

A Randomized and Controlled Trial of Hydrotherapy in Rheumatoid Arthritis

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Objective. The aim of this study was to evaluate the therapeutic effects of hydrotherapy which combines elements of warm water immersion and exercise. It was predicted that hydrotherapy would result in a greater therapeutic benefit than either of these components separately.

Method. One hundred thirty-nine patients with chronic rheumatoid arthritis were randomly assigned to hydrotherapy, seated immersion, land exercise, or progressive relaxation. Patients attended 30-minute sessions twice weekly for 4 weeks. Physical and psychological measures were completed before and after intervention, and at a 3-month followup.

Results. All patients improved physically and emotionally, as assessed by the Arthritis Impact Measurement Scales 2 questionnaire. Belief that pain was controlled by chance happenings decreased, signifying improvement. In addition, hydrotherapy patients showed significantly greater improvement in joint tenderness and in knee range of movement (women only). At fol-

lowup, hydrotherapy patients maintained the improvement in emotional and psychological state.

Conclusions. Although all patients experienced some benefit, hydrotherapy produced the greatest improvements. This study, therefore, provides some justification for the continued use of hydrotherapy.

Key words. Evaluation; Hydrotherapy; Rheumatoid arthritis; Warm water; Exercise.

INTRODUCTION

The beneficial use of water in the treatment of joint complaints was advocated by Hippocrates, cultivated by the Romans, exploited by the spa enthusiasts of the Eighteenth Century, and channelled toward contemporary practice as a result of the World Wars, when exercise was included in an attempt to speed up soldiers' recovery. Today, hydrotherapy remains a useful tool in the physiotherapist's armory, and favorable claims made on its behalf are upheld by many patients (1), many of whom have rheumatoid arthritis (RA). The use of exercises in warm water is promoted because of the physical properties of the water, namely, buoyancy and temperature. The weight-relieving property of water immersion allows easier movement with less pain, which may also be attributed to the warmth of the water. However, despite its impressive history and continuing popularity, the efficacy of hydrotherapy in the treatment of RA has not been adequately evaluated.

Literature about the efficacy of hydrotherapy in the treatment of RA is scarce, prompting one investigator to propose practical difficulties and high financial cost as primary deterrents to its evaluation (2). Despite this, other investigators have risen to the challenge. Hydrotherapy has been shown to increase muscle strength (3), increase joint range of movement (2), improve aer-

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obic capacity (4), reduce pain (2,4), and improve function (2–4). The common theme underlying these studies is the benefit of enhanced psychological function, which deserves fastidious attention in future studies (2,4,5). While these studies offer important insights into the use of water exercise, the conclusions remain equivocal, and to date, randomized, controlled trials using appropriate controls and measurement techniques have not been forthcoming. Hydrotherapy is an expensive procedure and, on economic grounds alone, demands serious evaluation.

Hydrotherapy may be defined in terms of two important components: warm water immersion and exercise. The relative contributions of each to the overall therapeutic benefit should be questioned given recent research findings. In a randomized study comparing a group receiving 3 weeks of spa therapy to a waiting list control group, Guillemin et al showed that in the short term (26 days), the effects of a course of hot underwater showers (36°C) had positive effects on a range of outcome measures—pain intensity and duration, lumbar stiffness, disability, and drug consumption—in 98 patients with chronic low back pain (6). Furthermore, with the exception of disability, these improvements were maintained over 9 months. Here, the effects of warm water per se are beneficial for some musculoskeletal disorders. Additionally, the immersion model, which was initially developed to study the physiological effects of weightlessness, has prompted questions about the authenticity of the ostensible rationale for hydrotherapy. Immersion to the suprasternal notch in warm water (35°C) results in a cascade of physiological reactions including diuresis, natriuresis, and inhibition of the sympathetic nervous system (7–10). The basis for these physiological effects is considered to be the hydrostatic pressure, which forces approximately 700 ml of blood from the lower extremities to the central compartment. Distension of the volume receptors by this central hypervolemia is regarded as the trigger for the physiological effects (7–10).

The present study was designed to test the hypothesis that the combined effects of water immersion and exercise in hydrotherapy are therapeutically superior to either used singly.

PATIENTS AND METHODS

Design. A 4-cell parallel design was used. Following initial assessment, patients were randomly assigned by an independent coordinator to 1 of the 4 groups: hydrotherapy or 1 of the 3 comparison groups of seated immersion, land exercise, or progressive relaxation. Random assignment was achieved using a random

numbers table and groups of subjects in blocks, so that equal numbers of subjects were allocated to each of the 4 groups (11).

Subjects. In order to estimate the sample size, data from the pilot study were used. The mean pre- to post-difference and standard deviation for the Ritchie articular index (5.0 ± 9.4), together with alpha set at 0.05 and power at 0.8, showed that a sample size of 140 would be required (35 per group) (12).

One hundred forty-eight patients with chronic RA (13) who met Steinbrocker functional class I, II, or III (14) were recruited from outpatient clinics at the Royal National Hospital for Rheumatic Diseases (Bath, UK). Nine patients dropped out prior to the post-test, and all were replaced except for one who withdrew following a myocardial infarction at the end of the data collection period. Reasons for sample attrition included transportation difficulties, shortage of time, and lack of interest. Thus, 139 patients completed the study, with the land exercise group consisting of 34 patients.

Inclusion and exclusion criteria. Only those patients who presented with involvement of at least 6 joints and who were maintained on a stable drug regimen for a period of 30 days in the case of nonsteroidal antiinflammatory drugs (NSAIDs) or 3 months for disease-modifying antirheumatic drugs (DMARDs) were included in the trial. Patients who had received intra-articular corticosteroid injections or physiotherapy treatment within 30 days of assessment for the study were excluded, as were patients who had joint replacement surgery within 6 months. Patients with a history of any known condition contraindicating exercise therapy or immersion in water (i.e., recent myocardial infarction, uncontrolled epilepsy, fear of water) were also excluded.

Procedure. All interventions took place in the gymnasium or hydrotherapy pool at the Royal National Hospital for Rheumatic Diseases. Patients were convened in small groups of 4 or 5. Three physiotherapists were trained to carry out the standardized exercise regimen, relaxation program, and other interventions. In accordance with standard therapeutic practice, the exercise sessions lasted for 30 minutes; the other interventions were designed to last an equivalent length of time. Evidence from the pilot study suggested that 8 sessions of hydrotherapy and land exercise would constitute a suitable course and be in line with existing clinical practice. For reasons of patient fatigue, all interventions were limited to 2 sessions per week. Patients attended for 4 consecutive weeks.

Exercises designed to increase the range of move-

ment of the key joints, namely, shoulder, elbow, wrist, hand, hip, knee, ankle, and foot, and to improve muscle strength of the main upper and lower limb groups were used for the two exercise groups (hydrotherapy and land exercise). The type, duration, and frequency of the exercises were standardized in consultation with the physiotherapists, and the speed and resistance were adjusted by the therapist in response to the individual's capabilities and progress.

An adapted and updated version of Jacobsen's progressive relaxation technique (15), including some mental imagery tasks, was tailored for use with arthritis patients in the two non-exercise groups (seated immersion and progressive relaxation). At each session, the physiotherapist read from a relaxation script following relaxation training. The progressive relaxation group relaxed in a quiet, darkened room on comfortable mats or exercise couches; patients could use pillows to support their heads and knees. The seated immersion group relaxed in the pool on weighted chairs with their legs dependent, in water at approximately 36°C, immersed to the suprasternal notch.

Assessments. The measurements detailed below were taken on 3 occasions: before and after the course, and at the 3-month followup. They were carried out by an independent assessor who was blind to the intervention condition. Patients were assessed on each occasion at the same time of day to control for diurnal variations. The patients and the relevant physiotherapist also completed evaluations before, during, and after the course.

Physical measures. *The Ritchie articular index.* The Ritchie articular index was used to assess joint tenderness (16). The index has been shown to be sensitive to change in previous studies evaluating the efficacy of physiotherapy treatments (4,5,17). Additionally, the intra-rater reliability has been shown to be acceptable (18), and the test is quick and easy to perform. Scores range from 0 to 78.

Morning stiffness. Morning stiffness is characteristic of RA, and variations in its duration are regarded as reflections of change in disease activity. Patients were asked to report the average duration of their morning stiffness (in minutes) as experienced over the previous 2 weeks.

Grip strength. Grip strength was included both as a functional and disease activity measure (19,20). Under standardized conditions, the grip strength of the dominant hand was measured using a digital grip strength monitor inflated to 20 mm Hg. The mean of 3 readings was recorded.

Active range of movement. Wrist and knee active

range of movement in flexion and extension was evaluated using a standard goniometer. These 2 joints were selected on the basis of the exercises performed, and the relative ease and reliability of measurement (21,22).

C-reactive protein (CRP). CRP, an acute-phase reactant, is used routinely to monitor disease activity in RA. A high level (above 10 mg/liter) is associated with active inflammatory joint disease. At each assessment, a 5-ml sample of blood was taken. Serum samples were frozen at -20°C within 2 hours of collection, and were subsequently tested in a single batch.

Pain measures. *The McGill Pain Questionnaire (MPQ).* The MPQ (23) assesses the quantitative and qualitative aspects of pain. A shorter version of this questionnaire (24) adapted for use with RA was self-administered. This allowed patients unrestricted choice from 69 adjectives covering sensory, evaluative, and affective dimensions. A number of indices can be derived from the results, but for this study, the weighted values for each of the 3 dimensions were divided by the number of words chosen in that category (25); a low number indicates mild pain and a high number indicates severe pain.

The Beliefs in Pain Control Questionnaire (BPCQ). Previous research has suggested that beliefs about controlling pain may be as important in controlling pain as the pain control itself (26). Additionally, there is some evidence that strong beliefs in internal or personal pain control are more often associated with better physical and psychological health than beliefs that pain is beyond personal control or is external (27). The BPCQ (28) has been standardized for use with patients with chronic RA and is relatively reliable and valid. Its 13 items constitute 3 subscales. The internal scale measures beliefs that pain is within one's personal control; so, a high score indicates strong internality. The other 2 scales measure beliefs that pain is controlled by factors which are beyond or outside one's personal control: the powerful doctors scale examines beliefs that pain control is in the hands of the doctors, and the chance happenings scale evaluates beliefs that pain is controlled by chance happenings or misfortune. High scores reflect high externality of each of these dimensions.

Health status measures. *The Arthritis Impact Measurement Scales 2 (AIMS2).* The original AIMS questionnaire (29) was designed to assess health status in patients with rheumatic diseases. It has been found to be a reliable, valid measure that is sensitive to clinical change (30-32). The revised and expanded version of the self-administered questionnaire, the AIMS2 (33), is divided into 12 subscales: mobility level, walking and bending, hand and finger function, arm function, self-

care tasks, household tasks, social activity, support from family and friends, arthritis pain, work, level of tension, and mood. Additional sections concern satisfaction with function, attribution of problems to arthritis, comorbidity, and designation of priority areas for improvement. Because it was anticipated that many of the patients in the study would be retired and/or their main form of work would be in the home, the work subscale of the AIMS2 was adapted to differentiate between employment and housework by the addition of 4 questions in which "housework" was substituted for the original "paid work." While a reliable and valid abbreviated version of the AIMS is available, it lacks sensitivity to changes in mobility, pain, anxiety, and depression (34), and was therefore rejected for use in this study.

To ensure its suitability for use with a British patient population, the language and spelling used in the questionnaire were anglicized according to the work done by Hill et al (35) on the original instrument. Following normalization of the scores according to the method devised by Meenan et al (29), a low number indicates less impact of arthritis.

Evaluation of interventions. Patients' and physiotherapists' perceptions of the interventions were monitored throughout the study, using quantitative techniques.

Patients' view of the intervention. Patients rated the course for effectiveness and enjoyment, using 2 separate scales. These were 5-point scales anchored by "not at all effective," which scored 1 on the scale, and "totally effective," which scored 5. These Likert-type scales were completed on 4 occasions: pre- and post-test to examine whether patient expectations were met, and twice during the course (after the fourth and eighth sessions).

Patients' view of the therapists. At the end of all 8 sessions, patients also completed 5 rating scales which evaluated their therapist on a range of characteristics. Each scale was scored 1–5, anchored at 1 point and 5 points as follows: warm–cold; caring–not caring; well-

informed–lack of knowledge; interested–not interested; and enthusiastic–not enthusiastic.

Therapists' view of the patients. To find out whether the therapists' expectations of success for the intervention could affect patient outcomes, the physiotherapists rated each patient after the first and last sessions, according to their expectations of the effectiveness of the intervention. A 9-point scale (maximum adverse effect = 1, maximum benefit = 9) was used.

Statistical methods. In this study we examined the hypothesis that hydrotherapy would give significantly more therapeutic benefit than the interventions consisting of the components of water or exercise alone. Data were analysed using the Statistics Package for the Social Sciences.

A factorial between-and-within subjects multivariate analysis of covariance (MANCOVA) design with repeated measures and for unweighted means was used to compare the 4 groups over the 3 time periods, and in relation to the covariates of disease duration, age, and education. To satisfy MANCOVA assumptions about the number of cases in relation to the number of dependent variables, the dependent variables were divided into 3 groups of conceptually related measures for separate analysis (36). The first group considered the physical variables of the Ritchie articular index, grip strength, and wrist and knee range of movement; the second examined the pain variables from the MPQ and the BPCQ, and the third consisted of the 5 composite health status scales from the AIMS2 questionnaire (31).

Data screening. Prior to the MANCOVA, the data was checked for compliance with the assumptions of this statistical test. Box plots and tests for multivariate normality were carried out on all dependent variables. Non-normal variables were log-transformed (e.g., disease duration, education, and grip strength) or square rooted (e.g., physical component scale of the AIMS2). Conventional methods of dealing with outliers were used in accordance with the usual procedures (36). Where appropriate, some variables were aggregated to

Table 1. The sociodemographic characteristics of the 4 intervention groups

Group	Males: females	Age, mean (SD) years	Disease duration, mean (SD) years	Functional class			Ritchie index, mean (SD)
				I	II	III	
Hydrotherapy	14:21	55.8 (12.5)	9.7 (7.7)	9	21	5	21.3 (10.6)
Seated immersion	11:24	58.7 (11.3)	12.2 (9.2)	5	28	2	19.9 (8.9)
Land exercise	8:26	58.5 (11.0)	11.9 (8.2)	3	24	7	21.8 (0.5)
Progressive relaxation	10:25	59.8 (9.3)	12.2 (9.6)	9	19	7	21.4 (9.1)

Table 2. Changes in physical variables, by study group, mean (SD) values

	Overall (n = 139)			Hydrotherapy (n = 35)			Seated immersion (n = 35)			Land exercise (n = 34)			Progressive relaxation (n = 35)		
	Pre	Post	Followup	Pre	Post	Followup	Pre	Post	Followup	Pre	Post	Followup	Pre	Post	Followup
Ritchie articular index	21.15 (9.7)	17.3* (9.4)	18.1 (10.9)	21.3 (10.6)	15.5† (9.4)	17.9 (12.8)	19.9 (8.9)	16.8 (9.7)	18.2 (9.3)	21.8 (10.5)	18.9 (9.2)	21.4† (9.7)	21.4 (9.1)	18.1 (9.6)	19.5 (11.2)
Knee range of movement, degrees	249.1 (25.6)	251.4 (26.4)	252.1 (24.1)	248.4 (25.9)	252.4 (27.0)	252.2 (23.5)	248.1 (27.4)	252.3 (25.7)	254.9 (26.3)	250.8 (25.9)	248.7 (28.1)	248.8 (25.7)	249.0 (24.6)	251.9 (28.5)	252.8 (21.7)
Wrist range of movement, degrees	167.4 (60.3)	172.1 (59.9)	174.3 (58.8)	178.5 (54.7)	181.8 (55.0)	186.8 (54.5)	170.9 (56.4)	179.9 (59.6)	176.7 (63.9)	161.2 (68.0)	166.8 (60.9)	171.3 (59.2)	158.3 (62.5)	159.6 (64.2)	161.9 (58.4)
Grip strength, mm Hg	140.4 (75.6)	142.6 (75.5)	138.9 (70.6)	145.8 (77.5)	152.5 (77.9)	152.2 (70.5)	134.8 (62.5)	141.7 (60.5)	126.6 (50.3)	143.9 (92.0)	142.0 (99.0)	137.9 (91.9)	137.5 (71.1)	134.2 (61.5)	137.3 (63.3)
Morning stiffness, minutes	41.2 (50.7)	36.9 (51.1)	33.9 (46.4)	39.0 (48.6)	39.1 (58.0)	35.3 (49.3)	40.9 (50.5)	39.1 (57.8)	31.0 (33.9)	33.8 (43.9)	27.2 (36.6)	24.1 (36.8)	50.3 (58.9)	41.4 (51.8)	44.5 (59.9)

* At post-test, joint tenderness was significantly lower than at pre-test (F = 9.68, df = 1, 108, P = 0.002).
 † Hydrotherapy patients had the greatest reduction in joint tenderness between pre- and post-test (F = 5.05, df = 1, 109, P = 0.03).
 ‡ Land exercise patients maintained a significant improvement in joint tenderness at followup (F = 4.9, df = 1, 112, P = 0.03).

Table 3. Changes in knee range of movement and affect, by sex, mean (SD) values

	Overall (n = 139)			Hydrotherapy (n = 35)			Seated immersion (n = 35)			Land exercise (n = 34)			Progressive relaxation (n = 35)		
	Pre	Post	Followup	Pre	Post	Followup	Pre	Post	Followup	Pre	Post	Followup	Pre	Post	Followup
Knee range of movement															
Men	245.4 (26.8)	249.2 (28.2)	248.1 (24.6)	244.8 (23.9)	245.2 (24.3)	243.6 (23.4)	235.4 (35.4)	243.4 (34.4)	243.8 (31.3)	254.8 (27.8)	256.3 (28.1)	253.7 (24.4)	246.6 (20.3)	252.0 (26.0)	251.7 (19.5)
Women	250.7 (25.8)	252.6 (26.3)	254.1 (24.0)	250.7 (27.6)	257.3* (28.3)	257.9 (22.4)	252.5 (23.4)	255.3 (22.2)	258.7 (24.1)	249.4 (25.8)	246.1 (28.3)	247.1 (26.6)	249.9 (26.5)	251.9 (26.4)	252.7 (23.0)
Affect, Arthritis Impact Measurement Scales 2															
Men	2.87 (1.5)	2.89 (1.5)	2.85 (1.2)	3.5 (1.5)	3.5 (1.8)	2.98 (1.6)	2.9 (1.8)	2.8 (1.5)	2.9 (1.4)	1.9 (1.5)	2.2 (1.4)	2.2 (1.1)	3.2 (1.4)	3.0 (1.6)	3.37 (0.8)
Women	3.5 (1.3)	3.04† (1.3)	3.0 (1.3)	3.6 (1.4)	3.2 (1.5)	3.03 (1.5)	3.4 (1.1)	3.05 (1.0)	3.1 (1.1)	3.5 (1.4)	3.03 (1.3)	2.9 (1.5)	3.3 (1.5)	2.9 (1.2)	3.1 (1.3)

* Women receiving hydrotherapy had significantly increased knee range of movement between pre- and post-test (F = 3.98, df = 1, 98, P = 0.049).
 † At post-test, women reported the greatest improvement in affect scores (F = 5.8, df = 1, 109, P = 0.02).

provide conceptually viable composites and to accommodate abnormal distributions. The evaluative and affective scales of the MPQ were integrated, in line with previous research (25). Also, the physical variables of right and left knee range of movement and right and left wrist range of movement were summed. Distributions of the AIMS2 subscales tended to be abnormal, and so, the 5 composite scales recommended by Meenan et al were used, since they exhibited relatively normal distributions (33). The physical component scale required square root transformation.

Morning stiffness and CRP failed to satisfy the normality requirements for multivariate analysis and were therefore excluded from parametric analysis. These 2 variables were examined using the Kruskal-Wallis non-parametric test.

Following additional tests for linearity, homoscedasticity, and multicollinearity, some covariates were removed from the analyses. Multicollinearity was a particular problem for education, income, and occupation; on statistical grounds, education was selected as the most representative of the 3.

Pearson correlation coefficients were used to examine relationships between variables of interest over the 3 assessments. Thus, a range of correlations is reported.

Patients' views of the interventions. Separate analyses of variance (ANOVAs) with repeated measures were used on the effectiveness and enjoyment rating scales.

The 5 scales, which related to the patients' views of their therapists, were subjected to principal components analysis. This revealed a single factor (eigenvalue = 4.2) that accounted for 83.4% of the variance and included all 5 scales. Factor scores were high, ranging from 0.89 (caring) to 0.76 (informative). In view of the 1-factor solution, it was not possible to rotate the data to obtain a varimax solution. A one-way ANOVA using the factor scores was employed to test for group differences.

Therapists' views of intervention effectiveness. The therapists' perceptions of effectiveness between the interventions at pre-test were examined using a one-way ANOVA. Pre- and post-test rating scales were compared within each intervention group using paired *t*-tests.

RESULTS

Sample characteristics. Of the 139 patients with chronic RA who completed the study, 96 were women and 43 were men; their mean age was 58.2 years (SD 11.1). The patients had a disease duration of 11.5 years (SD 8.7), and 66% were in Steinbocker functional class II, indicating that despite a "handicap of discomfort or

limited motion at one or more joints," the patients were able to function adequately for normal activities (14). Table 1 details some of the demographic features, showing that the intervention groups were comparable.

At the pre-test interview, 29.5% of patients reported one or more comorbidities on the AIMS2 questionnaire. These mainly related to cardiorespiratory problems (e.g., high blood pressure, asthma, angina). As these patients were evenly distributed throughout the intervention groups, no attempt was made to control for comorbidity in the analysis.

At baseline 73% of patients were prescribed DMARDs and 83% NSAIDs; 5.8% were taking oral steroids. The patients and their physicians were asked to maintain the type and dosage of pre-entry medications as far as was ethically possible during the study period. At each assessment, patients were questioned about their current medications. Ninety-seven percent of patients had been able to maintain pre-entry medications at post-test. By followup, this number had dropped to 79%, and 12.2% required an intraarticular corticosteroid injection. Changes in drugs and requirements for intraarticular injections were evenly spread throughout the intervention groups.

Is the effect of hydrotherapy significantly better than the other conditions? Physical variables. When hydrotherapy was compared with the other conditions for the group of physical variables, all patients, regardless of intervention, showed significant improvements in joint tenderness between pre- and post-test, as measured by the Ritchie index (from 21.15 to 17.3, $P = 0.002$). Hydrotherapy patients had the greatest reduction in joint tenderness, with a mean decrease of 27% between pre- and post-test (from 21.3 to 15.5, $P = 0.03$) (Table 2).

Analysis by sex showed that in women who received hydrotherapy, the total combined knee range of movement had significantly increased by 6.6° by the end of the course ($P = 0.049$). Although this improvement was maintained at followup, it was no longer statistically significant (Table 3).

Grip strength, wrist range of movement, duration of morning stiffness, and CRP levels did not change significantly.

Pain variables. All patients demonstrated a significant reduction in their evaluative/affective pain scores between pre- and post-test ($P = 0.005$), but this was not maintained at followup. There were no significant changes in sensory pain.

All patients reported significant pre- to post-test reductions in the belief that pain is controlled by chance happenings or misfortune ($P = 0.049$) (Table 4), but this was not maintained at followup. No differences in

Table 4. Changes in pain variables, by study group, mean (SD) values*

	Overall (n = 139)			Hydrotherapy (n = 35)			Seated immersion (n = 35)			Land exercise (n = 34)			Progressive relaxa- tion (n = 35)		
	Pre	Post	Follow- up	Pre	Post	Follow- up	Pre	Post	Follow- up	Pre	Post	Follow- up	Pre	Post	Follow- up
Sensory pain (MPQ)	2.48 (0.6)	2.59 (0.7)	2.45 (0.8)	2.55 (0.6)	2.64 (0.7)	2.46 (0.8)	2.4 (0.6)	2.7 (0.7)	2.45 (0.8)	2.53 (0.6)	2.57 (0.7)	2.5 (0.7)	2.4 (0.7)	2.4 (0.6)	2.4 (0.8)
Evaluative/ affective pain (MPQ)	2.16 (1.7)	1.8† (1.5)	2.0 (1.8)	2.63 (1.7)	2.1 (1.8)	2.06 (1.8)	2.4 (1.9)	1.9 (1.6)	2.06 (1.7)	2.1 (1.6)	1.3 (1.2)	1.7 (1.6)	1.6 (1.5)	1.8 (1.4)	2.3 (2.0)
Internal scale (BPCQ)	2.7 (0.8)	2.6 (0.8)	2.7 (0.8)	2.6 (0.8)	2.74 (0.7)	2.8 (0.7)	2.8 (0.8)	2.75 (0.9)	2.7 (0.8)	2.6 (0.8)	2.5 (0.7)	2.6 (0.8)	2.8 (0.8)	2.6 (0.8)	2.6 (0.7)
Powerful doctors (BPCQ)	3.8 (0.9)	3.89 (0.9)	3.96 (0.9)	3.9 (1.2)	3.85 (1.1)	3.87 (1.1)	3.9 (0.8)	3.9 (0.9)	4.06 (0.8)	3.7 (0.9)	3.8 (1.0)	3.75 (0.9)	3.87 (0.8)	3.96 (0.9)	4.1 (0.9)
Chance happenings (BPCQ)	3.44 (0.9)	3.37‡ (0.9)	3.3 (0.9)	3.46 (1.0)	3.47 (0.8)	3.4 (0.9)	3.5 (0.8)	3.3 (0.8)	3.2 (0.7)	3.4 (0.9)	3.2 (0.8)	3.1 (0.8)	3.48 (0.9)	3.5 (0.9)	3.65 (1.0)

* MPQ = McGill Pain Questionnaire; BPCQ = Beliefs in Pain Control Questionnaire.

† All patients reported a reduction in evaluative/affective (MPQ) between pre- and post-test ($F = 8.2$, $df = 1, 118$, $P = 0.005$).

‡ All patients reported a reduction in beliefs that pain was controlled by chance happenings between pre- and post-test ($F = 3.96$, $df = 1, 109$, $P = 0.049$).

the patients' beliefs in pain control by powerful doctors and in the personal control of pain (internal scale) were noted between groups or over time.

For patients in the hydrotherapy group, there were no additional benefits in terms of pain relief or beliefs concerning pain.

Health status measures—AIMS2. All patients significantly improved their physical capacity (by 4.8%) after treatment ($P = 0.007$), and further improvement was noted on this outcome measure at followup ($P = 0.008$) (Table 5).

Significant improvement in mood and tension occurred for all patients after treatment, as represented

by a reduction in affect scores ($P = 0.003$). Furthermore, women reported the greatest improvement ($P = 0.02$) (Table 3). At followup, all patients continued to show significant improvement in mood and tension ($P = 0.001$). However, patients receiving hydrotherapy demonstrated the greatest effect ($P = 0.03$) (Table 2).

These two AIMS2 scales, physical capacity and affect, were positively and significantly correlated at all assessments (P values between 0.01 and 0.001), suggesting that physical and psychological well-being are closely related.

No differences between groups or over time were observed in the social or work subscales.

Table 5. Changes in scores on the Arthritis Impact Measurement Scales 2 variables, by group, mean (SD) values

	Overall (n = 139)			Hydrotherapy (n = 35)			Seated immersion (n = 35)			Land exercise (n = 34)			Progressive relaxa- tion (n = 35)		
	Pre	Post	Follow- up	Pre	Post	Follow- up	Pre	Post	Follow- up	Pre	Post	Follow- up	Pre	Post	Follow- up
Physical capacity*	2.57 (1.8)	2.4 (1.9)	2.4 (1.9)	2.3 (1.9)	2.25 (2.1)	2.1 (1.8)	2.4 (1.5)	2.2 (1.7)	2.1 (1.7)	2.7 (2.1)	2.4 (1.9)	2.5 (2.1)	2.9 (1.8)	2.7 (1.9)	2.8 (1.7)
Affect†	3.3 (1.4)	3.0 (1.3)	2.9 (1.3)	3.5 (1.4)	3.3 (1.6)	3.0 (1.5)	3.2 (1.3)	2.98 (1.2)	3.0 (1.2)	3.2 (1.5)	2.8 (1.3)	2.7 (1.4)	3.3 (1.4)	2.9 (1.3)	3.2 (1.2)
Social	3.4 (1.1)	3.52 (1.2)	3.54 (1.3)	3.6 (1.2)	3.5 (1.3)	3.6 (1.3)	3.4 (1.2)	3.4 (1.2)	3.5 (1.2)	3.38 (1.2)	3.5 (1.3)	3.4 (1.4)	3.39 (1.0)	3.5 (1.1)	3.6 (1.1)
Pain‡	4.48 (2.2)	4.47 (2.2)	4.49 (2.3)	4.9 (2.2)	4.8 (2.7)	4.8 (2.5)	4.3 (2.2)	4.3 (2.2)	4.5 (2.4)	4.1 (1.9)	3.8‡ (1.8)	3.8 (1.9)	4.5 (1.9)	4.8 (1.9)	4.7 (2.2)
Work	3.17 (2.3)	2.8 (2.2)	2.97 (2.3)	3.05 (1.9)	2.4 (1.9)	2.8 (2.5)	2.79 (2.3)	2.8 (2.3)	2.5 (2.1)	3.09 (2.8)	3.1 (2.3)	3.3 (2.7)	3.1 (2.2)	2.9 (2.2)	3.2 (2.0)

* Physical capacity increased significantly at post-test for all patients ($F = 7.6$, $df = 1, 115$, $P = 0.007$); the improvement in physical capacity was maintained at followup for all patients ($F = 7.3$, $df = 1, 113$, $P = 0.008$).

† Levels of mood and tension decreased for all patients at post-test ($F = 9.3$, $df = 1, 113$, $P = 0.003$); the improvement in the affect scores was maintained at followup for all patients ($F = 10.8$, $df = 1, 112$, $P = 0.001$). At followup, hydrotherapy patients had significantly lower affect scores compared to the other groups ($F = 4.6$, $df = 1, 112$, $P = 0.03$).

‡ At post-test, land exercise patients had significantly less pain compared to other groups ($F = 4.2$, $df = 1, 105$, $P = 0.04$).

Other group findings. No additional benefits were observed for patients receiving seated immersion. Patients in the land exercise group were the only patients to maintain their improvement in overall joint tenderness between post-test and followup ($P = 0.03$). In addition, these patients had a significant reduction in pain on the AIMS2 between pre- and post-test ($P = 0.04$) (Table 2). However, this was not maintained at followup, and, as with the other patients in the study, there was a slight but significant increase in pain on this scale ($P = 0.04$). Despite the overall finding that affective/evaluative pain decreased significantly in the sample as a whole between pre- and post-test, the progressive relaxation group actually experienced a 12.5% increase in their pain ($P = 0.02$), and this persisted at followup ($P = 0.028$). Additionally, beliefs that pain is controlled by chance happenings were found to have been strengthened in the progressive relaxation group at followup (from 3.48 to 3.65, $P = 0.015$).

Perceptions of the interventions. *Patients' views.* All groups reported similar perceptions of the effectiveness of the interventions at pre-test, which did not change significantly over time. This score was high, with overall mean ratings (on a 1–5 scale) of 3.6 (SD 0.9) at pre-test and 3.4 (SD 1.15) at post-test. Similarly, ratings on intervention enjoyment were stable between groups and over time. At pre-test, the overall mean rating was 4.5 (SD 0.7), and at post-test, 4.7 (SD 0.6). A positive and significant correlation between effectiveness and enjoyment was observed at post-test ($r = 0.35$, degrees of freedom [df] = 110, $P = 0.0001$), suggesting that enjoyable treatment may be effective treatment.

All patients, regardless of the intervention, considered their therapist to be relatively warm, caring, informative, interested, and enthusiastic. Patients' views of intervention effectiveness were not significantly correlated with their views of the therapist ($r = 0.08$, df = 110, $P = 0.2$). However, patients' enjoyment of the intervention was significantly and positively correlated with their view of the therapist at all time points (P values range from 0.05 to 0.001).

Therapists' views. At the start of the study, therapists expected that patients in the seated immersion group would benefit more than those in the land exercise group ($F = 3.06$, df = 3, $P = 0.03$). This view was maintained throughout the study period ($t = -1.35$, df = 120, $P = 0.2$).

DISCUSSION

The present study shows that hydrotherapy has value-added benefits for the physical and emotional as-

pects of rheumatoid arthritis. These occur in addition to the physical and psychological benefits of "placebo attention" seen in all the intervention groups used in this study. The results suggest an enhancement effect in the interaction between exercise and the water, with minor emphasis on the former.

While all groups experienced improved joint tenderness over the 4 weeks, the hydrotherapy group experienced the most relief. This confirms reports by previous investigators, who noted improvement in clinically active joints after a pool program but not after a land program (4). Given that joint tenderness and pain may be similar constructs (37), it seems plausible, within the terms of current theory about pain, that the warmth of the water facilitates a closure of the "gate" in the spinal cord, and in enhancing the blood flow, relieves the pain (38). Given that hydrotherapy is used as a pain-relieving treatment, it is surprising that it was only the land exercise patients, who in addition to reductions in evaluative/affective pain (in common with other groups), experienced a similar reduction in pain scores on the AIMS2. However, as these 2 variables are significantly and positively correlated at all time points, it seems likely that both were measuring similar aspects of the pain experience ($r = 0.25$ – 0.41 , $P \leq 0.05$ – 0.01). An alternative theory is that the reduced joint tenderness seen in the hydrotherapy group may be attributed to the reduction of joint loading occasioned by the buoyancy. In addition, the hydrostatic pressure of water immersion is considered to reduce edema (39), and this may have been one of the factors in decreasing joint tenderness and increasing range of movement. The unexpected finding that the increase in knee range of movement was gender-specific may be due to the small number of men in the sample, which despite adjustment for the unequal numbers in the analysis, did not provide the most robust test of this feature. Further studies should seek to test an equal number of men and women. It may also be related to the severity of edema at study entry. Due to the unreliability of available measures, knee swelling was not assessed, and it is therefore unknown whether women presented with greater edema than did men, and hence had greater capacity for improvement. Given that significant and negative correlations were noted between the Ritchie articular index and knee range of movement ($r = 0.43$ – 0.63 , $P \leq 0.05$ – 0.01), this finding may be important for future trials.

The finding that mood and tension, measured by the affect scale (AIMS2), were significantly enhanced at followup in hydrotherapy patients is also worth comment, particularly because significant positive correlations were noted between the Ritchie index at post-test and affect at followup ($r = 0.63$, $P \leq 0.001$). It

therefore seems plausible that improvements in tenderness which occurred by the end of treatment but which were not altogether maintained at followup 3 months later, may have primed improvements in mood which had already begun by the end of treatment. While a causal relationship cannot be established by correlations, these findings are in line with some results from cognitive therapy, which show that psychological improvement often takes longer to develop than physiological change, and tends to follow it. This appears to demonstrate that important psychological changes may follow physiotherapy treatments and it is one of the values of longitudinal studies that include the measurement of psychological variables. Given that a recent paper showed psychosocial variables to be as important as disease and pain in determining function, this is an extremely important finding (40).

The finding that the seated immersion group had no benefits additional to those found in the other groups confirms the hypothesis that the exercise component of hydrotherapy is of central importance. Additionally, the finding that the progressive relaxation group had increased evaluative/affective pain at post-test and followup, whereas the exercising and seated immersion groups had decreased pain at post-test, supports the theory that both components of hydrotherapy are required for effective benefit. The finding that chance happenings scores were higher at followup in the progressive relaxation group cannot be attributed to similar increases in pain, as these 2 variables were not significantly correlated in this group. It is therefore difficult to explain why relaxation on land strengthens beliefs that pain is controlled by misfortune. This finding is all the harder to explain in view of the findings that patients in the progressive relaxation group enjoyed their course equally as well as those in the other groups, liked their therapist as much, and judged their progress to be equally efficacious.

This study represents the largest examination, to date, of hydrotherapy and its components in patients with RA. While quantitative improvement was small, but nonetheless significant, the clinical significance needs to be addressed. The literature suggests that demonstrable objective improvement with hydrotherapy is small (2–4). Stenström et al noted few significant differences between a hydrotherapy training and a control group (5). The authors suggest that limitations of present outcome measures are a factor, given the patients' enthusiasm to participate. In the study reported here, responses from hydrotherapy patients suggested that the water and the exercise together increased their confidence to move freely. A further influence on the outcome may be the limited duration of treatment, and extending the treatment time may have resulted in

greater therapeutic effect. Future studies examining both the therapeutic effects and the mediating actions are required to address these current limitations.

In conclusion, this controlled trial investigating the effects of hydrotherapy—a combination of water and exercise—showed that hydrotherapy gave superior benefits in terms of physical and psychological functioning compared to the benefits experienced simply as a result of participation in the study. While these results are moderate in effect, they provide some justification for continuing investment in this type of treatment.

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REFERENCES

1. Campion MR: *Adult Hydrotherapy: A Practical Approach*. Oxford, Heinemann Medical Books, 1990
2. Dial C, Windsor RA: A formative evaluation of a health education-water exercise program for class II and III adult rheumatoid arthritis patients. *Patient Educ Counseling* 7:33–42, 1985
3. Danneskiöld-Samsøe B, Lynberg K, Risum T, Telling M: The effect of water exercise therapy given to patients with rheumatoid arthritis. *Scand J Rehab Med* 19:31–35, 1987
4. Minor MA, Hewett JE, Webel RR, Dreisinger TE, Kay DR: Exercise tolerance and disease related measures in patients with rheumatoid arthritis and osteoarthritis. *J Rheumatol* 15:905–911, 1988
5. Stenström CH, Lindell B, Swanberg E, Swanberg P, Harms-Ringdahl K, Nordemar R: Intensive dynamic training in water for rheumatoid arthritis functional class II—a long-term study of effects. *Scand J Rheumatol* 20:358–365, 1991
6. Guillemin F, Constant F, Collin JF, Boulange M: Short and long-term effect of spa therapy in chronic low back pain. *Br J Rheumatol* 33:148–151, 1994
7. Epstein M: Renal effects of head-out water immersion in humans: a 15 year update. *Physiol Rev* 72:563–621, 1992
8. O'Hare JP, Heywood A, Summerhayes C, Lunn G, Evans JM, Walters G, Corral RJM, Dieppe PA: Observations on the effects of immersion in Bath spa water. *BMJ* 291: 1747–1751, 1985
9. Mano T: Sympathetic nerve mechanisms of human adaptation to environment—findings obtained by micro-neurographic studies. *Environ Med* 34:1–35, 1990

10. Weston CFM, O'Hare JP, Evans JM, Corrall RJM: Haemodynamic changes in man during immersion in water at different temperatures. *Clin Sci (Colch)* 73:613-616, 1987
11. Kazdin AE: *Research Design in Clinical Psychology*. Second edition. Boston, Allyn and Bacon, 1992
12. Altman DG: *Practical Statistics for Medical Research*. London, Chapman and Hall, 1991
13. Arnett FC, Edworthy SM, Bloch DA, et al: The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. *Arthritis Rheum* 31:315-324, 1988
14. Steinbrocker O, Traeger CH, Batterman RC: Therapeutic criteria in rheumatoid arthritis. *JAMA* 140:659-662, 1949
15. Jacobsen E: *Progressive Relaxation*. Chicago, University of Chicago Press, 1938
16. Ritchie DM, Boyle JA, McInnes JM, Jasani MK, Dalakas TG, Grieverson P, Buchanan WW: Clinical studies with an articular index for the assessment of joint tenderness in patients with rheumatoid arthritis. *QJM* 147:393-406, 1968
17. Sukenik S, Neumann L, Buskila D, Kleiner-Baumgarten A, Zimlichman S, Horowitz J: Sulphur bath and mud pack treatment for rheumatoid arthritis at the Dead Sea. *Ann Rheum Dis* 49:99-102, 1990
18. Levy J, Dick WC: The detection of change in disease activity in patients with rheumatoid arthritis. *Rheum Dis Clin North Am* 1:225-243, 1975
19. Lee P, Baxter A, Dick EC, Webb J: An assessment of grip strength measurement in rheumatoid arthritis. *Scand J Rheumatol* 3:17-23, 1974
20. Rhind V, Bird HA, Wright V: A comparison of clinical assessments of disease activity in rheumatoid arthritis. *Ann Rheum Dis* 26:126-130, 1987
21. Gogia PP, Braatz JH, Rose SJ, Norton BJ: Reliability and validity of goniometric measurements at the knee. *Phys Ther* 67:192-195, 1987
22. Rothstein JM, Miller PJ, Roettger RF: Goniometric reliability in a clinical setting. *Phys Ther* 63:1611-1615, 1983
23. Melzack R: The McGill Pain Questionnaire: major properties and scoring methods. *Pain* 1:277-299, 1975
24. Skevington SM: Pain and locus of control—a social approach. In: *Psychology and Medicine*. Vol. 1. Edited by DJ Osborne, M Gruneberg, JR Eiser. London, Academic Press, 1979
25. Charter RA, Nehemkis AM: The language of pain intensity and complexity: new methods of scoring the McGill Pain Questionnaire. *Percept Mot Skills* 56:519-537, 1983
26. Bowers KS: Pain, anxiety and perceived control. *J Consult Clin Psychol* 32:596-602, 1968
27. Phares EJ: *Locus of Control in Personality*. New Jersey, General Learning Press, 1976
28. Skevington SM: A standardised scale to measure beliefs about controlling pain (BPCQ): a preliminary study. *Psychol Health* 4:221-232, 1990
29. Meenan RF, Gertman PM, Mason JH: Measuring health status in arthritis: the Arthritis Impact Measurement Scales. *Arthritis Rheum* 23:146-152, 1980
30. Meenan RF, Anderson JJ, Kazis LE, Egger MJ, Altz-Smith M, Samuelson CO Jr, Willkens RF, Solsky MA, Hayes SP, Blocka KL, Weinstein A, Guttadauria M, Kaplan SB, Klippel J: Outcome assessment in clinical trials: evidence for the sensitivity of a health status measure. *Arthritis Rheum* 27:1344-1352, 1984
31. Potts MK, Brandt KD: Evidence of the validity of the Arthritis Impact Measurement Scales. *Arthritis Rheum* 30:93-96, 1987
32. Anderson JJ, Firschein HE, Meenan RF: Sensitivity of a health status measure to short-term clinical changes in arthritis. *Arthritis Rheum* 32:844-850, 1989
33. Meenan RF, Mason JH, Anderson JJ, Guccione AA, Kazis LE: AIMS2: the content and properties of a revised and expanded Arthritis Impact Measurement Scales health status questionnaire. *Arthritis Rheum* 35:1-10, 1992
34. Lorish CD, Abraham N, Austin JS, Bradley LA, Alarcón GS: A comparison of the full and short versions of the Arthritis Impact Measurement Scales. *Arthritis Care Res* 4:168-173, 1991
35. Hill J, Bird HA, Lawton CW, Wright V: The Arthritis Impact Measurement Scales: an anglicized version to assess the outcome of British patients with rheumatoid arthritis. *Br J Rheumatol* 29:193-196, 1990
36. Tabachnick BG, Fidell LS: *Using Multivariate Statistics*. Second edition. New York, Harper Collins, 1989
37. Gaston-Johansson F, Gustafsson M: Rheumatoid arthritis: determination of pain characteristics and comparison of RAI and VAS in its measurement. *Pain* 41:35-40, 1990
38. Melzack R, Wall P: *The Challenge of Pain*. New York, Penguin Books, 1988
39. Von Diringshofen H: Die Wirkungen des hydrostatischen Druckes des Wasserbades auf den Blutdruck in den Kapillaren und die Bindegewebsentwässerung. *Z Kreislaufforsch* 37:382-390, 1948
40. Crotty M, McFarlane AC, Brooks PM, Hopper JL, Bieri D, Taylor SJ: The psychosocial and clinical status of younger women with early rheumatoid arthritis: a longitudinal study with frequent measures. *Br J Rheumatol* 33:754-760, 1994