

A STUDY OF A DYNAMIC PROXIMAL STABILITY SPLINT IN THE MANAGEMENT OF CHILDREN WITH CEREBRAL PALSY

E. Blair
J. Ballantyne
S. Horsman
P. Chauvel

It has been claimed that Lycra-based dynamic splinting can control abnormal tone, stabilise posture and improve functional abilities of people with neurological disorders. This orthotic device is designed to correct deformity, provide joint stability and tone inhibition, and also to re-educate targeted impairments towards more normal function.

An 'UPsuit' is a body splint made of Lycra (Fig. 1). Each UPSuit is individually prescribed and designed to address the specific neurological and functional requirements of the user. It is very close-fitting and worn next to the skin. It has a circumferential base and the orientation of the fabric applies a dynamic correctional force to the target body part(s). Plastic boning is used on the posterior and lateral trunk to provide extra support if necessary. The flexibility of Lycra allows freedom of movement and ensures intimate skin contact even over bony structures. The porosity of the fabric enhances user comfort. This is the first such use of Lycra, which has different properties from other materials used for splinting such as thermoplastics, plasters and neoprene.

The first UPSuit was used to promote reach and play by a young child with athetosis. In recognition of the functional relationship between proximal stability and distal control (Waksvik and Levy

1979, Case-Smith *et al.* 1989, Noronha *et al.* 1989), the body splint was designed to provide stabilization of the trunk, pelvis and shoulder girdle. Traditional interventions based on this principle include postural equipment and manual handling, and there is even an isolated report of wrapping in crêpe bandages (Beaman 1960). The UPSuit differs from these techniques in that it is dynamic—providing support and control, while allowing and guiding movement—and its use does not depend on an external facilitator. As the user experiences more normal movement patterns, these preferred movements can be learned.

Clinical experience has suggested that splint wear reduces tone in spastic and dystonic muscles, decreases involuntary movement and improves axial tone in children with postural hypotonia. The present exploratory study of the UPSuit on children of various ages, and with a broad spectrum of motor and other impairments, was undertaken to determine which children would substantially benefit from UPSuit wear. The aims of this study were to identify: (1) how wearing an UPSuit affects motor capabilities and its determinants; (2) how wearing the suit affects temperament and its determinants; (3) the extent and determinants of compliance with UPSuit-wearing regimes; and (4) any contra-indications to



Fig. 1. Child without (left) and with (right) Lycra UPSuit.

TABLE I
Reasons for excluding from the study 34 of
64 children (aged 15 months to 14 years)
originally put forward by service providers

Principal reason for exclusion	N
No regular therapy	7
Parental refusal	6
Unsuitable impairment	5
Anticipated non-compliance of subject	5
Anticipated non-compliance of carer	4
Lived too far away	4
Carer's inadequate grasp of English	1
Poor health	1
Previous UPSuit exposure	1
Total	34

the prescription of such a suit.

Subjects

A request for possible subjects to all service delivery centres in Perth, Western Australia, yielded 64 candidates aged between 15 months and 14 years. The consent of the therapist was sought first. If consent was obtained, a letter describing the evaluation was sent to the primary caregiver seeking their consent and inviting the child to attend neurodevelopmental assessments by two independent physicians who regularly assess children with cerebral palsy.

Thirty subjects were selected to cover a range of type and severity of motor and associated impairments, evenly distributed in the age range, with each meeting the following criteria: (1) suboptimal

proximal stability; (2) in regular therapy; (3) therapist agreed to co-operate; (4) primary caregiver agreed to co-operate; (5) primary caregivers had adequate English; and (6) UPSuit not worn before evaluation. Reasons for non-participation are shown in Table I.

Neurodevelopmental assessment identified seven pairs sufficiently matched for age and abilities for one to act as the control for the other. One member of each pair was randomly assigned to wear the UPSuit, the other acting as the control. All unmatched subjects were assigned an UPSuit. Four matched pairs were too young to undertake spirometry, and two of the older pairs were too impaired, leaving just one matched pair for this assessment. Another matched pair capable of spirometry was recruited, but they lived too far from Perth to participate in the crossover trial. The final study sample therefore consisted of 32 participants. 24 children were assigned to wear an UPSuit, eight of whom had matched controls. Table II shows the distribution of age and abilities of participants and Table III the number contributing to each assessment. No subject was excluded for non-compliance, as this was considered an outcome variable.

Method

All effects attributable to wearing an UPSuit were sought and four outcomes were specified: changes in motor ability, temperament, voluntary muscle strength and respiratory function. Beneficial

TABLE II
Subjects' characteristics

	All recipients (N=24)	Controls (N=8)	Matched recipients (N=8)
Age (yrs)			
<4.5	9	3	2
4.5-8	6	2	3
>8	9	3	3
<i>Predominant motor impairment</i>			
Spasticity	7	4	2
Athetosis	5	1	2
Dystonia	7	2	3
Ataxia	4	1	1
Hypotonia	1	0	0
<i>Capacity for purposeful intent as estimated by therapists¹</i>			
Consistent	11	2	2
Intermittent	10	5	4
Limited	3	1	2
<i>Additional impairments</i>			
Current epilepsy	8	1	3
Impaired vision	5	1	1
Blindness	1	0	0
Impaired hearing	2	0	0
No speech	6	3	3
Gastrostomy	2	0	0
Congenital heart defect	1	0	1
Asthma	3	0	0
<i>Severity² of motor impairment (initial GMFM³ score)</i>			
Profound (<12%)	6		
Severe (12-31%)	9		
Moderate (32-72%)	5		
Mild (>89%)	4		

¹Formal IQ assessment extremely difficult in many subjects.

²Severity classified by relation of function to aids: little function without electronic aids/function dependent on aids/uses aids/does not use aids.

³GMFM=Gross Motor Function Measure (Russell et al. 1989), assessed only for recipients: none had GMFM scores in the range of 72-89 per cent.

effects on motor ability and temperament had already been observed, and detrimental effects on voluntary muscle strength and respiratory function were theoretically possible. It was expected that any significant enhancement of progress in motor ability would be detectable within

TABLE III
Number of subjects completing assessments

Assessment	All recipients (N=24)	Controls (N=8)	Matched recipients (N=8)
Motor abilities	22*	Not assessed	
Observer reports	24	Not assessed	
Trunk strength	10	3	3
Grip strength	4	4	3
Lung function/ capacity	6	2	2

*One subject withdrew from crossover trial before completion of second period due to fractured femur.

three weeks, while a longer period might be required to detect changes in voluntary muscle strength and respiratory function. Outcomes were therefore obtained from three concurrent studies: (1) a descriptive study, (2) a four-period crossover trial, and (3) a recipient-control study.

DESCRIPTIVE STUDY

The descriptive study sought all effects of UPSuit wear via structured questionnaires completed by independent observers (e.g. parents, teachers and therapists) in regular contact with each recipient: the mean number of questionnaires analysed per child was 3.29 (range one to six). Motor abilities were classified in domains which grouped activities using the same movement patterns. Thus the domain 'walking' refers to functional ambulation as well as prefunctional activities such as stepping and assisted ambulation; 'fine motor function' refers to all activities using the hands and fingers (e.g. grasping, electric wheelchair control and writing skills). For each child and for each reported domain, each observer's assessment of the effects of wearing the suit was coded as +1 (if beneficial), 0 (if neutral, no effect) or -1 (if detrimental). The means of these coded values were calculated over all observers reporting on the same ability and on the same child. Integral mean values (see Table IV) denote complete interobserver agreement, while non-integral values denote some disagreement; positive mean values denote beneficial effects, while negative values denote detrimental ones.

ABAB CROSSOVER TRIAL

The crossover trial (Ottenbacher 1986) investigated the effects that wearing the UPsuit had on motor abilities. Each period lasted three weeks, with an introductory week for habituation and adjustment, during which the caregivers were asked to gradually increase the duration of wear from one to eight hours per day. The following assessments were made and videoed at the end of each period (Fig. 2). (1) Progress towards motor Goals (Bower and McLellan 1992) chosen for each subject by their regular therapist in consultation with the research therapist such that progress toward each goal could be expressed as a proportion of the specified goal. The mean number of goals was 4.45 (range one to seven), and varied according to the abilities and stamina of the subject. (2) Positional stability and quality of movement were rated from video-recordings of goal-assessment of 19 recipients by two independent therapists ignorant of the timing of the video-recording with respect to the trial schedule and hence of exposure to the UPsuit.

For each recipient, all video-recordings of goal-assessment sessions were put onto a single tape in random order by the video technician. The two therapists viewed the first session on the tape together to determine which aspects of posture and quality of movement were to be rated for each child. They then independently rated the chosen aspects for each session relative to the first on a continuous scale of change from +2 (maximum improvement) to -2 (maximum deterioration) that could be envisaged for that particular child. Subject characteristics were therefore incorporated in the definition of the rating scale, enabling direct comparison between subjects. There were no frank disagreements between the ratings of the two therapists, and where numerical values were not identical the mean was taken. The significance of the differences of mean ratings between groups of observations was assessed using the Wilcoxon rank sum test, while the Wilcoxon signed rank test was used to assess the significance of any changes in rating within individuals.

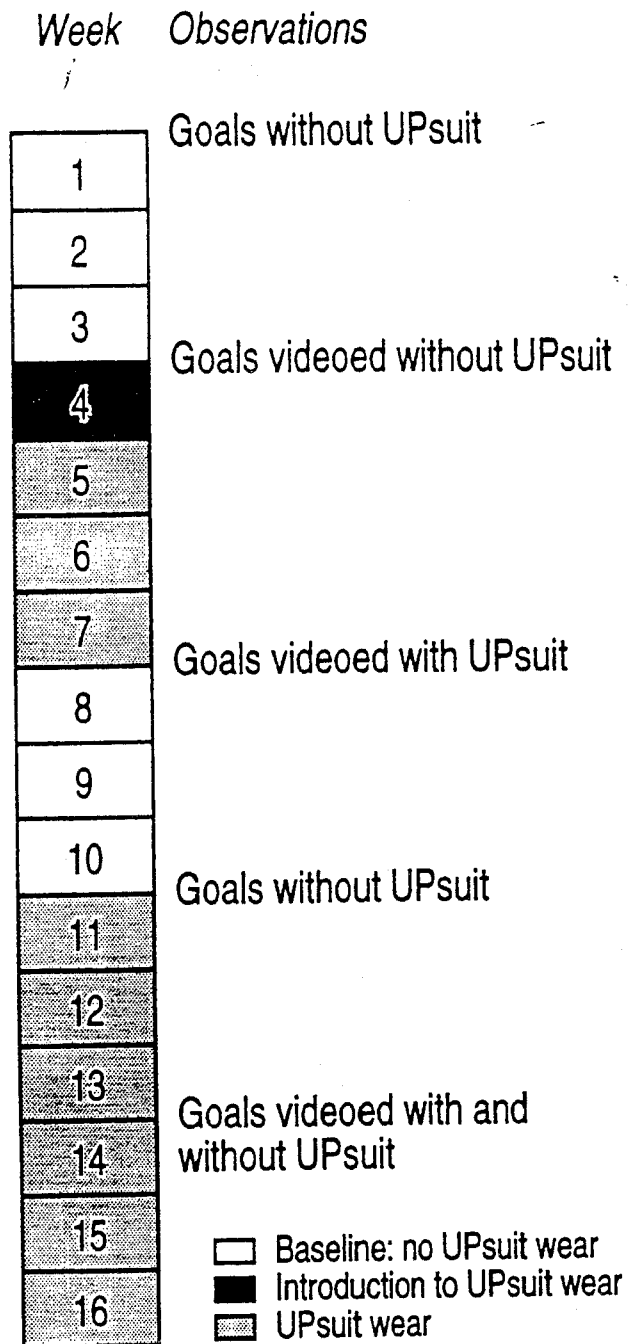


Fig. 2. Study schedule of UPsuit wear and formal observations.

RECIPIENT-CONTROL STUDY

The recipient-control study assessed changes in respiratory capacities and voluntary muscle strength. Both acute and chronic changes in respiratory volume and function were sought using spirometry before and immediately after the child put on the suit and after long-term wear. Only chronic change in voluntary muscle strength was of interest, so strength measurements were made when the suit was not being worn, to avoid confounding by any direct effects of the suit. Grip strength was measured using a vigrome-

TABLE IV
Effects of UPSuit on each motor domain as shown by distributions of mean coded values from observers' reports

<i>Within-subject mean over observers</i>	<i>N</i>	<i>Within-subject mean over observers</i>	<i>N</i>
A. DYNAMIC FUNCTIONS (number of subjects for whom domain was relevant)		Gross motor function of upper limbs (bringing hands to a position) (N=24)	
Rolling (N=12)		-1	3
-1	7	0	1
1	2	1	14
*	1	*	1
No report	2	No report	5
Crawling (N=9)		Fine motor function (manipulation of hands and fingers) (N=16)	
0	1	0	1
1	7	0.5	1
*	1	1	10
Lifting head in prone (N=5)		*	1
0	1	No report	3
0.67	2	B. STATIC FUNCTION (postural stability)	
1	1	Sitting (N=24)	
No report	1	0.67	2
Attaining sitting position (N=10)		1	16
1	2	No report	6
No report	8	Kneeling (N=5)	
Attaining standing position (N=6)		1	5
1	2	Standing (N=19)	
*	1	0	1
No report	3	1	16
Walking (N=15)		No report	2
-1	3	Head erect and stable (N=23)	
0.5	1	0.67	1
1	10	1	12
No report	1	No report	10
Head function (switching) (N=3)		Reduction of involuntary movement (N=14)	
1	2	0	1
No report	1	1	13

1=positive effect; 0=no change; -1=negative effect.

*Negative when UPSuit on, but positive on removal.

ter, and abdominal strength was assessed according to (1) duration of holding an abdominal 'crunch' and (2) number of sit-ups. Change was to be compared between members of pairs matched for age and ability, with one member of each pair being randomly chosen to wear the UPSuit. This was not possible, however, because so few adequately matched pairs were able to perform the tests. Variability in exposure to the UPSuit enabled the effects of UPSuit wear on muscle strength and respiratory function to be assessed by

multivariate analysis regressing change in outcomes on exposure to the UPSuit for all capable cases and controls.

DATA COLLECTION OF INDEPENDENT VARIABLES

We collected the following data from medical records and an initial interview with the primary caregiver: the child's gender, age, intellectual and sensory abilities, type and severity of motor impairments, other current medical problems, temperament, social interactions, socio-

TABLE V
Change rated from videos between -2 (worst) to +2 (best attainable for that child) relative to without suit and with no previous wear

	Mean change	SD	Difference	p
<i>A. Postural stability rating</i>				
With UPSuit (N=17)	+0.872	(0.548)	} +0.691	0.035*
Without UPSuit (N=13)	+0.181	(0.870)		
Individual difference in change (N=12)	+0.535	(0.289)		0.003†
<i>B. Quality of upper-limb movement with and without UPSuit</i>				
With (N=16)	+0.697	(0.650)	} +0.426	0.059*
Without (N=9)	+0.271	(0.650)		
Individual difference in change (N=9)	+0.433	(0.477)		0.014†
<i>C. Quality of upper-limb movement with and without immediate prior UPSuit</i>				
With (N=11)	+0.409	(0.777)	} +0.237	0.384*
Without (N=12)	+0.172	(0.826)		

*Wilcoxon rank sum test.

†Wilcoxon signed-rank test.

economic circumstances and home environment, and the caregiver's preconceived ideas concerning the UPSuit. Primary caregivers were asked to maintain a daily diary detailing the child's health status (a possible determinant of both outcomes and UPSuit exposure) and (for recipients) determinants and hours of UPSuit wear (to assess exposure and compliance). With one exception, all recipients' diaries were maintained and returned. Approximate hours of UPSuit wear were reconstructed from multiple carer reports for the recipient whose diary was lost.

When the impact of exposure to the suit was assessed, the following independent variables were considered: (1) calendar interval between observations, to allow change independent of wearing of the UPSuit to be recognised; (2) whether the suit was being worn during the observation; (3) total number of preceding hours of wear or hours of wear in the three weeks preceding the observation; (4) whether the observation took place immediately after the suit had been removed to allow recognition of short-term carry-over; and (5) subject characteristics.

Results

MOTOR CAPABILITIES

Distributions of mean coded values of

observers' responses are shown in Table IV.

The effect of the UPSuit on dynamic function (Table IVA) tended to be positive for all domains examined except rolling, though negative effects were also seen in some subjects for walking, gross motor function of the arms, crawling and standing.

Observers and video raters blind to the subjects' history of UPSuit exposure agreed that the UPSuit had a positive effect on postural stability. For each posture, observers noted improved stability in at least 89 per cent of subjects for whom reports were received (Table IVB), while the video raters found a significantly greater improvement after the addition of the UPSuit than without the suit (Table VA). Carry-over of postural improvement lasting from 30 minutes to 36 hours was noted in 14 subjects and was associated with regularity (rather than duration) of wear, a motor description of dystonia and higher activity levels.

The video raters rated quality of upper-limb movement as having improved significantly more after addition of the UPSuit than without it (Table VB). This difference was almost twice the difference between quality of upper-limb movement immediately after UPSuit re-

TABLE VI
Mean UPsuit wear by 24 recipients during six weeks intended wear in crossover trial

	Mean	(SD)	Minimum	Maximum	Ideal
Days of UPsuit wear (%)	60.2	(25.4)	9.5	95.2	95.5
Mean wear/day when worn (hours)	6.9	(2.0)	3.0	10.0	8.0
Total wear (hours)	177.5	(102.4)	23.3	393.6	315.0

moval and that with no recent UPsuit wear (Table VC). Involuntary movement was reduced in 13 of 14 subjects (Table IVB), the exception having such minimal involuntary movement that its presence was debatable. Six of the 13 experienced carry-over of reduced involuntary movement and these six tended to be older, with spastic muscles and involuntary movement that was less incapacitating.

TEMPERAMENT AND MOTOR CONFIDENCE

Observers were asked: 'Have you noted any marked changes in disposition (mood, self esteem, co-operation, motivation *etc.*) that you ascribe to wearing the UPsuit?' In response, observers of 11 of 24 recipients reported a gain in confidence to attempt motor tasks. For three subjects this was thought to be the most important benefit of the UPsuit, contributing significantly to increases in motor skills. Increased confidence was more likely to be reported in subjects with normal activity levels, moderate or severe overall severity, motor descriptions of hypotonia or ataxia and upper-limb tone described as hypotonic (2/2) or spastic (4/6). It was not associated with crossover trial compliance but was strongly associated with continuation of UPsuit wear, being seen in nine of 13 who continued to wear the UPsuit but in only two of 11 who ceased to wear it before the end of the nine-week period ($p=0.014$), but not with crossover trial compliance. This suggests that increased confidence provided a powerful incentive to continue wearing the suit.

RESPIRATORY FUNCTION AND CAPACITY

The duration of preceding UPsuit wear did not affect spirometry readings made when the suit was not worn. For seven capable children, wearing the suit decreased readings. The other child could

satisfactorily perform the test only when wearing the suit, either because the visible improvement in sitting position increased lung capacity or because greater sitting stability facilitated concentration on the test. Excluding this subject, respiratory function (forced expiratory volume in one minute) and capacity (forced vital capacity) were estimated to decrease by 4.8 per cent (95% CI, +10.3%, -19.9%) and 8.5 per cent (95% CI, +4.6%, -21.6%), respectively, when the UPsuit was put on. Observations of all recipients suggested that any acute reduction was clinically insignificant for 22 of 24 subjects but contra-indicated UPsuit wear in one child with extremely frequent respiratory infections and in a second child born preterm with bronchopulmonary dysplasia. While both children also suffered from asthma, attacks were not more frequent during UPsuit wear nor did UPsuit wear appear to exacerbate distress during an attack.

MUSCLE STRENGTH

Regression analysis found no evidence for an association between UPsuit wear and abdominal muscle strength or between grip strength and suit wear in children with adequate fine motor function to perform the test initially.

One child was noted to be less reliable in weight-bearing and lethargic after UPsuit removal, and several lines of evidence suggested that the dependency on the suit was psychological. Assessments of abdominal strength on a second child suggested that there were clinically significant decreases. Both children perceived the suit to be beneficial, which may have encouraged their very long hours of daily wear—more than 13 hours on several occasions.

TABLE VII
Independent determinants of crossover compliance known before receipt of an UPSuit

Item description	Sign	p
Regular activities outside the home*	-	0.002
Regular therapy at home	+	0.005
Current seizures	-	0.011
Absence of speech	-	0.014

*Linear variable: 0=<4 half-days, 1=>3 half-days, 2=full-time school.

COMPLIANCE WITH WEARING REGIME

There was no evidence of an incremental introduction to UPSuit wear in 14 subjects. Of the six children whose poor compliance contributed to the decision to discontinue UPSuit wear, five had no evidence of an incremental introduction, compared with eight of 17 for whom compliance was not an issue, though this difference may have been due to chance ($p=0.13$).

Twelve of 19 responding primary caregivers reported that their child adjusted immediately to wearing the UPSuit, four took one week to adjust, one took two weeks and two children were never happy to wear the suits. The suits were worn for a mean of only 60.2 (range 9.5 to 95) per cent of days of intended wear during the crossover trial (Table VI). 11.8 per cent of days' wear was lost because of laundering or illness, 15.7 per cent because of child or carer disinclination, and 12.3 per cent for other reasons.

Compliance in the crossover trial was defined as wear for >60 per cent of the days planned, with a total of >100 hours (about one-third of that requested), by these criteria, 12 subjects complied. Compliance in the crossover trial was associated with long-term wear; hence any of its determinants that can be known before prescription of a suit should identify those clients most likely to comply with a regime of suit-wearing. Of 33 variables describing subjects before UPSuit wear, four were identified as independently associated with compliance by multivariate regression analysis (Table VII).

Client motivation was lacking in three older, mildly impaired children in normal schools. For them the benefits of UPSuit wear did not outweigh their desire to conform with their peer group, a perception possibly strengthened by an acceptance of limitations imposed by their impairments. In contrast, a fourth mildly impaired child in a normal school attained functional improvements in all areas of motor competence. She differed in that she was younger (five years of age, compared with eight to 14 years) and the UPSuit had also been demonstrated and explained to her class before she started to wear it. While all four mildly impaired children gained in postural stability and quality of movement, the effect of the suit on dynamic function was determined primarily by the subject's attitude.

The entire study covered a mean of 53 (SD 37) days of UPSuit exposure for each subject (median 45, range five to 136 days) with a mean of 6.5 hours (SD 2.0) wear on each day of wear.

Identified problems inhibiting compliance, strategies for coping with them and contra-indications to the suit's use are listed in Table VIII.

Discussion

The UPSuit improves both postural stability and upper-limb movement in those patients presenting with pelvic, trunk and shoulder instability, increased muscle tone and/or involuntary movement, and is thus particularly appropriate for dystonic and athetoid subjects. For optimum benefit the wearers need to have a capacity for purposeful intent and active participation in their daily activities.

MOTOR CAPABILITIES

Expectations of dynamic functional improvement were more likely to be fulfilled in older children with normal capacity for purposeful intent and a positive attitude, who were not hypo-active, were moderately or severely (rather than mildly or profoundly) impaired and had increased muscle tone or involuntary movement. However, these associations were not strong and improved function was acquired by children in all descriptive categories.

TABLE VIII
Problems inhibiting compliance with regime of UPSuit wear, or contra-indicating the suit's use

<i>Factor</i>	<i>Strategy for coping</i>
Vomiting	Unzipping at meal-times; UPSuit modification, e.g. zipper to back
Wetting and soiling	Alter nappy arrangements
Upper-extremity cyanosis	Arm release
Difficulties in putting UPSuit on	Zipper arrangements; provision of assistance
Hyperthermia	Air conditioning; hydrophobic fabric
Induced muscle weakness	Restrict daily exposure
Inhibition of voluntary movement	Alter wear schedule
Subject attitude	Careful initial assessment: ensure incremental introduction; frequent checks on fit
Parent attitude	Careful initial assessment: replace with segmental limb splinting
Respiratory compromise	None: problems not amenable to UPSuit design modification or management
Intractable peripheral cyanosis associated with hypo-activity	None: problems not amenable to UPSuit design modification or management

Negative effects on dynamic function were observed in younger or more impaired children performing activities to which the UPSuit provided more resistance, such as rolling on the floor. However, when the UPSuit was removed, task performance sometimes improved. Such children may obtain maximum benefit from frequent short periods of wear with therapy immediately following removal.

After taking off the UPSuit, benefits lasted for 30 minutes to 36 hours in 14 of 24 recipients even after the short durations of exposure in this study. Independent clinical observation suggests that duration of persistence increase with total duration of exposure.

MOTOR CONFIDENCE

Almost half the recipients gained confidence in motor tasks. The others either did not lack confidence initially or were too severely impaired for confidence to play a role in determining motor performance.

VOLUNTARY MUSCLE STRENGTH

Voluntary muscle strength was not associated with duration of preceding wear, though limiting exposure to six hours a day is now recommended to avoid the possibility of weakness or dependency and to maximise any carry-over effects.

FACTORS AFFECTING SUCCESS

Incremental introduction is strongly recommended to determine whether initial alterations are needed, detect contra-indications and maximize the probability of long-term compliance.

Subject motivation influenced the degree of dynamic functional improvement and was able to overcome all contra-indications to success, with the possible exception of impaired lung function. Compliance was the key factor for three older mildly impaired male subjects (aged between eight and 14 years). They attended regular schools and their need to conform to their peer group resulted in disappointing and inconsistent changes in dynamic function.

However, our clinical experience has shown that prescription can be very successful in older children and adults when it is self-initiated with a view to attaining particular functional goals.

Useful predictors of compliance were the degree of contact between subject and primary caregiver and the presence of fewer impairments in addition to the motor impairment.

The two medical contra-indications were respiratory compromise (discussed in Results) and intractable peripheral cyanosis, seen in two recipients who were also hypo-active, very thin and pro-

TABLE IX
With hindsight, would the UPSuit be pre-
scribed again?

	N
YES, without reservation	5
YES, with reservations	6
Acceptable for short duration	2
Practical assistance needed	2
Questionable capacity for purposeful intent	2
NO, other modes of Lycra splinting possible	10
Medical contra-indications to UPSuit	4
Type of impairment	4
Carer compliance issues	2
NO, negative patient attitude to Lycra splinting	3
Total	24

foundly motor-impaired. Neither asthma nor gastrostomy was a contra-indication.

PRESCRIPTION

To justify the prescription of an UPSuit, there must be a specific neurological need, an intended functional outcome and no contra-indications. Consideration must also be given to patient and carer attitudes to UPSuit wear and the practicalities of donning the UPSuit within the client's and carer's daily routine.

Table IX shows retrospective assessments of the advisability of prescription after considering benefits obtained, contra-indications and degree of compliance. Patients or carers may not accept the invasiveness of the UPSuit due to the extent of body coverage or may require assistance to put the Lycra splint on, since the carer may require considerable strength to pull it into position. In such circumstances, dynamic Lycra splinting designed for and worn on the upper limbs may be an alternative. This includes full

SUMMARY

This paper describes a study of the UPSuit, a proximal stability splint fabricated from Lycra, in the management of children with cerebral palsy. The splint improved posture and reduced involuntary movement immediately. The amount of functional improvement depended on the type and severity of impairments, the subject's attitude, their capacity for purposeful intent and compliance. Compromised lung function and pre-existing hypoactivity were medical contra-indications to UPSuit wear whilst a limited capacity for purposeful intent or a negative attitude restricted benefits.

arm sleeve, gauntlet, wrist, thumb and glove splints, and is the subject of current research.

Conclusion

The benefits of UPSuit wear were: (1) immediate improvements in postural stability; (2) reduction in involuntary movement, also immediate; (3) the possibility of retention of these improvements after UPSuit removal; (4) increased confidence to attempt motor tasks; and (5) improved dynamic function, depending on type and severity of impairments, capacity for purposeful intent, subject's attitude and compliance with wearing regime. Compliance is a major issue in UPSuit prescription. Compromised lung function or pre-existing hypo-activity are important contra-indications. While the UPSuit was of undisputed value for some subjects, Lycra splinting applied only to the limbs may broaden the spectrum of persons with cerebral palsy who can benefit from this approach.

Accepted for publication 23rd August 1994.

Acknowledgements

The UPSuits were designed and manufactured by Second Skin. The authors gratefully acknowledge the financial assistance of the Medical Research Fund of Western Australia (MEDWA) and the support of Professor Fiona Stanley of the Institute for Child Health Research, Dr Ruth Shean and the therapists of the Cerebral Palsy Association of WA and Second Skin. They also thank Lesley Pereira (occupational therapist), Diana Davidson (physiotherapist), Annette Wallman (occupational therapist), Dr. Peter Silberstein (pediatric neurologist), John Otago (video technician) and the Department of Respiratory Medicine of Princess Margaret Hospital for assistance with assessments, and the subjects, their carers and therapists for their tolerance and interest.

Authors Appointments

*E. Blair, PhD, Institute for Child Health Research, P.O. Box 855, Perth, Western Australia 6872.
 J. Ballantyne, BAppSci(OT), Second Skin, 251 Adelaide Terrace, Perth.
 S. Housman, BAppSci(OT), The Cerebral Palsy Association, 106 Bradford St., Coolbinia.
 P. Chauvel, MPH, FRCP, Princess Margaret Hospital for Children, Subiaco.

**Correspondence to first author.*

The Upsuit was of great value to one-quarter of subjects, but Lycra splinting may benefit a wider spectrum of persons with cerebral palsy in the form of less intrusive splints applied to the limbs.

RÉSUMÉ

Etude de l'attelle de stabilité dynamique proximale dans la rééducation des enfants 'cerebral palsy'
L'article décrit une étude de 'l'UPSuit', une attelle de stabilité proximale fabriquée par Lycra, dans la rééducation de l'enfant IMC. Les attelles améliorent immédiatement la posture et réduisent les mouvements involontaires. Le degré d'amélioration fonctionnelle dépendait du type et du degré des incapacités, ainsi que de l'attitude du sujet et sa participation. Une fonction pulmonaire compromise et une hypoactivité pré-existante constituaient des contre-indications au port de 'l'UPSuit', alors que des capacités limitées pour une activité intentionnelle ou une attitude négative restreignaient le bénéfice. 'L'UPSuit' s'est montrée de grande valeur pour un quart des sujets mais les prothèses Lycra peuvent apporter un bénéfice à un spectre plus étendu de sujets IMC sous forme de attelles moins imposantes appliquées aux membres.

ZUSAMMENFASSUNG

Eine Studie über eine dynamische proximale Stabilitätsschiene bei der Behandlung von Kindern mit Cerebralparese

In dieser Arbeit wird eine Untersuchung des UPSuit, eine proximale Stabilitätsschiene aus Lycra, bei der Behandlung von Kindern mit Cerebralparese beschrieben. Die Schiene verbesserte die Haltung sofort und verminderte unwillkürliche Bewegungen. Art und Schweregrad der Behinderung und Einstellung und Compliance des Patienten bestimmten den Grad der funktionellen Verbesserung. Bei Gefährdung der Lungenfunktion und bestehender Hypoaktivität war das Tragen des UPSuit medizinisch kontra-indiziert, während sein Nutzen durch eingeschränkte Anwendung und negative Einstellung begrenzt wurde. Der UPSuit war für 25 Prozent der Patienten von großem Nutzen, die Lycra-Schienung könnte jedoch durch leichtere Schienen für die Extremitäten für weit mehr Patienten mit Cerebralparese hilfreich sein.

RESUMEN

Estudio sobre una férula dinámica de estabilidad proximal en el manejo de niños con parálisis cerebral

Este comunicación describe los estudios de la UP-suit, una férula de estabilidad proximal fabricada con Lycra, en el manejo de niños con parálisis cerebral. La férula mejoró la postura y redujo inmediatamente los movimientos involuntarios. El grado de mejora funcional dependía del top y gravedad de las incapacidades y de la actitud y aceptabilidad del sujeto. Una disminución en la función pulmonar y una hipoactividad preexistente constituyen una contraindicación al uso de la UP-suit, mientras que una capacidad limitada para un intento propositivo o una actitud negativa restringía sus beneficios. La UP-suit era de un gran valor en una cuarta parte de los pacientes con parálisis cerebral, pero las férulas con Lycra pueden beneficiar a un espectro más amplio de personas con parálisis cerebral, en forma de una aplicación menos intrusiva de las férulas en los miembros de los enfermos.

References.

- Beamab, P. (1960) 'Restriction, fatigue and motor capacity in athetoid children.' *Child Neurology and Cerebral Palsy. Little Club Clinics in Developmental Medicine, No.2.* London: Medical Advisory Committee of the National Society with Heinemann Medical, pp. 82-89.
- Bower, E., McLellan D. L., (1992) 'Effect of increased exposure to physiotherapy on skill acquisition of children with cerebral palsy.' *Developmental Medicine and Child Neurology*, 34, 25-39.
- Case-Smith, J., Fisher, A. G., Baver J. D. (1989) 'An analysis of the relationship between proximal and distal motor control.' *American Journal of Occupational Therapy*, 43, 657-662.
- Noronha, J., Bundy, A., Groll J. (1989) 'The effect of positioning on the hand function of boys with cerebral palsy'. *American Journal of Occupational Therapy*, 43, 507-512.
- Ottenbacher, K. J., *Evaluating Clinical Change: Strategies for Occupational and Physical Therapists.* Baltimore, MD: Williams & Wilkins. 1986.
- Russell, D. J., Rosenbaum, P. L., Cadman, D. T., Gowland, C., Hardy, S., Jarvis, S. (1989) 'The Gross Motor Function Measure: a means to evaluate the effects of physical therapy.' *Developmental Medicine and Child Neurology*, 31, 341-352.
- Waksvik, K., Levy, R. (1979) 'An approach to seating for the cerebral palsied.' *Canadian Journal of Occupational Therapy*, 44, 147-153.