

# The effect of intradialytic foot pedal exercise on blood pressure phosphate removal efficiency and health related quality of life in haemodialysis patients

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## Abstract

**Introduction:** Most dialysis patients have reduced aerobic power and muscle strength that often presents challenges in tolerating even the many activities required for daily living. As the American National Kidney Association recommends hemodialysis patients should be offered programs of exercise of 30 minutes per day our aim was to seek evidence for the merits of a structured exercise program for 17 patients in a small regional acute Western Australian hospital dialysis unit

**Method:** This study examined the effects of a program of intradialytic foot pedal exercises on patients' blood pressure, phosphate levels, satisfaction and health-related quality of life. Participation was recorded and categorised according to duration and consistency of pedalling. Blood pressure and serum phosphate were measured prior to haemodialysis, on commencement of the study and then at 4 weekly intervals. SF-12 scores were collected prior to commencement and on completion of the program.

**Results:** Participation in the exercise varied considerably, with few patients able to achieve consistent pedalling for 30 mins or more by week three. Participation decreased from 100% in week one to 61% in week 12. Repeated measures ANOVA indicated there were no significant changes in either serum phosphate, systolic blood pressure, diastolic blood pressure or satisfaction. Paired t tests undertaken for pre and post SF12 scores, and physical and mental component summaries, also showed no significant changes.

**Conclusions:** Although there was considerable variability across the group in the degree to which patients completed the recommended program of exercise, in general, it was not well tolerated. The major outcomes of the study lie in enhanced engagement between staff and patients, resulting in increased teaching opportunities and an increased awareness of the importance of some level of exercise or other activity.

## Introduction

This pilot study in a regional, acute Western Australian hospital dialysis unit examined the effects of a program of intradialytic foot pedal exercises on patients' blood pressure, phosphate levels, satisfaction with care and health-related quality of life (HRQOL). The study was part of the hospital's commitment

to work towards best clinical practice in hemodialysis (HD) by investigating whether exercise can help ameliorate the physiological, functional and psychological deterioration that often accompanies end stage renal disease (ESRD) (Cheema & Singh, 2005). This is also consonant with State government policy to support those with ESRD as

## Key words:

haemodialysis; quality of life; exercise; end stage renal disease

much as possible during HD treatment (DOHWA, 2002).

Increased attention to the growing proportion of the population with chronic diseases has seen a proliferation of studies into the efficacy of exercise therapy (Kujala, 2006). Systematic reviews of randomised clinical trials (RCT's) for patients with metabolic diseases, depression, cardiovascular disease, muscle, bone and joint diseases, cancers and asthma have shown that exercise can increase fitness and prevent the development of disease complications (Kujala, 2004; Pedersen & Saltin, 2006; Painter et al, 2000). With steadily increasing rates of ESRD among our ageing population these are particularly salient goals for HD patients.

Most dialysis patients have reduced aerobic power and muscle strength, rendering them less able than their asymptomatic peers to tolerate the energy requirements of many activities of daily living (Johansen, 2007; Mercer et al, 2002). They also begin at a lower baseline of exercise tolerance, which can discourage clinicians from offering them exercise regimes as part of their usual treatment. However, a growing body of research has shown that moderate exercise can have positive effects on their physical and mental health (Anderson et al, 2004; Kutner, 2007). These include improvements in aerobic capacity, lower

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extremity muscle strength, systolic blood pressure, and lipid metabolism (Anderson et al, 2004; Kutner, 2007; Parsons et al, 2006; Van Vilsteren et al, 2005). Studies have also demonstrated the merits of exercise on health-related quality of life (HRQOL) (Bennett et al, 2007; Johansen, 2007; Kutner et al, 2000; Painter et al, 2000). Painter et al's (2000) study was the first exercise study to report changes in HRQOL resulting from exercise counselling. Kutner et al's (2000) study found that physical activity scores (on the SF-36 index) predicted multiple QOL dimensions, with physical improvements being associated with mental and social, as well as physical health (Kutner et al., 2000).

Although some researchers have failed to find significant changes in self-reported HRQOL following an intradialytic exercise program, most have found major positive physical effects in programs ranging from 5 weeks to 6 months, with most programs consisting of 12 weeks duration (Bennett et al, 2007; Johansen, 2007; Mercer et al, 2002; Painter et al, 2000; Parsons et al, 2006). Scandinavian researchers developed a program combining intradialytic exercise and intense, supervised exercise on non-dialysis days, finding beneficial morphological, functional and psychosocial effects (Konstantinidou et al, 2002). An American clinical trial comparing intradialytic stationary cycling exercise with a control group study also found that the exercisers had a reduction in antihypertensive medication use after 6 months (Miller et al, 2002). As exercise improves blood pressure (BP) in the population at large, finding significant reductions in systolic BP from intradialytic exercise programs is unsurprising (Anderson et al, 2004). Low-intensity exercise programs can also help alleviate the constellation of symptoms called 'uremic

syndrome', characterised by autonomic or motor neuropathies, cardiac or skeletal muscle myopathies, anaemias, dysfunction of bone metabolism, immunologic compromise or other physiologic complaints (Parsons et al, 2006; Vaithilingham et al, 2004). The underlying premise of most exercise programs is that increasing blood flow to muscles and capillary surface areas will help flush urea and other toxins from the tissue to the vascular compartment for subsequent removal during dialysis (Kong et al, 1999; Parsons et al, 2006). Kong et al's (1999) study found that exercise increased the efficiency of dialysis by reducing the rebound of solutes due to increased perfusion of skeletal muscles. They contend that exercising the legs during dialysis increases the efficiency of dialysis with the potential to increase their health (Kong et al, 1999).

Despite agreement on the viability of exercise as adjunctive therapy for HD patients (Parsons et al, 2006), Cheema & Singh's (2005) systematic review of the literature found minimal advocacy for exercise programs, primarily because of the lack of strong, consistent evidence for various exercise programs. Their overall conclusion was that appropriately prescribed exercise involving aerobic and/or resistance training is safe and beneficial for people on dialysis, however, there remained a need for robustly designed randomized controlled studies (RCT) with standardised reporting (Cheema & Singh, 2005). Although this represents the gold standard, RCT's are often not feasible in small renal units where power analysis is precluded by small numbers of patients with widely diverse demographic profiles.

Measuring HRQOL and subjective indicators of patient perceptions present other methodological challenges. For example, one group in Australia

examined the effects of exercise HD patients participating in an intradialytic exercise program consisting of stretching, resistance training, cycling and leg exercises (Breugelmans et al, 2005). The researchers found improvements in physical performance, and they questioned patients about their quality of life (QOL) but without a rigorous research design were able to report only anecdotally that all patients participating in the program felt they had an increased sense of well-being and a better appetite (Breugelmans et al, 2005). Their further study incorporated stretching and other resistance exercises with cycling and leg exercises on a purpose built anabolic weight training machine for HD patients over a six month program (Bennett et al, 2007). They found improvements in physical function tests, decreased serum phosphate, increased urea reduction ratio and improvements in QOL in the exercising group (Bennett et al, 2007). Kolewaski et al (2005) conducted a qualitative study of dialysis patients two weeks after completing an eight week intradialytic exercise program of 3 times weekly bicycle ergometer. All patients felt they had improved performance in activities of daily living, a more positive attitude toward dialysis and enhanced QOL expressed as a sense of control (Kolewaski et al, 2005). As is the case in qualitative data, imprecise measurement of improvement prevents a common conclusion of the benefits of exercise. Other methodological difficulties include the lack of conceptual clarification, a lack of clarity on the interaction between cognitive and physical abilities and a lack of defined protocols for specific exercises.

Attempting to generalise what should be included in clinical protocols from a small cohort of disparate patients at the critical end of the illness continuum is also fraught with the difficulties of an uneven baseline health status.

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However, there remains a need for nursing research into the effectiveness of clinical approaches that will maintain as high a level of health as possible for HD patients, and include patient self-perceptions (DiCenso et al, 2005), and information on their health and lifestyle prior to diagnosis (Breiterman White, 2004; White & Grenyer, 2006). This type of information can help contextualise strategies tailored to their particular needs and preferences. Based on previous studies the American National Kidney Association recommends that HD patients should be offered programs of exercise of 30 minutes per day (KDQQLI, 2008), which is also the exercise standard for other adults (Dept. of Health and Aging, 2008). To date, the Caring for Australasians with Renal Impairment Guidelines (CARI, 2008), contain no exercise recommendations.

## Method

Permission for the study was granted by the Human Ethics Review Committee of Murdoch University, under delegated authority from the Director of Nursing of the hospital, an acute regional hospital licensed to treat both public and private patients. The research question addressed the extent to which a three month interdialytic foot exercise program affected blood pressure and phosphate levels, and self-rated satisfaction with treatment and improvements to HRQOL.

A poster was displayed in the unit to create interest in exercising during HD treatment, with follow-up information provided by the second author (LB), the renal Clinical Nurse Specialist (CNS). Prior to the study an internal planning group met to discuss the feasibility of the study and to seek advice from the hospital physiotherapist assisting HD patients. She recommended a gradual increase in exercise to enhance

participation and reduce any risk of injury. The program therefore introduced a continuous foot pedal exercise of increasing duration beginning with 15 minutes in the first week, 30 minutes in week 2, and 40 minutes the following and subsequent weeks. This was congruent with Parson et al's (2006) recommendation of 30 minute bouts of exercise as optimal for serum urea clearance. Patients undertook the exercise during the first two hours of dialysis to reduce the risk of hypotension which has been reported as more likely during the third hour (Parsons et al, 2006). Satisfaction with treatment scores, and open-ended comments on the program were collected weekly for the first 5 weeks of participation and then on completion of the program, at 12 weeks. Participation was recorded and categorised according to duration and consistency of pedalling. Blood pressure and serum phosphate were measured prior to haemodialysis, on commencement of the study and then at 4 weekly intervals. SF-12 scores were collected prior to commencement and on completion of the program.

Although there are quality of life measures specific to dialysis patients (Ferrans and Powers, 1998, ESRD: Moss, 2003) we chose the SF-12 to reduce patients' burden of response, especially for repeated measures, and because of its equal emphasis on physical and mental health. Like the SF 36, the SF 12 self-reported health status instrument is considered a valid, reliable and responsive measure of health status (Hurst et al, 1998), commonly used as a proxy for quality of life (QOL) (Ware et al, 1996). The shortened instrument (12 questions from the SF 36 version 1) has slightly lower discriminant validity than the SF 36 (Ware et al, 1996) but was chosen to lower the response burden among this group of patients, because of their

existing ill health. The SF- 12 includes 2 questions on physical functioning; 2 questions on role limitations because of physical health problems; 1 question on bodily pain; 1 question on general health perceptions; 1 question on social functioning; 2 questions on role limitations because of emotional problems; and 2 questions on general mental health (psychological distress and psychological well-being). Two summary measures are then calculated to produce a Physical Component Summary (PCS) and a Mental Component Summary (MCS) (Australian Health Outcomes Collaboration 2006).

A convenience sample of 17 volunteer patients was recruited into the study by nursing staff in the unit. Following commencement of the study a further 5 patients requested to be involved. After checking clinical indicators to ensure patient safety to participate, all volunteering patients were included. Data on type and extent of participation, blood pressure, serum phosphate, satisfaction and SF12 scores were analysed using SPSS 13 for Mac Os X. Descriptive statistics computed means and standard deviations or medians and interquartile ranges, as appropriate, depending on normality. Paired samples t test was used to test for differences between pre and post program SF12 scores, and one way repeated measures of analysis of variance (ANOVA) compared monthly serum phosphate, diastolic and systolic blood pressure, and satisfaction ratings. Any p values <0.05 were considered significant.

## Results

Initially, seventeen HD patients were recruited to participate in the study. Another two patients commenced participation in Week Two and a further three in Week Three of the program. The total sample constituted 14 males and 8 females with a mean age of  $67.6 \pm 11.2$

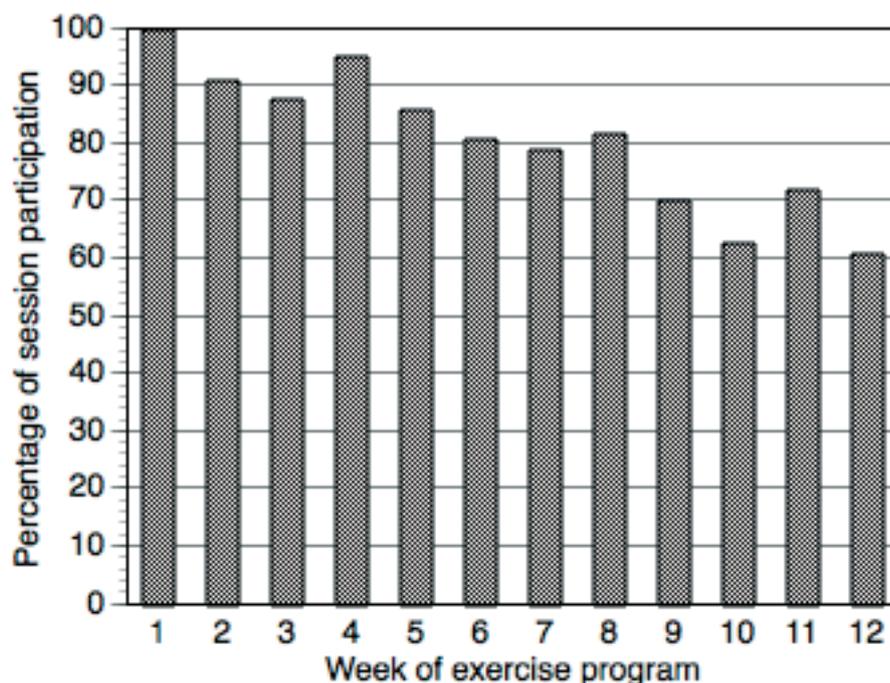
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years. One participant withdrew from the study after Week One and another after Week Two. A male patient died at home in Week Three. The total number of participants in Week One was 17, Week Two was 18 and from Weeks Three to Twelve was 19.

All received three HD treatments per week and had been receiving haemodialysis for a mean duration of  $2.6 \pm 1.7$  yrs. In addition to ESRF all participants were diagnosed with a minimum of three co-morbidities including but not limited to: hypertension, ischaemic heart disease, peripheral vascular disease, diabetes type II, inflammatory bowel disease, chronic hepatitis C, hyperparathyroidism and abdominal aortic aneurysm.

Participation in the exercise varied considerably in duration and consistency of pedalling according to individual capacity to cope with the exercise. Only 26% (n=5) of patients were able to achieve consistent pedalling for 30 mins or more by Week Three. Although another 4 participants at Week Three were able to achieve 30 mins or more of pedalling they needed to rest either often or sometimes during that period. A further two patients achieved consistent pedalling by Week 12. Session participation also varied with some patients unable to participate in all sessions due to feeling unwell or “not up to it” on the day. Session participation decreased from 100% in Week One to 61% in Week 12 (see Fig 1). Difficulties limiting participation, as commented on in the satisfaction survey, included the pedals being “too noisy” (n=4), “it gets boring” (n=3), and physical problems such as “a pinched nerve” (n=1), back and/or pelvis pain from the rocking motion (n=2), and cramping in the legs (n=1). Another patient had a prosthetic leg that proved problematic until Week 3

**Figure 1**



when he was then able to use the pedals properly for the first time. However some patients were motivated by the program to do further exercise with three patients obtaining pedals for use at home and one feeling encouraged to do more exercise in general. Eight patients made positive comments regarding the program such as: “enjoyable, terrific, brilliant”, “felt much improved”, “helps relax and remove stiffness”, and “quite enjoyable, gives something to do”, and two patients continue to use the foot pedals 5 months after the trial.

Repeated measures ANOVA indicated there were no significant changes in serum phosphate ( $F(3,48)=0.613, p=.610$ ), systolic blood pressure ( $F(2,37,35.67)=1.95, p=.15$ ), diastolic blood pressure ( $F(3,45)=0.781, p=.51$ ) or satisfaction ( $F(3,02,45.28)=0.912, p=.44$ ) (see Table 1, Fig. 2).

Paired t tests undertaken for each SF12 item and pre and post total SF12 scores indicated no significant changes ( $t(10)=.264, p=.813$ ). There were also no significant changes in either the pre and post physical component summaries ( $t(10)=1.28, p=.228$ ) or the mental component summaries ( $t(9)=-.714, p=.493$ ) (see Table 1).

### Discussion

As expected for a population with chronic disease requiring active treatment, analysis of SF-12 scores indicated a lower than normal rating of general health. The mean PCS and MCS scores for our sample were similar to other studies that found self assessed physical and mental health in hemodialysis patients was markedly diminished compared with the general population and those with other chronic diseases (Mittal et al, 2001). However, we did find a slight

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Figure 2

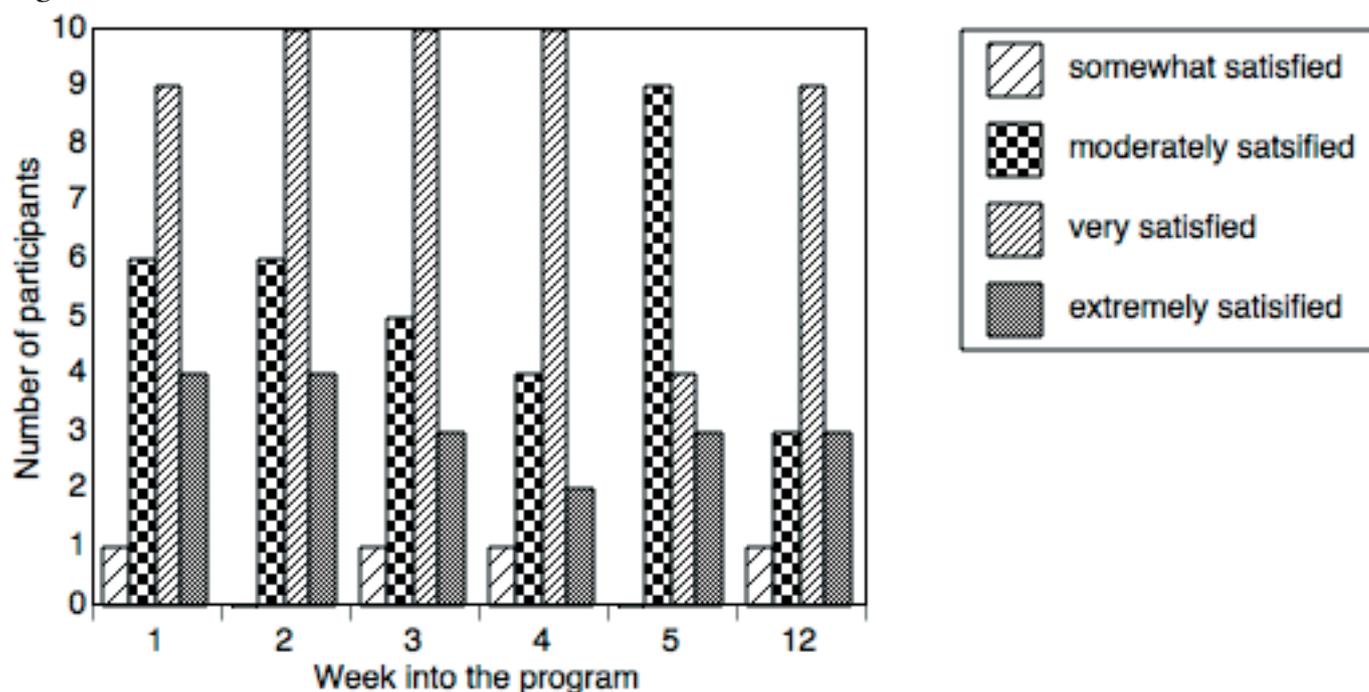


Table 1. Mean ( $\pm$  SD) phosphate and systolic and diastolic blood pressure (BP) according to week of the program (N=17)

	Pre-Program	Week 4	Week 8	Week 12
Phosphate (mmol/l)	1.79 $\pm$ 0.46	1.79 $\pm$ 0.56	1.69 $\pm$ 0.54	1.74 $\pm$ 0.55
Systolic BP (mmHg)	139.1 $\pm$ 26	138.7 $\pm$ 26	131.7 $\pm$ 24.8	142. $\pm$ 1 29
Diastolic BP (mmHg)	68.6 $\pm$ 13.8	69.3 $\pm$ 14.5	67 $\pm$ 12.4	69.9 $\pm$ 11.9

Table 2. Mean ( $\pm$ SD) total score and mental (MCS) and physical component summaries (PCS) from the SF12 pre and post participation in the exercise program

	SF12 total Score	MCS	PCS
Pre program	-12.62 $\pm$ 11.3	48.03 $\pm$ 5.8	41.95 $\pm$ 10.85
Post program	-13.5 $\pm$ 10.3	49.59 $\pm$ 8.0	38.56 $\pm$ 13.12

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improvement in mental health scores, albeit not at the level of significance. Our results also differed from other studies that have found improvements in phosphate removal and urea removal (Bennett et al, 2007; Kong et al, 1999; Vaithilingam et al, 2004). Although there was considerable variability across the group in the degree to which they completed the recommended program of exercise (>30mins consistent pedalling), in general, it was not well tolerated. Anecdotal information from participants indicated that it was not the increasing schedule of exercise, which was problematic; most found it “hard”, and “uncomfortable” from the beginning. Another influence on participation was the noise level. All machines had a certain degree of noise, but one in particular was noisy to the point of discouraging its use. Crowding in the HD unit may also have intensified the noise level.

One factor that seemed to be important to the success of our study was the attitude of the nurses. Greater success was observed where a staff member was enthusiastic and encouraging. This was also a finding from Painter et al's (2000) study, leading them to conclude that exercise counselling by nurses and others working with HD patients can have a major impact on their health, particularly in the physical domain. The program also was unable to sustain the involvement of the physiotherapist, who moved from her hospital position. This and the lack of available exercise specialists created a difficulty for staff to sustain the program for any extended length of time. However, among nursing staff there is support for further research with a larger population, and we have had discussions with colleagues interstate to consider a multi-site study with varying exercise regimes. A replication study in our dialysis unit would also provide insight into whether our findings were

an artefact of the sample, particularly when we found no significant reductions in clinical indicators or self-reported physical status. We expected serum phosphate levels to show a declining trend in light of Kong et al's (1999) study, but were unable to demonstrate this. It is unknown whether Kong et al's (1999) somewhat small (N= 11) sample may have also influenced their results. Clearly, further research should be conducted as a basis for clinical guidelines for exercise in HD patients. A mix of randomised, controlled trials and qualitative studies of satisfaction and influences on exercise would provide invaluable information for interventions designed to enhance quality of life.

## Limitations

Our intention in conducting the study was to seek evidence for the merits of a structured exercise program in this group of patients. The limited sample size and variability of demographic characteristics, co-morbidities and perseverance with the exercise program precludes any generalisations. However, to date, this has been a feature of other similar programs targeting dialysis patients. Johansen's (2007) review of different exercise programs for ESRD patients found a remarkable variety, and the lack of a clear, 'best practice' regimen for exercise. In future studies this may be overcome by instituting a change management process prior to the actual research study, wherein a multi-stage program would aim to strengthen both the exercise and research culture in the unit. Another way of overcoming sampling difficulties would be to discuss exercise strategies with individual patients, and attempt to tailor the program to their preferences and capabilities. Qualitative studies that elicit this type of information may also assist with developing clinical guidelines which include the patient perspective.

## Conclusion

We conclude that there may be therapeutic benefit to instituting a program of exercise as a way of overcoming the physical and mental effects of people spending long periods of time in a semi-recumbent position during their treatment. Although the burden of in-house exercise programs falls largely on clinical staff, the increased interaction between nurses and patients during exercise can provide opportunities for patient teaching and general health promotion. Extending nursing care to developing general body fitness and a sense of wellbeing conveys a sense of valuing the whole person, which can help individuals develop a broader perspective on their health that extends beyond their diagnoses. The program has had a major effect on the level of engagement between nursing staff and patients in the unit even though it did place an added burden on nursing staff to assist with the exercise program and the extra documentation required. There remains a palpable sense of enthusiasm for some type of activity among patients who had previously 'tuned out' during their treatment by sleeping or lying inert in front of their TV sets. To continue the momentum instigated by the program we have purchased a Nintendo Wii and are currently observing its effects on patient engagement. Early indications are that this form of activity can also stimulate a feeling of well-being in those forced to succumb to HD treatments for long periods of time.

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