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Louise Elliott & Louise Walker
a Addenbrooke’s NHS Trust, Cambridge, UK
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Rehabilitation interventions for vegetative and minimally conscious patients

Louise Elliott and Louise Walker

Addenbrooke’s NHS Trust, Cambridge, UK

Brain injury rehabilitation is a complex and challenging task for all members of the multidisciplinary team. Medical advances have allowed more severely impaired patients to survive and consequently the number of patients in the vegetative and minimally conscious states have proportionately increased. Thus, the need for evidence-based practice and further research demonstrating the effects of specific rehabilitation interventions is required. This article reviews the current research and consensus on rehabilitation for patients in the vegetative and minimally conscious states.

INTRODUCTION

The majority of brain injuries are caused by road traffic accidents, sporting injuries or assaults and result in patients demonstrating a multitude of physical, cognitive, social, behavioural, and emotional problems (Duff, 2001; Royal College of Physicians, 2003b). Progress in intensive care medical treatment has resulted in many patients, who would previously have died, surviving severe brain injury (Jennett, 1993; Noda, Maeda, & Yoshino, 2004). This has resulted in a proportional rise in the number of such patients left severely disabled in a vegetative or minimally conscious state (Royal College of Physicians, 2003b). Patients in the vegetative state show no signs of awareness but display sleep-wake cycles and eye opening (Jennett, 2002; Jennett & Plum, 1972). Those patients that demonstrate some evidence of awareness, despite profound cognitive and physical...
impairments, are described as being in the minimally conscious state (Giacino et al., 2002).

It has frequently been questioned whether brain injury rehabilitation is effective or whether it constitutes well-intentioned hand-holding while natural recovery takes place (Cope, 1995). Certainly, the scientific evidence demonstrating the value of rehabilitation interventions is predominantly restricted to stroke patients (Johansson, 2000; Watson, 2001). The limited evidence for vegetative and minimally conscious patients is frequently poorly described or defined (Giacino, 2001). Yet advances in neurophysiological research over the past 20 years has lead to dramatic changes in the understanding of the neural control of movement (Bethune, 1994). Many studies have demonstrated chemical and anatomical plasticity in the cerebral cortex and the potential ability of the brain to compensate for lesions (Bach-Y-Rita, 2003; Johansson, 2000). This work reinforces the importance of rehabilitation for all neurologically impaired patients to assist with facilitating beneficial plastic changes within the brain (Bach-Y-Rita, 2003; Johansson, 2000; Pomeroy & Tallis, 2002; Slade, Camberlain, & Tennant, 2002; Tolfts & Stiller, 1997).

Accurately diagnosing patients as either vegetative or minimally conscious is a difficult task (Shiel et al., 2004). It is however essential that the correct diagnosis is given as this may affect the patient’s long-term rehabilitation placement and his or her need for on-going treatment. Improvement from the initial stage of coma may be gradual and unless accurate assessment takes place, small gains may go unnoticed. When patients are slow to recover, professionals may be misled into believing that no recovery is occurring, even though slow but subtle progress is continuing over weeks or months (Shiel et al., 2000).

Even the most experienced therapist appreciates the complexity of treating brain injured patients due to the lack of a stereotypical clinical picture and the devastating consequences for the individual involved and his or her family and friends (Carr & Shepherd, 1998; Pickett-Hauber & Testant-Dufour, 2000; Slade et al., 2002). This article reviews some of the evidence and advice regarding rehabilitation interventions for vegetative and minimally conscious brain injured patients.

**NEUROLOGICAL REHABILITATION**

Many believe if there is no potential for recovery then there is no logical reason why rehabilitation should take place (Andrews, 1993). However many studies have shown that patients in the vegetative state can demonstrate varying degrees of recovery several years post-injury (Berrol, 1986; De Young & Grass, 1987; Levin, Saydjarin, & Eisenberg, 1991; Wales & Bernhardt,
2000; Watson, 2001). Tuel et al. (1992) found one third of a group of 49 brain injured patients considered dependent on admission to a rehabilitation unit (Bartel score below 60) achieved independence by discharge (Bartel score above 60). However, those who had a very low level of arousal benefited least. The role of rehabilitation for this patient group should however not only focus on improving function and communication, where possible, but also in maintaining existing ability and preventing deterioration (Andrews, 1993).

Unfortunately, direct evidence for the effectiveness of rehabilitation versus no treatment is only available from the 1960s, due to current ethical restrictions. Rusk et al. (1966, 1969) cited in Cope (1995) followed up 25 brain injured patients, who were not deemed appropriate for extensive rehabilitation, 5–15 years post-injury. They discovered five had died but of the 18 still alive there were hundreds of incidents of infections and respiratory complications. Contractures were evident in all patients even those initially without contractures.

EARLY VERSUS LATE INTERVENTION

Intensive care units should be deemed as early rehabilitation units (Gelling, 2004; Hough, 2001). Rehabilitation in this environment is aimed at improving patients motor and functional recovery while preventing or treating complications (Cope & Hall, 1982; Mazaux, De-S-Ze, Joseph, & Barat, 2001). Early rehabilitation has been associated with better outcomes in severely brain injured patients (Mackay, Bernstein, & Chapman, 1992; Oh & Seo, 2003). Patients in the vegetative and minimally conscious state are frequently denied early rehabilitation. This is either because of a belief that patients have to reach a specific level of responsiveness to benefit or because demand exceeds the beds available and patients therefore have to wait for a place on a specialist rehabilitation unit (Shiel et al., 2001).

Cope and Hall (1982) reported an analysis of 34 brain injured patients based upon prospectively gathered data, showing that brain injured patients, equally matched on severity of injury, co-morbidity and demographic measures, but varying on whether or not they had been referred “early” (before 35 days) or “late” (after 35 days) to a rehabilitation programme. They demonstrated that brain injured patients referred “early” had a greater than 50% reduction in total hospital treatment. However, caution is suggested when interpreting this since the “late” group had more medical problems and bilateral brain damage and were not matched for Glasgow Coma Scale Score or post-traumatic amnesia. Morgan, Chapman, and Tokarski (1988) also analysed the outcomes of 82 brain injured patients treated in the acute setting with either early rehabilitation (before seven days post-injury),
against those whose rehabilitation began after seven days. The patients given early rehabilitation were reported to have significantly shortened length of hospital stay and better functional outcomes.

Mackay et al. (1992) compared matched groups of severely head-injured patients who did or did not receive formal rehabilitation during their acute care. They demonstrated substantial benefits for those patients who had received formal rehabilitation during this period, with coma length and length of stay for the rehabilitated group being approximately one-third of the length of the non-rehabilitated patients. Additionally, in the rehabilitated group, 94% were discharged home compared to only 57% of the control group. However, assessors were not blinded to the intervention, which may have resulted in the possibility of researcher bias.

These studies demonstrate the need for early rehabilitation in brain injured patients. Although not specifically based on those in the vegetative and minimally conscious state they highlight the importance of early intervention.

INTENSITY OF REHABILITATION

Intensive specialist rehabilitation programmes have been shown to be effective for the patient and cost-efficient in the long term (Shiel et al., 2001; Slade et al., 2002; Zhu, Poon, Chan, & Chan, 2001). Rehabilitation units within Europe frequently provide increased levels of rehabilitation rarely obtainable within the current National Health Service (Grieve et al., 2001). This may explain why UK rehabilitation units typically have longer periods of stay when compared to Europe, although this requires further investigation (Wolfe, Tilling, Beech, & Rudd, 1999).

A number of studies have all demonstrated the efficacy of intensive therapy on patient outcomes (Hakim & Bakheit, 1998; Kwakkel et al., 1997; Shiel et al., 2001). Shiel et al. (2001) investigated the effect of increased intensity of rehabilitation on 56 patients with moderate and severe brain injuries in a two-centre prospective, controlled study with random allocation to groups. The results supported the anecdotal view that increased intervention facilitates a more rapid improvement and has the potential to lower the incidence of early behavioural disorders and physical deformities, such as contractures. This reduces the need for later rehabilitation and community teams to spend time on correcting avoidable deficits acquired in hospital. Indeed, Slade et al. (2002) conducted a randomised controlled trial that illustrated a significant reduction in length of stay when multidisciplinary therapy was increased by 67%. From these studies it is clear to see that improved intensity of rehabilitation may be beneficial in brain injured patients, although the benefit in vegetative and minimally conscious patients requires further investigation.
PHYSIOTHERAPY APPROACHES TO REHABILITATION

There is no universally accepted treatment regime for brain injured patients (Bethune, 1994). Most physiotherapists working with neurologically impaired patients would claim to be working within the influence of a named approach, such as Bobath, Movement Science (Motor relearning) or Johnstone (Partridge & Werdt, 1995). Yet scientific evidence demonstrating the value of specific rehabilitation interventions is limited and comparisons between different methods in current use have so far failed to show that one is superior to another (Johansson, 2000). Training, experience and personal belief appear to play as much of an important role in the selection of movement therapies as the literature on current motor control theories (Lettinga, Reynders, & Mulder, 2002). Ultimately it appears, regardless of the strategy employed, the more intensive the therapy the better the outcome (Slade et al., 2002; Taub & Uswatte, 2003).

Sensory stimulation

The human brain grows and adapts through utilisation and is exquisitely responsive to external stimulation and nourishment (Bach-Y-Rita, 2003; United States Department of Health and Human Services, 1998). Evidence from studies has illustrated that sensory deprivation leads to physical deterioration of the brain in animals and humans (Bragin, Vinogradova, & Stafekhina, 1992; Grossman & Hagel, 1996). Many brain injured patients with sensorimotor impairments therefore have associated motor-related disabilities (Dobkin, 2003). Consequently, one of the many interventions currently employed with severely brain injured patients is sensory stimulation (Ansell & Keenan, 1989).

Sensory stimulation is implemented to increase the level of arousal and awareness through stimulating the reticular activating system (Candeo, Grix, & Nicoletti, 2002; Tolle & Reimer, 2003). It aims to facilitate environmental inputs through all five sensory pathways at a frequency, duration and intensity far above those in the usual hospital setting (Le Winn & Dimancescu, 1978; Davis, 1991; Doman, Wilkinson, Dimancescu, & Pelligra, 1993; Lombardi et al., 2004).

Wood (1991) and Wood et al. (1992) however believe that patients exposed to an undifferentiated bombardment of sensory information lose the ability to process information due to habituation and that the type of white matter damage to most patients will inflict information processing limitations in response to stimuli. Doman et al. (1993) demonstrated miraculous results on 200 brain injured patients with a Glasgow Coma Scale Score of less than six for up to one week following injury. They showed that 91% of patients emerged from a coma through multi-sensory stimulation as
compared to none of the control group, consisting of only 33 patients. However, 56% of these remained severely impaired. Furthermore, Oh and Seo (2003) also demonstrated significant alterations in conscious levels after two weeks of sensory stimulation, composed of auditory, visual, olfactory, gustatory, tactile and physical stimulation twice a day, five days a week for four weeks. However, these results were based on only seven subjects within three months of injury where spontaneous recovery may occur.

Research has yet to clearly demonstrate the efficacy of sensory stimulation and it remains a controversial modality (Barreca et al., 2003). A Cochrane systematic review in 2004 indicated that there is still no reliable evidence to support or rule out, the effectiveness of multisensory programmes for patients in coma or vegetative state (Lombardi et al., 2004).

**Facilitating postural changes**

Little consensus exists concerning procedures that can be undertaken to improve arousal (Mazaux et al., 2001). However, it is known that a patient’s physical position can affect his or her responsiveness (Royal College of Physicians, 2003a). There is emerging observational evidence to suggest that facilitating positional changes, by standing brain injured patients on a tilt table, may also positively affect arousal and awareness (Ada, Canning, & Paratz, 1990; Richardson, 1991; Weber, 1984). A study by Elliott et al. (in press) has indicated that while standing upright, patients who were vegetative or minimally conscious showed significant improvement in arousal and/or awareness, as assessed using the Wessex Head Injury Matrix. This work suggested such interventions could have a significant impact on diagnosis, rehabilitation and outcome in vegetative and minimally conscious patients.

The importance of positional changes for these types of patients has also been shown to prevent hypovolaemia, alter resting muscle length, load vertebrae, redistribute skin pressure, benefit the respiratory system and assist in improving alertness and orientation (Hough, 2001; Morgan, Cullen, Stokes, & Swan, 2003; Wenger, 1982). Standing has been shown specifically to increase ankle range of movement and reduce lower limb spasticity in neurologically impaired patients (Bohannon, 1993; Bohannon & Larkin, 1985). It also assists in reducing osteoporosis (Cybulski & Jaegar, 1986) and improves circulation (Bromley, 1985) and renal function (Duffus & Wood, 1983). Although these studies are not specifically related to brain injured patients they do illustrate the physical benefits of standing patients who are unable to achieve this position themselves.

**Prevention and management of joint contractures**

The development of joint contractures is a common secondary problem in the severely brain injured adult (Lehmkuhl et al., 1990; Yarkony & Sahgal,
1987). Such secondary musculoskeletal changes, as a direct sequela to relative immobilisation imposed by neurological impairment, are associated with poor functional outcome (Ada & Canning, 1990; Herbert, 1988; Shumway-Cook & Wollacott, 2001). Therefore, it is critical that these complications are particularly addressed with vegetative and minimally conscious patients. The effects on muscle held in the shortened position are well documented, with a loss of sacromeres, a reduction in protein synthesis, an increase in protein breakdown, proliferation of collagen, and loss of extensibility in periartricular connective tissues (Ada & Canning, 1990; Bruton, 2002; Gossman, Sahrmann, & Rose, 1982; Herbert, 1988). Such adaptive changes to muscle held in a shortened position are more marked and take place more quickly than in their lengthened state (Ada & Canning, 1990).

Yarkony and Sahgal (1987), in a study of 75 brain injured adults admitted for in-patient rehabilitation, found a staggering 84% of patients presented with a contracture, which amplified proportionately with an increased duration of coma. Reasoning for such a high incidence in this population has been predominantly attributed to spasticity induced posturing (Booth, Doyle, & Montgomery, 1983; Singer, Singer, & Allison, 2001). However, this may also be due to injuries such as fractures or dislocations (Lehmkuhl et al., 1990), or heterotrophic ossification (Whyte & Glenn, 1986) and soft tissue shortening as a direct result of immobility and sustained posturing (Singer et al., 2001). The most common sites for development of contractures in the brain injured adult are hips, elbows, ankles, and shoulders (Yarkony & Sahgal, 1987). Equino-varus ankle contractures have been described to be the most common deformity associated with hypertonicity as they occur in both decorticate and decerebrate posturing (Booth et al., 1983; Conine, Sullivan, Mackie, & Goodman, 1990).

Physiotherapy plays a key role in the prevention and correction of contractures in these patients through a variety of techniques including manual stretching, positioning, weight-bearing activities, such as the tilt table, and splinting (Richardson, 2002; Singer et al., 2001). Pope (1992) made recommendations for the use of regular positional changes to help prevent contracture. For example, the use of the prone position in order to counteract the flexed posture adapted while sitting and in bed. Richardson (1991), in a single case study, looked at the effect of the tilt table to passively stretch tendo-achilles in a head injured patient and illustrated an improved foot position in the intervention period, thus facilitating further rehabilitation. It was concluded that the tilt table was an effective method for improving joint position in the neurological patient. Pope (1992) also suggested the use of the tilt-table in counteracting the flexed posture described earlier.

Manual stretching and passive movement of joints in order to maintain range of movement is a common method of contracture prevention (Lehmkuhl et al., 1990). However, there remains debate about how long a
muscle needs to be stretched to prevent soft tissue shortening. Tardieu, Lespargot, Tabary, and Bret (1988) studied 10 children, all of whom had cerebral palsy, and found no evidence of progressive contractures in the soleus muscle when it was stretched for at least six hours a day. To date however, there is no research in the adult acquired brain injured population on how long muscles need to be passively stretched for, to avoid muscle shortening and this requires further investigation.

The increase in muscle length observed following stretching applied to shortened muscles does appear to be a transient occurrence and is gradually lost (Herbert, 1988). The use of splinting and in particular serial casting, is documented to be effective in the management of soft tissue contractures resulting from spasticity as the stretch is applied for a significantly longer period of time (Booth et al., 1983; Mortenson & Eng, 2003). Serial casting is a technique where a series of splints are made to progressively and continuously stretch and regain range at a joint. Each cast is worn 24 hours a day and removed after a number of days, when a new cast is made. Evidence for the use of splinting is particularly documented in the management of equinovarus ankle contractures. Booth et al. (1983) reviewed charts of 201 patients and discovered 42 were found to have had serial casting as part of their management, and in 40 of these patients an increase in range of movement had been documented. Moseley (1997) also looked at the effect of casting and stretching on passive ankle dorsiflexion in nine adults who had sustained traumatic head injuries using a cross-over design study. The results showed an increase in passive dorsiflexion in the experimental group compared to the control. In this study, as with others, the severity of brain injury is not clearly documented, with subjects ranging from being “unconscious” to standing with assistance. Singer, Jegasothy, Singer, and Allison, (2003) splinted 16 brain injured patients with equinovarus deformities and also demonstrated increased range of movement with associated improvements in function. However, some of the patients’ functional abilities were not consistent with those seen in vegetative or minimally conscious patients. To date there is no paper solely looking at the effects of splinting in vegetative and minimally conscious patients.

Contracture management should be started in the acute stages following injury regardless of predicted outcome or proposed level of function (Booth et al., 1983). The need for liaison with the multidisciplinary and medical teams is imperative, especially in the acute intensive care environment (Booth et al., 1983). For patients who go on to make a good recovery, contractures can delay functional tasks such as standing, transferring or even walking (Ada & Canning, 1990). Contractures in the long-term dependent patient can hinder effective seating and hygiene needs, give rise to discomfort, and make nursing care more difficult (Edwards, 2002). However, in a study by Pohl, Mehrholz, and Ruckriem (2003) investigating
serial casting in 68 patients with severe cerebral spasticity they demonstrated no difference in improvements in range of movements between those patients splinted within 90 days of injury or those splinted after 90 days. They also illustrated no difference in those who had lower levels of consciousness (GCS below or above 12). However, this was a retrospective study, not randomised and they fail to state if patients actually gained improvement in range of movement.

It is important that physiotherapy does not work in isolation for the management of spasticity in these patients. Patients need to be on suitable doses of antispasmodics, while the use of botulinum toxin in focal hypertonicity is becoming ever more widely used in facilitating physiotherapy techniques (Sheean, 1998). Guidelines for splinting of the neurologically impaired patient have been produced by the Association of Chartered Physiotherapists with an Interest in Neurology (ACPIN, 1998).

CONCLUSION

As emergency medicine and hospital care continue to make strides to save victims of trauma, therapists need to continue to meet the challenges of the traumatic brain injury population to ensure quality of life (Mackay et al., 1992; Watson, 2001). This involves ensuring intensive rehabilitation is started as soon as possible after the initial insult, and ensuring sufficient therapists are available to facilitate therapeutic handling. The Royal College of Physicians (2003b) suggests that staffing provision in terms of numbers, experience and qualification in the management of brain injury should be appropriate to the needs of the case-load. Family and friends also play an important role in assisting with rehabilitation and in motivating the patient where possible (Gleckman & Brill, 1995).

Although research evidence to support existing clinical practice is sparse, lack of evidence of effect is not evidence of lack of effect. Withholding rehabilitation from patients before research has clarified whether all or only some of its components improve outcomes for patients might be depriving them of beneficial treatment (Edwards, 2002; Watson, 2001). Funding for research needs to be increased to ensure well-defined and controlled studies into the effectiveness of rehabilitation interventions for brain-injured patients can occur (United States Department of Health and Human Services, 1998).

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