cases are probably separate abnormal reactions to cortisone which are more likely to occur in cases of rheumatoid arthritis than in other diseases.

We thank Drs. R. Davison, D. M. Gallagher, and G. B. Robson for permission to use the clinical histories, and Mr. P. Tracy for the photomicrographs.

REFERENCES

- Ball, J. (1954). *Ann. rheum. Dis.*, **13**, 277.
 Bradley, R. L. (1954). *W. Va. med. J.*, **50**, 148.
 Cruickshank, B. (1954). *Ann. rheum. Dis.*, **13**, 136.
 Finck, P. A. (1955). *A.M.A. Arch. Path.*, **60**, 374.
 Friedman, H. H., Schwartz, S., Trubek, M., and Steinbrocker, O. (1953). *Ann. intern. Med.*, **38**, 732.
 Gumpel, R. C., Lewis, E. C., and Thomson, R. V. (1957). *A.M.A. Arch. intern. Med.*, **99**, 660.
 Kemper, J. W., Baggenstoss, A. H., and Slocumb, C. H. (1957). *Ann. intern. Med.*, **46**, 831.
 Levin, M. H., Rivo, J. B., Scott, W., Figueroa, W. G., Fred, L., and Barrett, T. F. (1953). *Amer. J. Med.*, **14**, 265.
 Nyström, G. (1953). *Ann. Med. intern. Fenn.*, **42**, 52.
 Ogryzlo, M. A. (1953). *Ann. rheum. Dis.*, **12**, 323.
 Palmer, T. H., Mason, P. J. H., and Adams, A. C. (1955). *J. Maine med. Ass.*, **46**, 349.
 Pessel, J. F., Beairto, E. B., Edwards, M. H., Rathmell, T. K., and Wise, J. S. (1953). *Amer. J. dig. Dis.*, **20**, 318.
 Sauer, W. G., Dearing, W. H., and Wollaeger, E. E. (1953). *Proc. Mayo Clin.*, **28**, 641.
 Sloan, S., Briggs, J. D., and Halsted, J. A. (1951). *Gastroenterology*, **18**, 438.
 Slocumb, C. H. (1953). *Ann. rheum. Dis.*, **12**, 323.
 Tulin, M., Kern, F., and Almy, T. P. (1952). *J. Amer. med. Ass.*, **150**, 559.
 Weinberger, H. J. (1953). *Ann. rheum. Dis.*, **12**, 323.
 West, H. F., and Newns, G. R. (1953). *Lancet*, **2**, 1123.

A CONTROLLED TRIAL OF VARIOUS FORMS OF PHYSIOTHERAPY IN ARTHRITIS

BY

D. E. HAMILTON, M.C.S.P.

E. G. L. BYWATERS, M.B., F.R.C.P.

AND

N. W. PLEASE, B.Sc.

From Hammersmith Hospital and the Postgraduate Medical School

In the field of physical medicine, therapeutic measures are critically assessed in comparatively few centres in this country or elsewhere. Much physiotherapy seems to be determined by an authoritarian approach or by superficial observation based on general impressions—for example, that if the patient does well the treatment must therefore be effective. The methods of quantitative assessment seem to be unknown in many non-teaching hospital departments. In so far as a physiotherapeutic department often contains and demands a great deal of expensive equipment, takes up considerable space, and personnel and patient's time, particularly in the fields of orthopaedics and rheumatism, we have felt that a controlled trial of various forms of physiotherapy would not only be useful in itself but be of educational value within the department.

A number of studies have compared the short-term or immediate physiological effects of various forms of physical treatment, but we wished to ascertain the relative value of various forms of physiotherapy as used in the ordinary way in the department over periods of several weeks in the care of patients with chronic arthritis. We were aware of the difficulties in running

a long-term trial, but we did not then realize how formidable they were. It still seems to us, however, that a trial of a realistic nature such as this, conforming to the conditions under which such patients are normally treated, gives information which is of much greater value to the clinician, to the patient, and to the public, than data, more easily arrived at, relating to the immediate physiological effects such as have been published not infrequently in the past.

The questions which the trial was designed to answer were: (1) Which of four forms of physiotherapy (short-wave diathermy, infra-red radiation, faradic stimulation, or paraffin-wax baths) produces the greatest functional improvement during one month's treatment? (2) Is there any significant difference between these treatments and the treatment given to patients on the same basic regime without the additional form of physiotherapy?

Plan of Trial

The trial was set up to study out-patient treatment of individuals with either rheumatoid arthritis involving the hands or knees, or with degenerative joint disease involving the knees. These joints were chosen because they are the easiest on which to assess function accurately. If other joints of these patients were also affected, they were to be treated but not assessed. The criteria for diagnosis were those operative in the rheumatism unit—that is, for rheumatoid arthritis a polyarthritis of unknown aetiology with pain, swelling, and limitation of joints and a raised sedimentation rate; for degenerative joint disease we accepted clinical and radiological evidence with a normal sedimentation rate. It was planned to select 100 patients consecutively referred to the physiotherapy department for treatment and meeting these criteria.

Instead of comparing four separate groups of patients treated in different ways, we treated each patient with each of the four treatments, so that each patient served to some extent as a control on himself. Because, however, it is known that the order of treatments is important and that in general the first treatment of whatever character given to any patient is usually more effective than the second, the order of treatment was allocated at random to each patient. Each patient therefore received one month of treatment A, one month of treatment B, one of C, and one of D, separated each from the other by one week's rest, but randomized in regard to sequence. For each of the three diagnostic categories (rheumatoid arthritis, hands; rheumatoid arthritis, knees; or degenerative joint disease, knees), a series of envelopes were prepared listing the order of these four treatments and sealed. When, therefore, a patient was selected for the trial and met the criteria, the next envelope in the appropriate one of the three categories was opened; this was intended to make sure that over the group as a whole no particular treatment had a greater chance of being first or last than the other treatments. Thus the patients were selected at random to a particular treatment order, but each patient received all four treatments.

The treatments selected for comparison consisted of:

- (1) Short-wave diathermy given for 20 minutes three times a week.
- (2) Infra-red radiation for 20 minutes three times a week.
- (3) In patients with knee involvement, faradism to the quadriceps 20 minutes three times a week, or, for patients with hand involvement, wax treatment 20 minutes three times a

week. (4) In addition, a fourth group was selected in which the patients were given what we called "cold short-wave diathermy," administered in the same way as ordinary short-wave diathermy but without turning on the current. A warning was given that they would probably not feel any heat. This served as a control group.

Every patient in each of these four groups was also put on a basic regime of active exercises, assisted or resisted, with calcium aspirin or tab. codeine. co. as required, and splintage as necessary. The active exercises were all given after the treatment on trial. The diagram shows the plan of this trial for a patient whose envelope indicated that he was to start on treatment A, to be followed by B, C, and D in that order. Assessments were made by one of us (D. E. H.) at the points indicated by arrows, before and after each month of treatment. In patients with knee involvement the thigh circumference was measured at a point 3 in. (7.5 cm.) above the superior border of the patella on a line marked by the injection of indian ink. This will not be further discussed, because it was found on assessment that the circumference reflected weight change rather than muscular strength in a ratio of approximately 1 in. (2.5 cm.) increase in circumference to every 14 lb. (6.4 kg.) gained in weight.

The range of movement was measured with a jointed "perspex" angle measure, from bony points marked with indian-ink injection. It is important to note that the angle measure was unmarked. The angle was fixed by a screw, the resulting angle being drawn on paper and then measured with a protractor. This ensured that the actual measurement on the patient was performed without reference to the preceding measurement. Power of extension of the knee from 90 degrees flexion was measured by a weighted boot of the Delorme type in pounds, always starting each session by extending against gravity only and adding by 2-lb. (0.9-kg.) increments. Care was taken that the thighs were parallel to the floor. The time to walk up four standard steps and down again was taken as the mean of two performances. In the same way, the time to walk 20 yards as the mean of two performances was noted with a stop-watch in seconds. For assessment of power in the hands, a mercury manometer attached to a sphygmomanometer cuff was used with the arm in supination and at 90 degrees elbow flexion. The range of wrist movement was measured as before and the time to tie three knots was also measured. This had to be taught and was practised before each reassessment. These assessments were entered on a standardized form.

We planned originally to select 100 patients for this purpose, but owing to various causes a number of these patients did not attend as they should have done over the whole five-months period. We had therefore to continue selection, so that a total of 131 were entered into the trial. Those patients who were unable to

attend for the full five-months course were not included in the results. A total of 64 patients were thus excluded. It did not seem that any particular bias was introduced by this exclusion. The reasons for non-attendance are shown in Table I; it will be seen that

TABLE I—Reasons for Non-completion of Course

	Sensitivity to Wax	Inter-current Disease	Holidays or Moving House	Recovery	Treatment Changed by Doctor	Family Difficulties	No Reason Known	Total
D.J.D. Rh. arth.	—	6 8	3 4	12 10	2 5	4 3	1 4	28 36
Total	2	14	7	22	7	7	5	64

they are very varied. The only troubles caused by this failure to attend were, firstly, the trial was prolonged and further patients had to be taken into it; secondly, it upset the prearranged distribution of treatment orders, so that the initial treatment with one particular measure occurred slightly more often than with others. Sixty-seven completed the scheme and 64 failed to do so. Five of the 67 patients who completed the scheme have also been excluded from the analysis—four because only one knee was affected and this might have affected walking-time and stair time, and one because cerebral arteriosclerosis slowed his reaction to such an extent that it masked the trial assessment.

Analysis of Results

We have taken for analysis of each assessment the quantitative difference between the beginning and the end of each month's treatment, a positive measure thus showing an apparent improvement and a negative one an apparent deterioration. It may be seen from Table II that, in each type of assessment averaged over all four

TABLE II

Group	Assessment	No. of Patients	Stand. Deviation	Mean	Mean/S.E.M.
R.A. knees (18 patients)	Range ..	18	11.30	1.32	0.99
	Power ..	18	6.12	1.93	2.67*
	Stair time ..	18	14.17	1.31	0.78
	Walk ..	18	25.65	2.07	0.69
D.J.D. knees (26 patients)	Range ..	26	10.89	1.81	1.74
	Power ..	26	5.57	2.05	3.85*
	Stair time ..	26	8.79	2.36	2.82*
	Walk ..	26	8.82	1.30	1.54
R.A. hands (33 patients)	Range ..	33	20.55	0.19	0.11
	Power ..	33	36.00	1.31	0.42
	Knot time ..	33	26.69	7.81	3.36*

* Significant (t test). Note—all positive. S.E.M. denotes standard error of the mean.

treatments, the mean differences are positive for all groups of patients. These means are also shown as ratios of the "standard error of the means" to examine their magnitude in relation to the inherent variability of the particular measurements. In four instances (starred in the table) the ratio mean S.E.M. is greater than 2, indicating that in these cases the apparent improvement is statistically significant at the 5% level.

It appears, therefore, that there is a demonstrable improvement in some of the tests and that the others, while not statistically significant individually, all have the same sign, suggesting that there is, in general, an overall improvement from the beginning to the end of the month. It is necessary now to examine whether the improvement is related to the particular treatment.

Table III details the results of the individual treatments. Treatment A was the dummy or "cold"

TABLE III

Group	Assessment	A "Cold" S.W.D.	B S.W.D.	C Infra- red	D Wax or Faradism
R.A. knees (18 patients)	Range ..	-0.62	0.46	-0.40	0.56
	Power ..	-1.37	0.32	0.32	0.72
	Stair time	0.09	0.76	-0.20	-0.64
	Walk ..	0.49	0.69	1.17	-2.34*
D.J.D. knees (26 patients)	Range ..	-0.24	-0.49	-0.09	0.81
	Power ..	0.91	-0.30	-0.80	0.20
	Stair time	-0.65	-0.09	1.49	-0.75
	Walk ..	-1.07	0.66	1.43	-1.02
R.A. hands (33 patients)	Range ..	-1.35	0.57	-0.35	1.13
	Power ..	-0.01	0.54	-0.35	-0.18
	Knot time	-0.90	0.78	-0.41	0.54

* Significant (t test).

short-wave diathermy plus the basic regime alone, whereas B, C, and D had a special treatment in addition to the basic regime. These figures have been analysed by approximate analysis of variance and no evidence could be found of any significant difference between these four treatments. To illustrate the results most clearly, the values given in Table III are "scores" instead of actual measurements. The scores may be looked upon as deviations from the average improvement shown in Table II. "Scores" are the "standardized" differences of each treatment mean from the overall mean of all treatments for the particular assessment and are obtained by expressing the difference of the treatment mean from the overall mean as a ratio of the standard error. Thus for the rheumatoid arthritis knee group of patients the range assessment showed that treatments A and C were below the average while B and D were above the average. The advantage of presenting them in this way is that statistically significant values (scores greater than 2) can be seen at a glance. In fact, only one value was significant, and this may well be a chance effect among so many comparisons. In general, over the three diagnostic categories, treatments A and C are not quite as good as B or D, since there are eight and seven minus signs as against three and five minus signs respectively, but none of these differences between treatments reaches positive significance levels.

When we come to examine the results of order of treatment in the same way (Table IV) it will be seen

TABLE IV

Group	Assessment	Order of Treatment			
		First	Second	Third	Fourth
R.A. knees (18 patients)	Range ..	1.45	-1.08	-0.67	0.29
	Power ..	-0.21	-0.57	-0.08	1.66
	Stair time	-0.43	1.18	-1.39	0.64
	Walk ..	0.12	1.58	-0.43	-1.28
D.J.D. knees (26 patients)	Range ..	-0.43	-1.07	0.68	0.81
	Power ..	0.20	0.45	-0.76	0.11
	Stair time	2.00*	-1.73	0.04	-0.30
	Walk ..	1.59	-0.62	0.09	-1.05
R.A. hands (33 patients)	Range ..	-1.29	-0.28	-0.21	1.78
	Power ..	2.02*	-1.98	-1.34	1.30
	Knot time	3.00*	-0.77	-1.40	-0.83

* Significant (t test).

that the first treatment scores three positive significant standardized differences, and in fact analysis of variance also shows that this is significant for the patients with rheumatoid arthritis affecting the hands. The second and third treatments, whatsoever they consist of, do not produce as much improvement, since the number of minuses in the second and third is higher than in the first and fourth treatments.

Summary

We may conclude that, although in each of the diagnostic categories there was some improvement after treatment compared with the state before treatment, this occurred more commonly in the first treatment, whatever that consisted of, and that when short-wave diathermy, infra-red, and Faradism or wax treatment are compared with a dummy exposure to short-wave diathermy, no significant difference is seen. This means that if there is a difference between treatments it is too small in relation to the variability of the group, and of the measurements, to be distinguishable in this number of patients from that due to chance variability. It must be remembered that all patients were on a good basic regime of exercises, analgesics, splintage, and encouragement, and it seems possible that the general improvement noted could in fact be due to this basic regime.

It should be realized that controlled trials like this do not prove that such and such a treatment is no good. Results merely indicate that, although improvement has occurred in certain measurements and in certain groups of patients, the variability due to measurements, due to patients, and due to chance is too large for effects due to differing treatment to show in the series under consideration. We have not felt that it was ethical to carry a group of patients who were not on a basic regime of analgesics, exercises, and splintage, and indeed it would not only be wrong but impossible to persuade people to attend for five months on such a basis. We have felt, on a basis of general impressions only, for a number of years, however, that the most useful measures in the field of physiotherapy were those which maintained muscle power by active exercise, and those which maintained joint movement, good posture, and the co-ordination of movement. These ends can be achieved by assisted and resisted exercises, encouragement, splintage, the use of analgesics, weight reduction when necessary, and postural re-education. And, while these other measures which we have discussed may be useful adjuncts, this present control trial has not indicated that they are significantly better than dummy treatment.

We are grateful to Miss Morris, superintendent physiotherapist, and to Dr. George Fearnley, for help both at the planning stage and later, and to the Board of Governors of Hammersmith Hospital for a grant to one of us (D. E. H.) specifically for this study.

Home accidents cause more deaths than road accidents. In recent years there have been over 1,000 home accident deaths annually in Scotland. It is clear that accidents in the home form one of the major hazards of present-day living, and an analysis of such accidents suggests that a good many are due to faulty design of certain features in the home. A booklet published by the Department of Health for Scotland has been issued to help pinpoint the various risks which arise in the home and suggest how they can be minimized. It has been prepared for architects and other technical officers as well as for members of housing committees and others interested in home safety. They will all wish to satisfy themselves on how far the safety provisions mentioned apply to the houses for which they are responsible. Safety is an essential factor to be kept in mind in the design and construction of new houses, and it is with this aspect that this booklet is primarily concerned. Some of the recommendations, however, could be applied with advantage to existing houses—in particular, the provision of fireguard fixings ("Designing for Safety in the Home," H.M.S.O. Price 1s. 3d.).