TITLE:

Accessible and sustainable prehabilitation: The first stakeholder-informed logic model for prehabilitation programs

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Abstract

Background: Prehabilitation programs treat modifiable risk factors to improve surgical outcomes. However, translation of research into practice remains slow. Logic models, visual representations of how a program works, have the potential to bridge research-to-practice gaps. We aimed to develop a stakeholder–informed logic model for prehabilitation programs in tertiary care centers by interviewing stakeholders about 1) what should be the mission, inputs, outputs, and targeted outcomes for prehabilitation implementation and evaluation? 2) how to optimize existing prehabilitation programs? **Methods**: This program evaluation used a qualitative research design and integrated knowledge translation (iKT) concepts to explore stakeholder perspectives. Semi-structured interviews were conducted with stakeholders of an existing prehabilitation clinic at a tertiary and quaternary care hospital network in Montreal, Canada between June 2022 and December 2023. Interviews were transcribed verbatim and analyzed using manifest summative content analysis to determine logic model items. Member check focus groups were performed with stakeholders throughout the analysis process.

Results: Sixty-one interviews were conducted with prehabilitation staff (n=12), patients (n=10), perioperative care physicians (n=10), nurses (n=9), dietitians (n=9), physiotherapists (n=5), and hospital administrators (n=6). Our findings underscored unanimous support for prehabilitation among participants yet revealed challenges hindering efficient resource utilization such as confusion regarding the program's mission and referral process (e.g., *who can refer, how to refer, which patients to refer*). Both clinician- (n=44) and patient-oriented outcomes (n=32) were valued by stakeholders; however, priority outcomes varied by stakeholder group and included patient adherence to the intervention (prehabilitation staff), enhanced experience and satisfaction (patients), and facilitation of discharge (inpatient staff and hospital administrators).

Significance: Through a collaborative effort with stakeholders, we developed a logic model to enhance the efficiency, accessibility, and sustainability of prehabilitation programs. Subsequent research should evaluate the real-world application of this logic model.

Résumé

Contexte : Les programmes de préhabilitation traitent les facteurs de risque modifiables dans le but d'améliorer les résultats chirurgicaux. Cependant, la transposition des avancées en recherche à la pratique clinique demeure lente. Les modèles logiques, représentations visuelles du fonctionnement d'un programme, ont le potentiel de combler les écarts entre la recherche et la pratique clinique. Notre objectif était de développer un modèle logique informé par les parties prenantes pour les cliniques de préhabilitation en interrogeant les parties prenantes sur 1) quels devraient être la mission, les intrants, les extrants et les objectifs et résultats nécessaires pour mettre en œuvre et évaluer les programmes de préhabilitation ? 2) quelles recommandations spécifiques devraient être faites pour optimiser les programmes de préhabilitation existants ?

Méthodes : Nous avons procédé à une évaluation de programme à l'aide d'une méthodologie de recherche qualitative et en nous basant sur des concepts d'application intégrée des connaissances. Des entretiens semi-structurés ont été menés entre juin 2022 et décembre 2023 avec les parties prenantes d'une clinique de préhabilitation de deux centres de soins tertiaires fournissant des soins ERAS à Montréal, au Canada. Les entretiens ont été transcrits et analysés à l'aide d'une forme manifeste d'analyse de contenu sommatif (c'est-à-dire un compte de fréquence) pour déterminer les éléments du modèle logique. Des groupes de discussion avec les parties prenantes et le personnel de la clinique de préhabilitation ont été organisés tout au long du processus d'analyse pour assurer la vérification par les membres.

Résultats : Soixante-et-un entretiens ont été menés auprès du personnel de la clinique de préhabilitation (n=12), des patients (n=10), des médecins de la trajectoire chirurgicale (n=10), des infirmières (n=9), des diététistes (n=9), des physiothérapeutes (n=5) et des membres de l'administration de l'hôpital (n=6). Nos résultats ont démontré que les participants, de façon

unanime, étaient en faveur de la préhabilitation, mais que des défis d'implémentation entravaient son utilisation, tel que la confusion concernant la mission du programme et le processus de référence (par exemple, qui peut référer, comment référer, et quels patients référer). Les différents groupes de parties prenantes ont exprimé différentes priorités pour les objectifs et résultats du programme, tel que l'adhérence à l'intervention pour le personnel de la clinique de préhabilitation, et les facteurs facilitant le congé pour le personnel hospitalier et les administrateurs hospitaliers. Pour les patients, une expérience de soins améliorée, tel que se sentir pris en charge et écouté, était prioritaire. L'expérience et la satisfaction des patients (n=32) ont été décrites aussi fréquemment que les résultats cliniques (n=44), tels que la durée d'hospitalisation.

Importance : En développant un modèle logique pour la préhabilitation de façon collaborative avec les parties prenantes, notre objectif est d'améliorer l'efficacité, l'accessibilité et la durabilité de la mise en œuvre de programmes de préhabilitation, tout en assurant l'inclusion des objectifs et résultats prioritaires aux différentes parties prenantes à l'échelle mondiale. Les recherches ultérieures devraient évaluer l'application du modèle logique dans le monde réel.

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Dedication

This MSc thesis is dedicated to my husband, Mokhles Benali and my family, particularly my mother, Christine Roy, and my father Daniel Corriveau. Your remarkable achievements and the incredible people you are serve as constant sources of inspiration, motivating me to always strive for excellence. I could not have done this without your encouragement and support.

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For the manuscript of this MSc thesis, I have conducted the majority of the work as the primary author, with the exception of the study design. The study was co-designed by Dr. Chelsia Gillis, Dr Francesco Carli, Dr. Nancy Mayo and the Steering Committee composed of Rona Fleming (a patient-partner), Dr. Sender Liberman, Dr. Alexander Amir, Debbie Watson, Michel Picard, and Andre Guigui. The majority of the interviews were conducted by me, with valuable help from Michelle St-Jacques who conducted all patient interviews, Marlyn Gill who conducted half the prehabilitation staff interviews, and Dr. Chelsia Gillis who conducted part of the physicians and hospital administrator interviews. Michelle St-Jacques, Dr. Chelsia Gillis, and Dr. Francesco Carli and me were involved equally in recruitment (sending the recruitment notice and approaching interested possible participants). The qualitative analysis was led by me and supported by Michelle St-Jacques, Sophia Yeung, and Dr. Chelsia Gillis.

I wrote the first draft of the manuscript and produced all figures and tables under the supervision of my supervisors. Finally, the co-authors Dr. Julio F. Fiore Jr., Dr. Nancy Mayo, Dr. Stéphanie Chevalier and Dr. Francesco Carli reviewed the manuscript and provided their guidance throughout.

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List of abbreviations

ADL - Activities of daily living

COREQ - Consolidated criteria for reporting qualitative research

EMR – electronic medical record ERAS – Enhanced recovery after surgery

FTE – Full time equivalent

HCP – Health care professional

HRQOL – Health related quality of life

iKT – Integrated knowledge translation

LOS – Length of stay

MUHC – McGill University Health Center

QOL – Quality of life

RCT – Randomized controlled trial

6MWT – 6-minute walking test

1. INTRODUCTION

Surgery is a cornerstone treatment for many medical conditions including cancer. However, it remains a highly morbid event. Many patients are not physically or metabolically fit for surgery and suffer serious medical or surgical complications post-operatively. In fact, modifiable risk factors are highly prevalent amongst surgical patients, such as malnutrition (20-45%)[1 2] and poor exercise tolerance (20-60%)[3 4]. Moreover, a large retrospective cohort study of 15,755 patients[5] suggested that patient-related factors contributed 8-fold more to post-operative complication rate after colectomy than surgeon and hospital level factors. Yet, standard care does not include preoperative optimization of patients to combat the stresses of surgery. Prehabilitation programs aim to fill this gap by treating modifiable risk factors, and as shown by several RCTs, improve surgical outcomes and functional recovery time. However, prehabilitation still primarily operates within the realm of research. Translation of research to practice remains slow due to lack of implementation guidance. Additionally, there is no universally accepted definition of prehabilitation or proposed standardized set of outcome measures which contribute to heterogeneity of research findings.

1.1 Thesis rationale

Uptake of prehabilitation services into practice may be enhanced by applying program planning methodology with the development of a logic model. Logic models are visual representations of how a program functions, and are a staple of program planning, implementation and evaluation. [6-12] Logic models can help cultivate mutual understanding among stakeholders by illustrating the connections between program elements, such as objectives and activities with expected outcomes. They also serve to align stakeholder efforts on unified and clearly defined priority outcomes. Hence, a logic model could facilitate the evaluation of prehabilitation programs

and ensure consistent incorporation of stakeholder-driven outcomes across prehabilitation initiatives globally. Finally, involving stakeholders is a key step in designing and implementing logic models to enhance relevance, effectiveness, ownership, and uptake of health interventions. [13]

1.2 Thesis objectives

1) The first objective of this study was to explore stakeholder's perspectives of prehabilitation including priorities and preferences to inform a revised version for program implementation.

   1.1) Explore what is working well and what can be improved with the existing prehabilitation program based on stakeholders.

   1.2) Understand what stakeholders believe should be the mission, inputs, outputs and outcomes measured.

2) The second objective was to develop the first stakeholder-informed logic model of prehabilitation for clinical practice to support program planning, implementation, and evaluation of existing and future programs.

1.3 Research questions

Our study posed the following research questions:

1) According to stakeholders, what should be the mission, inputs, outputs, and outcomes required to implement and evaluate prehabilitation programs?
2) What specific recommendations should be made to optimize our existing prehabilitation program?

2. LITERATURE REVIEW

2.1 Surgical outcomes and the surgical stress response

More than 1.4 million inpatient surgical procedures are performed in Canada each year [14]. Globally, >300 million surgical procedures occur annually. [15] Many surgical patients are older and suffer comorbidities, increasing their surgical risk profile. [4] Approximately 15-30% of patients suffer a serious medical or surgical complication after surgery and 1 in 5 develop a new patient-reported disability. [16-18]

Surgery is a physiological stressor that deregulates the body's homeostasis[19]. The stress response, initiated at the surgical site, is characterized by the activation of the immune-hypothalamic-pituitary-adrenal axis and the sympathetic nervous system which, in turn, results in the release of glucocorticoids, catecholamines, and glucagon (i.e., counterregulatory hormones) in the circulation. The goal of this process is to mobilize substrates (amino acids, lipids, glucose) for tissue repair. [20] This response is essential to post-operative healing, but it can trigger adverse effects such as hyperglycemia and catabolism[19 21], and an exaggerated or long-lasting stress response can lead to adverse outcomes[22]. Hyperglycemia results from increased central and peripheral insulin resistance. Simultaneously, increased concentrations of circulating glucagon lead to activation of glycogen phosphorylase and inactivation of glycogen synthase. [23] Glucagon also upregulates hepatic glucose production. [24] In a retrospective cohort study of 11,633 patients undergoing elective colorectal and bariatric surgery, post-operative hyperglycemia over 10 mmol/L was found to be correlated with higher risk of infection, mortality and surgical complications. [25] Additionally, the stress response increases proteolysis and lipolysis following tissue injury. Free fatty acid and glycerol are freed from stored triglycerides. [23] Whole body protein turnover accelerates with a

negative balance reflecting net catabolism. [26] The breakdown of lean tissue mass, more importantly skeletal muscle mass, releases amino acids for tissue repair at the injury site, synthesis of immune response related proteins and hepatic gluconeogenesis. [23 27]

The severity of the stress response is positively correlated with the severity of the surgical injury. [19 24] Surgical care is constantly evolving and new approaches are oriented towards the reduction of the surgical stress response, including catabolism, to improve outcomes after surgery. The Enhanced Recovery After Surgery (ERAS) program, first introduced by Kehlet et al. for colorectal surgery [28], is a multimodal approach to perioperative care that aims to moderate the surgical stress response, and promote improved outcomes after surgery and faster recovery.

Moreover, whether the stress response is critical or not, really depends on the patient's baseline reserves. [29] In a prospective cohort of 269 older adults who had major surgery, Stabenau et al., identified that only 16% followed a functional trajectory of "rapid improvement" in the year following surgery (28% and 23% experienced partial or little improvement, respectively) and only the patients with no or mild pre-surgery disability experienced rapid improvement after surgery. [30] A large retrospective cohort study of 15,755 patients[5] suggested that patient-related factors contributed 8-fold more to post-operative complication rate after colectomy than surgeon and hospital level factors. Modifiable risk factors are highly prevalent amongst surgical patients, such as malnutrition (20-45%)[1 2], and poor exercise tolerance (20-60%)[3 4]. In addition, malnutrition is often underrecognized and undertreated. [31] Malnutrition can arise from factors such as disease burden, inflammation, decreased food intake, or impaired food assimilation (e.g., diarrhea), and can present as "changes in body composition"[32], such as unintended weight loss or reduced muscle mass, and lead to "reduced functionality".[32 33]

Both surgery itself and underlying diseases (e.g., cancer) can lead to metabolic disturbances and nutrition impact symptoms (NIS) that contribute to malnutrition. Malnutrition is associated with increased complications postoperatively: surgical site infections, pneumonia, urinary tract infections, anastomotic leaks, increased length of stay and rate of readmissions. [2 34-39] Further, evidences indicates nutrition interventions targeting malnutrition provided in the preoperative period can improve surgical outcomes such as complications and length of stay. [40] A retrospective, observational study of 800 patients with gastric cancer who underwent gastrectomy observed that the rate of surgical site infection was lower in patients who received nutritional therapy for at least ten days before surgery. [41] In a meta analysis of 15 RCTs, involving 3831 patients, perioperative nutritional support effectively reduced both infectious and non-infectious complications and shortened hospital stays by approximately 2 days compared to control. [42] Thus, nutrition therapy is essential in surgical care and surgical patients require early nutritional screening, assessment and monitoring. [43 44]

2.2 Surgical prehabilitation

The relationship between physiological and functional reserve, and surgical outcomes is increasingly recognized. For instance, to help patients meet nutritional requirements pre- and postoperatively, the ERAS guidelines recommend preoperative education, and inclusion of routine nutrition education is briefly mentioned in the commentary. [45 46] Recent qualitative studies in surgical patients suggest that more importance should be placed on preoperative nutrition counseling, as patients viewed this to be a crucial catalyst for their adherence to some of the ERAS elements including early food intake initiation after surgery and management of NIS. [47-50] In a RCT, preoperative nutrition teaching administered during radiotherapy led to improvements in nutritional status and quality of life (QOL) among 111 colorectal cancer patients. [51] This suggests

that routine preoperative nutrition counseling, compared to traditional post-surgical in-hospital teaching at the onset of symptoms, improves patient satisfaction and adherence to ERAS elements and patient QOL. Yet, preoperative optimization of patients, including nutrition optimization, is only partly supported by ERAS recommendations and is not part of standard care.

Prehabilitation programs were introduced over a decade ago as an approach to prepare patients to withstand the rigors of surgery by targeting modifiable risk factors (e.g., undernutrition, poor exercise tolerance) that put patients at greater risk of poor surgical outcomes. [21] Prehabilitation programs are increasingly characterized by their multimodal approach, often encompassing exercise, nutritional and psychological interventions aimed at preparing patients physically and mentally during the natural waiting period for surgery. This comprehensive approach aims to enhance cardiorespiratory capacity and physiological reserves, ultimately reducing morbidity and promoting return to normal physical function post-operatively. Prehabilitation initiatives rely on early screening of surgical patients for modifiable risk factors and rapid referral, to allow enough time to apply the intervention and improve functional capacity. In a systematic review and meta-analysis conducted in 2018, comprising 9 studies (5 RCTs and 4 cohort studies) involving 914 patients undergoing colorectal surgery, it was found that nutritional prehabilitation, provided either alone or combined with an exercise program in a multimodal approach, effectively reduced hospital stays by an average of 2 days compared to standard ERAS care. [52] More recently, in the PREHAB randomized clinical trial, an international, multicenter trial of 251 patients with colorectal cancer, multimodal prehabilitation including nutrition intervention, intensive exercise (in-hopital, supervised 3 times per week), and psychological support reduced severe and medical-related complications postoperatively compared to standard ERAS care. [53] In a RCT comparing prehabilitation vs. rehabilitation in a center providing ERAS care, prehabilitation was shown to

expedite functional recovery after colorectal cancer surgery compared to rehabilitation and ERAS care alone; twice as many patients in the prehabilitation group had recovered their function 8 weeks after surgery (84% of patients) [54], compared to ERAS care (40%)[55], and one and a half times more compared to rehabilitation (60%)[54]. Other RCTs of multimodal prehabilitation have also indicated postoperative medical complications were reduced by half in patients who underwent prehabilitation compared to standard of care alone. [53 56 57] Altogether these findings suggest that patients undergoing surgery with ERAS care also derive benefits from prehabilitation. The integration of prehabilitation with ERAS protocols contributes to expedited recovery processes.

Nutrition constitutes a vital aspect of prehabilitation. Failure to adequately assess and optimize nutritional status can hinder participation and diminish the effectiveness of the prehabilitation intervention. Nutrition care in prehabilitation focuses on correction of caloric imbalance, attenuation of catabolism with management of nutrition impact symptoms to encourage optimal oral intake, adequate protein intake, glycemic control and promotion of immunity. [21 31] Although prehabilitation has the potential to improve functional capacity before surgery, malnutrition has been found to be an important inhibitor of the prehabilitation-functional capacity relationship. [58] A recent pooled analysis of multimodal prehabilitation trials in colorectal surgery suggested that patients with malnutrition, as defined by PG-SGA>=9, did not improve walking capacity and continued to lose more body mass (fat-free mass and fat mass) compared to the patients with a PG-SGA <9, despite prehabilitation. [58] These findings might be explained by the aggravating effect of the aerobic exercise program on the energy balance of these malnourished patients.

2.3 Knowledge gaps

Although results in the field of prehabilitation are promising, progress has been partially limited by 1) lack of implementation guidance and 2) variability in use and reporting of outcome measures across studies including implementation measures (e.g., patient adherence).

Lack of implementation guidance

Despite mounting evidence supporting prehabilitation, it has yet to be adopted as standard care. It is widely acknowledged that the translation of research findings into clinical practice can take up to 17 years, highlighting the international concern regarding this issue. [59] Several qualitative studies, including a recent systematic review of 26 qualitative prehabilitation studies involving 377 patients, 51 caregivers, and 156 healthcare providers, have explored patient and clinician perspectives without translating findings into a clear and effective program guideline, such as a logic model. [60] Without such a framework, the adoption of prehabilitation is likely to remain slow and ineffective, and the evaluation of current and future clinics is likely to occur without considering stakeholder priorities. Implementation strategies, defined as "methods or techniques used to enhance the adoption, implementation, and sustainability of clinical programs or practices", can facilitate the translation of research into the standard of care. [61] Collaborative work with program stakeholders has the potential to lead to the development of an effective framework for program evaluation and implementation.

Variability in outcome measures across studies

Certainty of evidence in prehabilitation research remains low to moderate, and the optimal prescription that will result in the best outcomes is still unknown. It proves challenging to synthesize data comprehensively, as highlighted by a recent extensive umbrella review of

systematic reviews of prehabilitation, which struggled to draw definitive conclusions on its effectiveness, primarily due to the variability of outcomes measured across studies. [62] Out of the 55 systematic reviews included, only 15 reviews could be pooled due to heterogeneity. [62] Previously, a scoping review of 110 prehabilitation studies identified that only 34% (n=37) of studies included a nutrition treatment component and from these, only a third (n=11) monitored adherence to the nutritional plan. [63] Similarly, prehabilitation researchers Engel et al., examined the quality of reporting of prehabilitation studies by comparing how 70 prehabilitation RCTs fared with methodological and intervention reporting checklists (e.g., Consolidated Standards of Reporting Trails). [64] Authors found that studies reported about half of the recommended checklist items from these reporting standards. [64] The authors also noted that progress in reporting of interventions in the field of prehabilitation were remained stagnant from year 1994 to 2022, and that reporting practices may improve with the development of a prehabilitation-specific reporting checklist. [64]

Adequately measuring and reporting outcomes is important to evaluate intervention effectiveness, and is especially important given the complex nature of prehabilitation interventions. [64] Proctor et al., who proposed a Conceptual Framework for the measurement of implementation outcomes, postulates that inferring success or failure of a program using only functional and clinical endpoints is problematic as it is impossible to discern where the success or failure lies. [65] Therefore, solely assessing outcomes without evaluating whether the prehabilitation prescription meets patient needs (i.e., if patients achieve estimated therapeutic targets) or assessing implementation outcomes (i.e., patient adherence to the prescribed intervention) does not offer a comprehensive assessment of the intervention's effectiveness. Yet, often monitoring of the

intervention is omitted, ultimately failing to improve our understanding of what intervention works best and for whom.

The absence of consensus in the literature regarding which outcomes to employ[66] indicates a logic model could be useful to standardize outcomes measured and reported. Smith et al. [67] note that "having an imprecise understanding of what was done and why during the implementation of a new innovation obfuscates identifying the factors responsible for successful implementation and prevents learning from what contributed to failed implementation".

To summarize, research in the field of prehabilitation is growing, but could be enhanced with 1) implementation guidance and 2) standardization of outcomes measured and reported across studies.

2.4 Program evaluation with the logic model

Program evaluation is used to assess the effectiveness of an intervention and identify theoretical and practical gaps regarding implementation. [12 68] Evaluation takes place to inform decision making and help launch new interventions, or change or improve existing ones. Program evaluation is even more important in the context of scarce resources, to allow efficient use of ressources. [68] The Public Health Agency of Canada proposes eight steps to program evaluation. [69 70] The process starts by taking the decision to conduct program evaluation, identifying and engaging with stakeholders, and describing the program elements and theory (the design, and expected outcomes based on the services delivered), such as with the use of a logic model. [6-12 71] Effective program evaluation relies on robust program planning. Without clarity on the intended outcomes of a program, it becomes impossible to determine whether the program has achieved its objectives. [11] Furthermore, without a guiding structure, programs also run the risk of being

implemented without evidence and spreading resources too thinly, or in directions that do not align with stakeholder priorities. [10 11]

Logic models are a management tool commonly employed in program evaluation and can help address the research to practice gap frequently encountered in health care. They are valuable for both clinicians and researchers during the design and implementation of interventions, enabling: 1) program evaluation, in collaboration with stakeholders to develop effective interventions or enhance existing ones, 2) resource allocation within the constraints of limited healthcare resources, 3) common understanding of the program amongst diverse stakeholders.

Logic models have emerged as staples of program planning, implementation, and evaluation, and are widely regarded as indispensable for implementing theoretically sound, evidence-based programs, and improving our understanding of what contributes to success or failure of an intervention. [72] Logic models are a "plausible, sensible model of how a program is supposed to work"[7] and provide a visual depiction of a program's structure and operation, illustrating the relationship between program resources, activities, and intended outcomes. By outlining a program, logic models can help promote a shared understanding among stakeholders and justify resource allocation for partners, governmental agencies, and funders. [10 12 73] In fact, in recent years, many governmental and funding agencies have begun to require logic models for program evaluation to ensure program effectiveness and accountability. [74 75]

Logic models vary in format and layout, but most include the following components[9 11]:

- **Mission:** the goal of the program, written in broad terms.
- **Inputs:** the resources invested in the program (i.e., staff, money, material)
- **Outputs:** specifies both the target population and the activities
    - **Target population:** intended service users

    - **Activities**: the services, products, or transactions that will be completed to achieve the intended outcomes.
- **Outcomes and indicators:** can be divided into short-, medium- and long-term effects of the activities of the program on service users, stakeholders, and the organization. Outcome indicators are measurable objectives to track whether the outcomes have been achieved. [9]

The logic model developed in this study draws from the W.K. Kellogg Foundation[11] and Dwyer[9] frameworks. Logic models can also specify process indicators (i.e., key process indicators or KPIs). [9] Process indicators serve as implementation measures, outlining what needs to be achieved to realize the outcome objectives. Process indicators are management tools used to evaluate program inputs (e.g., number of patients seen) and the quality of the implementation (essential in determining whether the success or failure of an intervention is related to the intervention itself or to implementation failure). [65] For instance, stakeholder satisfaction and experience are important outcomes used to evaluate both the intervention and the implementation[65]. Various approaches exist for developing a logic model, all of which should strive to accurately depict a program's operations, consider the organizational environment in which it will be implemented and ensure that activities are linked to outcomes. Hence, some approaches suggest starting by describing the overall mission and situational context of the program, to ensure coherence throughout the logic model. [76]

Finally, involving a variety of stakeholders in an open discussion is crucial for program evaluation and the development of an effective and useful logic model. [68] [69] Stakeholder engagement enables shared decision making about program elements such as program objectives, and enhances the likelihood of stakeholders accepting and utilizing the logic model and program

evaluation results. Involving stakeholders also reduces the likelihood of costly mismatches between clinician, health system, and patient needs. [73] [77] Public Health researcher Skivington further notes "meaningful engagement with appropriate stakeholders at each phase of the research is needed to maximise the potential of developing or identifying an intervention that is likely to have positive impacts on health and to enhance prospects of achieving changes in policy or practice." [78]

2.5 Qualitative analysis

2.5.1 Qualitative design to build a logic model of a complex intervention

Qualitative methods serve as an initial step in constructing robust logic models[79], as Qualitative methods are useful to they enable the exploration of stakeholder perspectives and identification of the components and contextual factors that produce outcomes in complex interventions like prehabilitation programs. [78] [80] An intervention is considered complex based on various factors such as "number of components involved; the range of behaviours targeted; expertise and skills required by those delivering and receiving the intervention; the number of groups, settings, or levels targeted; or the permitted level of flexibility of the intervention or its components." [78] Hence, a prehabilitation program qualifies as a complex intervention due to involvement from diverse stakeholder groups along the surgical trajectory (e.g., prehabilitation staff, referring healthcare providers, inpatient staff for continuity of care) and various specialties within the prehabilitation team (e.g., dietitian, physiotherapist, psychosocial specialist) delivering the multimodal intervention.

2.5.2 Pragmatic epistemology

The epistemological stance of a researcher, or the research paradigm, can be defined as "the beliefs they hold about knowing and the manner in which such epistemological premises are a part of and an influence on the cognitive processes of thinking and reasoning." [81] In other words, the research paradigm guides a researcher's approach to conducting research and understanding the world. Pragmatism[82], as a research paradigm, suggests that research should prioritize understandings of "real-life" problems and situations, and suggest practical applications. [82] Pragmatism refutes the need to search for the ultimate truth or reality, to embrace its evolving nature, because reality "is inseparable from human experience and needs and is dependent upon context". Hence, pragmatism supports involvement of stakeholders in knowledge production, as a way to generate more meaningful and applicable solutions.

2.5.3 Summative content analysis

Various methods exist to analyse qualitative data, meaning to sort and make sense of the data to better understand participants perspectives and experiences. Summative content analysis, defined by Hsieh and Shannon as "a research method for the subjective interpretation of the content of textual data through the systematic classification process of coding and identifying themes or patterns", involves a quantitative component of tracking the frequency of a specific word or group of words (i.e., codes) within interviews and across interviews. [83] Summative content analysis is a useful method to analyse large data sets, compare perceptions between stakeholder groups, and identify priority items based on frequency count.

Content analysis encompasses both manifest and latent analysis. Latent analysis involves delving beyond participants' words, providing researchers with the opportunity for interpreting

underlying implications. [83] [84] Conversely, manifest analysis pertains to a method wherein researchers concentrate on the explicit and visible content of the data, presenting findings closely aligned with participants' expressions. [84] Additionally, this methods allows for both inductive and deductive coding. Deductive coding categorizes participants' expressions into predefined categories, while inductive coding generates new theories based on the examination of the data. [83] [84]

3. MANUSCRIPT

Title: Development of a stakeholder-informed logic model for surgical prehabilitation in an acute care setting.

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3.1 Abstract

Background: Prehabilitation programs treat modifiable risk factors to improve surgical outcomes. However, translation of research into practice remains slow. Logic models, visual representations of how a program works, have the potential to bridge research-to-practice gaps. We aimed to develop a stakeholder–informed logic model for prehabilitation programs in tertiary care centers by interviewing stakeholders about 1) what should be the mission, inputs, outputs, and targeted outcomes for prehabilitation implementation and evaluation? 2) how to optimize existing prehabilitation programs? Methods: This program evaluation used a qualitative research design and integrated knowledge translation (iKT) concepts to explore stakeholder perspectives. Semi-structured interviews were conducted with stakeholders of an existing prehabilitation clinic at a tertiary and quaternary care hospital network in Montreal, Canada between June 2022 and December 2023. Interviews were transcribed verbatim and analyzed using manifest summative content analysis to determine logic model items. Member check focus groups were performed with stakeholders throughout the analysis process.

Results: Sixty-one interviews were conducted with prehabilitation staff (n=12), patients (n=10), perioperative care physicians (n=10), nurses (n=9), dietitians (n=9), physiotherapists (n=5), and hospital administrators (n=6). Our findings underscored unanimous support for prehabilitation among participants yet revealed challenges hindering efficient resource utilization such as confusion regarding the program's mission and referral process (e.g., who can refer, how to refer, which patients to refer). Both clinician- (n=44) and patient-oriented outcomes (n=32) were valued by stakeholders; however, priority outcomes varied by stakeholder group and included patient adherence to the intervention (prehabilitation staff), enhanced experience and satisfaction (patients), and facilitation of discharge (inpatient staff and hospital administrators).

Significance: Through a collaborative effort with stakeholders, we developed a logic model to enhance the efficiency, accessibility, and sustainability of prehabilitation programs. Subsequent research should evaluate the real-world application of this logic model.

3.2 Introduction

Major surgeries put patients under substantial physiological stress[85]. Standard surgical care primarily focuses on perioperative factors to enhance recovery and does little to physically and metabolically prepare patients to withstand this stress. [86] Preoperative malnutrition, for instance, affects approximately one-third of elective surgical patients and is associated with increased risk of postoperative complications and mortality[87]. [31 88] Similalrly, poor physical function is associated with prolonged length of stay (LOS) and delayed return of functional capacity postoperatively. [30 89 90] Prehabilitation has emerged to fill this gap in care; it is a proactive and multimodal approach to address surgical risk factors in the waiting period before surgery.

An umbrella review of 55 systematic reviews of prehabilitation conducted over the last decade indicated that patients who received a prehabilitation intervention (including nutrition, exercise, and psychological strategies), compared with non-prehabilitated participants, experienced improved functional recovery, fewer postoperative complications, shorter length of stay, and better quality of recovery (certainty of evidence from low to moderate) [91]. In addition, qualitative studies suggest that patients view prehabilitation as an opportunity to engage rather than passively wait for surgery. [92-94] Despite this evidence and appeal, uptake into clinical settings has been challenging. [88 95 96]

Timely realization of the benefits of medical research is an international concern. It is frequently stated that it takes an average of 17 years for research evidence to reach clinical practice[59]. Logic models have potential to bridge research-to-practice gaps[67 72 78 97]. Logic models are visual representations of how a program works, mapping out key components of an intervention and its outcomes, promoting a common understanding amongst stakeholders[6-12]. Hence, logic models have become a staple of program planning, implementation, and evaluation.

[11] Government program managers and funding agencies frequently use or require logic models to outline the anticipated outcomes of a proposed intervention and for evaluation of existing interventions[74 75]. Logic models have been used effectively to enhance patient experience on hospital wards for older patients in the UK[8 79], and in optimizing resource allocation by minimizing costly mismatches between clinician, health system, and patient needs. [98] To our knowledge, no logic model of prehabilitation exists.

Qualitative methods are useful to understand the program components and contextual factors that produce outcomes in complex interventions[80], such as prehabilitation, and are a first step in developing robust logic models[79 99]. Our study thus aimed to use semi-structured interviews and member check focus groups to explore stakeholder perspectives of prehabilitation and how to improve it. More specifically, our research questions were: 1) What should be the mission, inputs, outputs, and targeted outcomes for prehabilitation implementation and evaluation? 2) How to optimize an existing prehabilitation program? These findings were then used to populate the stakeholder-informed logic model of prehabilitation services.

Contributions to the literature

- Uptake of prehabilitation services into practice may be enhanced by developing and applying a logic model. We used qualitative content analysis to generate the first logic model of tertiary care prehabilitation services based on stakeholders' perspectives.
- We anticipate that by co-producing and refining this logic model for prehabilitation, we can enhance efficiency, accessibility and sustainability of prehabilitation.
- A logic model for prehabilitation can foster shared understanding amongst stakeholders, by elucidating the connection between program objectives and activities with expected outcomes, and facilitate program evaluation.
- By incorporating stakeholder-priority outcomes in future research and practice, prehabilitation initiatives could gain better acceptance and adherence.

3.3 Methods

Setting and design

We conducted a multisite qualitative study with semi-structured interviews and member check focus groups[100] at a tertiary and quaternary care hospital network with access to a surgical prehabilitation clinic. Characteristics of the study setting are provided in Table 1. Ethics approval for the study was obtained from the McGill University Health Center Research Ethics Board (protocol number 2022-8494).

The study was designed using program evaluation methodology and integrated knowledge translation (iKT) concepts[13 101]. Program evaluation can be defined as "a systematic way to

improve and account for health actions by involving procedures that are useful, feasible, ethical, and accurate" [71]. This evaluation specifies that program elements be defined, such as with the use of a logic model. [68 71] Both program evaluation and iKT methods involve researchers collaborating with stakeholders throughout the research process to enhance relevance, effectiveness, ownership, and uptake of health interventions. [13] To do this, we assembled a Steering Committee of 6 stakeholders, including a patient, surgeon, ERAS nurse coordinator, director of prehabilitation clinic, financial advisor, and associate director of surgery to co-develop the research project (aim, research and interview questions), facilitate recruitment, contribute to the interpretation of results and co-produce the logic model. The research was carried out and reported in accordance with the Consolidated Criteria for Reporting Qualitative Research checklist (COREQ) [102].

Table 1. Characteristics of the prehabilitation clinic of the McGill University Health Center (MUHC) in Montreal, Canada

The MUHC	• Network of 3 tertiary and quaternary care hospitals that serve the population of the province of Quebec, Canada. • Provides Enhanced Recovery After Surgery (ERAS) care and access to an on-site prehabilitation clinic at the Montreal General Hospital. • As part of the ERAS pathway, patients undergo an appointment at the preoperative clinic before surgery for medical clearance and 1-1 teaching of the ERAS elements. • Surgery Schools are not yet implemented.
Prehabilitation program	• Located within the Montreal General Hospital. • Philanthropically funded. • A clinical team comprising a physiotherapist (1FTE), a dietitian (0.5 FTE), a clinical lead (1FTE), and an administrative assistant (1FTE). • Serves roughly 200 patients yearly from various surgical specialties.
Referral to the prehabilitation program	Access to the prehabilitation clinic is based on referral by any member of the treating team.

Recruitment

Recruitment took place between June 2022- December 2023. We aimed to recruit key stakeholders, defined as follows: recipients of prehabilitation (patients), perioperative care physicians (surgeons, anesthesiologists), inpatient surgical staff (nurses, dietitians, and physiotherapists), preoperative clinic/prehabilitation staff, and hospital administrators. Consecutive patients who completed the prehabilitation program and spoke English or French were approached 4-8 weeks after their surgery in person or over the phone by M.S-J, with whom participants had no prior contact. Non-patient stakeholders were recruited using purposive sampling to include representative participants with experience working in surgery from different professions. Previous knowledge of prehabilitation was not mandatory to ensure comprehensive and robust findings were collected (e.g., avoid responses limited to what the current program already offers). Department heads and Steering Committee members were asked to send the recruitment notice by email, and interested participants emailed J.C. or C.G. Subsequently, snowball sampling was used to solicit additional potential participants by asking existing participants to recommend others. The purpose of the study was explained, and participants' informed consent was obtained (verbal or written) before enrollment.

Data collection

Semi-structured interviews were conducted by MS-J (patient interviews) and JC or CG (HCP interviews), depending on prior relationship with participants, under the supervision of CG, and were conducted only once in-person, over the phone, or by videochat depending on the participant's preference, with only the participant present. Interviews were audio recorded and transcribed verbatim using qualitative analysis software *NVIVO (Release 1.7.1).*

Interview questions were co-designed by our Steering Committee and were based on the logic model components: mission, inputs (e.g., resources), outputs (e.g., population served, services provided) and targeted outcomes [6 8 9 11]. We asked:

1) What has been your experience with prehabilitation (or prehabilitated patients)? What works well? What could be improved? (experience)
2) What is (or should be) the objective of a prehabilitation program? (mission)
3) What characteristics would prioritize someone for prehabilitation? (target population)
4) What services should a prehabilitation program offer patients? (inputs and activities)
5) How would you know if a prehabilitation program was successful? What outcomes are most important to you? (outcomes)

Prompts (e.g., "how/why is this important to you?" "Can you give me an example") were used sparingly at the discretion of the interviewer.

Data analysis

Interviews were analyzed iteratively to inform recruitment. Recruitment ceased when meaning saturation was obtained per stakeholder group, which we defined as the point at which no new information or concepts emerged from the data[103]. Roughly half the interviews (n=27, 44%) were coded by 2 independent researchers to ensure agreement in coding. JC was the main coder, and MSJ and SJ as secondary coders. Analytical memoing was conducted at the end of each interview and researchers met regularly throughout the analysis process to debrief and confirm interpretation of the data until consensus was reached. Coding was conducted using *NVIVO (Release 1)*. A manifest form of summative content analysis was used to identify the presence of certain words or concepts within the dataset[83 84]. Manifest analysis refers to a method whereby researchers focus on the explicit and visible content of the data, and report findings by staying close to the participants

words. [84] We conducted data analysis using Bengtsson's[84] 4-step approach to content analysis, incorporating Hsieh and Shannon's[83] specifications for summative content analysis (i.e., frequency count). We iteratively progressed through each phase and repeated them multiple times to ensure trustworthiness: 1) *decontextualization* (identifying meaning units, also called codes), 2) *recontextualization* (reviewing the data with meaning units in mind, ensuring all important content is covered), 3) *categorisation* (grouping codes with similar meaning into broader categories), 4) *compilation* (analysing and writing the results). The approach involved a combination of deductive (pre-determined codes) and inductive ("ground-up" codes based on the dataset) coding approaches[84 104]. Deductive coding was used to categorize participants' words into the overarching logic model categories, enabling the dataset to be organised, summarised, and analysed in a way that was relevant to the logic model. Subsequently, inductive coding was used to specify unique codes within each logic model category (i.e., subcategories).

Logic model

Our logic model template draws from the W.K. Kellogg Foundation[11] and Dwyer[9] frameworks as well as the implementation outcome framework by Proctor et al. (2011) [65]. The first step focused on defining the mission statement, to ensure the alignment of all subsequent categories. We distinguished between concepts to be incorporated and those to be excluded based on their alignment with the mission and meeting a minimum frequency count (arbitrarily set at $\geq$10% of participants). The final stage of consolidation was achieved through monthly 1hr workshops (member check focus groups[100]) with the prehabilitation clinic team and through feedback from the Steering Committee. While participants highlighted outcomes of importance, specific outcome measures (e.g., instruments, tests, questionnaires) were rarely mentioned; therefore, to enhance the

practicality of the logic model, we have provided concrete examples based on commonly used and validated outcome assessments available in the literature (Supplementary material 1).

Reflexivity of the research team

We acknowledge that the researcher's subjectivity and positionality influence the research process and knowledge production[105 106]. The research team is guided by a pragmatic view[82]: we aim to conduct contextually relevant and meaningful research with an application to real life problems. We value stakeholder experience and involvement to improve healthcare services. The data collection and analysis team included four dietitians (JC, MSJ, SY, CG), amongst which three work in prehabilitation (JC, MSJ, CG). CG, PhD, has been conducting ERAS and prehabilitation nutrition-related research for more than 10 years. JC conducted this study under the supervision of CG for her MSc thesis. Although Insider-researchers have a more practical grasp of the history and application, we recognize that they might be "more interested in the data production that is more aligned with their values instead of having empirical fidelity" [106]. This positionality thus required constant attention to the natural inclination to defend the role of prehabilitation in surgical care. This was counterbalanced by the diversity of the research team (i.e., 1 researcher outside of prehabilitation) and the Stakeholder Committee.

3.4 Findings

A total of 61 interviews were conducted with stakeholders and average interview time was 40 minutes (standard deviation: 14 minutes). None of the participants withdrew from the study. Among participants invited to participate in the study, 1 HCP (health care provider) and 4 patients declined. Additionally, we conducted several member check focus groups to reflect and refine the study findings with Steering committee members and interested interviewed participants,

representing 10 prehabilitation staff, 4 hospital administrators and 4 physicians (including 2 anesthetists, 1 surgeon, and 1 internist).

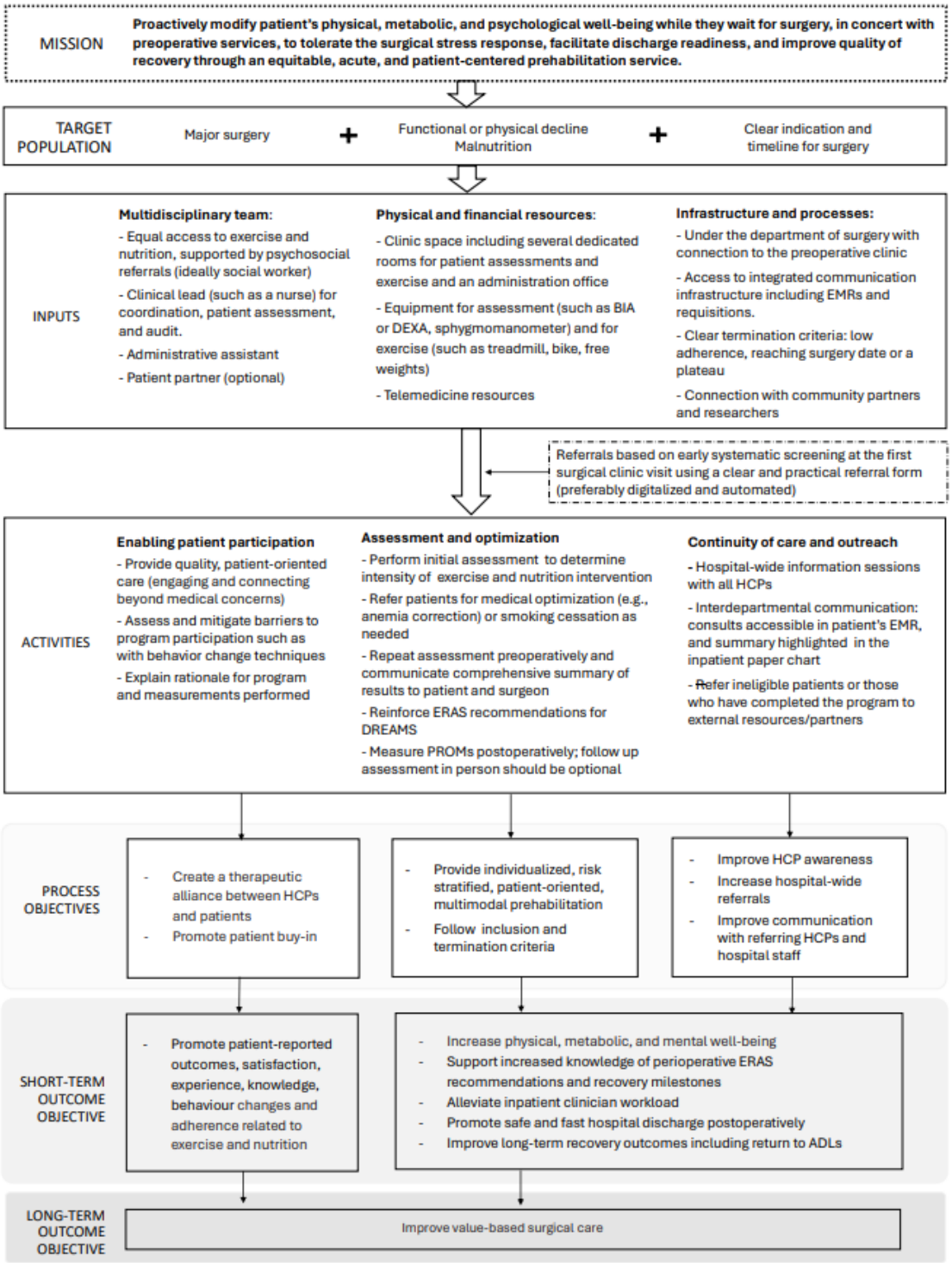
From the coding phase of the analysis, 242 codes and subcodes were charted, and organised deductively into four predetermined overarching logic model categories: *What is the mission? What is the target population? What are the resources needed? What activities are conducted? What outcomes should be measured?* Meaning saturation was reached in all stakeholder groups by interview six except for prehabilitation staff who had the most divergent viewpoints but was achieved by interview eight. A summarized version of the logic model is represented in Figure 1. Components included and excluded from the logic model along with justifications can be found in Supplementary Material 1.

Table 2. Characteristics of participants involved in interviews.

Baseline characteristic	Health care professionals (n=51)	Patients (n=10)
	Mean (SD)	*Mean (SD)*
Age	43 (±11)	65 (±15)
Years of experience in their position	13 (±10)	-
Years of experience working in surgery	13 (±10)	-
	n (%)	*n (%)*
Profession		
Prehabilitation staff	12 (23)	-
Physicians	10 (20)	-
Dietitians	9 (18)	-
Nurses	9 (18)	-
Physiotherapist	5 (10)	-
Hospital administrators	6 (11)	-
Sex		
Female	35 (69)	3 (30)
Country of origin		
Canada	30 (59)	5 (50)
Other	16 (35)	5 (50)
Highest educational level		
High School/College	2 (4)	8 (80)
University or postgraduate degree	49 (96)	2 (20)
Surgery type	-	
Cancer	-	5 (50)
Non-cancer urgent	-	3 (30)
Non-cancer non-urgent	-	2 (20)

SD is standard deviation. Non-cancer urgent included vascular and colorectal surgery. Non-cancer non-urgent included abdominal hernia repair.

Figure 1. Stakeholder-informed logic model of tertiary care prehabilitation.



BIA, bioelectrical impedance; DEXA, dual x-ray absorptiometry; ERAS, enhanced recovery after surgery; DREAMS, Drinking, Eating, Analgesia, Mobilizing and Sleeping; PROM, patient reported outcome measure; EMR, electronic medical record; HCP, health care professional; ADL, activities of daily living .

Table 3. Most frequent logic model items by stakeholder groups.

Logic model items	Overall frequency *n (%)*	Patients (n=10)	Prehabilitation staff (n=12)	Physicians (n=10)	Other HCPs (n=23)	Administrators (n=6)
Mission						
Modify patient's physical, metabolic, and psychological wellbeing **w**hile they wait for surgery	53 (87)	x	x	x	x	x
Integrated, in concert with preoperative services	22 (36)		x	x	x	x
Goal of improving tolerance to the surgical stress response, recovery outcomes quality care, and facilitate discharge	48 (79)	x	x	x	x	x
Equitable	37 (61)	x	x	x	x	x
Patient-centered	45 (74)	x	x	x	x	x
Target population						
Major surgery	9 (15)		x	x	x	x
Functional/physical decline or malnutrition	48 (79)	x	x	x	x	x
Patients with a clear indication and timeline for surgery	24 (39)	x	x	50:50		x
Resources						
Physical and financial resources	38 (62)	x	x	x		x
Proper referrals to prehabilitation based on early systematic screening at the first surgical clinic visit	31 (51)	x	x	x	x	x
Exercise and nutrition as main components (exercise n=29 and nutrition n=26)	40 (66)	x	x	x	x	x
Equal access to nutrition, exercise and psychosocial services	13 (21)	x	x			
Psychosocial specialist, social worker prefered	29 (48)	x	x			
Administrative assistant for scheduling	12 (20)	x	x			x

Clinical lead that coordinates the program and performs audits	11 (18)		x			x
Patient partner for guidance and support to patients (optional)	6 (10)	50:50				
Increase accessibility with telemedicine	19 (31)	x	x			
Sufficient time to provide high quality interventions	16 (26)	x	x			
Ongoing research activities and dissemination of research findings	15 (25)		x	x		
Activities						
Effective interdisciplinary and interdepartmental communication	49 (80)		x	x	x	x
Obtain patients' informed consent and enable participation through patient-centered care and behaviour change models	49 (80)	x	x	x	x	x
Initial assessment and follow-up assessments until surgery, and post-operatively, assessment of patient reported outcomes with optional in-person assessment	47 (77)	x	x	x	x	x
Individualized approach	39 (64)	x	x	x	x	
Hospital-wide information sessions with all HCPs to improve awareness, screening education, dispel misconceptions	36 (59)					
Clear inclusion and discharge criteria	17 (28)		x	x	x	x
Referral of patients requirering **s**ervices outside of prehabilitation who are ineligible, or have completed the program to hospital or community resources	13 (21)		x		x	
Ongoing and unbiased program auditing and improvement	8 (13)		x			x
Outcomes						

Process indicators including cost, penetration, compliance*	47 (77)		x	x	x	x
Clinical outcomes including length of hospitalization	44 (72)	x	x	x	x	x
Patient-reported outcomes and experience	38 (62)	x	x	x	x	x
Health care utilization and cost data including cost effectiveness, patient burden and workload for inpatient staff**	31 (51)		x	x	x	x
Physical and functional outcomes	30 (49)	x	x	x	x	x
Behaviour change	25 (41)	x	x	x	x	
Nutritional outcomes	16 (26)		x		x	
Key baseline indicators and social history demographic such as living situation, dependence for activities of daily living	13 (21)			x	x	x

X indicates that this item was mentioned by a majority (>50%) of the stakeholder group, and 50:50 diverging viewpoints held in similar proportions among stakeholders within the group. Overall frequency count refers to the number of stakeholders that discussed each logic model item at least once. The category of "other HCPs" includes physiotherapists, dietitians, and nurses.

* Process indicators include five sub-categories: adoption, penetration, and sustainability (n=47) such as the number of patients referred; acceptability and appropriateness (n=40) such as stakeholder satisfaction and experience; implementation cost (n=38); and feasibility and fidelity (n=26) such as patient adherence. The highest count for frequency was represented in this table.

** Health care utilisation and cost data includes 3 subcategories: administrative health care utilization data (n=31) such as hospital length of stay and readmissions; cost effectiveness (n=30) referring to the cost per patient trajectory; and patient burden and workload for inpatient staff (n=28) such as direct and indirect patient activities of clinicians. The highest count for frequency was represented in this table.

MISSION

All participants agreed with the importance of preoperative preparation, and most participants agreed that the role of prehabilitation is to optimize patients before surgery to enhance their capacity to withstand the physiological stress of surgery and improve recovery (n=53). It was suggested that prehabilitation should act as a complementary service to preoperative medical optimization, and hence should be integrated under the surgical mandate (in terms of its vision and scope) alongside existing preoperative services and Enhanced Recovery After Surgery (ERAS) (n=22). This integration aims to enhance accessibility of prehabilitation services, foster effective interdepartmental collaboration, and facilitate sharing of staff and resources without duplication. For instance, it was felt that prehabilitation extends beyond medical optimization and medical clearance, managed by perioperative physicians, and employs an innovative interdisciplinary approach to further enhance patient readiness. However, both services must work synergistically, as medical optimization can impact prehabilitation success (e.g., anemia can hinder participation in prehabilitation). In addition, prehabilitation optimization should make use of the existing waiting period before surgery (n=15): most surgeons and some patients expressed concerns with delaying surgery for prehabilitation but indicated a willingness to consider such delays if the prehabilitation team identified significant risks, highlighting the perceived value of risk assessment.

> **Physician**: *"I think that the time spent in prehab allows a much better assessment of a patient's physical condition. A pre-op assessment, say by internal medicine, just assesses their overall physical condition. […] Let's say somebody has asthma, they'll change the medication, someone has high blood pressure, they'll fix that. (…) but they don't have the ability to overall improve their physical condition."*

Most participants stressed the importance of offering equitable care (n=37). Hospital administrators and perioperative physicians enforced the idea that, to be equitable, prehabilitation's mission should be aligned with the specific priorities and challenges of a tertiary centre (n=12) including facilitating discharge. Although many patients stand to benefit from prehabilitation, most agreed that "*prehab needs to be very restrictive [selective about patients accepted into the program] in order to safeguard the outcomes*." Hence, program resources should be allocated based on highest risk and capitalize on community resources for low-medium risk patients.

Administrator: *"In our outpatient program (…) our waitlists are very long. Access to [care] is a huge, huge problem. So, we needed to change the way we practice to improve accessibility. It would be* unfair that one population *gets all this attention and resources [i.e., prehabilitation patient] and meanwhile … we have [other] patients waiting over a year."*

Lastly, participants also agreed that prehabilitation should be patient-centered (n= 45). Some HCPs described the main goal of prehabilitation to be "*giving back the power to the patients so that they can actively participate in their surgical journey."* Yet, patients' preferred levels of engagement varied. Not all patients wished to be empowered, and many waiting for urgent surgeries (e.g., cancer diagnosis) appreciated receiving directive care, highlighting the necessity to personalize care.

> **Surgeon:** *"I find that prehab gives them some kind of control over the process. They feel like they're doing something to help with the disease, to help with the recovery. So it gives them some power, so to speak. It's a very positive thing overall for the patients, and we hear excellent feedback from them about the program."*

TARGET POPULATION

Participants were in favour of targeting patients scheduled for major surgeries (n=9) with a clear indication or timeline for surgery (i.e., set or forecasted surgical date) (n=24) and presenting with elevated modifiable surgical risk factors (n=48) as defined by functional/physical decline (n=23) or malnutrition (n=21). HCPs cautioned against including patients who may not derive meaningful benefits, citing concerns about patient burden, resource utilization, and diluted outcomes. When referral criteria and indication for surgery were not clear, some observed that prehabilitation served as a "dumping ground" for patients; that is, patients became stagnant in the program with unclear indications for future treatments. This led to both patient and staff frustrations. In particular, patients described feeling discouraged, de-motivated, and lost trust in the prehabilitation team and the health care system.

> **Physician:** *"The main caveat of this service is, that the service should be self-limited to a period of time where the treatment is provided in a semi-intensive way, and then the patient goes to surgery right away. (...) it's like a dumping ground for chronic patients. It is not acceptable to accept the patient who doesn't have a clear surgical date. They ask you to take over (...) the management of the chronic illness before surgery."*

> **Prehabilitation staff:** *"I think a lot of the time we got ambiguous referrals or referrals of patients who really weren't that sick or weren't having major operations and then would still have to go through the assessment only at the end to say "you really don't need prehab, so good luck." And we've already wasted 2hours of time and resources."*

RESOURCES

Staffing and physical resources

It was perceived by most participants that the prehabilitation multidisciplinary team should be trained in evidence-based surgical care practices (e.g., ERAS) as well as behaviour change techniques, and should include the following staff: an exercise specialist (n=29), a registered nutritionist-dietitian (n=26), access to a psychosocial specialist (n=29), an administrative assistant for scheduling (n=12), and a clinical lead (e.g., pivot clinician, such as a nurse) that coordinates the program and performs audits (n=11). A minority of participants (n=6) suggested involving patient partners. Exercise and nutrition were described as the two main components of the prehabilitation intervention, with psychosocial services (namely, social work) supporting implementation by addressing barriers to program participation.

> **Prehabilitation staff**: *"To have a psychologist is extremely expensive. And in the hospital, forget about, you can't have one, at all. They're not available. (…) there are so many [patients] barriers which a social work would be ideal, especially because we have a contingent of patients who are material deprived. That will be very useful for link to the community and so on."*

Participants were in favour of including various exercise specialists. For instance, a physiotherapist could treat patients who present with "*restricted mobility*" requiring rehabilitation to exercise, but "*as they gain mobility, could be passed over to the kinesiologist"* who specializes in exercise training.

Participants were in favour of having equal-hour schedules for exercise and nutrition clinicians to meet baseline patient needs and ensure optimal coordination of patient care (n=13). In fact,

prehabilitated patients and some HCPs perceived the nutrition component as being less important to the mission due to extra clinic time and space dedicated to exercise. Many stakeholders, but mainly prehabilitation staff, perceived that nutrition was insufficiently supported in the current model.

> **Patient:** *"From my experience, the nutritionist was kind of non-visible. Unless you had an appointment with her. It was not… I barely saw her. I think maybe a change in the office to somewhere a little more visible. Or maybe even having multiple sessions."*

> **Prehabilitation staff: "***And then you have the nutritional support, unfortunately, we have the lack of days, and it's really hard to plan [appointments with the dietitian]. And, but I do think that those two [exercise and nutrition] definitely go hand in hand together."*

Furthermore, participants described a requirement for sufficient physical resources and access to hospital medical records for communication to the rest of the hospital (e.g., electronic software for charting). Despite challenges and limitations mentioned in use of telemedicine, many participants (n=19) expressed interest in expanding telemedicine practices to enhance clinic accessibility for patients who live far away, are isolated, or cannot afford frequent trips to the hospital.

Infrastructure and processes

Participants believed prehabilitation could fill a gap in current services by implementing a systematic screening of all surgical patients "*as soon as they see the surgeon*" (n=31). For instance, two hospital-staffed dietitians (not prehabilitation staff) identified urgent gaps in current hospital processes related to patient scheduling and insufficient dietitian resources for preoperative services: "*I would see them six days before their surgery. We are not going to have an impact*".

The current prehabilitation referral process was also referred to as unclear (*who can refer, how to refer, which patient to refer*), prompting suggestions for a simplified referral form (e.g., check box format), based on clearly defined inclusion criteria. Some participants further believed that screening and referral should be an automated process (rather than by surgeon referral) to remove user barriers. HCP interviews revealed that lack of awareness and misconceptions about the program were rampant among HCPs, impeding its integration within surgical services (n=36).

> **Physician:** "I haven't sent anyone there because I didn't realize that it's open to regular [clinic activities]. I thought [referring to prehabilitation] was only a decision made by the pre-op (clinic).

> **Inpatient dietitian:** "*I don't think the [standard] care and the follow-ups for those patients [malnourished, preoperatively] is optimal because you can only do what you can do in three hours per week [mandated]. And with the load of patients, for sure, some of them fall in the cracks."*

Moreover, surgeon's perception of the program influenced patients' perception and adherence. Without surgeon buy-in, patients did not always perceive prehabilitation as a "*real"* medical appointment. This highlights the importance of integrating prehabilitation within surgical practices.

> **Patient:** "*It's not in my favour to come out extra [to the hospital]. You know, it's... I come out for like real medical issues. I don't mind. But for something extra like that [prehabilitation], I wouldn't. I wouldn't want to do it…"*

ACTIVITIES

Clinical activities: assessment and optimization

Participants felt that patients referred to prehabilitation services, should undergo an initial assessment and continuous monitoring until surgery (n=47). The intervention should be individualized based on risk factors for malnutrition and physical or functional decline as well as based on patients' goals and preferred level of engagement (n=39). For instance, high risk patients (e.g., severely malnourished vs. well nourished) should receive personalized prescriptions and more frequent, in-person follow-ups, whereas lower risk patients receive "*universal recommendations that every patient should be following before surgery*" through a live in-person or online group class (for more efficient use of clinic resources).

> **Prehabilitation staff**: "*I don't think everyone needs the same prehab because this is not a one-type-fits-all situation. (…) we cannot waste time and energy and hours on patients that don't need to see a dietitian, or they don't need an exercise session two times per week."*

Participants also believed prehabilitation should follow clear criteria for termination of the intervention (n=17), based on reaching surgery date, achieving a plateau (maximal progress with available resources), or demonstrating lack of adherence. It was said that prehabilitation should continue to foster connections with existing resources (i.e., licensed community partners or other hospital departments) for smoking cessation or anemia correction (n=13) rather than perform these treatments "in house". Finally, prehabilitation should continue to support ongoing research activities and dissemination of research findings by partnering with researchers (n=15).

While some patients appreciated knowing how well they had recovered post-surgery, many felt recovered, perceiving a final in-person appointment weeks after surgery as unnecessary, and thus felt the postoperative appointment should be considered as optional. If postoperative assessments are not conducted in person, some participants (mainly prehabilitation staff) suggested measuring Patient Reporting Outcomes (PROs) of early and late recovery for quality improvement purposes.

> **Prehabilitation staff:** "*Depending on whatever your outcome is, which is usually quality of recovery or quality of life, they are usually done at 30 days, six months most of the time, and that could be something that can be done by patients, at home, online, they don't have to come in and it helps us capture outcomes."*

Enabling patient participation

Patient buy-in was seen as a pivotal factor influencing adherence and the success of prehabilitation. Beyond endorsement from the surgeon, strategies aimed at promoting patient buy-in included the continuous provision of comprehensive personalised information, improved patient understanding of health parameter measurements that gauged progress, and provision of patient-centered care (n=49). For instance, some patients explained that they didn't understand the purpose of the clinic measurements and as a result were unmotivated to attend these appointments. Likewise, another patient explained that knowing they were meeting just 17% of their protein needs was a powerful motivator, highlighting the importance of personalising treatment. Additionally, patients and HCPs expressed that trust was established through consistent delivery of high-quality, patient-centered care that went beyond just treating the disease, in which HCPs took the time to engage with patients, showing genuine interest in their personal life and recovery goals. This also included involving caregivers in the prehabilitation process to enhance understanding and support for the

patient, pertinent referrals outside of prehabilitation (e.g., for pain management), or adapting the program to telemedicine as needed.

> **Patient:** "*When I first came to the clinic, I didn't know where I was going. [The person doing the assessment] explained to me what [was the purpose]. It's the explanation that was perfect. Then start the tests (…) I was scared. But after their explanation, every question, it was gone. But in the beginning, when I first arrived, I said what's going on?"*
>
> **Patient:** *"I trusted them because of the way they approached me. It was very friendly, very open, very honest. I felt that it was done the right way. I didn't go in feeling like a patient. I went in almost feeling like a cousin, like an extended family."*

Continuity of care and outreach

The majority of participants recognized the importance of informed transitions of care (n=49). Some characterized prehabilitation's current implementation within the hospital as "haphazard" and noted **"**communication barriers". To improve communication with the rest of the hospital, use of electronic medical record (EMR) in addition to an in-paper-chart checkbox on the preoperative clinic form was recommended.

> **Outpatient Dietitian:** "We wouldn't know who's followed and who's optimized (…), and there was an overlap. It's only when I would meet the patient that I would find out that they're known to prehab."
>
> **Physician:** *"In the last year the prehab program changed how they document their visits [from sending reports through email to charting on the EMR], and I think that's been a very positive thing*."

Inpatient staff felt concise and comprehensive information on the following reduced their workload: the intervention provided, the patient's progress and readiness for surgery (e.g., change in malnutrition status), and key baseline indicators that facilitate discharge and discharge disposition including baseline cognition status, living arrangement, level of dependence, and support system.

> **Inpatient Dietitian**: "*Getting background information of what was being done as well and the recent changes in the intake, that really helped in my nutrition intervention and it saved me time (…) I take that into account when I initiate [timing and progression of] enteral feeds*."

OUTCOMES

Priority outcomes for prehabilitation staff mainly focused on adherence to the prescribed interventions. Patients expressed that, above all else, the sustained connection to the team throughout the preoperative period was important. Thus, for patients, experiential outcomes, including staff having enough time for them, feeling listened to, and receiving enough information to understand the process was priority.

> **Patient (translated from French):** *"Oh I would say it represented support [prehabilitation]. (…) When you are sick like that, you are abandoned*."

Hospital staff and administrators focused on factors that facilitated discharge, and often listed clinician-oriented and patient-oriented outcomes associated with discharge such as "complications, early mobilization, pain control, tolerating diet". However, among HCPs and administrators, patient experience and satisfaction (n=32) were described as frequently as

clinician- oriented and administrative outcomes (n=44) of postoperative complications (n=34) and length of stay (n=15).

> **Administrator:** "*Discharge management and discharge planning are a big aspect for nurses and for the organization. So how does prehabilitation help in terms of that? I think that also can be a good way to show (…) how [prehabilitation] reduces cost*."
>
> **Physician:** "*Does the patient feel that there was a benefit? To me, that's a big indicator of success. And that's what I hear often from patients is they say "I felt that really helped me. I felt like I gained a lot of strength before my surgery."*

Many HCP participants also recommended the inclusion of process indicators (i.e., , key process indicators, KPIs), which are management tools used to evaluate program inputs (e.g., number of patients seen, implementation cost) and the quality of the implementation (i.e., rate of dropouts**,** rate of adherence**, q**uality assurance scoring). [107]

Based on priority outcomes of all stakeholders, the long-term goal of prehabilitation was determined to be increasing value-based health care. For prehabilitation, this means maintaining a high-quality experience (e.g., feeling listened to) at the lowest cost to resources (i.e., stratified treatment intensity based on risk for poor surgical outcomes). Stakeholders anticipated that implementing prehabilitation would reduce postoperative resource burden, as prehabilitated patients tended to be fitter, more empowered, achieved readiness for discharge faster, and their medical and social history was readily available in charts, facilitating baseline and discharge assessments.

Physiotherapist (translated from French): "*Patients who participated in the prehabilitation program are more informed about what happens after surgery and what they should do, and they are more independent*."

Physician: "*When I see a patient in pre-op clinic (…) and I see they've gone to prehab, I say 'Oh, great, they've done a lot of the history for me*."

Table 2. Recommendations for practice based on 61 interviews with prehabilitation stakeholders

- The mission and target population of prehabilitation clinics must align with the objectives and outcomes of its environment; for prehabilitation units nestled within acute care centers, prehabilitation should target patients with highest risk of adverse surgical outcomes, including functional/physical decline or malnutrition, that can benefit from a short-term intervention that will modify morbidity.
- Prehabilitation should fall under the surgical department mandate, alongside, and not replicating, existing preoperative services and the ERAS mission for medical optimization, medical clearance, and preoperative education (e.g., Surgery School).
- Avoid duplication of existing resources/services by focusing on exercise and nutrition interventions, supported by psychosocial services to mitigate barriers that impede participation with treatment.
- Prehabilitation should provide individualized, risk stratified, multimodal care that enhances the patient's experience.
- Collaboration between exercise disciplines will ensure patients receive comprehensive physical optimization; A physiotherapist may treat patients with restricted mobility or impairments, then as they regain mobility, transition to a kinesiologist for exercise conditioning.
- Equal clinical time should be dedicated to both exercise and nutrition.
- The prehabilitation team must follow specific criteria for inclusion and for discharging patients from the intervention. Referral criteria include clear indication and timeline for major surgery and elevated surgical risk defined as functional or physical decline or malnutrition. Discharge criteria include reaching surgery date, achieving a plateau (maximal progress with available resources), or demonstrating lack of adherence.
- Surgeon buy-in and promotion of prehabilitation at the time of referral supports patient acceptance of prehabilitation as an important medical appointment.

- Priority outcomes for patients are centered on experience. Quality, patient-centered care and engagement through behaviour change techniques (e.g., setting goals with patients) helps build patient trust, and hence willingness to participate.
- Explanations about the program, measurements, and its goals should be provided in a simplified and comprehensive manner throughout the prehabilitation process.
- Prehabilitation initiatives should promote digital systems that systematically screen patients for referral, coordinate care, offer telemedicine, and monitor program adherence.
- To inform and promote optimal transitions of care, prehabilitation programs must ensure effective interdisciplinary and interdepartmental communication, which involves determining which outcomes will reduce workload and facilitate discharge at each institution. As an example, at the MUHC, preoperative cognitive status measured by the Montreal Cognitive Assessment (MoCA) test is used by Occupational Therapy to determine discharge disposition. By making this information available, prehabilitation programs could facilitate discharge planning. Other examples include physical impairments, living arrangement, level of dependence and support system.
- Promote penetration of prehabilitation by conducting hospital-wide information sessions with all HCPs for awareness, screening education, and dispel misconceptions. The information and message provided should be tailored meaningfully to engage each of the HCP specialties.
- In addition to traditional clinical and surgical outcomes, such as length of hospital stay, core outcomes for prehabilitation should include intervention adherence as well as patient-reported outcome and experience measures.
- In person, postoperative appointments at the prehabilitation clinic are optional. Instead, patient- reported outcomes should be employed.
- Given that patient adherence to prehabilitation appears to depend on how surgeons communicate the referral, future qualitative or mixed methods studies should explore how surgeons can effectively establish this relationship with patients.

3.5 Discussion

Our stakeholder-driven mission statement compares to the definition of prehabilitation proposed by Silver and Baima[108] for cancer, and the consolidated definition by Fleurent-Gregorie et al., based on a scoping review of 76 surgical RCTs. [109] Key components of our model are also aligned with international initiatives and expert recommendations: i) integrate prehabilitation as a

component of ERAS pathways to prevent duplication of services and discourage departments from working in silos [107] [110-114], ii) provide individualized, risk stratified care to use resources responsibly [107] [110] [115] [116],iii) standardize core outcomes according to stakeholder priorities. [117] To our knowledge, our mission of prehabilitation is the first to represent prehabilitation's unique positionality within tertiary care settings, and thus the need for "aligning the program's goal and activities with those of the setting it will be implemented in to increase utility" [99]. That is, to fit within tertiary care, prehabilitation must be time- and patient-restricted and facilitate earlier readiness for discharge. Effective prehabilitation programs, adapted for tertiary care, have employed short-term, specialized interventions, utilizing resources efficiently to improve clinical outcomes. [57] In fact, cost analysis studies show potential savings related to reductions in complications and readmissions only when personalized prehabilitation programs are applied in high-risk surgical patients. [118] [119]

PROMOTING ADHERENCE WITH PATIENT-CENTERED CARE

Our findings emphasize strategies to enhance patient participation and adherence, such as providing adequate program information to patients during surgeon referrals, delivering individualized care, and promoting engagement through behaviour change techniques such as goal setting. Similarly, a recent systematic review of 26 qualitative prehabilitation studies, involving 377 patients, 51 caregivers, and 156 healthcare providers highlighted the importance of effective communication between HCPs and patients to promote patient participation in prehabilitation efforts. [60] The authors found that gaps in communication and inadequate surgeon endorsement at referral hindered patient engagement. Additionally, patient misconceptions about exercise were found to negatively impact acceptance of the program. [60] [93] [94] [120] These findings resonate with ours, and highlight the need to support informed engagement and program adherence by providing

thorough risk assessment reports to both surgeons and patients, with clear explanations about prehabilitation benefits, rationales, and procedures to support. shared decision-making. [112] [121]

Contrary to other studies [60], we found that not all patients wished to be empowered; some patients waiting for urgent surgeries (e.g., cancer diagnosis) appreciated directive care. Hence our findings highlight that prehabilitation should be tailored to patients' preferences for "how they want, or are able, to be involved at every level" [48] (e.g., from informed to empowered[122]) to increase adherence and satisfaction. Nevertheless, partnering with patients to co-create a treatment plan (i.e., frequency of sessions and delivery mode) might encourage sustained motivation. [60] [92] [110] [112] [118] [120]. [60] For instance, offering the option of home-based sessions with remote support to improve accessibility may improve adherence. [60] [92] [110] [112] [118] [120] [123] A survey of 103 surgical patients revealed that a majority of participants (72%) were in favour of exercising in a home-based environment. [92]

THE LOGIC MODEL TO IDENTIFY AND ADDRESS BARRIERES TO IMPLEMENTATION

We identified several implementation barriers. For instance, although all participants agreed with the importance of preoperative preparation, most reported the program's mission and organizational structure were unclear. A surgeon in our study listed the urgency of cancer surgery as a barrier for referral; yet, in 2020, median wait time for priority surgeries in Canada, including cancer surgeries, ranged from 44-122 days[124]. Similar barriers to implementation have been reported worldwide. [88] [121] [125] A 2023 national survey of surgical practices revealed that 20% of surgeons and anesthesiologists felt there was not enough time to optimize patients before surgery, and 60% did not screen their patients for malnutrition despite believing their patients could benefit from prehabilitation. [88]. Finally, results of a prehabilitation survey conducted with 28 cardiothoracic surgeons in Australia and New Zealand found that 33% of respondents were unsure

who to refer for prehabilitation in thoracic surgery. [121] These findings underscore the potential value of logic models for prehabilitation.

Logic models are useful by clarifying the mission, structuring the program and its referral process, and promoting a common understanding of prehabilitation amongst stakeholders[6-12]. As an example, a psycho-oncology clinic that underwent program evaluation and reorganisation using a logic model (i.e., established clear goals and reassessed the target population and services offered), resulting in improved funding, outreach, and utilization. [126] Similarly, in British Columbia, Canada, a logic model was used to guide the development and use of public health information systems, and to effectively align resources with stakeholder-driven priority outcomes. [98] Finally, The Center for Disease Control and Prevention, with previously separate divisions working in silos, developed a logic model to align program divisions on unified goals and measurable outcomes, which enhanced program representation to stakeholders. [127]

STAKEHOLDER PRIORITY OUTCOMES

By specifying priority outcomes, logic models can help to align implementation efforts with stakeholder needs, standardize inclusion of stakeholder-priority outcomes, and enhance accountability by keeping practitioners focused on these outcomes[**128**]. Our findings suggest patients valued experience above all else, such as feeling supported by the prehabilitation team, and this therapeutic alliance was key for engagement. In a meta analysis of 11 qualitative studies on ERAS, feeling supported was also key for adherence to ERAS recommendation[129]. In fact, when patients were asked to describe successful recovery in an international, multicenter qualitative study, [130] clinical outcomes including early discharge were not mentioned by patients. Yet, a recent scoping review of 76 surgical oncology prehabilitation studies identified that clinical outcomes, such as length of hospital stay, and not patient-reported outcomes, dominated the

prehabilitation literature. [117] Altogether these findings suggest that while clinical, physical and functional, nutritional outcomes continue to be important [107 112], prehabilitation evaluation should expand by incorporating more patient-reported outcomes[112 115], including patient experience and patient-defined measures of recovery (such as return to family, work, leisure activities, and symptom resolution). [131] Our findings also shed light on a novel potential benefit of prehabilitation, which to our knowledge, has not been extensively studied: its impact on inpatient staff workload beyond hospital utilization metrics (e.g., length of stay, readmissions). A recent scoping review of prehabilitation studies and recommendation posited a "workflow for the prehabilitation pathway that when implemented into routines procedures of the hospital workflow is likely to decrease the workload of surgeons, anesthesiologists, physiotherapist and specialized nurses". [112]

Strengths and Limitations

Our study was designed to maximize trustworthiness[84 132] with triangulation amongst researchers, with the literature, and with member checking through member check focus groups[132]. To enhance credibility and dependability, the analysis process involved 2 independent coders, analytic memos, and findings were reviewed with member checks (participants were given the opportunity to review the researchers' interpretation of the data), and both participants and the diverse members of the Steering Committee co-developed the logic model.

However, qualitative findings are subject to limited transferability. Logic models are also subject to limited transferability as they need to align with their situational context. As a result, the logic model created in this study is specifically designed for prehabilitation clinics situated under the umbrella of a tertiary health center in a developed country; hence, transferability to other settings might be limited. While transferability is enhanced by our large sample size from two different sites, interviews were conducted in one province and thus might not be representative of other

provinces or countries. Our team also notes limitations with cultural representation: HCP participants were predominantly white female and participants did not represent all minority groups. Future studies should focus on obtaining international and culturally diverse feedback of the model. Finally, patient participants were recruited at completion of the program at 4-8 weeks post-surgery, and thus we might have missed interviewing patients who did not fully engage (e.g., did not return after surgery) and might have different views from the completers. [60]

3.6 Conclusion

This study proposes the first stakeholder-driven logic model of a prehabilitation program for tertiary care. The model is based on the experience of a single program. In addition to sustained implementation efforts, this logic model has the potential to enhance efficiency of prehabilitation implementation, standardize inclusion of stakeholder-priority outcomes, and facilitate sustainable deployment of prehabilitation programs worldwide. Next steps should involve real-life application of the proposed logic model, assessing its feasibility and adaptability across diverse hospital settings.

4. DISCUSSION

The discussion is divided into three key sections, each addressing a distinct aspect vital for scaling up prehabilitation: 1) the quality improvement section delves into strategies and specific recommendations for enhancing the current prehabilitation clinic; 2) the recommendations for research section highlight how our findings can be used to improve prehabilitation research by addressing research gaps; and 3) the policy change section discusses strategies for scaling up success by gaining policymakers' interest.

4.1 Quality improvement

In this section, I discuss what specific recommendations should be made to optimize the existing prehabilitation program of the Montreal General Hospital as identified by stakeholders in our study and accounted for in our logic model.

Our findings highlight that although all participants agreed with the importance of preoperative preparation, most reported the program's mission and organizational structure were unclear, with one participant using the word "haphazard" to describe its implementation. Other participants reported that the program's mission objectives and processes were unclear, impeding referrals to the program. More specifically, participants brought up that clear prehabilitation referral and discharge criteria were not followed, leading to inefficient resource allocation and both patient and staff frustrations. The first objective of a logic model is to clarify the program's goals based on stakeholder priorities and promote a shared understanding of the program amongst stakeholders. The revised target population criteria should be used to update the referral form to the prehabilitation clinic. It should be clearly indicated that, to be referred, patients should meet all three criteria as defined in the logic model. Currently, the prehabilitation clinic provides care to

any patients referred including low risk patients requiring long-term weight loss interventions for abdominal hernia repair. In fact, some participants in our study, predominantly surgeons and hospital staff, described targeting those with obesity (n=11) as they recognized obesity as a surgical risk factor, that also technically complicates the surgical procedure. However, some of them recognized the complexity of weight loss and the need for chronic, long-term management of patients with obesity (n=7). A subgroup of participants, mainly prehabilitation staff, expressed reservations about using prehabilitation resources for chronic weight loss management (n=5). It was felt that obesity management would require its own logic model, and thus obesity was excluded from this tertiary care model. In conclusion, our study underscores the critical need to improve clarity about the program's structure and function, which was done through the creation of the logic model, such as with the refining of the target population and referral criteria.

We also found that confusion, misconceptions and lack of awareness about the program's mission, conduct, and target population amongst stakeholders, as well as human error (e.g., forgetting to refer) impeded the use of the program. Similar findings have been discussed by Powell et al., in their recent survey of 24 clinicians involved in referring patients to prehabilitation. Awareness was particularly low at MUHC sites where a prehabilitation clinic was not physically present. As outreach initiatives, many participants appreciated being informed through presentations given during rounds. In fact, they found that clinician assumptions about who was a good candidate affected how they presented the program to patients, which in turn could affect how patients perceived the program and their adherence. [133] Implementation initiatives commonly incorporate educational meetings and the distribution of educational materials to clinicians at implementation sites[134], and our findings suggest that launching of prehabilitation programs should do the same to get stakeholders on board. To circumvent referrer bias and human error, our model

also proposes to use digitalized (preferably automated) methods to ensure standardized and systematic screening. This approach was also recommended by Sliwinski et al. in their implementation strategies to strengthen prehabilitation as a standard of care[112], and has been successfully tested and implemented by a prehabilitation initiative in British Columbia, Canada. [135] Hence, our model effectively addresses barrier to referral by specifying the importance of outreach in prehabilitation implementation, and strategies to improve program utilization.

Different expert groups around the world are evaluating the implementation of prehabilitation. Recently, a multinational group of prehabilitation advocates from Canada, the Netherlands, and the UK shared recommendations for implementation based on their experiences and perspectives. [136] Key components of their recommendations support our study design and findings. For instance, the following were accounted for in our logic model:

- "*collaboration with a wide range of stakeholders including those who will be designing, developing, delivering, funding and using the prehabilitation services"*
- "*systematic data collection with clearly identified target outcomes from the outset"*
- "*involvement of the whole team in prehabilitation prescription including identification of patients' levels of risk through appropriate assessment and need-based interventions"*
- "*recognition and acknowledgement of the value that each member of a diverse multidisciplinary team bring"*

These recommendations complement our findings and should be considered when implementing the logic model, such as working with a project leader to unite and motivate the team, and ambassadors that can advocate for prehabilitation.

4.2 Recommendations for research

Prehabilitation research could also benefit from following the logic model. Evidence supporting prehabilitation remains of low to moderate certainty partly because of variations in interventions and reported outcomes. [62] The inclusion of some standardized evaluation methods can enhance our comprehension of which intervention works best and for whom, and strategies conducive to improved patient adherence and cost-effectiveness. Our model specifies stakeholder prioritized outcomes that could be included in a future core outcome set and the need to develop a surgery-specific diet quality core outcome set.

A scoping review of prehabilitation studies identified that approximately two-thirds of the studies with a nutrition component did not monitor nor evaluate the nutrition intervention. [63] Measuring food intake and dietary patterns is an essential component of nutrition research involving diet-based interventions. As discussed in the *Knowledge gaps* section of this thesis, monitoring outcomes without monitoring implementation is not enough to determine real-world treatment effectiveness. More specifically for nutrition, failing to properly document specificities about diet can lead to inappropriate conclusions about the effect of a nutritional intervention or the effects of diet components on health. [137] Prehabilitation authors have suggested the development of a reporting checklist or set of core outcomes to measure. [62-64] [138] A core outcome set (COS) is "an agreed minimum set of outcomes which should be reported in all effectiveness trials of an intervention or condition." [139] Our logic model specifies standardized outcomes based on stakeholder priorities, which future prehabilitation studies should include and report to promote higher certainty of evidence and enable the generation of robust conclusions regarding intervention effectiveness. Clinical decisions about patient care are made based on these outcomes, which

makes the selection process of outcomes to be measured and reported in trials critical. In addition, the outcomes suggested in this logic model are based on stakeholder priorities.

However, monitoring diet and diet changes in response to an intervention remains resource and time-intensive for researchers, making adherence to dietary recommendations difficult to measure. [137] The challenge of adequately capturing diet quality lies in both the complexity of food interactions and diet variability within and amongst persons, as well as the limitations of available tools (either non-specific or time consuming). Diet monitoring remains however an essential component of not only the nutrition care process model, but also of research. Hence, future research should propose the development of a minimum set of dietary outcomes to measure (a diet quality COS) for preoperative onco-surgical nutrition research, which would allow for more accurate cross-study comparisons and result interpretation. [63] A practical tool that evaluates baseline food intake and dietary changes (in response to prehabilitation intervention), in comparison with the unique nutritional needs of the surgical patient, would permit better monitoring of adherence to recommendations and nutrition outcomes in prehabilitation research.

Finally, participants in our study highlighted the potential cost-saving effects that could arise from "shifting resources," which involves investing resources before surgery (i.e., through an intensive prehabilitation program) to save resources post-operatively. In particular, inpatient staff identified that prehabilitated patients reduced their workload as they were more empowered to actively participate in their care, and more likely to be discharged faster, as well as readily available patient history in the EMR decreased charting time and aided them in prioritizing patients to be seen in the context of limited inpatient resources. This highlights that evaluating staff burden could be a significant future measure to assess the intervention's effectiveness, and it was included in our logic model.

4.3 Policy change: "How do you scale up success?" [140]

Our research, developed collaboratively with stakeholders, presents a pragmatic and technically comprehensive solution during a time of heightened interest in prehabilitation. Multimodal prehabilitation is increasingly recognized as a vital component of the surgical pathway, alongside initiatives such as ERAS and minimally invasive surgery. [141] Research and clinical organizations are actively exploring the promotion or implementation of prehabilitation programs, and many have published papers with recommendations for implementation, although no structured approach currently exists. [112] [116] [136] [142] In addition to promising evidence supporting prehabilitation and a growing interest in the field, qualitative studies on prehabilitation indicate that patients perceive it as an opportunity for engagement rather than passively waiting for surgery, contrasting with the isolation experienced by patients without prehabilitation. As one patient put it, "*there is no preparation for surgery…you just show up*". [93] Patients were left feeling isolated, and perceived prehabilitation as a solution to fill this gap. [48] [93] Moreover, one participant highlighted a potential opening in provincial funding for surgical care, presenting a significant opportunity for prehabilitation to be incorporated into policy change.

> **Hospital administrator**: *"Historically, Quebec's health care system was looking at the numbers, the volume. But there is an opening right now in politics in general to look at the quality as well. It's not just how many surgeries we are doing, it's how I am doing it and what is the impact overall. Before the way the hospital was funded - and especially the surgical services - the OR got a piece, preop got a piece, and etc. Now, starting April 1st, 2023, it will become "funding by patient trajectory". The trajectory includes the moment the patient signed the consent for surgery, until the patient leaves the hospital. So for the*

cost, maybe I have a higher cost in the prehabilitation clinic, but less cost on the unit and improved the length of stay. So the cost for this patient's trajectory could be changed."

Health policy experts Cairney and Kwiatkowski state that "scientists who wish to bridge the research-policy gap should 1) generate technically and politically feasible policy solutions and seek opportunities to sell them during heightened attention, 2) seek to frame evidenced with strategies and storytelling in a persuasive manner." [140] They also note research often fails to translate to practice because scientists fail to retain policy makers' attention. Scientists who value high quality evidence (i.e., systematic reviews of RCTs) may overlook policymakers' limited capacity to digest vast amounts of information at once, hindering rational evidence-based decisions. On the contrary, the authors recommend scientists should present pragmatic and feasible solutions to the problem at hand and use "storytelling" as an approach that "facilitates the dissemination of best practices and invites others to learn from shared experiences." [140]

Prehabilitation is an intuitive concept that speaks to many, given the widespread experience of people with surgery (their own or their loved ones), and is highly valued according to our findings (all stakeholders interviewed were in favour of prehabilitation). In addition, our research design and findings echo Cairney and Kwiatkowski's strategies to "scale up" research into practice through 1) storytelling with patient and clinician testimonies in favour of prehabilitation, and 2) a pragmatic business case, proposed through the logic model, that promotes value-based initiatives.

4.4 Significance and future directions

4.4.1 Expected impact and significance

Implementing prehabilitation clinically presents a significant challenge. Through participatory research with stakeholders, we have developed a logic model that will help guide the

implementation and evaluation of prehabilitation programs, thereby contributing to bridging the gap between research and practice.

Stakeholder-informed logic model to improve surgical care

The mission statement proposed by the 2021-2031 Strategic Plan of the Canadian Institutes of Health Research (CIHR) mentions the importance of mobilizing knowledge into practice to improve the effectiveness and strength of health systems in Canada. [143] Our study effectively aligned with the CIHR's mission as it allowed us to understand how prehabilitation could be improved to best serve stakeholders based on a rigorous consultation process from a wide range of stakeholders. Our findings were also used to develop a tool to guide translation of research knowledge into clinical practice, which will ultimately support uptake of prehabilitation, and be used as a benchmark for program evaluation globally. Finally, the logic model will help promote a common understanding of prehabilitation amongst stakeholders and policy makers and standardize measurement on priority outcomes. In doing so, we expect to improve scalability and attract more sustainable funding from governmental agencies which frequently use or require logic models for program evaluation. [74] [75]

Patient-engaged research and healthcare services

Logic models and patient-engaged research, which are the foundation of our study, have the potential to improve the integration of research findings into clinical practice. The CIHR encouraged the integration of patient-engaged research in clinical practice as a way to improve health outcomes. [144] Our study is co-led by a patient-partner (Rona Fleming on our Steering Committee) and includes 10 interviews with patients. Involving patients in healthcare decision-making has the potential to enhance uptake of interventions as well as reduce costly mismatches between clinician, health system, and patient needs. [13]

4.4.2 Future directions: prospectively applying and refining the model

The logic model developed in this study is part of a broader initiative to support prehabilitation program implementation. Next steps should involve further refining the logic model, conducting implementation research to validate its real-world application, testing its application in other centers, and disseminating research findings.

Step 1. Quantitatively evaluate logic model elements with a Delphi

To gain a breadth of perspectives and increase transferability of our findings(i.e., obtain international expert and patient consensus), our research team plans to evaluate the qualitative items of the logic model (e.g., inputs: appropriate surgeon referral) using an online Modified Delphi technique. [145]

Step 2. Prospective application of the model

The next research study involves prospectively applying the model to a real-life prehabilitation clinic using mixed methods to collect quantitative outcomes and qualitative data. The process of implementation of prehabilitation should be guided, evaluated, and reported using implementation tools with the goal of improving rigor and reproducibility of prehabilitation implementation research. For instance, determinants of implementation and implementation strategies can be identified using the Consolidated Framework for Implementation Research (CFIR; Damschroder et al., 2009) and the Expert Recommendations for Implementing Change (ERIC) compilation of strategies (Powell et al., 2015) [146] respectively, and the implementation process can be reported using the Implementation Research Logic Model (IRLM; Smith et al., 2020) [67] or the Standards for Reporting Implementation Studies (StaRI; Pinnock et al., 2017). [147]

Step 3. Multi-centered international RCT

Our last step would be to evaluate this revised prehabilitation program in a multi-centered international RCT.

Step 4: Dissemination

The ultimate outcome of this extensive research effort will be a real-world-informed logic model template for surgical prehabilitation programs. To facilitate knowledge dissemination, we aim to publish in an open-access journal. Additionally, the prehabilitation team at the Montreal General Hospital plans to utilize the refined logic model and the lessons learned from its implementation to develop a website. This website will provide freely available resources to enable the evaluation of existing prehabilitation programs and support the development and monitoring of new programs that reflect stakeholder-defined objectives and outcomes.

4.5 Strengths and limitations

The Cochrane Qualitative Research Methods[132] group explores important components of critical appraisal of qualitative studies, based on core principle of quantitative study appraisal such as validity, reliability, generalisability and objectivity, which were translated and adapted to qualitative studies. The table below taken from *Chapter 4 – Critical appraisal of qualitative research* illustrates the translation of these critical appraisal criteria.

Table 5. Qualitative criteria for trustworthiness

Qualitative term	**Definition**	**Quantitative term**
Credibility	Truth value	Internal validity
Dependability	Consistency	Reliability
Transferability	Applicability	External validity or generalizability
Confirmability	Neutrality	Objectivity

The credibility criterion aims to assess whether the data collected truly reflect the perceptions of participants. This was possible through our rigorous methodology involving three different forms of triangulation: amongst researchers, with the literature, and with member check focus groups. First, two researchers independently coded half of the interviews, and researchers met regularly to discuss findings in groups of three, including two prehabilitation researchers and one non-prehabilitation researcher to balance emic and ethic perspectives ("insider" and "outsider" perspectives). Secondly, an in-depth review of the prehabilitation literature was performed to identify expert groups' recommendations and international initiatives. As discussed, our findings and our logic model align with international prehabilitation implementation efforts. Finally, member check focus groups were conducted with Steering Committee members and participants throughout the analysis and logic model development process. Hence, participants and Steering Committee members had multiple occasions to review researchers' interpretation of the findings and provide their input for items included in the logic model to ensure findings and the logic model truly reflect perceptions and priorities of participants and not of researchers. Furthermore, the Steering committee represented diverse stakeholders including a patient partner, ensuring adequate representation of stakeholder groups.

Dependability refers to how the research process was documented, and if it is logical, and can be traced. Researchers ensured thorough documentation along the analysis process. In fact, analytical memoing was performed by the interviewer researcher after each interview, and performed again after the interview was coded. Many of the analytical memos were read by a second researcher and were discussed and debriefed amongst researchers. Researchers also kept track of how codes were merged into broader categories in a Word document. Decisions about items included in the model were done by considering the frequency count of each item and their

alignment with the mission statement as well as debriefing with SY and CG. These decisions are thoroughly explained under "Rationale" in the supplementary table and are supported by provision of multiple quotes from all stakeholder groups.

Transferability refers to how applicable the research findings would be to other settings. Both qualitative research designs and logic models are subject to limited transferability as they relate to the specific experiences of the stakeholders of the program under evaluation. Also, logic models need to reflect the specific reality of the organisational context which it aims to represent. Our logic model was specifically created to reflect the reality of prehabilitation clinics under the umbrella of an acute care health center. Being mindful of this, we attempted to enhance transferability with our large sample size from two different sites. As an example, we were able to identify that experience, such as penetration of the prehabilitation intervention, were different between sites. The next research steps regarding the logic model also aim to enhance transferability (i.e., international Delphi technique).

Confirmability has to do with how likely findings are exempt from research bias and are truly produced by participants' narratives. This calls for researchers to reflect and disclose their specific positionalities and possible biases. This was particularly important to researchers who performed this study, given that some members of the research team were prehabilitation clinicians and researchers. This was fully disclosed to readers in the manuscript. Analytical memoing throughout the interview and analysis process also served the purpose of reminding researchers of their possible biases in conducting the research and generating their results. Our diverse research team and Steering Committee members also contributed to enhancing confirmability. Researcher SY (an outsider) was involved throughout the analysis process to interpret findings and create the logic model.

Finally, the research was conducted ethically. Patient participants were first approached to participate by a member of the prehabilitation clinic staff, then if interested, they were approached by a researcher with whom they had no prior contact and were explained the rationale for the study before being consented to participate. HCP participants were contacted by department heads who forwarded the invitation to eligible HCPs. Only participants who communicated interest were approached by the researchers. For both patients and participants, the rationale for the study, as well as the interviewer's role in prehabilitation was explained. Researchers recognized that some participants might have felt hesitant to disclose negative feelings or perceived flaws about the program to prehabilitation researchers. Hence, researchers emphasised the need to improve the current program and directly asked participants what could be improved. They also used strategies to promote conversation in this direction, such as disclosing to participants that implementations flaws had been reported by other participants previously interviewed.

Finally, logic models are based on assumptions that are made about the program and its environment, and hence only depict assumed causal connections and outcomes rather than direct cause-and-effect relationships. While the logic model aids in articulating causal linkages, building consensus, and evaluating targets, it's important to keep in mind other outcomes that might result from the intervention but that are not accounted for in the model as well as acknowledge factors other than the program that might influence outcomes. Randomized trials are the most reliable method to assess the effectiveness and efficacy of an intervention, but "the benefit of using a logic model cannot be rigorously tested through implementation research because of the unique context of workplaces and variable intervention designs". [73] Subsequently, our findings will lay the groundwork for future trials aimed at testing the effectiveness of a stakeholder-driven prehabilitation program, based on our logic model, in a randomized trial.

Moreover, our results indicated potential variations in perspectives and preferences for prehabilitation between patients awaiting urgent and non-urgent surgeries. However, our limited patient sample size precluded an in-depth exploration of these differences and achieving saturation between acute and chronic patients. We speculate that patients needing long-term care for chronic conditions may necessitate a distinct prehabilitation logic model compared to acute patients in tertiary care settings, warranting further investigation.

5. CONCLUSION

Prehabilitation interventions, including nutrition, exercise and psychological support, aimed at enhancing preoperative risk factors like malnutrition and exercise tolerance have been studied for over a decade and have shown promising results in improving recovery. Patients express a preference for prehabilitation interventions, perceiving them as an opportunity for active involvement rather than passive anticipation of surgery. However, despite patient interest and potential benefits, prehabilitation uptake in clinical settings remains slow, partly due to the lack of implementation guidance.

We conducted a program evaluation of prehabilitation using an integrated Knowledge Translation approach and a qualitative research design: we recruited and explored the perspectives of 61 prehabilitation stakeholders (patients, perioperative physicians, inpatient staff, preoperative and prehabilitation staff, and hospital administrators) to populate the first stakeholder-informed logic model of clinical prehabilitation services, which will serve as a blueprint for planning, implementing, and evaluating programs globally. Our findings highlight that all participants interviewed were in favour of prehabilitation, but that many drawbacks impede effective use of clinic resources. The mission of prehabilitation and its logic model components identified in this study resonate with findings from other qualitative prehabilitation work done with patients and

clinicians and with recent trends in global initiatives (e.g., tailoring the intervention, shift towards telemedicine).

By collaboratively developing a logic model for prehabilitation with stakeholders, our objective is to enhance the efficiency, accessibility, and sustainability of prehabilitation programs. Coupled with sustained implementation efforts, this project is part of a broader initiative to facilitate accessible and sustainable deployment of prehabilitation programs worldwide. Moreover, we aim to standardize the inclusion of stakeholder-driven outcomes, thus ensuring consistency across prehabilitation initiatives worldwide. The model is based on the experience of a single program. Future research will focus on applying the logic model to existing prehabilitation programs and testing its application in other centers.

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APPENDIX

Supplementary table

Supplementary table 1. What is the mission?

Mission statement	Proactively modify patient's physical, metabolic, and psychological well-being while they wait for surgery (n=53), in concert with preoperative services (n=22), to tolerate the surgical stress response, facilitate discharge readiness and improve quality of recovery (n=48) through an equitable (n=37), acute (n=12), patient-oriented (n=45) prehabilitation service.
Rationale	- The mission of the clinic must align with that of a tertiary care center. Tertiary care priority is to facilitate discharge. Prehabilitation is at the intersection of primary care and tertiary care. It is physically located within a tertiary care center but offers a preventive care approach aimed at enhancing the rapidity at which the patients recover from surgery, - Everyone stands to benefit from prehabilitation, but resources must be allocated equitably and in a way that meets the objectives and outcomes of a tertiary care centre (e.g., early discharge from hospital). Hence, prehabilitation should target patients that require an acute intervention that will modify postoperative morbidity. - Prehabilitation should not duplicate existing resources/services and thus should focus on enhancing patients' physical, metabolic, and psychological well-being, which leaves medical clearance/optimization to preoperative services. Medical optimization is important; however this is a service already provided by preoperative services. - Prehabilitation should be integrated within the hospital (making it accessible to surgical patients). Prehabilitation is ideally integrated under the surgical mission, alongside preoperative services and the Enhanced Recovery After Surgery (ERAS) mission. - Prehabilitation takes advantage of the existing surgical waiting period. - Prehabilitation works to optimize patients before surgery. It is recognized that there is value in providing this service postoperatively; however, rehabilitation services already exist. - Prehabilitation should be patient-oriented, including providing quality care that recognizes all aspects of the patients' lives and accompanies patients in this critical time of their life (waiting for surgery). This also refers to individualizing the patient-engagement approach based on patients' preferences, along the patient engagement continuum, from being informed to being empowered.

Items excluded from the logic model	- Prehabilitation should medically optimize patients (n=13). - Prehabilitation does not have to be related to surgery: it could be used also be used to prepare patients for medical treatments other than surgery such as adjuvant therapy (n=3). - Prehabilitation should continue in the post-operative period (n=11).
Exemplar quotes	**Administrator: "***I think it would be good to know, and to define the roles between what's the role of preop and what's the role of prehab."* **Prehabilitation staff: "***Improve their status physical, nutritional status, emotional statutes and to get ready for surgery so that he [patient] can recover faster and better after surgery and obviously hope that they don't have any complications throughout the journey."* **Prehabilitation staff:** *"I think compared to anywhere else in health care, we're [prehabilitation clinic] giving them a lot more. When they come here, they don't sit and wait for an hour, they're seen right away. When they come here, they tend to be seen for an hour or often times more. (…) that's a good thing."* **Prehabilitation staff:** *"I always emphasize that we are working with, and working for very sick people. If you want to maximize your outcome, then you have to know everything, as much as possible, you have to try to touch upon the entire aspect of the patient. "* **Surgeon:** "*You need to be sure that we're not delaying any surgical treatment too much. (…) If I had a tumor to my lung, I want it to be removed today. I don't want to do four weeks of prehabilitation, this even if I'm unfit, I want to take it out."* **Surgeon:** *"We sometimes have people from prehab saying "can we take two or four more weeks with this patient?" If we're talking about a few weeks, it really has no oncological effect on the patients - so if there's something objective that can be changed - I'm usually very open."* **Physician***: "I think that the time spent in prehab allows a much better assessment of a patient's physical condition. A pre-op assessment, say by internal medicine, just assesses their overall physical condition. […] Let's say somebody has asthma, they'll change the medication, someone has high blood pressure, they'll fix that. They will prescribe iron for anemia, but (…) they don't have the ability to really overall improve their physical condition."* **Prehabilitation staff**: "*I see prehab as supporting the most critically unwell patients preoperatively to try and maximise their chances of getting back to their normal life, their baseline life post-operatively."*

Supplementary table 2. What is the target population?

Target population	Patients should be referred to prehabilitation if they meet all the following criteria: - Surgical patients undergoing major surgery (n=9) AND - Patients presenting with elevated surgical risk (n=48): functional or physical decline (frail, decrease in function) (n=23), and/or malnutrition (n=21) AND - Patients with a clear indication and timeline for surgery (n=24)
Rationale	- The target population should be aligned with the mission of prehabilitation delivered in an acute care setting. Hence, prehabilitation should target patients at high risk for poor surgical outcomes that require an acute intervention. - When referral criteria and indication for surgery are not clear, prehabilitation can serve as a "dumping ground" for patients (i.e., patients become stagnant in the program).
Items excluded from the logic model	- Cancer diagnosis alone (n=18), medical comorbidities (n=11), obesity (n=11), and social vulnerability (i.e., presenting with psychosocial difficulties such as social isolation, depression, or anxiety) (n=7). These alone (i.e., in the absence of the aforementioned elevated surgical risk factors) should not be criteria for referral. o Prehabilitation services can screen and identify medical comorbidities and refer to the preoperative clinic for management o Prehabilitation should mitigate psychosocial factors to improve prehabilitation participation, but this service is not equipped to optimize or resolve psychological factors, which often require chronic management, in the short window of opportunity before surgery o Prehabilitation for weight management would require a different logic model: weight management requires a specialized, long-term approach (n=7) which cannot be offered in the context of limited tertiary care resources (n=5) - Young and autonomous patients with suboptimal lifestyle habits (n=4) - Patients that require multiple prehabilitation services as a proxy for elevated surgical risk (n=3) - All patients should be seen for assessment by every professional with "the idea being that there is always something [to optimize]" (n=3)

	- Prehabilitation can function as a bridge between surgical and medical interventions, can help make patients a candidate for surgery (n=3). Patients with history of chronic pain (n=1) - Patients going for short stay surgeries and that would benefit from preoperative teaching (n=1)
Exemplar quotes	**Physiotherapist:** *"I'm not speaking about somebody who is maybe 40, 50 years old, who's probably working or very active in their lives, and they're already exercising, they're already active , I don't think it's necessary because I think it will be just one more demand on the patient in an already very, very demanding journey they're on when they have cancer."* **Prehabilitation staff:** *"If not, they should… well, we need to define what the role of prehabilitation is, and we need to define if we are also a weight loss clinic. In my opinion, I don't think we should be a weight loss clinic. (…) So if you have a multi-comorbid hernia patient that you know for sure that he will be at risk of post-operative complications and you know that it's a complex hernia and high chances that this person will … will complicate and will have a hard time recovering or even dying in the OR table. So then yes these patients should definitely be seen. But sometimes we're seeing twenty-five-year-old obese patients that have a hernia. And, you know, I don't I don't think prehabilitation is their place. I personally, I don't I don't think so."* **Prehabilitation staff***: "I think maybe one thing that we could do better (…) perhaps not all of the patients [seen in the prehabilitation clinic] would fit the narrow criteria of who stands to benefit most from prehab."* **Prehabilitation staff:** *"Yeah , so I think it's just a lot of the time we got ambiguous referrals or referrals of patients who really weren't that sick or weren't having major operations and then we would still have to go through, see them, and do the medical history or assessment only for them to be at the end like we've wasted already , you know , two hours of time and resources , but you really don't need prehab, so good luck. Do you know what I mean? I just think that that could be cut down."* **Physician:** *"The main caveat of this service is, that the service should be self-limited to a period of time where the treatment is provided in a semi-intensive way, and then the patient goes to surgery right away. (…) it's like a dumping ground for chronic patients. It is not acceptable to accept the patient who doesn't have a clear surgical date. they ask you to take over (…) the management of the chronic illness before surgery."* **Patient (translated from French):** *"I've been waiting for two years, and it's been a year and a half since I saw the doctor. We had decided on December [for the surgery] but December has long passed and there is nothing new."*

Supplementary table 3. What resources are needed?

Resources/inputs	- Prehabilitation should be implemented alongside preoperative services, under the department of surgery, and connects with both anesthesia and internal medicine. - Physical and financial resources (n=38): o Funding o Joint clinic space, and rooms for all clinic members: approximately 6 rooms or shared office space (including several dedicated rooms to see patients, administration offices, and an exercise space) o Office equipment (hospital forms like blood test requisitions, desks, computers, access to a printer, etc.) o Equipment for assessment (e.g., BIA or DEXA for body composition, hand dynamometer for grip strength, measuring tape for height or waist and calf circumference, timer and hallway space for physical tests, sphygmomanometer for blood pressure, pulse oximeter for oxygen saturation, etc.) and for exercise (e.g., treadmill, stationary bicycle, recumbent bike, free weights, exercise bench, elastic bands, walker for patients to ambulate safely, etc.) o Access to integrated communication infrastructure such as the patients' electronic medical record (EMR) o Resources to provide telemedicine: electronic resources and digital infrastructure, and staff and patient training - Proper referrals to prehabilitation based on early systematic screening for malnutrition or reduced functional capacity at the first surgical clinic visit using a clear and practical referral form (n=31) - Multidisciplinary team trained in surgical care and behavior change: o Exercise specialist (n=29) and nutritionist (n=26) as the two main components of the program. Prehabilitation can utilize various exercise specialists including kinesiologists, physiotherapists, and physiotherapy technicians. o Psychosocial specialist (n=29) to address phycological and material barriers to program participation. In Quebec, Canada, this would ideally be a social worker as they can provide counseling and guidance for community resources. o Equal accessibility to nutrition and exercise services (n=13) o Administrative assistant for scheduling (n=12) o Clinical lead: pivot clinician, such as a nurse, that receives referrals, coordinates and consolidates services according to patient needs, and communicates back to referring department or health care professional (n=10), coordinates the program (n=7) and also performs audits (n=7)

	- Sufficient time to provide the intervention and quality care (n=16) - Connections with clinics and licensed community partners for patient referrals (n=13), and collaboration with researchers for ongoing research activities and dissemination of research findings (n=15) - Patient partner (n=6) that can provide guidance and support to patients (optional)
Rationale	- Efficient organization with consideration for multidisciplinary expertise is important in onco-surgical clinics. Having sufficient resources and clearly defined roles and processes aids with this. For instance, equal access to all clinicians (e.g., equal worked hours) allows to coordinate and schedule clinic activities easily. Patients and health care professionals wrongfully perceived nutrition as being less important than exercise because of reduced resources for nutrition (fewer hours and smaller office space) compared to exercise. - Collaboration between varied exercise professionals is ideal in prehabilitation. Physiotherapists are trained in medical management of exercise and are specialized in rehabilitation and recovering function. Kinesiologists can exercise patients and improve fitness. For instance, physiotherapists could work with patients who have low function, to get them to a level where they can exercise. - Prehabilitation staff preferred a full-time psychologist for mental well-being resources, while hospital staff suggested a social worker. Given the scarcity of psychologists in the public sector, social workers emerge as a fitting option to assist patients in overcoming psychological and material barriers to program participation. - Prehabilitation should capitalize on existing community and in-hospital resources and maximize referrals out of prehabilitation for activities that are non-prehabilitation-specific (e.g., smoking cessation, help from a psychologist or psychiatrist for mental illnesses). - Prehabilitation initiatives should work on integrating digital systems that can integrate patient education, coordinate care, enable interdisciplinary communication and communication with the patient or compliance monitoring. There are limitations and contraindications to telemedicine with certain populations. - Hospital-wide screening and referral processes need to be in place to properly identify and refer patients to prehabilitation. Screening for prehabilitation should be based on the target population criteria and should be done early in the surgical trajectory. Referral to prehabilitation should be expeditious and allow enough time for implementation of the intervention. At the moment, systematic screening processes with validated tools are not always used, which leads to patients being missed or referred too close to surgery.

	- Surgeon buy-in and explanation of prehabilitation at the time of referral promotes patient acceptance of prehabilitation as an important medical appointment.
Items excluded from the logic model	- Medical optimization (n=13). Although an important component of risk management, this is already managed by the preoperative clinic. - Cancer symptom management to improve patient quality of life (QOL) and program participation (n=3) - Other potential team members: occupational therapist (n=2), communication and/or marketing specialist (n=1), technology specialist (e.g., to help run telemedicine platforms) (n=1).
Exemplar quotes	**Prehabilitation staff***: "How should we do the screening? (...) It's too late when they come to pre-op [clinic], they're already scheduled for surgery."* **Prehabilitation staff:** *"So like some European countries, my vision would be to see preoperative assessment come in much earlier in the patient's surgical trajectory, literally from the booking time. (...) And then those with the pitfalls, they come to prehab for further management, OK? They don't sit lingering at home doing nothing between the time that they get booked for surgery."* **Dietitian:** *"So we work to integrate the CNST [Canadian Nutrition Screening Tool] in the pre-op questionnaire together to make it more specific, because what would happen is that the [previous] questions weren't [validated], I would get patients that (...) didn't really need a nutrition intervention."* **Dietitian:** *"We get referrals that are way too late. And then we're asked to do miracles. It's like, well, you know this patient, you want to give him chemo, but you should have referred him to me before he lost 30 pounds, now there's not much I could do, now he's cachectic."* **Prehabilitation staff***: "What doesn't work is that sometimes we work with patients for a very short period of time, and in that short period of time, it's… so it could sometimes be hard to achieve goals and make changes. Sometimes depending on the patient, they need more time.* **Surgeon:** "W*e can do frailty screening in our clinics and target those patients for prehab that would be ideal."* **Patient:** *"The surgeon [referred]. (...) he told me, I recommend that you go there. So we see if you're ready for the operation or not, for the surgery or not. I went automatically, you know. As soon as he mentioned. [The prehabilitation clinic] called me and I said, "OK, I'm coming to you guys".* (...) *I trusted the doctors and I trusted them when they said, "you need to… you need to, you know?".* **Prehabilitation staff:** "*We haven't been able to get graduates [prehabilitation patient graduates] to come and support the current ones. I think it would be wonderful and a very big advocacy move to have former graduates come back, stay involved, so get them to touch in with the principles that they practiced for long term health gain , OK , and to help current graduates, you know , develop that extra psychological resilience because they have a support network , right* ?"

	Prehabilitation staff: "*And then you have the nutritional support, unfortunately, we have the lack of days. And it's really hard to plan everybody in into two and a half days to see a dietitian. And, but I do think that those two [nutrition and exercise] definitely go hand in hand together."* **Administrator: "***From my perspective I can tell you that for the clerical staff like it's a lot of work on one person. I can guarantee you. Like you need another half person."* **Prehabilitation staff**: "*There is a distinct difference between (kinesiologists and physiotherapists). Kinesiologists are for strengthening and conditioning of patients. (…) I definitely think that it's a continuum whereby let's say a patient has very restricted mobility, a physiotherapist would be best for them. But as you gain the mobility, maybe pass over to the Kin, who's going to apply a little more expertise on how to properly condition the patient now*. **Physiotherapist:** "*I am questioning the role of the physiotherapist in this clinic.(…) This is one of the issues that all physios have, there's a bit of a gray zone; although we educate people on the importance of physical activity, this is where one starts to.. the role of the kinesiologist versus the physiotherapist, right? (…) I'm not saying that the physio does not have a role (in prehabilitation). I think, if we're maybe looking at a more, you know, an elderly patient that may have various impairments of different systems, whether it be the Neuro, Resp it may need an evaluation to identify the impairments to provide a therapeutic plan. I think, you know, it [physio] may be indicated… but for all patients? I think that needs to be looked at*."

Supplementary table 4. What are our activities?

Activities	- Inform transition of care by ensuring effective interdisciplinary and interdepartmental communication (n=49):
	  o *Where*: have consults accessible in the patient's EMR, but also indicate in the inpatient paper chart if they have been prehabilitated (e.g., adding a prehabilitation check box on the preoperative clinic form, or printing the prehabilitation summary of care before surgery and placing it in the chart)
	  o *How:* include a consolidated prehabilitation assessment report and individual consults for nutrition, exercise and psychosocial
	  o *What*: chart information about the intervention provided, key baseline indicators that facilitate discharge (e.g., cognition, living arrangement, dependence, support system), and the patient's progress and readiness of surgery in a concise and comprehensive manner
	- Obtain patients' informed consent to participate and promote/enable participation (n=49):
	  o Provide continuous and effective information (vetted by patients) to patients about the program and explain the goal of the program and the measurements performed (e.g., why are we doing this?)
	  o Foster trust by providing quality, patient-oriented care
	  o Facilitate engagement through goal setting and assess and mitigate barriers to program participation (e.g., symptoms management, anxiety and depression management, motivational interviewing, behaviour change)
	  o Involve a caregiver to help with comprehension and retention of the intervention and with compliance.
	- Conduct an initial assessment, and continuous follow up assessments until surgery (n=47).
	  o Post-operative in person visit for follow up assessment (Optional)
	- Prepare patients for surgery by modifying patients' physical, metabolic and mental well-being, and reinforce ERAS recommendations, with the aim of facilitating readiness for discharge (n=43).
	- Individualize the prehabilitation approach based on the following (n=39):
	  o Patient's goals and preferred level of engagement (e.g., from informed to empowered[122]) as assessed by each clinician
	  o Underlying conditions (e.g., surgery type, diagnosis and prognosis, past medical history)
	  o Risk assessment (e.g., functional capacity, nutritional status, risk of complications based on NSQIP surgical risk calculator)

	- Promote prehabilitation penetration by conducting hospital-wide information sessions with all HCPs for awareness and screening education, and to dispel misconceptions (n=36) - Provide the prehabilitation intervention for a defined period of time and stop the prehabilitation intervention according to clearly defined criteria: reaching surgery date, reaching a plateau (maximal progress with resources available), or lack of compliance (n=17). A member of the prehabilitation team (e.g., pivot clinician) should oversee tracking and applying discharge criteria (e.g., monitoring missed appointments with regards to the criteria, and terminating the prehabilitation intervention for patients who fail to comply) - Refer out: refer patients requiring non-prehabilitation services (e.g., patients who smoke to community or in-hospital smoking cessation resources), or who are ineligible or have completed the program (n=13). Similarly, screen for comorbidities requiring medical optimization (e.g., cognition, polypharmacy), and refer patients requiring medical optimization to the preoperative clinic for management by internal medicine (n=13). - Support ongoing and unbiased program auditing and improvement (n=7).
Rationale	- Prehabilitation is a short and intensive intervention for which patients need to buy-in and adhere to generate meaningful outcomes. Prehabilitation staff generally explain to patients the goal of the clinic and reasoning behind the measurements performed, but explanations are not always well understood by patients. Explanations should be provided in a simplified, comprehensive, and personalized manner throughout the prehabilitation process. Patient centered care offered by the clinic's team members helped build patient trust, and hence willingness to participate. - Individualizing the prehabilitation intervention allows for efficient use of clinic resources and is part of patient-oriented care. - Efficient communication is important to prevent duplication of services and ensure adequate transition of care. Most agreed that documentation in the EMR was essential. However, considering limited availability of computer stations on the units, inpatient staff were in favor of also using an in-paper-chart method for rapidly identifying which patients had been prehabilitated such as a checkbox on the preoperative form. - The prehabilitation clinic is not well known to all surgical staff. Misconceptions are rampant amongst HCP. Misconceptions and lack of awareness about the program impede referrals.

	- Decisions to proceed with surgery are made by the patient and the surgeon. The prehabilitation team communicates information about their risk assessment (risk for surgery and/or readiness for surgery).
Items excluded from the model	- Providing direct support to caregivers (n=1) - Inpatient prehabilitation: prehabilitation intervention provided on the ward for patients who require a hospital admission to improve their health and physiological reserve before surgery (n=6). This was excluded from the model because the reality of inpatient care is very much different from outpatient services. It could be considered as a next step for already established clinics.
Exemplar quotes	**Administrator:** "*So I think the initial assessment is necessary in order to establish a good and safe plan*." **Physician:** "*The goal is really to assess these patients, intervene and follow them. Again, it could be done in person the first time, sometimes, if we want to see more patients, some of that can be done remotely*." **Prehabilitation staff: "***The goal of prehab is to physically and mentally prepare patients for the upcoming stress of surgery, which for many is one of the biggest challenges, both physically and mentally, that they may experience*." **Physiotherapist:** "*I believe that teaching is very important so that they're ready for surgery, what to expect. And a lot of times we tell our patients (…) how to stay active going into surgery so that they would have a better result afterwards*." **Physiotherapist (translated from French):** "*People who participated in prehabilitation are more informed about the post-operative trajectory and what they have to do, and they are more independent. (…) A lot of patients are surprised to see a physiotherapist one day after their surgery. They don't think they can move. (…) In my opinion, what is important is first, teaching, and second, really increase the patient's physical capacity and help prepare the patient for surgery and improve outcomes, to finally, help with discharge*." **Administrator: "***I think there are universal recommendations that every patient should be following before surgery. And I don't find currently that we do have the right material for that to promote in hospital. So I think we should be going more to something digital*." **Dietitian**: "*I think for the cancer patients (…) managing symptoms in those four weeks of prehab might be very beneficial to get the most out of the actual prehab intervention*." **Prehabilitation staff:** "*I don't think everyone needs the same prehab because this is not a one-type-fits-all situation. (…) we cannot waste time and energy and hours on patients that don't need to see a dietitian, or they don't need an exercise session two times per week*." **Prehabilitation staff:** "*What also works really well is the in-person, the supervised training, for those people who really need it because not all people are physically inclined to move, don't have the experience, and are anxious and don't know. So the in-person training is a must. It works really well for certain people*." **Dietitian:** "*So I had to prioritize for the follow ups, the ones that were more at risk, or malnourishment, or that have more questions and really wanted that nutritional intervention*."

	Patient: "*I think. If somebody cares about me, I have to listen to them, you know. The people [in prehabilitation], I didn't know. But they cared about me. They taking care about me, and I start listening to everything that they said. (…) They give the advice, they teach me. And I did*." **Prehabilitation staff:** "*So we have some leeway in in how often and when we talked to them, but we are constrained by, by time and by budget because we're not flush with funds in this program*." **Patient**: "*Afterwards we went over the results. everything was explained to me and I saw my improvements. And what I could do more work on, and left on very, very good terms. I like to see results. I like to see where I started to where I came from. Like where I am now, compared to where I came from. They asked me personally [if I wanted to see the results]. Uh some people probably wouldn't care, but I think the fact that they would take the time to sit and explain and go over the sheets with me. Give me again another sense of confidence. I didn't just feel like a number, like a patient just going in and out. It didn't feel like a clinic. If I could say it that way. You wait for 3 hours, you see the doctor for two minutes and then you leave [at other clinics]. Wasn't like that at all [at the prehabilitation clinic]. They took the time. They were friendly. They ask me how I was doing. That's something important."* **Prehabilitation staff:** "*I do see a lot of patients coming here without proper information background, which has to be started from the moment that they sit down with their surgeon."* **Patient:** "*When I first came to the clinic, I didn't know where I was going. [The person doing the assessment] explained to me what [was the purpose of prehabilitation]. It's the explanation that was perfect. Then start the test (…) I was scared. But after their explanation, every question, it was gone. They help me lots. But in the beginning, when I first arrived, I said what's going on?"* **Patient (translated from French):** "*Everything was done with explanations (…) but it's at the end that you understand. (…) There are a lot of explanations, but sometimes it's at the end. It's when I saw the end results that I understood the explanation I received in the beginning."* **Physiotherapist:** "*Unless the patient tells me [they received prehabilitation], I have no idea if they've been followed. I don't know what happens. (…) Like there's no communication*." **Physician**: "*I'm not an expert. So something more in a simplified way … you know, has the patient improved his hemoglobin A1C? Has there been improvement in the anemia or the iron studies or electrolytes, albumin, pre albumin, nutritional support and sort of functional assessment scores. But again, I think something like in a more … (…) simplified format*." **Dietitian:** "*Because prehab, we don't have access to your notes. So that's the part that's unfortunate because we wouldn't know who's followed and who's optimized, in advance. (…) It's only when I would meet the patient that I would find out that they're known to prehab*." **Administrator:** "*I'm not sure if the preop [clinic] gets information about patients referred [to prehabilitation]. So for example, if they made a referral and this patient went to the prehab clinic, then what were the results? It's easy to just send a referral, but then you don't know what happened in the universe with that patient. So at least (…) like a small report*". **Physiotherapist:** "*When they go through the preop clinic, there can be some sort of a checklist, meaning they were referred to prehab. (…) maybe a medical summary or physio summary, like some sort of report, that can be in the patient's chart or [in the EMR]."* **Physician:** "*The other good thing is in the last year or maybe a bit more the prehab program changed how they document their visits. (…) Right now, it's uploaded on the patient's EMR*." **Nurse:** "*[The preoperative clinic] created a tool where we can note it [if the patient is likely to be a complex discharge] and then everybody is aware when the patient has a surgery date (…) the liaison nurse especially, to do discharge planning instead of finding out at the last minute. (…) If*

	we flag them as complex, they'd also try to give that patient a bed on that unit instead of going somewhere they're a little less familiar." **Physician:** "*I haven't sent anyone there [prehabilitation] because I didn't realize that actually it's open to regular [clinic activities]."* **Physician:** "*Our trajectory in terms of the government, is surgery within four weeks. So that is a measure that the Quebec government looks at. And so it kind of precludes sending patients to prehab because we're trying to fulfill the scheduling*." **Prehabilitation staff:** "*Just like ERAS, prehab needs an active auditing system to see where the weaknesses are, what works, what doesn't work and have the data to back that up and to have metrics to improve how we're doing."*

Supplementary table 5. What are the outcomes?

Long-term outcome objectives	Improve value-based surgical care

Long term outcome indicators	**Concepts mentioned by participants**	**Examples of outcome assessments (italics denote suggestions by study researchers)**
	Patient reported outcomes (PROs) (n=38):	
	- **Experience and satisfaction (n=32)**	Questionnaire to be completed at program completion before surgery (e.g., I was able to trust the team, I had more confidence, I felt good going into surgery, I felt the team was cohesive, I felt a connection with the team, etc.). *CAHPS Outpatient, Ambulatory Surgery Survey (OAS AHPS).*
	- **Symptom improvement**	Patient-Generated Subjective Global Assessment (PG-SGA) for nutrition impact symptoms, Edmonton Symptom Assessment Scale (ESAS) for cancer symptoms, Visual Analogue Scale for pain, *Fatigue Severity Scale (FSS), Dyspepsia Symptom Severity Index (DSSI), MD Anderson Symptom Inventory (MDASI), Patient-reported outcomes version of the Common Terminology Criteria for Adverse Events (PRO-CTCAE)*
	- **Anxiety and depression**	Distress Thermometer, Hospital Anxiety and Depression Scale (HADS)
	- **Activity and function**	Dependence for ADLs, Duke Activity Status Index (DASI), Barthel Index, Functional Independence Measure (FIM), *Brief fatigue inventory, EuroQoL five dimensions, five levels (EQ-5D), Community Healthy Activities Model Program for Seniors questionnaire (CHAMPS), Katz ADL Index*
	- **Self efficacy and patient activation**	Patient Activation Measure (PAM), Self efficacy scale
	- **Health-related quality of life (HRQOL)**	*HRQOL questionnaires should include both generic and disease specific.* EQ-5D, Short Form Health Survey (SF-36), *Functional Assessment of Cancer Therapy (FACT), European Organisation for the*

		Research and Treatment of Cancer - core questionnaire (EORTC-QLQ-C30).
	- **Early period of recovery**	*Quality of Recovery questionnaires (QOR-9, - 15, - 40), Abdominal Surgery Impact Scale (ASIS*)
	- **Recovery after hospital discharge**	SF-36 (Physical and Mental Summary Scores), *PROMIS-29 (Domains: anxiety, depression, fatigue, pain and consumption of analgesics, physical function, sleep, social roles), WHODAS-2.0 (Domains: cognition, mobility, self-care, getting along, life and participation)*
	Administrative health care utilization data (n=31)	Hospital length of stay (n=14), ICU length of stay, discharge disposition (home vs rehabilitation or convalescence center), readmissions and emergency visits, length of readmission, postoperative complications, time to readiness for discharge. *patient visits or phone calls to surgeon, general practitioner, or specialist.*
	Cost effectiveness (n=30)	"Numeric savings" from the prehabilitation intervention: cost per patient trajectory, and cost difference between prehabilitated vs non-prehabilitated patients.
	Workload for inpatient staff (n=28)	Direct patient activities (nursing, dietitian, physiotherapists, etc.), indirect patient activities (time required to screen and prioritize patients, charting time,) # of people required to mobilize the patient.
Short- and medium-term outcome objectives	- Increase patient knowledge related to exercise and nutrition. - Support increased knowledge of perioperative ERAS recommendations and recovery milestones. - Behaviour changes related to exercise, nutrition, and mental well-being. - Increase physical, metabolic, and mental well-being. - Improve patient engagement/activation. - Alleviate inpatient resources including clinician workload. - Promote safe and fast hospital discharge postoperatively. - Improve recovery outcomes (including return to normal health and ADLs postoperatively for patients).	

	Concepts mentioned by participants	Examples of outcome assessments (italics denote suggestions by study researchers)
Short- and medium-term outcome indicators	**Patient reported outcomes (PROs) (n=39)**	- Similar to PROs listed above
	Clinical outcomes (n=44)	- Change in objective physiological measures: laboratory values, blood pressure, blood oxygenation, heart rate. - Change in clinical metrics (e.g., diabetes mellitus, hypertension, or dyslipidemia medication dosage). - Change in cognition: Montreal Cognitive Assessment (MoCA). - Medical, surgical outcomes (n=34): LOS (n=15), post-operative complications, *time to readiness for discharge, days alive at home.*
	Physical and functional outcomes (n=30)	- Endurance (e.g., 6 minute walk test, timed-up and go test, short physical performance battery), balance (e.g., Berg balance test, short physical performance battery), strength (e.g., arm-curl, sit-to-stand, grip strength), patient reported activity (see above under *Activity and Function* of PROs), and cardiopulmonary exercise testing (CPET) if available for high risk patients, or as requested by the surgeon, pulmonary function tests - Meeting physical activity guidelines such as those of the WHO (e.g., 150–300 minutes of moderate-intensity aerobic physical activity per week)
	Behaviour change (n=25)	- Physical and functional, and nutritional outcomes (see sections *Physical and functional outcomes* and *Nutritional outcomes)* - Meeting patient defined goals - Compliance measures (see *Feasibility and Fidelity* section under *Process Indicators*) - Behaviour change assessment (e.g., University of Rhode Island Change Assessment Scale (URICA)), or reduction of barriers through barrier questionnaires based on a behaviour change model (e.g., Capability Opportunity

		Motivation model of Behaviour change (COM-B))
	Nutritional outcomes (n=16)	- Weight, body composition (BIA, DXA), malnutrition assessment measures (e.g., PG-SGA), nutrition impact symptom assessment (e.g., PG-SGA), dietary intake assessment measures (e.g., 24hr recall, *diet quality check list*, FFQ).
	Key baseline indicators and social history demographic (n=13)	- Living situation, dependence for ADLs, *employment, Health literacy (e.g., Brief Health Literacy Screen)*
Process objectives	- Create a therapeutic alliance between HCPs and patients and their caregiver. - Provide individualized, risk stratified, quality multimodal prehabilitation care to high-risk surgical patients. - Follow criteria for inclusion and for terminating the intervention. - Promote patient adherence to the prehabilitation intervention. - Improved awareness of preoperative preparation and prehabilitation amongst HCPs. - Increased hospital-wide referrals of high-risk patients to prehabilitation. - Improved communication with referring HCPs, patients, and hospital staff.	
Process indicators	**Concepts mentioned by participants**	**Examples of outcome assessments (italics denote suggestions by study researchers)**
	Adoption, penetration and sustainability (n=47)	- Observational measure of therapeutic alliance (e.g., Working Alliance Inventory) - # of patients referred from each referring hospital site, # of referrals from each eligible department - # of clinics referring
	Acceptability and appropriateness (n=40)	- Stakeholder satisfaction and experience, including satisfaction about services provided, and communication - *Knowledge tests to assess patients' knowledge of preparation for surgery and ERAS recommendations.*
	Implementation cost (n=38)	- Cost of staff salaries - Cost of equipment and material, processes, and rent.

	- Cost of maintenance
Feasibility and fidelity (n=26)	- **Adequacy of the work environment** (safe, supportive, collaborative, stimulating): ▪ employee satisfaction ▪ employee turnover rate and absences (e.g., sick days) ▪ *exit questionnaires at employee departure.* - **Respect of inclusion criteria and target population**: ▪ # of appropriate referrals, ▪ % of patients followed that meet inclusion criteria ▪ % of high- and moderate-risk patients followed by the clinic according to the assessment - **Respect of termination criteria**: ▪ *# of patients discharged and reason for discharge (e.g., surgery, no longer surgical candidate, patient refuses to continue, poor compliance)* ▪ *# of prehabilitation patients who had surgery, # of those who did not have surgery (and reason for not having surgery)* - **Capacity**: ▪ # of patients seen at the clinic over time ▪ *# of in-person appointments, # of tele-consult appointments,* ▪ *clinician statistics (hours worked, % clinical time met)* - **Dose or amount of program delivered to patients**: ▪ *average length of the program,* ▪ *average # of appointments with each clinician received,* ▪ *# of total appointments attended vs scheduled /missed, # of total appointments cancelled/postponed* - **Patient compliance and adherence**: ▪ *Dropout rate (and reasons for drop-out)*

	▪ *(# of patients that came to their post-operative appointment (and reasons for not coming)* ▪ Exercise compliance: 1) supervised exercise compliance (exercises completed as intended, not only "session compliance" attendance), 2) self-reported home-based exercise compliance (e.g., exercise logbook/journal), 3) technology (e.g., smartwatch) ▪ Nutrition: 24hr recall/food records, diet quality score (e.g., Healthy Eating Index), % of estimated energy and protein requirements met. ▪ Patient well-being: anxiety and depression score, QOL. *# of days (delay) between surgical visit and patient's first prehabilitation appointment, # of days (delay) between referral received and patient's first prehabilitation appointment.* - *# of training sessions conducted with HCPs* - *% of referrals made by prehabilitation to other clinics and community resources when required*
Rationale	- Strong connections are established with patient as a result of the time and patient centered care provided. - Patients cared about the experience more than any other outcomes. - Satisfied patients are more likely to be compliant. - Caregivers feels indirectly supported when their loved ones are cared for by prehabilitation. - Inpatient focus is about facilitating discharge. - Improving communication with hospital staff by providing more effective and timely information about the patient history, baseline status, and the prehabilitation intervention received will contribute to alleviating charting workload and will shape clinical practice differently for inpatient.
Exemplar quotes	**Physician**: "*So we look at all of the physical markers, we look at all of the quality of life markers. That's a big one. And then we look at all of the outcomes from surgery*." **Physician**: "*Important outcomes for sure is the length of stay and the complications. I think that's the composite outcome you have to study. (…) You can also study how the patient feels because sometimes I mean, if they get fitter, even if I don't decrease the length of stay or I don't decrease the percentage incidence of complications, but they feel better, that's already a plus. So you your intervention is already making*

somebody healthier, happier and more functional. So it's for sure, first, clinical outcomes, but then also, let's say, well-being."

Physician: "*So for the pain ratings the BPI, the brief pain inventory, is good enough. For the medication, they are not very, they are not very strongly validated research tools to compare before and after pain medication.. But there are some … if it's about pain, if it's about the opioids, one possible research item is morphine equivalent daily dose*."

Physician: "*Does the patient feel that there was a benefit. To me, that's kind of a big indicator of success. And that's what I hear often from patients is they say 'I felt like that really helped me. I felt like I gained a lot of strength before my surgery. I felt like my breathing was better. I'm still using those exercises and that makes me feel better."*

Physician: "*If you can get people out of the hospital quicker, and maybe the other thing is a lot of people, after they'd left the hospital, they'd go to a rehabilitation facility. If they could get back to a good physical state quicker, then they won't have to be transferred to rehab, because that also lengthens hospital stay. You have a patient sitting around in the hospital waiting for a bed in rehab*."

Physiotherapist: "*We look at endurance a lot. (…) So, for example, it can be a six minute walk test, that can be a therapeutic target. And we want to increase that target endurance. We can be looking at balance, which is a Berg balance test, and we want to look at it would make a change there."*

Prehabilitation staff: "*We can divide it into the recovery phases. So if we look at early, intermediate and late recovery phases*."

Occupational therapist: "*I don't know what level of function you assess [at prehabilitation], if it's mobility and transfers, but for us, we we're assessing the way they're grooming, bathing, dressing, including their mobility and transfers. we're also assessing what we call instrumental activities of daily living. Can they manage their medications? Banking, cleaning, you know, managing their home, returning to work/school, whatever the case may be. So you know that's the level of function that we're assessing. (…)So that is helpful [to see the physical function tests from the prehabilitation clinic]. But you know there are tools out there that put all that information in a way where you get a meaningful score, and the score determines if they're fully independent, they require some supervision, or they require some assistance at home. The functional independence measure is one. FIM it's called. There's the Barthel for geriatric patients as well; we would just need to validate what would be the most sensitive one for this clientele*."

Inpatient nurse: "*When it comes to you're going to rehab or to convalescence, there has to be a spot. So some people could be ready for discharge to rehab, but they're here [in hospital] for like a whole bunch of extra days just because of that."*

Administrator: "*How do you put that "hey, you did a great job" into a document or in numbers? It has to be a close monitoring and reassessment, like exit questionnaires when a patient trajectory is completed, like how satisfied you are with our service and for the same patient from the surgeon point of view, how satisfied they are with the job that you did with the patient*."

Administrator: "*Discharge management and discharge planning, because that's a big aspect for nurses, but also for the organization and what we're looking into [as managers]. So how does prehabilitation help in terms of promoting discharge planning. I think that also can be a good way to show (…) how [prehabilitation] reduces cost at the end*."

Administrator: "*If I'm talking as a manager, one of the surgical outcomes, is the length of stay in the hospital. Numbers are good, but the quality indicators as well are important for me. (…) So usually in the surgical unit, they have those patient experience."*

Dietitian: "*It would be way easier if we have all the data already in the system. You know like height, weight*."

Physiotherapist: "*The patient is a little bit more prepared [post-operatively, when they've received preop teaching] (…) They're staying less in hospital, they know what to expect, they come in more prepared, so they're effectively, recovering more quickly. And so I think that helps a lot*."

Physiotherapist (translated from French): "*Also they [prehabilitated patients] get their leave faster than others. (…) the people who participated in your program are more informed about what happens after surgery and what they should do, and they are more independent."*

Physician: "*When I see a patient in pre-op clinic or the night before their surgery (…) and I see they've gone to the prehab, and I say 'Oh, great, because they've done a lot of the history for me.*'"

Administration: "*Is there a numeric savings on that, whether it be on cost or patient bed days, or satisfaction, or is it the same whether there is a pre intervention assessment or not when you compare with a group that doesn't go through your Clinic?"*

Physiotherapist: "*Would you decrease the work? (…) Will it change the work of a physio? If you're better off post-op, it will be easier to transfer you and make you walk. Intuitively, that's what I would think. (…) How many people do I need to get a person up. It will make a difference in my day if I don't have to go find a PAB or a nurse or somebody to help me, if I can get you up by myself*."

Patient: "*It's the support that they give you.*"

Patient: *"[And what was your goal with the prehab program?] Um exactly what I got out of it. Just kind of a little bit of guidance, a little bit of motivation um, to get a little bit stronger and to give me direction. I think that's what they did the most, is that they gave me some direction of what I needed to do, how to get back on track*."

Patient: "*The teamwork is well done. It motivates you, it gives a good... Because everything falls into place, everything is better and prepares the patient."*

Prehabilitation staff: "*Everybody with the same goals and working together. And also for the patient, they feel it. The patient feels when they're in the hands of a of a united team*."

Prehabilitation staff: "*I think the frail study we're working on is once per week [in-person appointments]or we do it on zoom as well, which is great for the individual because they're older, they rely heavily on family members and sometimes it's the family members who are driving them around, and when we can say we can do zoom they go "oh great!" They'll just put zoom on sit back and have a cup of tea. That's important. And, you know, we always have to support the caregivers, the family members, they live around*."

Administrator: "*Definitely, if patient satisfaction improves, and the quality of the care is improved, then I'm interested."*

Prehabilitation staff: "*Depending on whatever your outcome is, which is usually quality of recovery or quality of life, they are usually done at 30 days, six months most of the time, and that could be something that can be done by patients, at home, online, they don't have to come in and it helps us capture outcomes*."

Administrator: "*I have quality performance indicators, but they are established really related to time. It's related to transfer, audits that are done. So if I'm talking about the pre-op clinic, it's really how many patients we are seeing, how many they are seeing by phone, some demographic. That is mainly the indicators that we are seeing."*

ADLs: activities of daily living.