Others simply focus their analysis on the transcripts and employ thematic,^{67,175–177} content,⁷² narrative,¹⁷⁸ or discourse analysis.¹⁷⁹ Others share no specific methodology for analysis, describing only their visual examination of the body maps^{180,181} or their discussions with participants about body maps and transcripts.¹⁸²

This study offers a more rigorous visual analysis methodology for exploring the content of the body maps¹⁵³ rather than limiting the analysis to discussions of the body maps. Embodied knowledge is of the body and cannot be reduced to words,¹⁴¹ so excluding the image from data analysis does not allow for a true understanding of the embodied experience. Relying on a description of the body map excludes

senses, expressions, emotions, and the significant meaning found directly in the art.^{65,140,141,157,169} Had the body maps not been analyzed using compositional interpretation, the many ways that pain was felt and how instability is experienced would not have been fully understood. The intensity and range of emotions expressed through the vivid colours, from joy (vivid yellow, blue, and green) to sadness (black), would have been reduced by reading the transcripts of the discussions alone. Thus, to understand the embodied experience, both data collection and analysis must include arts-based research methods.

4.2 Embodied Experiences of Early Mobility

Exploring the embodied experience revealed several novel elements of early mobility in the CSICU. Using arts-based research methods for PER revealed the significant impact of mobility on patients following CS, highlighting the importance of being seen as a person rather than just a patient. Also uncovered were the positive emotions associated with early mobility in the CSICU and the need to feel mentally prepared for mobility following cardiac surgery. These elements are embodied knowledge, as they are emotions and feelings that reside in the body and thus cannot be expressed only in words.

The themes of Making Meaning of Movement and Person-First are novel findings that this study contributes to the extant literature. The themes are an outcome of engagement, as without facilitating PWLE to share their experiences, questions related to these would not have been considered by the research team. Embodied understanding the meaning behind movement is important for researchers and healthcare providers. This can be leveraged to support the implementation of future early mobility interventions. These findings challenge the predominance of a biomedical lens when applying knowledge about early mobility for patients undergoing CS to consider adopting an understanding for integrating a patient-first approach in consultation with the person who is having surgery. In this way, incorporating patient-related mobility goals based on their attached meanings and connection to their pre-operative lives would be the starting point in executing the plan for mobility post-CS, linking mobility to relevant outcomes that will motivate the patient to meet evidence-based and guideline-supported post-operative

mobility outcomes. Messaging about the importance of early mobility following CS can be tailored to patients by linking to what is meaningful to them and by focusing on the person first.

Moving Through the Emotions related to early mobility has been described by one other study more narrowly.¹⁸³ The emotions discussed in that study most closely reflected the categories of Being Restricted and Redefining Self, as the authors described a mix of emotions experienced while patients struggle to retain independence and normal life through early mobility.¹⁸³ They specifically mention that patients felt unprepared for the effort, weakness, and perceived lack of control they experienced.¹⁸³ These authors also shared how patients felt helpless as they required healthcare providers to support them in mobilizing.¹⁸³ This view limits the emotions to seemingly negative ones, missing the category Happy to Be Alive. This balance in emotions is an important contribution of the current work and is another engagement outcome. Understanding the positive emotions associated with early mobility helps researchers and healthcare providers better connect with patients and support them in their early mobility journey.

The category If You Know, You Can Endure is a novel finding of this study. Some studies do explore knowledge related to mobility,^{184–186} however, these studies miss the patient perspective of feeling mentally prepared to endure mobilizing. This important perspective needs to be integrated into pre-operative education to help prepare patients and care partners for early mobility. This education could focus more on developing coping strategies for the potential difficulties of early mobility, such as pain. Pain is a commonly described symptom related to early mobility following CS.^{183–186} Discussing pain with patients and sharing that engaging in early mobility can reduce pain scores¹⁸⁵ may support patients in mentally preparing for pain and how they can overcome it in the moments of early mobility.

4.3 Implications

Clinically, the findings can guide patient care and support the success of early mobilization in the CSICU by expanding the lens through which we look at early mobility. Clinicians can use these findings to better relate to patients, motivate them, and form more meaningful therapeutic relationships. This may

support the success of early mobility. For example, rather than viewing early mobility as purely physical, we now begin to understand the emotions and meaning that patients impart on mobility. It may be prudent to enter a reciprocal partnership with the patient when devising a post-operative mobility plan that has been tailored by, for and with the patient's goals in mind.

These findings also have research implications, as the data indicate that using arts-based research methods for PER can elicit embodied knowledge from PWLE that is missing from the existing literature. The emotion and meaning patients place on early mobility nudges researchers to consider outcomes beyond the physical when evaluating early mobility interventions. This shift to exploring broader outcomes for interventions refocuses researchers on the need to take a holistic approach to healthcare and interventions. Incorporating the lived experience in intervention development can help researchers understand the impacts of the interventions and how to evaluate them appropriately. This challenges the dominant biomedical paradigm through which health research is typically conducted. Researchers need to be open to all sources of knowledge, such as the lived experience, and incorporate these into their work. This will support research directed at priorities and outcomes that patients, who are the end users of the research, deem important.²

4.4 Strengths and Limitations

This work has several strengths. First, there is a strong framework underpinning the approach to engagement.³² This is a strength because it provides an evidence-informed foundation for the project. Second, a layered data analysis occurred using both visual and narrative methodologies. This layered approach helped to overcome the limitations of each independent method. Such an analysis yields rich, reliable, and robust results. Third, the research team includes two PWLE who collaborated from ideation to dissemination as equal team members.

This work has limitations. First, there was a relatively small number of PWLE engaged as consultants. Engaging a more diverse group of PWLE consultants would have likely introduced a broader range of potentially unique perspectives. Second, all PWLE underwent CS at the same hospital, which

also limits the generalizability of the findings. Third, due to the small group size, diversity beyond self-identified gender, role (patients or care partners), and geographic location was not possible. We recognize the limitation of this, and future research will intentionally focus on recruiting based on ethnic diversity in meaningful and culturally sensitive ways. This approach will support the development of an understanding of the needs of patients and care partners of different ethnicities rather than comparing the perspectives of patients and care partners based on ethnicity. Finally, the low number of care partners engaged and their preference to co-create body maps with their loved ones limits the understanding of their experiences. These should be explored in future studies.

5. Conclusion

Engaging people with lived experiences through the arts-based method of body mapping was empowering and helped reduce the sense of tokenism. Body mapping revealed previously unknown aspects of their embodied experiences of early mobility. Embodied experiences are best explored using arts-based research methods, as they involve senses, expressions, emotions, and significant meaning that come from and reside in the body and cannot be verbalized. This is important knowledge to consider, which is overlooked when PER focuses only on verbal communication. Expanding PER methods to include arts-based research methods can deepen understanding of the embodied experiences of PWLE, ultimately enabling improvements to the healthcare system and patient health outcomes.

List of Abbreviations

CS – cardiac surgery

GRIP—2 - Guidelines for Reporting Involvement of Patients and the Public

ICU – intensive care unit

PER – patient and care partner engagement in research

PWLE – people with lived experience

Declarations

Ethics approval and consent to participate

Institutional review board approvals were obtained in March 2024 (HE2024-0035, RRC/2024/2158). All persons with lived experience (PWLE) reviewed and signed a consent form prior to participating in the workshops. PWLE were informed that consent was an ongoing process and that they could withdraw consent until data analysis began, after which it was no longer possible to remove their data from the study. No PWLE withdrew their consent.

Consent for publication

Not applicable.

Availability of data and materials

Data are available from the corresponding author upon reasonable request.

Competing interests

RCA has received honoraria from Edwards Lifesciences, Medtronic, Serb Pharmaceuticals, HLS Therapeutics and Bioporto. RCA has also served on the Advisory Board for Alexion and Renibus Therapeutics Inc. None of these are relevant to this manuscript. The other authors declare no competing interests.

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Authors' contributions

This study was conceptualized by EKP, TAD, RCA, SOM, and ASHS. EKP and SOM conceptualized the methods used in the study and analyzed the data. EKP, SOM, JLH, AG, and KS planned and facilitated the workshop sessions and began data analysis. CS, SG, and AF provided clinical expertise to inform data analysis. JLH supported the creation and revision of the main figure. EKP drafted the original

manuscript and revised it based on feedback from authors and reviewers. All authors reviewed, revised, and approved the final manuscript.

Acknowledgements

None.

Appendix 6.1

Table 6.9. Guidelines for Reporting Involvement of Patients and the Public Checklist

Section and topic	Item	Reported on page No
Section 1: Abstract of paper		
1a: Aim	Report the aim of the study	3
1b: Methods	Describe the methods used by which patients and the public were involved	3
1c: Results	Report the impacts and outcomes of PPI in the study	3
1d: Conclusions	Summarise the main conclusions of the study	4
1e: Keywords	Include PPI, “patient and public involvement,” or alternative terms as keywords	4
Section 2: Background to paper		
2a: Definition	Report the definition of PPI used in the study and how it links to comparable studies	5
2b: Theoretical underpinnings	Report the theoretical rationale and any theoretical influences relating to PPI in the study	6
2c: Concepts and theory development	Report any conceptual models or influences used in the study	n/a
Section 3: Aims of paper		
3: Aim	Report the aim of the study	5-6
Section 4: Methods of paper		
4a: Design	Provide a clear description of methods by which patients and the public were involved	10
4b: People involved	Provide a description of patients, carers, and the public involved with the PPI activity in the study	7-8
4c: Stages of involvement	Report on how PPI is used at different stages of the study	8-9
4d: Level or nature of involvement	Report the level or nature of PPI used at various stages of the study	8-9
Section 5: Capture or measurement of PPI impact		

5a: Qualitative evidence of impact	If applicable, report the methods used to qualitatively explore the impact of PPI in the study	n/a
5b: Quantitative evidence of impact	If applicable, report the methods used to quantitatively measure or assess the impact of PPI	n/a
5c: Robustness of measure	If applicable, report the rigour of the method used to capture or measure the impact of PPI	n/a
Section 6: Economic assessment		
6: Economic assessment	If applicable, report the method used for an economic assessment of PPI	n/a
Section 7: Study results		
7a: Outcomes of PPI	Report the results of PPI in the study, including both positive and negative outcomes	14-22
7b: Impacts of PPI	Report the positive and negative impacts that PPI has had on the research, the individuals involved (including patients and researchers), and wider impacts	n/a
7c: Context of PPI	Report the influence of any contextual factors that enabled or hindered the process or impact of PPI	n/a
7d: Process of PPI	Report the influence of any process factors, that enabled or hindered the impact of PPI	n/a
7ei: Theory development	Report any conceptual or theoretical development in PPI that have emerged	n/a
7eii: Theory development	Report testing of theoretical models, if any	n/a
7f: Measurement	If applicable, report all aspects of instrument development and testing (eg, validity, reliability, feasibility, acceptability, responsiveness, interpretability, appropriateness, precision)	n/a
7g: Economic assessment	Report any information on the costs or benefit of PPI	n/a
Section 8: Discussion and conclusions		
8a: Outcomes	Comment on how PPI influenced the study overall. Describe positive and negative effects	24-29
8b: Impacts	Comment on the different impacts of PPI identified in this study and how they contribute to new knowledge	n/a
8c: Definition	Comment on the definition of PPI used (reported in the Background section) and whether or not you would suggest any changes	n/a

8d: Theoretical underpinnings	Comment on any way your study adds to the theoretical development of PPI	n/a
8e: Context	Comment on how context factors influenced PPI in the study	n/a
8f: Process	Comment on how process factors influenced PPI in the study	n/a
8g: Measurement and capture of PPI impact	If applicable, comment on how well PPI impact was evaluated or measured in the study	n/a
8h: Economic assessment	If applicable, discuss any aspects of the economic cost or benefit of PPI, particularly any suggestions for future economic modelling.	n/a
8i: Reflections/critical perspective	Comment critically on the study, reflecting on the things that went well and those that did not, so that others can learn from this study	30

PPI=patient and public involvement

Brief Discussion of the Manuscript

Most of the study findings are novel contributions to the literature. Engaging patients and care partners to share their embodied knowledge in a way that is meaningful to them uncovered knowledge that clinicians and researchers had not known to ask about in previous research. This knowledge is important to consider in the development of early mobility education and interventions. If clinicians understand the symptoms that patients feel when mobilizing, such as the brain fog that was so commonly described, they can tailor their conversations with patients to better support mobility. If clinicians understand that patients often view mobility as moving towards going home, they can motivate patients effectively to mobilize. For this reason, we used this knowledge in the intervention described in Chapters 8 and 9. The clinician partners on this research team and the manager and nurse educator of the CSICU supported the identification of where quotes from the presentations of the body maps and images of the body maps would supplement the information being shared with clinicians. I then identified potential quotes and images and incorporated them into the education. In this way, the experiences of patients and care partners were shared directly with clinicians to support their understanding of early mobility.

Chapter 7 : Early mobility to improve health outcomes following cardiac surgery (EVE)

Clinical Trial Development: Findings from Workshop 2 - Co-created Definition and Prioritized Barriers, Facilitators and Outcome and Experience Measures

Preface to the Manuscript

This manuscript is the second in a series describing the engagement work we conducted with patients and care partners as part of the needs assessment.^{9,10} This manuscript continues the consideration of the lived experience of early mobility, as required with research done through a pragmatic worldview.^{24,26} This research supports developing an intervention that is meaningful to patients and care partners.

Manuscript Status

Accepted for publication in *Frontiers in Rehabilitation Sciences*.¹⁷² The author original manuscript version is included in this thesis document.

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Contributions of Authors

This study was conceptualized by Drs. Duhamel, Arora, Schultz, and O’Keefe-McCarthy and me as part of the engagement plan for my dissertation. Dr. O’Keefe-McCarthy and I conceptualized the methods of this study. Jacqueline L. Hay, April Gregora, Kathy Smith, Dr. O’Keefe-McCarthy, and I planned and facilitated the workshop sessions. Carly Shaski, Gavin Bozek, Sarah Gilchrist, and Dr. Fagan provided clinical expertise to inform data analysis. As the first author, I drafted the original manuscript and revised it based on feedback from authors and reviewers. All authors reviewed, revised, and approved the final manuscript.

Manuscript

Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Trial Development: Findings from Workshop 2 - Co-created Definition and Prioritized Barriers, Facilitators and Outcome and Experience Measures

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Ethics Approval and Consent to participate: Institutional review board approvals were obtained in March 2024 (HE2024-0035, RRC/2024/2158). All persons with lived experience (PWLE) reviewed and signed a consent form prior to participating in the workshops. PWLE were made aware that consent was an ongoing process, and they could withdraw consent until data analysis began, at which point it was no longer possible to remove their data from the study. No PWLE withdrew their consent.

Consent for Publication: All PWLE consented to the use of their quotations and images of their body maps in publications. This consent was captured on the consent form.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests: RCA has received honoraria from Edwards Lifesciences, Medtronic, Serb Pharmaceuticals, HLS Therapeutics and Bioporto. RCA has also served on the Advisory Board for Alexion and Renibus Therapeutics Inc. None of these are relevant to this manuscript. The other authors declare no competing interests.

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Author Contributions: EKP and SOM co-conceptualized this study, facilitated workshops, analyzed data, and wrote and revised this manuscript. JLH, AG, and KS facilitated workshops, supported data analysis, visualization, and manuscript revision. AMC, SG, AF, CS, GB, MCA, ASHS, RCA, and TAD supported data analysis and visualization. ASHS also supported funding acquisition. All authors reviewed and approved the final version of the manuscript.

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Abstract

New or worsening cognitive, mental, and/or physical health after a stay in an intensive care unit (ICU) defines post-intensive care syndrome (PICS). PICS is prevalent post-cardiac surgery (CS), and interventions are needed for prevention. Early mobility shows potential to prevent PICS but is not optimally integrated into CSICU clinical care. This may relate to the absence of engagement of people with lived experience (PWLE) in CSICU early mobility research. PWLE of the CSICU were engaged to meet three objectives: 1) co-create a definition of early mobility, 2) identify barriers and facilitators to early mobility, and 3) prioritize outcome and experience measures for use in future intervention research. Engagement occurred through two virtual consultation workshops involving group discussions, consensus building, and prioritization using the nominal group technique. Eight patients and two care partners participated. The co-created definition of early mobility was *a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient uses their muscle strength intentionally*. The top barrier to early mobility was brain “fuzziness/fogginess”. The top facilitator was a “positive attitude”. The top physical outcome was “Do you feel lightheaded/dizzy?”. The top cognitive outcome was “Do you feel fuzzy/foggy”. The top mental outcome was “Are you focusing on the positives in your life right now?”. The top experience measure was “Do you feel your doctors gave you the care and attention you needed?”. This important contribution of the lived experience with early mobility in the CSICU advances the literature and will empower future research to align with the perspectives and priorities of people undergoing CS. This contribution may advance the integration of early mobility into CSICU clinical care and reduce the prevalence of adverse cognitive, mental, and/or physical health outcomes that are seen in PICS.

Keywords

1. Cardiac surgery
2. Intensive care
3. Post-intensive care syndrome

4. PICS
5. Early mobility
6. Patient and public involvement
7. Patient engagement in research

1. Introduction

Early mobility through ambulation and cycling improves physical health outcomes following cardiac surgery (CS).^{76–78} Physical health outcomes are one element of post-intensive care syndrome (PICS), a syndrome defined as a new or worsening deterioration in cognitive, mental, and/or physical health after admission to the intensive care unit (ICU).⁹² Our group previously investigated the incidence of PICS following CS, which ranged from 16% to 99%.¹⁸⁷ With this potentially high prevalence, interventions are needed to prevent the occurrence of PICS and support optimal health outcomes for patients with a prolonged stay in the CS intensive care unit (ICU).

Despite best-practice support, integration of early mobility into CSICU clinical care remains underutilized.^{7,132} It has been hypothesized that the lack of integration may relate to an absence of engagement of people with lived experience (PWLE) of the CSICU in early mobility research.^{2,32} Referred to as patient engagement in research (PER), PWLE of a health issue (e.g., patients and their care partners) can be meaningfully and actively engaged in the research process from design to knowledge translation.^{32,135,136} Generating knowledge through PER is recognized as a means to improve the healthcare system.^{32,135,136} However, there is a lack of PWLE perspectives informing early mobility CSICU literature. For example, there is minimal data on a PWLE-informed definition of early mobility. Similarly, identification of barriers and facilitators that need to be overcome or leveraged to integrate early mobility into CSICU clinical care successfully using a PER approach. Finally, there are a lack of studies exploring outcome measures important to PWLE when evaluating early mobility interventions. This paucity of PWLE-informed research limits the evidence available to improve the delivery of healthcare through integrating beneficial early mobility interventions informed by PWLE.

This third article in a series of three describes Phase 2 of a two-phased workshop to develop a PWLE-informed early mobility intervention for use in the CS ICU. The methods employed in this workshop have been described as a model in the first article.¹³⁴ The findings of Phase 1, in which the arts-based research method of body mapping^{66–70} was used to co-create and co-analyze an understanding

of the embodied experience of mobility in the CS ICU from PWLE perspectives, have been reported in the second article.¹⁶⁸ Phase 2, reported here, employed two virtual consultation workshops to engage PWLE of the CS ICU to meet three objectives: 1) to co-create a definition of early mobility, 2) to identify barriers and facilitators to early mobility, and 3) to prioritize outcome and experience measures for use in future intervention research. This work is part of the Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Feasibility Trial Development study.

2. Methods

2.1 Research Design

PWLE engagement occurred through two virtual consultation workshops involving group discussions, consensus building, and prioritization using the nominal group technique. Reporting of this work follows the updated Guidelines for Reporting Involvement of Patients and the Public (GRIPP-2) long-form checklist.⁴⁵ See Appendix 7.1 for the GRIPP-2 checklist.

2.2 PWLE Recruitment

10 PWLE were recruited to participate in this study, as suggested for group size to facilitate discussion and participation.¹⁵¹ The PWLE co-authors (AG & KS) suggested the inclusion of care partners due to one's difficulty in remembering her own CSICU hospitalization (AG), and one's experience as a caregiver for her husband during his CSICU hospitalization (KS). This decision is supported by the literature, which states that care partners play an integral role in organizing memories of the time spent in the CSICU.¹⁸⁸

A database of patients who have undergone CS at St. Boniface Hospital in Winnipeg, MB, who agreed to be contacted for future research, was used to recruit PWLE. Inclusion criteria were as follows: 1) adults over 18 who have undergone or had a loved one undergo elective or semi-urgent outpatient coronary artery bypass grafting, valve CS, or a combination of the two in the last five years, 2) cognitively able to participate in consultation workshop, 3) had access to the internet and an electronic device, 4)

were willing to reflect on personal experiences relating to CS and share these in a group setting, 5) could speak and read English, and 6) consent to be recorded.

2.3 Equity, Diversity, and Inclusion Considerations

The diversity of PWLE engaged in this study was limited by the small group size and existing diversity of former CS patients who consented to be approached about future research, who met our inclusion criteria. Due to these limitations, we focused on recruiting PWLE based on diversity at three levels: 1) self-identified gender, 2) patients and care partners, and 3) rural and urban geographic location of participants. Our approach lacks focus on racial and ethnic diversity, which is a limitation. Future research should focus on recruiting diverse groups in both meaningful and culturally sensitive ways that facilitate developing an understanding of the needs of PWLE of different ethnicities, rather than comparing experiences among ethnicities. Inclusion was supported through confidential, personalized discussions with each participant. Any required supports for participation in the virtual workshops were identified. Additionally, we offered two times to meet with PWLE on Microsoft Teams to introduce them to the virtual platform prior to the first virtual workshop session. In this way, we supported equitable access to the virtual workshop sessions to promote participation and comfort with the virtual platform.

2.4 Levels and Stages of Engagement

The International Association for Public Participation's Spectrum of Public Participation³³ was used to define levels of engagement. Engagement is defined along the Spectrum from "inform" to "empower", with the latter having more impact on research decision-making.³³ Similar to other work by the research team,^{38,138,189} a multi-level approach to engagement was used. First, two PWLE (AG and KS) were engaged at the level of collaborate.³³ This level is in the middle of the Spectrum and is described as "to partner with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution".³³ Both PWLE collaborators are members of the research team and contribute lived expertise at all stages of the research through planning meetings, developing the workshop plan, co-facilitating the workshops, co-analyzing the workshop findings, and co-authoring

all publications.¹³⁷ Second, additional PWLE (n=10) were engaged at the level of consult through the PWLE engagement panel, a level described as gaining public feedback to drive research decisions.³³ The PWLE consultants were engaged at the stages of data collection and co-analysis.¹³⁷ Specifically, PWLE consultants were engaged in discussions that generated the data that was used to guide the larger research project. They generated the early mobility definition, barriers, facilitators, and outcome and experience measures through facilitated discussions. They then co-analyzed their data through facilitated prioritization and consensus-building. All words and terms presented in the results were generated and defined by the PWLE consultants. Multi-level engagement allowed this research to be directly guided by lived experiences. Collaborating with PWLE ensured they guided the research process, and consulting additional PWLE ensured a broader range of perspectives contributed to generating the early mobility definition, as well as generating and prioritizing barriers, facilitators, and outcome and experience measures. The levels of engagement informed the compensation provided.¹⁵² Compensation is described for both phases of this study in the article describing Phase 1.¹⁷²

2.5 Ethical Considerations

This work was conducted in alignment with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans – TCPS 2.¹⁴⁴ Institutional review board approvals for the case study exemplar were obtained in March 2024 from the University of Manitoba Research Ethics Board 1 (HE2024-0035) and the St Boniface Hospital Research Review Committee (RRC/2024/2158). A consent form was provided at the time of recruitment for PWLE to review. This consent form was reviewed and signed by all PWLE prior to participating in the workshops. The ongoing nature of consent was discussed with all PWLE. They were made aware that they could leave the workshops at any time and could withdraw consent at any point until data analysis began, at which point it was no longer possible to remove their data from the study. No PWLE withdrew their consent. Demographics were collected using a self-report questionnaire during Workshop 1, including self-identified sex, gender, and ethnicity, role (patient or care partner), ICU length of stay, type of CS, and year of CS.

2.6 Approach and Data Analysis

The CIHR SPOR Framework³² and previous virtual consultation workshops completed by research team members^{139,145} informed the approach to engaging PWLE. Two virtual workshops were held in June 2024. Data collection and analysis occurred simultaneously throughout the workshops. The aims of the first virtual workshop were to co-create a PWLE-informed definition of early mobility and to generate a list of barriers and facilitators to early mobility and a list of outcome and experience measures to evaluate a future early mobility intervention. The aim of the second virtual workshop was to prioritize the lists of barriers, facilitators, outcome, and experience measures using the nominal group technique.

The engagement approach has been shared in detail elsewhere.¹³⁴ Briefly, in the first virtual workshop, PWLE discussed what early mobility meant to them to co-create a definition. Next, barriers and facilitators to early mobility were generated and discussed by PWLE. Finally, outcomes and experiences related to early mobility, important to PWLE, were generated and discussed. Following this workshop, the barriers, facilitators, and outcome and experience measures were entered into a survey using Microsoft Forms. The outcome measures were grouped by the first author (EKP) under the three domains of PICS: cognitive, mental, and physical.^{92,187} In the second virtual workshop, the barriers, facilitators and outcome and experience measures were prioritized by PWLE using the nominal group technique.^{139,146–150} Two rounds of prioritization occurred, with a discussion between rounds focused on the initial prioritization from least agreement to most agreement.^{139,146–150} During this discussion, the first author (EKP) revised the survey to capture all changes, such as rephrased or combined research directions. Once the second survey was completed, PWLE logged out of the virtual workshop.

PWLE demographics were described using the median and interquartile range (IQR) for continuous variables and frequencies and proportions for categorical factors.¹⁵⁸ Microsoft Forms (version 2) and Excel (version 16.99.2) were used to analyze the second survey responses from PWLE. Where PWLE ranked each item (i.e. first choice, second choice) was noted along with the amount of agreement

or disagreement (i.e. items that were both first and last choice by PWLE). The barriers, facilitators, and outcome and experience measures were ranked from most to least agreement based on where each PWLE ranked each item by Microsoft Forms. The top three barriers, facilitators, and outcome measures from each domain of PICS, and experience measures were identified from this ranking.

Finally, the definition of early mobility was enhanced by members of the research team after the virtual consultation workshops. This occurred through discussions at research team meetings, written feedback, and discussions with the PWLE and clinician partners. The enhancement of the early mobility definition aimed to ensure clinical utility, as clinicians identified elements missing from the PWLE definition that were necessary. Importantly, no PWLE-identified elements were removed by clinicians; only additions occurred.

3. Results

Eight patients and two care partners participated in this study. Four PWLE self-identified their sex/gender as female/women and six as male/men. The PWLE included one male/man care partner, one female/woman care partner, three female/woman patients, and five male/man patients. Demographic information is presented in Table 7.1. Two people self-identified as Métis, of which one also self-identified as Ojibwe. Two PWLE declined to self-identify their ethnicity. The median age of PWLE was 69 (IQR 61-82) years. The median CS ICU length of stay was 5 (IQR 3-30) days. One PWLE did not remember their CS ICU length of stay. One PWLE had CS in 2021, two in 2022, and the remaining seven underwent CS in 2023.

Table 7.1. Demographics of PWLE participants

Participant ID	Age	Sex assigned at birth	Self-identified Gender	Self-identified ethnicity	Role (Patient or care partner)	ICU LOS	Type of CS	Year of CS
P1	82	Male	Man	Irish	Patient	5 days	CABG + Valve	2021
P2	68	Male	Man	n/a	Patient	Unknown???	Valve	2022
P4	60	Female	Woman	White	Patient	6 days	CABG + Valve	2023
P5	63	Male	Man	Metis	Care Partner	6 days	CABG + Valve	2023
P6	70	Male	Man	Participant left blank	Patient	30 days	CABG	2023
P7	59	Female	Woman	Caucasian	Patient	3 days	Valve	2022
P8	80	Female	Woman	Canadian-French	Patient	7 days	valve	2023
P9	75	Male	Man	White/Caucasian	Patient	3 days	CABG	2023
P10	73	Male	Man	CDN	Patient	5 days	CABG	2023
P11	60	Female	Woman	Metis/Ojibwe	Care Partner	3 days	CABG	2023

3.1 Definition of Early Mobility

Initially, PWLE shared a variety of definitions of “*early*” and “*mobility*”. Definitions of *early* ranged from the “day of surgery” to “discharge from the ICU” (clarified to mean after ICU discharge). After a discussion, PWLE came to the consensus that the definition of early needs to be person-specific and tied to patient assessments and meeting individual patient-defined milestones rather than a specific timeframe. *Mobility* was initially defined as sitting and standing at the side of the bed, sitting in a chair, and walking. After a discussion, PWLE came to the consensus that mobility needs to be defined in terms of a spectrum of activities that will achieve the ultimate goal of getting home, as well as how patients need to move to accomplish this. This led to the PWLE definition of early mobility, encompassing a spectrum of activities required for daily living, that begin when a patient in the ICU is ready to engage in activities following CS. This PWLE definition was enhanced by the clinician team members as described above. The final co-created definition of early mobility was *a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient uses their muscle strength intentionally.*

3.2 Prioritization of Barriers, Facilitators of Early Mobility

The results of the prioritization are presented in Figures 7.1 and 7.2. The top three barriers to early mobility were brain “fuzziness” or “foginess”, “paraphernalia” (lines, tubes, etc.), and “weakness” (Figure 7.1). The top three facilitators of early mobility were a “positive attitude”, “being encouraged/ forced/ helped/ reminded”, and “receiving education about pre-existing health issues interacting and causing unclear discomfort” (Figure 7.2).

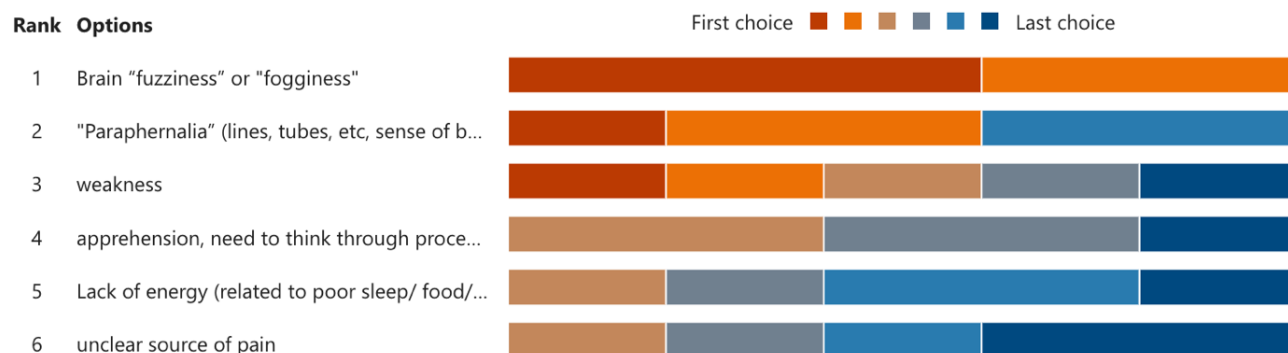


Figure 7.1. Ranking of barriers to early mobility in the cardiac surgery intensive care unit.

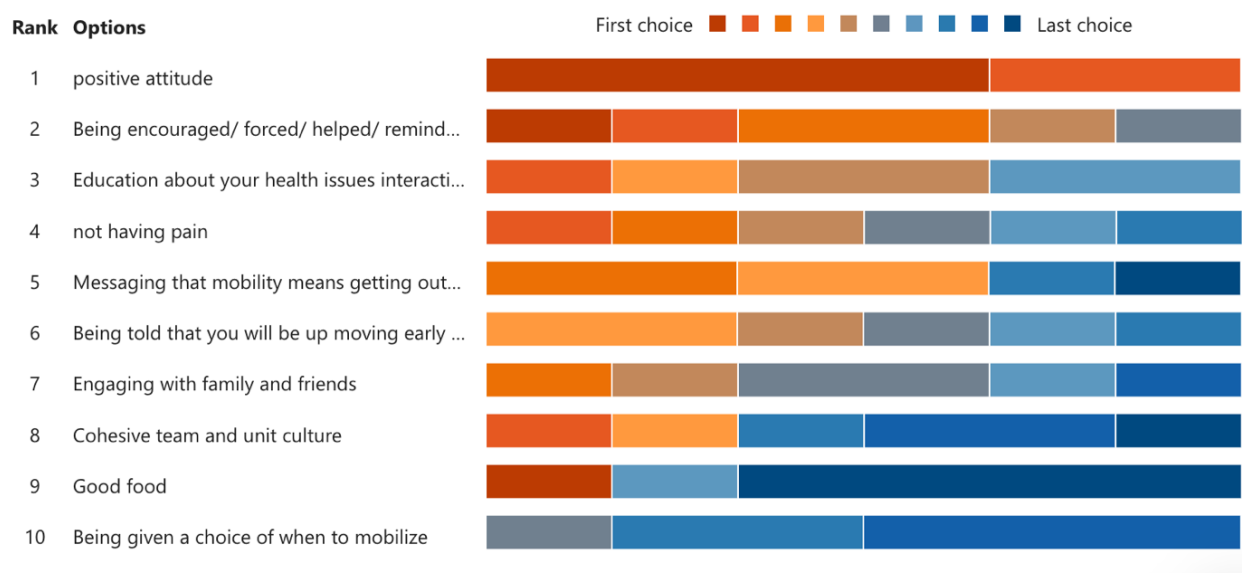


Figure 7.2. Ranking of facilitators to early mobility in the cardiac surgery intensive care unit.

3.3 Prioritization of Outcome Measures and Experience Measures of Early Mobility

Outcome measures for use in future intervention research were divided into physical, cognitive, and mental outcomes to support their future use in PICS research (Figures 7.3-7.6). The top three physical outcomes were “Do you feel lightheaded or dizzy?”, “Do you feel you have balance when you stand and walk?”, and “Do you have confidence in moving?” (Figure 7.3). The top three cognitive outcomes were “Do you feel fuzzy/ foggy?”, “Are you seeing anything strange/ odd/ hallucinating?”, and “Care partner

question – does your loved one seem confused/ are they hallucinating?” (Figure 7.4). The top three mental outcomes were “Are you focusing on the positives in your life right now?”, “Are you feeling anxious?”, and “Are you focusing on the negatives in your life right now?” (Figure 7.5). The top three experience measures were “Do you feel your doctors gave you the care and attention you needed?”, “Do you feel your nurses gave you the care and attention you needed?”, and “Do you feel the care team asked how you were doing and listened to your answer?” (Figure 7.6).

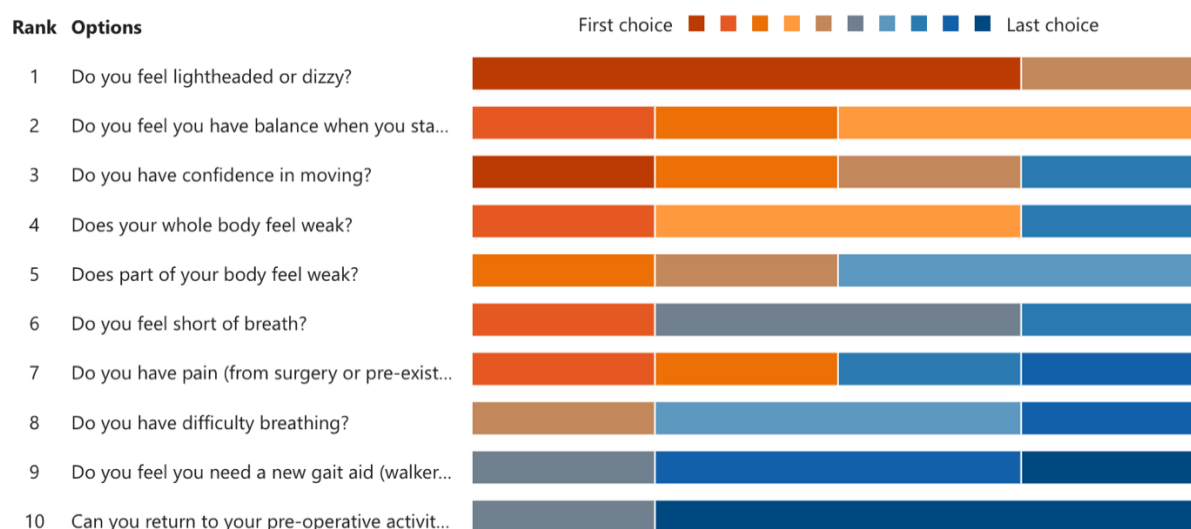


Figure 7.3. Ranking of the physical outcome measures of early mobility in the cardiac surgery intensive care unit.

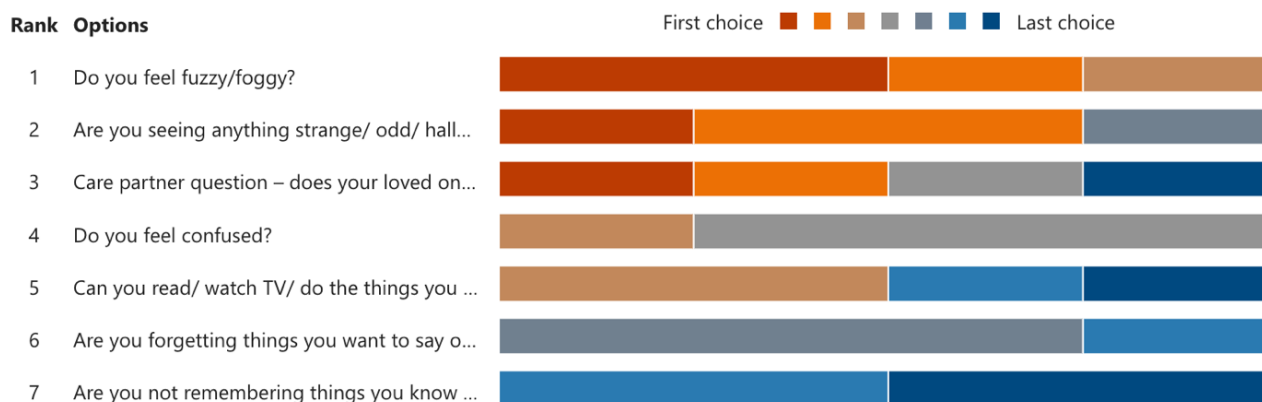


Figure 7.4. Ranking of cognitive outcome measures of early mobility in the cardiac surgery intensive care unit.



Figure 7.5. Ranking of mental outcome measures of early mobility in the cardiac surgery intensive care unit.

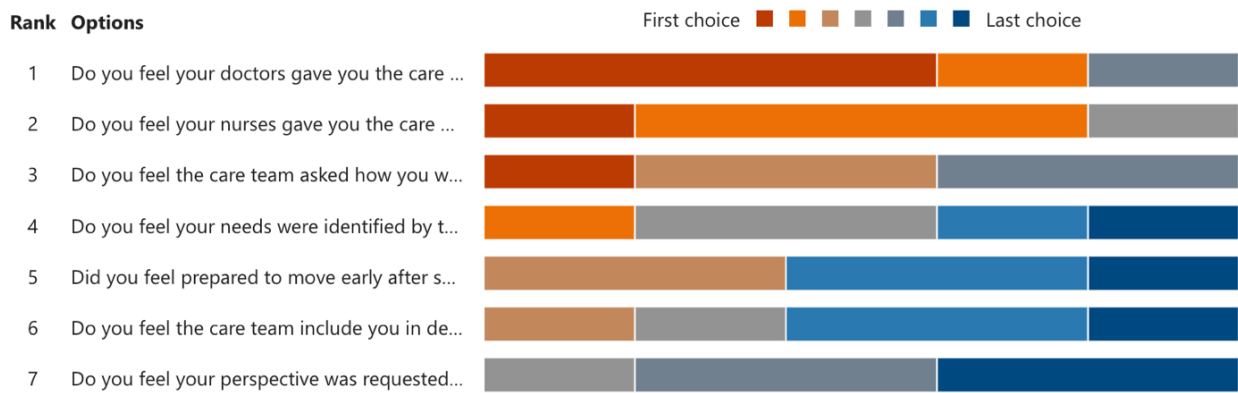


Figure 7.6. Ranking of experience measures of early mobility in the cardiac surgery intensive care unit.

4. Discussion

Ten PWLE participated in two virtual consultation workshops, during which a definition of early mobility was co-created, and early mobility-related barriers, facilitators, outcome measures, and experience measures were generated and prioritized. The research team, including PWLE and clinician partners, then enhanced the definition to incorporate elements identified as necessary by clinicians. Barriers, facilitators, outcome measures, and experience measures were generated and prioritized by PWLE to support early mobility intervention implementation and future evaluation. Taken together, this work contributes lived experience knowledge that reconceptualizes how early mobility is defined, the barriers and facilitators to early mobility, and how early mobility interventions should be evaluated in

future research. Such knowledge is important to support the integration of early mobility into CS ICU clinical care.

4.1 Definitions

This study is one of the first to co-create a definition of early mobility with PWLE and clinicians for the CS ICU: *a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient uses their muscle strength intentionally.* Important elements of the definition include concepts such as *progression*, *functional life activities*, *as soon as the patient can participate*, and *intentionally*. The important elements of our co-created definition have never been included in the same definition.

Progression is included because mobility is not one activity but rather a variety of movements that can build on one another. One definition describes a series of movements,¹⁹⁰ similar to our proposed *progression*. This element is missing from other published early mobility definitions.¹⁴³ Including *progression* supports the spectrum of activities that will achieve the ultimate goal of getting home by viewing them as changing throughout recovery. As one PWLE co-author (AG) noted, the mobility activities undertaken when a patient first wakes after CS, such as standing, are the building blocks of those undertaken closer to discharge, when standing progresses to walking. This *progression* supports how patients need to move to accomplish the ultimate goal of discharge from the hospital to home.

The element of *functional life activities* in the co-created definition is reflected in some early mobility interventions.^{143,191–193} This element is also included in the early mobility definition by Yang and colleagues, who state that the goal of early mobility is to “improve the mobility and functional status of critically ill patients”.¹⁹⁰ Inclusion of *functional life activities* incorporates the conceptualization of mobility in aging research to be more than just walking or cycling to include activities required to *function*, such as bathing, eating, and brushing teeth.^{194,195} Including *functional life activities* in the definition reflects consensus in the PWLE workshops that mobility should be defined as the way patients need to move to be safely discharged home. This includes being able to perform *functional life activities*

as they are performed at home. Expanding the definition of mobility to include activities such as standing at a sink to brush one's teeth instead of sitting in a chair and using a kidney basin supports these activities in a clinical setting.

Two other studies have noted that early participation is based on patient-specific factors *as soon as the patient can participate*.^{196,197} In one of these studies, early was defined as when the patient was determined to be clinically stable by the attending intensivist¹⁹⁶. In the other study, early was defined as when the patient had achieved hemodynamic and respiratory stability.¹⁹⁷ Using such patient-specific factors supports individualized, patient-centred care by beginning early mobility when the patient is ready, not at an arbitrary post-operative time. Including a post-operative time of within six hours post-surgery was suggested by the clinician members of the research team. This is meant to provide a tangible “deadline” for clinicians that requires them to identify criteria to opt out of mobilizing their patient. This deadline engages clinicians in planning to mobilize sooner and supports staff in understanding that mobility should occur within this timeframe, not after. The timeframe of six hours post-surgery aligns with local guidelines.¹⁹⁸ *As soon as the patient can participate* defines “early” as patient-specific and allows clinicians to refer to exclusion criteria and their clinical judgement to determine when to start. Two other studies of early mobility in the CS ICU have noted the element of early being based on patient-specific factors *as soon as the patient can participate*.^{196,197} In one of the cited studies, early was defined as when the patient was determined to be clinically stable by the attending intensivist.¹⁹⁶ In the other study, early was defined as when the patient has achieved hemodynamic and respiratory stability.¹⁹⁷ Using such patient-specific factors supports individualized, patient-centred care by beginning early mobility when the patient is ready, not at an arbitrary post-operative time. Including a post-operative time of within six hours post-CS, was suggested by clinician members of the research team. This is meant to provide a tangible “deadline” for clinicians, requiring them to identify criteria to opt out of mobilizing their patient. This deadline engages clinicians in planning to mobilize sooner and supports staff in

understanding that mobility should occur within this timeframe, not after. The timeframe of six hours post-surgery aligns with local guidelines.¹⁹⁸

Intentionally implies that mobility requires purposeful movement and intent to move from the patient. This element is included in the early mobility definition used by the Trial of Early Activity and Mobilization Study (TEAM) investigators.¹⁹⁹ These researchers used the wording “patients could assist with the activity using their own muscle strength and control,” which aligns with our requirement for movements to be purposeful and with intent. This element is missing from other early mobility definitions.¹⁴³ The inclusion of *intentionally* clarifies that mobility does not include non-purposeful movements and passive range of motion. A recent study by our research team noted that some healthcare providers included non-purposeful movements and passive range of motion in their early mobility definitions.¹³³ Defining early mobility as requiring patients to move *intentionally* supports using mobility to prevent or overcome ICU-acquired weakness. ICU-acquired weakness is seen more often in patients with longer mechanical ventilation, who are less likely to be mobilized out of bed.²⁰⁰ The diagnosis of ICU-acquired weakness includes the strength of active muscle contraction, suggesting that mobility requires contraction, and thus *intent* from the patient. This clarifies that early mobility does not include passive range of motion. *Intentionally* also ties the definition of early mobility back to the goal of mobility, to return home and be able to function. This clarifies that early mobility does not include non-purposeful movements.

4.2 Barriers and Facilitators

Many of the barriers and facilitators to early mobility in the CS ICU identified in this study are novel. No identified studies included the barriers of brain “fuzziness” or “fogginess” or weakness, nor the facilitators “positive attitude” nor “receiving education about health issues interacting and causing unclear discomfort”. These are important considerations for future early mobility intervention research. PWLE are equal partners in early mobility interventions, and the interventions cannot be successful without their participation. Educating healthcare providers about the brain “fuzziness” or “fogginess”

experienced will support communication. Healthcare providers can provide short, clear directions that they repeat consistently to support patients in mobilizing while feeling brain “fuzziness” or “fogginess”. Mobility aides, such as walkers, can be provided to support patients in feeling more confident when they feel weak. Patients and families can also be educated about these symptoms and reassured that it is normal and that the health care team will work with them to co-create a plan to address them. The facilitators can also be shared with patients and families to help them prepare for recovery and mobility.

The barrier “paraphernalia” (lines, tubes, etc.) has been described as a barrier in the CS ICU early mobility literature.¹⁸⁴ There are ways to overcome this barrier, such as locating lines and tubes in strategic locations that support mobility (i.e. avoiding the femoral vessels), securing lines and tubes, and planning for mobility with the patient to identify who is responsible for monitoring lines and tubes.¹⁸⁴ In addition to these strategies, patients and their families can be made aware of the safety of moving with this paraphernalia and the low rate of inadvertent removal found in the literature.⁷⁶

The facilitator “being encouraged/ forced/ helped/ reminded” has been noted in two other CS ICU early mobility studies.^{183,184} This has been described as the barrier of patient refusal or lack of motivation, with the suggestion of adjusting the treatment plan with patient input.¹⁸⁴ In the other study, patients wanted motivation about the importance of early mobility, even to the point of “nagging”.¹⁸³ They felt it was the healthcare provider’s role to get them moving, and this was a facilitator for them.¹⁸³

4.3 Outcome and Experience Measures

The outcome and experience measures prioritized by patients can be used in future research to align intervention evaluation with patient priorities. Currently, hospital length of stay, pulmonary function, 6-minute walk test, hemodynamic measurements, heart rate variability, functional outcomes, and days to walk are the most common groups of outcome measures used in early mobility studies.¹⁴³ None of the physical, cognitive, nor mental outcome measures suggested by patients are included in these outcome measures. No located study included experience measures as their primary outcomes. Our recent scoping review found that patient-reported outcome measures (PROMs) were the primary outcome measures in

seven CS ICU early mobility studies.¹⁴³ PROMs measured functional outcomes,^{201,202} quality of life,²⁰³ self-efficacy,²⁰⁴ and pain.^{185,205,206} While using PROMs is a step towards understanding early mobility interventions from the perspective of the PWLE,¹⁴³ using outcome and experience measures identified as important to PWLE further incorporates their perspectives in intervention evaluation. Future research is required to identify tools to evaluate the outcomes and experiences identified and prioritized by PWLE in this study.

4.4 Limitations

There are several limitations to this study. First, our recruitment approach lacks focus on racial and ethnic diversity, which is a limitation. Future research should focus on recruiting diverse groups in both meaningful and culturally sensitive ways that facilitate developing an understanding of the needs of PWLE of different ethnicities, rather than comparing experiences among ethnicities. Second, all PWLE had surgery at the same hospital, which limits the diversity of their healthcare experiences. This work should be replicated with PWLE from other hospitals to validate and expand the findings. Finally, this work does not provide guidance on specific tools to measure the identified outcomes and experiences. Future research should explore the alignment of outcome and experience measures with available tools.

5. Conclusion

The report provides a definition of early mobility that was co-created among PWLE, clinicians, and researchers. PWLE also identified and prioritized outcome and experience measures for early mobility. This important contribution of the lived experience with early mobility in the CS ICU advances the literature and will empower future research to align with the perspectives and priorities of people undergoing CS. This contribution may advance the integration of early mobility into CS ICU clinical care and reduce the prevalence of adverse health outcomes, such as the cognitive, mental, and/or physical health outcomes that are seen in PICS.

List of Abbreviations

CS – cardiac surgery

GRIPP-2 - Guidelines for Reporting Involvement of Patients and the Public

ICU – intensive care unit

PER – patient and care partner engagement in research

PICS- Post-intensive care syndrome

Declarations

Ethics approval and consent to participate

Institutional review board approvals were obtained in March 2024 (HE2024-0035, RRC/2024/2158). All persons with lived experience (PWLE) reviewed and signed a consent form prior to participating in the workshops. PWLE were informed that consent was an ongoing process and that they could withdraw consent until data analysis began, after which it was no longer possible to remove their data from the study. No PWLE withdrew their consent.

Consent for publication

Not applicable.

Availability of data and materials

Data are available from the corresponding author upon reasonable request.

Competing interests

RCA has received honoraria from Edwards Lifesciences, Medtronic, Serb Pharmaceuticals, HLS Therapeutics and Bioporto. RCA has also served on the Advisory Board for Alexion and Renibus Therapeutics Inc. None of these are relevant to this manuscript. The other authors declare no competing interests.

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Authors' contributions

This study was conceptualized by EKP, TAD, RCA, SOM, and ASHS. EKP and SOM conceptualized the methods used in the study and analyzed the data. EKP, SOM, JLH, AG, and KS planned and facilitated the workshop sessions and began data analysis. CS, SG, and AF provided clinical expertise to inform data analysis. JLH supported the creation and revision of the main figure. EKP drafted the original manuscript and revised it based on feedback from authors and reviewers. All authors reviewed, revised, and approved the final manuscript.

Acknowledgements

None.

Appendix 7.1

Table 7.2. Guidelines for Reporting Involvement of Patients and the Public Checklist

Section and topic	Item	Reported on page No
Section 1: Abstract of paper		
1a: Aim	Report the aim of the study	n/a
1b: Methods	Describe the methods used by which patients and the public were involved	n/a
1c: Results	Report the impacts and outcomes of PPI in the study	n/a
1d: Conclusions	Summarise the main conclusions of the study	n/a
1e: Keywords	Include PPI, “patient and public involvement,” or alternative terms as keywords	n/a
Section 2: Background to paper		
2a: Definition	Report the definition of PPI used in the study and how it links to comparable studies	7-8

2b: Theoretical underpinnings	Report the theoretical rationale and any theoretical influences relating to PPI in the study	7-8
2c: Concepts and theory development	Report any conceptual models or influences used in the study	n/a
Section 3: Aims of paper		
3: Aim	Report the aim of the study	16
Section 4: Methods of paper		
4a: Design	Provide a clear description of methods by which patients and the public were involved	18-20
4b: People involved	Provide a description of patients, carers, and the public involved with the PPI activity in the study	17
4c: Stages of involvement	Report on how PPI is used at different stages of the study	18
4d: Level or nature of involvement	Report the level or nature of PPI used at various stages of the study	18
Section 5: Capture or measurement of PPI impact		
5a: Qualitative evidence of impact	If applicable, report the methods used to qualitatively explore the impact of PPI in the study	20
5b: Quantitative evidence of impact	If applicable, report the methods used to quantitatively measure or assess the impact of PPI	20
5c: Robustness of measure	If applicable, report the rigour of the method used to capture or measure the impact of PPI	n/a
Section 6: Economic assessment		
6: Economic assessment	If applicable, report the method used for an economic assessment of PPI	n/a
Section 7: Study results		
7a: Outcomes of PPI	Report the results of PPI in the study, including both positive and negative outcomes	n/a
7b: Impacts of PPI	Report the positive and negative impacts that PPI has had on the research, the individuals involved (including patients and researchers), and wider impacts	n/a
7c: Context of PPI	Report the influence of any contextual factors that enabled or hindered the process or impact of PPI	n/a

7d: Process of PPI	Report the influence of any process factors, that enabled or hindered the impact of PPI	n/a
7ei: Theory development	Report any conceptual or theoretical development in PPI that have emerged	n/a
7eii: Theory development	Report testing of theoretical models, if any	n/a
7f: Measurement	If applicable, report all aspects of instrument development and testing (eg, validity, reliability, feasibility, acceptability, responsiveness, interpretability, appropriateness, precision)	n/a
7g: Economic assessment	Report any information on the costs or benefit of PPI	n/a
Section 8: Discussion and conclusions		
8a: Outcomes	Comment on how PPI influenced the study overall. Describe positive and negative effects	n/a
8b: Impacts	Comment on the different impacts of PPI identified in this study and how they contribute to new knowledge	n/a
8c: Definition	Comment on the definition of PPI used (reported in the Background section) and whether or not you would suggest any changes	n/a
8d: Theoretical underpinnings	Comment on any way your study adds to the theoretical development of PPI	n/a
8e: Context	Comment on how context factors influenced PPI in the study	n/a
8f: Process	Comment on how process factors influenced PPI in the study	n/a
8g: Measurement and capture of PPI impact	If applicable, comment on how well PPI impact was evaluated or measured in the study	n/a
8h: Economic assessment	If applicable, discuss any aspects of the economic cost or benefit of PPI, particularly any suggestions for future economic modelling.	n/a
8i: Reflections/critical perspective	Comment critically on the study, reflecting on the things that went well and those that did not, so that others can learn from this study	n/a

PPI=patient and public involvement

Brief Discussion of the Manuscript

As noted in the previous chapter, including PWLE in the needs assessment of intervention mapping is novel but required when conducting research through a pragmatic worldview. The findings of this study are used in step four of intervention mapping. One performance objective is consistently defining early mobility. The definition of early mobility co-created with PWLE and clinicians for the CSICU, *a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient uses their muscle strength intentionally*, was used in step four of intervention mapping, creating an intervention.^{9,10} The barriers and facilitators were also used in creating an intervention. The symptom “brain foggiess” was highlighted through quotes and images in the intervention. The facilitators “being encouraged” and “positive attitude” were also integrated in the learning module through quotes and suggestions on how to operationalize these. In this way, the experiences of patients and care partners were shared directly with clinicians through their words and art. Thus, this research directly impacted the intervention and its content.

Chapter 8 : Early mobility to improve health outcomes following cardiac surgery-Education (EVE-E): Intervention development using intervention mapping

Preface to the Manuscript

This manuscript describes the six steps of intervention mapping and how the information gathered in the needs assessment was shaped into an intervention targeted at clinician behaviours. The findings from Chapters 2-7 are transformed into performance objectives in step two and are tied to theory-informed methods for behaviour change in steps three and four. The intervention is described and shared in the manuscript appendices. Finally, the implementation and evaluation plans, steps five and six of intervention mapping, are described.

Manuscript status

This is an original chapter that has not yet been submitted for publication.

Authors

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Contributions of Authors

This study was conceptualized by the entire authorship team. Dr. Ashe introduced intervention mapping and shared an example of its use. The work described in Chapters 2-7 informed the development of the intervention in this chapter. As the first author, I drafted the original manuscript and revised it based on feedback from co-authors, specifically Jacqueline L. Hay. This manuscript will be reviewed and revised further by the broader research team following the submission of this dissertation.

Manuscript

**Early mobility to improve health outcomes following cardiac surgery-Education (EVE-E):
Intervention development using intervention mapping**

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Abstract

Background

It is recognized that a know-do gap exists between the creation of new health research knowledge and its translation into clinical healthcare. Some healthcare practices have demonstrated efficacy and effectiveness, such as early mobility after cardiac surgery in the intensive care unit. Translating early mobility research findings into practice should be straightforward, as established early mobility protocols are available to follow. Yet, early mobility remains under-integrated in cardiac surgery intensive care unit clinical care. Translating the best available evidence into clinical practice requires behaviour change among healthcare providers. One approach that promotes behaviour change tailored to the specific setting is intervention mapping, a systematic, theory-driven, multi-level method for designing, developing, implementing, and evaluating behaviour-based interventions.

Objective

The objective of this article is to describe how the six steps of intervention mapping can be used to create and plan the implementation and evaluation of an intervention to support the integration of early mobility into clinical care in the cardiac surgery intensive care unit.

Methods

First, a needs assessment is completed by gathering empirical and clinical knowledge to understand the gaps. Next, barriers and facilitators to the behaviour are identified and reframed into performance objectives, which are then linked to determinants of change and mapped into a matrix. In step 3, program design begins by selecting the theory to inform the behaviour change. The intervention is developed in the fourth step, followed by the creation of the implementation plan in step 5. And finally, in step 6, the evaluation plan is developed.

Results

By integrating evidence from the literature with clinician and patients' knowledge and an understanding of barriers and facilitators to implementation specific to the environment, this novel approach facilitates the translation of research into practice, thereby closing the know-do gap.

Conclusions

Using intervention mapping to develop, implement, and evaluate an early mobility education intervention that targets the behaviours of cardiac surgery intensive care unit clinical care clinicians is one way to support closing the know-do gap.

1. Introduction

1.1 Background

It has long been recognized that a know-do gap exists between the creation of new health research knowledge and its translation into clinical healthcare.¹⁻³ Even 15 years after publication, research knowledge is only applied to 60% of patients.¹ Some healthcare practices have demonstrated efficacy and effectiveness; as a practical matter, everything that needs to be known is already known. Early mobility after cardiac surgery (CS) in the intensive care unit (ICU), defined as a progression of functional life activities that begin as soon as the patient can participate (typically within six hours post-surgery), where the patient intentionally uses their muscle strength,¹⁷² is an example of this. Studies exploring early mobility in the CS ICU have demonstrated that patients experience minimal adverse events, such as accidental line removals, mediastinitis, surgical site wound dehiscence, and hemodynamic instability,^{82-85,89,90} and show improvements in their physical functioning.⁷⁶⁻⁷⁸ Informed by this evidence, two guidelines that inform CS ICU care recommend early mobility.^{86,87}

Translating early mobility research findings into practice should be straightforward, as established early mobility protocols are available to follow.¹⁴³ Yet, the application of early mobility in the real world is not what it should be. Even with these recommendations, safety, and benefits, early mobility is still poorly integrated into CS ICU clinical care.^{7,132} We need to explore new approaches to close this know-do gap. Translating the best available evidence into clinical practice requires behaviour change among healthcare providers.¹ One approach that promotes behaviour change tailored to the specific setting is intervention mapping, a systematic, theory-driven, multi-level method for designing, developing, implementing, and evaluating behaviour-based interventions.^{9,207}

1.2 Objective

The objective of this paper is to describe the six steps of intervention mapping²⁰⁷ applied in developing an early mobility education intervention program for CS ICU clinicians.

2. Methods

2.1 Design

This article describes the development of an early mobility intervention using the 6-step method of intervention mapping.²⁰⁷ The reporting of the six-step intervention map follows the GUIDance for the rEporting of intervention Development (GUIDED) checklist.²⁰⁸ Ethical approvals were obtained for all aspects of this study from the University of Manitoba Research Ethics Board and the St Boniface Hospital Research Review Committee (HE2024-0035, RRC/2024/2158 and HE2024-0036, RRC/2024/2159).

2.2 Intervention Mapping Process

Intervention mapping has been applied in the development of interventions targeting movement behaviours in high school students²⁰⁹ and stroke patients,²¹⁰ attendance and adaptation in cardiac rehabilitation participants,²¹¹ and to improve an ICU discharge protocol.²¹² A six-step process is used to develop a tailored intervention (Figure 8.1).²⁰⁷ First, a needs assessment is completed by gathering empirical and clinical knowledge to understand the gaps. This step may include a literature review and the collection of data from the target clinical population through both qualitative and quantitative methods.²⁰⁷ Barriers and facilitators to the behaviour are identified in step 2 and reframed into performance objectives, which are then linked to determinants of change and mapped into a matrix.²⁰⁷ In step 3, program design begins by selecting the theory to inform the behaviour change.²⁰⁷ The intervention is developed in the fourth step, followed by the creation of the implementation plan in step 5.²⁰⁷ Finally, in step 6, the evaluation plan is developed.²⁰⁷ Each step is described in detail below.

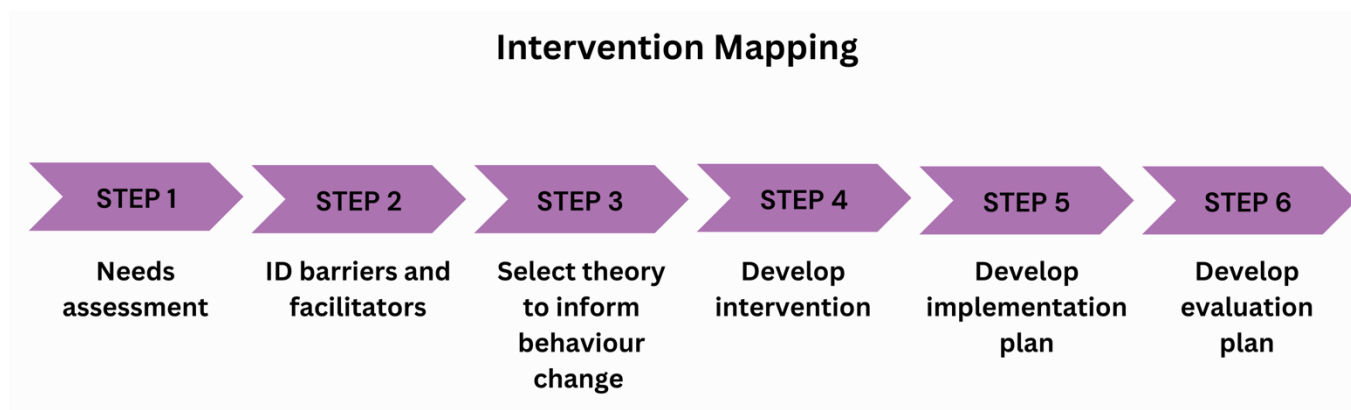


Figure 8.1. Overview of the six steps of intervention mapping.

2.2.1 Step One: Needs Assessment to Identify Gaps Through Literature and Lived and Clinical Experience

Creating an early mobility intervention for patients in the CS ICU that healthcare providers can integrate into their daily care requires not only an understanding of the existing literature but also the current behaviours and macro (hospital), meso (unit), and mirco (individual) level factors of the clinicians, as well as the perspectives of patients and care partners. Therefore, we began this step by forming a research team mindfully, comprised of individuals with expertise and commitment to CS who brought diverse perspectives, including research, clinical, and lived experience. Our team included partners who would assist with program development and resources, as well as those who had influence and authority to help champion change and support resource allocation. Since both quantitative and qualitative methods are recommended when completing a needs analysis,²⁰⁷ we conducted a scoping review to understand the existing literature, behaviour mapping to quantify the current state of early mobility in our CS ICU,¹³² and two qualitative studies to explore the perspectives of our clinicians and people with lived experience of our CS ICU.^{133,168,172} These studies have been reported in detail elsewhere.

2.2.2 Step Two: Creation of Performance Objectives

Our comprehensive needs assessment^{132,133,143,168,172} provided invaluable information that supported both the development and implementation of the intervention. Key findings included an inconsistent definition of early mobility, a culture that does not consistently prioritize mobility, unawareness about the safety issues related to immobility, a generic approach to mobility motivation, and a limited understanding of the patient experience of mobility (see Table 8.1). The key findings were then reframed into Performance Objectives (see Table 8.1) to describe the anticipated behaviour changes that are the target of the intervention.²⁰⁷ For example, an inconsistent definition of early mobility was reframed to “consistently define mobility”.

Table 8.1. Matrices of change.					
Identified Gap	Performance Objective	Link to Theoretical Domains Framework	Behaviour Change Technique	Methods of Action	Implementation Plans
Inconsistent definition of early mobility	Consistently define mobility	Social influences	4.1 Instruction on how to perform behaviour 9.1. Credible source	Knowledge Attitudes towards behaviour	Infographic
Culture does not consistently prioritize mobility	Consistently prioritize mobility	Attitudes towards behaviour Knowledge	12.2. Restructuring the social environment 13.2. Framing/reframing	Environmental context & resources	
Unaware about the safety issues related to immobility	Understand the safety issues related to immobility	Beliefs about consequences Knowledge	5.1 Information about health consequences 9.1. Credible source 12.2. Restructuring the social environment 13.2. Framing/reframing	Environmental context and resources	
Generic approach to mobility motivation	Take a patient-centric approach to mobility motivation	Knowledge	9.1. Credible source 13.2. Framing/reframing	Attitudes towards behaviour	

Limited understanding of the patient experience of mobility	Understand and leverage the patient experience of mobility				
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2.2.3 Step Three: Link Performance Objectives to Theory to Inform Behaviour Change

We selected the Theoretical Domains Framework²¹³ as our theoretical framework to inform the behaviour change (see Figure 8.2 for an overview of this framework).²⁰⁷ This framework consists of 12 domains that influence behaviour change, reflect a broad range of potential barriers, and support a range of implementation strategies to change clinical practice.²¹³ Each of the domains has constructs that describe its components.²¹³ For example, the domain Knowledge includes the constructs knowledge, knowledge about condition/ scientific rationale, schemas, mindsets, and illness representations, and procedural knowledge.²¹³ These constructs were reviewed, and the domains that were perceived to best align with the performance objectives were selected. Domains linked include: Social Influences, Knowledge, and Beliefs about Consequences (Table 8.1).²¹³

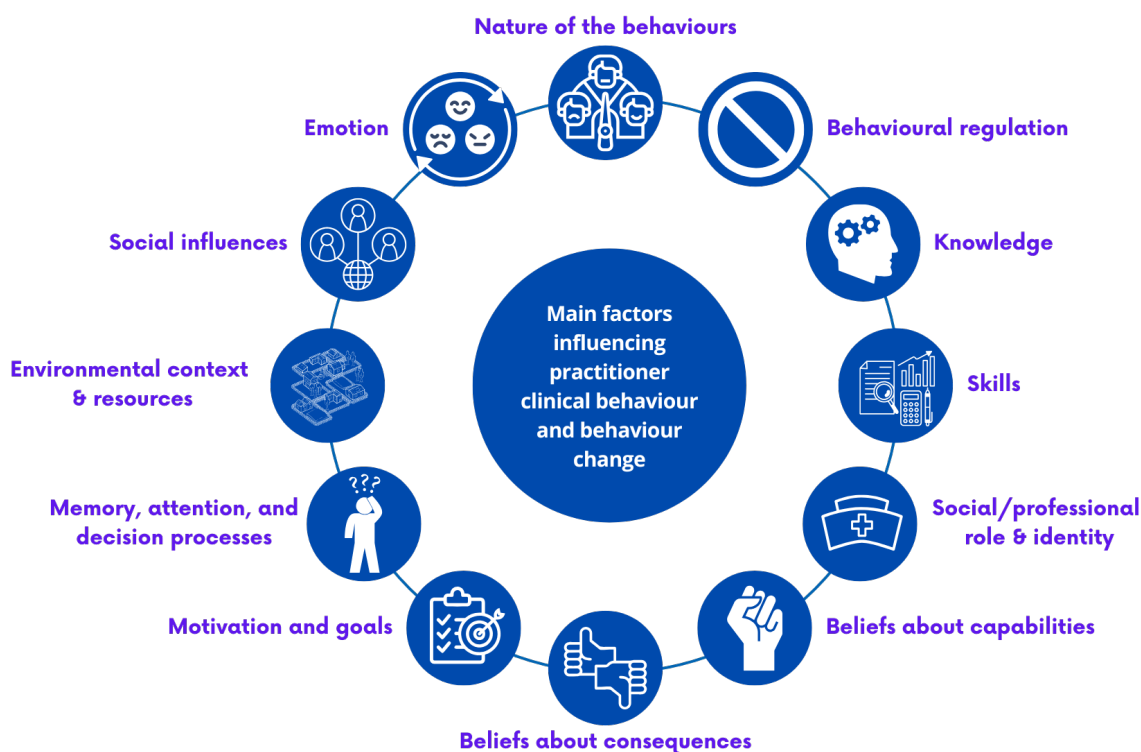


Figure 8.2. Overview of the Theoretical Domains Framework.

Next, Behaviour Change Techniques¹³ were selected to provide theory-informed methods that have been proven to change behaviour that fit in the local CS ICU context.²⁰⁷ Five Behaviour Change Techniques were linked to the identified Domains (see Table 8.1): 4.1 – Instruction on how to perform behaviour (advise or agree on how to perform behaviour), 5.1 – Information about health consequences (provide information about health consequences of performing behaviour), 9.1 – Credible source (provide verbal or visual communication from a credible source in favour of or against the behaviour), 12.2 – Restructuring the social environment (change or advise to change the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour [other than prompts/cues, rewards and punishments]), and 13.2 – Framing/reframing (suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions about performing the behaviour).¹³ These support intervention development by identifying how to change the identified behaviours in an evidence-informed way.

2.2.4 Step Four: Develop Intervention

In developing the intervention, we considered that similar Behaviour Change Techniques could be applied to address multiple Performance Objectives to support early mobility in the local CS ICU (Table 8.1). For example, Behaviour Change Technique 12.2 – Restructuring the social environment involves further changes, including physical modifications to the environment.¹³ These elements were considered by the research team, and a plan for an educational intervention (Appendix 8.1), along with an infographic (Appendix 8.2), was conceived.

The usual type of education for this CS ICU is a paper-based learning module. The CS ICU clinicians on the research team were consulted about potential virtual-based education options, such as a video or a virtual learning module. The clinicians shared important insights related to the limited ability to play and hear virtual-based education in the CS ICU. Such insights highlight the importance of including clinical partners in intervention development and led to the decision to use a paper-based learning module.

The Performance Objectives served as an outline for the content of the learning module. Evidence from the literature, including that generated by our research team, informed the content of the learning module. For example, the early mobility definition co-created among researchers, clinicians, and people with lived experience in a previous study by this research team is shared in the module.¹⁷² The seminal findings from the Dallas Bedrest Study were also included to provide insights into the consequences of immobility.²¹⁴ An iterative, collaborative approach was used to identify which images would effectively convey the embodied patient's experience of the CS ICU, as well as their best placement within the module. First, the clinical partners reviewed the initial draft of the learning module and identified where they felt images would support and reinforce learning. The first author then reviewed the available body map images and selected those that aligned best with the content identified by the clinical partners. Quotations from the body mapping were added to the images to share the embodied patient experience and support clinicians in understanding how to approach providing individualized care. The iterative,

collaborative approach to developing the learning module continued, as the module was then shared with the CS ICU manager and nurse educator for their feedback. Minor wording changes were made to improve clarity. Changes were made to the location and size of images to support their usefulness based on feedback. Specifically, the images were enlarged to fit an entire page to enable clinicians to explore the details in the body maps and compare experiences. The CS ICU manager and nurse educator noted that although the overall experiences were depicted so differently, they had similar elements which they felt were important to emphasize in the module to aid clinicians in understanding the individualization needed to enhance patient care.

The infographic was developed concurrently with the learning module, with the support of two people with lived experience of the CS ICU to influence multiple performance objectives. To support a culture change that prioritizes early mobility, the infographic provides a visual reminder for clinicians, patients, and care partners alike. Accessibility was considered in the use of images to communicate the progression through modes of early mobility clearly, regardless of a patient's education level or primary language. Finally, based on feedback from people with lived experience, we included space for the patient's goals to be added to support the performance objective of enacting patient-centric care. The infographic was also shared with the CS ICU manager and nurse educator for their feedback and insights on its use. Both agreed on the value of the visual reminder of early mobility in the CS ICU rooms and considered an important element in shifting the early mobility culture. The learning module and infographic are provided in the supplemental material.

2.2.5 Step Five: Develop Implementation Plans

The CS ICU manager and nurse educator were engaged in discussions about implementation, and to support the culture shift, all staff in the CS ICU would be required to complete the module. The timeline for staff to complete the module was estimated to be 8-10 weeks, informed by their experience with previous education initiatives. They suggested that webinars may be required to support learning. The first author created a [narrated video webinar](#) that was shared with the staff at several lunchtime

sessions. No research team members visibly supported the delivery of the webinars, as they would be collecting evaluation data and did not want to influence staff behaviours by being associated with the education. The CS ICU manager and nurse educator shared that they would implement this learning module as they do all other education, by providing paper copies as well as emailing them to all CS ICU staff. Reminders to complete the module were verbally given at the beginning of each shift, when staff briefly gathered to hear important updates. Compliance and completion will be tracked by having staff sign and date a sheet when they have completed the education. The CSU manager and nurse educator will follow up with individual staff as needed. Individual staff members would be reminded to complete the education during their shifts throughout the implementation timeline, informed by this sign-off tracking sheet.

2.2.6 Step Six: Develop Evaluation Plan

We repeated our quantitative approaches to evaluate the impact of the intervention on early mobility behaviours through observations. Behaviour mapping will be used again to describe the type, timing, and amount of early mobility behaviours.^{132,215,216} Behaviour mapping was repeated prior to the intervention implementation (June 2025) to incorporate observations of activities of daily living, such as eating/drinking, bathing, and hand washing, among others. Observations will occur again in October and November 2025 after intervention implementation. As in the previous behaviour mapping study, observation data will be summed into four-hour time blocks (i.e. 0630–1030, 1031–1430, 1431–1830, and 1830–2230) across all observation days.¹³² To understand the context within which mobility occurred, the median and interquartile range will be calculated for the number of patients admitted to the CS ICU, the number of patients with contraindications to mobility, the number of nurses, and the number of nurses without an assignment.¹³² Nurse-to-patient ratios will also be noted as the number of patients each nurse was assigned to care for. For example, 1:1 would be one nurse for one patient, and 1:2 would be one nurse for two patients.¹³² This will allow for an understanding of elements that may influence mobility behaviours beyond the education intervention, such as insufficient staffing.

Differences pre- and post-education intervention will be explored using independent t-tests for each mode of mobility, activity of daily living, mobility location, and mobility supports. If the context of mobility differs in the pre- and post-observations, standardization will occur based on the hourly data to allow for exploration of differences based on patient hours. For example, if fewer nurses are caring for two patients post-education intervention compared to pre-education intervention, any differences noted in mobility behaviours could be due to the availability of nurses to support mobility. Standardizing based on patient hours would allow for a more specific exploration of the impact of the education intervention by removing the difference in potential nurse availability. Such an evaluation will support understanding the impact of the intervention on early mobility behaviours.

4. Discussion

Here, we describe a six-step process for developing an intervention to encourage healthcare providers to adopt early mobility in the CS ICU, utilizing intervention mapping. By integrating evidence from the literature with clinicians' knowledge and an understanding of barriers and facilitators to implementation specific to the environment, this novel approach facilitates the translation of research into practice, thereby closing the know-do gap sooner. Incorporating clinician and patients' insights into healthcare provider-targeted interventions helps operationalize integrated knowledge translation (iKT).

iKT is defined as involving knowledge users throughout the research process as equal partners with researchers to improve the applicability of research findings.³ We achieved this by engaging the CS ICU clinical care team and people with lived experience as members of the research group and gathering diverse perspectives through focus groups and patient engagement. The goal of iKT is to enhance the impact of research by applying the principles of knowledge translation to the entire research process.³ Therefore, we followed each step of the knowledge-to-action cycle in developing this intervention map to enhance early mobility in the CS ICU.²¹⁷

Overall, the lack of uptake of early mobility research findings into healthcare practice can be viewed as a production problem, where research does not address the priority questions of knowledge

users.²¹⁸ We already know early mobility works. The body of evidence supporting the efficacy of early mobility for CS ICU patients is robust. Early mobility is efficacious and has been demonstrated through numerous systematic reviews^{77,81,82,90} and is included in the Enhanced Recovery After Surgery CS guidelines as a recommendation.⁸⁷ What we do not know is how to integrate early mobility into practice effectively. Findings from our focus groups suggest that healthcare providers recognize the importance of incorporating early mobility into their clinical practice, but they lack guidance on how to operationalize it consistently. Rather than continuing to demonstrate the efficacy of early mobility, an implementation science approach should be pursued to explore how to integrate mobility into practices effectively. The body of literature supports that multiple modes of mobility are efficacious; however, implementation practices need to be created based on the constraints of each CS ICU to be operationalized successfully.

Future research priorities should shift from exploring the effectiveness or efficacy of early mobility interventions to evaluating the implementation of these interventions in clinical practice.¹ This means using an implementation science approach to research. Implementation science research examines the process of integrating research evidence into clinical care to improve health outcomes, recognizing that disseminating research evidence alone is insufficient to change practice.^{4,5} The systematic processes involved in implementation science should support the integration of early mobility into care.^{4,5} Evidence generated through implementation science research identifies barriers and enablers to using research evidence, as well as strategies to overcome barriers..^{4,6} To support other clinical areas in integrating early mobility into care, research must provide clear descriptions of the interventions (TIDIER) and the implementation plans. In doing so, others can implement early mobility practices, as they will be able to understand whether a given intervention will work in their clinical context.⁴⁻⁶

Intervention mapping has been shown to support the effectiveness and fidelity of interventions in cardiac care.^{219,220} A program for patients with congenital heart disease transitioning from pediatric to adult specialty care significantly improved patient empowerment, perceived parental involvement,

knowledge level, and satisfaction with physical appearance.^{219,220} Small, moderate, and large effect sizes on satisfaction with physical appearance, decreased perceived parental involvement, and increased patients' level of knowledge of congenital heart disease, respectively,²¹⁹ Of the 56 measures of the fidelity of the components of intervention and implementation steps of the program, 71.4% were high or somewhat high, and 28.6% were low or somewhat low.²²⁰ The high fidelity demonstrates that intervention mapping was able to support behavioural change in clinicians, enabling them to adopt the intervention to support pediatric patients transitioning to adult specialty care. This study provides a powerful example of intervention mapping as a tool for implementation science and iKT.

5. Limitations

Given that interventions developed through intervention mapping are context-dependent, approaches may need to be altered to suit different contexts. For example, barriers may differ among CSICUs, and the format of the learning module preferred by individual clinicians may differ. The intervention described here can be considered a starting point for other CSICUs to take and modify to address their own specific requirements.

6. Conclusion

Using intervention mapping to develop an early mobility intervention that targets the behaviours of CSICU clinicians is one way to support closing the know-do gap. Integrating early mobility interventions into clinical care requires behaviour change. Targeting behaviours through intervention mapping can support intervention feasibility and fidelity, uptake, and effectiveness. Our intervention development method operationalizes implementation science and iKT and is well-suited for areas of research that have demonstrated efficacy, such as early mobility.

Appendix 8.1

Learning Module



Early Mobility After Cardiac Surgery

By the EVE Team:

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Definition

Early mobility can mean different things to different people. For this reason, it is important to share a definition and explanation of early mobility so that everyone working in Intensive Care Cardiac Surgery (ICCS) has a shared mental model.²²¹ We define early mobility as **a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient uses their muscle strength intentionally.**

Let's break this definition down:

- **Progression:** mobility is not one activity but rather a variety of movements that can build on one another.
- **Functional life activities:** mobility is more than just walking or cycling and includes activities required to function, such as bathing, eating, and brushing teeth.
- **As soon as the patient can:** makes “early” patient-specific and allows clinicians to refer to exclusion criteria and their clinical judgement to determine when to start.
- **Within 6 hours post-surgery:** this provides a “deadline” for clinicians that requires them to identify criteria to opt-out of mobilizing. This deadline engages clinicians in planning to mobilize sooner and supports staff in understanding that mobility should occur within this timeframe, not after.
- **Intentionally:** mobility requires purposeful movement and intent to move from the patient. Things like passive range of motion would be considered a supplement to early mobility²²² to support success but are not mobility.

Why is Early Mobility Important?

Early mobility is important because it supports recovery from cardiac surgery. Early mobility positively impacts respiratory outcomes such as pleural effusions and atelectasis.⁸⁸ In the ICU, some studies cited reduced hospital length of stay,^{89,90} others cited no impact on hospital length of stay,^{78,82} and one cited increased ICU hospital length of stay and no impact on hospital length of stay.⁷⁶ There are indications that early mobility may reduce the incidence of depression and anxiety in ICU patients.⁹¹

Studies have looked at immobility in the general population. In 1966, five healthy 20-year-old male volunteers spent three weeks on complete bedrest without weight bearing.²¹⁴ Their cardiopulmonary function was evaluated by VO₂max and cardiac output at baseline and after bed rest.²¹⁴ Average VO₂max, and average maximal cardiac output declined by over 25% after bed rest.²¹⁴ Further studies since have showed the same deleterious effects.²²³

Early mobility is also important because it goes beyond physiology and hospital length of stay. Patients describe mobility as being more than just moving post-operatively. Mobility is tied to surviving and getting home, and what motivates people is tied to what is meaningful to them. Patients describe waking from surgery and, before opening their eyes, moving their hands and feet to ensure they are alive.

“Once I kinda woke up so to say, I moved my hands, arms, legs and I feel OK, I can...everything is working, yeah...I survived.”

Being able to move means survival in a broader sense, that they will be well again and able to move through their lives. Recovery from cardiac surgery is an emotional experience. Patients describe fluctuating from frustration and embarrassment about being restricted by their symptoms and medical equipment to being happy to be alive and able to move and work towards getting home and taking this opportunity to redefine themselves.

“Yeah restricted. Yeah, but I couldn’t sit up because of these flippin tubes you know. And the staff didn’t want you to sit up because of these tubes.”

“Yeah, it slowed me down. I don’t...well, I still do things in a hurry, but not as fast as I used to... you can’t change 100%...it did make me stop and realize that, you know, you don’t have to rush everything. But that it really didn’t have so much to do with my heart, like it wasn’t a physical condition, it was more of a mental...a mental condition.”

On the next page, you will see a body map that includes vivid yellows and is titled “Alive Again”. This patient shared that moving after surgery made them realize they had survived and would be able to do the things that they love – being outside in their garden, again.

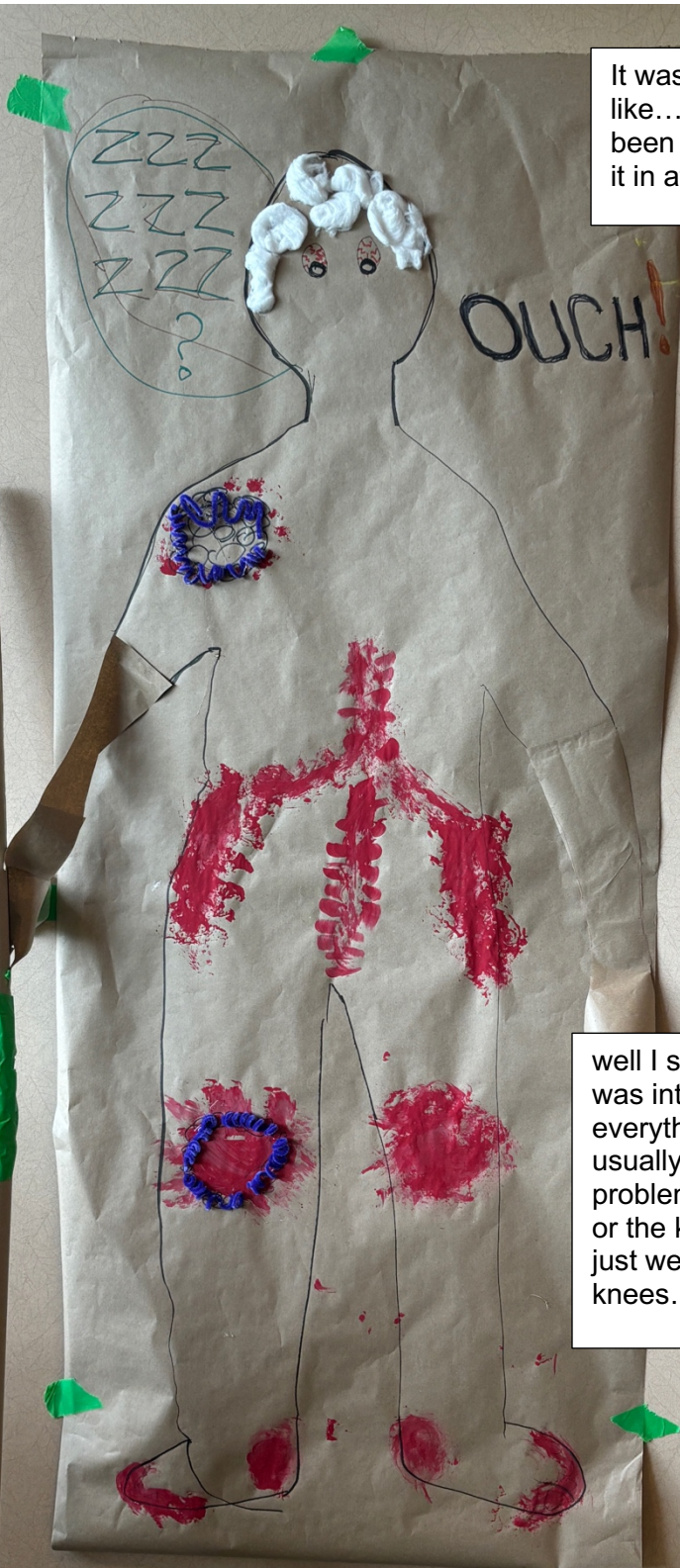
You know, everything is fuzzy everyone said it is everybody when you first wake up even...even all through that that first evening ,that first night and for me anyway, until the next day, it was still...you were still foggy...

"I had shoulder pain. So that's the 25 lbs, it felt like a weight on my shoulders...that was the worst of it, that pressure, that weight on your shoulders. I couldn't get comfortable in any way."

"I did my sunshine with the garden and then I can be outside again. It's...it's my...my freedom of...of having...living again."

Alive
Again





It was that it was head fog it was like...I wouldn't really hadn't been told of this or was aware of it in at first, of it is...

well I suffer from gout ...it was interacting with everything, inflamed it, and usually I'll get a little bit of a problem in the in the ankle or the knee, but it would've just went from heels to the knees...

How Can the Healthcare Team Support Early Mobility?

The healthcare team is integral in supporting early mobility. Rather than looking at early mobility as a task to complete or a box to check off, we can also make movement meaningful. We can think of early mobility as steps towards a patient going home and being confident in their ability to do their activities of daily living. There are studies describing challenges patients have after being hospitalized for a hip fracture. They share that having their activities of daily living done for them in the hospital makes them feel unable to do things for themselves when they return home.²²⁴ ***This can help us have patience with our patients.*** While it will take patients longer to wash themselves, this is important for them to do so they can take back control and build self-efficacy and confidence.

“Well, it was shortly after when I wanted to use the bathroom properly and I know I still have the catheter but thought OK but want be able to get washed yourself and do all that that...And I felt OK, this isn't so bad, and I'm in the house, but, it's only a bungalow, and, I thought I should be able to manage.”

Understanding the patient's goals is important. We can ask patients what is important to them movement-wise. Maybe they want to be able to walk up the stairs to their seats at the Jets game, be able to garden, or be able to sit in their chair and watch their grandkids play. These examples each provide expectations for mobility and can help us motivate each patient in an individualized way.

“It's a priority for me. I live on acreage, I have to maintain and if I can't maintain it then, you know, my whole lifestyle is going to change so...so I was fighting to maintain a lifestyle. That wasn't looking too good with the situation I was in.”

This patient's body map can be seen on the previous page. Their brain fog and non-surgical pain from their gout negatively impacted their ability to move after surgery. Working with this patient to understand why it is important to move would have helped them verbalize their pain. This would help the healthcare team get them moving.

We also need to remember who our patients are. They are mostly elective surgical patients, living in the community with their heart issues until very recently. ***If they walked into the hospital, there is no reason not to expect them to walk, with our support, soon after surgery.*** Similarly, it is important to remember that they had surgery to correct their heart issues. Unlike medical ICU patients, they are no longer limited by illness, and we need to help them get ready to go home.

Motivation

The healthcare team can work with patients to get up and move. ***We need to remember language matters, and it's not just what we say, but how we say it.*** It is important to set the expectation to move and provide patients with choice and control. For example, instead of saying, “You have to get up now,” provide options or bargain to identify a mutually agreeable time: “When do you want to get up (offer time window).” It is also important to reassure the patient that it is safe to move. You can also help motivate them by tying into how the task relates to their personal goals. ***Rather than telling patients they need to get up at certain times, work with them to move when and how to meet their goals.*** If someone wants to be able to work in their garden, ask how far they must walk to get there and break that distance down into smaller goals. This same patient could be encouraged to walk to a window to see a hospital garden.

It is also important to bargain with patients. If they say they don't want to mobilize at lunchtime, ask them when we do it in the afternoon instead. Share the reasons for moving and that there is a paradox. Moving can hurt after surgery, and needing help can be discouraging for anyone. At the same time, moving is important for recovery and will help patients feel like they are figuratively moving toward hospital discharge.

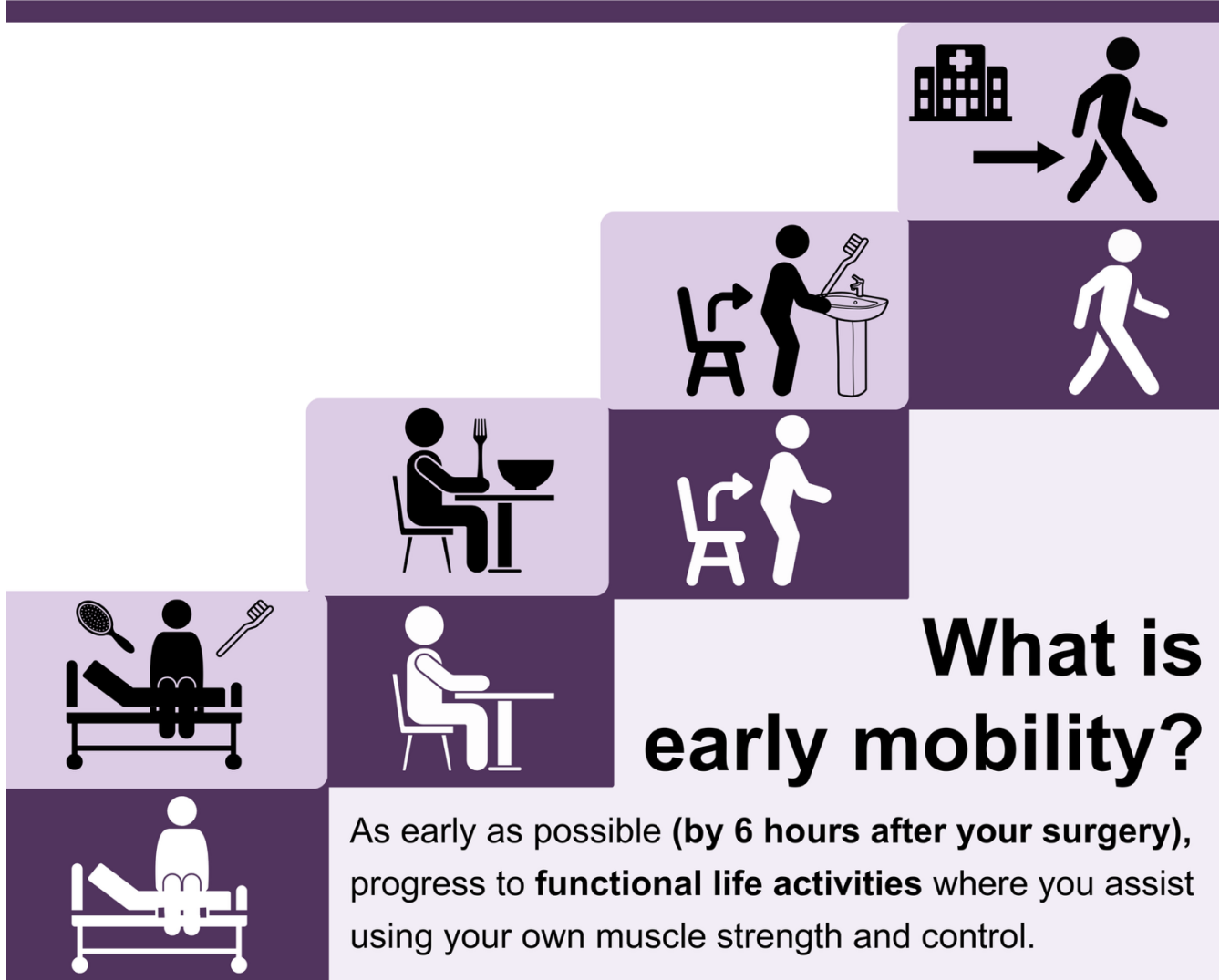
Take Home Messages

- Work as a team with each patient to motivate them to move. *We need to remember language matters, and it's not just what we say, but how we say it.*
 - Early mobility is a progression of functional life activities in which the patient intentionally assists using their own muscle strength and control as early as possible, by 6 hours post-op.
 - Early mobility has positive effects on respiratory outcomes, helps reduce hospital stays, and is important for patients as it reflects their recovery after surgery.
 - Be patient-centred to support mobility by making movement meaningful and with motivation.
- If they walked into the hospital, there is no reason not to expect them to walk, with our support, soon after surgery.

Appendix 8.2

Infographic

' s goal(s) after surgery



Brief Discussion of the Manuscript

This manuscript provides an example of the step-by-step approach to using intervention mapping and offers potential theoretical frameworks and theory-informed behaviour change methods.¹⁰ This makes intervention mapping accessible to researchers with little experience in this method of intervention development. The intervention development method and intervention are described in depth, and examples of the learning module and infographic are included for transparency and fulsome reporting. The final step of intervention mapping, evaluation, is described in the next chapter.

Chapter 9 : The Implementation and Evaluation of an Education Intervention to Support

Early Mobility in the Cardiac Surgery Intensive Care Unit: Findings of the Early mobility to improVE health outcomes following cardiac surgery-Education (EVE-E) clinical trial

Introduction

Background

Early mobility can be defined as a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient intentionally uses their muscle strength.¹⁷² There is robust evidence supporting the efficacy of early mobility in the cardiac surgery intensive care unit (CSICU).^{77,81,82,90} Early mobility is included as a recommendation in the Enhanced Recovery After Surgery CS guidelines.⁸⁷ Early mobility, however, remains inconsistently integrated into routine CSICU clinical care.^{7,132} Thus, the clinical knowledge gap related to early mobility is not its efficacy or effectiveness, but rather how to successfully implement early mobility into CSICU clinical care.

Integrating early mobility into clinical care requires more than an intervention; it requires behaviour change of clinicians.¹ A research methodology that targets behaviour change is intervention mapping.^{9,207} This systematic, theory-driven, multi-level six-step methodology incorporates knowledge from the literature, clinicians, and novel insights from people with lived experience to design, develop, implement, and evaluate behaviour-based interventions.^{9,207} The previous chapter described how an early mobility education intervention was developed to change clinicians' early mobility behaviours in the CSICU.²²⁵ This chapter presents an evaluation of the impact of an early mobility education intervention on healthcare providers' behaviours regarding early mobility support for patients in the CSICU.

Objectives

The aim of this study was to implement and evaluate an early mobility education intervention directed at CSICU clinicians. As the learning module was implemented according to the usual practices

of the local CSICU, no implementation objective was set. The intervention objective was to explore changes in clinician behaviours supporting patients' early mobility in the CSICU.

Methods

Design

This study employed a single-group, pre-post, quasi-experimental, exploratory, non-randomized clinical trial design to assess the efficacy of the intervention. Reporting of this work follows the Standards for Reporting Implementation Studies Statement.²²⁶ The checklist is available in Appendix 9.1. Ethical approval was obtained from the University of Manitoba Research Ethics Board (HE2023-0351) and the St. Boniface Hospital Research Review Committee (RRC/2023/2145).

Context and Participants

This study took place in the CSICU of a tertiary hospital in central Canada. The context has been described in detail elsewhere.¹³² Nurses, healthcare aides, and physiotherapists were included in this study because they are predominantly observed delivering early mobility in the CSICU.¹³² All CSICU nurses, healthcare aides, and physiotherapists were required by their managers to complete the learning module intervention.

Description of Intervention and Implementation Strategy

This intervention was developed in accordance with the six-step process of intervention mapping.⁹ Intervention development has been described in detail elsewhere.²²⁵ All nurses, healthcare aides, and physiotherapists were provided with virtual copies of the learning module by their manager via their work email. Paper copies were also made available in the CSICU. All clinicians were asked to read the module. This is the usual process for education delivery in the CSICU. As this was education provided by the CSICU manager, completion of the learning module was not part of the research process and thus did not require consent. Clinicians could complete the learning module independently or in a group, as they preferred. As the learning module was self-directed, no research team members or CSICU staff members were required to deliver it. The learning module could be reviewed when clinicians were

working in the CSICU. As it was also shared via email, they could choose to review it at home as well. The learning module could be reviewed once or as many times as the clinician felt necessary to understand the content. The time they spent reviewing the learning module was also related to the time required to understand the content. No incentives were offered to complete the learning module. Adherence was supported by the CSICU manager, who reminded staff to complete the learning module.

Outcomes

The primary outcome was a change in patients' early mobility behaviours. This was measured through behaviour mapping.^{215,216} In this method, systematic observations of behaviours of interest are conducted over an extended period across multiple days.^{215,216} Similar to our previous study, a standard operating procedure was created to mitigate potential inter-rater disagreement.¹³² It included definitions of each mobility mode (range of motion, sitting at the side of the bed, sitting in a chair, marching, ambulating, and cycling), who supported it (nurse, physiotherapist, healthcare aide, family, other), and where it occurred (bed, room, hallway).¹³² The standard operating procedure also included the route of travel through the CSICU and contraindications to mobility.¹³² Next, interrater agreement via percent agreement was determined between the two observers through simultaneous observation for three hours.¹³² If inter-rater agreement via percent agreement was low (less than 80%), the standard operating procedure would be revised, and simultaneous observations would be repeated until inter-rater percent agreement exceeded 80%.

Data collection occurred on four days pre-intervention and four days post-intervention, each including 2 weekdays (a Tuesday and a Thursday) and 2 weekend days (a Saturday and a Sunday).¹³² Observations occurred over a 16-hour period each day (0630–2230h), reflecting the most frequent time for mobilization.¹³² Each observer observed for eight hours each day. Baseline observations occurred prior to the learning module being shared with clinicians in June 2025. Observations occurred again in October 2025, after clinicians had reviewed the learning module and had time to integrate its concepts into their clinical practice.

For this study, the mode of mobility (range of motion, sitting at the side of the bed, getting out of bed to a chair, marching on the spot, ambulating, or cycling) and functional activities (brushing teeth, eating or drinking, washing one's face, bathing, and washing or brushing one's hair) were observed every 15 minutes. Total early mobility modes is defined as a combination of all modes of mobility (range of motion, sitting at the side of the bed, sitting in a chair, marching, ambulating, and cycling). Also observed every 15 minutes were the location of the activity (in bed, in the ICU room, or in the ICU hallway) and who supported the activity (nurse, healthcare aide, physiotherapist, family, or other). Hourly, the number of patients admitted to the CSICU, the number of patients with contraindications to mobility (on mechanical circulatory support, with a lumbar drain in situ, or with an open chest), the number of nurses, the nurse-to-patient-ratio, and the number of nurses without an assignment were recorded. Nurse-to-patient ratios were shared as a potential barrier to early mobility in the study in Chapter 4, with participants describing the difficult of mobilizing their patients when they have more than one patient to care for in the CSICU.¹³³

Sample Size

No sample size calculation was performed as this was an exploratory study.

Analysis

Microsoft Excel version 16.90 was used for data entry and for calculating percent agreement. All further data analysis occurred using SPSS version 27. Interrater agreement was determined via percent agreement.^{132,158,215} The median and interquartile range were calculated for the hourly data, except for the nurse-to-patient ratio.¹³² The nurse-to-patient ratios were noted as the number of patients each nurse was assigned to care for.¹³² Rates of the behaviour in each 15-minute block were summed and then standardized per patient-hour. Mann-Whitney U tests were then used to compare individual mobilization modes, total mobilizations, and functional activity rates before and after the intervention. Data were standardized per patient-hour and reported as the median and interquartile range (IQR [Q1–Q3]), unless otherwise specified. Standardizing in this way allowed us to account for the hourly data collected and

supports further data analysis that includes the number of nurses and nurse-to-patient ratios. A p-value <0.05 was considered statistically significant.

Results

The inter-rater percent agreement was 91% for mode of mobility, 100% for functional activities, 97% for location of mobility, and 98% for who supported the activity. Thus, no changes to the standard operating procedure were required. Data collection commenced shortly thereafter.

Context and Hourly Data

The median number of nurses was 11 (11-12) in the CSICU pre-intervention and 9 (9-11) post-intervention ($U=9520$, $z=-14.495$, $p<0.001$). The median was 12 patients (11-13) in the CSICU pre-intervention and 10 patients (8-10) in the CSICU post-intervention ($U=3506.5$, $z=-17.989$, $p<0.001$). Of these patients, a median of 1 (1-1) and 1 (0-1) had pre-identified contraindications to early mobility pre-intervention and post-intervention, respectively. An additional contraindication emerged during data collection when a patient came from the operating room with a stiff pacing wire in situ. During the second, third, and fourth post-intervention observations, the observers noted three patients who were unable to mobilize out of bed (two were unconscious, one required a ceiling lift) but who did not meet the contraindications. These patients were noted to have mobility limitations during the observations to allow for consideration of their inability to perform any mobility beyond being lifted from bed to a chair. Due to the mobility contraindications and limitations, there were fewer patients per-patient-hour in the CSICU post-intervention (6 [5-8]) than pre-intervention (11 [11-12]; $U=490$, $z=-19.6$, $p<0.001$). Due to this difference, data were standardized per patient-hour, unless otherwise specified.

Pre-intervention, the nurse-to-patient ratio was 1:1 across the observation period on one observation day (Thursday), except for a 2-hour period when there was one nurse caring for two patients. On other pre-intervention observation days, it was 1:2 9 times (Tuesday), 13 times (Sunday), and 18 times (Friday), with the last observation day having 2 nurses with 2 patients for 7 hours. The nurse-to-patient ratio never exceeded 1:2.

Post-intervention, the nurse-to-patient ratio was 1:1 across the observation periods, except for one hour on Tuesday when there was one nurse caring for two patients, 3 one-hour periods on Sunday, when there was one nurse caring for two patients, four one-hour periods on Thursday, and 10 one-hour periods on Saturday. There was never more than one nurse with two patients in the post-intervention observations. The nurse-to-patient ratio never exceeded 1:2.

Standardized Data

Table 9.1 shows the median (IQR) for the mobility modes standardized per patient hour. The functional activities were grouped together for analysis. No change was noted in per-patient-hour observations of functional activities post-intervention compared to pre-intervention ($U=31746$, $z=-1.610$, $p=0.107$). Per-patient-hour observations of sitting in a chair decreased post- (0.57, 0-1.33) from pre-intervention (0.8, 0.36-1.5; $U=26155.5$, $z=-4.531$, $p<0.001$) (Table 9.1). Despite this, there was a significant increase in total early mobility (all modes per-patient-hour combined) pre- intervention (0.9 [0.4-1.6]) compared to post-intervention (1.1 [0-2.0]; $U=30322$, $z=-2.037$, $p=0.04$). This change was driven by increased ambulation, despite the median ambulation not changing because of the low absolute observation count (26 of 775 observations pre- intervention and 32 of 339 observations post-intervention; Table 9.2).

To explore the ambulation data in the context of the differing patient-hours pre- and post-intervention, the ratio of count/ patient-hours of ambulation was calculated (Table 9.2). Pre-intervention, the standardized ratio of counts of ambulation per patient-hour was 0.04 ambulations per patient-hour, and post-intervention, this ratio was 0.08 ambulations per patient-hour (Table 9.2). These data indicate that, when accounting for differences in patient-hours pre- and post-intervention, more patients were ambulating post-intervention compared to pre-intervention. The ratios of count/ patient-hours of sitting in a chair and total mobility show the results as the standardized data, a decrease in sitting in a chair post-intervention compared to pre- and an increase in total mobility post-intervention compared to pre (Table 9.2). No other early mobility modes or functional activities had differing ratios pre- and post-intervention.

Table 9.1 Changes in modes of mobility and functional activities pre- and post-intervention for patients without mobility contraindications or limitations.

	Pre-Intervention			Post-Intervention			p-value
	Median	Q1	Q3	Median	Q1	Q3	
Range of motion	0	0	0	0	0	0	0
Site side of bed	0	0	0	0	0	0	0
Chair*	0.80	0.36	1.50	0.57	0	1.33	<0.01
Stand	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
Ambulate	0	0	0	0	0	0	0
Functional activities	0	0	0	0.08	0	0	0.107
Total early mobility modes*	0.89	0.40	1.60	1.14	0	2.00	0.04

Q1=first quartile; Q3=third quartile; * indicates statistical significance

Table 9.2. Absolute counts of pre- and post-intervention modes of mobility and functional activities for patients without mobility contraindications or limitations.

		Pre-Intervention		Post-Intervention	
		Patient-hours=713.75		Patient-hours=415	
		Count	Ratio count/patient-hour	Count	Ratio count/patient-hour
Early mobility modes	Range of motion	6	0.01	4	0.01
	Sit side of bed	16	0.02	17	0.04
	Chair	712	1.00	271	0.65
	March	0	0	3	0.01
	Ambulate	26	0.04	32	0.08
	Total	775	1.09	339	0.82
Functional activities	Brushing teeth	4	0.01	5	0.01
	Eating/ drinking	94	0.13	54	0.13
	Washing face	1	0	0	0
	Bathing	2	0	0	0
	Other	8	0.01	6	0.01
	Total	109	0.15	65	0.16

Time of Day Pre- and Post-Intervention

As shown in Figures 9.1 and 9.2, absolute observations of total early mobility modes and sitting in a chair decreased in frequency from morning (0630-1145h, including breakfast time) to afternoon (1200-1645h, including lunchtime) to evening (1700-2230h, including dinner time), more post-

intervention than pre-intervention. As shown in Figure 9.3, ambulation was observed more frequently in the evening pre-intervention and more frequently in the morning and afternoon post-intervention. These observations suggest that patients moved from sitting in a chair to ambulating, then returned to bed, which aligns with the reduction in observations of patients sitting in a chair.

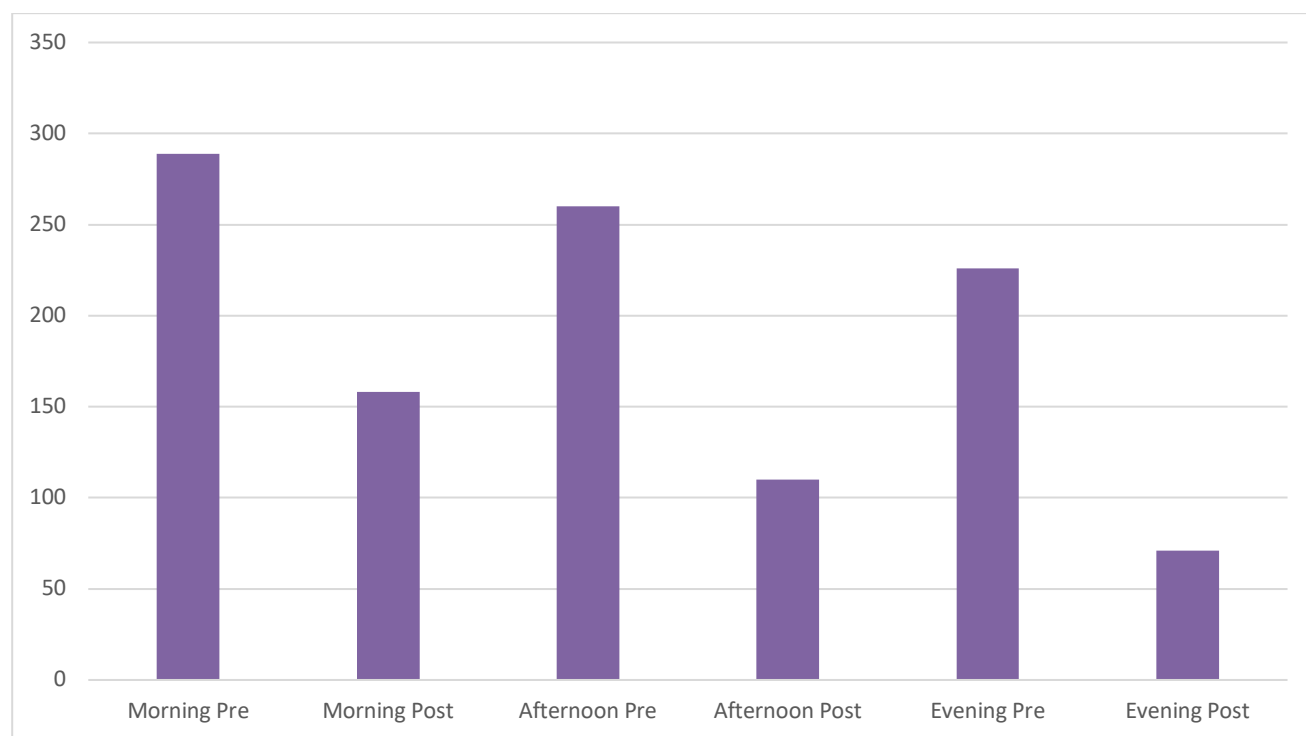


Figure 9.1. Absolute counts of total modes of mobility pre- and post-intervention by time of day.

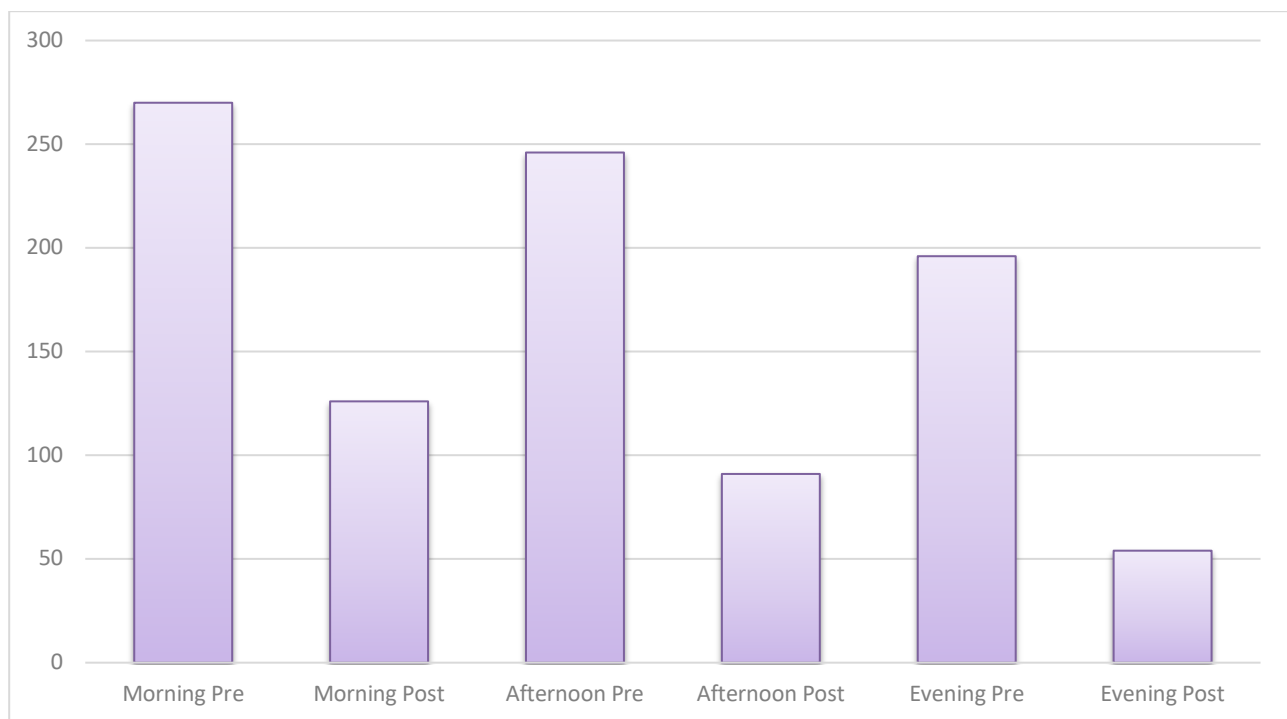


Figure 9.2. Absolute counts of sitting in a chair pre- and post-intervention by time of day.

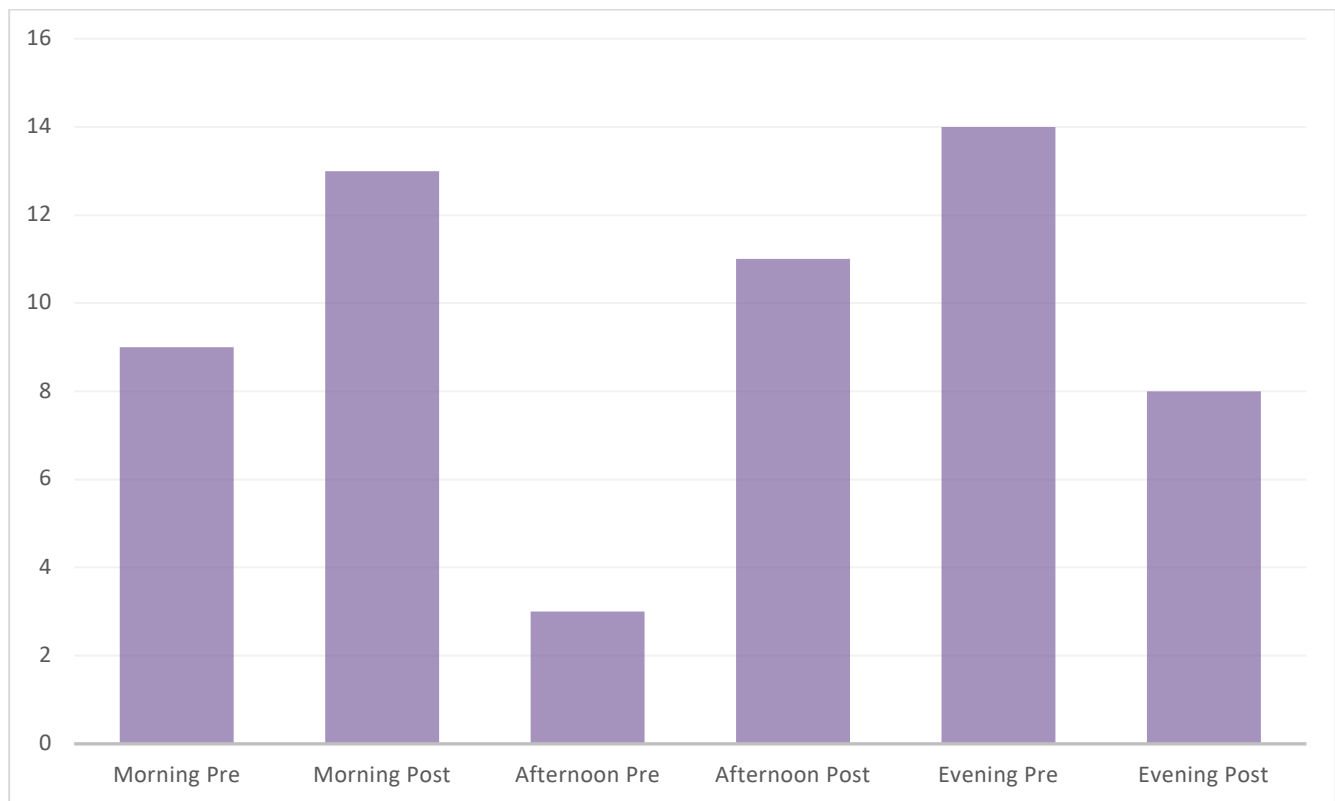


Figure 9.3. Absolute counts of ambulation pre- and post-intervention by time of day.

Discussion

An early mobility intervention focused on educating healthcare providers led to an increase in per-patient-hour observations of total early mobility, a combination of all modes of mobility (range of motion, sitting at the side of the bed, sitting in a chair, marching, ambulating, and cycling) post-intervention compared to pre-intervention ($p=0.04$) despite per-patient-hour observations of mobilizations to a chair decreasing ($p<0.01$). This means that patients spent less time sitting in a chair post-intervention. There was also an increase in ambulations per-patient-hour post-intervention (standardized ratio of 0.08 ambulations per-patient-hour) compared to pre-intervention (standardized ratio of 0.04 ambulations per patient-hour). This change did not shift the median number of per-patient-hour observations of ambulation, likely due to the small number of observations. Both pre- intervention and post-intervention, mobility was clustered around mealtimes and decreased throughout the day from morning to afternoon to evening. There were fewer per-patient-hour observations of sitting in a chair in the evening post-intervention than pre-intervention. Post-intervention, per-patient-hour observations of ambulation were higher in the morning and afternoon than pre-intervention. These findings suggest that using intervention mapping leads to interventions that successfully change behaviours.

Changes in Sitting in a Chair Behaviours

These findings suggest that the education intervention was successful in changing healthcare providers' behaviours regarding early mobility support for patients in the CSICU. This success was partly driven by a reduction in per-patient-hour observations of sitting sedentary in chairs for long periods. The reduced number of per-patient-hour observations and the drop in the median number of patients in a chair post-intervention suggest that patients were not sitting in chairs for long periods but rather moving from bed to a chair and back to bed. This change may relate to the inclusion of progression in the definition of early mobility provided in the learning module.

The early mobility definition used in the learning module, a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where

the patient uses their muscle strength intentionally, was co-created in previous research by this team.¹⁷² The definition was included in the learning module as the intervention mapping process uncovered an incongruence in how clinicians in this CSICU conceptualized and operationalized how early mobility was defined.^{133,225} Progression was defined in the learning module as mobility not being one specific activity but rather a variety of movements that can build on one another.²²⁵ Including progression in the early mobility definition may have shifted the mindset of clinicians from thinking that getting to a chair means early mobility is “completed” to thinking of getting to a chair as one step of mobility.²²⁵ This conceptualization of early mobility supports enacting it in a way that mimics how patients need to move to achieve the ultimate goal of hospital discharge to home.¹⁷² In the CSICU, this could include shifting early mobility from hours sitting in a chair to moving from bed to a chair, to ambulating, and then returning to bed.

Changes in Time of Day of Ambulation

The time of day that ambulation was observed changed post-intervention compared to pre-intervention. Observations of ambulation occurred more frequently in the evening pre-intervention and more frequently in the morning and afternoon post-intervention. These observations suggest that patients ambulated more often, and potentially multiple times a day, post-intervention. The increase in observed ambulation in the morning and afternoon suggests that patients ambulated earlier during their CSICU stay. It is common to see patients arriving from the operating room in the late afternoon and early evening in this CSICU. Observations of ambulation in the morning suggest that patients are ambulating the morning after their CS rather than waiting until the next evening. This means that clinicians supported patients in ambulating sooner in the CSICU stay which was an element included in the learning module.

The learning module also highlighted two differences between CSICU and medical-surgical ICU patients: CSICU patients often walked into the hospital on the morning of their surgery, and were no longer limited by illness upon arrival from the operating room.²²⁵ If a patient was able to walk earlier in the day and there were no surgical complications, there was no reason not to expect them to walk, with

support, soon after surgery.²²⁵ This component of the learning module addressed the incongruence in how clinicians in this CSICU conceptualized and operationalized the safety of early mobility.^{133,225} Despite studies reporting minimal adverse events and hemodynamic stability with mobilization 12 hours postoperatively^{83–85} and clinicians in this CSICU conceptualizing that early mobility is safe, they described operationalizing early mobility with a focus on its lack of safety.¹³³ Rather than sharing data about the benefits and safety of early mobility, we shared the information in a patient-centred way, which was highlighted as important to patients.¹⁶⁸ This message reframed early mobility from a task to be completed to something that clinicians engage in with patients.¹⁶⁸ This put the patient at the center of care and removed safety concerns that didn't apply to that specific patient.^{133,225}

Limitations and Strengths

There are limitations of this analysis that warrant consideration. First, because observations were anonymous, it is not possible to link observed mobility to a specific patient or clinician. For this reason, the same patient may be observed mobilizing several times during the same index event (i.e. not every observation may be an independent event). Second, standardizing the findings by patient-hour led to potentially confounding variables, such as the number of nurses caring for two patients, not being considered. Third, fidelity to the implementation strategy and intervention core components cannot be commented on due to the delivery of the education and the anonymous data collection, which provide context only at the unit level. Fourth, the statistical approach was exploratory and descriptive. This will support future studies that are powered to explore similar interventions by providing an estimated effect size and the expected number of observations. Finally, there was no exploration of the intervention's impact on clinicians' conceptualizations of early mobility. Future qualitative research should explore these to understand how the learning module impacted their perceptions about early mobility. A strength of this study was the creation of a standard operating procedure to guide the observations. This supported the collection of reliable data. Reliability was further strengthened through simultaneous observations and the calculation of percent agreement prior to the commencement of data collection.

Conclusions

An educational intervention to support clinicians in engaging in early mobility behaviours developed through intervention mapping led to statistically and clinically significant changes in total mobility in the local CSICU. Such interventions are important to support behaviour change and integrate best practices from research into clinical care. This can close a knowledge gap and improve patient care and outcomes.

Appendix 9.1

Standards for Reporting Implementation Studies: the StaRI checklist for completion

The StaRI standard should be referenced as: Pinnock H, Barwick M, Carpenter C, Eldridge S, Grandes G, Griffiths CJ, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor SJC for the StaRI Group. Standards for Reporting Implementation Studies ([StaRI](#)) statement. *BMJ* 2017;356:i6795

The detailed Explanation and Elaboration document, which provides the rationale and exemplar text for all these items is: Pinnock H, Barwick M, Carpenter C, Eldridge S, Grandes G, Griffiths C, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor S, for the StaRI group. Standards for Reporting Implementation Studies ([StaRI](#)). [Explanation and Elaboration document](#). *BMJ Open* 2017;7:e013318

Notes: A key concept of the StaRI standards is the dual strands of describing, on the one hand, the implementation strategy and, on the other, the clinical, healthcare, or public health intervention that is being implemented. These strands are represented as two columns in the checklist.

The primary focus of implementation science is the implementation strategy (column 1) and the expectation is that this will always be completed.

The evidence about the impact of the intervention on the targeted population should always be considered (column 2) and either health outcomes reported or robust evidence cited to support a known beneficial effect of the intervention on the health of individuals or populations.

The StaRI standards refers to the broad range of study designs employed in implementation science. Authors should refer to other reporting standards for advice on reporting specific methodological features. Conversely, whilst all items are worthy of consideration, not all items will be applicable to, or feasible within every study.

Checklist item	Reported on page #	Implementation Strategy	Reported on page #	Intervention
		“Implementation strategy” refers to how the intervention was implemented		“Intervention” refers to the healthcare or public health intervention that is being implemented.
Title and abstract				
Title	1	1		Identification as an implementation study, and description of the methodology in the title and/or keywords
Abstract	2	2		Identification as an implementation study, including a description of the implementation strategy to be tested, the evidence-based intervention being implemented, and defining the key implementation and health outcomes.

Introduction					
Introduction	3	4	Description of the problem, challenge or deficiency in healthcare or public health that the intervention being implemented aims to address.		
Rationale	4	4	The scientific background and rationale for the implementation strategy (including any underpinning theory/framework/model, how it is expected to achieve its effects and any pilot work).	4	The scientific background and rationale for the intervention being implemented (including evidence about its effectiveness and how it is expected to achieve its effects).
Aims and objectives	5	4	The aims of the study, differentiating between implementation objectives and any intervention objectives.		
Methods: description					
Design	6	5	The design and key features of the evaluation, (cross referencing to any appropriate methodology reporting standards) and any changes to study protocol, with reasons		
Context	7	5	The context in which the intervention was implemented. (Consider social, economic, policy, healthcare, organisational barriers and facilitators that might influence implementation elsewhere).		
Targeted ‘sites’	8	5	The characteristics of the targeted ‘site(s)’ (e.g locations/personnel/resources etc.) for implementation and any eligibility criteria.	5	The population targeted by the intervention and any eligibility criteria.
Description	9	5-6	A description of the implementation strategy	5-6	A description of the intervention
Sub-groups	10	n/a	Any sub-groups recruited for additional research tasks, and/or nested studies are described		
Methods: evaluation					
Outcomes	11	6-7	Defined pre-specified primary and other outcome(s) of the implementation strategy, and how they were assessed. Document any pre-determined targets	6-7	Defined pre-specified primary and other outcome(s) of the intervention (if assessed), and how they were assessed. Document any pre-determined targets
Process evaluation	12	6-7	Process evaluation objectives and outcomes related to the mechanism by which the strategy is expected to work		
Economic evaluation	13	n/a	Methods for resource use, costs, economic outcomes	n/a	Methods for resource use, costs, economic

			and analysis for the implementation strategy		outcomes and analysis for the intervention
Sample size	14	7	Rationale for sample sizes (including sample size calculations, budgetary constraints, practical considerations, data saturation, as appropriate)		
Analysis	15	7-8	Methods of analysis (with reasons for that choice)		
Sub-group analyses	16	n/a	Any a priori sub-group analyses (e.g. between different sites in a multicentre study, different clinical or demographic populations), and sub-groups recruited to specific nested research tasks		

Results					
Characteristics	17	9-10	Proportion recruited and characteristics of the recipient population for the implementation strategy	9-10	Proportion recruited and characteristics (if appropriate) of the recipient population for the intervention
Outcomes	18	n/a	Primary and other outcome(s) of the implementation strategy	10-14	Primary and other outcome(s) of the Intervention (if assessed)
Process outcomes	19	n/a	Process data related to the implementation strategy mapped to the mechanism by which the strategy is expected to work		
Economic evaluation	20	n/a	Resource use, costs, economic outcomes and analysis for the implementation strategy	n/a	Resource use, costs, economic outcomes and analysis for the intervention
Sub-group analyses	21	n/a	Representativeness and outcomes of subgroups including those recruited to specific research tasks		
Fidelity/adaptation	22		Fidelity to implementation strategy as planned and adaptation to suit context and preferences	n/a	Fidelity to delivering the core components of intervention (where measured)
Contextual changes	23	n/a	Contextual changes (if any) which may have affected outcomes		
Harms	24	n/a	All important harms or unintended effects in each group		
Discussion					
Structured discussion	25	14-18	Summary of findings, strengths and limitations, comparisons with other studies, conclusions and implications		
Implications	26	18	Discussion of policy, practice and/or research implications of the implementation strategy (specifically including scalability)	18	Discussion of policy, practice and/or research implications of the intervention (specifically including sustainability)
General					

Statements	27	5	Include statement(s) on regulatory approvals (including, as appropriate, ethical approval, confidential use of routine data, governance approval), trial/study registration (availability of protocol), funding and conflicts of interest
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Chapter 10 : Conclusion and Contributions to the Literature

In this chapter, I synthesize the previous nine chapters and then provide a summary of Chapters 2-9. I discuss the components of this dissertation with a focus on the novel elements of this dissertation. I explore novel contributions to knowledge, how existing knowledge was advanced, where the published components of this dissertation have had impact already, and where they may have impact in the future. I discuss the knowledge translation that has occurred with components of this dissertation research through integrated, traditional, and novel knowledge translation. Next, strengths and limitations of the complete dissertation are discussed. Future research directions are proposed then I reflect on the dissertation research and approaches used. Finally, the dissertation is concluded.

Synthesis

Implementation science research focuses on moving research findings into clinical practice to close the know-do gap.^{4,5} Rather than continuing to explore proven interventions, this research focuses on how to integrate this knowledge for the benefit of patients.^{4,5} Early mobility has been shown to reduce physical symptoms of PICS in CSICU patients. Early mobility is recommended by guidelines and is safe, with few adverse events and hemodynamic stability reported within 12 hours postoperatively.⁸³⁻⁸⁵ Despite this, early mobility is poorly integrated into CSICU clinical care.^{7,132} This may relate to the research approaches used thus far in early mobility research, which were not designed purposefully to be integrated into clinical practice.¹⁴³ A novel approach, using PER, ABM, and implementation science, better supports early mobility intervention development and integration into clinical care. It is likely that PICS will continue to increase in prevalence as the population of CS patients ages; therefore, there is a need to change how we deliver clinical care to address its negative health outcomes.

One way to operationalize implementation science is through intervention mapping, a six-step process to create, implement, and evaluate an intervention focused on changing behaviours.^{9,10} Overall, this dissertation provides a framework for developing an intervention in this novel manner and

incorporating clinician and lived experiences. The evaluation focuses on clinical utility and its effectiveness in changing clinician behaviours. This dissertation demonstrates that an intervention developed using intervention mapping can change clinician behaviours. In Chapters 2-7, existing literature and stakeholder knowledge was gathered. The intervention development process is described in Chapter 8, where the findings from Chapters 2, 3, 4, 6, and 7 are aligned with behaviour change techniques to guide intervention development. Finally, the intervention evaluation is presented in Chapter 9. Overall, this dissertation demonstrates that intervention mapping can be used to operationalize implementation science and iKT to support the development and testing of interventions that are delivered by the clinical care team and can be integrated into care rather than stopped once the trial is complete. It also provides an approach for understanding embodied experiences by using ABMs for PER and incorporating them into intervention design. Researchers can use ABM for PER to understand more than just thoughts and perceptions. For example, researchers can use ABM for PER to delve into embodied knowledge to better understand how healthcare is experienced to support improvements. Embodied knowledge is a type of knowledge that resides in the body in our senses, expressions, emotions, and significant meaning.^{65,140,141,157,169} These elements can be difficult to verbalize, so using art to share them unlocks this previously untapped knowledge. Embodied knowledge adds to the knowledge that PWLE can share with researchers to inform research questions and design. Understanding the experiences of PWLE more fully may assist in aligning how researchers, clinicians, and patients conceptualize and understand phenomena, thereby helping to close the know-do gap.^{2,32} Used together, an implementation science/iKT approach and engaging PWLE to explore their embodied knowledge advance PICS, early mobility, PER, and intervention mapping research, ultimately supporting the goal of health research and improved patient health outcomes.^{2,32}

This dissertation demonstrates that conducting research through a pragmatist worldview that allows for the use of multiple forms of knowledge, including experiential, clinical, and embodied knowledge, to guide research is valuable.^{18,25,26} It also demonstrates that allowing the research question

to guide research design enables the generation of rich knowledge. Exploring the perspective of clinicians, those who are embedded within the clinical context, as described in Chapter 4, provided key knowledge that was central to the education intervention developed in Chapter 8. The understanding of the incongruencies that exist for clinicians between conceptualization and operationalization of early mobility shifted the intervention development from an early mobility protocol towards something that would align the conceptualization and operationalization of early mobility. Without valuing clinical knowledge, an underlying cause of inconsistent mobility practices would not be understood and could not be addressed. Researchers in isolation valuing only empirical knowledge could previously have identified nor addressed this gap. Similarly, the approach used to engage PWLE described in Chapter 5 values their lived expertise and embodied knowledge. The worldview that guided this dissertation allowed us to approach engagement in a novel way, by understanding that there is some knowledge that is difficult to put into words but can be shared through art. Providing space for PWLE to share their embodied experiences and begin to analyze these with the research team generated knowledge that would likely not be uncovered any other way. This knowledge challenges assumptions of clinicians and researchers, several of whom have shared surprise that pain was not a more prominent theme related to early mobility and at the extent of brain fog that was experienced by PWLE. Had we simply asked PWLE to describe their experience with early mobility, without providing space for PWLE to own how they share their knowledge and experiences through ABMs, we would not have the same rich and deep understanding of the complexity and emotionality of this time. We would not understand the significance and deep meaning that early mobility holds. Being guided by a pragmatic worldview, which values the lived experience and requires it to fully understand a phenomena and requires researchers to design research in the best way to answer the question,^{18,25,26} and being true to the research findings along the way and allowing them to guide research directions is a key underlying reason for the success of the intervention developed in this dissertation. It is also a key learning of mine from this research that I will use moving forward and I hope others see and will be impacted by.

Summary

The manuscript in Chapter 2 reviews the early mobility in the CSICU literature and identifies many aspects that may be driving the lack of integration of early mobility into clinical care.¹⁴³ The published scoping review described the extent, range, and nature of interventions in the early mobility literature over the past 4 decades years (1983-2024). Prior to this work, several systematic reviews have explored the effects of early mobility on CSICU patients; however, they include only randomized controlled trials.^{77,82,90} This limits the breadth of understanding of the state of the literature, as pilot studies, quality improvement studies, and grey literature are not included. This published scoping review also explores possible reasons for the noted lack of integration of early mobility into CSICU clinical care by exploring early mobility research reporting over time. Finally, the consideration of sex and gender in results and discussions was unknown despite the cited impacts of these variables on exercise in the literature prior to the novel work described in this chapter. The review comprehensively describes the current state of the literature which informed the next steps in this dissertation.

This scoping review uncovered that overall, the early mobility in the CSICU literature is consistent in terms of primary outcomes, when early mobility starts, mode of early mobility, the lack of use of patient-reported outcome measures, the lack of reporting or discussion of sex and gender, and the lack of clear reporting of the interventions. This review also identified the heterogeneity in primary outcome measures and intervention protocols, which makes a comparison of studies in a meta-analysis difficult. When reviewing the body of literature over the past 40 years (1983-2024), the lack of progress in the research is evident. This manuscript concludes with a call to approach future research in a different manner to support the development of interventions that are usable in the CSICU. We suggest intervention mapping as a method to undertake research in a novel manner that would include knowledge users in the research process. This should develop interventions that are usable in the CSICU, which may improve the translation of research findings into clinical care.

This scoping review impacted the direction of this dissertation in several ways. It is part of the first step of intervention mapping as this constituted the literature review of the needs assessment.^{9,10} The results led me to think about the poor clarity of reporting of interventions and to review the existing early mobility protocol in the CSICU. I noticed gaps in that protocol that are consistent with those found in the literature. For example, a lack of motivation strategies, a description of exercise that does not enable replication, a lack of a rule for the starting level of activity, and a lack of clarity on rules for the progression of exercise. These gaps provided ideas for educational needs for the intervention ultimately developed, and for elements to consider in future early mobility intervention protocols for this CSICU. The lack of inclusion of patient-reported outcome measures strengthened my belief in the need to include lived experiences in future research and to understand outcomes important to patients and care partners in future research. This review sparked my consideration of the essential elements required in an early mobility definition that informs future research and clinical care. The early mobility definition ultimately created is based on the work reported in Chapters 6 and 7. Finally, this review began my thinking about including functional activities in early mobility interventions. This was something discussed with a care partner in the body mapping workshops reported in Chapter 6. When reviewing the results of this scoping review, I noted the dominance of one mode of mobility in protocols and the lack of consideration of the need to prepare patients to return to their lives after hospital discharge. I closely read the few included articles that included functional movements and began to consider how functional movements could be included in early mobility protocols.

This scoping review greatly impacted this dissertation as described above. I hope it will also cause other early mobility researchers to pause and consider how to move this body of literature forward. Researchers need to do differently to do better. We need to provide front-line clinicians with clear and complete protocols that allow for replication. We need to evaluate these protocols in ways that are meaningful to patients and that are consistent among studies to allow for comparison of protocols. We need to report findings disaggregated by sex and gender to allow for an understanding of these elements.

I take these calls to action seriously and intend to move forward with these in mind beyond this dissertation to model that we can do differently and do better.

A study that explores the current state of early mobility in the local CSICU is shared in Chapter 3.¹³² There was a lack of observational studies of early mobility in the CSICU, so this study filled that gap in the literature. The objective was to use behaviour mapping to describe patterns of patients' mobility in one CSICU to understand their mobility patterns early after admission to the unit. This study informed the next steps in this dissertation by providing an understanding of the current state of early mobility.

In this study, we revealed the dominance in the mode of mobility of moving patients out of bed to a chair and keeping them there for hours. Being in a chair was observed 10 times more often than any other mode of mobility. Ambulation was observed 18 times in this study rather than the 32 observations expected based on the early mobility protocol. The lower amount of ambulation observed indicates that patients are not moving enough according to the local early mobility protocol. It seems that clinicians rely on getting patients out of bed to a chair as the main metric for early mobility in this CSICU. The observations of patients sitting in a chair for long periods of time indicate that patients are being sedentary. This led me to consider the concept of sedentary behaviour and how we need to incorporate this concept into future research and education. Seeing the number of mobilizations out of bed suggests to me that CSICU clinicians believe in early mobility and that there is a good baseline to build upon. From an implementation science standpoint, it seems the clinicians know the literature that demonstrates that early mobility is beneficial for patients; what is lacking is consistent operationalization of this research in the clinical area. The lack of a clear early mobility definition in the literature or in the clinical setting and the inconsistent clinician education related to early mobility are likely contributing to the practices of CSICU clinicians. These are complex issues to overcome, as behaviour change is complex. It is easier to overcome, however, than uninformed or unengaged clinicians. An implementation science

approach to support the use of the existing early mobility research more consistently may lead to improved and more consistent early mobility behaviours in this CSICU.

This study was completed prior to my and our research group's consideration of functional activities as modes of early mobility. For this reason, when we replicated this study to support the evaluation of the education intervention described in Chapter 8, we purposefully expanded the research to observe activities of daily living in addition to the original modes of early mobility observed in this chapter. Behaviour mapping was novel to many members of the research team; however, it has become a valuable tool to gather observational data. It was used by a Masters student member of the team in a different study to understand the involvement of family members in early mobility in the CSICU. Thus, this manuscript and study have positively impacted this dissertation and the broader research team. Overall, this study provided contextual information missing from current observational studies of early mobility using a novel observational method.

Chapter 4 presents a manuscript describing the focus groups conducted with CSICU clinicians, where perceptions of early mobility were discussed along with perceived barriers and facilitators of early mobility.¹³³ Through focus group discussions and individual interviews, the incongruencies in how early mobility is conceptualized and operationalized by CSICU clinicians were identified.¹³³ These incongruencies were grouped at the micro (clinician), meso (unit), and macro (hospital) level.¹³³ Together, the incongruencies led to uncertainty for clinicians and, ultimately, inconsistent mobilization.¹³³ In addition, four barriers and four facilitators to early mobility were identified, grouped as patient care-related (barriers=2, facilitators) and clinician-related (barriers=2, facilitators=3).¹³³ The clinician perspectives included novel contributions to the literature that may help overcome the inconsistent integration of early mobility within the local CSICU.¹³³

These findings suggest tangible behavioural barriers that must be overcome to integrate early mobility into this CSICU beyond getting patients out of bed to a chair. These barriers need to be addressed through behaviour change, which are difficult to achieve. The findings also identify facilitators

that can be leveraged to support early mobility. Importantly, the incongruencies between how clinicians conceptualize (think about) early mobility and how they operationalize (do) early mobility were key in shaping the intervention described in Chapters 8 and 9. If clinicians do not conceptualize and operationalize early mobility in a unified manner, any early mobility intervention introduced to this CSICU is likely to be unsuccessfully incorporated into clinical care. Specifically, a shared and consistent conceptualization of what early mobility means and reframing safety to include why sedentary behaviour is unsafe were key findings that needed to be addressed prior to a broader intervention being developed and introduced.

The manuscript in Chapter 5¹³⁴ details the methods used in the studies in Chapters 6 and 7.^{168,172} This manuscript details the process of preparing and facilitating the workshops during which the body maps are created and how the body maps are co-analyzed with the PWLE participants.¹³⁴ It then shares the process of preparing for and facilitating discussions on a virtual platform to co-create a definition of early mobility and generate a list of barriers and facilitators to early mobility, along with outcome and experience measures that should be considered when evaluating early mobility interventions.¹³⁴ Finally, the steps to prepare for and prioritize the barriers and facilitators and outcome and experience measures are shared.¹³⁴

Guidance on how to use ABMs to engage PWLE in research is lacking. This in turn limits a researchers' ability to use deploy powerful approaches in engagement research. The manuscript that is embedded in Chapter 5 provides a detailed description of the methods as a model to guide other researchers in the future. Rather than summarizing the methods used in the three half-day, in-person workshops and two 4-hour-long virtual workshops in sections of Chapters 6 and 7, I sought to describe the preparation for each workshop, the goals of each workshop, and how these were achieved. By splitting the reporting of the preparation and goals of each workshop away from the reporting of the results gained through the approach provides researchers with a model to use in their own studies. Describing how we applied the model to our own work provides a tangible example that helps researchers

understand how to apply it. We also provide guidance on how to engage PWLE throughout the research process. We describe how data were co-analyzed and co-synthesized with PWLE during the workshops and how a deeper analysis of the recordings of the body map presentations can also include PWLE. This supports researchers in engaging in a meaningful way beyond only data collection.

The manuscript in Chapter 6 describes the findings of a study using an ABM, body mapping, for PER to explore embodied experiences of early mobility in the CSICU.¹⁶⁸ Using this ABM, we uncovered many novel elements of the early mobility experience of PWLE that were previously missing from the literature.¹⁶⁸ These elements were sensory, emotional, and feelings, which are difficult to verbalize because they are elements of embodied knowledge, that which comes from and resides in the body.¹⁴¹ PWLE depicted their pain, happiness, sadness, medical equipment, brain fog, instability, and the importance of attitude to recovery.¹⁶⁸ They shared their journey to recovery from CS and how early mobility was key to this.¹⁶⁸ They described how much meaning mobility held for them, as it was used as an indicator of being alive and recovering.¹⁶⁸ The deep significance of early mobility to PWLE of CS would not have been captured if engagement had been limited to discussions.¹⁶⁸

Chapter 6 provides a novel understanding of the embodied experiences of patients and care partners with early mobility in the CSICU. It shares the meaning patients assign to movement post-CS and the elements that push patients towards mobilizing through person-first care and attitudes, and those that hold them back through the paradox of movement and how they move through the emotions. The meaning and these elements are shared in two ways. First, the embodied experiences are shared directly through the art created by the PWLE participants, as pictures of the body maps are included as figures in the manuscript. Second, the themes and categories created from the transcripts of the discussions and participant observation of the videos are shared in a manner similar to typical qualitative research. This layered approach to data analysis provides a richer description of the data that blends the interpretive nature of art with the academic rigour of formal qualitative analysis.

The majority of the findings of Chapter 6 are novel contributions to the literature. Engaging patients and care partners to share their embodied knowledge in a way that is meaningful to them uncovered knowledge that clinicians and researchers had not known to ask about in previous research. This knowledge is important to consider in the development of early mobility education and interventions. If clinicians understand the symptoms that patients feel when mobilizing, such as the brain fog that was so commonly described, they can tailor their conversations with patients to better support mobility. If clinicians understand that patients often view mobility as moving towards going home, they can motivate patients effectively to mobilize. For this reason, we used this knowledge in the intervention described in Chapters 8 and 9. The clinician partners on this research team and the manager and nurse educator of the CSICU supported the identification of where quotes from the presentations of the body maps and images of the body maps would supplement the information being shared with clinicians. I then identified potential quotes and images and incorporated them into the education. In this way, the experiences of patients and care partners were shared directly with clinicians to support their understanding of early mobility.

The next steps of the engagement work are described in Chapter 7. In two virtual consultation workshops, we co-developed an early mobility definition that clinicians further developed, *a progression of functional life activities that begins as soon as the patient can participate (typically within six hours post-surgery), where the patient uses their muscle strength intentionally*, which is the first early mobility definition developed this way.¹⁷² A PWLE- and clinician-informed early mobility definition is important, as these are the people who engage in early mobility behaviours.¹⁷² The definition needs to speak to them and provide them an understanding of how to “do” early mobility.¹⁷² This definition includes concepts such as progression, functional life activities, as soon as the patient can participate, and intentionally, which were not all included in existing early mobility definitions. This manuscript also shares novel barriers and facilitators to early mobility in the CSICU: brain “fuzziness/fogginess”, weakness, positive attitude, and receiving education about health issues interacting and causing unclear discomfort.¹⁷² These

are important considerations for future early mobility intervention research, as these need to be overcome or leveraged to support the success of an intervention. This manuscript also shares patient-prioritized physical, cognitive, and mental outcome measures and experience measures that can be used in future research to align intervention evaluation with patient priorities.¹⁷² The outcome and experience measures shared differ from the measures used in existing early mobility research: hospital length of stay, pulmonary function, 6-minute walk test, hemodynamic measurements, heart rate variability, functional outcomes, and days to walk.¹⁷² The current misalignment of intervention evaluation with patient priorities may be a barrier to robust intervention evaluation.¹⁷²

In Chapter 8, the remaining five steps of intervention mapping are described.²²⁵ The findings from Chapters 2, 3, 4, 6, and 7 are transformed from gaps to performance objectives and are then tied to the domains of the Theoretical Domains Framework.²²⁵ This allows for linkage with Behaviour Change Techniques, which are used to generate the components of the educational intervention.²²⁵ The manuscript in Chapter 8 provides a roadmap for other researchers to use intervention mapping to operationalize implementation science and iKT.²²⁵ Intervention mapping remains a novel approach to intervention development, so providing this framework and example of its use should support other researchers in using this approach.²²⁵

Finally, in Chapter 9 the intervention evaluation is presented. The intervention was evaluated through changes in early mobility behaviour. Changes in behaviour were observed using behaviour mapping before and after the delivery of the educational intervention. Behaviour mapping included observations of activities of daily living (called functional activities in the manuscript) to align with the PWLE and clinician-informed early mobility definition. The intervention had a statistically significant impact on early mobility behaviours, with an increase in total mobility observed. This research suggests that an education intervention co-developed by researchers, clinicians, and PWLE influences clinician behaviours, to increase patients' early mobility behaviours. It also demonstrates the utility of intervention mapping at developing interventions to change behaviours.

Impact

In this section, I summarize my work within the broader literature and beyond only implementation science and intervention mapping. While this dissertation describes a novel approach to implementation science, the components of this dissertation offer much more than simply a needs assessment for the first step of intervention mapping. I explore how this dissertation adds to the existing early mobility in the CSICU, arts-based, and patient engagement literature by contributing new knowledge and advancing existing knowledge. I examine the local impacts of individual projects and publications. I also suggest how they will likely have impacts nationally and within specific communities of research in the future. Finally, I share some of the novel knowledge translation that has occurred. Figure 1.2 in Chapter 1 provided a visual overview of what was known and not known prior to this dissertation. Figure 10.1 builds on the foundation of Figure 1.2 and provides a visual of what this dissertation specifically adds to the collective knowledge.

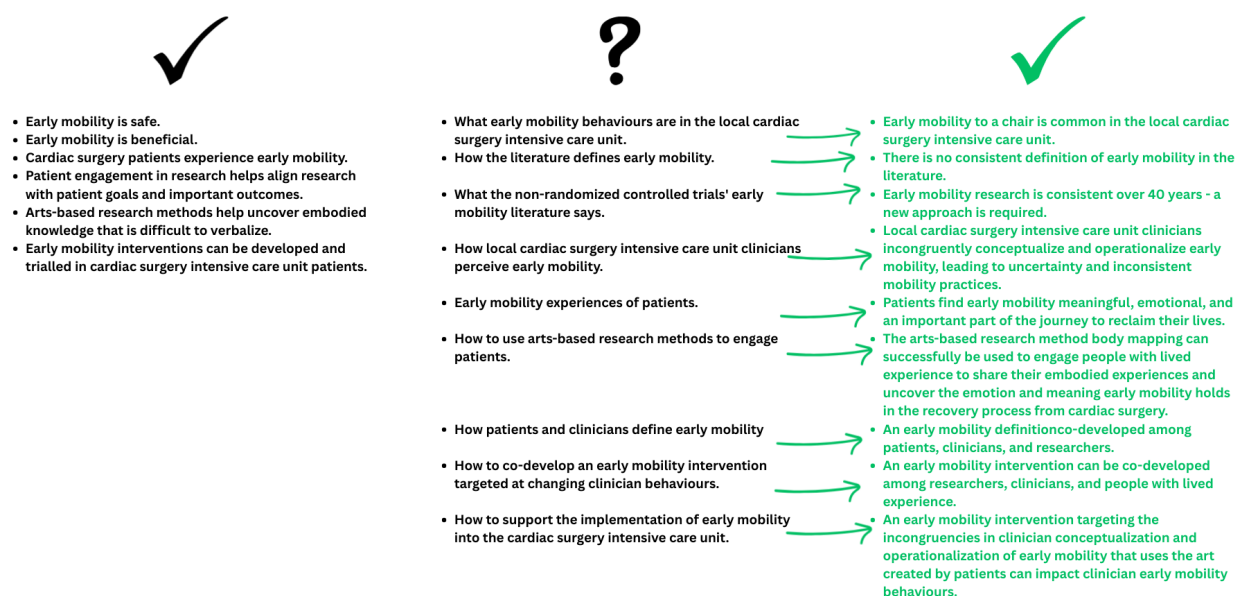


Figure 10.1. What was known (black text) and what knowledge this dissertation adds (green text) (adapted from Figure 1.2)

What is new?

This work contributes new knowledge to the existing early mobility in the CSICU, arts-based, and patient engagement literature. The scoping review of early mobility in the CSICU interventions offers a novel perspective on the existing early mobility literature by highlighting the lack of progress in research over the past 40 years.¹⁴³ The scoping review also critically analyses the quality of reporting of early mobility interventions and the consideration of sex and gender, which are also novel.¹⁴³ By including these aspects in the scoping review, we provide an alternative, more critical lens through which to view the existing early mobility in the CSICU literature.¹⁴³ This lens expands the considerations of reviews of early mobility in the CSICU beyond focusing on the impacts of early mobility in the CSICU on patient outcomes and challenges researchers to reconsider the design of their interventions and research to advance the science of early mobility in the CSICU.¹⁴³

This work also contributes new knowledge related to the practices of early mobility in CSICU clinical care. Using behaviour mapping to observe early mobility behaviours in the CSICU builds on the existing healthcare provider reports, surveys, and accelerometer data.¹³² Behaviour mapping provides important, and previously missing, contextual information about early mobility.¹³² Self-report data can be rife with self-report bias and recall issues.¹³² Survey data can misrepresent early mobility practices through biases and potential issues with validity and reliability.¹³² Accelerometers can provide objective data related to mobility, but this data lacks context, such as the specific timing of mobility, the location of the mobility, the mode of mobility, and who is supporting the mobility.¹³² Behaviour mapping provides this contextual information.¹³² This information is important to consider, as it can inform future research interventions and improvements in clinical care. For example, our study noted that mobility was most frequently observed during the 0630–1030 time period.¹³² This cannot be tied to nursing assessments, as these occur at 0800, 1200, 1600, and 2000.¹³² This timing also cannot be tied to meal times, as patients should also be mobilized to a chair for lunch and dinner.¹³² The frequency of mobility during this time

period can inform improvements in clinical care by identifying that mobility should be emphasized at non-breakfast meal times or with afternoon and evening nursing assessments.¹³² This is important information that was previously missing from the early mobility in the CSICU literature.

Prior to this dissertation, early mobility definitions used in research and clinically were not co-created with PWLE and clinicians. Definitions were often focused on the timing of when mobility began post-operatively.¹⁴³ Timing was delineated by post-operative day, a certain number of hours following extubation, or when a patient met certain criteria.¹⁴³ Other definitions included modes of mobility, that mobility could be a functional life activity, a progression through activities, and the requirement for patients to participate in mobility actively but no existing definition included all of these elements. These were the elements identified by PWLE and clinicians as important when defining early mobility to ensure the definition is meaningful to both groups.¹⁷² The co-created definition developed for this dissertation is therefore novel but also meaningful to those who will use it, clinicians and PWLE.¹⁷² This should support a shared conceptualization of early mobility in the CSICU and the future integration of early mobility interventions.

Outcome measures used in early mobility studies were noted in our scoping review of early mobility interventions to be consistent over time and focused on pulmonary function, physical function, and length of stay.¹⁴³ Patient-reported outcome measures were not commonly used outcome measures, with no progression in their use over time.¹⁴³ We suggest the development of a core outcome set for early mobility interventions to support their evaluation in a manner that allows for comparison among interventions.¹⁴³ We also suggest including patient-reported outcome measures in this core outcome set.¹⁴³ Patient-reported outcome measures provide important intervention efficacy information to consider.¹⁴³ Objective measures may show improvements, but if patients do not feel those improvements, the intervention efficacy should be questioned.¹⁴³ “If the intervention is beneficial but the experience is poor, patients may decline to participate, reducing the effectiveness of the intervention”.¹⁴³ We took this work further in our engagement study by co-creating and prioritizing outcome and experience measures

for early mobility in the CSICU with PWLE.¹⁷² This study contributed cognitive, mental, and physical outcome measures that can be used alongside the experience measures as the first step in developing a PWLE-informed core outcome set.¹⁷² Together, these measures will support a holistic evaluation of early mobility interventions that align with the domains of PICS and with the symptoms that impact patients most meaningfully.

Prior to this dissertation, patient experiences of early mobility in the literature were limited to qualitative studies and surveys.¹⁶⁸ Exploring embodied lived experiences through PER using ABMs is novel and an important contribution to the current global literature on this topic. The embodied experience perspective added new considerations of how early mobility practices are experienced by patients.¹⁶⁸ The depiction of the symptoms, feelings, emotions, and medical equipment provided unique insights into how early mobility practices are interpreted by patients.¹⁶⁸ Rather than being interpreted by researchers, we co-analyzed the data with PWLE. This ensured that the meaning behind what was included on the body maps was interpreted in the context and manner intended.¹⁶⁸ This novel approach to exploring the experience of early mobility highlighted the positive and negative emotions that exist within patients.¹⁶⁸ It also enforced the need to ensure patients and their care partners are mentally prepared for early mobility so that they are able to approach early mobility with a positive attitude to achieve their goals.¹⁶⁸ These are important elements to the early mobility experience that were previously missing from the literature.

We took what was shared through body mapping and incorporated the embodied knowledge into an educational intervention.²²⁵ This is one of the first instances an early mobility intervention has been described as being developed informed by the lived experience. Incorporating the art created by PWLE into the intervention is also novel. Doing this allows PWLE to speak directly to clinicians, sharing not only their physical experiences but also their feelings and emotions.

Finally, this is the first time that intervention mapping has been used to develop an early mobility intervention for the CSICU. This focus on implementation and overcoming barriers to clinicians

incorporating early mobility practices into their daily patient care is a new approach which was successful in creating a statistically significant change in total mobility, which had a small effect size.

What Existing Knowledge Was Advanced?

In addition to the new knowledge generated by the work in this dissertation, three areas of knowledge were advanced: using ABMs for PER, intervention mapping, and barriers and facilitators to early mobility in the CSICU. In a narrative review, we noted that ABMs for PER were predominantly used in research with populations identified as marginalized PWLE, children, and in older adults.⁶⁵ In this dissertation, ABMs were used to engage PWLE regardless of aspects of their identity that could lead to them being marginalized or their age. This novel approach advances the knowledge of the use of ABMs for PER by demonstrating the value in understanding the embodied experiences of PWLE even in non-marginalized adults. This shifts the focus of ABMs from only being used to give voice to those who have historically been silenced or those who may not have the words to describe their experiences to being a way to share knowledge that cannot be put into words.

Related to ABMs for PER, this dissertation also advances the knowledge of using ABMs and body mapping in health research. The narrative review mentioned above noted the many forms of art that have been used in health research.⁶⁵ This dissertation builds on this knowledge base to further demonstrate that ABMs can be used for PER and the value and power of doing so. Body mapping was not one of the art forms found to be used in health research.⁶⁵ This dissertation demonstrates that body mapping can be used in health research to explore the embodied experience. In this way, this dissertation furthers the body of literature supporting the use of ABMs for PER.

This dissertation also advances the intervention mapping literature. This work provides a new application of intervention mapping with early mobility in the CSICU. The process of intervention mapping is clearly described, which provides a roadmap for future researchers to use this novel method for intervention development. This dissertation is the first time that intervention mapping has been used to develop an early mobility intervention. This expands the body of evidence of the use of intervention

mapping. Finally, the intervention created in this dissertation through intervention mapping uses embodied knowledge. This is the first time this form of knowledge has been used to inform intervention development using intervention mapping. This expands the knowledge available to inform the first step of intervention mapping, moving beyond the literature and quantitative and qualitative research alone. Embodied knowledge explored using ABMs is different from other forms of knowledge and should be considered as an addition to other knowledge sources. This dissertation provides an example of how to explore embodied knowledge and how to incorporate it into an intervention.

Finally, this dissertation builds on the knowledge of barriers and facilitators to early mobility in the CSICU. New barriers and facilitators were identified that were previously missing from the literature. These newly identified barriers and facilitators come from PWLE and clinicians.^{133,172} These provide more for researchers and clinicians to consider when developing early mobility interventions and for clinicians to consider when planning to incorporate early mobility into their local practice.

Where is This Work Likely to Have Impact?

This work is likely to have an impact on CSICUs, early mobility research, clinical education policy, and theories used to drive clinical research. These impacts are likely to be driven by the implantation science approach, the use of ABMs and PER, and the guiding worldview of pragmatism.

This dissertation demonstrates the value of an implementation science approach and may impact other CSICUs, as researchers can utilize implementation science to more rapidly translate research findings into clinical practice. In this way, this dissertation will impact CSICU clinical care by demonstrating that implementation science is possible in this context. The quasi-experimental trial of the intervention will need to be strengthened through a cluster randomized trial to demonstrate the efficacy of the educational approach. This further research can be accomplished with researcher partners found through organizations such as the Canadian Cardiovascular Society, the Canadian Council of Cardiovascular Nurses, the Canadian Association of Critical Care Nurses, the Cardiac Surgery

International Nursing and Allied Professional Research Network, and the Enhanced Recovery After Surgery – Cardiac Surgery group.

This dissertation may also impact clinical education policy. The use of lived experiences in education may be supported through policy development due to the impact of the intervention described in Chapters 8 and 9. Integrating the lived experience through images of body maps and quotes from PWLE were key components of the intervention, which did significantly change clinical practice. The use of art in the intervention may also influence clinical education policy. When discussing the intervention with the clinical educator and manager of patient care, they mentioned the impact of seeing the art on them and how it made them feel what the PWLE must have felt. This should be explored further to support policy change to include art in clinical education. Finally, the intervention itself could become required education by policy due to the significant impact it had on clinician behaviours. The manager of patient care could require all staff to complete the education annually through policy to support early mobility behaviours. This policy could flow to other areas of the hospital, such as the cardiac surgery inpatient unit, which would expand the impact of the intervention.

It is anticipated that this work will provide an important framework for early mobility research. The scoping review challenges the status quo of early mobility research and will hopefully lead to changes in intervention reporting, sex and gender considerations, and outcome selection. The experiences shared through body mapping can inform future research and provide previously unknown considerations to researchers. The co-created definition outlines a new way to define and operationalize early mobility, which may impact the modes of mobility used in future interventions. This work highlights the importance of considering the lived, embodied experience of early mobility and provides a way of exploring it. This may impact future research as researchers may continue to explore these experiences or may use the experiences we shared in their own work. Finally, this dissertation may impact how future early mobility interventions are developed. Using intervention mapping and focusing on the

implementation of interventions is important to move the early mobility body of evidence forward. This dissertation provides examples of how to do this.

Finally, this dissertation may impact the use of pragmatism as a guiding worldview for clinical research. As noted in a Master's students defense, pragmatism is not yet a mainstream, fully accepted guiding worldview. This dissertation demonstrates the value of this worldview and its utility for clinical research that engages clinicians and PWLE. Clinical research remains driven by positivist and post-positivist worldviews, purporting to objectively seek a single truth through rigours studies with strict inclusion and exclusion criteria.^{15,20} These worldviews cannot be used when engaging clinicians or PWLE as a single truth cannot exist due to the assumed contextual differences.^{24,26} They also do not require engagement of populations of interest, so researchers may not be asking a research question that is relevant to clinicians or PWLE.^{18,25} To overcome the know-do gap, we need to engage the people impacted by health research, PWLE² and clinicians. This means we need to be guided by a non-positivist or post-positivist worldview.

As described in Chapter 1, the assumptions of pragmatism support engaging PWLE and using ABMs. A single truth cannot exist if one is guided by a worldview that assumes there are different realities and contextual differences.^{24,26} If health research should focus on questions relevant to the people impacted by health research, PWLE² and clinicians,^{18,25} they need to understand the experience of those people. Performing research through a pragmatic worldview supports truly engaging PWLE and clinicians and exploring topics relevant to them. This, in turn, should support closing the know-do gap and move research findings into practice.

Knowledge Translation

The knowledge generated in this dissertation has been translated in several ways. These include traditional knowledge translation through publication and conference presentations, iKT through the research approaches, and novel knowledge translation. This section shares these knowledge translation approaches.

Traditional Knowledge Translation

The works described in Chapters 2, 3, and 4 are published in academic journals. The scoping review in Chapter 2 is published in *Anaesthesia, Critical Care, & Pain Medicine*.¹³¹ This journal was selected due to its broad readership of perioperative researchers and clinicians, who are the target audiences of the scoping review. The behaviour mapping study in Chapter 3 is published in *Intensive & Critical Care Nursing*.¹³² This journal was selected because the study is of interest to critical care nurses and researchers, given their role in supporting early mobility in the CSICU. This publication has been cited by researchers outside of our research group.^{227,228} The qualitative study in Chapter 4 is published in *Clinical Rehabilitation*.¹³³ This journal was chosen due to its focus on rehabilitation. The findings of this study can inform future research on early mobility, which is a form of rehabilitation. Researchers can investigate the barriers and facilitators identified and explore the factors impacting early mobility.¹³³

The scoping review in Chapter 2 and the behaviour mapping study in Chapter 3 were both presented as oral presentations at Updating Your Cardiovascular Nursing Toolkit, a national cardiovascular nursing conference hosted by the Canadian Council of Cardiovascular Nurses. The scoping review was presented in 2024, and the behaviour mapping study in 2025. This conference was selected for presentation due to its attendance by clinical cardiovascular nurses. This is the target audience for behaviour change to support early mobility. Sharing these findings directly with them generated dialogue and several attendees shared how they were reflecting on their clinical practice as a result of the presentations. For example, one nurse stated that patients are critically ill post-operatively, so expecting them to ambulate in the CSICU is not logical. We then discussed how more than half of the patients who undergo CS are outpatients, who are functioning in the community and walk into the hospital on the day of their CS. Barring any complications, it is not unreasonable to expect these patients to ambulate the day after CS, as was included in the mobility protocol at that time. This nurse agreed that this is true and shared that they needed to reflect on their practices and assumptions. The qualitative study

in Chapter 4 was presented as a poster at the Canadian Cardiovascular Congress in 2025. This conference was selected as it is the largest gathering of cardiovascular health and research professionals in Canada.

Integrated Knowledge Translation

An iKT approach was used throughout this dissertation to ultimately change clinicians' early mobility behaviours in the local CSICU. The intervention described in Chapter 8 was co-created among researchers, CSICU clinicians, and PWLE. Feedback from CSICU clinicians beyond the research team, such as the clinical educator and the manager of patient care, was sought. This broadened iKT beyond research team members. The intervention was integrated into clinical education at SBH in the CSICU in the manner suggested by CSICU clinicians. This extended iKT from intervention development to intervention implementation.

The iKT approach was successful. As described in Chapter 9, patients are sitting in chairs for shorter periods and ambulating more following the education intervention. This intervention is also sustainable. The paper-based learning module and video developed for this dissertation will continue to impact the local CSICU, as they can be used to mobilize knowledge to clinicians who join the CSICU team and for continuing learning for existing CSICU clinicians. These evidence-informed educational tools indicate that knowledge translation does not need to take 15 years.¹ An implementation science approach supports more rapid movement of research evidence into clinical practice, partly through iKT.

Novel Knowledge Translation

The work in this dissertation has been shared in novel ways. First, in the spring of 2025, several body maps were displayed in the Buhler Gallery of SBH with a public discussion. This discussion included two patient partners, one core research team member and one PWLE who participated in the workshops described in Chapters 5-7. We discussed the processes of why and how the body maps were created, the key elements of the body maps, how participating in this research impacted each person, and the deeper impacts of using art rather than only conversation. We displayed several body maps for attendees to view. Attendees included members of the general public, managers, clinical staff, research

staff, and administrative staff from SBH. PWLE who participated in the body mapping workshops who wished to be contacted related to knowledge translation were also informed of the event. Two participants attended and networked with other attendees after the discussion. Many of the attendees can use the findings of this research in their daily work, but who may not have been exposed to this research without this novel knowledge translation. The research staff also learned about incorporating art into research, which may support other research teams at SBH using this approach.

This art exhibit connected me with the President and CEO of the St Boniface Hospital Foundation, Karen Fowler. She was interested in the research and how we incorporated art into the research process and wanted to highlight this through the Foundation. This led to a feature in St Boniface Hospital Foundation Believe magazine, “Mapping the Healing Journey Through Art”, in September of 2025. This story highlighted the body mapping work completed during my dissertation research. Several photographs of the body maps, including close-ups on elements and full photographs, were included. This story was shared through social media, and it remains available on the Foundation’s [website](#).

The feature in Believe led to me being asked to participate in the Radiothon for Hope and Healing in November of 2025. I discussed my research related to early mobility after cardiac surgery and the creation of body maps with the radio host. Not being able to show the art created challenged me to use the narrative analysis and share in a novel manner. I shared the participants’ stories and described what they depicted rather than simply showing the art.

I shared the body maps and research on television and radio related to the Foundation’s Mega Millions Lottery. I was interviewed on camera for morning television, where a body map was shared and the host and I discussed the art and the research. I then sat down with two radio hosts and again discussed the art and the research, using the narratives from the PWLE participants.

This work was shared at Cardiology Grand Rounds in May 2025. This consisted of a 45-minute presentation where I shared an overview of how we developed the intervention. Grand Rounds are primarily attended by medical doctors and researchers. PER, ABMs, and implementation science are not

common approaches discussed at these rounds, however, there was significant support from clinical and research leaders for this presentation. I have been invited back to present the findings of the research in March of 2026.

After the Grand Rounds presentation, I was invited to present at the Cardiac Sciences Quality Committee in November of 2025. This presentation focused on implementation science and behaviour change through intervention mapping. The goal of this presentation was to support clinical leaders in driving continuous quality improvement within their units in an evidence-informed manner. I provided an overview of the six-steps of intervention mapping and used the research described in Chapter 2-8 as an example of each step.

Two pieces of visual art have been created by an artist, Logan Michaelson, based on the body mapping research. This artist reviewed the body maps, the coding scheme for the transcripts and participant observation, and the draft publications. She transformed these into visual art that depicts the emotional journey that PWLE described early mobility in the CSICU to be. These canvases have been approved to be displayed in the local CSICU by the Critical Care Program Director before they have even been seen. These will be daily visual reminders to the local CSICU staff of the importance and experience of early mobility to patients.

Altogether, this novel knowledge translation has helped broaden the scope of who is aware of this research and its findings. The knowledge translation through public discussions, radio, and television has made this work accessible to the general public, who may be undergoing cardiac surgery in the future or have a loved one doing so. Knowing about the findings of this research may support their recovery journey. The novel knowledge translation through public discussions, radio, television, at Grand Rounds, and at the Quality Committee also increased the accessibility of this research to clinicians. Some may have been exposed to this research through the work described in Chapter 4 or Chapter 8, but some may not have heard of this work. This increases the awareness of clinicians of the experiences of patients which may allow them to change the way they provide care. Knowing how someone experiences the care

provided allows for reflection that may extend beyond early mobility, which may positively impact the broader patient journey. It also increases the awareness of clinicians of how to support behaviour change to drive changes in clinical care. Those clinicians who were already aware of this research may benefit from the continued exposure to it or may hear or see something new each time they see the art or hear the narratives. This allows for continued growth, reflection, and the possibility of further changes in care provision. Finally, novel knowledge translation through public discussions, radio, television, at Grand Rounds, and at the Quality Committee may have exposed this research to other researchers who may not be exposed to the publications. These researchers may consider an implementation science approach to future studies, may consider exploring the experience of PWLE, or may consider using ABMs in their research. Without these novel knowledge translation opportunities, the general public, clinicians, and researchers would have limited to non-existent knowledge of this research and its impact would be much smaller.

Strengths and Limitations

This dissertation has several strengths and limitations. First, the work was guided by an interdisciplinary committee of a kinesiologist, a cardiac surgeon/ intensivist, and two nurses. This strengthens the dissertation as different disciplines bring many important differences, such as understandings of the clinical context, ways of framing research questions and projects, and how to share findings. As clinical care is provided by interdisciplinary teams, my interdisciplinary committee has helped share this work to make it valuable to the CSICU team. Second, the broader interdisciplinary research team of a patient engagement researcher, a physiotherapist, clinicians, and PWLE is also a strength. This team brought other diverse perspectives and allowed for a blend of clinical, research, and lived expertise throughout this dissertation. Third, PWLE were embedded throughout this dissertation as collaborators.³³ This supported the work to be guided by their lived expertise and to ensure the research aligned with their priorities. As this dissertation focuses on clinical care and patient outcomes, it was important to ensure that it aligned with what is important to those who receive healthcare. Fourth, this

dissertation began with a reflection on the guiding pragmatic worldview and how the approaches used (PER and ABM) align with this worldview. This strengthens the dissertation as it provides a clear description of the lens through which questions are asked and the types of knowledge that are valued. Using and describing a worldview allows readers to understand more deeply the decisions made and the reasons for these decisions. Finally, a variety of research designs and type of manuscripts were used in this dissertation. It includes a scoping review, an observational study, qualitative didactic research, ABMs, engagement, intervention development, and a quantitative intervention evaluation. This strengthens the dissertation by demonstrating my ability to ask research questions relevant to PWLE and clinicians and to answer them using the best possible approach.^{18,25,26}

A limitation of investigation within this dissertation is that it was conducted in only one CSICU, thus potentially impacting diversity in perspectives and processes available.. It also limits the diversity in experiences of PWLE and clinicians which limits the experiences that can be used to inform intervention development. Second, the lack of qualitative evaluation of the intervention means that this dissertation may be missing key elements to understand the impact of the intervention. This limitation is beyond only the intervention and relates to the entire dissertation as there is a limited ability to understand how the entirety of the research shared here came together to change clinical care. Some researchers may critique the use of a pragmatic worldview due to its novelty and potential ability to be used to support research done in a non-rigorous manner. I would argue against these limitations for several reasons. First, being novel does not mean it is a limitation; it simply means that researchers have not discovered the benefits and value of this worldview. Second, a pragmatic worldview does not enable non-rigorous research, it removes the requirement of being bound by the assumptions of control and lack of bias that positivism and post-positivism hold.^{18,25,26} Pragmatism sees the world as a place open to interpretation and requires the inclusion of diverse perspectives to understand the depth and breadth of a phenomenon.^{18,25,26} Perhaps one can never know the full depth of a topic because one cannot talk to every person who has experienced it. Despite this, we have to value all knowledge and include those who have

experienced something to truly understand it. A pragmatic worldview requires us to include these sources of knowledge, which is a strength to the research. I think any worldview has its drawbacks, which is why we need to share how we view the world so we can understand how we are viewing something and what we are assuming

Future Research Directions

This dissertation lays the foundation for addressing CS PICS in novel ways: through patient-centric early mobility. This thesis utilized novel approaches, including using ABMs for PER and intervention mapping. This foundational work done in this dissertation allows for the development of many future research projects.

First, I encourage researchers to utilize the innovative approaches to PER and intervention development in ways similar done in this thesis but for their PICS specific research interest. For example, a PICS definition could be co-created similarly to how an early mobility definition was co-created among PWLE, clinicians, and researchers. The original PICS definition, coined in 2010, was created by “stakeholders from the rehabilitation, outpatient, and community care settings”⁹² at a Society of Critical Care Medicine conference. While co-created among a variety of clinicians and researchers, it is missing the lived and embodied experience. A similar process for co-creating the early mobility definition could be used. Body mapping could be undertaken to explore the embodied experience of recovering in the CSICU. These embodied experiences could be summarized, discussed, and shaped into a definition through the co-analysis and co-synthesis described in the methods manuscript in Chapter 5. In this way, ABMs for PER can again be used, furthering the use of this engagement approach and strengthening the body of evidence supporting their use.

Next, the outcome and experience measures prioritized in Chapter 7 could be built upon to develop a core outcome set²²⁹ for a PICS diagnosis at hospital discharge. A core outcome set exists for PICS diagnosis as an outpatient for non-CS patients.²³⁰ The process for creating this core outcome could be replicated to create a core outcome set for CSICU PICS. The outcome and experience measures

prioritized by patients could be explored more deeply, with specific tools being selected to measure each outcome in a way that aligns with the symptoms experienced by PWLE. This could occur through virtual consultation workshops with PWLE, clinicians, and researchers. A core outcome set would support the robust evaluation of interventions directed at CSICU PICS and would support comparison of intervention efficacy and effectiveness in the future.

Subsequently, the incidence of PICS in the CSICU could be explored as this is currently poorly understood.¹⁸⁷ Existing literature is insufficient in determining the incidence, as it is limited to specific CS procedures or does not provide baseline assessments to compare post-CSICU assessments against. Cognitive impairment is reported to range from 21% to 38% by three studies.^{231–233} Two of these studies include only patients undergoing coronary artery bypass grafting, limiting the generalizability to the cardiac valve population.^{232,233} The remaining study had a sample size of 34 and no sample size calculation, so it may be underpowered.²³¹ A study is needed that determines the incidence of cognitive impairment post-CS, including CABG, valve, and a combination of CABG and valve surgeries, with clinical care that reflects current recommendations. The mental health domain also has insufficient literature to provide a baseline incidence. Anxiety was reported to occur in 16% of patients post-valve CS, however, there was no measurement of anxiety preoperatively.²³⁴ While observational studies cannot determine causality, without understanding the incidence of anxiety preoperatively, one cannot identify a relationship between a CSICU stay and anxiety. Depression was reported to occur in 18% of patients post-valve CS²³⁴ and 5.6% (severe depression) to 60.1% (moderate depression) of patients post-CABG.²³⁵ There was no measurement of depression preoperatively in either study, again limiting the ability to relate depression postoperatively with the CSICU stay.^{234,235} No studies assessed the incidence of PTSD nor the physical domain of PICS. For this reason, an observational study of the incidence of CS PICS should be undertaken. A prospective pre- and post-CS study of consecutive patients undergoing coronary artery bypass grafting, cardiac valve surgery, or a combination of the two should occur. Data collection should include all elements of the core outcome set previously created. Outcomes should be

measured pre-operative, at ICU discharge, at hospital discharge, and at 1- and 3-months post-hospital discharge. This would provide a baseline understanding of the incidence of CSICU PICS in the local CSICU. This supports determining the effectiveness of future interventions directed at preventing PICS.

These three studies set the stage for an early mobility intervention aimed at preventing CSICU PICS. The intervention would be developed in a way that aligns with the early mobility definition described in Chapter 7 should be developed, pilot tested and then tested for effectiveness with a multi-center stepped cluster randomized clinical trial. The intervention should include activities of daily living along with ambulation and sitting in a chair to align with the co-created definition. It should include multiple mobilizations each day to align with the Canadian 24-hour Movement Guidelines²³⁶ to avoid sedentary behaviour.¹³² Activities should be progressed from more to less support of clinicians and care partners in alignment with the findings in Chapter 6. The findings of the scoping review of early mobility interventions highlighted the lack of transparent reporting of early mobility interventions, which may be preventing their clinical use.¹⁴³ This early mobility intervention must be described in enough detail to support replication. The outcome and experience measures described in Chapter 7 should be included in the evaluation of its effectiveness. This will align the evaluation with the preferences and priorities of PWLE. The acceptability and feasibility should be assessed during the pilot study. This intervention should be developed using intervention mapping to support its clinical utility. This process will take more time than other ways of developing interventions but, as discussed in Chapter 8, may improve acceptability and feasibility.

Beyond this CSICU PICS and early mobility intervention research, there are other future research studies that can build upon this dissertation. Numerous opportunities exist to explore further the scoping review data extracted in Chapter 2. A more in-depth analysis of sex and gender considerations that offers tangible suggestions for integrating these analyses into future research is one possibility. Additionally, a more detailed examination of the outcome measures used to evaluate early mobility interventions is warranted. In the scoping review, we simply listed the outcome measures used by prevalence and

categorized them. A deeper exploration of the primary and secondary outcome measures and linking these to the outcome and experience measures reported in Chapter 7 would provide a missing lens to the current early mobility literature. Several systematic reviews and meta-analyses exist,^{77,82,90} however, there has been little discussion about the appropriateness of comparing the interventions based on the selected outcome measures. This secondary analysis would provide a better understanding of the outcome measures used in early mobility intervention research and is the starting point to creating a core outcome set²²⁹ for early mobility in the CSICU.

Clinicians are key to operationalizing early mobility in the CSICU.¹³² Little is understood about how their practices vary based on intersectional aspects of their lives. For example, does sex impact early mobility practices? In the CSICU, some male nurses with a larger physical build will be given patients who need more support to mobilize, with a comment relating to their ability to support mobility. The impact of the sex of a clinician on early mobility has never been explored in a study. Other intersectional factors, such as ethnicity, gender, being a parent, having family members experience hospitalization, and having family members who are healthcare providers, have also not been explored in relation to early mobility practices. An observational study of early mobility behaviours using behaviour mapping combined with interviews exploring the rationale for the behaviours observed is one way these intersectional factors could be explored. Asking about specific decisions and mobility behaviours undertaken or not undertaken would provide insights into these important intersectional factors, as differences in early mobility practices would need to be overcome to support behaviour change.

Finally, thus far, clinicians have been included in this research as objects through focus group discussions and as collaborators as research team members. Their shared experiences have been limited to what can be shared verbally. Therefore, engaging in ABM with clinicians to explore their embodied experiences of caring for patients in the CSICU should be undertaken. This exploratory work would be the first of its kind and would provide important insights into the experiences of those caring for patients in the CSICU. This work could support nurse retention by uncovering aspects of the role that drive nurses

away from the CSICU. It could also uncover reasons nurses remain in the CSICU and how they maintain resilience in the face of a challenging environment.²³⁷ Understanding embodied experiences may also support improved educational interventions for CSICU clinicians by highlighting important aspects of experiences to consider in the future. The embodied experience of a CSICU nurse is not known, so the potential utility of the findings is vast. Similar to the work in Chapter 6, understanding the embodied experience will open many opportunities and raise more questions than answers. This valuable and untapped knowledge should be a priority to explore in the future.

Reflection

In this dissertation research, I sought to shift power from the research team to PWLEs and clinicians, and to integrate existing early mobility research knowledge into clinical practice through the novel co-development of an intervention. I take this opportunity to reflect on whether I was successful in these goals. Using ABMs for PER led to PWLE sharing emotions, feelings, and experiences that I would not have known to ask about. We provided examples of body maps during the first workshop session and each of these was unique.¹⁶⁸ This was meant to show that there is no “right way” to create a body map and reinforce to PWLE that they could share whatever they wished, however they wished. The body maps and discussions about them directly informed the content of the virtual workshops described in Chapter 7.¹⁷² I used the words and phrases that PWLE used and asked them to clarify these to ensure a shared understanding. They then created their own early mobility definition and prioritized their perceived barriers and facilitators to early mobility along with outcome and experience measures.¹⁷² Upon reflection, I believe that we engaged PWLE in a way that fully shifted power from the research team to the PWLE participants. I also believe that the inclusion of PWLE as research team members, who helped to shape the research questions for this study, create the process for the workshops, co-facilitate the workshops, and co-analyze the findings also shifted power. Their inclusion as equal team members ensured that the research aligned with lived experiences and priorities.

The intervention developed in this research was driven by the needs of clinicians identified in the study reported in Chapter 4.¹³³ When writing the grant to support this work, the intervention included compared the efficacy of early mobility through ambulation with cycling. The rationale for this intervention was that existing early mobility literature compared ambulation or cycling to standard of care and there is a knowledge gap in which mode of mobility is superior. When reflecting on the findings of Chapter 4 and the experiences shared in Chapter 6 and 7, I realized that the intervention needed to shift to reflect the needs of clinicians and needed to include sharing the experiences of PWLE. In the intervention, we shared images of 2 body maps. In this way, PWLE were empowered to “speak” directly to clinicians through their art rather than their experiences being filtered by the research team. This was mentioned as a powerful element when the educator and manager reviewed and provided feedback on the intervention. In this way, I believe I was successful in shifting power from the researchers to PWLE and clinicians, as their knowledge and experiences completely shaped and informed the intervention developed.

The intervention significantly changed the behaviours of clinicians through an increase in ambulation and a reduction in sedentary behaviour while sitting in a chair. The intervention was co-created among the research team which included academic researchers, PWLE, and clinicians. It was informed directly by the literature, clinicians, and PWLE through the novel intervention development approach of intervention mapping. In this way, I believe I was also successful in my second goal. I was able to approach intervention development differently and demonstrate that using intervention mapping can lead to an intervention that causes behaviour change. Existing and new early mobility research knowledge was integrated into clinical care through this intervention. This includes the new knowledge generated in this dissertation. Using intervention mapping reduced the know-do gap from over 15 years to 1 year, as the new knowledge generated is now being used clinically to inform early mobility behaviours of clinicians.

Conclusions

This dissertation has made several novel contributions to early mobility in the CSICU literature. These contributions include identifying the lack of progress of early mobility research over 40 years, the current state of early mobility behaviours in the local CSICU, the incongruencies between conceptualization and operationalization of early mobility in the local CSICU, how ABMs can be used for PER, the embodied experiences of early mobility in the CSICU, PWLE-prioritized outcome and experience measures to evaluate early mobility interventions, PWLE-perceived barriers and facilitators to early mobility, how to co-develop an early mobility intervention informed by the literature, clinicians, and PWLE, and the impact such an intervention can have on clinical care. This dissertation met its aim to co-create and test an early mobility intervention informed by clinicians, PWLE, and the literature. This was demonstrated by the work presented in Chapter 9, where an increase in ambulation and a reduction in sitting in a chair was observed post-intervention. This dissertation also met the broader aim to “generate high-quality, clinical- and lived-experience-informed evidence to support the integration of early mobility interventions into CSICU clinical care”. Specifically, the knowledge shared in Chapters 4-7 comes from clinical and lived experience experts and this knowledge drove the creation of the intervention described in Chapters 8 and 9. Overall, this dissertation demonstrates that interventions directed at early mobility in the CSICU can be developed in a novel way and can lead to small but significant change.

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Appendix A: Overview of studies described in Chapter 1

Author, Year, & Location	Researcher Clinical Backgrounds	CS PICS Domain(s) Targeted	Intervention	Outcome Measures	Results
Alamari 2020 ¹⁰² USA + Saudi	Nursing, physician	Mental -Anxiety	Massage	Visual Analogue Scale (VAS) pain and anxiety scores pre vs 30 min post massage	No significant differences were found in pain, anxiety, depression, or subjective sleep quality at baseline between groups. The foot massage group reported lower pain and anxiety compared to control am and pm
Aygin 2019 ¹⁰⁶ Turkey	Nursing	Mental -Anxiety	Acupressure	VAS for anxiety, Richards-Campbell Sleep questionnaire	Acupressure significantly reduced anxiety and increase sleep quality
Azeem 2018 ¹¹⁴ Saudi	Physician (intensive care specialist & anesthesia)	Cognitive – Delirium	Medication (Dexmedetomidine)	Delirium via Confusion Assessment Method (CAM)	Dexmedetomidine= shorter length of mechanical ventilation, significant shorter duration of ICU stay and lower risk of delirium
Azimian 2019 ¹¹² Iran	Nursing (critical care), physician (cardiologist)	Mental - PTSD	Sleep promotion	Pre-op and 2 months post discharge PTSD measured via Impact of Event Scale-Revised	Pre-op= mean of the total scores of the control 10.41 ± 5.25 and intervention groups 10.71 ± 5.10 , $p = 0.82$ 2 months post= mean of the total scores of the control 29.50 ± 5.90 and intervention group 11.72 ± 6.48 , $p < 0.001$

Bang & Park 2020 ¹⁰⁷ South Korea	Nursing	Mental - anxiety	Acupressure	Anxiety via State Trait Anxiety Inventory Sleep quality score Sleep satisfaction via VAS Measured pre-op, 7 days post-op, and 14 days post-op	sleep and sleep satisfaction scores of the experimental group were significantly higher than those of the control group. No significant difference was found in anxiety
Boitor 2018 ¹⁰³ Canada	Nursing	Mental - anxiety	Massage	Pain intensity, pain unpleasantness, anxiety all via numeric 0-10	massage group reported significantly lower pain intensity, pain unpleasantness, and anxiety compared with both hand holding and standard care. No statistically significant differences were noted between hand holding and standard care for any of the symptoms
Chandrababu 2020 ¹⁰⁴ India	Nursing	Mental – anxiety Mental & physical – Quality of life	Massage	state anxiety inventory Pain via VAS Fatigue via identity consequence fatigue scale Barnason efficacy expectation scale Quality of Life index	experimental group had a significant decrease in anxiety (p = 0.001), fatigue (p = 0.001), pain (p = 0.001), and increased self-efficacy (p = 0.001) and quality of life (p = 0.001).
Dai 2020 ¹⁰⁸ China	Physician (cardiac surgery)	Mental – anxiety & depression	Music	Numerical Rating Scale (NRS), Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) were used to measure the patient's pain, anxiety and depression before and	Pre=no sig differences in the NRS, SDS and SAS scores between the 3 groups After 30 min of music therapy= NRS, SDS and SAS scores of patients in group A were sig lower than before music therapy,

				after 30 min of the intervention	and the differences were stat sig. before and after the intervention in groups B and C, the NRS, SDS and SAS scores were not statistically significant. the NRS, SDS and SAS scores in patients in group A were significantly lower than those in groups B and C, and the differences were statistically significant. The scores were not significantly different between groups B and C.
Doering 2016 ¹²⁷ USA	Nursing	Mental - depression	Cognitive behavioural therapy	Beck Depression Inventory Brief Pain Inventory Pittsburgh Sleep Quality Index Control via Cardiac Attitude Scale-Revised	CBT for depression increased perceived control and decreased pain interference and pain severity Group effects remained significant for perceived control and pain interference and a trend was observed for pain severity after controlling for variables that differed at baseline. There were no group differences in sleep disturbance over time
Fazlollah 2021 ¹⁰⁵ Iran	Nursing, medical sciences	Cognitive - delirium	Massage	Delirium observation screening scale Richard Campbell sleep questionnaire (RSCQ), pain via VAS	delirium incidence= intervention =26.7 %= vs control =23.3 % (p > 0.05). The difference in RSCQ scores was not significant between groups of intervention and control

					The pain intensity was lower in the intervention group
Ford 2020 ¹¹⁵ Australia	Medicine (cardiac surgery), nursing	Cognitive - delirium or valve replacement	Medication (melatonin)	CAM duration and severity of delirium, length of hospital stay, cognitive function, and mood and anxiety symptoms at discharge and 3 months after the surgery.	~20% incidence of delirium (not diff between groups) Length 3 days melatonin, 2 placebo. groups did not differ in terms of length of stay, mood, anxiety, and cognitive performance.
Guo 2012 ¹²³ China	Nursing	Mental - anxiety	Education	Hospital Anxiety and Depression Scale Brief Pain Inventory-short form (BPI-sf) ICU length of stay (LOS) Hospital LOS Pre intervention + 7 days post-op	preop education = a greater decrease in anxiety score and decrease in depression score no difference between groups in average pain, current pain, and interference in general activity, mood and walking ability. preop education group = less interference from pain in sleeping some evidence to suggest a reduced number of hours spent in the ICU among preoperative education patients but no difference in hospital LOS
Ince 2021 ¹¹⁶ USA	Physician (anaesthesia)	Cognitive-delirium	Medication (dexmedetomidine)	atrial fibrillation, diagnosed by clinicians in the ICU, presence of delirium assessed with the CAM ICU, data on pain scores, and opioid consumption, occurring	Postop pain levels were similar among patients with or without atrial fibrillation. 34% patients had atrial fibrillation and 15% had delirium

				between ICU admission and the earlier of postoperative day five or hospital discharge	before hospital discharge within the first 5 postop days. The risk of atrial fibrillation was not significantly different between groups there were no associations between postop pain and the risk of postop delirium. Postop opioid consumption was not significantly associated with post-op atrial fibrillation nor delirium. Atrial fibrillation and delirium were not associated with pain after CS. Opioid use was not associated with atrial fibrillation and delirium.
Kalogianni 2016 ¹²⁴ Greece	Nursing, physician (intensive care, cardiac surgery)	Mental – anxiety	Education	anxiety were conducted on admission-A, before surgery-B and before discharge-C by the state-trait anxiety inventory	state anxiety on the day before surgery decreased only in the intervention group. mean decrease in state score during the follow-up period was greater in the intervention group No significant difference was found in the LOS or readmission. Lower proportions of chest infection were found in the intervention group Multivariate linear regression revealed that education and score in trait anxiety scale on

					admission are independent predictors of a reduction in state anxiety
Lee 2013 ¹²⁵ Korea	Physician	Cognitive – delirium	Education	DSM IV via psych Severity via length of delirium and tx with meds ICU LOS	incidence of postoperative delirium was significantly lower in the intervention group (12.24%) than that in the control group (34.78%), P = 0.009 Among the patients who developed postop delirium, there was no statistical difference between the two groups regarding secondary outcomes.
Likhvantsev 2021 ¹¹⁷ Russia	Physician (anaesthesia intensive care)	Cognitive – delirium	Medication (dexmedetomidine)	CAM ICU Severity via ICU delirium screening checklist	decrease in the rate of delirium in the dexmedetomidine group compared with the placebo group was demonstrated Reduced ICU and hospital LOS observed Mortality at 30 days was 2.4% in both groups. multivariate analysis= only dexmedetomidine administration and bypass time were independent predictors of delirium development
Mardani 2012 ¹¹⁸ Iran	Nursing, physician (cardiac surgery)	Cognitive – delirium, cognitive impairment	Medication (dexamethasone)	MMSE DSM IV delirium	dexamethasone = reduced time to extubation, POD1= delirium, extubation time, and ICU LOS significantly decreased without increasing serious complications such as infectious diseases.

					Adverse event= hyperglycemia No differences renal, cardiac, cerebrovascular and respiratory system
Meybohm 2012 ¹²⁶ Germany	Physician (anaesthesia, cardiac surgery)	Cognitive – cognitive impairment	Remote ischemic preconditioning	Postop neurocognitive dysfunction day prior to sx, post-op day (POD) 5-7, 3 months post via comprehensive test battery (in supplement)	5-7d=52% of control and 46% of RIPC patients had POCD (p = 0.753) with a trend to more cognitive decline in the control group 3m= incidence and severity of POCD did not differ
Moazen-Zadeh 2018 ¹⁰⁹ Iran	Physician (psychiatry), medical sciences, vaccine & serum research	Mental – anxiety & depression Cognitive – cognitive decline	Saffron	Wechsler Memory Scale Mini-mental state exam (MMSE) HADS	No significant difference was detected between the saffron and placebo groups. Also, no significant time × treatment interaction effect was found for any of the scales.
Newman 2021 ⁸⁵ Canada	Rehabilitation sciences, physiotherapy, physician	Physical	Early mobility	handgrip strength, Functional Status Score for the Intensive Care Unit (FSS-ICU), 2-min walk test (2MWT),	Patients were cycled on 80.5% of eligible days, with limited PT staffing accounting for 48.5% of the missed sessions. 3 adverse events occurred in 3 individual patients (2.2 per 100 patient-cycling sessions)
Ottens 2014 ¹¹⁹ Netherlands	Physician (anaesthesia, cardiac surgery, intensive care, epidemiology)	Cognitive – cognitive impairment	Medication (dexamethasone)	Neuropsych battery	No effect 1-month follow-up, 13.6% in the dexamethasone group 7.2% in the placebo group fulfilled the diagnostic criteria for POCD

					12-month follow-up, 8 of 7% in the dexamethasone group 3.5% in the placebo group had POCD
Pedersen 2014 ¹²⁰ Denmark	Physician (anaesthesia, psychiatry)	Cognitive – delirium	Medication (haloperidol)	Delirium Observation Screening (DOS) scale and CAM-ICU Detect delirium= checklist to eliminate precipitating/ inducing factors and a protocol for standardized dosing with haloperidol was applied	Incidence= 21% then 22% POD1 x2 onset Duration 1d then 3d no increase in the proportion of delirium- and coma-free days
Pengelly 2022 ¹³⁰ Australia	Exercise physiology, physiotherapy, physician (cardiac surgery, anaesthesia)	Cognitive – cognitive impairment	Physical activity	cognitive function, assessed using the Alzheimer's Disease Assessment Scale- cognitive subscale (ADAS-cog), at baseline, 14 weeks and 6 m postop	14 weeks=ADAS-cog score was significantly better for the resistance training group (p=0.010), 53% of the aerobic-based rehabilitation group experienced cognitive decline by 2 points or more from baseline compared to 0% of the resistance training group 6m=not stat sig No safety issues
Sirvinskas 2014 ¹¹³ Lithuania	Physician (cardiac surgery)	Cognitive – cognitive impairment	Head cooling	Pre-op + 10 th day MMSE Modified visual reproduction test Trail making, WAIS-Digit Span, WAIS Digit Symbol Substitution Test	incidence of POCD at 10th day = 36% in Group H and 64% in Group C The temperature during the aortic cross-clamp period was associated with a lower rate of POCD

Susheela 2017 ¹²¹ USA	Physician (anaesthesia)	Cognitive – delirium	Medication (Propofol, Dexmedetomidine, IV acetaminophen)	feasibility was assessed by the number of patients who completed the study MMSE CAM	All patients completed the study successfully. incidence =42%, 67% in the groups P & D, 33% in D+A group and 0% P+A group. incidence =17% in the group receiving IVA vs 67% that did not receive IVA. mean range of duration of delirium was 0-1 days. 1 patient in the D group experienced hypotension
Wang 2022 ¹²² USA	Physician (anaesthesia)	Cognitive – delirium	Medication (dexmedetomidine)	Intraoperative mean arterial pressures (MAPs) recorded at 1-min intervals from arterial catheters or at 1-5-min intervals oscillometrically. Postop blood pressures recorded every half-hour or more often. Delirium BID during the initial 5 PODs via CAM ICU	no significant association between intraoperative hypotension and delirium increase in intra-op AUC of MAP <60 mmHg was not significantly associated with the odds of atrial fibrillation Post-op MAP <70 mmHg per hour and MAP <80 mmHg per hour were significantly associated with atrial fibrillation
Wang 2020 ¹¹¹ China	Physician (anaesthesia)	Mental – PTSD Mental & Physical – Quality of Life	ICU Diaries	1`= significant PTSD symptoms via Chinese version of Impact of Event Scale-Revised, IES-R 3 months post-ICU.  2`= memories of the ICU at 1 month, QoL (Medical Outcomes Study 36-item	85 and 83 patients completed the follow-up interviews at 1 month and 3 months Significant PTSD symptoms were reported by 14.63% in the intervention group vs 21.43% in the control group

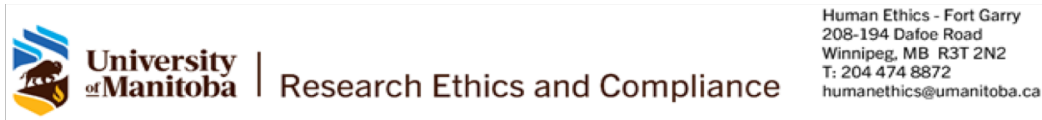
				Short-Form, SF-36), sleep quality (Pittsburgh Sleep Quality Index Questionnaire, PSQI), anxiety, and depression symptoms (HADS) at 3 months	no significant differences between groups in IES-R score, symptoms of intrusion, symptoms of avoidance, numbers of memories of feeling and delusional memories, SF-36 score and anxiety score significant differences were found in symptom of hyperarousal score, numbers of factual memories and PSQI score No adverse effect was reported
Zeng 2021 ¹¹⁰ China	Physician (cardiac surgery)	Mental – anxiety & depression Mental & Physical – Quality of Life	Humanized care	cardiopulmonary function= chest CT, FEV1/FVC, 6MWT self-efficacy=general self-efficacy scale SQ= Pittsburgh Sleep Quality Index incidence of adverse reactions, anxiety and depression=self-rating anxiety and depression scales QOL= SF-36 patient satisfaction= self-made	Intervention = enhanced cardiopulmonary function and self-efficacy, better SQ and QOL, as well as lower incidence of adverse reactions and anxiety and depression, and higher satisfaction.

Zhou 2020 ¹²⁹ China	Physician (cardiac surgery, plastic surgery)	Mental – anxiety & depression	Continuous nursing	Self-Rating Depression Scale (SDS) and Self-Rating Anxiety Scale (SAS) at admission and 1 year after operation. Seattle Angina Pectoris Questionnaire (SAQ) at discharge and 1 year after operation.	1 year post-op, SAQ score in 5 items in continuous nursing group was significantly better than that in conventional nursing group. The continuous nursing group exhibited significantly decreased SAS and SDS scores 1 year post-op compared to the preoperative SAS and SDS scores The SAS and SDS scores of the continuous nursing group were significantly better than those of the conventional nursing group 1 year post-op Then incidence rate of chest tightness or chest pain and coronary restenosis in continuous nursing group were significantly less than that in conventional nursing group
Zhou 2020 ¹²⁸ China	Physician (cardiac surgery)	Cognitive – cognitive impairment	isolated impaired fasting glucose	Pre-, intra-, and post-op blood glucose levels, serum insulin levels, insulin resistance index (homeostatic model assessment of insulin resistance [HOMA-IR]), lactic acid levels, and neuron-specific enolase (NSE) and S100B levels were measured.	HOMA-IR levels were higher in the IIFG group than the control group 30 min after the beginning of bypass, at the termination of bypass, and 2 h after the termination of bypass. Cerebral OER and lactic acid increased intraoperatively in both groups, especially in the IIFG group. NSE and S100B levels were higher in the IIFG group than in the control group at the termination of bypass, 2 h after the termination

				cerebral oxygen extraction ratio (OER) was calculated. Cognitive function was assessed via the MMSE	of bypass, and at 24 h postoperatively. No significant difference between the groups for MMSE. Delirium occurred in two patients in the IIFG group, and one in the control group. No other signs and symptoms of brain injuries were detected in either group.
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Appendix B: Ethical Approvals

Approval for Chapter 3



PROTOCOL APPROVAL

Effective: January 31, 2024

Expiry: January 30, 2025

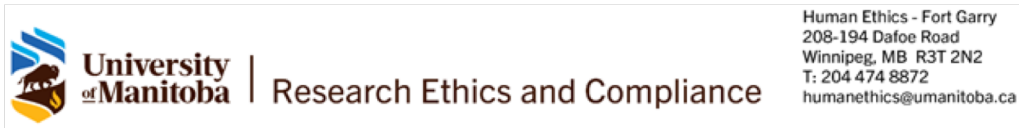
Principal Investigator: Emily Hyde
Advisor(s): Todd Duhamel, Rakesh Arora
Protocol Number: HE2023-0351
Protocol Title: *An Observational Study to Determine the Current State of Mobility in a CS ICU Using Behaviour Mapping*

Sidney Frankel, Acting Chair, REB1

Research Ethics Board 1 has reviewed and approved the above research. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2022).

This approval is subject to the following conditions:

- i. Approval is granted for the research and purposes described in the protocol only.
- ii. Any changes to the protocol or research materials must be approved by the HEO before implementation.
- iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.
- iv. This approval is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.
- v. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.
- vi. The University of Manitoba may request to audit your research documentation to confirm compliance with this approved protocol, and with the UM *Ethics of Research Involving Humans*[Ethics of Research Involving Humans](#) policies and procedures.



PERSONNEL CHANGE APPROVAL

July 16, 2024

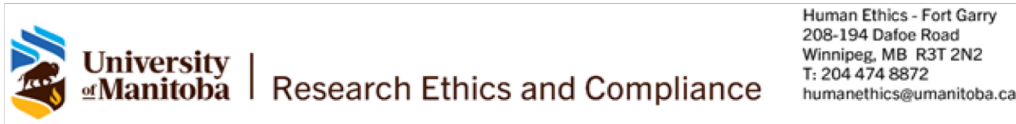
Principal Investigator: Annette Schultz
Protocol Number: HE2024-0036
Protocol Title: *Understanding Barriers and Facilitators of Early Mobility in the Cardiac Surgery Intensive Care Unit: Phase 2 of "Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Trial Development"*

Human Ethics Office as designated by , REB1

Research Ethics Board 1 has reviewed and approved your Amendment Request submitted on July 16, 2024 to the above-noted protocol. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans- TCPS 2* (2022).

This approval is subject to the following conditions:

- i. Approval is granted for this amendment only.
- ii. Any further changes to the protocol require subsequent amendment approvals from the HEO before implementation.
- iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.
- iv. Amendment Approvals do not change the protocol expiry date. Please refer to the original Protocol Approval or subsequent Renewal Approvals for the protocol expiry date.



PROTOCOL APPROVAL

Effective: March 26, 2024

Expiry: March 25, 2025

Principal Investigator: Annette Schultz
Protocol Number: HE2024-0035
Protocol Title: *Understanding the Lived Experience of Early Mobility Using Body Mapping: Phase 1 of "Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Trial Development"*

Sidney Frankel, Acting Chair, REB1

Research Ethics Board 1 has reviewed and approved the above research. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2022).

This approval is subject to the following conditions:

- i. Approval is granted for the research and purposes described in the protocol only.
- ii. Any changes to the protocol or research materials must be approved by the HEO before implementation.
- iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.
- iv. This approval is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.
- v. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.
- vi. The University of Manitoba may request to audit your research documentation to confirm compliance with this approved protocol, and with the UM *Ethics of Research Involving Humans*[Ethics of Research Involving Humans](#) policies and procedures.



AMENDMENT APPROVAL

June 14, 2024

Principal Investigator: Annette Schultz
Protocol Number: HE2024-0036
Protocol Title: *Understanding Barriers and Facilitators of Early Mobility in the Cardiac Surgery Intensive Care Unit: Phase 2 of "Early mobility to improve health outcomes following cardiac surgery (EVE) Clinical Trial Development"*

Human Ethics Office as designated by , REB1

Research Ethics Board 1 has reviewed and approved your Amendment Request submitted on June 14, 2024 to the above-noted protocol. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans- TCPS 2* (2022).

This approval is subject to the following conditions:

- i. Approval is granted for this amendment only.
- ii. Any further changes to the protocol require subsequent amendment approvals from the HEO before implementation.
- iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.
- iv. Amendment Approvals do not change the protocol expiry date. Please refer to the original Protocol Approval or subsequent Renewal Approvals for the protocol expiry date.



RENEWAL APPROVAL

Effective: January 20, 2025

New Expiry: January 30, 2026

Principal Investigator: Emily Hyde
Advisor(s): Todd Duhamel, Rakesh Arora
Protocol Number: HE2023-0351
Protocol Title: *An Observational Study to Determine the Current State of Mobility in a CS ICU Using Behaviour Mapping*

Natalie Riediger, Acting Chair, REB1

Research Ethics Board 1 has reviewed and renewed the above research. The Office of Human Research Ethics (OHRE) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans- TCPS 2 (2022)*.

Please note the following important information about your renewal approval:

- i. Any changes to the protocol or research materials must be approved by the OHRE **before implementation**.
- ii. Any **deviations** to the research or **adverse events** must be reported to the OHRE immediately through an **REB Event**.
- iii. This renewal is valid for **one year only**. A Renewal Request must be submitted and approved prior to the above expiry date.
- iv. A **Protocol Closure** must be submitted to the OHRE when the research is complete or if the research is terminated.