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## A Pilot Randomized Controlled Trial of an Energy Management Program for Adults on Chronic Hemodialysis: The Fatigue-HD Study

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## 23 **Abstract**

24 **Background:** Identifying interventions to reduce fatigue and improve life participation are top  
25 research priorities of patients on chronic hemodialysis. We aimed to determine the feasibility and  
26 value of conducting a randomized controlled trial of an energy management program for people  
27 on chronic hemodialysis.

28 **Methods:** We conducted a parallel-arm, 1:1, blinded, pilot randomized controlled trial.  
29 Participants were on chronic hemodialysis and reported fatigue on the Fatigue Severity Scale.  
30 Participants were randomized to an attention control (general disease self-management  
31 education) or the Personal Energy Planning (PEP) program, a tailored, web-supported 7-9 week  
32 energy management program. Eligibility, recruitment and attrition rates were recorded, and  
33 standardized intervention effects were calculated for several fatigue and life participation  
34 questionnaires at immediate post-intervention and 12 weeks post-intervention.

35 **Results:** 159 of 253 screened patients were eligible to be approached. 42 (26%) had fatigue,  
36 were interested and consented to participate, of whom 30 met eligibility criteria and were  
37 randomized (mean age 62.4 ( $\pm$ 14.7), 60% male). Twenty-two enrolled participants (73%)  
38 completed all study procedures. Medium-sized intervention effects were observed on the COPM-  
39 Performance Scale, global life participation scale, and global life participation satisfaction scale  
40 at immediate post-intervention follow-up, compared to control. At 12-week follow-up, large and  
41 very large intervention effects were observed on the COPM Performance and Satisfaction Scales,  
42 respectively.

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3 43 **Conclusion:** It is feasible to enroll and follow patients on hemodialysis in a randomized  
4  
5 44 controlled trial of an energy management intervention. As the intervention was associated with  
6  
7 45 improved life participation on some measures, a larger trial is justified.  
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10  
11 46 **Keywords:** Fatigue, life participation, chronic kidney disease, dialysis, energy management  
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14 47 **Article Summary:**  
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- 16  
17 48 • Fatigue and its impact on life participation have been identified as top concerns of  
18  
19 49 patients on chronic hemodialysis  
20  
21 50 • Feasible and evidence-based interventions to address these outcomes in the chronic  
22  
23 51 hemodialysis population are currently limited  
24  
25 52 • This study suggests it is feasible to enroll and follow patients on hemodialysis in a  
26  
27 53 randomized controlled trial of an energy management intervention  
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29 54 • Results also suggest a potential impact of energy management education on life  
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31 55 participation, which suggests a randomized trial would be of value  
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36 56 **Strengths and Limitations:**  
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39 57 • We developed the study protocol using the SPIRIT guidelines for a pilot RCT, and used a  
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41 58 standardized intervention training protocol to maximize treatment fidelity across program  
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43 59 administrators  
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45 60 • We used randomization, participant blinding and an active control group to control for  
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47 61 bias  
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49 62 • Required proficiency in English means results might not be generalizable to non-English  
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51 63 speaking populations  
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- 64 • Unequal attrition rates between the intervention and control groups limits the conclusions  
65 that can be drawn about program efficacy from this pilot study, underscoring the need for  
66 further research to confirm these preliminary findings

For peer review only

## 81 **Introduction**

82 Kidney failure is associated with a variety of symptoms, including pain, nausea, and insomnia,  
83 that can affect quality of life<sup>1,2</sup>. One of the most challenging symptoms, chronic fatigue<sup>3</sup>, is  
84 experienced by an estimated 70% of the kidney failure population on chronic hemodialysis <sup>1</sup>.  
85 Fatigue can negatively affect various aspects of well-being in people with kidney failure,  
86 including mood, motivation, and quality of life<sup>4,5</sup>. However, its negative impact on their ability to  
87 participate in valued life activities (ie., life participation) has been identified as their top priority  
88 for research and intervention<sup>5</sup>. People on hemodialysis have described limitations in their ability  
89 to perform valued activities, such as work, socializing, and household management, because of  
90 fatigue <sup>4-6</sup>. They have indicated that the ability to participate in life activities should be a key  
91 indicator of treatment effectiveness<sup>5</sup>. However, evidence-based treatments to reduce fatigue or  
92 mitigate its impact on life participation are limited for this population. There are a complex and  
93 poorly-understood range of factors that contribute to kidney disease fatigue, including anemia,  
94 chronic inflammation, malnutrition, and depression<sup>7</sup>, which limits efficacious treatments.  
95 Erythropoietin stimulating agents (ESAs) and exercise training are currently the primary  
96 evidence-based approaches for treating fatigue in this population<sup>8,9</sup>; however, ESAs are already  
97 used in a large proportion of patients, and exercise training is challenging to promote in this  
98 patient group<sup>10,11</sup>. There is therefore a need to explore alternative approaches that can help  
99 people with kidney disease fatigue participate in valued life activities.

100  
101 Energy management education (EME) aims to improve life participation in people with fatigue  
102 by providing strategies to conserve or reallocate energy during routine daily activities<sup>12</sup>. Energy  
103 management strategies can include prioritizing, changing body postures, organizing the home  
104 environment, or using assistive tools (eg. mobility aids, long-handled reachers)<sup>13</sup>. The Personal



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3 105 Energy Planning (PEP) program is an energy management program designed to improve life  
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5 106 participation in the kidney failure population, by helping patients identify energy management  
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7 107 strategies that target individual life participation goals<sup>14</sup>. Proof-of-concept evidence suggests the  
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10 108 Personal Energy Planning (PEP) program might be associated with improvements in life  
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12 109 participation and/or fatigue in dialysis patients<sup>15</sup>, justifying the need for further evaluation with a  
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14 110 randomized controlled trial. However, recruitment for randomized trials can be challenging in  
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16 111 the kidney failure population<sup>16</sup>, in part due to a reluctance among dialysis patients to participate  
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18 112 in research studies that require extra study-related activities or visits<sup>17</sup>.

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23 114 We designed a randomized controlled trial of the “PEP” program<sup>18</sup> that attempts to minimize  
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25 115 study burden by using simple communication materials (eg. a brochure-style consent form); brief  
26  
27 116 questionnaires; concise intervention sessions; and a flexibility around missed or delayed  
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29 117 treatment sessions. However, the feasibility of recruiting and retaining participants for a trial  
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31 118 remains unknown. More information is also needed about how the “PEP” program impacts  
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33 119 various facets of life participation and fatigue, to inform the choice of a primary outcome  
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35 120 measure and aid power calculations for a randomized controlled trial.

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40 122 The primary objective of our pilot trial was to estimate the proportion of patients on chronic  
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42 123 hemodialysis that met eligibility criteria, agreed to participate, and completed all study  
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44 124 procedures for a randomized controlled trial of the “PEP” energy management education  
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46 125 program. Our secondary objective was to estimate the effects of the program on various facets of  
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48 126 fatigue and life participation, to ensure a trial will be adequately powered and will use the most  
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50 127 appropriate primary outcome measure.

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## 129 **Methods**

### 130 *Study design*

131 We conducted a multi-site, parallel group, 1:1, pilot randomized controlled trial  
132 ([www.clinicaltrials.gov](http://www.clinicaltrials.gov); NCT03825770). We randomized 30 participants on chronic  
133 hemodialysis to undergo the PEP energy management program, or an active control (general  
134 self-management support).

### 135 *Ethics Approval*

136 This pilot trial adhered to the principles of the Declaration of Helsinki and was approved by the  
137 Conjoined Health Research Ethics Board at the University of Calgary (#18-1657).

### 138 *Participants*

139 We recruited participants on chronic hemodialysis therapy at six hemodialysis units from  
140 February 1, 2019 to August 27, 2019. We sought patients aged  $\geq 18$  years who were undergoing  
141 hemodialysis for  $\geq 3$  months at time of recruitment; were clinically and cognitively stable (able to  
142 provide informed consent); and scored an avg. of  $\geq 4$  on items 5, 7, 8 and 9 from the Fatigue  
143 Severity Scale<sup>19</sup> (ie., items that assess the impact of fatigue on life participation). We excluded  
144 patients if they had a plan in place to discontinue in-center hemodialysis within 6 months of  
145 recruitment; if they had inadequate written and verbal English comprehension for study  
146 activities; if they resided in a long-term care facility; or, if they had a visual impairment that  
147 would preclude them from engaging with study materials.

148 We approached patients identified by clinical staff as being clinically and cognitively stable and  
149 English-speaking, to assess their interest in the study. Interested patients provided written

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3 150 informed consent before we conducted full eligibility screening. We then enrolled and  
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5 151 randomized eligible and consenting patients into the study.  
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9 152 *Randomization and blinding*

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12 153 We allocated participants equally (1:1) to intervention or control, using a computer-generated  
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14 154 random number sequence. We used permuted blocked randomization, with block sizes of 2-6,  
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16 155 stratified by dialysis unit. We concealed allocation by having a research manager not otherwise  
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18 156 involved with the study, provide treatment allocation to study coordinators over the phone. Study  
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20 157 participants were blinded to their treatment status (intervention or active control). It was not  
21  
22 158 feasible to blind study coordinators, given the extensive training they received to learn to  
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24 159 administer the intervention compared to the control.  
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29 160 *Intervention: The “PEP” Program*

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32 161 Participants randomized to the treatment arm completed the tailored, 7-9 week PEP program  
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34 162 (Table 1), teaching them how to use energy management strategies (e.g., simplifying tasks,  
35  
36 163 pacing, using assistive devices, organizing home environments) to improve participation in three  
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38 164 self-selected life activities. Study coordinators received in-person training in the treatment and  
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40 165 control protocols from a trained occupational therapist prior to administering the intervention.  
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42 166 They were also provided with a written guidebook for administering the treatment and control  
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44 167 conditions. Study coordinators monitored and encouraged participant adherence to the treatment  
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46 168 protocol during weekly visits. Missed or incomplete intervention sessions were documented and  
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48 169 addressed as outlined in the study protocol<sup>18</sup>.  
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54 170 *Control: General information about kidney disease*  
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3 171 Participants randomized to the control arm reviewed general information about kidney disease  
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5 172 management (eg. blood pressure management; diet; communicating with healthcare team) from  
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7 173 the Kidney School online learning modules during six to eight 1:1 sessions with a trained study  
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9 174 nurse coordinator. Sessions took place while participants were undergoing hemodialysis.  
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13 175 *Data collection*  
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17 176 Trained study coordinators collected baseline demographic and clinical data on participants at  
18  
19 177 the time of the first study visit, through chart review and/or participant interview. The study  
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21 178 coordinators tracked the number of screened patients who met study eligibility criteria,  
22  
23 179 consented to participate, and completed all study procedures (intervention and assessment  
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25 180 sessions), using study logs. The study coordinators administered a series of self-reported  
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27 181 questionnaires measuring life participation and fatigue (Table 2), at three timepoints:  
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- 30 182 1. Pre-intervention baseline;  
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32 183 2. One week after the PEP program was completed;  
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34 184 3. 12 weeks after the PEP program was completed  
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38 185 Participants completed study questionnaires during their hemodialysis sessions.  
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41 186 *Statistical analyses*  
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45 187 We calculated the proportion of patients on hemodialysis meeting each of the feasibility  
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47 188 endpoints (study eligibility, enrolment and completion), with accompanying 95% confidence  
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49 189 intervals. We reported participant demographic and clinical data as means and standard  
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51 190 deviations for continuous parametric data; medians and interquartile ranges for continuous  
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53 191 nonparametric data; and frequencies and percentages for categorical data. We then calculated  
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55 192 simple and standardized treatment effect sizes for each life participation and fatigue outcome  
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193 measure, at both the immediate post-intervention and twelve weeks post-intervention timepoints.

194 We used the Cohen's D statistic to calculate standardized effect sizes, and categorized effect size  
195 estimates as very small (0.01-0.20), small (0.2-0.49), medium (0.5-0.79), large (0.8-1.19), or  
196 very large (>1.20). Missing follow-up data were addressed using pairwise deletion.

197 Post-hoc sensitivity analyses were performed that assumed best-case scenario for missing data  
198 (ie. the median intervention effect was imputed for missing intervention values, and the median  
199 control effect was imputed for missing control values), and worst-case scenario (ie. the median  
200 intervention effect was imputed for missing control values, and the median control effect was  
201 imputed for missing intervention values).

#### 202 *Sample size*

203 We originally chose a sample size of 40 patients for the pilot trial. This was based on  
204 recommendations for optimal pilot study sample sizes<sup>20</sup>, an expected participant pool of 425  
205 patients, and our anticipated eligibility and recruitment rates. The target sample size was  
206 subsequently reduced to 30 due to an inability of our study team to follow patients on evening  
207 dialysis shifts, which reduced our potential participant pool from 425 to 253 patients.

#### 208 *Patient and public involvement*

209 The study intervention was developed based on results of patient engagement research which  
210 suggested a need to further investigate fatigue in kidney disease. Two patients were involved in  
211 the development of the intervention through a series of individual interviews that informed  
212 program refinement. Two patients were consulted about the acceptability of the active control  
213 used in this study. A patient partner reviewed the manuscript and provided feedback about the  
214 discussion and interpretation of results.

## 215 **Results**

### 216 *Feasibility*

217 We screened all patients (n=253) undergoing daytime chronic hemodialysis at six dialysis  
218 centers between February and August 2019 for preliminary eligibility ie. (no language barrier,  
219 clinically and cognitively stable) (Figure 1). All 159 patients who met preliminary eligibility  
220 (63% (95% CI 57, 69%)) were approached. 42 patients (26% (95% CI 20%, 34%)) reported  
221 fatigue, were interested in participating, and provided consent. Of those, 30 patients (71% (95%  
222 CI 55%, 84%)) met full study eligibility criteria and were enrolled and randomized. In total, 30  
223 of 159 clinically stable and English-speaking patients (19%, 95% CI 13%, 25%) were enrolled in  
224 the study.

225 22 of 30 enrolled patients (73% (95% CI 54%, 88%)) completed all study procedures: 8 in the  
226 intervention group, and 14 in the control group. Reasons for study discontinuation in the  
227 intervention group included: hospitalization or illness due to nephrectomy (n=1), hypoxia (n=1),  
228 neurological symptoms (n=1), or unknown reason (n=1); low blood pressure during dialysis  
229 (n=1); switching dialysis modalities (n=1); and kidney transplantation (n=1). The reason for  
230 discontinuation in the control group was hospitalization due to unknown reason (n=1).

### 231 *Participant characteristics*

232 Baseline characteristics of participants are described in Table 3. The mean age of participants  
233 was 62.4 (SD = 14.7), 60% were male, and 50% had diabetes. Participants had been on dialysis  
234 for a median of 3.6 years (IQR 1.8, 7.3), and 77% were living independently at baseline. Thirty  
235 percent of participants screened positively for cognitive impairment, and 40% screened

236 positively for depression. Participant characteristics were similar across treatment and control  
237 groups (Table 3).

238 *Effect size estimates*

239 We observed a large standardized intervention effect at the immediate post-intervention follow-  
240 up assessment on the COPM-Performance Scale (Cohen's  $D = .64$ ; moderate effect), compared  
241 to control. At immediate post-intervention, participants in the intervention group ( $n=10$ ) reported  
242 a clinically meaningful improvement ( $\geq 2$  points) in 40% of their life participation goals  
243 according to the COPM-Performance Scale, compared to 21% in the active control group ( $n=14$ )  
244 (Figure 2). We also observed moderate intervention effects on the Fatigue Management  
245 Questionnaire's Global Life Participation Scale (Cohen's  $D = .52$ ), Global Life Participation  
246 Satisfaction Scale (Cohen's  $D = .52$ ), and Self-Efficacy Scale (Cohen's  $D = .51$ ). The remainder  
247 of fatigue and life participation measures detected either small intervention effects, or no effects,  
248 at immediate post-intervention follow-up compared to control (Table 4).

249 At 12-weeks post-intervention, we observed large and very large effects on the COPM-  
250 Performance Scale (Cohen's  $D = .94$ ) and COPM-Satisfaction Scale (Cohen's  $D = 1.42$ ) in the  
251 intervention group ( $n=8$ ), respectively, compared to control ( $n=14$ ) (Table 4). Participants in the  
252 intervention group reported a clinically meaningful improvement ( $\geq 2$  points) in 64% of their life  
253 participation goals according to the COPM-Performance Scale at the 12 week post-intervention  
254 timepoint, compared to 24% in the active control group (Figure 2). We found minimal to no  
255 effects associated with the intervention on the remainder of fatigue or life participation measures  
256 at the 12-week post-intervention follow-up, compared to control. Results of the sensitivity  
257 analysis, assuming best-case and worst-case scenarios for missing data, are included in Appendix  
258 1.

**Discussion**

In this pilot study, we assessed the feasibility of recruiting and retaining patients on chronic hemodialysis with fatigue for a randomized controlled trial of an energy management program, and the potential impact of such a program. Although previous proof-of-principle evidence<sup>15</sup> suggested a randomized controlled trial was warranted, the proportion of participants who would commit to completing study activities (eg. intervention sessions, outcome questionnaires) for a trial was unknown. Furthermore, the impact of the “PEP” program on various facets of life participation and fatigue compared to a control group remained unclear. We were able to recruit ~25% of clinically stable and English-speaking hemodialysis patients into this pilot randomized controlled trial, and retain 70% of enrolled participants for the duration of the trial, which met our pre-trial expectations for study participation<sup>18</sup>. Although fatigue did not appear to be affected by the PEP program, the program was associated with medium to large-sized effect on personalized life participation at both short-term and medium-term follow-up, compared to an attention control condition. Collectively, these results suggest that a randomized controlled trial of the PEP program would be feasible, and is warranted.

Our recruitment and retainment results suggest that, despite the added responsibilities of filling out study questionnaires and completing the intervention or control program, the study was acceptable to a substantial proportion of our target population. We note that although only 25% of all stable and English-speaking hemodialysis patients consented to participate, only 50-70% of them likely had fatigue, based on existing estimates of fatigue prevalence<sup>1</sup>; thus, we estimate that approximately half of eligible patients with fatigue in fact agreed to the study. This suggests that study burden was not an insurmountable barrier to recruitment. Although the dropout rate was



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3 282 higher in the intervention arm than the control (43 vs. 13%), our documented reasons for study  
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5 283 withdrawals were unrelated to the intervention, and were rather due to the general medical  
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7 284 complexity of this patient population. We therefore assume that with a larger sample of patients,  
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10 285 the attrition rate would balance between the two groups. Our overall attrition rate of 30% is not  
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12 286 unexpected for the dialysis population over the course of a five-month study, given that they  
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14 287 typically experience high rates of acute medical events and hospitalizations<sup>21,22</sup>. We attribute the  
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16 288 general acceptability of the intervention to the use of study materials that were user-friendly (eg.  
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18 289 a brochure-style consent form); brief questionnaires to assess target outcomes; and a flexible  
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20 290 protocol for missed treatment sessions. Acceptability could be further increased in a full-scale  
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22 291 trial by reducing the number of questionnaires used to assess life participation and fatigue,  
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24 292 particularly now that the pilot trial has provided clarity about the best measures for assessing  
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26 293 these outcomes.

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31 294 The finding that the PEP program was associated with improvements in life participation,  
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33 295 compared to control, is important because this outcome directly aligns with patient priorities<sup>3,5</sup>.  
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35 296 Patients on hemodialysis with fatigue view life participation as “the fundamental goal of  
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37 297 treatment, because it symbolizes some indicator of being able to live a life without being  
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39 298 confined by the disease”<sup>5</sup>. Although fatigue was not directly impacted by the intervention, our  
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41 299 results suggest that energy management strategies developed during the intervention might have  
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43 300 helped participants to accomplish their day-to-day goals more effectively by working around  
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45 301 fatigue. This improvement in personalized life participation we observed is relatively unique  
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47 302 within the energy management literature<sup>23</sup>. Our intervention incorporated a number of novel  
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49 303 features to more directly target life participation, compared to other energy management  
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51 304 interventions, in accordance with the priorities of hemodialysis patients. For example, we used  
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3 305 personalized goal-setting to ensure interventions were tailored to specific patients' needs, and a  
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5 306 problem-solving training approach to facilitate patient independence at solving their own life  
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8 307 participation challenges. Our findings support the potential efficacy of these features, although it  
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10 308 is important to note the potential impact of unequal attrition between the intervention and control  
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12 309 groups on our pilot results. This further emphasizes the need for a full-scale trial to more  
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14 310 conclusively establish program effectiveness.

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18 311 With respect to outcome measures, we found that the Canadian Occupational Performance  
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20 312 Measure<sup>24</sup> detected the strongest intervention effects compared to other life participation and  
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22 313 fatigue measures. The COPM is the only measure we used that assesses life participation in three  
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24 314 patient-chosen activities, rather than a generic set of life activities. Although the COPM has not  
25  
26 315 been formally validated in the kidney failure population, it has strong validity, reliability and  
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28 316 responsiveness data from multiple other clinical populations and age groups<sup>25</sup>. It also aligns with  
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30 317 patient preferences for a measure of life participation that is individualized<sup>5</sup>. Collectively, these  
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32 318 findings suggest the COPM is the best choice for a primary outcome for an RCT of the "PEP"  
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34 319 program. Estimates based on our pilot results suggest data on 36 participants would be needed to  
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36 320 detect a clinically meaningful change of >2 points on the COPM-performance scale in a  
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38 321 randomized controlled trial, with significance set at 80% power and  $p=0.05$ . Based on our rates  
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40 322 of screened-to-enrolled patients, the participant screening pool would need to include 415  
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42 323 patients on hemodialysis to achieve this sample size.

#### 43 44 45 324 *Study Limitations*

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49 325 We excluded non-English speaking patients from the study, limiting its generalizability to non-  
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51 326 English-speaking kidney failure populations. Positive findings about the PEP program might,

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3 327 however, justify developing program materials in the future that are accessible to a wider range  
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5 328 of renal patients. We were also unable to blind study coordinators to participants' treatment  
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7 329 allocation, which might have unduly affected their approach to treatment. The infeasibility of  
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9 330 blinding is a well-recognized limitation of trials that study psychosocial or behavioural  
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11 331 interventions, because of the challenges of identifying and implementing an appropriate control.  
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13 332 Finally, unequal attrition rates between the intervention and control groups limits the conclusions  
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15 333 that can be drawn about program efficacy from this pilot study, and underscores the need for  
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17 334 further research using a larger sample of patients to confirm our preliminary results.  
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### 23 335 **Conclusions**

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26 336 The PEP energy management program appears to be acceptable to patients, and might lead to  
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28 337 improvements in life participation. Further investigation in an adequately powered randomized  
29  
30 338 controlled trial is warranted.  
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32

### 33 339 **Acknowledgements**

34  
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36  
37 340 None.  
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### 40 341 **Conflict of Interest Statement**

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42  
43 342 The authors have no conflicts of interest to disclose. Results presented in this paper have not  
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45 343 been published previously in whole or part, except in abstract format.  
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### 49 344 **Data Sharing Statement**

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52 345 Data from the study can be made available upon reasonable request to the corresponding author.  
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### 56 346 **Authors' Contributions**

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3 347 JF led the design, coordination, analysis and authorship of the study and manuscript. BH  
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5 348 provided advice and mentorship on all aspects of the study. CT, BM and MD helped with the  
6  
7 349 development of the participant identification plan, and provided advice on other key study issues.  
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9 350 PR and ME contributed feedback on trial design. All authors assisted with the interpretation and  
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11 351 presentation of results for publication. NV provided review and perspective from a patient's  
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13 352 point of view.  
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446 **Table 1: Description of the Personal Energy Planning (“PEP”) Program**

| Program Section                                   | Description  |
|---|--|
| <b>Part 1:<br/>Computer modules</b>               | <ul style="list-style-type: none"> <li>• Participants complete 3 computer modules over 3 sessions (~20-30 mins each) that explain the basic principles of energy management</li> <li>• Modules are completed on laptops during hemodialysis sessions, with support for module completion provided by study coordinators</li> </ul>   |
| <b>Part 2:<br/>Individualized problem-solving</b> | <ul style="list-style-type: none"> <li>• Participants work 1:1 with a trained administrator over 4-6 sessions (~30 mins each) to develop energy management strategies for 3 life participation goals</li> <li>• Energy management strategies are developed using a metacognitive problem-solving process called “<b>Goal-Plan-Do-Check</b>”:             <ol style="list-style-type: none"> <li>1. Set a life participation <b>goal</b></li> <li>2. Analyze current energy expenditure patterns to come up with a <b>plan</b> to conserve energy for the goal;</li> <li>3. <b>Do</b> the plan;</li> <li>4. <b>Check</b> to see if it worked, and what aspects of the plan should be revised</li> </ol> </li> <li>• This process continues until an effective plan is found for each goal, or the program maximum of 9 weekly treatment sessions is reached</li> <li>• Study coordinators use <b>guided discovery teaching</b> to encourage patient independence in working through the Goal-Plan-Do-Check process</li> </ul> |

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454 **Table 2: Life Participation and Fatigue Outcome Measures**

| Outcome                   | Measure  | Description  |
|---------------------------|--|--|
| <b>Life participation</b> | <i>Canadian Occupational Performance Measure</i> <sup>24</sup> – <i>Performance Subscale (COPM-P)</i>  | Asks individuals to rate, on a 10-point Likert scale, his/her performance in three self-selected priority activities of everyday living. The COPM has been found to be a valid, reliable, clinically useful and responsive measure of occupational performance in multiple chronic disease populations <sup>25</sup> .       |
|                           | <i>Canadian Occupational Performance Measure</i> <sup>24</sup> – <i>Satisfaction Subscale (COPM-S)</i> | Asks individuals to rate, on a 10-point Likert scale, their satisfaction with their performance in three self-selected priority activities of everyday living.   |
|                           | <i>Reintegration to Normal Living Index</i> <sup>26</sup> (RNLI)                                       | Assesses the degree to which individuals who have experienced traumatic or incapacitating illness achieve reintegration into normal activities, using 11 declarative statements accompanied by a visual analogue scale. The RNLI has strong validity and reliability in multiple chronic disease populations <sup>27</sup> . |
|                           | <i>Fatigue Management Questionnaire (FMQ)</i>  | Asks individuals to rate various aspects of their fatigue management (e.g., overall impact on life participation; satisfaction; self-efficacy) on five Likert-scale questions. The FMQ was created for this study to assess life participation and self-efficacy pertaining specifically to fatigue management.              |
| <b>Fatigue</b>            | <i>Fatigue Severity Scale</i> <sup>19</sup> (FSS)  | Includes 9 items that ask individuals to rate, on a Likert scale from 1-7, the severity of their fatigue and its impact on their life during the past week. The FSS is a valid, reliable and responsive measure <sup>28</sup> that has been used in the dialysis population.   |
|                           | <i>Modified Fatigue Impact Scale</i> <sup>29</sup> (MFIS)  | A 21-item Likert-based scale that assesses the effects of fatigue on physical, cognitive, and psychosocial functioning. The MFIS is frequently used as a primary outcome measure in energy management education studies.   |
|                           | <i>SONG-HD Fatigue</i> <sup>5</sup>  | Assesses the severity of fatigue, and its impact on daily living, in people on chronic hemodialysis using 3 Likert-style questions. The measure was developed in conjunction with kidney failure patients and other key informants, and is currently undergoing psychometric validation.                                     |

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462 **Table 3: Baseline Characteristics of Participants**

|   | All Participants<br>(n=30) | Control<br>(n = 15) | Intervention<br>(n = 15) |
|---|----------------------------|---------------------|--------------------------|
| <b>Age (yrs) (mean, SD)</b>                       | 62.4 (14.7)                | 64.8 (14.4)         | 60.0 (15.1)              |
| <b>Male</b>                                       | 18 (60)                    | 10 (67)             | 8 (53)                   |
| <b>Residence</b>                                  |                            |                     |                          |
| <i>Independent living</i>                         | 27 (90)                    | 14 (93)             | 13 (86)                  |
| <i>Retirement/supported living</i>                | 3 (10)                     | 1                   | 2                        |
| <b>Lives alone</b>                                | 20 (67)                    | 6 (40)              | 4 (27)                   |
| <b>Married</b>                                    | 17 (57)                    | 10 (67)             | 7 (46)                   |
| <b>Employed</b>                                   | 4 (27)                     | 0 (0)               | 4 (27)                   |
| <b>Education</b>                                  |                            |                     |                          |
| <i>No high school diploma</i>                     | 3 (10)                     | 2 (13)              | 1 (7)                    |
| <i>High school diploma</i>                        | 12 (40)                    | 6 (40)              | 6 (40)                   |
| <i>College/trade school</i>                       | 10 (33)                    | 5 (33)              | 5 (33)                   |
| <i>University degree</i>                          | 4 (13)                     | 2 (13)              | 2 (13)                   |
| <i>Graduate/professional degree</i>               | 1 (3)                      | 0 (0)               | 1 (7)                    |
| <b>Uses computer/tablet/phone</b>                 | 27 (3)                     | 14 (93)             | 13 (86)                  |
| <b>Dialysis vintage (yrs) (Median, IQR)</b>       | 3.6 (1.8, 7.3)             | 2.6 (1.7, 6.0)      | 4.0 (1.7, 9.5)           |
| <b>Comorbidities</b>                              |                            |                     |                          |
| <i>Diabetes</i>                                   | 15 (50)                    | 9 (60)              | 6 (40)                   |
| <i>Depression</i>                                 | 9 (30)                     | 3 (20)              | 6 (40)                   |
| <i>Coronary artery disease</i>                    | 10 (33)                    | 6 (40)              | 4 (27)                   |
| <i>Congestive heart failure</i>                   | 8 (27)                     | 3 (20)              | 5 (33)                   |
| <i>Cerebrovascular disease</i>                    | 3 (10)                     | 3 (12)              | 0 (0)                    |
| <i>Alzheimer's disease</i>                        | 1 (3)                      | 0 (0)               | 1 (7)                    |
| <i>Multiple Sclerosis</i>                         | 1 (3)                      | 0 (0)               | 1 (7)                    |
| <i>Chronic Obstructive Pulmonary Disease</i>      | 1 (3)                      | 1 (7)               | 0 (0)                    |
| <i>Cancer</i>                                     | 7 (23)                     | 5 (33)              | 2 (13)                   |
| <b>Baseline serum hemoglobin (g/L) (Mean, SD)</b> | 101.6 (18.7)               | 107.7 (8.7)         | 95.0 (23.3)              |
| <b>Baseline serum albumin (g/L) (Mean, SD)</b>    | 35.0 (10.8)                | 33.0 (3.9)          | 37.2 (15.0)              |
| <b>Activities of daily living dependence</b>      | 7 (23)                     | 2 (13)              | 5 (33)                   |
| <b>MiniCog impaired</b>                           | 9 (30)                     | 4 (27)              | 5 (33)                   |
| <b>Personal Health Questionnaire-2 impaired</b>   | 12 (40)                    | 5 (33)              | 7 (47)                   |

\*Data are expressed as n(%) unless otherwise specified

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464 **Table 4: Changes in Fatigue and Life Participation Ratings in the Intervention versus Control Groups**

| Domain             | Measure         | Study Arm | Baseline           | Immediate Post-Treatment Follow-up |                                   |                                | 12 Weeks Post-Treatment Follow-up |                                   |                                |
|--------------------|-----------------|-----------|--------------------|------------------------------------|-----------------------------------|--------------------------------|-----------------------------------|-----------------------------------|--------------------------------|
|                    |                 |           | Median score (IQR) | Median score (IQR)                 | Median change from baseline (IQR) | Cohen's D effect size estimate | Median score (IQR)                | Median change from baseline (IQR) | Cohen's D effect size estimate |
| Life Participation | COPM-P          | Control   | 4.3 (3.7, 7.7)     | 4.7 (2.5, 7.8)                     | -0.3 (-1.8, +1.0)                 | 0.64<br>Medium                 | 4.3 (1.7, 5.3)                    | +0.3 (-2.0, +1.3)                 | 0.94<br>Large                  |
|                    |                 | Treatment | 4.7 (4.0, 6.7)     | 5.3 (4.7, 6.7)                     | +1.3 (+0.3, +1.7)                 |                                | 6.8 (5.4, 7.6)                    | +1.9 (0.0, +3.5)                  |                                |
|                    | COPM-S          | Control   | 4.0 (2.3, 8.0)     | 6.0 (3.0, 8.0)                     | +0.3 (-0.8, +2.0)                 | 0.13<br>Very small             | 4.0 (1.0, 5.0)                    | 0.0 (-2.0, +0.7)                  | 1.42<br>Very large             |
|                    |                 | Treatment | 4.0 (3.3, 5.3)     | 5.3 (3.8, 6.5)                     | +0.7 (-0.3, +1.8)                 |                                | 6.7 (4.9, 7.5)                    | +1.8 (+1.4, +3.1)                 |                                |
|                    | FMQ-Global LP   | Control   | 6.0 (4.7, 7.0)     | 6.5 (4.8, 8.1)                     | 0.0 (-1.4, +2.4)                  | 0.52<br>Medium                 | 5.6 (3.0, 8.0)                    | -0.4 (-2.0, +1.0)                 | 0.17<br>Very small             |
|                    |                 | Treatment | 4.7 (3, 6.3)       | 6.3 (5.8, 7.4)                     | +1.8 (+.5, +2.1)                  |                                | 5 (2.25, 5.75)                    | +1.0 (-2.0, +4.0)                 |                                |
|                    | FMQ-Global LPS  | Control   | 5.0 (4.0, 8)       | 7.5 (4.5, 9.0)                     | +1.0 (-1.3, +3.3)                 | 0.52<br>Medium                 | 6.0 (4.0, 7.5)                    | 0.0 (-2.0, +1.0)                  | 0.17<br>Very small             |
|                    |                 | Treatment | 4.0 (2.0, 5.0)     | 7.0 (4.5, 8.3)                     | +4.0 (+.5, +5.3)                  |                                | 4.5 (2.25, 5.75)                  | 0.0 (-2.0, +4.0)                  |                                |
|                    | RNLI            | Control   | 78 (51, 88)        | 81.0 (58.0, 94.0)                  | -1.0 (-5.0, +15.0)                | Favours control                | 83 (60, 101)                      | +5.5 (-7.5, +24.0)                | Favours control                |
|                    |                 | Treatment | 71 (56, 83)        | 61.5 (51.5, 78.8)                  | -3.0 (-10.0, +11.3)               |                                | 61.5 (50.5, 78.5)                 | -1.0 (-20.0, +12.8)               |                                |
| Fatigue            | FSS             | Control   | 5.0 (4.3, 6.1)     | 4.3 (3.8, 5.9)                     | -0.3 (-1.1, +1.0)                 | 0.37<br>Small                  | 4.0 (2.7, 4.9)                    | -1.1 (-1.8, -3.5)                 | Favours control                |
|                    |                 | Treatment | 6.0 (5.6, 6.3)     | 5.3 (4.4, 6.0)                     | -0.6 (-1.9, +0.2)                 |                                | 5.2 (4.1, 6.0)                    | -0.8 (-1.0, 0.0)                  |                                |
|                    | MFIS            | Control   | 50.0 (38, 55)      | 39.5 (29.5, 49.3)                  | -6.5 (-23, +5)                    | Favours control                | 29 (22.5, 49.5)                   | -12.0 (-20.0, -6.5)               | Favours control                |
|                    |                 | Treatment | 52.0 (45, 59)      | 48 (38.5, 51.5)                    | -8.0 (-13, +1.5)                  |                                | 47.5 (39.0, 65.0)                 | -1.0 (-10.0, +12.0)               |                                |
|                    | Song-HD Fatigue | Control   | 6.0 (4.0,7.0)      | 4.5 (3.3, 7.0)                     | 0.0 (-2.0, 0.0)                   | 0.16<br>Very small             | 5.0 (3.25, 6.0)                   | -1.0 (-2.0, +1.0)                 | Favours control                |
|                    |                 | Treatment | 6.0 (3.8, 9)       | 5.0 (3.8, 6.0)                     | -1.0 (-4.5, +2.5)                 |                                | 6.0 (5.0, 6.0)                    | 0.0 (-1.0, +3.0)                  |                                |
|                    | Self-Efficacy   | Control   | 5.0 (5.0, 8.0)     | 6.2 (5.0, 9.0)                     | +0.2 (-1.0, +3.3)                 | 0.51<br>Medium                 | 8.0 (4.5, 9.0)                    | 0.0 (-1.0, +3.0)                  | 0.02<br>Very small             |
|                    |                 | Treatment | 4.0 (2.0, 5.0)     | 6.5 (4.3, 7.3)                     | +3.0 (-0.0, +3.0)                 |                                | 5.0 (3.0, 5.0)                    | +0.5 (-1.5, +3.0)                 |                                |

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466 **Legend:** FSS = Fatigue Severity Scale; MFIS = Modified Fatigue Impact Scale; Global LP = Global Life participation; Global LP-S = Global Life Participation Satisfaction; RNLI =  
467 Reintegration to Normal Living Index; COPM-P = Canadian Occupational performance Measure – Performance Scale; COPM-S = Canadian Occupational Performance Measure –  
468 Satisfaction Scale; SONG-HD Fatigue = Standardized Outcomes in Nephrology - Hemodialysis Fatigue

469 \*Values expressed are medians (interquartile ranges)

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3 471 **Figure Legends**

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7 474 **Figure 1:** CONSORT Participant Flow Diagram

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9 476 **Figure 2:** Proportion of Patients Achieving Life Participation Goals in Intervention vs. Control

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11 478 Note: “Improved” means increase of  $\geq 2$  points (established MCID) on COPM performance subscale;

12 479 “no change” means no clinically significant change; “declined” means decrease of  $\geq 2$  points on

13 480 COPM performance subscale

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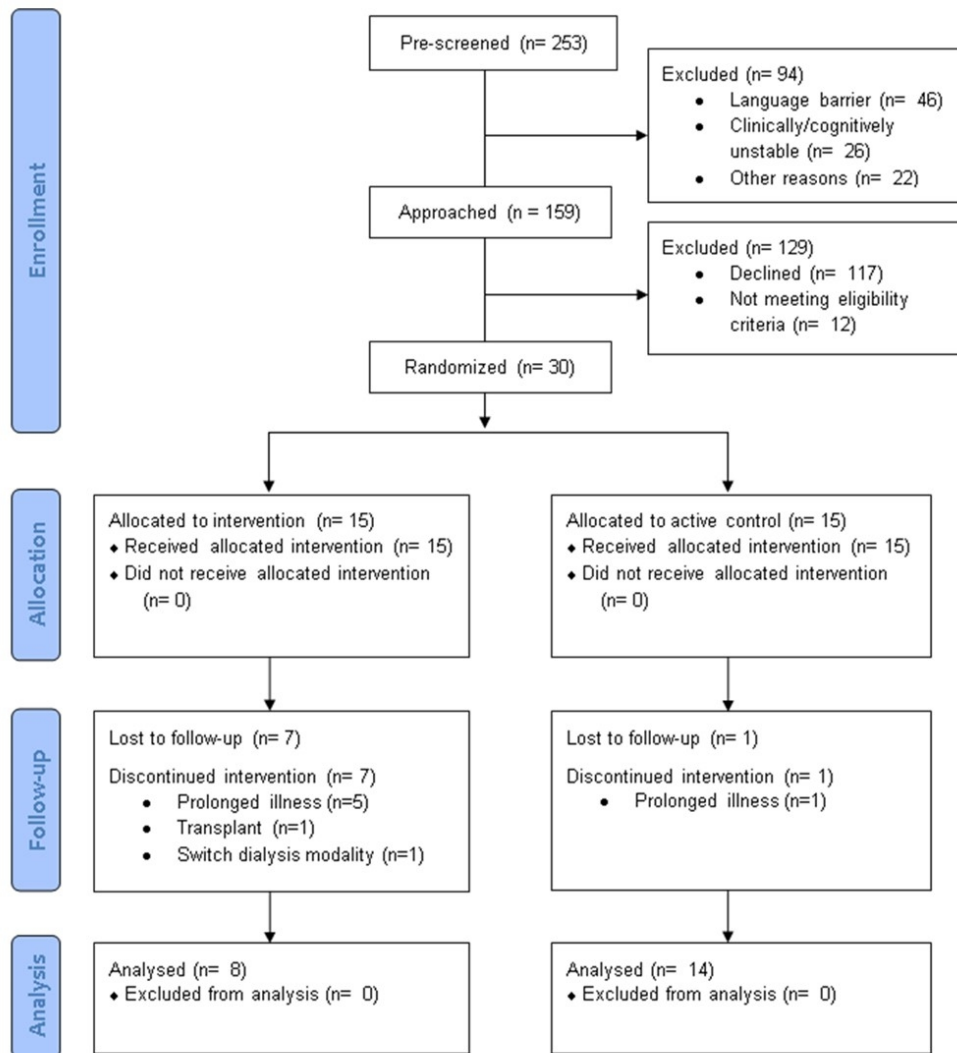
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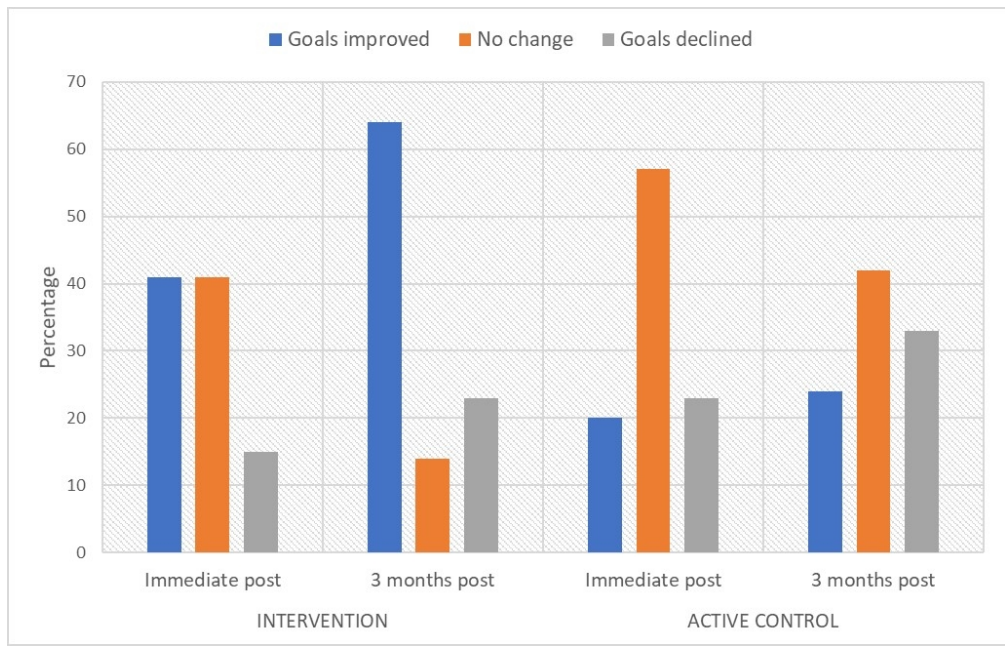
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CONSORT Participant Flow Diagram

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Proportion of Patients Achieving Life Participation Goals in Intervention vs. Control

173x110mm (150 x 150 DPI)

### Appendix 1: Cohen's D Effect Size Estimates, Assuming Best-Case and Worst-Case Scenarios for Missing Data

|                      | Immediate Post-Intervention |                    | 12 Weeks Post-Intervention |                    |
|----------------------|-----------------------------|--------------------|----------------------------|--------------------|
|                      | Worst-case scenario         | Best-case scenario | Worst-case scenario        | Best-case scenario |
| <b>FSS</b>           | .28<br>Small                | .36<br>Small       | Favours control            | Favours control    |
| <b>MFIS</b>          | Favours control             | Favours control    | Favours control            | Favours control    |
| <b>Global LP</b>     | .30<br>Small                | .74<br>Medium      | .42<br>Small               | .48<br>Small       |
| <b>Global LP-S</b>   | .32<br>Small                | .67<br>Medium      | .07<br>Very small          | .08<br>Very small  |
| <b>Self-Efficacy</b> | .43<br>Small                | .71<br>Medium      | Favours control            | Favours control    |
| <b>RNLI</b>          | Favours control             | Favours control    | Favours control            | Favours control    |
| <b>COPM-P</b>        | .25<br>Small                | .83<br>Large       | .30<br>Small               | 1.02<br>Large      |
| <b>COPM-S</b>        | .02<br>Very small           | .14<br>Very small  | .52<br>Medium              | 1.65<br>Very large |
| <b>SONG-HD</b>       | No difference               | .25<br>Small       | Favours control            | Favours control    |

**Legend:** FSS = Fatigue Severity Scale; MFIS = Modified Fatigue Impact Scale; Global LP = Global Life participation; Global LP-S = Global Life Participation Satisfaction; RNLI = Reintegration to Normal Living Index; COPM-P = Canadian Occupational performance Measure – Performance Scale; COPM-S = Canadian Occupational Performance Measure – Satisfaction Scale; SONG-HD Fatigue = Standardized Outcomes in Nephrology - Hemodialysis Fatigue

# Adapted CONSORT Checklist for Clinical Trials

| Section/Topic  | Checklist Item  | Response                     |
|--|---|------------------------------|
| <b>Title</b>   | Identified as a randomized trial in the title.  | Yes <input type="checkbox"/> |
| <b>Background</b>  | Specific objectives or hypotheses clearly stated.   | Yes <input type="checkbox"/> |
| <b>Trial Design</b>  | Trial design ( <i>such as parallel, factorial</i> ) including allocation ratio.   | Yes <input type="checkbox"/> |
|  | Important changes to methods after trial commencement ( <i>such as eligibility criteria</i> ), with reasons.  | NA <input type="checkbox"/>  |
| <b>Participants</b>  | Eligibility criteria for participants.  | Yes <input type="checkbox"/> |
|  | Settings and locations where the data were collected.   | Yes <input type="checkbox"/> |
| <b>Interventions</b>   | The interventions for each group with sufficient details to allow replication, including how and when they were actually administered.  | Yes <input type="checkbox"/> |
| <b>Outcomes</b>  | Completely defined per-specified primary and secondary outcome measures, including how and when they were assessed.   | Yes <input type="checkbox"/> |
|  | Any changes to trial outcomes after the trial commenced, with reasons.  | NA <input type="checkbox"/>  |
| <b>Sample Size</b>   | How sample size was determined.   | Yes <input type="checkbox"/> |
|  | Explanation of any interim analyses and stopping guidelines.  | NA <input type="checkbox"/>  |
| <b>Randomization</b>   |   |                              |
| • <b>Sequence generation</b>   | Method used to generate the random allocation sequence.   | Yes <input type="checkbox"/> |
|  | Type of randomization; details of any restriction ( <i>such as blocking and block size</i> ).   | Yes <input type="checkbox"/> |
| • <b>Allocation concealment mechanism</b>                            | Mechanism used to implement the random allocation sequence ( <i>such as sequentially numbered containers</i> ), describing any steps taken to conceal the sequence until interventions were assigned. | Yes <input type="checkbox"/> |
| • <b>Implementation</b>  | Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions.  | Yes <input type="checkbox"/> |
| <b>Blinding</b>  | If done, who was blinded after assignment to interventions ( <i>for example, participants, care providers, those assessing outcomes</i> ).  | Yes <input type="checkbox"/> |
|  | If relevant, description of the similarity of interventions.  | Yes <input type="checkbox"/> |
| <b>Statistical Methods</b>   | Statistical methods used to compare groups for primary and secondary outcomes.  | Yes <input type="checkbox"/> |
|  | Methods for additional analyses, such as subgroup analyses and adjusted analyses.   | Yes <input type="checkbox"/> |
| <b>Participant Flow</b> ( <i>a diagram is strongly recommended</i> ) | For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome.   | Yes <input type="checkbox"/> |
|  | For each group, losses and exclusions after randomization, together with reasons.   | Yes <input type="checkbox"/> |
| <b>Recruitment</b>   | Dates defining the periods of recruitment and follow-up.  | Yes <input type="checkbox"/> |
|  | Why the trial ended or was stopped.   | NA <input type="checkbox"/>  |
| <b>Baseline Data</b>   | A table showing baseline demographic and clinical characteristics for each group.   | Yes <input type="checkbox"/> |
| <b>Numbers Analyzed</b>  | For each group, number of participants ( <i>denominator</i> ) included in each analysis and whether the analysis was by original assigned groups.   | Yes <input type="checkbox"/> |
| <b>Outcomes and Estimation</b>                                       | For each primary and secondary outcome, results for each group, and the estimated effect size and its precision ( <i>such as 95% confidence interval</i> ).   | Yes <input type="checkbox"/> |
|  | For binary outcomes, presentation of both absolute and relative effect sizes.   | NA <input type="checkbox"/>  |
| <b>Ancillary Analyses</b>  | Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory.  | Yes <input type="checkbox"/> |
| <b>Harms</b>   | All important harms or unintended effects in each group.  | NA <input type="checkbox"/>  |
| <b>Data Sharing</b>  | A data sharing statement is included.   | Yes <input type="checkbox"/> |

## Additional Details:

# BMJ Open

## A Pilot Randomized Controlled Trial of an Energy Management Program for Adults on Maintenance Hemodialysis: The Fatigue-HD Study

|                                 |  |
|---------------------------------|--|
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| <b>Primary Subject Heading</b>: | Rehabilitation medicine  |
| Secondary Subject Heading:      | Renal medicine   |
| Keywords:                       | Dialysis < NEPHROLOGY, REHABILITATION MEDICINE, Chronic renal failure < NEPHROLOGY, End stage renal failure < NEPHROLOGY   |
|                                 |  |

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1 **A Pilot Randomized Controlled Trial of an Energy Management Program**  
2 **for Adults on Maintenance Hemodialysis: The Fatigue-HD Study**

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22 **Trial Registration:** NCT03825770; clinicaltrials.gov

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3 **23 Abstract**  
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6 **24 Background:** Identifying interventions to reduce fatigue and improve life participation are top  
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8  
9 **25** research priorities of people on maintenance hemodialysis.  
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11  
12 **26 Objective:** Our primary objective was to explore the feasibility of conducting a randomized  
13  
14 **27** controlled trial of an energy management program for people on maintenance hemodialysis.  
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17  
18 **28 Design:** Parallel-arm, 1:1, blinded, pilot randomized controlled trial.  
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21 **29 Participants:** Participants were recruited from 6 dialysis units in Calgary, Canada. Eligible  
22  
23 **30** patients were on maintenance hemodialysis, clinically stable, and reported disabling fatigue on  
24  
25 **31** the Fatigue Severity Scale items 5, 7, 8 and 9.  
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29 **32 Randomization:** Participants were randomized using a computer-generated random number  
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31 **33** sequence according to permuted blocked randomization, stratified by dialysis unit.  
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34 **34 Blinding:** Participants were blinded to treatment allocation.  
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38 **35 Interventions:** Participants received an attention control (general disease self-management  
39  
40 **36** education) or the Personal Energy Planning (PEP) program, a tailored, web-supported 7-9 week  
41  
42 **37** energy management program.  
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45  
46 **38 Outcomes:** Eligibility, recruitment and attrition rates were recorded, and standardized  
47  
48 **39** intervention effects (Hedge's G) were calculated for fatigue and life participation questionnaires  
49  
50 **40** at one week post-intervention and 12 weeks post-intervention.  
51  
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53  
54 **41 Results:** 159 of 253 screened patients were eligible to be approached. 42 (26%) had fatigue,  
55  
56 **42** were interested, and consented to participate, of whom 30 met eligibility criteria and were  
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3 43 randomized (mean age 62.4 ( $\pm$ 14.7), 60% male). Twenty-two enrolled participants (73%)  
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5 44 completed all study procedures. Medium-sized intervention effects were observed on the  
6  
7 45 Canadian Occupational Performance Measure (COPM)--Performance Scale, global life  
8  
9 46 participation scale, and global life participation satisfaction scale at one week post-intervention  
10  
11 47 follow-up, compared to control. At 12-week follow-up, large and very large intervention effects  
12  
13 48 were observed on the COPM Performance and Satisfaction Scales, respectively.  
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18 49 **Conclusion:** It is feasible to enroll and follow patients on hemodialysis in a randomized  
19  
20 50 controlled trial of an energy management intervention. As the intervention was associated with  
21  
22 51 improved life participation on some measures, a larger trial is justified.  
23  
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26 52 **Keywords:** Fatigue, life participation, chronic kidney disease, dialysis, energy management  
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3 62 **Strengths and Limitations:**  
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- 5 63       • We referenced the SPIRIT guidelines for a pilot RCT throughout the development and  
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7 writing of the trial protocol, and used a standardized intervention training protocol to  
8 64  
9 maximize treatment fidelity across program administrators  
10 65  
11  
12 66       • We used randomization, participant blinding and an active control group to control for  
13  
14 bias  
15 67  
16  
17 68       • Required proficiency in English means results might not be generalizable to non-English  
18  
19 speaking populations  
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22 70       • Unequal attrition rates between the intervention and control groups limits the conclusions  
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24 that can be drawn about program efficacy from this pilot study, underscoring the need for  
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26 further research to confirm these preliminary findings  
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## 82 Introduction

83 Kidney failure is associated with a variety of symptoms, including pain, nausea, and insomnia,  
84 that can affect quality of life<sup>1,2</sup>. One of the most challenging symptoms, chronic fatigue<sup>3</sup>, is  
85 experienced by an estimated 70% of the population with kidney failure on maintenance  
86 hemodialysis<sup>1</sup>. Fatigue can negatively affect various aspects of well-being in people with kidney  
87 failure, including mood, motivation, and quality of life<sup>4,5</sup>. However, its negative impact on their  
88 ability to participate in valued life activities (ie., life participation) has been identified as their top  
89 priority for research and intervention<sup>5</sup>. People on hemodialysis have described limitations in their  
90 ability to perform valued activities, such as work, socializing, and household management,  
91 because of fatigue<sup>4-6</sup>. They have indicated that the ability to participate in life activities should  
92 be a key indicator of treatment effectiveness<sup>5</sup>. However, evidence-based treatments to reduce  
93 fatigue or mitigate its impact on life participation are limited for this population. There are a  
94 complex and poorly-understood range of factors that contribute to kidney disease fatigue,  
95 including anemia, chronic inflammation, malnutrition, and depression<sup>7</sup>, which limits efficacious  
96 treatments. Erythropoietin stimulating agents (ESAs) and exercise training are currently the  
97 primary evidence-based approaches for treating fatigue in this population<sup>8,9</sup>; however, ESAs are  
98 already used in a large proportion of patients, and exercise training is challenging to promote in  
99 this patient group because of several factors including inadequate staff expertise, competing  
100 patient symptoms, and low motivation among patients to participate in exercise<sup>10,11</sup>. There is  
101 therefore a need to explore alternative approaches that can help people with kidney disease  
102 fatigue participate in valued life activities.

103

104 Energy management education (EME) aims to improve life participation in people with fatigue  
105 by providing strategies to conserve or reallocate energy during routine daily activities<sup>12</sup>. The

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3 106 theory underlying energy management is that life participation can be improved in people with  
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5 107 chronic fatigue by minimizing the exertional fatigue associated with performing daily  
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7 108 activities<sup>12,13</sup>; this exertional fatigue could either be a casual or exacerbating factor in the  
8  
9 109 underlying fatigue and disability experienced in many chronic diseases, including kidney  
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11 110 disease. Energy management strategies can include prioritizing, changing body postures,  
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13 111 organizing the home environment, or using assistive tools (eg. mobility aids, long-handled  
14  
15 112 reachers)<sup>14</sup>. The Personal Energy Planning (PEP) program is an energy management program  
16  
17 113 designed to improve life participation in people with kidney failure, by helping patients identify  
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19 114 energy management strategies that can facilitate their individual life participation goals<sup>15</sup>. Proof-  
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21 115 of-concept evidence has suggested the Personal Energy Planning (PEP) program might be  
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23 116 associated with improvements in life participation and/or fatigue in dialysis patients<sup>16</sup>, justifying  
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25 117 the need for further evaluation with a randomized controlled trial. However, recruitment for  
26  
27 118 randomized trials can be challenging in people with kidney failure<sup>17</sup>, in part due to a reluctance  
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29 119 among dialysis patients to participate in research studies that require extra study-related activities  
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31 120 or visits<sup>18</sup>. Furthermore, the acceptability of, and interest in, the energy management approach  
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33 121 has never been explored in people on maintenance hemodialysis.  
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42 123 We designed a randomized controlled trial of the “PEP” energy management program<sup>19</sup> that  
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44 124 attempts to minimize study burden by using simple communication materials (eg. a brochure-  
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46 125 style consent form); brief questionnaires; concise intervention sessions; and a flexibility around  
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48 126 missed or delayed treatment sessions. However, the feasibility of recruiting and retaining  
49  
50 127 participants for a trial of an energy management program remains unknown. More information is  
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52 128 also needed about how the “PEP” program impacts various facets of life participation and  
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3 129 fatigue, to inform the choice of a primary outcome measure and aid power calculations for a  
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5 130 randomized controlled trial.  
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10 132 The primary objective of our pilot trial was to estimate the proportion of patients on maintenance  
11  
12 133 hemodialysis that met eligibility criteria, agreed to participate, and completed all study  
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14 134 procedures for a randomized controlled trial of the “PEP” energy management education  
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16 135 program. Our secondary objective was to estimate the effects of the program on various facets of  
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18 136 fatigue and life participation, to ensure a trial will be adequately powered and will use the most  
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20 137 appropriate primary outcome measure.  
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## 25 26 139 **Methods**

### 27 28 29 140 *Study design*

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33 141 We conducted a multi-site, parallel group, 1:1, pilot randomized controlled trial<sup>19</sup>  
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35 142 ([www.clinicaltrials.gov](http://www.clinicaltrials.gov); NCT03825770). We randomized 30 participants on maintenance  
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37 143 hemodialysis to undergo the PEP energy management program, or an active control (general  
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39 144 self-management support).  
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### 42 43 145 *Ethics Approval*

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46 146 This pilot trial adhered to the principles of the Declaration of Helsinki and was approved by the  
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48 147 Conjoined Health Research Ethics Board at the University of Calgary (#18-1657).  
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3 150 *Participants*  
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6 151 We recruited participants on maintenance hemodialysis therapy at six hemodialysis units from  
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8 152 February 1, 2019 to August 27, 2019. We sought patients aged  $\geq 18$  years who were undergoing  
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10 153 hemodialysis for  $\geq 3$  months at time of recruitment; were clinically and cognitively stable (able to  
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12 154 provide informed consent); and scored an avg. of  $\geq 4$  on items 5, 7, 8 and 9 from the Fatigue  
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14 155 Severity Scale<sup>20</sup> (ie., items that assess the impact of fatigue on life participation). We excluded  
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16 156 patients if they had a plan in place to discontinue in-center hemodialysis within 6 months of  
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18 157 recruitment; if they had inadequate written and verbal English comprehension for study  
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20 158 activities; if they resided in a long-term care facility; or, if they had a visual impairment that  
21  
22 159 would preclude them from engaging with study materials. Original exclusion criteria also  
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24 160 included a score of  $>3$  on the PHQ-2 depression tool; however, this was subsequently removed  
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26 161 due to interest from patients in participating in the study, and a lack of conclusive evidence that  
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28 162 depression would impede study participation or outcomes. Instead, we measured and monitored  
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30 163 depression at baseline in all enrolled participants.  
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37 164 We approached patients identified by clinical staff as being clinically and cognitively stable and  
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39 165 English-speaking, to assess their interest in the study. Interested patients provided written  
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41 166 informed consent before we conducted full eligibility screening. We then enrolled and  
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43 167 randomized eligible and consenting patients into the study.  
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47 168 *Randomization and blinding*  
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51 169 We allocated participants equally (1:1) to intervention or control, using a computer-generated  
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53 170 random number sequence. We used permuted blocked randomization, with block sizes of 2-6,  
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55 171 stratified by dialysis unit. We concealed allocation by having a research manager not otherwise  
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3 172 involved with the study, provide treatment allocation to study coordinators over the phone. Study  
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5 173 participants were blinded to their treatment status (intervention or active control). It was not  
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8 174 feasible to blind study coordinators, given the extensive training they received to learn to  
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10 175 administer the intervention compared to the control.

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13 176 *Intervention: The “PEP” Program*

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16 177 Participants randomized to the treatment arm completed the tailored, 7-9 week PEP program<sup>14,18</sup>  
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18 (see Table 1 for further information). The PEP program is a two-part intervention that teaches  
19 178 participants how to use energy management strategies (e.g., simplifying tasks, pacing, using  
20  
21 179 assistive devices, organizing home environments) to improve participation in three self-selected  
22  
23 180 life activities. In the first part of the intervention, participants complete 3 web modules that  
24  
25 181 define and explain the energy management approach, and describe a structured strategy for  
26  
27 182 problem-solving around fatigue. In the second part of the intervention, participants work 1:1 with  
28  
29 183 a study coordinator during 4-6 sessions to apply the principles and strategies from part one, and  
30  
31 184 problem-solve around their fatigue problems to accomplish 3 life participation goals (eg. cook  
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33 185 dinner twice per week; garden in the backyard more frequently). The number of individual  
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35 186 sessions during this part was determined by individual patient needs and progress.  
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43 188 Study coordinators received in-person training in the treatment and control protocols from a  
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45 189 trained occupational therapist prior to administering the intervention. Training consisted of three  
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47 190 in-person training sessions, led by an occupational therapist (JF), on the core facilitation skills of  
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49 191 the problem-solving method used in PEP (client-chosen goals, guided discovery, global problem-  
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51 192 solving strategy, dynamic performance analysis, and energy management strategies). They were  
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53 193 also provided with a written guidebook, including suggested scripts to introduce key concepts;  
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3 194 example dialogues between coach and patients; and analysis questions and suggested energy  
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5 195 management suggestions for various possible life participation goals. Study coordinators  
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8 196 monitored and encouraged participant adherence to the treatment protocol during weekly visits.  
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10 197 Missed or incomplete intervention sessions were documented and addressed as outlined in the  
11  
12 198 study protocol<sup>19</sup>.

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16 199 *Control: General information about kidney disease*

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19 200 Participants randomized to the control arm reviewed general information about kidney disease  
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21 201 management (eg. blood pressure management; diet; communicating with healthcare team) from  
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23 202 the Kidney School online learning modules during six to eight 1:1 sessions with a trained study  
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25 203 coordinator. Sessions took place while participants were undergoing hemodialysis.

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29 204 *Data collection*

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32 205 Trained study coordinators collected baseline demographic and clinical data on participants at  
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34 206 the time of the first study visit, through chart review and/or participant interview. The study  
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36 207 coordinators tracked the number of screened patients who met study eligibility criteria,  
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38 208 consented to participate, and completed all study procedures (intervention and assessment  
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40 209 sessions), using study logs. The study coordinators administered a series of self-reported  
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42 210 questionnaires measuring life participation and fatigue (see Table 2 for list of measures and  
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44 211 details), at three timepoints:

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48 212 1. Pre-intervention baseline;  
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50 213 2. One week after the PEP program was completed;  
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52 214 3. 12 weeks after the PEP program was completed

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56 215 Participants completed study questionnaires during their hemodialysis sessions.  
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3 216 *Statistical analyses*  
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6 217 We calculated the proportion of patients on hemodialysis meeting each of the feasibility  
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8 218 endpoints (study eligibility, enrolment and completion), with accompanying 95% confidence  
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10 219 intervals. We reported participant demographic and clinical data as means and standard  
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12 220 deviations for continuous parametric data; medians and interquartile ranges for continuous  
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14 221 nonparametric data; and frequencies and percentages for categorical data. We then calculated  
15  
16 222 raw and standardized treatment effect sizes for each life participation and fatigue outcome  
17  
18 223 measure, at both the one week post-intervention and twelve weeks post-intervention timepoints.  
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20 224 We used the Hedge's G statistic to calculate standardized effect sizes, and categorized effect size  
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22 225 estimates as very small (0.01-0.20), small (0.2-0.49), medium (0.5-0.79), large (0.8-1.19), or  
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24 226 very large ( $>1.20$ )<sup>21</sup>. Missing follow-up data were addressed using pairwise deletion.  
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30 227 Post-hoc sensitivity analyses were performed that assumed best-case scenario for missing data  
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32 228 (ie. the median intervention effect was imputed for missing intervention values, and the median  
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34 229 control effect was imputed for missing control values), and worst-case scenario (ie. the median  
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36 230 intervention effect was imputed for missing control values, and the median control effect was  
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38 231 imputed for missing intervention values).  
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43 232 *Sample size*  
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45 233 We originally chose a sample size of 40 patients for the pilot trial. This was based on  
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47 234 recommendations for optimal pilot study sample sizes<sup>22</sup>, an expected participant pool of 425  
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49 235 patients, and our anticipated eligibility and recruitment rates. The target sample size was  
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51 236 subsequently reduced to 30 due to an inability of our study team to follow patients on evening  
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53 237 dialysis shifts, which reduced our potential participant pool from 425 to 253 patients.  
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3 238 *Patient and public involvement*  
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6 239 The study intervention was developed based on results of patient engagement research which  
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8 240 suggested a need to further investigate fatigue in kidney disease. Two patients were involved in  
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10 241 the development of the intervention through a series of individual interviews.. Two patients were  
11  
12 242 consulted about the acceptability of the active control used in this study. A patient partner  
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14 243 reviewed the manuscript and provided feedback about the discussion and interpretation of  
15  
16 244 results. Patient involvement resulted in refinement and improvement of both the intervention and  
17  
18 245 control conditions, to enhance their acceptability to patients. Our patient partner provided  
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20 246 valuable insights about important qualitative information to collect from patients, which was  
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22 247 subsequently incorporated into a sub-study involving a follow-up interviews with study  
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24 248 participants.  
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30 249 **Results**  
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34 250 *Feasibility*  
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36 251 We screened all patients (n=253) undergoing daytime maintenance hemodialysis at six dialysis  
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38 252 centers between February and August 2019 for preliminary eligibility ie. (no language barrier,  
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40 253 clinically and cognitively stable) (Figure 1). All 159 patients who met preliminary criteria for the  
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42 254 study (63% (95% CI 57, 69%)) were approached. 42 patients (26% (95% CI 20%, 34%))  
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44 255 reported fatigue, were interested in participating, and provided consent. Of those, 30 patients  
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46 256 (71% (95% CI 55%, 84%)) met full study eligibility criteria and were enrolled and randomized.  
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48 257 In total, 30 of 159 clinically stable and English-speaking patients (19%, 95% CI 13%, 25%) were  
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50 258 enrolled in the study.  
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22 of 30 enrolled patients (73% (95% CI 54%, 88%)) completed all study procedures: 8 in the intervention group, and 14 in the control group. Reasons for study discontinuation in the intervention group included: hospitalization or illness due to nephrectomy (n=1), hypoxia (n=1), neurological symptoms (n=1), or unknown reason (n=1); low blood pressure during dialysis (n=1); switching dialysis modalities (n=1); and kidney transplantation (n=1). The reason for discontinuation in the control group was hospitalization due to unknown reason (n=1).

### *Participant characteristics*

Baseline characteristics of participants are described in Table 3. The mean age of participants was 62.4 (SD = 14.7), 60% were male, and 50% had diabetes. Participants had been on dialysis for a median of 3.6 years (IQR 1.8, 7.3), and 77% were living independently at baseline. Thirty percent of participants screened positively for cognitive impairment, and 40% screened positively for depression. Participant characteristics were similar across treatment and control groups (Table 3).

### *Effect size estimates*

We observed a large standardized intervention effect at the one week post-intervention follow-up assessment on the COPM-Performance Scale (Hedge's G = .62; moderate effect), compared to control. At one week post-intervention, participants in the intervention group (n=10) reported a clinically meaningful improvement ( $\geq 2$  points) in 40% of their life participation goals according to the COPM-Performance Scale, compared to 21% in the active control group (n=14) (Figure 2). We also observed moderate intervention effects on the Fatigue Management Questionnaire's Global Life Participation Scale (Hedge's G = .50), Global Life Participation Satisfaction Scale (Hedge's G = .50), and Self-Efficacy Scale (Hedge's G = .50). The remainder of fatigue and life

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3 281 participation measures detected either small intervention effects, or no effects, at one week post-  
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5 282 intervention follow-up compared to control (Table 4).  
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8 283 At 12-weeks post-intervention, we observed large and very large effects on the COPM-  
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10 284 Performance Scale (Hedge's  $G = .90$ ) and COPM-Satisfaction Scale (Hedge's  $G = 1.36$ ) in the  
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12 285 intervention group ( $n=8$ ), respectively, compared to control ( $n=14$ ) (Table 4). Participants in the  
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14 286 intervention group reported a clinically meaningful improvement ( $\geq 2$  points) in 64% of their life  
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16 287 participation goals according to the COPM-Performance Scale at the 12 week post-intervention  
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18 288 timepoint, compared to 24% in the active control group (Figure 2). We found minimal to no  
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20 289 effects associated with the intervention on the remainder of fatigue or life participation measures  
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22 290 at the 12-week post-intervention follow-up, compared to control. Results of the sensitivity  
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24 291 analysis, assuming best-case and worst-case scenarios for missing data, are included in Appendix  
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## 31 293 **Discussion**

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35 294 In this pilot study, we assessed the feasibility of recruiting and retaining patients on maintenance  
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37 295 hemodialysis with fatigue for a randomized controlled trial of an energy management program,  
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39 296 and the potential impact of such a program. Although previous proof-of-principle evidence<sup>16</sup>  
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41 297 suggested a randomized controlled trial was warranted, the proportion of participants who would  
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43 298 commit to completing study activities (eg. intervention sessions, outcome questionnaires) for a  
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45 299 trial was unknown. Furthermore, the impact of the "PEP" program on various facets of life  
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47 300 participation and fatigue compared to a control group remained unclear. We were able to recruit  
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49 301 ~25% of clinically stable and English-speaking hemodialysis patients into this pilot randomized  
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51 302 controlled trial, and retain 70% of enrolled participants for the duration of the trial, which met  
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53 303 our pre-trial expectations for study participation<sup>19</sup>. Although fatigue did not appear to be affected  
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3 304 by the PEP program, the program was associated with medium to large-sized effect on  
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5 305 personalized life participation at both short-term and medium-term follow-up, compared to an  
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7 306 attention control condition. Collectively, these results suggest that a randomized controlled trial  
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10 307 of the PEP program would be feasible, and is warranted.  
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14 309 Our recruitment and retainment results suggest that, despite the added responsibilities of filling  
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16 310 out study questionnaires and completing the intervention or control program, the study was  
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18 311 acceptable to a substantial proportion of our target population. We note that although only 25%  
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20 312 of stable and English-speaking hemodialysis patients consented to participate, only 50-70% of  
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22 313 them likely had fatigue, based on existing estimates of fatigue prevalence<sup>1</sup>; thus, we estimate that  
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24 314 approximately half of eligible patients with fatigue in fact agreed to the study. This suggests that  
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26 315 study burden was not an insurmountable barrier to recruitment. Although the dropout rate was  
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28 316 higher in the intervention arm than the control (43 vs. 13%), our documented reasons for study  
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30 317 withdrawals were unrelated to the intervention, and were rather due to the general medical  
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32 318 complexity of this patient population. We therefore assume that with a larger sample of patients,  
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34 319 the attrition rate would balance between the two groups. Our overall attrition rate of 30% is not  
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36 320 unexpected for the dialysis population over the course of a five-month study, given that they  
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38 321 typically experience high rates of acute medical events and hospitalizations<sup>23,24</sup>. We attribute the  
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40 322 general acceptability of the intervention to the use of study materials that were user-friendly (eg.  
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42 323 a brochure-style consent form); brief questionnaires to assess target outcomes; and a flexible  
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44 324 protocol for missed treatment sessions. Acceptability could be further increased in a full-scale  
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46 325 trial by reducing the number of questionnaires used to assess life participation and fatigue,  
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48 326 particularly now that the pilot trial has provided clarity about the best measures for assessing  
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50 327 these outcomes.  
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3 328 The finding that the PEP program was associated with improvements in life participation,  
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5 329 compared to control, is important because this outcome directly aligns with patient priorities<sup>3,5</sup>.  
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8 330 Patients on hemodialysis with fatigue view life participation as “the fundamental goal of  
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10 331 treatment, because it symbolizes some indicator of being able to live a life without being  
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12 332 confined by the disease”<sup>5</sup>. Although fatigue was not directly impacted by the intervention, our  
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14 333 results suggest that energy management strategies developed during the intervention might have  
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16 334 helped participants to accomplish their day-to-day goals more effectively by working around  
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18 335 fatigue. In addition, the fatigue measures used in this study do not directly assess exertional  
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20 336 fatigue (the type of fatigue targeted by the PEP program); as such, participants might have been  
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22 337 reporting that their underlying “baseline” level of fatigue had not changed in response to the  
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24 338 program, but still might have been experiencing a reduction in exertional fatigue during valued  
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26 339 activities. The improvement in personalized life participation we observed in this study is,  
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28 340 nonetheless, significant and relatively unique within the energy management literature<sup>25</sup>. Our  
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30 341 intervention incorporated a number of novel features to more directly target life participation,  
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32 342 compared to other energy management interventions, in accordance with the priorities of  
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34 343 hemodialysis patients. For example, we used personalized goal-setting to ensure interventions  
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36 344 were tailored to specific patients’ needs, and a problem-solving training approach to facilitate  
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38 345 patient independence at solving their own life participation challenges. Our findings support the  
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40 346 potential efficacy of these features, although it is important to note the potential impact of  
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42 347 unequal attrition between the intervention and control groups on our pilot results. This further  
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44 348 emphasizes the need for a full-scale trial to more conclusively establish program effectiveness.  
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52 349 With respect to outcome measures, we found that the Canadian Occupational Performance  
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54 350 Measure<sup>26</sup> detected the strongest intervention effects compared to other life participation and  
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3 351 fatigue measures. The validity and reliability of the life participation measures used have not  
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5 352 been established in the chronic kidney disease population; as such, measures such as the  
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7 353 Reintegration to Normal Living Index or Fatigue Management Questionnaire might not have  
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9 354 detected intervention effects because, for example, they did not capture relevant areas or aspects  
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11 355 of life participation among this population; were not worded in an understandable way, or were  
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13 356 not responsive enough to capture changes in the outcomes, among other potential explanations.  
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15 357 The COPM is also the only measure we used that assessed life participation in patient-chosen  
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17 358 activities, rather than a generic set of life activities and/or areas which might not have been  
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19 359 relevant to the study participants. This also might explain the enhanced performance of the  
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21 360 COPM at detecting change associated with the intervention, compared to the other life  
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23 361 participation measures. Although the COPM has similarly not been formally validated in people  
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25 362 with kidney failure, it has strong validity, reliability and responsiveness data from multiple other  
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27 363 clinical populations and age groups<sup>27</sup>, and uniquely aligns with preferences of people with  
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29 364 kidney disease for a measure of life participation that is individualized<sup>5</sup>. Collectively, these  
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31 365 findings suggest the COPM is the best choice for a primary outcome for an RCT of the “PEP”  
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33 366 program. Estimates based on our pilot results suggest data on 36 participants would be needed to  
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35 367 detect a clinically meaningful change of >2 points on the COPM-performance scale in a  
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37 368 randomized controlled trial, with significance set at 80% power and p=0.05. Based on our rates  
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39 369 of screened-to-enrolled patients, the participant screening pool would need to include 415  
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41 370 patients on hemodialysis to achieve this sample size.

### 371 *Study Limitations*

372 We excluded non-English speaking patients from the study, limiting its generalizability to non-  
373 English-speaking people with kidney failure. Positive findings about the PEP program might,

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3 374 however, justify developing program materials in the future that are accessible to a wider range  
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5 375 of people with kidney disease. We were also unable to blind study coordinators to participants'  
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7 376 treatment allocation, which might have unduly affected their approach to treatment. The  
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9 377 infeasibility of blinding is a well-recognized limitation of trials that study psychosocial or  
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11 378 behavioural interventions, because of the challenges of identifying and implementing an  
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13 379 appropriate control. Finally, unequal attrition rates between the intervention and control groups  
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15 380 limits the conclusions that can be drawn about program efficacy from this pilot study, and  
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17 381 underscores the need for further research using a larger sample of patients to confirm our  
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19 382 preliminary results.  
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### 25 383 **Conclusions**

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28 384 The PEP energy management program appears to be acceptable to patients, and might lead to  
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30 385 improvements in life participation. Further investigation in an adequately powered randomized  
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32 386 controlled trial is warranted.  
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39 388 None.  
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### 42 389 **Conflict of Interest Statement**

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46 390 The authors have no conflicts of interest to disclose. Results presented in this paper have not  
47  
48 391 been published previously in whole or part, except in abstract format.  
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### 51 392 **Data Sharing Statement**

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55 393 Data from the study can be made available upon reasonable request to the corresponding author.  
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### 394 **Authors' Contributions**

395 JF led the design, coordination, analysis and authorship of the study and manuscript. BH  
396 provided advice and mentorship on all aspects of the study. CT, BM and MD helped with the  
397 development of the participant identification plan, and provided advice on other key study issues.  
398 PR and ME contributed feedback on trial design. All authors assisted with the interpretation and  
399 presentation of results for publication. NV provided review and perspective from a patient's  
400 point of view.

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503 **Table 1: Description of the Personal Energy Planning (“PEP”) Program**

| Program Section                                   | Description  |
|---|--|
| <b>Part 1:<br/>Computer modules</b>               | <ul style="list-style-type: none"> <li>• Participants complete 3 computer modules over 3 sessions (~20-30 mins each) that explain the basic principles of energy management</li> <li>• Modules are completed on laptops during hemodialysis sessions, with support for module completion provided by study coordinators</li> </ul>   |
| <b>Part 2:<br/>Individualized problem-solving</b> | <ul style="list-style-type: none"> <li>• Participants work 1:1 with a trained administrator over 4-6 sessions (~30 mins each) to develop energy management strategies for 3 life participation goals</li> <li>• Energy management strategies are developed using a metacognitive problem-solving process called “<b>Goal-Plan-Do-Check</b>”:             <ol style="list-style-type: none"> <li>1. Set a life participation <b>goal</b></li> <li>2. Analyze current energy expenditure patterns to come up with a <b>plan</b> to conserve energy for the goal;</li> <li>3. <b>Do</b> the plan;</li> <li>4. <b>Check</b> to see if it worked, and what aspects of the plan should be revised</li> </ol> </li> <li>• This process continues until an effective plan is found for each goal, or the program maximum of 9 weekly treatment sessions is reached</li> <li>• Study coordinators use <b>guided discovery teaching</b> to encourage patient independence in working through the Goal-Plan-Do-Check process</li> </ul> |

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510 **Table 2: Life Participation and Fatigue Outcome Measures**

| Outcome                   | Measure   | Description  |
|---------------------------|---|--|
| <b>Life participation</b> | <i>Canadian Occupational Performance Measure</i> <sup>26</sup> – <i>Performance Subscale (COPM-P)</i> | Asks individuals to rate, on a 10-point Likert scale, his/her performance in each of three self-selected priority activities of everyday living. Higher scores out of 10 indicate better performance. The COPM has been found to be a valid, reliable, clinically useful and responsive measure of occupational performance in multiple chronic disease populations <sup>27</sup> .  |
|                           | <i>COPM</i> <sup>26</sup> – <i>Satisfaction Subscale (COPM-S)</i>                                     | Asks individuals to rate, on a 10-point Likert scale, their satisfaction with their performance in three self-selected priority activities of everyday living. Higher scores out of 10 indicate better satisfaction with performance.  |
|                           | <i>Reintegration to Normal Living Index</i> <sup>28</sup> (RNLI)                                      | Assesses the degree to which individuals who have experienced traumatic or incapacitating illness achieve reintegration into normal activities, using 11 declarative statements each accompanied by a 10-point visual analogue scale. Scores are then added to produce an overall score out of 110, with higher scores indicating better reintegration to normal living. The RNLI has strong validity and reliability in multiple chronic disease populations <sup>29</sup> .  |
|                           | <i>Fatigue Management Questionnaire (FMQ)</i>   | Asks individuals to rate various aspects of their fatigue management (e.g., overall impact on life participation; satisfaction; self-efficacy), out of 10, on five Likert-scale questions. Scores are then summed and averaged for each of two subscales (Performance subscale, or FMQ-P, and Satisfaction subscale, or FMQ-S), with higher scores out of 10 indicating better fatigue management. The FMQ was created for this study to assess life participation and self-efficacy pertaining to fatigue management. |
| <b>Fatigue</b>            | <i>Fatigue Severity Scale</i> <sup>20</sup> (FSS)   | Includes 9 items that ask individuals to rate, on a Likert scale from 1-7, the severity of their fatigue and its impact on their life during the past week. Scores are then summed and averaged to create a total score out of 7, with higher scores indicating worse fatigue. The FSS is a valid, reliable and responsive measure <sup>30</sup> that has been used in the dialysis population.  |
|                           | <i>Modified Fatigue Impact Scale</i> <sup>31</sup> (MFIS)   | A 21-item Likert-based scale that assesses the effects of fatigue on physical, cognitive, and psychosocial functioning. Scores are summed to produce an overall score out of 84, with higher scores indicating worse fatigue impact. The MFIS is frequently used as an outcome measure in energy management studies.   |
|                           | <i>*SONG-HD Fatigue</i> <sup>32</sup>   | Assesses the severity of fatigue, and its impact on daily living, in people on maintenance hemodialysis using 3 Likert-style questions. Scores are summed to produce a total score out of 9, with higher scores indicating worse fatigue. The measure was developed in conjunction with kidney failure patients and other key informants, and is currently undergoing psychometric validation.   |

511 \*Measure was finalized and added after trial registration, upon consultation with the measure developers

512 **Table 3: Baseline Characteristics of Participants**

|   | All Participants<br>(n=30) | Control<br>(n = 15) | Intervention<br>(n = 15) |
|---|----------------------------|---------------------|--------------------------|
| <b>Age (yrs) (mean, SD)</b>                       | 62.4 (14.7)                | 64.8 (14.4)         | 60.0 (15.1)              |
| <b>Male</b>                                       | 18 (60)                    | 10 (67)             | 8 (53)                   |
| <b>Residence</b>                                  |                            |                     |                          |
| <i>Independent living</i>                         | 27 (90)                    | 14 (93)             | 13 (86)                  |
| <i>Retirement/supported living</i>                | 3 (10)                     | 1                   | 2                        |
| <b>Lives alone</b>                                | 20 (67)                    | 6 (40)              | 4 (27)                   |
| <b>Married</b>                                    | 17 (57)                    | 10 (67)             | 7 (46)                   |
| <b>Employed</b>                                   | 4 (27)                     | 0 (0)               | 4 (27)                   |
| <b>Education</b>                                  |                            |                     |                          |
| <i>No high school diploma</i>                     | 3 (10)                     | 2 (13)              | 1 (7)                    |
| <i>High school diploma</i>                        | 12 (40)                    | 6 (40)              | 6 (40)                   |
| <i>College/trade school</i>                       | 10 (33)                    | 5 (33)              | 5 (33)                   |
| <i>University degree</i>                          | 4 (13)                     | 2 (13)              | 2 (13)                   |
| <i>Graduate/professional degree</i>               | 1 (3)                      | 0 (0)               | 1 (7)                    |
| <b>Uses computer/tablet/phone</b>                 | 27 (3)                     | 14 (93)             | 13 (86)                  |
| <b>Dialysis vintage (yrs) (Median, IQR)</b>       | 3.6 (1.8, 7.3)             | 2.6 (1.7, 6.0)      | 4.0 (1.7, 9.5)           |
| <b>Comorbidities</b>                              |                            |                     |                          |
| <i>Diabetes</i>                                   | 15 (50)                    | 9 (60)              | 6 (40)                   |
| <i>Depression</i>                                 | 9 (30)                     | 3 (20)              | 6 (40)                   |
| <i>Coronary artery disease</i>                    | 10 (33)                    | 6 (40)              | 4 (27)                   |
| <i>Congestive heart failure</i>                   | 8 (27)                     | 3 (20)              | 5 (33)                   |
| <i>Cerebrovascular disease</i>                    | 3 (10)                     | 3 (12)              | 0 (0)                    |
| <i>Alzheimer's disease</i>                        | 1 (3)                      | 0 (0)               | 1 (7)                    |
| <i>Multiple Sclerosis</i>                         | 1 (3)                      | 0 (0)               | 1 (7)                    |
| <i>Chronic Obstructive Pulmonary Disease</i>      | 1 (3)                      | 1 (7)               | 0 (0)                    |
| <i>Cancer</i>                                     | 7 (23)                     | 5 (33)              | 2 (13)                   |
| <b>Baseline serum hemoglobin (g/L) (Mean, SD)</b> | 101.6 (18.7)               | 107.7 (8.7)         | 95.0 (23.3)              |
| <b>Baseline serum albumin (g/L) (Mean, SD)</b>    | 35.0 (10.8)                | 33.0 (3.9)          | 37.2 (15.0)              |
| <b>Activities of daily living dependence</b>      | 7 (23)                     | 2 (13)              | 5 (33)                   |
| <b>MiniCog impaired</b>                           | 9 (30)                     | 4 (27)              | 5 (33)                   |
| <b>Personal Health Questionnaire-2 impaired</b>   | 12 (40)                    | 5 (33)              | 7 (47)                   |

\*Data are expressed as n(%) unless otherwise specified

RUNNING HEAD:

514 **Table 4: Changes in Fatigue and Life Participation Ratings in the Intervention versus Control Groups**

| Domain             | Measure         | Study Arm | Baseline           | One Week Post-Treatment Follow-up |                                   |   | 12 Weeks Post-Treatment Follow-up |                                   |  |
|--------------------|-----------------|-----------|--------------------|-----------------------------------|-----------------------------------|---|-----------------------------------|-----------------------------------|--|
|                    |                 |           | Median score (IQR) | Median score (IQR)                | Median change from baseline (IQR) | Hedge's G Hedge's Geffect size estimate | Median score (IQR)                | Median change from baseline (IQR) | Hedge's G Hedge's G effect size estimate |
| Life Participation | COPM-P          | Control   | 4.3 (3.7, 7.7)     | 4.7 (2.5, 7.8)                    | -0.3 (-1.8, +1.0)                 | 0.62<br>Medium                          | 4.3 (1.7, 5.3)                    | +0.3 (-2.0, +1.3)                 | 0.90<br>Large                            |
|                    |                 | Treatment | 4.7 (4.0, 6.7)     | 5.3 (4.7, 6.7)                    | +1.3 (+0.3, +1.7)                 |   | 6.8 (5.4, 7.6)                    | +1.9 (0.0, +3.5)                  |  |
|                    | COPM-S          | Control   | 4.0 (2.3, 8.0)     | 6.0 (3.0, 8.0)                    | +0.3 (-0.8, +2.0)                 | 0.13<br>Very small                      | 4.0 (1.0, 5.0)                    | 0.0 (-2.0, +0.7)                  | 1.36<br>Very large                       |
|                    |                 | Treatment | 4.0 (3.3, 5.3)     | 5.3 (3.8, 6.5)                    | +0.7 (-0.3, +1.8)                 |   | 6.7 (4.9, 7.5)                    | +1.8 (+1.4, +3.1)                 |  |
|                    | FMQ-Global LP   | Control   | 6.0 (4.7, 7.0)     | 6.5 (4.8, 8.1)                    | 0.0 (-1.4, +2.4)                  | 0.50<br>Medium                          | 5.6 (3.0, 8.0)                    | -0.4 (-2.0, +1.0)                 | 0.16<br>Very small                       |
|                    |                 | Treatment | 4.7 (3, 6.3)       | 6.3 (5.8, 7.4)                    | +1.8 (+.5, +2.1)                  |   | 5 (2.25, 5.75)                    | +1.0 (-2.0, +4.0)                 |  |
|                    | FMQ-Global LPS  | Control   | 5.0 (4.0, 8)       | 7.5 (4.5, 9.0)                    | +1.0 (-1.3, +3.3)                 | 0.50<br>Medium                          | 6.0 (4.0, 7.5)                    | 0.0 (-2.0, +1.0)                  | 0.16<br>Very small                       |
|                    |                 | Treatment | 4.0 (2.0, 5.0)     | 7.0 (4.5, 8.3)                    | +4.0 (+.5, +5.3)                  |   | 4.5 (2.25, 5.75)                  | 0.0 (-2.0, +4.0)                  |  |
|                    | RNLI            | Control   | 78 (51, 88)        | 81.0 (58.0, 94.0)                 | -1.0 (-5.0, +15.0)                | Favours control                         | 83 (60, 101)                      | +5.5 (-7.5, +24.0)                | Favours control                          |
|                    |                 | Treatment | 71 (56, 83)        | 61.5 (51.5, 78.8)                 | -3.0 (-10.0, +11.3)               |   | 61.5 (50.5, 78.5)                 | -1.0 (-20.0, +12.8)               |  |
| Fatigue            | FSS             | Control   | 5.0 (4.3, 6.1)     | 4.3 (3.8, 5.9)                    | -0.3 (-1.1, +1.0)                 | 0.36<br>Small                           | 4.0 (2.7, 4.9)                    | -1.1 (-1.8, -3.5)                 | Favours control                          |
|                    |                 | Treatment | 6.0 (5.6, 6.3)     | 5.3 (4.4, 6.0)                    | -0.6 (-1.9, +0.2)                 |   | 5.2 (4.1, 6.0)                    | -0.8 (-1.0, 0.0)                  |  |
|                    | MFIS            | Control   | 50.0 (38, 55)      | 39.5 (29.5, 49.3)                 | -6.5 (-23, +5)                    | Favours control                         | 29 (22.5, 49.5)                   | -12.0 (-20.0, -6.5)               | Favours control                          |
|                    |                 | Treatment | 52.0 (45, 59)      | 48 (38.5, 51.5)                   | -8.0 (-13, +1.5)                  |   | 47.5 (39.0, 65.0)                 | -1.0 (-10.0, +12.0)               |  |
|                    | Song-HD Fatigue | Control   | 6.0 (4.0,7.0)      | 4.5 (3.3, 7.0)                    | 0.0 (-2.0, 0.0)                   | 0.15<br>Very small                      | 5.0 (3.25, 6.0)                   | -1.0 (-2.0, +1.0)                 | Favours control                          |
|                    |                 | Treatment | 6.0 (3.8, 9)       | 5.0 (3.8, 6.0)                    | -1.0 (-4.5, +2.5)                 |   | 6.0 (5.0, 6.0)                    | 0.0 (-1.0, +3.0)                  |  |
|                    | Self-Efficacy   | Control   | 5.0 (5.0, 8.0)     | 6.2 (5.0, 9.0)                    | +0.2 (-1.0, +3.3)                 | 0.50<br>Medium                          | 8.0 (4.5, 9.0)                    | 0.0 (-1.0, +3.0)                  | 0.02<br>Very small                       |
|                    |                 | Treatment | 4.0 (2.0, 5.0)     | 6.5 (4.3, 7.3)                    | +3.0 (-0.0, +3.0)                 |   | 5.0 (3.0, 5.0)                    | +0.5 (-1.5, +3.0)                 |  |

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516 **Legend:** FSS = Fatigue Severity Scale; MFIS = Modified Fatigue Impact Scale; Global LP = Global Life participation; Global LP-S = Global Life Participation Satisfaction; RNLI =  
517 Reintegration to Normal Living Index; COPM-P = Canadian Occupational performance Measure – Performance Scale; COPM-S = Canadian Occupational Performance Measure –  
518 Satisfaction Scale; SONG-HD Fatigue = Standardized Outcomes in Nephrology - Hemodialysis Fatigue

519 \*Values expressed are medians (interquartile ranges)

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3 520 **Figure Legends**

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7 523 **Figure 1:** CONSORT Participant Flow Diagram

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9 525 **Figure 2:** Proportion of Patients Achieving Life Participation Goals in Intervention vs. Control

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11 527 Note: “Improved” means increase of  $\geq 2$  points (established MCID) on COPM performance subscale;

12 528 “no change” means no clinically significant change; “declined” means decrease of  $\geq 2$  points on

13 529 COPM performance subscale

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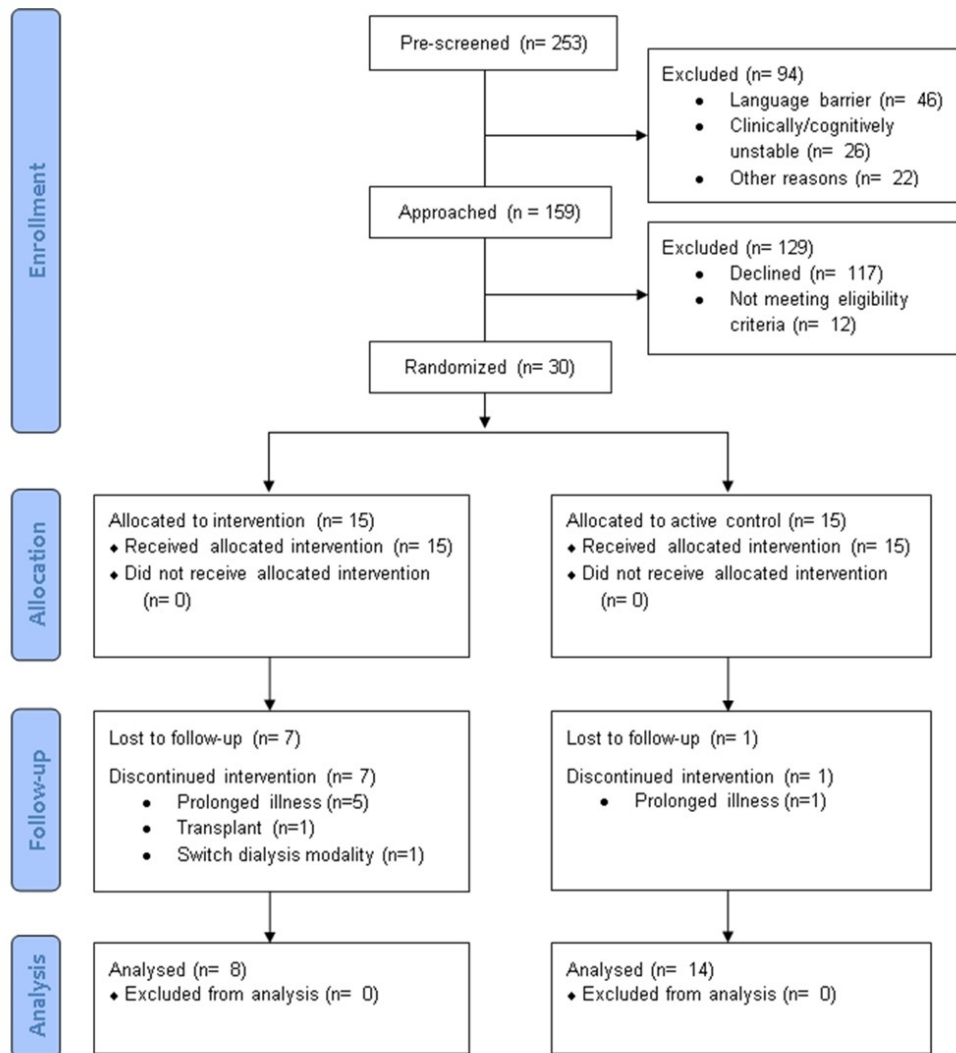
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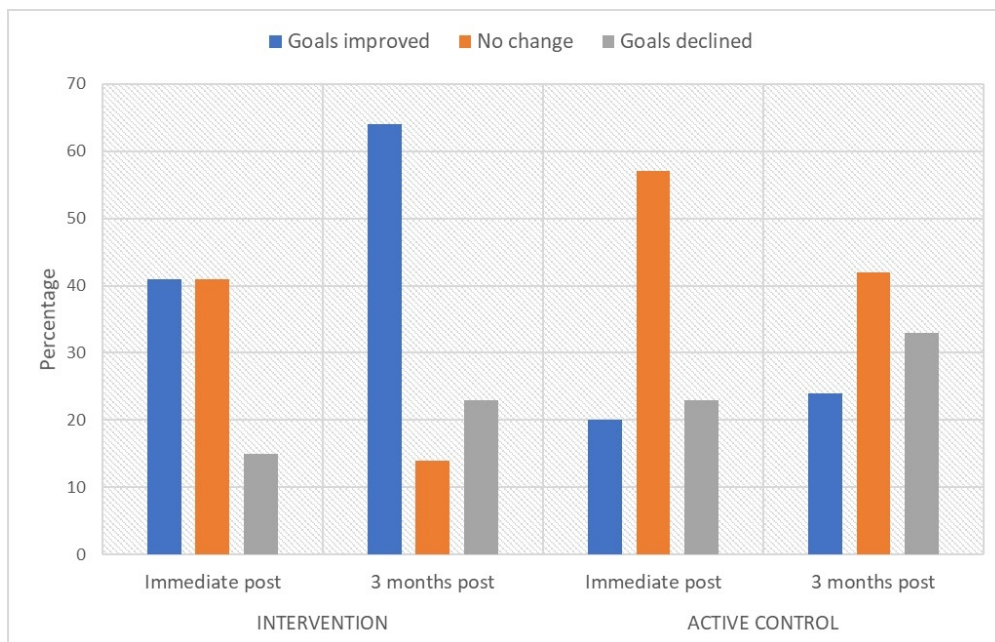
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CONSORT Participant Flow Diagram

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Proportion of Patients Achieving Life Participation Goals in Intervention vs. Control

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### Appendix 1: Hedge's G Effect Size Estimates, Assuming Best-Case and Worst-Case Scenarios for Missing Data

|                      | Immediate Post-Intervention |                    | 12 Weeks Post-Intervention |                    |
|----------------------|-----------------------------|--------------------|----------------------------|--------------------|
|                      | Worst-case scenario         | Best-case scenario | Worst-case scenario        | Best-case scenario |
| <b>FSS</b>           | .27<br>Small                | .35<br>Small       | Favours control            | Favours control    |
| <b>MFIS</b>          | Favours control             | Favours control    | Favours control            | Favours control    |
| <b>Global LP</b>     | .29<br>Small                | .71<br>Medium      | .40<br>Small               | .46<br>Small       |
| <b>Global LP-S</b>   | .31<br>Small                | .65<br>Medium      | .07<br>Very small          | .08<br>Very small  |
| <b>Self-Efficacy</b> | .41<br>Small                | .68<br>Medium      | Favours control            | Favours control    |
| <b>RNLI</b>          | Favours control             | Favours control    | Favours control            | Favours control    |
| <b>COPM-P</b>        | .24<br>Small                | .80<br>Large       | .29<br>Small               | 0.98<br>Large      |
| <b>COPM-S</b>        | .02<br>Very small           | .13<br>Very small  | .50<br>Medium              | 1.59<br>Very large |
| <b>SONG-HD</b>       | No difference               | .24<br>Small       | Favours control            | Favours control    |

**Legend:** FSS = Fatigue Severity Scale; MFIS = Modified Fatigue Impact Scale; Global LP = Global Life participation; Global LP-S = Global Life Participation Satisfaction; RNLI = Reintegration to Normal Living Index; COPM-P = Canadian Occupational performance Measure – Performance Scale; COPM-S = Canadian Occupational Performance Measure – Satisfaction Scale; SONG-HD Fatigue = Standardized Outcomes in Nephrology - Hemodialysis Fatigue



## CONSORT 2010 checklist of information to include when reporting a pilot or feasibility trial\*

| Section/Topic                    | Item No | Checklist item  | Reported on page No |
|----------------------------------|---------|---|---------------------|
| <b>Title and abstract</b>        |         |   |                     |
|                                  | 1a      | Identification as a pilot or feasibility randomised trial in the title  | 1                   |
|                                  | 1b      | Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)   | 2                   |
| <b>Introduction</b>              |         |   |                     |
| Background and objectives        | 2a      | Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial  | 6-7                 |
|                                  | 2b      | Specific objectives or research questions for pilot trial   | 7                   |
| <b>Methods</b>                   |         |   |                     |
| Trial design                     | 3a      | Description of pilot trial design (such as parallel, factorial) including allocation ratio  | 7                   |
|                                  | 3b      | Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons  | 8                   |
| Participants                     | 4a      | Eligibility criteria for participants   | 8                   |
|                                  | 4b      | Settings and locations where the data were collected  | 8                   |
|                                  | 4c      | How participants were identified and consented  | 8                   |
| Interventions                    | 5       | The interventions for each group with sufficient details to allow replication, including how and when they were actually administered   | 9; Table 1          |
| Outcomes                         | 6a      | Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed                                | 10; Table 2         |
|                                  | 6b      | Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons  | Table 2             |
|                                  | 6c      | If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial   | 14-15               |
| Sample size                      | 7a      | Rationale for numbers in the pilot trial  | 11                  |
|                                  | 7b      | When applicable, explanation of any interim analyses and stopping guidelines  | N/A                 |
| Randomisation:                   |         |   |                     |
| Sequence generation              | 8a      | Method used to generate the random allocation sequence  | 8                   |
|                                  | 8b      | Type of randomisation(s); details of any restriction (such as blocking and block size)  | 8                   |
| Allocation concealment mechanism | 9       | Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned | 8                   |



|  |     |   |                      |
|--|-----|---|----------------------|
| Implementation                                       | 10  | Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions   | 8                    |
| Blinding   | 11a | If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how  | 8                    |
|  | 11b | If relevant, description of the similarity of interventions   | 8-9                  |
| Statistical methods                                  | 12  | Methods used to address each pilot trial objective whether qualitative or quantitative  | 11                   |
| <b>Results</b>                                       |     |   |                      |
| Participant flow (a diagram is strongly recommended) | 13a | For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective | Figure 1             |
|  | 13b | For each group, losses and exclusions after randomisation, together with reasons  | Figure 1             |
| Recruitment  | 14a | Dates defining the periods of recruitment and follow-up   | 8                    |
|  | 14b | Why the pilot trial ended or was stopped  | N/A                  |
| Baseline data  | 15  | A table showing baseline demographic and clinical characteristics for each group  | Table 1              |
| Numbers analysed                                     | 16  | For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group  | 12                   |
| Outcomes and estimation                              | 17  | For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group        | 12-14;<br>Appendix 1 |
| Ancillary analyses                                   | 18  | Results of any other analyses performed that could be used to inform the future definitive trial  | N/A                  |
| Harms  | 19  | All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)   |                      |
|  | 19a | If relevant, other important unintended consequences  | N/A                  |
| <b>Discussion</b>                                    |     |   |                      |
| Limitations  | 20  | Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility   | 18                   |
| Generalisability                                     | 21  | Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies   | 14-17                |
| Interpretation                                       | 22  | Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence                                   | 14-17                |
|  | 22a | Implications for progression from pilot to future definitive trial, including any proposed amendments   | 14-17                |
| <b>Other information</b>                             |     |   |                      |
| Registration   | 23  | Registration number for pilot trial and name of trial registry  | 7                    |
| Protocol   | 24  | Where the pilot trial protocol can be accessed, if available  | 7 (reference)        |
| Funding  | 25  | Sources of funding and other support (such as supply of drugs), role of funders   | 19                   |
|  | 26  | Ethical approval or approval by research review committee, confirmed with reference number  | 7                    |

1 Citation: Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016;355.

2 \*We strongly recommend reading this statement in conjunction with the CONSORT 2010, extension to randomised pilot and feasibility trials, Explanation and Elaboration for important  
3 clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological  
4 treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see [www.consort-statement.org](http://www.consort-statement.org).  
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For peer review only