



Feasibility of Intradialytic Cycling Program in a Remote Community Hemodialysis Unit: Mixed-Methods Analysis of Implementation

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Abstract

Background: There is growing evidence demonstrating the benefits of intradialytic cycling. However, there are relatively few centers where this practice has been adopted with no reports from hemodialysis units in rural, remote, and northern locations. Maintaining mobility and quality of life for patients on kidney replacement therapy living in remote northern communities is inhibited by inclement weather and lack of access to resources and infrastructure that support physical activity. The integration of intradialytic cycling during hemodialysis offers patients a form of safe physical activity year-round.

Objective: This study focuses on better understanding the feasibility and acceptability of implementing intradialytic cycling in a remote northern geographical context.

Design: A feasibility study using a mixed-methods explanatory design was adopted for this study.

Setting: The research is conducted in Prince George, British Columbia.

Participants: The participants are patients attending a community-based dialysis unit in remote northern British Columbia and health professionals working in the same facility.

Methods: Quantitative measures were captured through cycling logbooks and quality of life measure, and qualitative data were obtained through semi-structured interviews and analyzed using thematic analysis.

Results: Six (43%) eligible patients used leg ergometers more than once for a median of 2.5 (interquartile range: 1–4) months and 87% of hemodialysis sessions. Participants cycled for a median of 65 (interquartile range: 39–76) minutes per session, with frequent variability noted between participants and different hemodialysis sessions for the same participant. Nine patients completed the European Quality of Life Health Questionnaire prestudy, with 5 (56%) also completing it poststudy. Interviews with 9 patients, 4 nurses, and 1 physiotherapist led to the identification of themes instrumental to implementation: a supportive community dialysis unit, shared responsibility, knowledge of patients/providers, and benefits associated with engagement. Themes that were identified as being key to acceptability in this remote dialysis unit were trust, connection, and engagement through common values.

Limitations: Due to dialysis unit size, we had a small number of participants.

Conclusions: This study demonstrates the feasibility of implementing best practice in a remote community and provides insight into the elements of context and participation that contribute to acceptability in the implementation of intradialytic cycling.

Abrégé

Contexte: De plus en plus d'études attestent des bienfaits du cyclisme intradialytique. Relativement peu de centres ont cependant adopté cette pratique et aucun rapport ne fait état de son intégration dans les unités d'hémodialyse des régions rurales, éloignées et nordiques. Dans ces communautés, les conditions météorologiques défavorables et le manque d'accès aux ressources et aux infrastructures encourageant l'activité physique sont une entrave au maintien de la mobilité et de la qualité de vie des patients sous thérapie de remplacement rénal. L'intégration du cyclisme intradialytique permettrait aux patients de pratiquer une forme d'activité physique sécuritaire à longueur d'année.

Objectifs: L'étude examine la faisabilité et l'acceptabilité relativement à l'instauration du cyclisme intradialytique dans l'unité d'hémodialyse d'une région géographique nordique éloignée.

Type d'étude: Étude de faisabilité à visée explicative utilisant une méthode mixte.

Cadre: L'étude est menée à Prince George, en Colombie-Britannique.



Participants: Des patients qui fréquentent une unité de dialyse communautaire dans le nord de la Colombie-Britannique et des professionnels de la santé qui travaillent dans le même établissement.

Méthodologie: Les mesures quantitatives ont été saisies au moyen de carnets de bord de cyclisme et de mesures de la qualité de vie. Les données qualitatives ont été obtenues au moyen d'entrevues semi-structurées et analysées à l'aide d'analyses thématiques.

Résultats: Les résultats portent sur les six (43 %) patients admissibles ayant utilisé une bicyclette ergométrique plus d'une fois pendant une médiane de 2,5 mois (intervalle interquartile: 1-4 fois) et 87 % des séances d'hémodialyse. Les participants ont pédalé 65 minutes en moyenne (intervalle interquartile: 39-76 minutes) par séance; de fréquentes variations ayant été observées entre les participants et entre les différentes séances d'hémodialyse pour un même participant. Neuf patients ont rempli le questionnaire européen sur la qualité de vie et la santé avant l'étude et cinq patients (56 %) l'ont fait après l'étude. Des entrevues avec neuf patients, quatre infirmières et un physiothérapeute ont permis de dégager les thèmes essentiels pour l'instauration du cyclisme intradialytique: un environnement favorable dans l'unité de dialyse communautaire, une responsabilité partagée, la connaissance des patients/fournisseurs de soins et les bienfaits associés à l'engagement. Les thèmes jugés essentiels à l'acceptabilité dans l'unité de dialyse examinée étaient la confiance, l'établissement d'une bonne relation et l'engagement par le biais de valeurs communes.

Limites: La taille de l'unité de dialyse explique le faible nombre de participants.

Conclusion: Cette étude démontre qu'il est possible d'instaurer de meilleures pratiques dans une communauté éloignée. Elle donne également un aperçu des éléments de contexte et de participation qui favorisent l'acceptabilité du cyclisme intradialytique.

Keywords

hemodialysis, intradialytic cycling, intradialytic exercise, remote setting, feasibility

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Introduction

Widespread availability of hemodialysis (HD) has enabled patients with kidney replacement therapy (KRT) to receive long-term treatment.¹ However, a huge burden of symptoms remains a major challenge for quality of life in patients on KRT.² A recent qualitative study involving patient groups undergoing HD identified a prioritized need for interventions to improve quality of life associated with symptoms such as fatigue, muscle cramping, body aches, and depression.³ Intradialytic exercise (IDE) has shown promising outcomes in improving both quality of life and physical function for patients on KRT.⁴ Currently, IDE is predominantly available in large urban centers.⁵ The higher prevalence of KRT in remote and northern communities⁶ necessitates exploring the feasibility of implementing intradialytic cycling (IDC) in these regions.

While elderly patients on KRT are most interested in finding solutions to improve energy, strength, and maintenance of independence, younger patients seek wellness to improve

candidacy for transplant but identify lack of time, availability of fitness facilities, and associated costs as potential barriers to regular exercise.^{7,8} These barriers are further exacerbated for patients living in remote and northern communities where adults tend to be less physically active, face more social and cultural isolation, and have less access to wellness and physical activity programs.⁹ The term *northern* is most frequently used to describe the geographical land-mass north of the 60th parallel. However, for the purposes of this study, "northern" describes a provincial region situated more than 800 kms north of the more populous metropolitan regions to the south.

Abnormalities in muscle function are common in patients with chronic kidney disease (CKD), resulting in significant effects on physical function.¹⁰ This process is exaggerated in KRT and leads to significant functional decline after starting HD.¹¹ In addition to uremia, chronic inflammation, and malnutrition, HD procedures and concurrent illnesses all lead to fatigue, inactivity, and functional decline.¹² The consequential decrease in physical performance is associated with

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frailty and with higher mortality in patients with CKD.¹³ Patients on KRT experience twice the number of falls per person-year, which compared with patients not undergoing dialysis carries 4 to 5 times risk of hip fracture and 2 to 3 times risk of mortality.^{14,15}

Recently, many studies have shown the importance of exercise or regular physical activity to prevent muscle wasting in patients on KRT.¹⁶ Exercise improves many indicators of physical functioning, subjective mood, and reported quality of life in patients on KRT.¹⁶⁻¹⁸ In addition, considering that cardiovascular disease is the major cause of death in patients on KRT, exercise and regular physical activity have the potential to reduce cardiovascular risk by modulating blood pressure and improved efficiency of HD.^{19,20} Studies have shown benefits of using both intradialytic and interdialytic exercise programs, and their positive effects on physical function and symptoms.²¹ Cycling during HD was associated with higher adherence than an exercise program administered outside of HD.^{22,23}

Availability of a supported IDE program is highly valued by both patients and health professionals although there are concerns related to impact on health professionals' workload and workflow due to limited resources.²⁴ These programs are largely available and reported based on experiences from large urban and tertiary hospital settings.⁷ Meanwhile, it has previously well documented that rural, remote, and northern areas have a smaller range and number of health professionals and that these have increased workloads while also having decreased educational opportunity and access to professional support.²⁵ The existing gap in the literature on implementing and sustaining IDE programs in HD units located in smaller sites and especially in rural, remote, and northern communities needs to be further explored to better understand whether and how such programs can be deployed within such a different medical landscape. As is pointed out by the Canadian Rural Road Map Implementation Committee, "Policy decisions are too often guided by urban health care models without understanding the potential negative effects in rural communities. Rural communities need rural-based solutions and to develop regional capacity to innovate, experiment, and discover what works" within their realities.²⁶

Using explanatory mixed methods, this feasibility study aimed to address the gap by implementing an IDE program in a remote community-based dialysis unit (CDU) and collecting data on both participation and experience by users and staff. The domains of interest for feasibility of this study included acceptability, adherence, and tolerability from the patients' perspective while also evaluating the acceptability and impact on workload from the health professionals' perspective. Furthermore, this study seeks to explore the key factors that promote and those that hinder the implementation of the IDC program. By having access to the results of a study conducted in a setting that reflects the rural and remote realities of providing health care, we hope that it will help

increase access to programs for those receiving KRT in rural, remote, and northern communities and offer a means to improve quality of life and well-being.

Material and Methods

Study Design

An explanatory mixed-methods feasibility study was utilized to better understand, from both patient and health professional perspectives, the acceptability of implementing IDE programs in a remote northern community setting. This research was informed by the knowledge translation framework Promoting Action on Research Implementation in Health Services Framework (PARIHS) that focuses on 3 key elements necessary for successful implementation of research into practice: (1) level and nature of the evidence to be used, (2) the context in which the research will be implemented, and (3) the facilitation necessary to enable the implementation of the research.²⁷ Building on the existing evidence of the effectiveness of IDC, this study focused on the latter 2 elements. To do so, a mixed-methods approach in feasibility studies allows researchers to identify the challenges and facilitators of implementing a novel intervention through the inclusion of qualitative methods that capture the complexity and nuances of the new context,²⁸ in particular to this study, the remote setting.

Quantitative data were captured using a cycling logbook and quality of life measures, whereas qualitative data on acceptability were obtained through semi-structured interviews. Each phase of data collection occurred sequentially and data from each method were analyzed separately, as in an explanatory approach to mixed-method research design.²⁹

Study Population

Fourteen medically stable patients on KRT on HD attending a CDU in remote northern British Columbia were invited to participate in this study alongside health professionals working in the same facility. Figure 1 illustrates distribution of study participants. The CDU is located 800 km from the nearest tertiary care center. Recruitment was conducted via posters and leaflets provided to all the patients in the CDU. Patients were excluded from participating if they were younger than the age of 19, not a patient at the CDU, experiencing an acute infection, had unstable heart disease (including bradycardia or tachycardia at rest), or were advised by a physician not to participate in physical activity. All patients were naïve to IDE. All health professionals working in the CDU were eligible to participate in this study.

Approval was obtained from the University of British Columbia's Clinical Research Ethics Board (Ethics certificate H17-00673) and written informed consent was obtained from all participants prior to the start of the study. Enrolled participants were not remunerated.

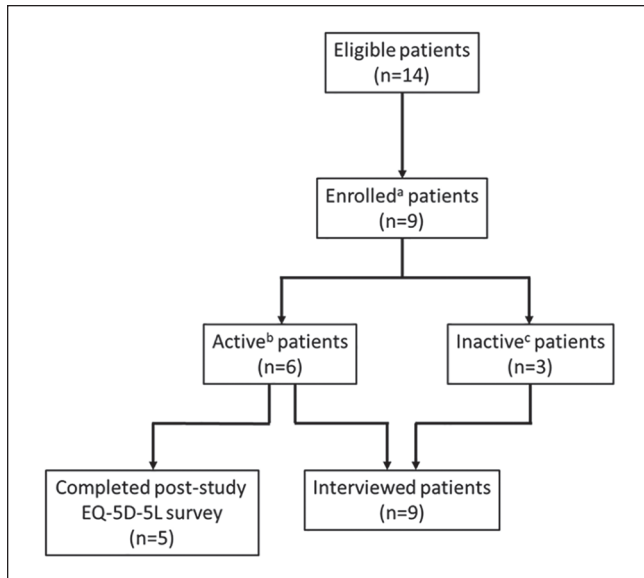


Figure 1. Flow diagram of patient participants.

^aCompleted prestudy EQ-5DL-5L survey.

^bCycled more than once.

^cCycled once (n = 1) or did not cycle (n = 2).

Materials

Each HD machine was assigned a leg cycle ergometer (Monark 881E Rehab Trainer, Monark Exercise AB, Vansbro, Sweden). To ensure patients were properly positioned to use the ergometer safely and comfortably, backrests and anti-slip mats were made available as needed. All participants received a 1-page summary of precautions/contraindications to exercise from kidney.org adapted by our research team. In addition, participating patients were provided with a cycling logbook and 2 copies of the European Quality of Life (EuroQual) Health Questionnaire (EQ-5D-5L™) to be completed at the beginning and end of a 3-month trial. Materials for the interviews consisted of a lapel microphone and an audio-recording device.

Study Procedure

The research team (M.E.K. and R.K.R.) provided a catered 1-hour orientation session to the health professionals (nurse, dietician, pharmacist, social worker, etc.) working within the CDU to introduce the study and demonstrate use of the cycle ergometers. A 1-page summary of the study, including the purpose, procedure, and responsibilities, was distributed to all present. Health professionals were asked to (1) collect questions about the study and cycling, and pass these along to the physiotherapist or study team members, as appropriate; (2) motivate/encourage patients who were cycling and help with cycle set up, if necessary; (3) check in with patients who were no longer cycling to see whether they were experiencing difficulties; and (4) reflect on challenges or additional

work with having cycling available in the CDU. Being aware that the introduction of new interventions within the CDU can increase workload on health professionals, the study was purposefully designed to attempt to minimize such demands. However, the intervention was also not meant to be entirely patient-driven. Instead, we aimed for a shared collaborative process from the onset.

Enrollment of patients was ongoing for 6 months with an expected duration of participation of at least 3 months. All patients in the CDU were scheduled to dialyze for 4 hours and received standard medical care. The study protocol permitted participants to cycle during the first half of the HD period (ie, first 2 hours).

To conduct this study, a community physiotherapist was hired to (1) review and explain benefits of IDC; (2) enroll study participants; (3) determine the appropriate leg cycle ergometer settings for participating patients; (4) provide in-person and phone consultations with participants, if requested; and (5) visit the CDU twice weekly to answer questions and troubleshoot problems brought up by either participating patients or health professionals. The physiotherapist shared any reported or perceived concerns with the research team.

Enrollment for both patients and health professionals consisted of signing an informed consent form and reviewing the 1-page summary of precautions/contraindications to exercise. In addition, participating patients filled out the EQ-5D-5L survey as part of the enrollment process. The EQ-5D-5L is a standardized self-report measure tool that was selected for its ease of administration and has been shown to be sensitive to low levels of health.³⁰ Participating patients were asked to complete the EQ-5D-5L at enrollment and approximately 3 months following their individual enrollment date.

Participating patients received a logbook. If they cycled during a HD session, they were instructed to record the times at which they started and stopped cycling, along with an intensity level determined by referring to the Rate of Perceived Exertion (RPE) BORG Scale³¹ that was included as reference in the logbook. If participants did not cycle, they recorded the reason why they did not cycle on that day. Thus, the logbook captured frequency, duration, and intensity of cycling for each participant for each HD session. Completion of EQ-5D-5L and logbooks was done by patients while at the CDU.

Semi-structured interviews with participants were conducted in-person by a research assistant. The research assistant was a female medical student with a BHSc who had previous experience in interviewing health professionals and health professions learners. She volunteered to join our research team as part of a medical school scholarship course requirement and was interested in qualitative research and knowledge translation. The research assistant was briefed by the authors on how to perform semi-structured interviews. She had no prior relationship with the study participants.

The interviews were conducted as close to the end of an enrolled patient's participation in the study, and at the end of the study with enrolled health professionals. Interview questions were developed iteratively by our research group members (M.E.K., R.K.R., and A.S.) (Supplemental Materials 1 and 2). Enrolled patients were asked to describe their experience with respect to (1) learning about the use of cycle ergometers during HD, (2) utilizing the leg cycle ergometer, and (3) the effect of cycling on day-to-day function. Enrolled health professionals were asked about (1) their experience with the implementation of leg cycle ergometers for HD patients in their work environment and (2) their perspectives on facilitating the change in practice. Interview questions and guides were developed to capture participants' experience with the implementation of this intervention within the context of a CDU setting. The interview questions were not piloted as the general topic that they addressed were of greater importance and interest than the precise question. The research assistant was aware of that modification was allowed to obtain a full response to the underlying topic of each question. Interviews were conducted once with each participant one-on-one at the CDU in a private room. Minimal notes were taken during the interview so as not to interrupt the flow and eye contact. Interviews with health professionals lasted approximately 20 minutes, whereas those with patients lasted approximately 15 minutes with participants and 9 minutes with nonparticipants. At the start of each interview, the research assistant would introduce herself to the interviewee and explain her current status as a medical student, her role on the research team, and the overall purpose for the interview. Detailed transcription was performed by the same research assistant who conducted the interviews and all transcripts were reviewed by 1 of the authors (M.E.K.) for accuracy. Transcripts were not returned to participants for comment or correction.

Formal detailed cost analysis was not undertaken. Six leg ergometers were purchased by the research team at the cost of CA\$2839 per cycle and further CA\$2462 were spent on hiring a part-time community physiotherapist.

Analytic Methods

Quantitative feasibility measures, including eligibility, recruitment, retention, and adherence, were calculated. Adherence was captured using a cycling logbook. Data from the logbooks were analyzed using descriptive statistics for the duration of participation in the study out of the expected 3 months, and for the frequency, duration, and intensity of cycling on the leg ergometers. In addition, EQ-5D-5L data were analyzed for pre/post changes in the 5 dimensions and global scale to reflect a measure of health-related quality of life.

Qualitative data analysis was conducted in 2 parts: first, a deductive process informed by O'Cathain et al³² guide for feasibility studies and, second, an inductive process

following Braun and Clarke³³ thematic analysis to consider the role of context in implementation. Initially, the transcripts were individually read and reread by all 3 of the authors (M.E.K., R.K.R., and A.S.) to gain familiarity. Subsequently, informed by O'Cathain et al,²⁸ transcripts were coded using a priori codes of acceptability, challenges to implementation, practicality of implementation, and expansion.³⁴ Coding was done using QSR International's NVivo 12, a qualitative data analysis computer software package. The authors reviewed their individual coding during face-to-face meetings, at which time discrepancies in coding were discussed, alternate understandings were conferred and settled by consensus.

To better understand the feasibility of this intervention, capture the influence of context,³⁵ and provide recommendations for future implementation in other rural, remote, and northern settings, a second-order analysis was conducted using thematic analysis by looking across the coded data retrieved in the earlier deductive analysis for patterns and identifying new themes that described and organized the experiences and perceptions of participants with regard to implementation. Reviewing the themes and defining and naming them coincided with interpretation³³ of the features considered as crucial for implementation of IDC. A concept map³⁶ was then drawn to illustrate the elements and relationships that were exclusively related to the implementation in a remote and northern community context. Participants did not provide feedback on the findings. To establish confirmability, the concept map and themes were then checked against the transcripts to verify interpretations were found in the original data. This article adheres to the Consolidated Criteria for Reporting Qualitative Research (COREQ) reporting guidelines. Quantitative and qualitative data were analyzed separately with the qualitative results being interpreted to further explain the data collected through the quantitative measures.²⁹

Results

Quantitative Results

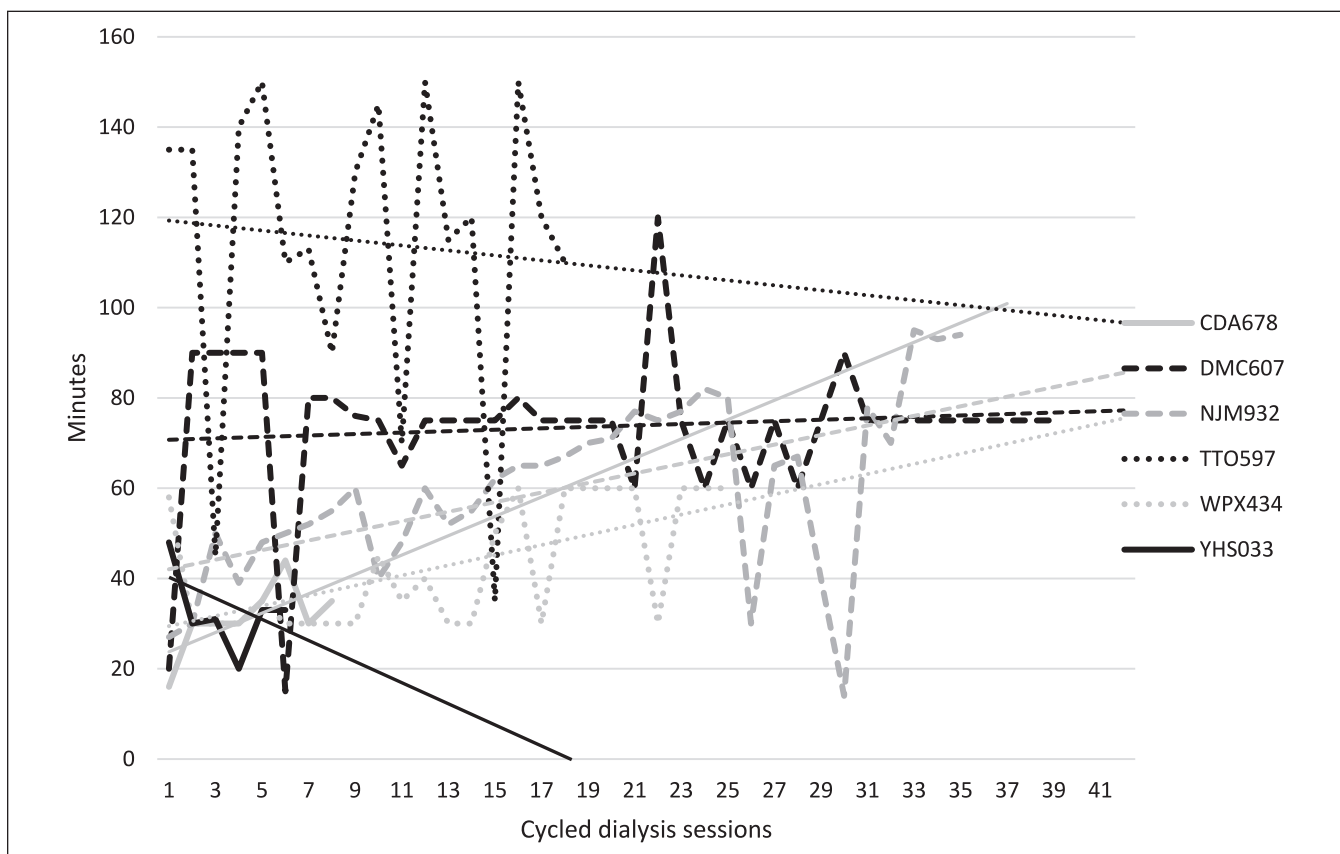
Of 14 eligible patients, 9 were enrolled in this study (64%); of those, 2 never cycled, 1 cycled once, and the remaining 6 patients (3 males) cycled more than once. The patient participants that cycled more than once were between the ages of 62 and 85. Of these participants, 5 were Caucasian and 1 was Métis. The 3 patients (1 male) who enrolled but did not cycle or cycled only once were within the same age range and all were Caucasian. Table 1 shows a summary of feasibility measures for this study, including eligibility, recruitment, retention, and adherence.

Further exploration of adherence parameters shows that participants were active for a median of 2.5 (interquartile range [IQR]: 1-4) months of the expected 3 months of participation and cycled during a median of 94% of the HD sessions that they attended (IQR: 70.5-100). Participants cycled

Table 1. Summary of Feasibility Measures.

Feasibility measure	Definition	Result	Notes
Eligibility	% patients meeting eligibility criteria	100% (14/14)	CDU patients are generally more medically stable patients than those undergoing treatment in the hospital HD unit
Recruitment	% patients recruited from total eligible	64% (9/14)	Patients who completed a prestudy EQ-5D-5L survey
Retention	% patients who cycled ≥ 1 time	78% (7/9)	
Adjusted retention	% patients who cycled > 1 time	67% (6/9)	
Adherence	% patients who completed $\geq 50\%$ of 3 months of cycling	67% (4/6)	Patients enrolled for an expected duration of participation of 3 months

Note. CDU = community dialysis unit; HD = hemodialysis.

**Figure 2.** Linear regression trends for duration of cycling in minutes during each hemodialysis session at which patients cycled.

for a median of 63.5 (IQR: 39-76) minutes per session at an average Perceived Exertion Scale of 3, which corresponds to an “easy” rating described as a light rhythmic breathing that can be maintained for hours. Table 2 shows the descriptive statistics obtained from logbook data from the 6 participating patients that cycled more than once.

It was incidentally noted that logbook entries were not made for a median of 20.1% of HD sessions (IQR: 0-28.3). During the data analysis, such empty entries were assumed to signify that a participant did not cycle on a given day

although there was no way to find out retroactively whether this was the case and, if so, for what reason. Based on the log entries from patients who did write down reasons why they did not cycle on a given day, the reasons most commonly noted were feeling unwell, being tired, and having pains related to other medical conditions.

Figure 2 illustrates the variability of time spent cycling during each HD session where a participant cycled. There was generally variability in the amount of time cycled, both between different participants and between different sessions

for the same participant. There was a slight increase in the amount of time spent cycling over the duration of the participation in the study for 4 of the 6 participants.

Nine patients completed the EQ-5D-5L survey prestudy with 5 (56%) also completing it poststudy (see Supplemental Material 3). Self-care and anxiety/depression were the only 2 dimensions where all 5 participants reported having “no problems.” Patients ranked themselves on the global scale prestudy at a median of 75 (IQR: 60-80) and poststudy at a median of 80 (IQR: 50-85).

Qualitative Results

A total of 9 patient participants, 4 nurses, and 1 physiotherapist were interviewed at the conclusion of the study. Given the goal of our study, we elected to include interviews with 2 patients who did not cycle at all and 1 patient who only cycled once, so that reasons that prevented participation were also captured. While there was variation in the understanding of the purpose and the overall benefit of IDC, both patients and health professionals were positive about the experience. A number of themes instrumental to the implementation of IDC were conceptualized from the inductive second-order analysis: The supportive environment within the CDU was identified as the ground through which the themes of Trust, Connection, and Engagement through Common Values flourished and nurtured acceptability through the themes of Shared Responsibility, Know your Patient/Provider, and the Benefits of the implementation of IDC in this remote CDU. Each of the themes is described below with illustrative quotes and the interconnection of these groupings illustrated in the concept map at the end of the Results section.

Supportive CDU environment. From the perspectives of both nurses and patients, the CDU was described as a very supportive environment in which to introduce a novel intervention and illustrated the elements of a learning organization. A small physical space staffed by a small number of consistent health professionals with regular patients facilitated communication about the project, allowed for greater responsiveness to changes or challenges, and created a general sense of openness and acceptance to the implementation of a best practice. Nurse 582 stated, “. . . [it’s had a] positive effect . . . [on] patients, and . . . it hasn’t really affected our workload in any way . . . I would jump on board with it all over again.”

Nurse participants also described the organizational supports they received to facilitate the project, such as managers attending information sessions and showing interest in the project. Nurse 592 said,

I think that was important to show how we [can] include everyone, the physio, the researchers, the nurses, . . . the manager, and so on and we . . . figured out . . . our different roles in it. And I think that’s important . . . [that] it was well defined

[and] well setup. The equipment . . . [and] the information was there. I think it rolled out very well.

This, in turn, motivated nurses to support patients to participate in the study. Patients and health professionals alike described how the friendly supportive nature of those working in and attending the CDU fostered an openness and willingness to try something new that had possible potential benefits.

Trust and connection. Patient participants described a definite trust in their health professionals and having a clear connection to them which offered security in participating in an initiative, sometimes without a full understanding of the benefits of participating. When asked whether hearing about the benefits of cycling had an impact on their participation, Patient YHS033 said,

. . . Not sure [laughter] actually to be honest. I’m not sure . . . Yeah, . . . actually it does, . . . anything to make you feel better ’cause you’re always feeling kind of yucky to begin with, right? So anything that’ll help normalize [laughter] . . . the way I feel . . .

Engagement through common values. Both health professionals and patient participants identified that being engaged in an initiative that contributed to health and quality of life, and a desire to learn and try something new were at the root of participation. Nurse 582 stated,

I think for the most part when they got them [cycles] patients were really excited about the opportunity to . . . do that because . . . a lot of them they feel exhausted when they leave dialysis. They don’t . . . really lead too active of a lifestyle outside of this. So, this was that opportunity to . . . fill that time while they’re [here].

Similarly, Patient NJM932 explained, “I thought that . . . at least you’re doing something constructive, helping your body in some way, keep mobile rather than just lying there and doing nothing at times.”

These values of participation to improve health and well-being resulted in both patient and health professional engagement in the initiative, which drove their desire to learn more and educate themselves about the project. This in turn increased the trust and connection between patients and between patients and health professionals.

Shared responsibility. The sense of shared responsibility by both health professionals and patients for the successful implementation of a new initiative appeared to contribute to the perspective expressed by health professionals that the addition of leg cycle ergometers to the daily HD routine did not increase their workload. Nurse 582 mentioned, “No, . . . the patients that are doing it have really . . . taken that . . . on themselves and get it [cycle] . . . set up themselves.”

However, patients perceived that the extra activity was a burden on nurses, as described by Patient WPX434:

They [nurses] gotta set it up just right for our comfort. And then they have to adjust all the numbers . . . on it. And then . . ., when we're done, they gotta haul it back, to put it away.

On the contrary, nurses described being pleasantly surprised by the minimal impact, as summarized by Nurse 592, "It's faster than making a cup of coffee . . ."

The presence of a physiotherapist who was able to support nurses and patients in introducing IDC was also seen as beneficial and relieved the nurses of the perceived burden of workload and responsibility. Nurse 582 stated,

. . . that's not my expert[ise]. . . They . . . know, how to sit, where to fit . . . She was, she's the expert on that . . . Again that was my concern in the beginning that we would be stuck having to do that. And I didn't want that.

The nurses made it clear that it was not necessary for the physiotherapist to be there all the time. The most important times were orientation to staff, patient introduction to intervention, and problem-solving patients' concerns. Nurse 416 explained,

I think . . . it's [involvement of the physiotherapist] important because people come to us with . . . certain injuries and stuff and we want to make sure that we're not compromising that existing injury . . . I'm thinking that in terms of some of our people, . . . quite frail . . . that's probably a good reason to have a physiotherapist.

Know your patient and know your provider. There was a clear advantage of patients knowing their health professional and health professionals knowing their patients. Nurse participants described close monitoring of the patients and the advantages of knowing them each as individuals. Nurse 592 described this advantage thus: "The idea of just breaking through those barriers where they've been told . . . not to exercise very much, or how much good it will do."

It was evident that the regularity of HD resulted in patients at the unit having close connections with each other and providing peer support. Patient WPX434 explained, "She's 20 years older than I am . . . So that really motivated me too," whereas patient SFI907 would encourage other patients in close proximity by saying, "I'll race you around the block." Despite some participants not engaging in the IDC, all participants appeared to encourage and motivate each other to cycle and sometimes engage in friendly competition, as further described by Nurse 416:

And then, . . . gave them a kind of a little bit of competition, who could get there. And then one lady went away for a month and . . . she couldn't bike, so she got back and she was like, "I gotta catch up to [another participant's name redacted]."

This peer support was key in patients using the cycles assuming the shared responsibility of orienting anyone new to IDC. Nurse 582 explained,

. . . So as we get new patients that's . . . part of their . . . orientation here and "these are available," . . . even have them talk to some patients that are using them . . . Because often I find they're more apt to do something when they see another patient doing it, not because I'm telling them to: "You should do this" . . .

Benefits. While the benefits of exercise were not noted by all participants, there was a general attitude that physical activity was not easy but had long-term gains. Patient NJM932 stated, "When I went home from [the CDU], . . . after exercising, whatever amount, I'd be feeling a lot better. And then I'd go home . . . and actually, have a productive day."

Patient CDA687 expressed the value in participating in the study not only for their own personal health benefit but also that of others:

What motivated me more than anything. . . . I thought, "well, hey, why not try this and . . . help see if it makes a difference so that they can do this study and help others," right? I'm all for that.

Regardless of how much or how little they cycled, participants shared a belief in the importance of exercise and that IDC offered a safe alternative to being physically active in a northern climate in winter. Patient CDA687 explained,

I think it's really important for anybody. Not just us . . . We try to walk as much in the summer. When it becomes winter though it's, up here, with the snow and that, it's kind of dangerous, walking too much. So, and I have a tendency to have a fall every winter.

Through participant interviews, this study found that the CDU, in and of itself, provided a safe, supportive, learning environment that facilitated participation in this new initiative, and from this grew Trust, Connection, and Engagement through Common Values that produced the themes: knowing your patient/provider, shared responsibility, and the benefits that resulted from participation. These made the IDC both feasible and acceptable to patients and health professionals. The relationship of these meaning-based concept themes to each other can be viewed as a tree (see Figure 3).

Perspectives on nonparticipation. The lack of participation of the 3 patients who had enrolled in the study but did not cycle or cycled only once were related to preexisting physical ailments. The 2 patients who did not cycle at all both had prior issues with leg pains caused by arthritis, neuropathy, and peripheral artery disease. The patient who cycled once had experienced myocardial infarctions in the past. All 3 patients were worried that their conditions would worsen with cycling. Patient NXT703 explained,

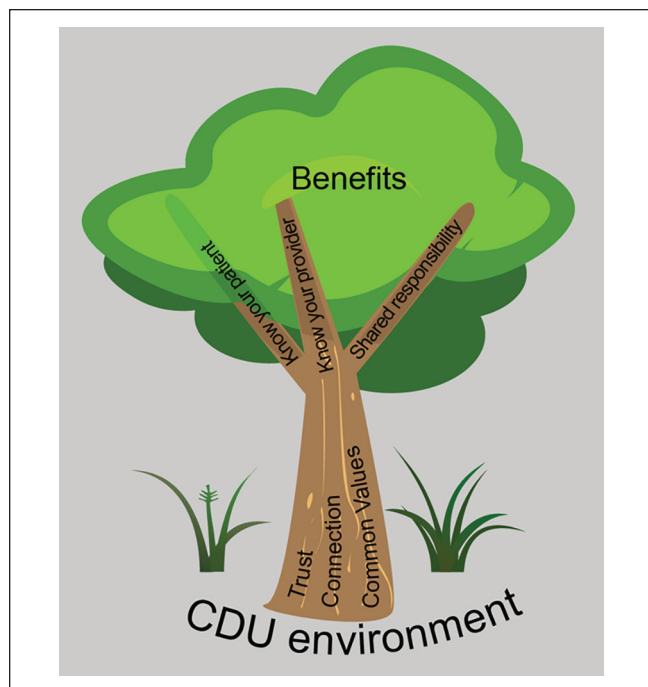


Figure 3. Schematic of qualitative results.

Note. The safe, learning CDU environment was considered foundational to participation in intradialytic cycling. This supportive environment nurtured trust, connection, and engagement through common values and branched to the elements of knowing your patient/provider, shared responsibility, and the benefits that resulted from participation. CDU = community dialysis unit.

Well exercise is always important but . . . there's just different things for me that came into play, . . . with my neuropathy. And so it didn't work out so well for me. But yeah, . . . of course it's important.

Discussion

There is growing evidence demonstrating the benefits of IDC and practice guidelines regarding implementation.^{16-21,37} However, there are relatively few centers where this practice has been adopted and even fewer of them are in a rural, remote, or northern context.⁵ Situated in a remote community, this study demonstrates the feasibility of implementing IDC and, through patient and health professional perspective, offers greater explanation of the influence that context and participation has on implementation and acceptability.

The CDUs in rural, remote, and northern communities draw upon a much smaller population. Our intervention's feasibility measures of eligibility of 100%, recruitment of 64%, adjusted retention of 67%, and adherence of 67% (patients completing $\geq 50\%$ of the expected 3 months of cycling) compare favorably with those seen in other studies. For example, a study by Miller et al¹⁹ had recruitment of 37% and adherence of 60% (patients completing a 6-month exercise program where they cycled for a mean of 56% of

HD sessions), whereas a study by DePaul et al³⁸ had 71% eligibility, 44% recruitment, 80% retention, and 75% adherence at 3 months postintervention. Given that IDC programs often see a decline of 6% to 56% in the number of participants continuing to cycle after the initial few months,³⁹ capturing the barriers and facilitators will allow better understanding of how to tailor programs in such a way as to keep more patients active for a longer duration of time.

Patient participants in this study received HD 3 times per week and many of them cycled for a minimum of 30 minutes during each HD session and reached or exceeded the physical activity guideline of 150 minutes per week of exercise recommended for adults 18 to 64 years of age.⁴⁰ Participants cycling times compared, yet again, favorably with those reported by Miller et al¹⁹ of a median of 42 minutes per week at the end of the first month of their study and 135 minutes by the end of the sixth month.

It is evident from Figure 1 that participants self-adjusted cycling time on a daily basis with most of them displaying frequent variations in the duration of cycling between HD sessions. This is not surprising given that both the end-stage kidney disease process itself and the HD treatment can lead to daily changes in levels of perceived well-being in patients.³ Yet, 3 of the 4 patients who cycled more than 10 times over the course of the study showed a slight but generally positive trend in the duration of time spent cycling as a function of time despite the complexity of their chronic disease and the 3-month study participation timeframe.

EQ-5D-5L survey results, reveal that average pre- and poststudy scores remained relatively unchanged in the dimensions of mobility (pre 1.8, post 2), usual activities (pre 1.6, post 1.6), pain/discomfort (pre 1.6, post 1.8), and on the global scale (pre 71, post 70). The dimensions of self-care (pre 1.0, post 1.0) and anxiety/depression (pre 1, post 1) were not considered to be problematic by our participants. This finding differs from previous studies that have identified both factors as barriers to the quality of life of patients undergoing HD.⁴¹ Looking at the overall quality of life reported by our participants (global score of 70/100), it is conceivable that the participating patients were generally more medically stable, reporting a better quality of life than is generally seen in HD populations.

In this study, even if all the CDU patients had participated, their numbers would still have been insufficient to make definitive statements about whether the IDE initiative changed the quality of life using any scale. Thus, we used this scale not only simply in an exploratory manner but also to informally evaluate patient participation in filling out simple forms. Rural clinical health research is still in its infancy in Canada⁴²⁻⁴⁴ and very rarely experienced in our CDU patient population. The fact that both the prestudy and poststudy EQ-5D-5L forms were completed by the vast majority of our active participants was further confirmation of the participatory culture within our CDU environment.

Table 2. Descriptive Statistics of Patients Cycling.

Patient participant	Duration of participation in study (months, % out of expected 3 months)	Frequency of cycling (% of hemodialysis sessions)	Duration of cycling (minutes per session, median and IQR)	Range of cycling intensity (on the Perceived Exertion Scale)
CDA687	1 (33%)	73	30 (30-35)	2-5
DMC607	3.5 (117%)	100	75 (75-76)	2-10
NJM932	4 (133%)	88	62 (48-75)	3
TTO597	1.5 (50%)	100	120 (105-141)	4
WPX434	4 (133%)	63	35 (30-60)	1-3
YHS033	1 (33%)	100	32 (27-37)	3
Median (IQR) or Mean (SD) across patients	2.5 (IQR: 1-4) or 83% (SD = 49%)	87% (SD = 16%)	63.5 (IQR: 39-76)	3

Note. IQR = interquartile range; SD = standard deviation.

The interviews conducted with patients provided much richer information when it came to understanding how the IDE intervention affected the quality of life and function. In fact, these anecdotal reports were so meaningful that, with the help of medical students, the research team developed a patient-centered 5-minute video (<http://bit.ly/cycdialvid>) to highlight these benefits. In the video, patients mention that cycling killed boredom during dialysis sessions, increased their energy so that they felt like doing things when they went home after a dialysis session, helped with weight loss, and became a group activity. Our chosen quality of life instrument had not captured these elements. Further consideration should be given to how quality of life is measured in future studies. We ponder whether there is perhaps no single good quality of life measure. Perhaps, by using approaches, such as interviews or videos, as supplements to the traditional quality of life scales, a much richer mosaic of those quality of life outcomes that are not captured by a scale but important to patients might be discovered.

Interviews with patient participants and health professionals provided insight into the context and the facilitators and barriers to implementation of IDE using leg ergometers which addresses the final 2 elements of the PARIHS framework. The implementation of this best practice was well received by all study participants, in part because it was eagerly awaited and supported by health professionals and partnering organizations. While the research study provided the infrastructure to initiate the best practice, the CDU environment provided a participatory culture that demonstrated the feasibility and ensured the implementation. The shared responsibility by patients and health professionals facilitated participation to a greater extent than just knowing the benefits of physical activity during HD and may have contributed to patients' ongoing motivation to cycle. Participants noted that they were surrounded by supportive peers and health professionals who they could trust, had a connection with, and that, in turn, provided motivation and resulted in greater benefits. The social aspect of IDC was deemed very important by our participants, which may be a unique feature due

to the size and geographic location of our CDU. The importance of social interaction in participating in physical activity was also identified by Pelletier et al⁴⁵ in a study looking at physical activity in remote and northern communities. Situating this study in the remote northern context was one of the drivers of this study. Unlike in urban settings, where patients have greater choice and access to such programs, residents of remote communities have limited availability of physical activity programs in the community. Similar to other studies, participants identified inclement weather and fear of falling in the winter as barriers to physical activity⁴⁶ and so the integration of IDC during HD offers patients a form of safe physical activity year-round.

Increased workload and lack of understanding of benefits and risks are commonly identified barriers to the implementation of IDC during HD.^{47,48} Previous research by Heiwe and Tollin⁴⁹ using the PARIHS framework found that while the use of IDC was a positive experience for patients overall, this was outweighed by barriers such as patient concern for staff workload and fear and worry about the workload associated with IDC. Concerns regarding increased workload for the health professionals were raised by some patient participants in this study; however, health professionals noted that the workload was less than anticipated and concepts of shared responsibility and effort relative to benefit were seen as facilitators. This positivity may have been bolstered by a long-standing desire at the unit to bring this established practice to their unit. Successful implementation of the evidence requires "negotiating and developing a shared understanding about the benefits, disadvantages, and risks and losses of the new practice over the old."⁵⁰

Inability to identify and recruit a staff member as IDC program champion can be a huge challenge in rural and remote CDU situations. Our patient participants showed exceptionally high level of ownership and willingness to help sustain our IDC program without putting extra burden on the health care staff. Our intervention had been designed from the onset to be a shared collaborative process between patients and staff, but the patient participants' engagement

exceeded our original expectations. This might be a feature of small CDU in a closely knit remote northern setting with established provider relationships. In the future, we see an opportunity of early patient partnership, in co-creating a vision and adopting a paradigm shift approach to empower patients to lead implementation of IDC programs with support from health care staff. This approach requires further research but has the potential to impact patient wellness in many rural and remote parts of Canada. Such patient-driven and provider-supported wellness programs in small rural and remote communities can be sustained and add value by partnering with established community wellness programs (eg, YMCA) for fundraising and recruiting patients and community members. In this regard, our intervention was a real-life example of a collaboration between the University of British Columbia's Department of Physical Therapy Northern and Rural program who purchased 3 of the 6 leg ergometers and the Northern Health Kidney Care program (a fund administered through a group of local nephrologists) who paid for the community physiotherapist.

The introduction of physical activity during HD requires a significant shift for health care professionals and patients from the current practice of patients being sedentary throughout their HD to engaging in aerobic activity but was found to not be prohibitive by the nurses that participated in our study. A qualitative study by Young et al⁵¹ looked at patient and staff perceptions of IDC before and after implementation and concluded that staff training and patient education were critical to the successful implementation of IDC. It is possible the employment of a physiotherapist assisted in overcoming those challenges by strategizing changes to workload and maximizing exercise acceptance, uptake, and active participation of patients.

Patients on HD are a complex and diverse group and, when initiating physical activity programs, a number of musculoskeletal, dialysis-related issues, and co-morbidities need to be considered. Thus, the skills of a physiotherapist in assessing physical function and exercise prescription were valued by both patients and health professionals in this study. As trust and connection form the basis of the relationship between nurses and the patient, having a physiotherapist available to consult as needed provided the nurses with just-in-time education and reassurance. The health professionals noted that access to a physiotherapist was most important during staff orientation, patients' introduction to IDC, and for problem-solving regarding issues experienced by patients. This was further confirmed by the physiotherapist being present twice weekly in the CDU at the beginning of the intervention, to only visiting the unit once approximately every 2 weeks once the enrollment was completed and the patients were comfortable with the cycling. In a study by Young et al,⁵¹ patients identified that an exercise physiologist was important to the initial implementation of IDE. Recognizing the scarcity of physiotherapists in rural, remote, and northern regions, consideration should be given to

whether this consultation can take place virtually. It is also worth noting that the cost of the physiotherapist over the 6 months that the intervention lasted averaged out to only CA\$410 per month.

Limitations

Despite the small number of participants, it would appear that the data regarding recruitment, frequency, and duration of cycling compare well with that captured by studies with more participants. During data analysis, it was discovered that the Rate of Perceived Exertion BORG Scale was either used unreliably (eg, missing data) or incorrectly (eg, rating of 10 of 10 when cycling on HD for over an hour) by some patients. Better patient education and increased supervision by health professionals would rectify the accuracy of the data collected. Similarly, the EQ-5D-5L was not always administered immediately following the end of each patient's participation in the study due to the community physiotherapist visiting the CDU on a rotating schedule. The delay in the administration of the test might have had an effect on recall or the measure may not have been as sensitive as necessary for this population. Similarly, this study interviewed 9 patient participants and the interviews were very focused on the feasibility and acceptability of this intervention. As such, the interviews with patients were short and concise, thus limiting the richness of the descriptions provided. However, the consistency of participants' experiences lends confidence to the results.

In addition, the duration of participation was variable, from cycling once to cycling beyond the 3-month expected duration of participation. Adherence among those who cycled more than once was 67%. Reporting of attrition is variable in studies, as are attrition rates. Nevertheless, our study's 33% attrition (2 of 6 patients completed <50% of 3 months of cycling) compares reasonably with the mean attrition rate of 23% (range = 6%-56%) cited in a recent systematic review of IDC.³⁹ Similarly, our study's adherence of 67% (4 of 6 patients completed \geq 50% of 3 months of cycling) compares well with that of a small 6-patient Irish 8-week IDE program combining 10 to 15 minutes of stationary cycle ergometers and 30 to 35 minutes of resistance training and where 5 of 6 patients completed 75% of the program.⁵²

As most patients on HD have a sheet on which they record machine- and health-related data for each HD session (blood pressure, speed of machine, pre- and postdialysis weight, etc), we would suggest adding a section where information regarding exercise during the session could be recorded. These forms are usually filled out by health professionals or at least reviewed by them before the patient leaves the clinic. These health professionals could identify missing data and ensure that the exercise section is filled out prior to the patient leaving the CDU. With the help of an undergraduate student, our research team also developed a poster to provide

CDU patients with a visual reminder of the benefits of cycling and how to get started with the cycle in 5 easy steps (see Supplemental Material 4).

As is noted in the findings from this study, building connections between patients and strengthening patient-health professional relationships by empowering patients were crucial to participation and sustainability of this implementation. Future research in this area would benefit from patient partnership in project co-design and implementation strategies to increase sustainability of programs and patient outcomes.

Overall, this study demonstrates the feasibility of implementing best practice in a remote northern community and outlines the importance of an organizational and health service environment that is open to learning and change, and facilitators such as trust and connection that lead to a shared responsibility for novel best practices.

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Ethics Approval and Consent to Participate

The study protocol was approved by the University of British Columbia's Clinical Research Ethics Board (Ethics certificate #H17-00673). Informed consent was obtained from all participants.

Consent for Publication

All authors consent to publication.

Availability of Data and Materials

The data and materials are available from corresponding author upon reasonable request.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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