Physiotherapy 92 (2006) 83–87

Uptake of and adherence to exercise during hospital haemodialysis

Matthew Torkington, Maureen MacRae, Chris Isles *

Renal Unit, Dumfries and Galloway Royal Infirmary, Bankend Road, Dumfries DG1 4AP, UK

Abstract

Objectives To determine the uptake of and adherence to exercise during hospital haemodialysis.
Design Eight-week intradialytic cycling programme, supervised by a physiotherapist.
Participants Forty-nine patients who were being treated by hospital haemodialysis in Dumfries at the start of July 2003.
Main outcome measure The percentage of patients who were still exercising at the end of the 8-week programme.
Results Three patients were ineligible: one died, one moved to another centre and one transferred to peritoneal dialysis. Eight (17%) patients were not interested in taking part in the study and 16 (35%) had medical problems that prevented them from taking part. Twenty-two of the remaining 46 (48%) patients began the programme. Those who exercised were younger (58 versus 67 years) and had fewer comorbidities (1.3 versus 2.1) than patients who did not exercise. Seventeen patients (77% of those who started exercising and 38% of those eligible to exercise) were still cycling at the end of the 8-week period. Sixteen of the 22 patients felt that they had benefited from the programme, and all 22 patients said that the programme should continue.
Conclusions Around 40% of haemodialysis patients may be suitable for and able to complete an 8-week intradialytic cycling programme. This is a higher rate of adherence to exercise than reported in the literature. Our experience of haemodialysis patients in south-west Scotland suggests that uptake and adherence may be maximised by the presence of a physiotherapist during each dialysis session, and by targeting patients for exercise during dialysis rather than in an outpatient setting.

Keywords: Exercise; Rehabilitation; Hospital haemodialysis; Chronic kidney disease

Introduction

Renal dialysis patients have some of the highest death rates from cardiovascular disease recorded in the literature [1]. The role of exercise in preventing cardiovascular disease through modification of risk factors such as obesity, hypertension and raised blood cholesterol [2] is well accepted. Exercise has also been shown to provide some protection against other chronic illnesses such as osteoporosis, type 2 diabetes and depression [2]. While exercise is commonly recommended in the treatment of cardiac and pulmonary disease, it is not yet widely used in patients with end-stage renal disease (ESRD) [3].

Dialysis patients have reduced exercise capacity [4], are less active [5] and have greater muscle atrophy [5] compared with sedentary age- and sex-matched people from the general population. The cause of reduced exercise capacity is multifactorial including anaemia, uraemic myopathy and neuropathy, disuse atrophy, impaired muscle metabolism, autonomic dysfunction, malnutrition and associated comorbidities [6]. Recombinant erythropoietin increases haemoglobin and has been shown to improve but not normalise exercise capacity [7], suggesting that anaemia is not solely responsible for poor performance [8].

A growing body of evidence, mainly from America, shows that patients with ESRD will benefit from exercise. Exercise during dialysis [9], on non-dialysis days [10] and lifestyle approaches [11] have all shown improvements in exercise capacity and quality of life. There is also evidence that exercise during dialysis can help to reduce solute rebound, leading to more effective dialysis [12]. However, few authors have considered the likely uptake of and adherence to exercise.

* Corresponding author. Tel.: +44 1387 241335; fax: +44 1387 241361.
E-mail address: Chris.isles@nhs.net (C. Isles).

0031-9406/$ – see front matter © 2005 Chartered Society of Physiotherapy. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.physio.2005.08.004

The purpose of this study was to determine the proportion of patients who might benefit from a formal exercise programme during hospital haemodialysis.

Methods

All hospital haemodialysis patients in Dumfries were invited to join an intradialytic cycling programme during July and August 2003, supervised by a physiotherapist (M.T.). Those expressing an interest were assessed by the physiotherapist and consultant nephrologist (C.I.) for suitability and medical fitness. Intradialytic cycling has been shown to be safe during the first 2 hours of haemodialysis before 3 litres of fluid has been removed [13]. For this reason, exercise was performed during the first 2 hours of each dialysis session. The exercise bicycles used (Medimotion Ltd, Pencader, Carmarthenshire, UK) had been specially adapted to fit a dialysis chair (Fig. 1) and could be rapidly disconnected if a patient developed hypotensive or other symptoms. An 8-week study period was chosen for convenience. All patients came for dialysis three times a week, giving a possible 24 exercise sessions for each subject. The intensity of the sessions was adjusted on an individual basis using the Borg scale of perceived exertion [14]. Usually, heart rate is used to assess intensity of aerobic exercise but this is inappropriate in a haemodialysis population because of autonomic dysfunction; as such, a perceived exertion scale is preferable [15]. In this study, a 15-point scale (6–20) as described by Borg [14] was used, and each patient's exercise time and resistance on the bicycle were adjusted on an individual basis to achieve levels of exertion between somewhat hard (perceived exertion 13) and hard (perceived exertion 15).

The primary outcome measure of this study was the proportion of patients who were still exercising at the end of the 8-week programme. Secondary outcome measures were the differences recorded before and after exercise in the 10-m shuttle walk test [16], haemoglobin, body mass index, urea reduction ratio, nutritional status and nine domains of quality of life using the Short Form 36 (SF36) questionnaire. Statistical comparisons of those who cycled and those who did not cycle were not undertaken in Table 1 because of the way subjects were selected for inclusion in the exercise programme. Paired *t*-tests with 95% confidence intervals were used for the mean differences in physical parameters before and after exercise, and Wilcoxon-signed rank tests with 95% confi-

Fig. 1. Eighty-year-old patient cycling during the first 2 hours of a dialysis session.

Table 1
Baseline data in those cycling and those not cycling

	Cycling	Not cycling
Number	22	24
Average age	58 (18)	67 (10)
Male (%)	16 (73)	15 (63)
Diabetes mellitus (%)	1 (4.5)	6 (25%)
Body mass index (kg/m^2)	23.9 (5.0)	24.7 (5.5)
Number of comorbidities	1.3 (0.7)	2.1 (1.0)
Urea reduction ratio (%)	70.6 (4.2)	69.8 (6.0)
Haemoglobin (g/l)	116 (14)	113 (13)
Serum albumin (g/l)	39 (3)	38 (4)
Months on dialysis	47.9 (45.9)	41.8 (34.6)
Number on beta-blockers	10	8
Appetite score (maximum 15)	12.9 (3.8)	13.1 (2.6)

Figures in parentheses are standard deviations unless otherwise stated. Urea reduction ratio is predialysis urea minus postdialysis urea divided by the predialysis urea: target value is ≥65%. Comorbidities were previous myocardial infarction, chronic obstructive pulmonary disease, diabetes and rheumatoid arthritis.

dence intervals were used for median differences in SF36 domains (Table 2).

Results

All 49 patients who were being treated by hospital haemodialysis in Dumfries at the start of July 2003 were invited to participate in our exercise programme. Three patients were ineligible: one died during the recruitment phase, one moved to another centre and one transferred to peritoneal dialysis. Eight (17%) of the remaining 46 patients were not interested in exercising during dialysis even after the potential physical and quality-of-life benefits had been explained to them, and 16 (35%) patients had medical or physical problems such as lower limb amputation that prevented them from taking part. Twenty-two (48%) patients began the exercise programme and all gave their informed consent. Those who exercised were younger (mean age 58 versus 67 years), had fewer comorbidities (1.3 versus 2.1) and were less likely to be diabetic (1/22 versus 6/24) than those who did not exercise. There were no other important differences between the two groups at the start of the programme (Table 1).

The 22 patients who started the exercise programme completed 415 (79%) of a possible 528 exercise sessions. The most common reasons for not exercising on a particular day were feeling tired (used 17 times by six patients) or non-specifically unwell (used 19 times by four patients). Eighteen of the 22 (82%) patients completed more than half of the exercise sessions. Those who dropped out during the programme did so because they no longer wished to continue ($n = 1$) or because they developed an intercurrent medical illness ($n = 3$). Time spent cycling varied between individuals depending on their previous level of fitness, and ranged from 5 to 30 minutes for the first session. Cycling time increased as fitness improved, reaching 20–60 minutes by the end of the programme. Most patients managed to cycle continuously. Two were unable to do this and did interval training instead. Seventeen patients (77% of those who started, 38% of those eligible) were still cycling at the end of 8 weeks.

Sixteen patients who were assessed before and after exercise showed an increase in average distance walked of 91 m (from 298 to 389 m, $P < 0.001$), with no significant changes in haemoglobin, urea reduction ratio, or nutritional status as judged by appetite score, serum albumin, or predialysis urea. There was a small but statistically significant increase

Table 2
Measurements before and after exercise in 16 subjects

	Before (S.D.)	After (S.D.)	Difference (95% CI)	*P* value
Physical parameters				
Distance walked (m)	298 (217)	389 (262)	91 (44, 140)	<0.001
Haemoglobin (g/l)	117 (15)	120 (16)	3 (−5, 10)	0.53
Body mass index (kg/m^2)	24.2 (5)	25 (5)	0.8 (0.2, 1.4)	0.01
Urea reduction ratio (%)	70.5 (4.7)	70.4 (5.9)	−0.1 (−2.6, 2.4)	0.92
Appetite score (maximum 15)	12.8 (4)	12.9 (2.7)	0.1 (−1.7, 1.9)	0.88
Serum albumin (g/l)	40.1 (2.6)	40.4 (3)	0.3 (−0.6, 1.1)	0.55
Predialysis urea (mmol/l)	22.4 (5.9)	22.3 (5.7)	−0.1 (−2.0, 1.9)	0.94
Quality of life (SF36)				
Change in health	50 (27.4)	54.7 (33.2)	4.7 (−12.5, 25.0)	0.68
Emotional limitation	41.6 (43)	25 (35.5)	16.6 (−50.0, 16.7)	0.21
Energy/vitality	39.1 (24.3)	47.2 (22.3)	8.1 (2.4, 15.0)	0.02
General health perception	44.6 (24.2)	46.2 (21)	1.6 (−8.5, 11.0)	0.78
Mental health	64 (23.8)	71 (22.7)	7.0 (0.0, 14.0)	0.06
Pain	62.5 (31.9)	62.5 (24.6)	0.0 (−11.1,11.1)	1.00
Physical function	44.1 (26.2)	46.3 (24.5)	2.2 (−2.5, 7.5)	0.63
Physical limitation	76.6 (37)	62.5 (42.8)	14.1 (−37.5, 0.0)	0.24
Social function	50 (35.6)	51.4 (33.2)	1.4 (−11.1, 16.7)	0.86

High scores are better than scores in Short Form 36 (SF36) for all domains except emotional limitations, physical limitations and pain, where lower scores indicate less emotional limitation, less physical limitation and less pain. Differences are means for physical parameters and medians for SF36 domains (which were not normally distributed).

in body mass index of 0.8, which is more likely to represent fluid than an increase in fat-free mass given the short duration of our exercise programme and the fact that variable fluid weight gains of up to 5 kg are common between dialyses in haemodialysis patients. There was a significant improvement in the energy/vitality domain of the SF36 ($P = 0.017$), together with favourable trends in general health perception and mental health that did not achieve statistical significance; a likely consequence of the small sample size (Table 2). We recorded only one adverse event in 415 treatment sessions: a 40-year-old man who had an episode of symptomatic hypotension during exercise while undergoing more intensive ultrafiltration than usual. Sixteen of the 22 patients felt that they had benefited from the programme and all 22 patients said that the programme should continue.

Discussion

The main findings of our study were that around 50% of the hospital haemodialysis population were interested and able enough to start a thrice-weekly dialysis cycling programme, and that just under 80% of those who started (or 40% of those eligible) were sufficiently motivated to continue exercising after 2 months. Those who continued to exercise showed an increase in walking distance of just under 100 m during a shuttle walk test, and this was statistically significant. The increase in walking distance was associated with an improvement in well-being as judged by the quality-of-life scores, which in turn were likely related to improved physical fitness as there were no important changes in haemoglobin, nutritional status or effectiveness of dialysis during the 8 weeks of study.

To the authors' knowledge, this is the first attempt to determine the proportion of a haemodialysis population prepared to participate in an intradialytic cycling programme. Lower rates of uptake and completion have been reported for other forms of exercise. Thus, the completion rate of 38% after 8 weeks found in this study compares favourably with 28/120 (23%) renal patients who completed a 12-week home exercise programme [17]; is better than 16/177 (9%) patients who were still exercising at 3 months either by bicycle before or during haemodialysis or by treadmill before haemodialysis [18]; and is considerably better than 7/174 (4%) haemodialysis and peritoneal dialysis patients who completed a 3-month outpatient programme consisting of cycling, calisthenics and either walking or jogging [19].

The success of this programme is likely to reflect, at least in part, the presence of a physiotherapist (M.T.) during each dialysis session, who not only knew more about the physiology of exercise than the dialysis nurses but could also deal more effectively with the inevitable minor musculoskeletal problems that arose during exercise. Without a dedicated member of staff to continually motivate and encourage patients, it is likely that more would have dropped out. Another probable reason for the higher uptake of and adherence to exercise training in our study is that patients were only asked to exercise during dialysis. This meant that exercise did not take up as much time as a formal outpatient or home exercise programme. Targeting patients for exercise while on dialysis seems an entirely logical approach. Daul et al. [20] reached similar conclusions in their 2004 review of exercise training programmes in Germany. Less than 1% of dialysis patients in Germany participated in outpatient rehabilitation programmes when these took place in a gym. During the 1990s, no fewer than 500 sports therapists were trained to practice rehabilitation exercises with patients suffering from chronic kidney disease. In 2004, Daul et al. [20] estimated, as found in the present study, that 50% of all haemodialysis patients in Germany are interested in exercising and that 80% of these (40% of the dialysis population) actually do exercise during dialysis, supervised by qualified therapists.

If exercise during dialysis is an effective way of improving physical fitness in dialysis patients, can we be certain that it is also safe? Moore et al. [13] studied the cardiovascular response to submaximal stationary cycling during haemodialysis in eight patients. They found that with fluid removal set at 1356 ml/hour, the eight subjects were able to cycle during the first 2 hours of dialysis with no adverse cardiovascular effects. A decrease in cardiac output, stroke volume and mean arterial pressure meant that five of the eight patients could no longer exercise after 3 hours. They concluded that it is safe to cycle during the first 2 hours of haemodialysis. It has also been shown that exercise training can augment cardiac vagal activity and therefore decrease vulnerability to arrhythmia [10]. This suggests that exercise may improve the autonomic dysfunction associated with ESRD, and therefore reduce the chance of symptomatic hypotension during dialysis.

As a direct consequence of Moore et al.'s work [13], exercise was restricted to the first 2 hours of dialysis and before 3 litres of fluid was removed in this study. Hence or otherwise, only one episode of symptomatic hypotension was recorded in 415 exercise sessions. The subject in question was one of the fittest patients in the unit who had been cycling regularly for 1 hour at a time for 6 weeks. On the day he 'crashed', he had been more hypertensive than usual. His hypertension was thought to be due to excess fluid and therefore his ultrafiltration rate was increased from 600 to 950 ml/hour. With hindsight, it seems likely that the ultrafiltration rate he could cope with while exercising was exceeded. Fortunately, he knew he was going to faint and alerted the staff who were able to correct matters promptly.

This study has a number of limitations. First, a smaller dialysis population was studied than reported by others. However, all patients on the intradialytic programme were assessed, including the elderly and those with multiple comorbidities. Second, only one form of exercise was offered. It was felt that the advantages of doing so outweighed the drawbacks for reasons already stated. Moreover, a physiotherapist with an interest in sports medicine tailored each patient's cycling programme to their abilities following a baseline assessment of exercise capacity and need. Third, a practice shuttle walk test was not performed at the start of the study. It seems unlikely that failure to do so could have been responsible for an improvement in walking distance of just under 100 m by the time the second shuttle walk test was performed at the end of the study. Fourth, the walk test and the SF36 were not validated in our dialysis population. Others have done so and have found that these tests are valid, reliable and responsive in renal patients [15,21]. Finally, power calculations were not performed before the study commenced. This was because the primary aim was to determine the proportion of haemodialysis patients who might benefit from an intradialytic exercise programme, not the extent to which they might benefit.

In conclusion, exercise therapy has become an important component of treatment for a number of chronic diseases. Haemodialysis patients have recently been shown to benefit from exercise, although uptake and adherence remain poor. This study of haemodialysis patients in south-west Scotland suggests that these may be maximised by provision of a trained physiotherapist and by targeting patients for exercise during dialysis.

Acknowledgements

The authors would like to thank Harper Gilmour, Department of Public Health, University of Glasgow, for statistical advice, and Anne Bray for typing the manuscript.

Ethical approval: Dumfries Research Ethics Committee.

Funding: This work was supported by a grant from Tenovus Scotland.

Conflict of interest: None.

References

[1] Muntner P, He J, Hamm L, Loria C, Whelton PK. Renal insufficiency and subsequent death from cardiovascular disease in the United States. J Am Soc Nephrol 2002;13:745–53.
[2] Health Education Board for Scotland, The promotion of physical activity in Scotland: strategic statement; 2001. http://www.hebs.scot.nhs.uk/.
[3] Millar B. Physical activity in end stage renal disease and renal transplantation. UpToDate; 2003. http://www.uptodate.com/.
[4] Painter P, Johansen K. A call to activity. Adv Ren Replace Ther 1999;6:107–9.
[5] Johansen K, Chertow GM, Ng AV, Mulligan K, Carey S, Schoenfeld Y, et al. Physical activity levels in patients on haemodialysis and healthy sedentary controls. Kidney Int 2000;57:2564–70.
[6] Kouidi E, Albani M, Natsis K, Megalopoulos A, Gigis P, Guiba-Tziampirl O, et al. The effects of exercise training on muscle atrophy in haemodialysis patients. Nephrol Dial Transplant 2000;13:685–99.
[7] McMahon L, Mckenna MJ, Sangkabutra T, Mason K, Sostaric S, Skinner SL, et al. Physical performance and associated electrolyte changes after haemoglobin normalisation: a comparative study in haemodialysis patients. Nephrol Dial Transplant 1999;14:1182–7.
[8] Painter P, Moore G, Carlson L, Paul S, Myll J, Phillips W, et al. Effects of exercise training plus normalisation of haematocrit on exercise capacity and health related quality of life. Am J Kidney Dis 2002;39:257–65.
[9] Mercer T, Crawford C, Gleeson N, Naish P. Low-volume exercise rehabilitation improves functional capacity and self-reported functional status of dialysis patients. Am J Phys Med Rehabil 2002;81:162–7.
[10] Deligiannis A, Kouidi E, Tourantonis A. Effects of physical training on heart rate variability in patients on haemodialysis. Am J Cardiol 1999;84:197–201.
[11] Tawney KW, Tawney PJ, Hladik G, Hogan SL, Falk RJ, Weaver C, et al. The life readiness programme: a physical rehabilitation programme for patients on haemodialysis. Am J Kidney Dis 2000;36:581–91.
[12] Kong CH. Exercise for rebound reduction and rehabilitation in haemodialysis patients. Dial Transplant 2004;33:266–71.
[13] Moore GE, Painter PL, Brinker KR, Stray-Gundersen J, Mitchell JH. Cardiovascular response to submaximal stationary cycling during haemodialysis. Am J Kidney Dis 1998;31:631–7.
[14] Borg GA. Perceived exertion and pain scales. Champaign (IL): Human Kinetics; 1998.
[15] Fitts SS, Guthrie MR. Six minute walk by people with chronic renal failure. Assessment of effort by perceived exertion. Am J Phys Med Rehabil 1995;74:54–8.
[16] Tobin D, Thow M. The 10 metre shuttle walk test with Holter monitoring: an objective outcome measure for cardiac rehabilitation. Coron Health Care 1999;3:3–17.
[17] Williams A, Stephens R, McKnight T, Dodd S. Factors affecting adherence of end-stage renal disease patients to an exercise programme. Br J Sports Med 1991;25:90–3.
[18] Cappy CS, Jeblonka J, Schroeder ET. The effects of exercise during haemodialysis on physical performance and nutrition assessment. J Renal Nutr 1999;9:63–70.
[19] Shalom R, Blumenthal JA, Williams RS, McMurray RG, Dennis VW. Feasibility and benefits of exercise training in patients on maintenance dialysis. Kidney Int 1984;25:958–63.
[20] Daul AE, Schafers RF, Daul K, Philipp T. Exercise during haemodialysis. Clin Nephrol 2004;61(Suppl.):S26–30.
[21] Mittal SK, Ahern L, Flaster E, Maesaka JK, Fishbain S. Self-assessed physical and mental function of haemodialysis patients. Nephrol Dial Transplant 2001;16:1387–94.