Randomized controlled trial of physiotherapy in 56 children with cerebral palsy followed for 18 months

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This study aimed to determine whether motor function and performance is better enhanced by intensive physiotherapy or collaborative goal-setting in children with cerebral palsy (CP). Participants were a convenience sample of 56 children with bilateral CP classified at level III or below on the Gross Motor Function Classification System (GMFCS), aged between 3 and 12 years. A 2×2 factorial design was used to compare the effects of routine amounts of physiotherapy with intensive amounts, and to compare the use of generalized aims set by the child's physiotherapist with the use of specific, measurable goals negotiated by the child's physiotherapist with each child, carer, and teacher. Following the six-month treatment period there was a further six-month period of observation. Changes in motor function and performance were assessed by a masked assessor using the Gross Motor Function Measure (GMFM) and the Gross Motor Performance Measure (GMPM) at three-month intervals. There was no statistically significant difference in the scores achieved between intensive and routine amounts of therapy or between aim-directed and goal-directed therapy in either function or performance. Inclusion of additional covariates of age and severity levels showed a trend towards a statistically significant difference in children receiving intensive therapy during the treatment period. This advantage declined over the subsequent six months during which therapy had reverted to its usual amount. Differences in goal-setting procedures did not produce any detectable effect on the acquisition of gross motor function or performance.

In our previous studies (Bower and McLellan 1992, 1994b) we identified two elements that were widely believed by health care professionals and parents to be of particular importance in determining the rate of motor progress in children with cerebral palsy (CP). Both of these elements would be supported by basic principles of learning theory. One element was the intensity of physiotherapy treatment, i.e. the number of therapy sessions within a set time period. The other was the identification of precise objectives that were adopted and understood by the child and considered helpful by parents and carers.

Physiotherapists often identify a set of general aims in relation to the treatment of their patients, such as improvement of trunk balance or gait pattern. While such aims reflect the general direction of changes in the patient's performance they do not define the achievement with any measurable precision. Such general aims can be contrasted with specific measurable goals of therapy collaboratively agreed upon by the child, parents, teacher, and therapist. Setting a treatment goal involves identifying and formulating standards of motor activity which are in advance of the child's current capacity or which retard deterioration (Bower and McLellan 1994a). Goals need to be formulated in such a way that there is no doubt as to the extent to which they have been achieved when performance is reviewed.

Other studies

McLaughlin and colleagues (1998) compared selective dorsal rhizotomy plus intensive physiotherapy (192 hours, SD 40.1) with intensive physiotherapy alone (171.8 hours, SD 51.1) over a 24 month period. Intensive physiotherapy emphasized muscle strengthening procedures for all children participating in the trial. The 17 children with a mean total Gross Motor Function Measure (GMFM; Russell et al. 1993) score at baseline of 71.3 (SD 16.8) and a mean age of 7.2 years (SD 4.5) who received intensive physiotherapy alone showed a mean change of 4.2 percentage points on the GMFM after 12 months and a mean change of 7.2 percentage points over the entire 24 months. In a similar trial over a 12 month period, Wright and colleagues (1998) found a change of 4.4 percentage points in GMFM mean total score in children receiving therapy only (116.4 minutes weekly, SD 17.6) who had a GMFM mean total score of 56.5 (SD 12.2) at baseline and a mean age of 58 months (SD 12.7). The children receiving therapy only had sets of treatment goals identified for them which were to be followed from the start of the study. These goals were different from those followed by the children receiving selective dorsal rhizotomy and physiotherapy.

In our last study (Bower et al. 1996) we measured prospectively the effect of different intensities of physiotherapy and different aim and goal setting procedures applied for two weeks in a group of 44 children, using a 2×2 factorial design. Over this relatively short period a clinically and statistically significant improvement of 4.3 percentage points in GMFM score was detected in children whose goals had been precisely formulated. The independent effect of increased intensity of physiotherapy treatment showed a trend towards improvement of 4.2 percentage points in GMFM score that did not reach statistical significance. In that study it was not attempted to identify changes in the nature of performance, i.e. specifically how the motor functions were performed. This aspect may be important in the prevention of developmental

deformity or secondary biomechanical constraints (O'Dwyer et al. 1989) but it is more difficult to evaluate (Bower and McLellan 1994a). The term 'performance' is used in this paper to denote the manner in which the motor act is achieved (i.e. the pattern of movement) and the term 'function' to denote the degree of motor function achieved.

Previous studies have investigated the effects of two weeks (Bower et al. 1996), three weeks (Bower and McLellan 1992), and five weeks (Bower and McLellan 1994b) of more intensive goal-directed physiotherapy and we have detected improvement in motor function. The implication is that the eventual level of motor function acquired would be higher with such therapy than with current routine therapy. In routine clinical and educational settings, however, therapy is provided less for its short term effects than for its long term cumulative effects. Treatment of greater intensity using precise goal-setting methods does improve motor function over short time periods. However, it was not clear whether these changes were temporary deviations within the range of variance inherent in the child's basic abilities or whether there was an underlying change in motor function or performance that would be consolidated in a cumulative way over longer periods of time. If the latter is the case, a treatment group and a control group would be expected to diverge progressively the longer that treatment continued, with regard to level of motor function or performance acquired. Further, if treatment then reverted to the previous level, the treatment group would maintain its advantage over the control group but would subsequently run parallel to rather than diverge further from it.

We have now undertaken a prospective randomized controlled trial in children with bilateral CP aiming to establish whether intensive physiotherapy accelerates the acquisition of motor function and performance over a six month period, and if so, to determine if the effect is cumulative. We also aimed to establish whether collaborative goal-setting accelerates the acquisition of motor function and performance over a six month period, and if so, to determine if this effect is cumulative.

Method

ASPECTS OF TREATMENT COMPARED

Two aspects of treatment were studied: (1) intensity of treatment, and (2) the nature of objectives and the objective-setting process employed. Objectives were defined as either aims or goals. An example of an aim, which was not measurable and decided upon by the child's therapist is 'improve sitting', whereas an example of a goal, which was measurable and collaboratively set by the child, parents, teacher, and therapist was 'sit on a school chair pushed under a desk and maintain independently for one minute while listening to a story'.

ASPECTS OF TREATMENT CONTROLLED

Specific key aspects of ongoing intervention were noted by the child's physiotherapist throughout the entire trial period, e.g. hydrotherapy, horse riding, community occupational therapy, school physical education, and exercise programmes.

TRIAL DESIGN

Following a baseline period of six months observation the study incorporated a 2×2 factorial design with pre-stratified randomization into four treatment groups totalling 56 children. After a six month treatment period there was a further six month observation period. Using the 2×2 factorial design the effects of the usual amounts of physiotherapy given to children were compared with the effects of intensive amounts (an hour a day Monday to Friday) in children over the middle six month treatment period; the effects of using broad, generalized aims decided upon by the child's physiotherapist were compared with the effects of using specific, measurable goals directed at motor skill acquisition and collaboratively set by the child's physiotherapist with the child, parents, and teachers. Figure 1 illustrates the entire study design and Table I illustrates the 2×2 factorial design of the treatment period.

NUMBER OF PARTICIPANTS

The number of children required for the study was calculated on the basis of our earlier findings (Bower et el. 1996). These had shown a standard deviation in the GMFM scores of the order of 18 percentage points at entry to the study. A statistically significant result was achieved over a two week period with a change in GMFM total score of 4.3 percentage points. It was hypothesized that a treatment period lasting 26 weeks would achieve a difference in GMFM score between the groups of at least 15 percentage points (approximately three times greater than the difference achieved after two weeks). Based on earlier results, in the current study we calculated that a comparison of two groups of 24 children

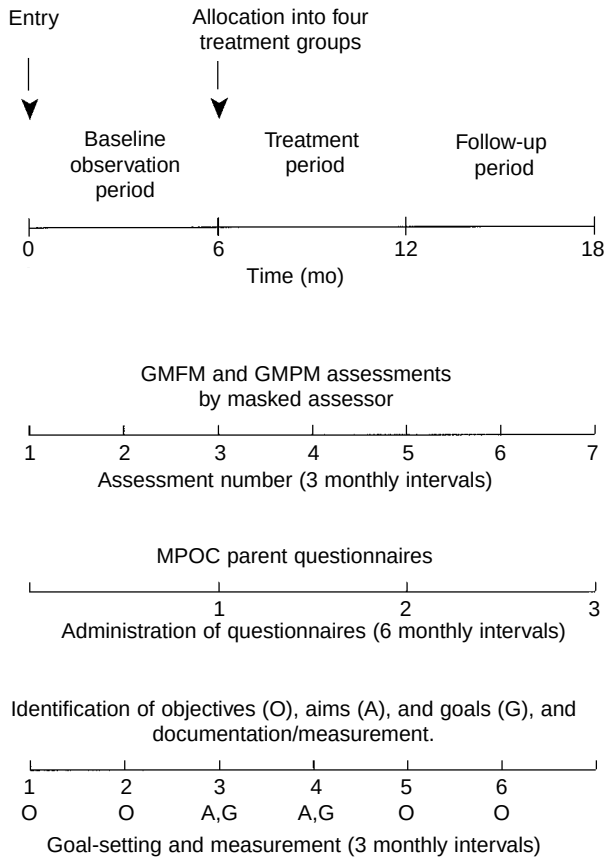

Figure 1: *Schedule of allocation, assessment, identification of aims and goals, and documentation/measurement.*

should detect a change in GMFM total score of 15 percentage points over 26 weeks with 80% power. All participating children had an established diagnosis of bilateral CP at level III or below on the Gross Motor Function Classification Systems (GMFCS) and were aged between 3 and 12 years at entry to the study.

RECRUITMENT

The paediatric superintendent physiotherapists of 50 different health districts were approached and invited to participate in the project. Thirty-three agreed on the basis that those physiotherapists on their staff who gave intensive therapy would be funded at the rate of £20 ($30) per hour of therapy given during the treatment period.

Over a six month period 56 children treated by 56 physiotherapists (one child each) were entered into the trial following informed consent. The children were from 33 different health authorities across the south of England involving permission from 30 different ethics committees (each with different requirements). There were 31 males and 25 females. All the therapists had high expectations for future change in the child selected by them to participate in the trial. Fifty-four of these physiotherapists considered that their approach was eclectic, while two followed the Bobath approach (Bower and McLellan 1994a). Of the 54 eclectic physiotherapists, 16 had undertaken a six week Bobath course at some time during their careers, five had undertaken courses in Conductive Education and two were most interested in a musculoskeletal approach (stretching and strengthening muscles and positioning to prevent deformity).

Table I: 2×2 factorial design of study for treatment period

	Physiotherapies		
Goal setting	*Routine (n)*	*Intensive (n)*	*Total (n)*
Aims	Group 1, 15	Group 2, 13	28
Goals	Group 3, 13	Group 4, 15	28
Total	28	28	56

Table II: Number of children in each treatment group following classification, stratification, and randomization

Stratification category according to age and GMFCS level	*Treatment group (n)*			
	Group 1 routine and aims	*Group 2 intensive and aims*	*Group 3 routine and goals*	*Group 4 intensive and goals*
Category 1 (n=10) <7 y, level III	3	3	2	2
Category 2 (n=7) ≥ 7 y, level III	2	1	2	2
Category 3 (n=23) <7 y, level IV	6	5	6	6
Category 4 (n=6) ≥ 7 y, level IV	1	2	1	2
Category 5 (n=5) <7 y, level V	1	1	1	2
Category 6 (n=5) ≥ 7 y, level V	2	1	1	1
Total (N=56)	15	13	13	15

CLASSIFICATION, STRATIFICATION, AND RANDOMIZATION

The children's motor functional status was classified according to the GMFCS at level III, IV, or V by the researcher with the child's own physiotherapist and parent or carer present. Children at level III walk independently with assistive devices, sit, but may need some support to maximize hand function and use a manual wheelchair or buggy (depending on age). Children at level IV have independent floor mobility (e.g. sit, roll, or crawl) but need support to enable hand use and use a powered wheelchair or buggy (depending on age or availability). Children at level V are severely limited in self-mobility even with the use of assistive technology, have no independent mobility, and experience difficulty with antigravity head and trunk postures.

Children were stratified before randomization on the basis of functional motor severity into one of six categories using the GMFCS and age (Table II).

Following stratification each child was allocated a trial number and randomized into one of the four treatment groups using a computer programme (Random Log) in blocks of four so that after every four subjects there was one in each of the four treatment groups. This process was undertaken by a person not otherwise involved in the trial.

The number of children at each motor functional level as classified on the GMFCS and their age status is shown for each treatment group in Table II. The numbers are similar for each of the four groups.

To examine the effectiveness of the randomization technique in balancing prognostic factors the following variables were compared: the age of the child, the length of time the child had been receiving physiotherapy before the study, the length of time the child had been receiving physiotherapy from their particular physiotherapist, and the number of potentially eligible children from whom each of the physiotherapists had made their selection.

Table III shows the mean ages of the children in each of the four treatment groups, the mean number of years that physiotherapy had been received by each child, the mean number of years that physiotherapy had been received from the current physiotherapist, and the mean number of potentially eligible children available to each physiotherapist. The four groups were clinically comparable in these variables.

TREATMENT GROUPS

Each child received one of four treatment regimes provided by their own physiotherapist during the treatment period: (1) current pattern of physiotherapy to continue for each child; (2) current pattern of physiotherapy to be provided more intensively, one hour per day Monday to Friday; (3) therapy to be guided by collaborative setting of specific, individual, and measurable goals at the current intensity, i.e. amount as in Group 1; (4) therapy to be guided by collaborative setting of specific, individual, and measurable goals and provided more intensively, one hour per day Monday to Friday.

There were 15 children in Group 1, 13 children in Group 2, 13 children in Group 3, and 15 children in Group 4.

IDENTIFICATION OF OBJECTIVES, AIMS, OR GOALS

During the baseline observation period and the follow-up observation period the child's therapist identified his or her objectives of treatment and the dimensions in the GMFM in which change was expected as a result of the objectives. This

process was documented by the researcher and undertaken at three-monthly intervals as shown in Figure 1.

The childrens' therapists were also encouraged to identify the attributes in the GMFM in which change was expected.

Following randomization and during the five days before the treatment period the child's therapist identified either aims or goals according to the child's treatment group and the dimensions in the GMFM in which change was expected. This process was documented by the researcher and aims or goals were reviewed for each child at three-monthly intervals as shown in Figure 1.

The collaborative goal-setting process involved the child's physiotherapist discussing the problems with the child (if appropriate), the parents, carers, teachers, or nursery nurses, setting goals with them including establishing their baseline measurements, undertaking the intervention, and after a set period (three months) evaluating the goals to ascertain to what extent they had been achieved.

OUTCOME MEASURES

Motor function of the children was assessed using the GMFM (Russell et al. 1993). This measure is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with CP. The measure has been reported to be sensitive to motor change over time in a number of previous studies (McLaughlin et al. 1991, 1994; Bower and McLellan 1992; Parker et al. 1993). It has a selection of 88 items with five dimensions: lie and roll; sit; crawl and kneel; stand; walk, run, and jump. Each item is scored on a five-point Likert scale. Having documented the aims or goals of the treatment period we were able to divide the dimensions of the GMFM retrospectively into those in which aims or goals had been set and those in which aims or goals had not been set. Consequently at the end of the study period we were able to monitor progress in those dimensions of the GMFM in which aims or goals of treatment had been set during the treatment period.

Motor performance was assessed using the Gross Motor Performance Measure (GMPM; Boyce et al. 1998). This measure is a standardized observational instrument designed and validated to evaluate change over time in specific features of gross motor performance. The instrument is designed to be used in conjunction with the GMFM. Gross motor performance is evaluated on 20 of the 88 items of the GMFM. There are three static and 17 dynamic items divided equally betwen five dimensions of the GMFM. Attributes have been selected as described in the manual for each of the 20 items. The attributes are chosen from: alignment, coordination, dissociated movements, stability, and weight shift. Attributes for each item are measured on a five-point Likert scale and scores were calculated so that children are not penalized for unattainable GMFM items.

Our hypothesis is that change in motor function is associated with divergence in GMFM scores between the experimental and control groups. If there is change in motor performance it is expected that there will be divergence in GMPM scores between the experimental and control groups.

Parents' perceptions of care-giving were measured using the Measure of Processes of Care (MPOC; King et al. 1995). This measure is a standardized questionnaire designed and validated to describe parents' perceptions of how health care providers give services to children and families. There are 56 questions arranged in five scales: (1) enabling and partnership, (2) providing general information, (3) providing specific information on the child, (4) coordination and comprehensive care, and (5) respect and support. Each item is measured on a seven-point Likert scale.

PROCEDURES

Assessment of motor function and performance was undertaken by a trained and masked independent assessor on seven separate occasions at three-monthly intervals for each child throughout the 18 month period (Fig. 1).

Following training the assessor achieved a score of 0.99 in the GMFM when the criterion score was set at 0.80 using a weighted kappa, and a score of 0.86 in the GMFM when the criterion score was set at 0.70 using a weighted kappa.

The assessor was masked to the amount of treatment given, whether treatment was directed by aims or goals, and particular functions or performance targeted by the treatment.

All assessments took place in the child's normal treatment location with which the child was familiar, with either a parent or a familiar carer present but not the child's physiotherapist or the researcher who were both masked from the results until the end of the study.

The questionnaire measuring processes of care was given to parents and collected by the researcher on three separate occasions: following randomisation but before the treatment period, at the end of the treatment period, and at the end of the six months follow-up observation period.

Each child's therapist documented the type and amount of therapy given on each occasion throughout the study period.

STATISTICAL ANALYSIS

Statistical analysis using multiple linear regression in SPSS (version 9), was used to calculate analysis of covariance.

Table III: Status of children in each treatment group following randomization

Treatment status of children	*Group 1* *Routine and aims*	*Group 2* *Intensive and aims*	*Group 3* *Routine and goals*	*Group 4* *Intensive and goals*
Age (y), mean (range)	6.3 (4–12)	5.4 (3–9)	5.9 (3–11)	5.5 (3–12)
Routine physiotherapy received by the child (y), mean (range)	4.7 (2–9)	4.5 (2–8)	4.8 (3–10)	4.5 (2–10)
Physiotherapy previously received from current physiotherapist (y), mean (range)	1.7 (0.5–5)	2.0 (0.1–7)	2.0 (0.3–4)	2.5 (0.2–6)
Treated by current physiotherapist from whom the child was recruited (y), mean (range)	5.7 (2–10)	8.9 (2–25)	6.9 (1–22)	8.3 (1–20)

Results

INITIAL SCORES OF MOTOR FUNCTION AND PERFORMANCE

The initial scores on the GMFM (all dimensions) and on the GMPM (all attributes) in each of the four treatment groups are shown in Table IV. The range of scores is large as shown by the standard deviations of all the groups. No statistically significant difference in severity between the four groups was found.

WITHDRAWALS FROM ALL OR PART OF THE 18 MONTH TRIAL PERIOD

Of the 56 children stratified, randomized, and assessed one child in stratification category 3 died following the treatment period. He had been randomized into Group 3 (Routine and Goals) and had undergone 5 out of the 7 assessments. GMFM and GMPM results have been calculated excluding his scores. Three children (one child from stratification category 1 and randomized into Group 1, one child from category 4 and randomized into Group 3, and one child from category 2 and randomized into Group 4) underwent orthopaedic surgery during their 18 months participation in the trial. These three children all continued with their treatment and assessments throughout and the GMFM and GMPM results were calculated both including and excluding their scores.

AIMS AND GOALS SET FOR TREATMENT IN THE MIDDLE SIX MONTHS TREATMENT PERIOD

The number of aims or goals set per GMFM dimension, the dimensions of the GMFM in which change was anticipated as a result of the aims or goals set and the changes that occurred are shown in Table V. All the aims or goals could be allocated into one of the five dimensions of the GMFM. Goals for children at level III on the GMFCS were usually concerned with upright balance and mobility. Goals for children at level IV on the GMFCS were often concerned with upright weight-bearing, transfers and getting in and out of wheelchairs. Goals for children at level V on the GMFCS were usually concerned with postural management in lying or sitting.

The 'sitting' and 'standing' dimensions attracted the most aims and goals but the greatest percentage improvements were found in the 'walk, run, and jump' dimension in the first three months of the treatment period in therapy directed by both aims and goals. The greatest percentage deterioration was found in the 'lie and roll' dimension in the second three months of the treatment period in therapy directed by aims.

It was found that none of the clinical physiotherapists was familiar with the GMPM and although they were willing to identify individual items in the measure, they were not willing to identify the attributes which might change. As the GMPM is scored by change over time in attributes and not items, we were unable to monitor progress in those attributes of the GMPM in which aims or goals of treatment had been set during the treatment period.

Among the 28 children who were randomized for collaborative goal-setting the median number of goals set per child for the first three months of the treatment period was 5 (range 3 to 10) of which a median of 3 (range 0 to 6) were completely achieved. The median number of goals set per child for the second three months of the treatment period was again 5 (range 4 to 10) of which a median of 3 (range 0 to 8) were completely achieved.

AMOUNT AND COST OF PHYSIOTHERAPY TREATMENT GIVEN

The median amount of physiotherapy received per child in the routine and intensive regimes, the interquartiles, minima and maxima are shown in Figure 2 for each three-month period. During routine three-month periods the median amount of physiotherapy given was around six hours, whereas during each of the two intensive three-monthly treatment periods the median amount of physiotherapy given was 44 hours. The cost of providing intensive therapy to 28 children over the six month period was £50 510 ($75 765) on the basis that only therapy actually received by the child was paid for at the rate of £20 ($30) per hour. No child received the full intensity of treatment offered which was 120 hours for the 6 month treatment period.

Table IV: Initial scores on GMFM and GMPM

	n	*Mean (SD)*
Initial scores on GMFM (all dimensions)		
Group 1, routine and aims	15	39.5 (27.3)
Group 2. intensive and aims	13	35.2 (17.8)
Group 3, routine and goals	13	35.2 (20.5)
Group 4, intensive and goals	15	38.8 (28.3)
Initial Scores on GMPM (all attributes)		
Group 1, routine and aims	15	38.9 (21.2)
Group 2 , intensive and aims	13	34.5 (17.8)
Group 3, routine and goals	13	39.9 (20.4)
Group 4, intensive and goals	15	37.7 (23.2)

Table V: Dimensions of GMFM in which change was anticipated, and changes in these dimensions over the first and second three-month segment of the treatment period

	Lie and roll		*Sit*		*Crawl and kneel*		*Stand*		*Walk, run, jump*	
	T1	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*	*T1*	*T2*
Aims (n=28)										
Number of aims set (105)	4	5	18	17	9	11	13	14	5	9
Function improved	3	1	13	8	3	4	8	6	4	6
Function deteriorated	0	4	4	7	5	5	4	4	1	1
Goals (n=28)										
Number of goals set (125)	7	6	19	22	3	5	20	19	10	14
Function improved	3	3	11	13	2	3	11	7	8	3
Function deteriorated	4	3	6	6	1	2	4	2	2	7

T1, treatment period 1 (first three months); T2, treatment period 2 (second three months).

One child from stratification category 1 attending mainstream school was randomized into the intensive regime. This child routinely received physiotherapy once each school term, but during the first three months of intensive treatment received 37 hours of physiotherapy. At this point the child and parents requested a reduction to once or twice a week. During the second three months, 15 hours of physiotherapy were received.

One child in category 5 was unwell with respiratory and reflux problems during much of the intensive period and received 27 hours of physiotherapy in the first three months and 32.5 hours during the second. The other two children who received less than 35 hours out of a possible 60 hours (33 and 34 hours) every three-month period were both in category 5.

AMOUNT OF OTHER PHYSICAL INTERVENTION UNDERTAKEN THROUGHOUT THE TRIAL PERIOD

Over the 18 month study period, the mean number of weeks in which other physical interventions were reported in each treatment group are shown in Table VI. No statistically significant differences were found between the four groups.

TYPE OF THERAPY GIVEN DURING THE TRIAL

Throughout the trial the therapy given was described by each physiotherapist involved and was found to consist of a mixture of muscle stretching, passive corrective manual handling, positioning, including the use of equipment, orthoses and casting as considered necessary, muscle strengthening and active movement in addition to gross motor skill training along developmental and functional lines as considered appropriate by the child's physiotherapist. Treatment was primarily targeted at gross motor abilities and not manual dexterity.

Despite some differences in the background training of the therapists involved it was interesting to notice the remarkable similarities in their documented treatments. Differences in therapy given were largely influenced by differences in childrens' severity levels, their families, and environments and not by differences in therapists' techniques.

MASKING OF THE INDEPENDENT ASSESSOR

The independent assessor was required to make a forced choice retrospectively as to which treatment she believed each child had received. She allocated 14 out of the 27 children receiving goal-setting correctly and 15 out of the 28 children receiving intensive therapy correctly.

CHANGES IN MOTOR FUNCTION

Figure 3 shows the mean changes in total scores per child in all five dimensions of the GMFM in the group receiving therapy directed by aims ($n=28$) and in the group receiving therapy directed by goals between assessments 3 and 5 ($n=27$), and the differences between those mean total scores with 95%

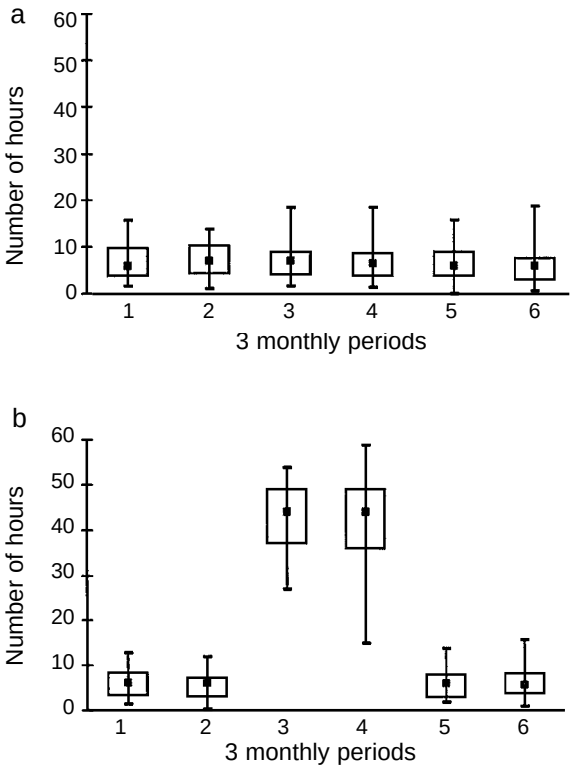

Figure 2: *Number of hours of treatment received during each three-month period over 18 months of study in (a) routine and (b) intensive groups. Box and whisker plot: box covers interquartile range, square indicates median, whiskers extend to minimum and maximum values.*

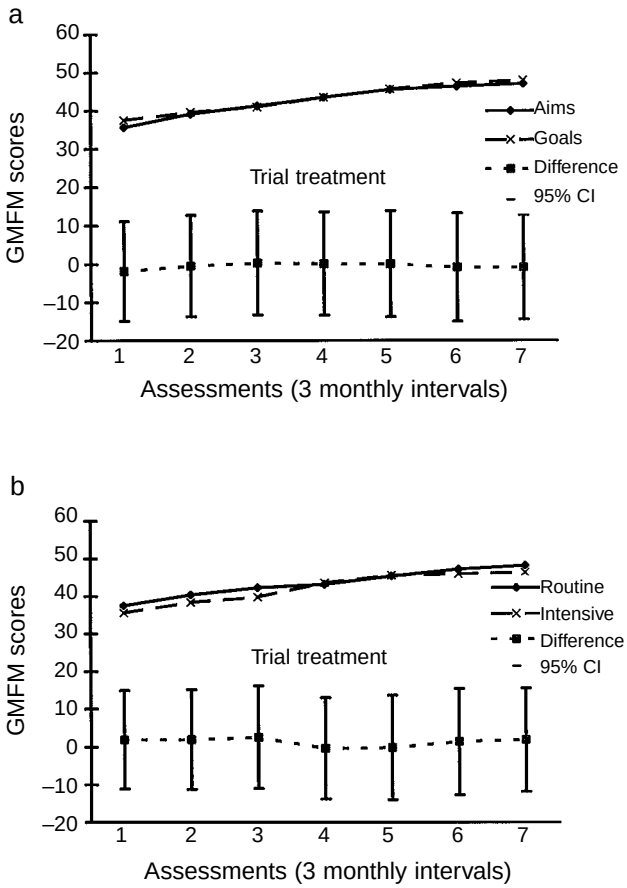

Figure 3: *GMFM mean total scores and difference in mean total scores (a) between aims and goals (n=28/n=27), and (b) between routine and intensive treatment (n=27/n=28).*

confidence intervals (CI) at each three-monthly assessment over the 18 months period.

During the six month treatment period, between assessments 3 and 5, children receiving aim-directed therapy (n=28) improved their mean total GMFM score by 4.4 percentage points and children receiving goal-directed therapy (n=27) improved their total mean GMFM score by 4.6 percentage points.

After the first three months of the treatment period there was a difference of 0.8 percentage points in favour of goal-directed therapy in the dimensions of the GMFM scores in which goals were set compared with aim-directed therapy in the dimensions of the GMFM in which aims were set. This changed in the second three months of the treatment period to a difference of 0.2 percentage points in favour of aim-directed therapy in the same dimensions of the GMFM as described above.

Figure 3 also shows the mean changes in total scores per child in all five dimensions of the GMFM in the group receiving routine amounts of therapy (n=27) and in the group receiving intensive amounts of therapy between assessments 3 and 5 (n=28) and the differences between these mean total scores with 95% CI at each three-monthly assessment over the 18 months period.

During the six-month treatment period children receiving routine amounts of therapy (n=27) improved their mean total GMFM score by 3.1 percentage points and children receiving intensive amounts of therapy (n=28) improved their mean total score by 5.9 percentage points.

After the first three months of the treatment period there was a difference of 3.1 percentage points in favour of intensive physiotherapy in the dimensions of the GMFM scores in which aims and goals had been set compared with routine amounts of therapy in the equivalent dimensions, and a difference of 0.3 percentage points in favour of intensive therapy in similar dimensions of the GMFM scores compared with routine amounts in the equivalent dimensions after the second three months of treatment period.

There was no visible difference in the slopes of the graphs when scores of the three children who underwent orthopaedic surgery were excluded. The graph of the children at GMFCS level III (less severe) did not show a steeper slope than the graph of the children at GMFCS level IV. Changes in children at GMFCS level V seemed to be most influenced by their general health status.

Only two out of the 55 children showed a lower GMFM mean total score at the end of the 18 months study than at the beginning. One of these children was having problems with a rapidly subluxating hip and the other had gained a great deal of weight and became wheelchair dependent.

CHANGES IN MOTOR PERFORMANCE

Figure 4 shows the mean changes in total scores per child in all five attributes in the GMPM in the group receiving therapy directed by aims (n=28) and in the group receiving therapy directed by goals between assessments 3 and 5 (n=27), and differences between those mean total scores with 95% CI at each three-monthly assessment over the 18 months period.

During the six months treatment period children receiving aim-directed therapy (n=28) improved their mean total GMPM score by 2.9 percentage points and children receiving goal-directed therapy (n=27) improved their mean total GMPM score by 1.8 percentage points.

Figure 4 also shows the mean changes in total scores per child in all five attributes in the GMPM in the group receiving routine amounts of therapy (n=27) and in the group receiving intensive amounts of therapy between assessments 3 and 5 (n=28), and the differences between those mean total scores with 95% CI at each three-monthly assessment over the 18 months period.

During the six month treatment period children receiving routine amounts of therapy (n=27) improved their mean total GMPM score by 3.3 percentage points and children receiving intensive amounts of therapy (n=28) improved their mean total score by 1.3 percentage points.

There was no difference in the slopes of the graphs when the scores of the three children who underwent orthopaedic surgery were excluded. The graph of children at GMFCS level IV (more severe) shows a slightly steeper slope than children at level III. This may have been due to the method of calculating scores (see above). Children at GMFCS level V seemed to be most influenced by their general health status.

STATISTICAL ANALYSIS OF CHANGES IN MOTOR FUNCTION AND PERFORMANCE

Data were analysed by analysis of covariance in which the covariate was the mean of the three baseline assessments.

There were no statistically significant differences in the GMFM or GMPM scores between aim and goal-directed therapy or between routine and intensive amounts of therapy at any of the later assessments, as shown in Table VII, nor were there any statistically significant differences when the results of the three children who underwent orthopaedic surgery were excluded.

FURTHER STATISTICAL ANALYSIS

Further analysis using a number of additional covariates, namely age (under and over 7 years) and severity levels (III, IV, and V on the GMFCS) showed a trend towards a statistically

Table VI: Number of weeks throughout the trial during which other physical interventions were reported

Interventions	*Group 1* *Routine and aims*	*Group 2* *Intensive and aims*	*Group 3* *Routine and goals*	*Group 4* *Intensive and goals*
Riding (wk), mean (range)	1.5 (0 to 10)	0.9 (0 to 10)	1.5 (0 to 10)	1.2 (0 to 8)
Hydrotherapy (wk), mean (range)	2.8 (0 to 11)	2.0 (0 to 9)	4.4 (0 to 11)	3.0 (0 to 12)
Occupational therapy (wk), mean (range)	0.7 (0 to 9)	0.9 (0 to 9)	1.5 (0 to 12)	1.5 (0 to 9)
Physical education (wk), mean (range)	4.4 (0 to 11)	4.1 (0 to 12)	4.9 (0 to 10)	5.4 (0 to 11)
Conductive education (wk), mean (range)	1.4 (0 to 10)	2.3 (0 to 11)	1.3 (0 to 10)	1.1 (0 to 11)

significant difference with an estimated effect of 2.5 percentage points ($p=0.056$, 95% CI –0.06 to 5.2) in the GMFM mean total score in favour of intensive therapy ($n=28$) at assessment 5, the end of the six months treatment period. This trend was not maintained at assessment 6 where the estimated effect was 1.8 percentage points ($p=0.16$, 95% CI –0.75 to 4.4) or at assessment 7, where the estimated effect was 0.9 percentage points ($p=0.59$, 95% CI –2.7 to 4.7).

Analysis of covariance showed no statistical significance between any of the other factors. Statistical significance was set at $p<0.05$.

CHANGES IN MPOC

Fifty-six questionnaires were distributed to parents on the first and second occasions and 55 on the third occasion. Fifty-four were returned completed by parents on the first and second occasions and 50 on the third occasion. A scale score has been included only if there were valid responses to at least two-thirds of the scale's items.

There was one incomplete parental response on the first occasion in the Providing General Information scale, five on the second occasion and one on the third occasion. There were two incomplete parental responses on the Providing Specific Information About the Child scale on the third occasion. These incomplete responses were not included in the results. All other responses were complete.

Table VIII shows the mean scores from the parents of children receiving aim ($n=26$, occasions 1 and 2; $n=24$, occasion 3) or goal directed ($n=28$, occasions 1 and 2; $n=26$, occasion 3) therapy in both routine and intensive regimes in the middle six-month period, and the standard deviations on occasions 1, 2 and 3.

Providing General Information scored the lowest throughout but showed the greatest increases in mean score: 0.5 in relation to goal-directed therapy between occasions 1 and 2, and in relation to aim-directed therapy an increase of 0.5 on the first occasion and 0.2 on the second occasion.

Coordinated and Comprehensive Care scores showed consecutive decreases in children receiving aim-directed therapy (–0.1 on the first occasion and –0.1 on the second).

In all other cases there was an increase in mean score between occasions 1 and 2, varying between 0.1 and 0.5, and a decrease in mean score, varying between –0.1 and –0.4, between occasions 2 and 3.

Table VIII also shows mean scores from parents of children receiving routine ($n=27$, occasions 1 and 2; $n=24$, occasion 3) and intensive ($n=27$, occasions 1 and 2; $n=26$, occasion 3) amounts of therapy in both aim and goal-directed therapy, and the standard deviations on occasions 1,2, and 3.

Providing General Information again scored the lowest throughout but showed the greatest increase in mean score (0.7) in relation to intensive amounts of therapy between occasions 1 and 2, and in relation to routine amounts of therapy an increase of 0.3 on the first occasion and 0.3 on the second.

Enabling and Partnership scores for children receiving intensive amounts of therapy in the middle period showed a continuous decrease in mean score (–0.01 on the first occasion and –0.3 on the second).

In all other cases there was an increase in mean score between occasions 1 and 2, varying between 0.04 and 0.7, and a decrease in mean score, varying between –0.2 and –0.6 between occasions 2 and 3.

SUMMARY OF RESULTS

In summary there were no statistically significant differences in the scores achieved between intensive and routine amounts of therapy in either function or performance or between aim-directed or goal-directed therapy. There was a trend towards a statistically significant increase ($p=0.056$) in motor function scores in the children receiving intensive therapy during the period of enhanced treatment when additional covariates were introduced. This small advantage was lost over the subsequent six months when the therapy reverted to its usual level of intensity. Parental perceptions of the quality of care received demonstrated that they were least satisfied with the provision of general information even during periods of intensive therapy and collaborative goal-setting.

Discussion

Many problems can confront a researcher attempting to set up a prospective randomized controlled trial with children suffering chronic childhood disability and their families in community settings.

In this study 48 therapists had agreed to participate in the trial before the granting of funding. Only 15 of the original therapists agreed to participate following the granting of

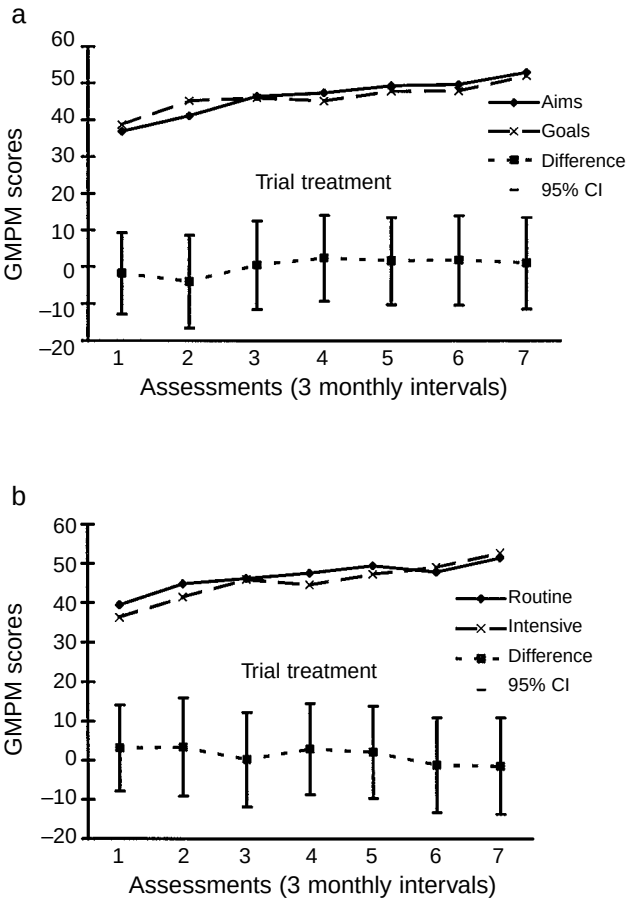

Figure 4: *GMPM mean total scores and difference in mean total scores (a) between aims and goals (n=28/n=27), and (b) between routine and intensive treatment (n=27/n=28).*

funding six to nine months later so a further period of recruitment was necessary.

It was decided to recruit 56 therapists and children instead of the original 48 to allow for withdrawals. These therapists and children came from a much wider area than originally anticipated, involving extensive travelling for the researcher and masked assessor as each child and/or therapist were visited eight or nine times by the researcher and seven times by the masked assessor. This approach, where the researcher and one masked assessor dealt personally with all the children, carers, and therapists, may well have contributed to the fact that the only withdrawal over the 18 month period was due to a child's death.

Parents were pleased to be included in the trial and expressed that important questions were being addressed.

The trial is considered to have been large enough as even the upper limits of the 95% CI indicate that, at best, intensive amounts of therapy had a mean total score advantage of about 8 percentage points on the GMFM over routine amounts of therapy at assessments 4, 5, 6, and 7 (Table VII). This was below the 15 percentage points in mean total GMFM score calculated as the minimum likely change over 26 weeks based on the results of the earlier short term study (Bower et al. 1996).

In the past the terminology used to describe children with CP has not been successfully standardized. The use of the GMFCS to classify the children in this trial helped to delineate more precisely the severity of motor dysfunction of each child than in previous trials and to group the children accordingly.

Therapists' experience with paediatric problems and/or long term familiarity did not seem to influence which type or age of child was selected for inclusion by them. Travelling time, educational commitments, and cooperation and/or compliance were all factors considered by these therapists when

Table VII: Statistical analysis of changes in GMFM and GMPM scores using analysis of covariance in which covariate is mean of three baseline assessments

Measure	*Assessment (n)*	*Effect estimate*	*p value*	*95% CI*
Between aim[a] and goal[b] directed therapy				
GMFM	4	–0.93	0.55	(–4.04 to 2.18)
	5	–0.91	0.53	(–3.80 to 1.98)
	6	–0.93	0.50	(–3.69 to 1.83)
	7	–0.79	0.69	(–4.77 to 3.18)
GMPM	4	–3.96	0.07	(–8.17 to 0.26)
	5	–3.28	0.14	(–7.69 to 1.13)
	6	–2.81	0.29	(–8.05 to 2.44)
	7	–2.05	0.38	(–6.71 to 2.61)
Between routine[c] and intensive[d] therapy				
GMFM	4	2.57	0.10	(–0.54 to 5.67)
	5	2.46	0.09	(–0.43 to 5.35)
	6	1.89	0.18	(–0.87 to 4.66)
	7	1.22	0.54	(–2.76 to 5.19)
GMPM	4	–0.51	0.81	(–4.73 to 3.71)
	5	0.22	0.92	(–4.20 to 4.63)
	6	2.67	0.31	(–2.58 to 7.91)
	7	2.86	0.23	(–1.81 to 7.52)

[a]$n=28$, [b]$n=27$, [c]$n=27$, [d]$n=28$.

Table VIII: Measure of Process of Care scores[a]

Scale	*Occasion 1*		*Occasion 2*		*Occasion 3*	
Therapy directed by aims and goals, mean (SD)	Aims	Goals	Aims	Goals	Aims	Goals
Enabling and partnership	5.4 (1.5)	5.7 (1.4)	5.5 (1.5)	5.7 (1.2)	5.1 (1.6)	5.5 (1.4)
Providing general information	3.0 (1.6)	3.4 (2.0)	3.5 (1.9)	3.9 (2.0)	3.6 (1.6)	3.8 (2.0)
Providing specific information	5.3 (1.6)	5.4 (1.6)	5.4 (1.5)	5.6 (1.3)	5.0(1.6)	5.1 (1.7)
Coordinated,comprehensive care	6.0 (1.2)	5.5 (1.5)	5.9 (1.3)	5.8 (1.2)	5.8 (1.3)	5.5 (1.4)
Respectful and supportive care	5.7 (1.4)	6.0 (1.3)	5.8 (1.4)	6.1 (1.1)	5.6 (1.4)	5.8 (1.4)
Routine and intensive therapy, mean (SD)	Routine	Intensive	Routine	Intensive	Routine	Intensive
Enabling and partnership	5.1 (1.6)	5.9 (1.2)	5.3 (1.5)	5.9 (1.2)	4.9 (1.6)	5.7 (1.3)
Providing general information	2.8 (1.6)	3.6 (2.0)	3.0 (1.6)	4.2 (2.0)	3.4 (1.6)	4.0 (1.9)
Providing specific information	4.9 (1.6)	5.8 (1.4)	5.1 (1.4)	6.0 (1.3)	4.7 (1.6)	5.4 (1.7)
Coordinated, comprehensive care	5.0 (1.7)	6.0 (1.2)	5.3 (1.6)	6.1 (1.1)	4.9 (1.6)	5.7 (1.3)
Respectful and supportive care	5.5 (1.4)	6.2 (1.2)	(1.4) 5.6	6.3 (1.0)	5.4 (1.4)	6.0 (1.2)

[a]Maximum possible score=7.0.

making their choice of child. Children's health status was not a factor mentioned, although, particularly in those children at level V on the GMFCS, it might have been expected to influence both the ability to attend treatment sessions and the assessment results. In retrospect it would have been helpful to measure the general health status of the children throughout the trial as it may have also affected both motor function and performance results in children at levels III and IV.

TRIAL DESIGN

The results of this trial shown in Figures 3 and 4 illustrate the importance of including adequate baseline observation and follow-up observation periods in design to show the ongoing pattern of change in the participating children. Only one observation was included at baseline in the Bower et al. (1996), McLaughlin et al. (1998) and Wright et al. (1998) trials.

OBJECTIVES, AIMS AND GOALS

Physiotherapy for children with CP targets other areas in addition to those measured in this study which were specifically the acquisition of motor function and performance by the child. Examples of other areas are the ease of handling a child by carers, and the specific effect of external changes in the child's environment such as the use of orthoses. Children in this trial were assessed in bare feet and without the use of orthoses. However, any carry-over effect on the acquisition of motor function or performance by, for example, the use of orthoses by individual children in this study would have been included in our measurements.

Forty-one per cent of the children chosen by therapists (23/56) were under 7 years of age and at level IV of the GMFCS. It seemed that therapists felt that these children might improve their upright weight-bearing and transfers which should make the management of many daily living activities easier.

Most objectives, aims, or goals were concerned with motor functional change, and therapists found it difficult to describe and quantify performance change. The collaborative goal-setting process usually took under an hour including baseline measurement. Parents, carers, and teachers sometimes needed guidance towards more realistic goals. For example, the parents of one child at GMFCS level III and under 7 years of age expected their child to learn to ride a bicycle and to roller skate as a result of six months intensive goal-directed treatment. This was gradually modified to walking up and down 10 steps independently holding the only available rail with one hand.

Children with parents present often did not really participate in the collaborative goal-setting process. They seemed in many cases to be dominated, however unintentionally, by their parents, although one felt that the children themselves were often well aware of their own capacities.

TREATMENT AND PHYSICAL ACTIVITY

The two main reasons children did not receive the full 120 hours intensive physiotherapy in the middle six-month treatment period were illness in children at GMFCS level V and annual leave entitlement for the physiotherapists involved. At the end of the six months intensive treatment period although all 28 therapists felt that the child treated by them had improved, only one of the 28 said she would be willing to continue with the intensive regime. All other therapists said that both they and the children were very tired and needed a rest. Many of the parents agreed. Throughout the trial a high percentage of time was spent by therapists who were giving routine amounts of therapy on equipment, orthotics, and consultation. In the case of therapists giving intensive amounts of treatment, time spent on these aspects was in addition to the treatment session.

The reported amount of any other physical activity undertaken was very small, as shown in Table VI. The maximum number of weeks in which physical education sessions were reported was 12 out of a possible 72 over the 18 months trial period. School holidays might account for 22 weeks of this. Riding and hydrotherapy occurrence seemed to be governed by the seasons. Occupational therapy seemed to occur principally if there was a reported equipment problem or if requested by a teacher for a functional hand problem, e.g. writing.

It often seemed that physiotherapy was the only regular physical activity undertaken by the child.

OUTCOME MEASURES AND RESULTS

Both motor outcome measures (GMFM and GMPM) were considered responsive to change over time. There seemed to be more variability between assessments of the same child in the GMPM than in the GMFM, indicating that the manner in which a child performed a motor activity was more likely to vary as a result of behaviour or fatigue than the degree of motor function achieved. This could not be attributed to assessor variability in view of the score achieved by the independent assessor when compared with the GMPM training tape.

Taking all 55 children into consideration, the greatest GMFM change throughout the entire 18 months of the trial was found in 'weight shift' followed by 'dissociated movements'. The least change was in 'alignment'. Physiotherapists often focus on improvement in 'alignment' to counteract the development of deformity. It is possible that this is a more difficult aspect of motor performance in which to encourage change than weight shift and dissociated movement. Greater use of the GMFM may provide more information in this area.

In our last study (Bower et al. 1996) the experimental treatment (more intensive physiotherapy and the use of collaborative goal-setting procedures rather than aims) showed a statistically significant advantage for collaborative goal-setting procedures only in those dimensions of the GMFM in which goals had been set. There was a trend for intensive therapy to confer an advantage in the dimensions of the GMFM in which aims or goals had been set as compared with routine amounts of therapy in the equivalent dimensions.

The size of the statistically significant advantage was 4.3 percentage points (collaborative goal setting); the advantage of the trend in favour of intensive therapy (which was not statistically significant) was 4.2 percentage points. Clinical significance of changes of this magnitude can be assessed from the GMFM manual (Russell et al. 1993) in which 1.8 percentage points is suggested to be the smallest change of clinical importance to parents.

The implication of that study was that an advantage of approximately 4 percentage points could be conferred by two weeks of the experimental treatment. It is yet to be determined whether this treatment simply raising the motor ability of the child to the ceiling of the child's day-to-day range of ability or whether is contributed to an increase in underlying motor skill. If the latter, then longer periods of experimental treatment would confer greater gains. If all the 4 percentage

points had been due to increased motor skills, after six months it might be theoretically possible to show a gain of 48 percentage points. However, in our prediction for this longer study we made a more modest estimate of 15 percentage points. If all the gain in the previous study had simply been due to raising the day-to-day motor ability to its ceiling without increasing motor skill at all, then after six months any gains would be expected to be once again 4 percentage points.

This longer study found no statistically significant advantage after six months, consistent with the view that neither more intensive therapy nor collaborative goal-setting procedures had improved the acquisition of skills.

When additional covariates were included (severity and age) there was a trend in favour of intensive therapy taking the data nearer to statistical significance without actually reaching it. At the end of the six-month treatment period the size of the advantage of more intensive therapy was only 2.8 percentage points across all dimensions of the GMFM. There was a non-significant difference of 3.4 percentage points in favour of intensive physiotherapy in the dimensions of the GMFM scores in which aims and goals had been set compared with routine amounts of therapy in the equivalent dimensions. There was also a non-significant difference of 0.6 percentage points in favour of goal-directed physiotherapy in the dimensions of the GMFM scores in which goals were set compared with aim-directed therapy in the dimensions of the GMFM in which aims were set. These figures should be seen in the context of changes in all groups, presumably due to maturation of motor function over the entire 18 month period of the study, which were approximately 10 to 12 percentage points.

Neither the McLaughlin et al. (1998) nor the Wright et al. (1998) trials included information concerning the amount of therapy received at baseline before the commencement of the intensive period. In the McLaughlin et al. study the type of physiotherapy was changed from neurodevelopmental therapy to an emphasis on muscle strengthening in both groups at the start of the trial. In the Wright et al. study different treatment goals were identified for the physiotherapy only group and followed from the start of the trial.

Both studies showed changes between 3 and 4.4 percentage points in the GMFM mean total score over 12 month periods. The McLaughlin et al. trial included children of the same age as the trial described in this paper but they were much less severe, whereas the Wright et al. trial included mainly younger children who were slightly less severely disabled than those included in the trial described in this paper.

In our view the most reasonable interpretation of our data is that in studies of this type the stimulus of providing a change from routine therapy is likely to be accompanied by increases in the level of motor ability of approximately 2 to 4 GMFM percentage points, and that this does not indicate an increase in the underlying level of motor skill of the child. It is doubtful that more prolonged trials of therapy would show a different result, partly on account of our failure to show a greater change after 6 months than after the 2 weeks' intensive therapy given in our previous study (Bower et al. 1996). In addition, in the current study intensive therapy was considered tiring and stressful by many of the participants who were glad when the intensive therapy ended.

The MPOC was given to parents on the first occasion after randomization but just before the treatment period began. Knowing which group their child had been randomized into may have influenced parental responses and, in retrospect, it would have been better to have given it to parents earlier. Some parents commented that completing the forms at six-month intervals was too often. The lowest scores in the Providing General Information scale were on the question, to what extent does the centre where you receive services: (1) provide opportunities for special guests to speak to parents on topics of interest? (2) have general information about different topics (e.g. financial costs or assistance, genetic counselling, dating and sexuality)? and (3) provide opportunities for the entire family to obtain information? This last part of the question showed the third lowest score.

Further research needs to be undertaken to ascertain whether parents would take advantage of such services if they were made available.

Conclusions

Intensive physiotherapy, in contrast to collaborative goal-setting, produced a trend towards improvement in the GMFM scores which was not statistically significant. This trend declined in the follow-up observation period.

The results of this trial suggest that for children aged 3 to 12 years with bilateral CP at levels III or below on the GMFCS, altering their routine physiotherapy by increasing its intensity for a period of six months has very little effect upon the outcome of gross motor function or performance at the end of this time. Such advantage as might occur is likely to be lost over the subsequent six months if treatment reverts to its routine amount. Differences in goal-setting procedures have not been shown in this study to have any detectable effect upon the acquisition of gross motor function or performance. However, the identification of specific, measurable goals might be employed in order to log changes in function in future studies, thereby developing further the approach of Stilwell and colleagues (1998) in their Problem Resolution scale for adults with head injuries. It is possible that specific problems could be resolved by treatment even if no improvement in gross motor function or performance has occurred.

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References

Bower E, McLellan DL. (1992) Effect of increased exposure to physiotherapy on skill acquisition in children with cerebral palsy. *Developmental Medicine & Child Neurology* **34:** 25–39.

—— (1994a) Assessing motor-skill acquisition in four centres for the treatment of children with cerebral palsy. *Developmental Medicine & Child Neurology* **36:** 902–9.

—— (1994b) Measuring motor goals in children with cerebral palsy. *Clinical Rehabilitation* **8:** 198–206.

—— Arney J, Campbell MJ. (1996) A randomised controlled trial of different intensities of physiotherapy and different goal-setting procedures in 44 children with cerebral palsy. *Developmental Medicine & Child Neurology* **38:** 226–37.

Boyce W, Gowland C, Rosenbaum P, Hardy S, Lane M, Plews N, Goldsmith C, Russell D, Wright V, Potter S, et al. (1998) *Gross Motor Performance Measure Manual.* Kingston, Ontario: School of Rehabilitation Therapy, Queens University.

King S, Rosenbaum P, King G. (1995) *The Measure of Processes of Care. A Means to Assess Family-Centred Behaviours of Health Care Providers.* Hamilton, Ontario: Neurodevelopmental Clinical Research Unit, McMaster University.
McLaughlin J, Bjornson K, Graubert C, Pong A, Hays R, Hoffinger S. (1991) Ability to detect functional change in the Gross Motor Function Measure: a pilot study. *Developmental Medicine & Child Neurology* **33** (**Suppl. 64**)**:** 26.
——Astley S, Hays R, Hoffinger S, Armantrout P, Roberts T. (1994) The role of selective dorsal rhizotomy in cerebral palsy: critical evaluation of a prospective clinical series. *Developmental Medicine & Child Neurology* **36:** 755–69.
———Graubert C, Hays R, Roberts T, Price R, Temkin N. (1998) Selective dorsal rhizotomy: efficacy and safety in an investigator-masked randomized clinical trial. *Developmental Medicine & Child Neurology* **40:** 220–33.
O'Dwyer NJ, Neilson PD, Nash J. (1989) Mechanisms of muscle growth related to muscle contracture in cerebral palsy. *Developmental Medicine & Child Neurology* **31:** 543–52.
Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. (1997) Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine & Child Neurology* **39:** 214–23.
Parker DF, Carriere L, Hebestreit H, Salsberg A, Bar-Or O. (1993) Muscle performance and gross motor function of children with spastic cerebral palsy. *Developmental Medicine & Child Neurology* **35:** 17–23.
Russell D, Rosenbaum P, Gowland C, Hardy S, Lane M, Plews N, McGavin H, Cadman D, Jarvis S. (1993) *Gross Motor Function Measure Manual,* 2nd edn. Kingston, Ontario: School of Rehabilitation Therapy, Queens University.
Stilwell P, Stilwell J, Hawley C, Davies C. (1995) Measuring outcome in community-based rehabilitation services for people who have suffered traumatic brain injury. *Clinical Rehabilitation* **12:** 521–31.
Wright VF, Sheil EMH, Drake JM, Wedge JH, Naumann S. (1998) Evaluation of selective dorsal rhizotomy for the reduction of spasticity in cerebral palsy: a randomized controlled trial. *Developmental Medicine & Child Neurology* **40:** 239–47.

Notices

Assessment and Management of Young Children with Severe Visual Disability: Institute of Child Health and Great Ormond Street Hospital for Children NHS Trust
University College London, January 29–February 2, 2001

This course aims to provide an understanding of the developmental impact of severe visual disability, as well as considering family, medical, and educational viewpoints. Assessment techniques which provide as basis for developmental and visual intervention in the early months and years, are discussed and demonstrated for children both with and without additional disabilities. Fee £450. Tel: +44 (0)20 7829 8692. Fax: +44 (0)20 7831 6902. E-mail: Courses@ich.ucl.ac.uk. Web site: www.ich.ucl.ac.uk.

International Symposium on West's Syndrome and Related Infantile Epileptic Encephalopathies (ISWS)
Yayoi Memorial Hall, Tokyo Women's Medical University, Shinjuku-ku, Tokyo, Japan. February 10–11, 2001

This meeting is relevant to those who wish to gain a better understanding of etiopathogenesis and exploration of new treatment strategies in various intractable epileptic encephalopathies, including West's syndrome, early infantile epileptic encephalopathies with suppression burst (Ohtahara syndrome), and severe myoclonic epilepsy in infancy (Dravet). The official language of the meeting is English. The deadline for Abstracts is October 31, 2000. For further information, please contact Yukio Fukuyama, Secretariat, ISWS, c/o Child Neurology Institute, Samban-cho TY Plaza, 5F1, 24 Samban-cho, Chiyoda-ku, Tokyo, 102-0075, Japan. Tel: +81 3 3238 1580; Fax: +81 3 3238 1502. E-mail: yfukuyam@sc4.so-net.ne.jp

Practical Neurology Series: Institute of Child Health and Great Ormond Street Hospital for Children NHS Trust
University College London, February 26–March 2, 2001

This series of five study days aims to provide an up-to-date and comprehensive review of the clinical approach to neurological problems in children, including diagnosis and management. The topics will cover neurological and developmental examination; headaches, hydrocephalus, and brain tumours; neuromuscular disorders; acute neurology; movement disorders and neurometabolic disorders. Fee: £450 week/£100 day. Tel: +44 (0)20 7829 8692. Fax: +44 (0)20 7831 6902. E-mail: Courses@ich.ucl.ac.uk. Web site: www.ich.ucl.ac.uk.

Prechtl's Method of Qualitative Assessment of General Movements
Graz, Austria, April 3– 7, 2001

International training courses on a new non-intrusive and cost-effective method of functional assessment of the young nervous system. Basic and advanced level. Tel: +43 316 380 4266. Web site: www-ang.kfunigraz.ac.at/~gmtrust/.
E-mail: christa.einspieler @kfunigraz.ac.at