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"Evaluating Efficacy and Methodological Approaches in Neurological Physiotherapy: A Review of Controlled Trials and Early Rehabilitation Practices"

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Introduction :

A substantial amount of research now exists which is relevant to the treatment of neurological patients, and it is important that physiotherapy treatment is based on this research. There is no evidence at present that one overall approach is superior to another. The approaches that have been compared for efficacy in controlled trials include the Bobath, proprioceptive neuromuscular facilitation, and functional (traditional) approaches (Dickstein et al., 1986 A; Loggigian et al., 1983 A; Lord and Hall, 1986 A). These trials have some problems in their design. For example, the study of Loggigian et al. was the only one of the three that randomized adequately, and all three studies arguably had insufficient power to detect differences, owing to small numbers. A single-case design was used by Wagenaar et al. (1990 A) to compare neuro-developmental (a modernized version of Bobath) and Brunnström methods of treatment, and also found no substantial differences. It is possible that differences do exist between the effectiveness of these approaches, but were not demonstrated in these studies. Elements of treatment packages have been investigated with more success. In randomized controlled trials, training of weight distribution via auditory feedback has improved symmetry of body-weight distribution in sit-to-stand (Enghardt et al., 1993 A), and visual feedback about weight bearing in the standing position has improved standing balance (Sackley and Lincoln, 1997 A). EMG biofeedback has been shown to facilitate recovery of arm function (Crow et al., 1989 A). In another randomized controlled trial, repeated pressing movements with the arm (in a position contrary to the typical pattern of spasticity) to push the body backwards in a 7 rocking chair resulted in a better outcome on the Fugl-Meyer test (Feys et al., 1998 A). An enhanced therapy regimen for the arm, which included more intensive therapy, encouragement for the patient and relatives to be active participants in the rehabilitation, facilitation of learning new skills and self-directed exercise programmes, was found to improve strength, range and speed of movement in another randomized controlled trial (Sunderland et al., 1992 A). Task-specific training of reaching beyond arm's length in sitting was shown to improve outcome compared with a control placebo treatment by Dean and Shepherd (1997 A). There is also evidence that home exercise programmes (Turton and Fraser, 1990 A) and forced use of the affected arm by restraint of the intact arm in chronic patients (Taub et al., 1993 A) improve outcome of upper limb function. Given this evidence, there is good reason to incorporate these elements of active learning, including feedback and task-specific training, into our management of patients. One must have a framework in which to use these elements and in this chapter I shall describe management of the patient within the context of the framework developed by Carr and Shepherd (1987a C, 1987b C, 1989 C, 1994 C). This is chosen because it is based on current information available from the movement sciences and it incorporates the above-mentioned interventions, which are supported by experimental evidence.

General Principles:

The overall aim of my treatment would be to retrain the patient's motor control so that her motor performance is as close to normal as possible, since normal performance is the most efficient. At a later stage it may be necessary to alter this aim and adopt a more functional approach. Whilst motor control is being regained, it is essential to preserve muscle length and joint integrity, which are both at risk while the patient is unable to move normally. A problem-solving approach is used, which can be summarized in four steps (Carr and Shepherd, 1987a, p. 31 C). • The task to be trained is analysed by comparing the patient's motor performance with a normal model, which is based on findings from studies of the biomechanics of the task. • Practice of either the missing component(s) of the task or the whole task occurs, with the therapist and patient identifying the goal to be achieved, and instructions, feedback, manual guidance and structuring of the environment are used to facilitate relearning of motor control.• The movement or part of a movement which is initially assessed is reassessed under the same conditions at the end of the training. • The therapist encourages transference of training to the patient's everyday setting by making it possible for them to practise in context, communicating with staff and relatives and organizing self-monitored practice for the patient.

Some of the key principles of the motor training are:

• The patient is encouraged to be an active learner in the rehabilitation process.

• A sound analysis of biomechanics and motor control of normal and abnormal movement underpins training.

• Training is task specific because movements are normally organized so they are specific to a particular goal and set of environmental conditions.
• Active motor control, particularly the control of force and timing of muscle activity, is believed to minimize the clinical signs of spasticity.

Treatment and Management:

Early Intervention Early intervention aims to maintain optimal respiratory function, preserve integrity of the musculoskeletal system and start the process of regaining motor control.

Respiratory Function

Mechanical ventilation and paralysis will have adverse effects on respiratory function, including decreased functional residual capacity, microatelectasis, decreased lung compliance, increased secretions and a tendency towards infection (Ada et al., 1990 C). The respiratory status of the patient must therefore be assessed and treated appropriately, with due care so that any techniques used do not cause secondary brain damage, for example, by raising intracranial pressure (Frost, 1985 C). Techniques may include modified postural drainage, vibrations, rib springing, chest percussion and suction with humidification. Any intervention would be based on an analysis of the patient's pulmonary, cardiovascular and neurological status (Ada et al., 1990 C).

Preserving Integrity of the Musculoskeletal System

Positioning

In the earliest stage, when Krishvi was sedated and unable to move, I would position her to prevent the development of contractures and reflex hyperexcitability. Hypertonia, the increased resistance to passive movement, may develop due to altered mechanical properties of muscle (Dietz and Berger, 1983 A) as well as hyperexcitable reflexes. In a study by O'Dwyer et al. (1996 A) of 24 stroke patients, hypertonia was associated with contracture but not with reflex hyperexcitability and it was suggested that contracture may actually potentiate hypertonia. To preserve muscle length, the muscles at risk of developing contractures are identified and these are put in a lengthened position for part of the day. For example, pectoralis major (which remained persistently tight in Mrs LM) and biceps brachii are muscles normally at risk in stroke patients owing to the typical resting posture of the flaccid arm in sitting, with the arm adducted and the elbow flexed, and the hand resting on the lap. Muscle atrophy resulting from disuse occurs faster and to a greater degree in muscles immobilized in a shortened position (Gossman et al., 1986 B), so this is another reason to position muscles in their lengthened position. To lengthen these muscles, in supine, the patient's arm could be supported on a table in abduction, with the elbow extended. At the same time, a round heavy can could be placed into the hand (taped on if necessary) to maintain length of the finger flexors and the adductor muscles of the thumb. For the lower limb, length of soleus and gastrocnemius could be maintained by keeping bedclothes off the feet with a bed cradle or by pleating the sheets, and by putting the lower legs in splints to maintain dorsiflexion for some of the day, providing the plantar flexors are not hypertonic. Short-leg plaster casts with the ankles in the plantargrade position, as described by Ada and Scott (1980 C), would be advisable if hypertonus is already present as other methods will not hold the feet in position and so will not prevent muscle shortening. Mrs LM's restlessness might mean plasters would not be suitable. I would monitor the plasters closely to check for circulatory problems and would leave the first casts on for four to five days, then remove to check the condition of the leg. The limitation of casts on ankle movement when Krishvi starts to activate the tibialis anterior and begins to stand would be considered before reapplication. If the hips are constantly externally rotated, I would use sandbags or pillows along the sides of the legs to obtain a position of neutral rotation. To avoid shortening of neck flexors, Krishvi could lie supine without a pillow some of the time. There is as yet no clear evidence in humans as to how long the limb should be positioned to prevent muscle-length changes. It is known in mice, however, that a half-hour stretch daily is sufficient to prevent loss of sarcomeres and retain extensibility of connective tissue (Williams, 1990 B). It is also known that the biochemical changes which result in changes to sarcomere numbers begin after only 24 hours of immobilization. Once established, length changes are reversible for up to six weeks in animal studies (Gossman et al., 1982 B). Therefore, it is essential to prevent changes early and, in the absence of evidence in humans, I would use a prolonged stretch for half an hour per day. The stretch would normally be a greater than resting length, the amount of stretch depending on krishvi's comfort and the tightness of the muscle. One study of children with cerebral palsy demonstrated that to prevent short soleus muscles shortening further, at least six hours per day was needed with the muscle at greater than its resting length (Tardieu et al., 1988 B). I would therefore consider half an hour to be a minimum time.

Passive Range of Motion Exercises

Slow, passive range of motion exercises, avoiding any forceful movements at the end of range, could be useful at this stage to maintain extensibility of connective tissues. I would use everyday movements such as reaching the hand to the back of the head or reaching towards the ceiling, as these would be a safe way to perform passive movements and are less likely to cause myositis ossificans, which can result from forceful movements at the end of range (Ada et al., 1990 C). Whilst performing movements with the arm, I would encourage Krishvi to try to actively do the movements, such as protracting the shoulder to reach towards the ceiling, or to someone's hand. Accessory joint mobilizations (Maitland, 1979 C) could be performed if necessary, to maintain range.

Standing and Sitting

As soon as Krishvi's intracranial pressure, heart rate and blood pressure were stable, I would commence standing with physical assistance. This has benefits for the patient's level of awareness, respiratory function, kidney, bladder and bowel functions. It will also help preserve muscle length and joint integrity in the lower limb and will start to reintroduce the patient to postural adjustments and the normal standing position. Loading of the bones will occur in the standing position, which is essential to prevent resorption (Ada et al., 1990 C) and compression of joint cartilage, which is necessary for its nutrition. In this position, I would encourage Krishvi to extend her hips and knees and keep her head up, conveying this by visual or physical demonstration if necessary. Sitting would also be commenced at this time to encourage head control and postural adjustments in sitting. I would encourage interactions between staff, relatives and Krishvi to occur on the right side some of the time to encourage the patient not to neglect that side. I would ascertain from the speech therapist the best way of communicating with krishvi. After Transfer to Ward General Approach, Once Krishvi has been transferred to the ward and is ready to start more active movement with the therapists, my approach would be to organize treatment around functional movements needed in everyday life, such as supine to sitting, balance in sitting, sit-to-stand, standing and reaching activities with the arm. My comments are mainly restricted to the approach I would take initially, given krishvi's problems at this time. Training strategies would obviously change in accordance with changing performance. The movement is analysed by comparing the patient's performance with normal biomechanics and motor control of that movement. Carr and Shepherd (1987a C) list the invariant kinematic features of each functional activity. These are derived from studies of the biomechanics of these movements. The therapist observes which of these invariant kinematic features are missing or are not performed normally and notes the particular compensatory movements the patient makes. A decision is made about Krishvi's main problems and training is aimed at improving these particular problems. There is growing evidence that dyscontrol after stroke is due more to underactivation of muscles rather than overactive or 'spastic' antagonist muscles interfering with the activation of agonists (Burke, 1988 B; Fellows et al., 1994 A; Sahrmann and Norton, 1977 A). The emphasis is therefore on training the underactivated muscles that are needed to perform the task. Krishvi is expected to be able to decrease compensatory activity as she improves the ability to generate force in the muscles that are underactive. A problem-solving approach to training is used throughout, where observation and analysis are followed by training, re-evaluation and progression. The movement or part of a movement which is initially assessed is reassessed under the same conditions at the end of the training. Where possible, any change in performance is measured objectively. If necessary, part of the skill may be practised first, followed by practice of the whole task that was initially observed. Wherever possible, I would choose a strategy where Krishvi could elicit the desired muscle activity herself, with no, or minimal, manual guidance. She is then more likely to execute the movement in the correct temporo-spatial sequence. This is hard to achieve through handling. She will also receive more normal feedback from the periphery, in the absence of manual guidance, and will be better prepared for practising these movements on her own. 13 Patients are likely to recover faster if they perceive themselves to be in control of their rehabilitation (Partridge and Johnston, 1989 A). It would therefore be made as clear as possible to the patient that the responsibility for her rehabilitation is jointly between her and the therapist. Until the patient had more language, this may be difficult to explain but it can be communicated in other ways; for example, by giving her choice in the organization of her day, deciding on treatment goals together, with the therapist's guidance, and expecting her to work on practising movements when the therapist is not present. Overall progress would be measured by the Motor Assessment Scale (Carr et al., 1985), which I would use every two weeks or so.

Balance in Sitting

At this stage, Krishvi requires the support of two therapists to sit. The invariant kinematic features of sitting include hip flexion to 90 degrees with trunk extension (including anterior tilt of the pelvis), head and neck extension, and foot placement under the knees. Because she is pushing strongly into extension in sitting, I would work first on obtaining active hip flexion, with extended head, neck and trunk. This could be done, for example, by encouraging the patient to reach for an object in front of her with the left arm, which may also discourage the tendency to push herself backwards with this arm. Support may be needed initially from a therapist seated in front, with the patient's extended arms resting on her shoulders. The object needs to be placed high enough to require some trunk extension in order to grasp it, and is moved further away systematically as practice continues. Varying the distance and direction systematically during practice has been shown to be effective in improving extent of reach by Dean and Shepherd (1997 A). The object should be something meaningful to the patient, such as one of her personal belongings, and preferably a bright colour, to hold her attention. Regarding the problems with midline orientation, I would note the side to which the patient was tending to fall to most, and work on eliciting the appropriate postural adjustments for moving to that side. Postural adjustments are anticipatory and ongoing (Belenkii et al., 1967 B; Horak et al., 1984 A) and are specific to the task being performed (Cordo and Nashner, 1982 B), so training would occur in conjunction with movements in sitting, rather than in isolation. For example, if the patient was tending to fall to the right, pillows could be placed on the right side and she could be guided towards this side until her elbow rests on the pillows (Carr and Shepherd, 1987a, p. 95 C). I could facilitate the appropriate adjustment by manual guidance under the elbow, encouraging lateral flexion of the trunk to the opposite side. She should then be instructed to regain the midline sitting position, while the therapist facilitates this again with her hands. As a progression from this, the patient could practise reaching to the right side, as illustrated in Carr and Shepherd (1987b, p. 44 C).

Standing

Standing practice would continue daily, which is important both for retraining the ability to be in this position and also for maintaining length of muscles such as soleus, gastrocnemius, iliopsoas, psoas major and hamstrings. Because Krishvi was pushing into plantar flexion, I would try the following training strategy to encourage standing with dorsiflexed ankles. From a sitting position on a high plinth, two therapists on either side assist the patient to stand by helping her to extend hips and knees. Standing from a high seat requires less vertical force generation at the knee and hip (Ellis et al., 1984 B; Murray et al., 1967 B). A table is placed in front, at hip height, so that the hips will touch the table if the ankles are sufficiently dorsiflexed. The goal is to move the body forward by dorsiflexing the ankles, until the hip touches the table. The table is a visible means of support and Krishvi will want to be close to it.

The appropriate set of postural responses might be elicited more easily if she was doing an everyday task which would normally require ankle dorsiflexion, such as reaching forward for an object at shoulder height, so I would also try this. This is an example of structuring the environment to achieve the goal. If Krishvi does not understand what is required, visual demonstration can be given before she attempts it herself, by the therapist herself doing the movement to the table (the patient views from the side). Or, she can be manually assisted to do the movement a few times to give her the idea. The right lower limb was described as markedly weak. A calico splint around the right knee to help to hold it extended (Carr and Shepherd, 1987a, p. 118 C) might allow her to stand with less help while practising. In addition, at this stage, the weakness in the gluteus maximus and hamstrings for hip extension, and the quadriceps for knee extension, needs to be addressed. It may be difficult for Krishvi to work on these components in standing, and if so, part of the skill would be practised in another position. I would choose a strategy which is task specific. For example, practice of unilateral hip extension in a supine position, with the affected foot over the side of the bed, could commence to elicit activity in the hip extensors and increase their strength and endurance. With the hip extensors working unilaterally, at around 0 degrees of hip extension, and the body straight, they are activated in a similar way to that in standing. Practice of knee extension could occur in a sitting position, with the therapist simulating weight-bearing by giving firm pressure through the heel towards the extended knee, while the patient practises eccentric and concentric contractions of the quadriceps (Carr and Shepherd, 1987a, p. 136 C) or by static quadriceps contractions if very weak. Both of these components also need to be practised in the context in which they are needed, that is, standing. Whole-skill practice is more task specific and so is more likely to improve performance of the skill (Carr and Shepherd, 1987a C) but in patients with difficulty eliciting movement components, part-skill practice can be necessary. When practising components of a skill, I would choose a movement that closely resembles the way in which the muscles would work in the whole skill. I would expect this to result in better transference of training as several studies have demonstrated the specificity training effects (Gonnella et al., 1981; Rasch and Morehouse, 1957 B; Sale and McDougall 1981 B). For example, the knee extension exercise above involves weightbearing in the relevant knee joint range for standing.

Sit-to-stand

The biomechanics of sit-to-stand would be analysed according to the invariant kinematic features (Carr and Shepherd, 1987a, p. 102 C) and training would accordingly aim at improving the main missing component(s). Practice would occur from a high plinth. Krishvi could then do more herself and thus need less manual help from the therapists. The height chosen would be measured and practice would occur from this height until it was judged that the height could be lowered. Once she could sit-to-stand independently, the height of the plinth could be used as an objective measure of change in performance. Normal sit-to-stand requires overlap of the pre-extension (hip flexion and ankle dorsiflexion) and extension phases (thighs off to standing) (Vander Linden et al., 1994; Carr and Shepherd 1987a C). For example, the head reaches its maximum horizontal velocity just prior to thighs off so that this momentum can be transferred to extension at thighs off (Vander Linden et al., 1994; Schenkmann et al., 1990 B). For this reason, I would try to train the component in a way that involved both of these phases. For example, if the main problem was decreased hip flexion with an extended trunk, one way to train this is as follows. A curtained screen would be placed in front of Mrs LM, and the goal of moving her head to touch the curtain, and then pushing down and back through her heels at the end of the movement, is conveyed to her.

Upper Limb Training

As there was no movement in the right upper limb at this stage, I would try to elicit activity in the arm in various positions. In doing this, I would be considering factors such as the type of contraction required, the relationship of the arm to gravity, and the changed length–tension relationship of individual muscles. For the same neural input, optimal force production is greatest for eccentric contractions, then isometric and then concentric contractions (Albert, 1991 C), so it may be easier for Krishvi to produce an eccentric contraction at this early stage. For example, in the supine position, an eccentric contraction of triceps brachii might be elicited in the outer range, with the upper arm held at 90 degrees to the horizontal, as she tries to control the movement of the hand to the head. Also, when a concentric contraction is immediately preceded by an eccentric contraction, elastic energy is stored and potentiates the concentric contraction (Cavanagh et al., 1968 B). Using this principle, when the patient can do an eccentric triceps contraction, it could be used to potentiate the concentric contraction. Finger extension might be more easily elicited in a position of finger flexion, as the fingers are likely to have been resting in a flexed position for much of the day. Muscles adapt to the length at which they are kept by changing their number of sarcomeres (decreased in the case of a muscle in a shortened position) so the peak tension in the finger extensors may now be produced in a lengthened position (Gossman et al., 1982 B). I would be particularly interested in obtaining some activity in the external rotators of the shoulder. Infraspinatus and teres minor are both external rotators and part of the rotator cuff, which is crucial in providing stability at the gleno-humeral joint. The rotator cuff forms a force couple with the deltoid at the shoulder, in elevation of the arm (Nordin and Frankel, 1989 B). External rotation is also significantly and negatively correlated with shoulder pain (Bohannon, 1988 A). Since tightness of right pectorals and rhomboids has developed, the arm would be positioned to specifically stretch these muscles for some time during the day, and training of protraction (serratus anterior) and shoulder abductors (for example, middle deltoid as a prime mover and supraspinatus as a stabilizer) would be a priority. There is some activity in the left upper limb, and it is described as being ‘overactive’. As recovery of movement occurs, repetition of incorrect movements and length–tension changes can result in a muscle imbalance, where some muscles are easier to activate than others and are therefore used frequently and sometimes inappropriately. Other muscles, however, remain underactivated. To prevent this muscle imbalance developing further, I would identify the underactive muscles and work on increasing activation of these, in a way that discourages compensatory ‘overactivity’. For example, to encourage forward flexion (for which the anterior deltoid is the prime mover) whilst discouraging internal rotation at the shoulder, the patient could be positioned side-lying with her arm extended on a table in front of her. A target object would be placed in the direction of forward flexion and Krishvi encouraged to move the arm along the table to touch the object, or knock it off the table. The arm will not move easily if it is pressing into the table, so, to achieve the goal, she cannot use internal rotation.

Pain in Supination

Regarding the pain at the end of the range of supination and wrist extension, I would perform a subjective and objective assessment of the joints and muscles that might contribute (Maitland, 1979 C). I would consider tightness of pronators or joint stiffness at radio-ulnar joints (inferior and superior) as possible causes of pain on supination and tightness of long finger flexors and wrist flexors and stiffness of wrist joint and carpal bones as likely causes of the pain on wrist extension, because of the period of virtual immobilization of the right arm. If the pain is caused by these problems, stretching of tight muscles and training of supination and wrist extension would be needed. Positive joint signs would be treated with the appropriate accessory joint mobilizations (Maitland, 1979 C). Strategies for training supination could include pouring water from one container to another, with assistance, in the direction of supination, or trying eccentric and isometric contractions in different parts of the range.

Self-monitored Practice

As soon as it seems practical, relatives would be encouraged to practise with Krishvi specific exercises set by the therapist. Skill in performance increases as a direct function of the amount of practice. The study by Feys et al. (1998 A) is an example of how repetitive practice of movements can result in improved outcome. The average physiotherapy training session, which must be divided into treatment of several different problems, is unlikely to allow enough time for learning to take place, although performance may change. Therefore, it is logical to require the patient to practise outside the treatment sessions. Small but significant improvements in ADL and function have been found with higher intensities of rehabilitation (Kwakkel et al., 1997 A). Self-monitored practice is one way in which higher intensity of rehabilitation can be managed. In an observation of a stroke rehabilitation ward, Keith et al. (1980 A) demonstrated that much of a patient's day is spent alone, doing little. Much of this time could be used productively in practice. In the case of Krishvi, the relatives could help by positioning her hand, palm down over the edge of the wheelchair arm, to allow her to practise wrist extension. The relative could hold her own hand in an appropriate place and encourage her to move her hand up towards her own. To ensure compliance and that practice is done correctly, the exercises would be recorded in the patient's own practice book and the relatives would be asked to record in the book the exercises done. Polaroid photographs of the exercises would be used when needed. A detailed discussion of ways of ensuring that practice takes place and is done correctly can be found in Ada and Canning (1990 C).

Walking

Preparation for walking has already begun with practice of hip and knee extension and standing. As soon as Krishvi could manage it, stepping forward and back with the left leg would be performed in order to improve the ability to dorsiflex the ankle whilst lengthening the right plantar flexors, and to accustom her to bearing weight through the right leg. This proved to be particularly important in this case, as dorsiflexion was limited at day 27 and tightness in the right tendo Achilles remained at five and a half months. Initial training would aim to ensure that the hip and knee extensors are activated strongly enough to support the weight of the body in standing. Once able to stand, training would continue to depend on the therapist's analysis of Krishvi's standing each day. In general, I would aim for improving the ability to transfer the weight to one leg, whilst maintaining a degree of knee and hip extension which was within her current abilities. Measurable feedback about weight transference would be indicated by bathroom scales under the feet and given orally via the therapist, or by auditory feedback from a pressure-sensitive device. The goal would be set so as to be achievable but challenging. It might be, for example, to maintain 30% of body weight on the leg, with the knee within five degrees of full extension, for one minute. Krishvi's ability to do movements while standing, with the appropriate postural adjustments, would also be practised. This may start with looking up to the ceiling, which requires a slight anterior movement of the centre of mass, and progress to turning to look behind, then reaching for objects at the side, in front and behind. A stepping exercise using a block is helpful for stroke patients (Nugent et al., 1994 A). The patient starts with the affected leg on a block and then lifts the unaffected leg onto the block by extending the affected hip and knee. There was a dose-response relationship between an increased number of repetitions of this exercise and improved walking outcomes on the Motor Assessment Scale. This exercise could be introduced even at an early stage, as it was in this study.

Organization of Daily Treatment

In a typical 45-minute to one-hour session, I would aim to work on about three different problems identified from different functional activities. At around day 27, these might be hip and knee extension for standing, hip flexion for sit-to-stand and forward flexion for reaching in the right upper limb. This is purely a hypothetical choice, as the problems would be identified and would change based on ongoing analysis of Krishvi's problems.

Other Factors Affecting Learning:

Krishvi was said to have poor concentration and was easily distracted. Learning will be adversely affected by poor concentration so a strategy would be worked out to improve concentration, in conjunction with a neuropsychologist, if one is available. Krishvi would be treated in a quiet room, and the number of tasks to be learned would be reduced. As concentration improved, she would gradually be exposed to more distractions during treatment. The time for which Krishvi concentrated on the task she was learning could be measured daily, and a chart made to show change in the time she was able to concentrate. The chart is displayed where she can check on progress herself.

Exercise Tolerance

Poor exercise tolerance is a consequence of the period without regular exercise. A decrease in cardiovascular fitness can be partially prevented, and improved by including exercise in the patient's rehabilitation programme specifically for that purpose. For Krishvi, practice of sit-to-stand from a high chair or plinth could be used when she was able to do this independently with someone standing by. The practice could be supervised by a physiotherapy helper, or relative, who can remind the patient about the quality of the movement. The number of repetitions will depend on her cardiovascular response, which can be monitored by heart rate, and also on the quality of the performance. Forty to 50 repetitions of sit-to-stand per day would not be unusual when using this framework for treatment (Canning, 1987 A).

Training in the Later Stages

Motor skills can be classified as 'closed', where the movement is performed under invariant conditions each time, or 'open', where conditions change between attempts (Gentile, 1987 C). It appears that much of physiotherapy in the rehabilitation gym tends to train closed motor skills. For example, sitto-stand is practised from a plinth most of the time. In real life, open skills are needed, so therapy needs to incorporate learning open skills. To this end, sit-to-stand would be practised from different types and heights of seats, and also under different conditions such as standing up in order to walk out of the door, or to reach for a box of tissues. This would require Krishvi to problem-solve about the best solution for each situation. This type of training has been shown to be more successful in training normal individuals to transfer their learning to movements in different contexts than practice in unvarying situations (Shea and Morgan, 1979 B). The factors present while walking in the real world, such as talking while walking, avoiding stationary and moving objects, and walking on a moving object (for example, a bus), could be introduced into the latter stages of walking training. The involvement of the patient as an active learner would have prepared her well for carrying out a home exercise programme. Leading up to Krishvi's discharge, this programme would be demonstrated to her and updated regularly as performance changes. A home visit would help to establish what objects and furniture could be used within the programme. There is reason to expect the home programme to improve outcome, according to a study by Turton and Fraser (1990 A).

Implications

In summary, patients are not passive recipients of treatment, but have an active learning role in their rehabilitation. Accordingly, therapists have a role as trainer, facilitating patients' learning of motor skills. Empowering stroke patients in this way allows them to do more practice for themselves outside the training sessions and may result in faster recovery of motor control. An important skill for therapists involves choosing training strategies at a level which allows the patient to practise the desired movement without too much compensatory activity from inappropriate muscles. To achieve this, the therapist must draw on their broad range of knowledge, including areas such as muscle biology, as well as knowledge more closely associated with neurological conditions. This chapter has tried to describe a treatment approach that is grounded in scientific findings. In response to a general demand for evidence-based treatments, physiotherapy treatment is rightly moving on from a stage where praxis-based treatment was considered satisfactory. More studies are obviously needed to evaluate the effectiveness of components of treatment approaches and the approaches as a whole. For now, we can concentrate on incorporating those interventions that have been demonstrated to be effective. In doing so, we need to be careful to note the limitations of the existing research. For example, can the interventions shown to be effective in patients more than one year after stroke, such as the forced-use paradigm, be applied earlier to patients as effectively? Whatever interventions therapists decide to adopt in their own practice, they need to examine the theoretical and experimental evidence to ensure there is a sound basis for their use.

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