

Rehabilitation after traumatic brain injury

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Head injury is a common disabling condition but regrettably facilities for rehabilitation are sparse. There is now increasing evidence of the efficacy of a comprehensive multidisciplinary rehabilitation team compared to natural recovery following brain injury. This chapter outlines some basic concepts of rehabilitation and emphasises the importance of valid and reliable outcome measures. The evidence of the efficacy of a rehabilitation programme is discussed in some detail. A number of specific rehabilitation problems are outlined including the management of spasticity, nutrition, pressure sores and urinary continence. The increasingly important role of assistive technology is illustrated, particularly in terms of communication aids and environmental control equipment. However, the major long-term difficulties after head injury focus around the cognitive, intellectual, behavioural and emotional problems. The complex management of these disorders is briefly addressed and the evidence of the efficacy of some techniques discussed. The importance of recognition of the vegetative state and avoidance of misdiagnosis is emphasised. Finally, the important, but often neglected, area of employment rehabilitation is covered.

Traumatic brain injury is common. Unfortunately facilities for rehabilitation of those after brain injury are few and far between. As there is now good evidence of the efficacy of multidisciplinary rehabilitation, the lack of appropriate rehabilitation facilities means that many people have less than adequate rehabilitation and thus do not meet their full potential. This will also mean there is unnecessary physical and psychological burden both upon the individual disabled person and their carers and family.

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The annual attendance rate at casualty with head injury is around 1,500–2,000 per 100,000 population *per annum*¹. However, only a quarter or so of these people are admitted to hospital. The majority of those admitted will have sustained a minor head injury, whereas around 10% will have had a moderate head injury and 5% a severe head injury. On this basis, the annual incidence of severe head injury is around 20 per 100,000 population. The prevalence of those with residual problems after head injuries is difficult to estimate with accuracy as there have

been relatively few studies on the subject. However, most people surviving head injury have a normal life expectancy and, as many are relatively young at the time of injury, it is likely there is a high prevalence of residual disability arising from brain injury. A conservative estimate is that there is at least 150 individuals with persistent disability per 100,000 population². Head injury is certainly one of the most prevalent neurological conditions and the prevalence is probably increasing. This is due to the increased rate of survival given advances in medical and surgical techniques, road side and intensive care, which are outlined in other chapters in this book. There is little doubt that in recent years more people are surviving, with consequently more severe injuries, who previously would have died. It is important that advances in acute medical and surgical management of head injury are balanced by an appropriate increase in resourcing for rehabilitation facilities.

There are significant problems following both minor and moderate head injuries but the emphasis of this chapter will be on those with the more serious consequences that follow severe injury to the head and brain.

Concepts of rehabilitation

Rehabilitation is rather different from most other medical and surgical specialities. It is a process that is based on the principles of education and one in which the disabled person and their family must be involved for it to have any meaning. This process also has to go beyond the confines of physical disease and must deal with the psychological consequences of physical disability and with the social milieu in which the disabled person has to operate. Here is another dimension which differentiates rehabilitation from most acute medicine – it is a process that cannot be carried out by physicians alone and requires active partnership with a range of other health and social service professionals. It is essentially a team process in which the doctor clearly has an important role to play but a role that is not always paramount.

Modern rehabilitation practice is based around the concepts of impairment, disability and handicap as outlined by the World Health Organization in 1980 (Table 1).

Impairment is a descriptive term and is obviously an essential part of the diagnostic process. However, rehabilitation goes beyond impairment and places such impairments within their functional context – the disability. It is, after all, the disability that matters to the individual and not the impairment. Handicap describes the social context of the disability. Obviously rehabilitation professionals need to be aware of the social context of the individual and the family but many aspects of handicap go beyond the health service and are part of the necessary

Table 1 Definition of the WHO International Classification of Impairment, Disability and Handicap – Geneva 1980

Impairment	Any loss or abnormality of psychological, physiological or anatomical structure or function
Disability	Any restriction or lack of activity resulting from an impairment to perform an activity in the manner or in the range considered normal for people of the same age, sex and culture
Handicap	A disadvantage for a given individual resulting from impairment or disability that limits or prevents the fulfilment of a role that would otherwise be normal for that individual

rehabilitation process carried out by social service professionals, employment professionals and a whole variety of other governmental and non-governmental agencies as well as the disabled person's family and friends.

Recently the WHO has redefined these concepts. The modern terminology that will be introduced in the near future still encompasses the term impairment but now replaces Disability with Activity and Handicap with Participation. This is not simply a sign of political correctness but does serve to emphasise the positive aspects of disability rather than the negative connotations.

Against this background it can be seen that rehabilitation is an active and dynamic process which assists the disabled person to acquire the necessary knowledge and skills in order to maximise their own physical, psychological and social function. Rehabilitation uses three basic approaches: (i) approaches to reduce disability; (ii) approaches designed to acquire new skills and strategies that will reduce the impact of disability; and (iii) approaches that help to alter the environment, both physical and social, so that a given disability carries as little handicap as possible.

For example, a middle aged man after a traumatic brain injury may have made a reasonably good physical recovery but is still troubled with a residual hemiparesis and associated problems with spasticity as well as difficulties with urinary frequency and occasionally incontinence.

Measures to reduce his disability could include appropriate treatment for his spasticity and medication to help control his bladder symptoms. Approaches designed to acquire new skills could include physiotherapy to improve his gait and fatigueability and the possibility of using a wheelchair for longer distances. Intermittent self-catheterisation techniques could be taught. The final approach would be to assist him to adapt his environment both at home and at work to make it easy for him to manage. There may be a need for grab rails in the toilet or adaptations to the bathroom or kitchen. Liaison with his employers might be important to make similar adaptations to his work place. There may be a need to negotiate with his employers to allow him to return to work part-time or alternatively to

allow short rest breaks during the day to minimise fatigue. The involvement of his family is also likely to be important in order to involve them more in the acceptance of his condition and necessary adjustment to their own lifestyles.

Goal setting

The basic nature of rehabilitation is to work with the disabled person and family in partnership. Professionals should impart accurate information and advice, give guidance on prognosis and natural history and work with the individual to establish realistic goals within an appropriate social context. Some disabled individuals will wish to take a major leading role in developing their own rehabilitation goals while others will wish to take a more passive role and rely on the expertise of the team. Whichever approach is adopted, realistic goal setting is the key to a good quality rehabilitation programme. In many rehabilitation units, these goals are agreed between all parties but obviously adjusted on a regular basis. The first goal should be a long distance strategic aim, for example, to return home and remain at home independently. Once a realistic long-term goal is agreed steps will need to be defined in order to achieve that goal. It is important that goals are broken down into short-term and achievable units and that such goals should be measurable. For example, if an eventual goal is independent walking, then this will require a breakdown into a number of short stages such as sitting without support, standing without support, walking with assistance, walking with aids and finally independent walking.

Outcome measurement

The implication of goal setting is that the team and disabled person should know when those goals have been achieved. Thus, valid and reliable outcome measures are vital to underpin the rehabilitation process. Regrettably few units routinely use and monitor their work by means of such measures. Crude global measures, such as the Glasgow Outcome Scale³, are obviously too crude as active rehabilitation monitors. There are a variety of scales available but most suffer from significant disadvantages. The commonest used scales in the UK are the Barthel⁴ or Modified Barthel and the Functional Independence Measure (FIM) (sometimes with the addition of the Functional Assessment Measurement, FAM)⁵. The former is a valid and reliable scale but is very physically orientated and suffers from detrimental floor and ceiling effects. It is really only of use in the immediate post-acute rehabilitation.

The FIM is a broader measure of disability that takes longer to administer and is also rather physically orientated. The addition of the FAM adds a broader psychological dimension. However, it is not yet fully validated within the context of head injury. A number of other global scales have been developed including the Northwick Park Dependency Scale⁶ and the Newcastle Independence Assessment Form⁷ which attempt to measure a broader impact of disability and can also be used in the longer term. However, many such scales are rather too long and complex for use in a busy clinical setting. In addition, such global scales may not measure short-term gains. It may be more appropriate to use a variety of different outcome measurements at different stages during recovery. For example, if a goal is improvement of hand function this can be adequately monitored by use of the Nine Hole Peg Test⁸, whereas improvement in walking could be measured by the simple expediency of a timed 10 m walking test. There is no space in this chapter to describe and discuss all possible scales available and the reader is referred to an excellent reference text on this subject⁹. However, it is important to emphasise that the use of valid and reliable outcome measures is vital in order to monitor goals, assess progress and adjust the rehabilitation programme. Collation of statistics may also be important in the future if the performance of individual rehabilitation units are to be compared across the country.

Setting of rehabilitation

Rehabilitation should start as early as possible. It is not uncommon for individuals to be eventually transferred to a rehabilitation unit with avoidable complications already present. Regrettably, muscle contractures, pressure sores and unnecessary aggressive behaviour are not unusual. If the rehabilitation team can be involved in the early stage, even on the intensive care unit, then it is more likely that such complications can be avoided. As soon as the individual is medically and surgically stable, transfer should be considered to the local rehabilitation unit – if there is one available. The recovery curve is steepest in the first 3 months or so after injury and it is important to capitalise as much as possible on this phase of rapid improvement. Most brain injury units will admit individuals a week or so after injury and have an average length of stay of about 3–4 months for those with severe brain injuries. However, longer term rehabilitation is important if short-term gains are not to be lost. Outpatient or day centre rehabilitation should continue at least until physical recovery has plateaued. Recovery of cognitive and intellectual problems can take longer than the physical problems and it is often such psychological difficulties that cause the most handicap and the most

distress to the family. Carers' distress is known to increase and not decrease with time. Thus, long-term support, or at least the ability to contact the head injury team, should be maintained for some time after discharge and probably at least for 2 years. Thus, the community team or at least an outreach service or outpatient service from an hospital orientated rehabilitation unit is an important aspect of a comprehensive rehabilitation service. Community teams would clearly need to establish links with social service colleagues as well as other relevant professionals such as employment rehabilitation experts. Many disabled people find benefit from links with the head injury charity, Headway (4 King Edward Court, King Edward Street, Nottingham NG1 1EW, UK: tel +44 (0)115 924 0800). There are a number of examples of good practice around the UK but unfortunately such good practice is rarely published. One example is the Northumberland Head Injury Team based in the rural town of Morpeth in Northumberland. This team has developed close links with the regional rehabilitation service in Newcastle upon Tyne which in turn has links with the regional neurosurgical unit. Most post-acute rehabilitation is conducted in the hospital setting or at the regional rehabilitation centre and then individuals are discharged back to the community. At this point, the community team becomes involved and is able to deliver ongoing physical and psychological rehabilitation through a multidisciplinary team, based in a cottage hospital, as well as being able to deliver services within the home. The team itself is associated with Headway which shares the same premises. Long-term contact is maintained with all head-injured people within the county. The team is able to access both health and social service budgets which is of real benefit when designing home based care packages and respite breaks.

Evidence of efficacy

The previous section has described the basic concepts and process of rehabilitation. It is essentially a multidisciplinary and educational process. However, is there evidence that this holistic approach actually produces any real benefit over and above standard care and/or natural recovery?

There are many problems to be overcome when addressing the efficacy of head injury rehabilitation. The 'gold standard' of a randomised and blind study is almost impossible to achieve as there are very few people who have not received some form of rehabilitation after acute injury. Rehabilitation is obviously a multi-faceted and multi-professional process without clear cut definitions. Rehabilitation after head injury is a long-term process with many impairments taking 2 years or more to make full recovery. Thus, ideally studies should be long-term with good

follow-up data. There are also significant problems in judging outcome. Most would agree that overall quality of life compared to pre-injury lifestyle would be the best measure of rehabilitation efficacy. However, no satisfactory quality of life scale exists nor may be achievable. Many studies revert to the less satisfactory, but at least measurable, outcomes such as return to work or the residential setting. If one is looking for a high standard of 'proof' with the same level of certainty as, for example, stroke rehabilitation, then that level of evidence does not exist within the field of traumatic brain injury. There are a large number of outcome studies but the great majority fail to address such vital issues as pre-injury function, nature of rehabilitation, severity of injury nor make any attempt to match with a control group. There are no studies that span the continuum of rehabilitation from intensive care to final community re-integration. However, amongst the difficult and confusing literature there are some studies worthy of consideration which begin to provide good evidence of the value of head injury rehabilitation.

Post acute rehabilitation

McKay and colleagues¹⁰ compared matched groups of severe head injury people who did or did not receive formal rehabilitation during their acute trauma centre admission. All people in the rehabilitation group received physical, occupational or speech therapy whereas in the non-rehabilitation group only a very small minority did so. In the rehabilitation group, therapy was also initiated quickly whereas in the other group therapy started about 3 weeks after the acute episode. Overall coma length, rehabilitation stay and cognitive functioning showed a significant benefit in the rehabilitation group. A higher proportion of that group (94%) were discharged home compared to only 57% of the control group.

An interesting study by Blackerby¹¹ demonstrated an increase in intensity of rehabilitation for 5–8 h/day produced a reduction in the average length of stay. An important study by Cope and Hall¹² compared 34 head injured people who had either been referred 'early' or 'late' to a comprehensive inpatient rehabilitation programme. The early group had significant reduction in occupied hospital bed days both in the acute phase and the rehabilitation phase. Both groups reached equivalent levels of functional recovery at discharge and social stages at 2 years post-injury. Aronow¹³ produced one of the very few case controlled studies – matching patients from an inpatient head injury programme with similar patients in neuro-trauma programme who received no formal rehabilitation. On the outcome scale used (not widely published in terms of validity and reliability), the rehabilitation group had a significantly better outcome than the non-rehabilitation group.

Interestingly, this was one of the few studies that undertook an economic analysis. It demonstrated that the better outcome of the rehabilitation group resulted in an average cost saving of \$11,949 per annum for those with up to one month post-traumatic amnesia.

More recently Semlyen *et al*¹⁴ produced one of the very few long-term follow-up studies using a quasi experimental design to compare treatment effects between two groups. The first group received a co-ordinated multidisciplinary rehabilitation programme in a regional rehabilitation centre whilst the other group had single discipline rehabilitation provided in local hospitals. All people had been admitted via the same neurosurgical centre. Fifty six individuals with severe head injury were included in the study. On a number of outcome measures it was found that the group who received the co-ordinated multidisciplinary rehabilitation demonstrated significant functional gains throughout the study period but also maintained treatment effect after rehabilitation input had ended. Furthermore, care givers in this group had significantly reduced levels of distress, as measured by the General Health Questionnaire¹⁵. This study might demonstrate that the skills learnt in rehabilitation are generalisable back into the home setting such that further gains can be made. Hopefully, it is also an indication that full involvement of the carer in the rehabilitation programme eventually produces improved levels of distress as they are better able to cope with the variety and complexity of the problems that the head injured person demonstrates. Obviously this study needs replication before firm conclusions can be drawn.

Another method for assessing the efficacy of rehabilitation is to study intervention at a time when natural recovery has stopped. In one such study, Tuel *et al*¹⁶, reviewed the records of 49 severely head injured people all admitted to an inpatient rehabilitation facility more than 12 months after injury: 53% of these individuals showed improvement in terms of the re-admission compared to discharge Barthel scores. Similar results were found in a group admitted to a comprehensive rehabilitation programme more than one year after injury in a study by Cope and colleagues in 1991¹⁷.

Unfortunately, few studies have addressed the importance of routine follow-up. However, Wade and colleagues¹⁸ have recently published the results of a randomised controlled trial to determine whether a routine follow-up appointment after head injury of any severity affects outcome 6 months later. A large scale patient population (1,156) were randomised to one of two groups. One group was offered additional information, advice, support and further intervention as needed, whilst the other group received standard care. The early intervention by a specialist head injury service significantly reduced social morbidity and severity of post-concussion symptoms at 6 months.

It is clear that much work still needs to be done in this field. However, the few good quality studies do now lend strong support to the view that a comprehensive head injury rehabilitation programme does produce worthwhile benefit over and above standard care and spontaneous recovery.

Specific rehabilitation problems

It is not possible in this brief chapter to cover the whole field of physical and psychological disability following traumatic brain injury and to discuss the various treatment modalities. However, this section will address some specific and important areas worthy of individual consideration.

Severe physical disability

It is somewhat surprising after severe head injury that there are relatively few people who have very severe physical disability in the long-term. The longer term problems of traumatic brain injury will tend to be the cognitive, intellectual, behavioural and emotional difficulties rather than the physical problems. This has been confirmed by a number of studies^{19,20}. However, in the short-term, and sometimes long-term, major difficulties can arise in a few key areas. Spasticity can be particularly troublesome after traumatic brain injury and, if not treated aggressively, can often lead to muscle contracture and a functionally useless limb. Passive stretching in the acute phase is important as may be the use of orthoses or even serial splinting and casts in order to prevent such contracture. Whilst there are a number of modern oral anti-spastic agents (*e.g.* Baclofen, Dantrium and Tizanidine) troublesome spasticity tends to be focal and thus better treated by a local modality. Botulinum toxin has recently been introduced as a potent muscle relaxant and a number of studies have now demonstrated efficacy in the management of spasticity^{21,22}. Fortunately, the effects will wear off after 2–3 months and thus not impair long-term recovery as used to be the case with other focal techniques such as phenol and alcohol nerve blocks.

Heterotopic ossification is fortunately unusual but, nevertheless, a troublesome and irritating complication which remains rather difficult to treat effectively. The onset is usually 1–4 months after injury and signs will include a decreased range of movement, leg swelling and even fever as well as pain. Pharmacological prevention is usually unsuccessful and management often will need to rely on a range of movement exercises and progressive stretching with the use of serial splinting²³.

Nutrition is a particular problem. The reasons are two-fold – an increased catabolic rate immediately after brain trauma compounded by the common occurrence of swallowing difficulties. If maintenance of good nutritional status is difficult, preferably a judgement made only after adequate dietary advice, then nasogastric feeding can be used in the very short-term. However, if adequate nutrition cannot be maintained within a few days then a fine bore percutaneous endoscopic gastrostomy (PEG) tube should be inserted. This is a relatively simple and straightforward procedure with few complications²⁴. If nutrition is not maintained, this can have serious consequences for wound healing and an increased risk of pressure sores.

Pressure sores themselves remain unfortunately rather common and are nearly always avoidable. Rigid adherence to regular turning regimens, as well as the use of appropriate pressure relieving mattresses, and to appropriate lifting and handling techniques should avoid the occurrence of pressure sores. However, risks can be increased by poor nutrition as well as by other factors such as urinary or faecal incontinence. Regrettably, once sores are present they can be extremely time consuming to heal and often require surgical intervention to excise the ulcer, bony prominence or affected bone and resurface the defect by skin grafting or other techniques such as myocutaneous flap²⁵.

Urinary continence can also be troublesome after head injury. Whilst in the short-term indwelling catheterisation can be used, in the long-term this is a most undesirable solution. Appropriate assessment regarding the exact nature of the underlying detrusor and/or sphincter problem combined with appropriate pharmacology can often relieve the situation. However, if there remains impairment of bladder emptying then the technique of clean intermittent self-catheterisation can be invaluable – either performed by the patient or sometimes by an appropriate carer²⁶.

Communication problems can be troublesome after brain injury. Thus, an assessment by a speech therapist is important and various speech and language interventions can obviously be of benefit, particularly for dysarthria and dysphagia. However, those with very severe disablement are often unable to communicate orally and need to revert to an appropriate communication aid. These can vary from simple pointing boards to more complex pre-programmed artificial voice communicators. There are a number of Communication Aid Centres around the UK who have particular expertise in this field.

Communication aids are but one form of assistive technology which is increasingly important in reducing disability and handicap in those with severe physical problems. Environmental control equipment provides a means of controlling simple electrical equipment around the house such as the ability to turn the television, lights and other equipment on and



Fig 1 Modern environmental control equipment illustrates the increasing use of assistive technology to assist severely disabled people.

off and the ability to answer the telephone, open the door and adjust the bed. Such independence can be very important to an individual who is otherwise totally dependent on a third party. The application of relatively simple technology can sometimes make a dramatic difference to level of independence. For example, there are a number of devices which enable a severely disabled person to drive a motor vehicle. These can vary from simple hand controls to more complex joystick steering with voice controlled accessory equipment (Figs 1 & 2).

Overall, those with severe physical disabilities need the support and expertise of a regional rehabilitation centre which in turn will have access to the necessary wide range of multidisciplinary expertise, facilities and equipment.

Cognitive and intellectual problems

There are a whole variety of important cognitive impairments that can follow a head injury²⁷. The commonest are those associated with attention deficits, problems with concentration, memory, perception, information processing speed and problem solving. Natural recovery of neuropsychological difficulties can take place over a prolonged period of time and certainly up to 2 years post-injury. Obviously this is a complex



Fig 2 A variety of both simple and complex adaptations are now possible to enable an individual with severe physical disabilities to safely control a motor vehicle

and specialist area and detailed assessment of the extent of the impairment and consequent disability needs to be made by a clinical neuropsychologist. It is somewhat controversial whether neuropsychological intervention can actually promote recovery but there is little doubt that coping strategies can be designed which effectively reduce disability. There are very few randomised trials in this field and indeed such trials are probably inappropriate when one is dealing with so many variables. The use of well designed single case studies is a methodology which is probably best pursued in this area. Most work has been conducted in the field of memory disorders²⁸. Rehabilitation can be divided into those techniques involving internal strategies and those dependent on external resources. Internal strategies, for example, can involve the use of various mnemonic techniques such as the use of imagery, methods to organise information in particular sequences (*e.g.* the PQRST technique) as well as other techniques that involve the use of acronyms, rhymes and systematic queuing. An alternative or even co-existent strategy is to devise interventions to reduce the handicapping effects of amnesic problems. Some may appear simple and obvious such as planned use of a personal organiser with electronic alarm systems, colour codes around the house or a rigid use of lists, memos and diaries. However, there is no doubt that such techniques, whilst not influencing

memory impairment, can certainly reduce the effects of such impairment and have positive benefit in terms of disability and handicap²⁹. Similar approaches have been taken to the remediation of problem solving deficits, attention deficits and perceptual problems³⁰.

Behaviour and emotional problems

Many people with head injury develop behavioural problems in the short-term, particularly whilst emerging from coma or the phase of post-traumatic amnesia. However, a few individuals develop persistent and severe behavioural problems and can be a source of extreme disruption on the acute or rehabilitation ward and certainly a source of major difficulty for the family. However, the pioneering work of Eames and colleagues³¹ showed the application of behavioural management techniques can be effective in ameliorating difficult behaviour and also improve independent living function as well as compliance with physical therapy even years after injury. Behavioural management techniques are complex and there is a danger in a chapter of this nature of being too simplistic. However, the obvious strategy in such circumstances is to increase desirable behaviour often by the use of positive reinforcement and to decrease undesirable behaviour often by the use of negative reinforcement. The latter may include 'time-out', such as withdrawal of praise for a defined period of time following inappropriate behaviour. Another form of negative reinforcement is 'response cost' in which, within a token economy, tokens are withdrawn for inappropriate behaviour as well as being given for appropriate behaviour. In the past there have been other more controversial punishment techniques but most centres now find such techniques to be unnecessary. Staff at a rehabilitation unit should have a degree of expertise in the management of behavioural problems but, nevertheless, those with severe and persistent difficulties should be referred to appropriate psychiatric or specialist behavioural units. Regrettably such units are rare in the UK. The use of drug therapy in the management of such behaviours is best avoided. Certainly the use of sedative anxiolytic or psychotropic medication is generally unhelpful and indeed may worsen behaviour. Occasionally such intervention is essential because of the proximity of vulnerable people or because of extreme pressure on staff time and resources. There is very little good quality literature on this subject but some studies have indicated an improvement in aggression and episodic dyscontrol by the use of serotonergic anti-depressant Trazodone³² or by the use of the anti-convulsant Carbamazepine³³. Other authors advocate the use of lithium or beta-blockade with Metoprolol³⁴. If severe agitation does require treatment, then some would advocate the use of Buspirone which is chemically distinct from other anxiolytics. For

negative behaviours some improvement is occasionally noticed following the use of dopamine agonists. A few authors continue to use stimulants such as Dexamethetamine or methyl phenidate but such medication should be used with caution and only by those with some experience in the field. Other behavioural problems can be less troublesome but, nevertheless, give rise to marital stress, social isolation and often unemployment. Such problems can include egocentricity, poor judgement, lack of initiation, reduced drive, lethargy, disinterest, lack of depth of feeling, irritability, aggressiveness, reduced tact and increase or decrease in sexual interest. Alongside these problems, both in the patient and the carer, can be associated disorders of mood, particularly depressive illness and anxiety.³⁵ It is important for the multidisciplinary team or primary care team to recognise such problems and treat appropriately. There is no evidence that, for example, depressive illness responds less well in the context of acquired brain injury than in the context of endogenous depression. Thus, standard approaches, either psychological or pharmacological, should be used as aggressively as needed. Even if some of these problems are not remediable they should be recognised and explained to the family and colleagues. The immediate family will often benefit from counselling and supportive psychotherapy.

Coma and vegetative state

Fortunately there are very few individuals who remain in prolonged coma or prolonged vegetative state following brain injury. One study³⁶ found that 0.6% of all brain injured individuals admitted to a neurosurgical unit remained in prolonged coma (of more than 2 weeks' duration). Care certainly needs to be taken in the early diagnosis of coma and/or vegetative state as later recovery has clearly been documented. Andrews³⁷ has recently found a very high incidence of misdiagnosis in the so called persistent vegetative state. In view of the level of misdiagnosis referral to a specialist centre is desirable. In any case, quality of life should be maximised and unnecessary complications avoided, particularly contractures, pressure sores and malnutrition. Prolonged reassessment is necessary in order to ensure that some form of cognitive recovery is not taking place. There are regrettably a number of case studies illustrating cognitive recovery when attendants, staff and relatives believe the individual was still in a vegetative state.

Return to work

It is regrettable that many rehabilitation facilities feel that their job is complete after the patient has been discharged back home and perhaps

followed up for a few months. Obviously the best long-term outcome, in those of working age, is to return to the pre-accident employment situation. In the UK there is scant attention to employment rehabilitation. Such rehabilitation rarely takes place at all or if so is the responsibility of a completely separate government department which is likely to be lacking in the necessary expertise for the management of those with brain injury problems. Obviously if an individual can return to work this is a boost to self-esteem and independence, particularly from the financial viewpoint. Such re-employment is obviously of overall benefit to the State in terms of a reduced benefits and may even enable the carer to return to employment as well. In the US, a number of studies have shown the efficacy of an employment support scheme. In such schemes, a trained rehabilitationist accompanies the individual back to work and further rehabilitation will take place in the workplace allowing an opportunity for specific goal orientated re-entry as well as an opportunity for education of employer and work colleagues. The work, for example, by Wehman and colleagues³⁸ has clearly demonstrated the effectiveness of supported employment programmes. Forty one head injured people were included in the initial study who had a pre-injury employment rate of 91% but a post-injury employment rate of only 36%. This figure improved in 71% of follow-up after supported intervention. This group was a mean period of 7 years from injury and thus the chances of spontaneous recovery were obviously minimal. The improved integration of employment professionals with health and social service professionals must be a priority in the future.

Conclusions

This chapter has outlined the broad concepts of rehabilitation for people with traumatic brain injury. There is now ample evidence of the efficacy both of the overall holistic multidisciplinary approach as well as the efficacy of individual physical and psychological techniques. Obviously much more work needs to be done for the confirmation of the efficacy of individual techniques so best practice guide-lines can be developed. However, there is still the fundamental problem of inadequate rehabilitation resources for the increasing numbers of people who survive severe brain injury.

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