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PERSONAL PRACTICE

# Rehabilitation of head injured children

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Most children who suffer a head injury in Britain receive excellent emergency care, but the availability and quality of rehabilitation are far from satisfactory. This paper describes our experiences in a Children's Brain Injury Rehabilitation Unit, which caters primarily, though not exclusively, for patients with traumatic head injury.

## Epidemiology of head injury in childhood

Between the ages of 1 and 14 years accidents constitute the greatest single cause of death and head injuries account for 40% of these, amounting to 403 in the United Kingdom in 1985.[1] Only about one quarter of children who received a fatal head injury were travelling in motor vehicles; in most accidents the child was a pedestrian or cyclist (PM Sharples, A Aynsley-Green, JA Eyre, paper presented at Annual Meeting of British Paediatric Association, York 1989). Less common causes included falls from high buildings or playground equipment, and child abuse.

There were 40 370 admissions of children with head injury in 1985,[2] but there are no reliable data on the severity of the injuries, although the majority are presumably mild. Severe persisting disability as a result of head injury in childhood is uncommon,[3] and services might best be planned on a supradistrict or regional basis; however, children with moderate injuries should be offered rehabilitation locally.

The severity of head injury is usually measured by depth and duration of coma[4] or of post traumatic amnesia*. Outcome is divided into five categories: death, persistent vegetative state, severe disability (conscious but disabled), moderate disability (disabled but independent), and good recovery.

Coma lasting less than 20 minutes is considered mild; up to six hours, moderate; six to 48 hours, severe; and over 48 hours, very severe. There is some correlation between length of coma and outcome with respect to IQ, while a post traumatic amnesia of greater than 24 hours also correlates with a worse outcome.[5] Prediction of outcome category with respect to disability is accurate in only 70% of cases by the end of the first week after injury.

## Mechanisms of injury and recovery

The most potent cause of serious traumatic brain injury is the acceleration-deceleration force,[6 7] which leads to shearing stresses between different layers of brain tissue and instantaneous pressure changes within brain cells, causing devastating damage yet often leaving little or no external sign of injury. These forces also cause contusion of the brain and rupture of blood vessels and other structures such as pituitary stalk and olfactory nerves. Many parents find it hard to understand how their child can have sustained such severe injury without any fracture or external sign. An explanation, although distressing, may help them to come to terms with what has happened.

Penetrating injuries occur when the child is struck by or falls on an object. Consciousness is usually retained and the focal nature of the brain injury is reflected in the neurological signs. Crushing injuries may damage both skull and facial skeleton as well as causing brain injury, but the neurological sequelae may be surprisingly mild. Missile injuries cause both focal and generalised damage by a combination of these mechanisms.

Immediate coma after head injury is usually due to primary damage to neural pathways. Deterioration after injury may be due to brain swelling or to intracranial bleeding.[8] Diffuse cerebral swelling occurs in around 40% of severely injured children and is probably related to changes in cerebral haemodynamics. Intracranial haematomata may also occur, both in the extradural and subdural sites, though they are less common than in adults.

## Mild injuries

The pathophysiology of the 'mild' injuries associated with concussion was until recently regarded as a reversible and purely functional disturbance affecting primarily the reticular activating system. Animal studies suggest that there are in fact structural changes in the vascular endothelium and in neuronal membranes, and permanent axonal damage. Abnormalities in magnetic resonance imaging scans after apparently minor head injury support this view.[9] Thus the post concussional syndrome can no longer be considered to be purely functional but is a reflection of physical brain injury.

## Recovery

The exact mechanism of recovery is not fully understood.[10] The new connections between neurones that are established are often misconnections and may not be advantageous to recovery of function. The brain of the young child may have a greater degree of plasticity than that of older children or adults, although there are limits to this plasticity. Any advantage this may

*A period of variable length after closed head trauma during which the patient is confused, disoriented, suffers from retrograde amnesia, and seems to lack the capacity to store and retrieve new information.

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confer to the younger child is offset by the fact that brain injury frequently impairs the capacity for new learning much more than the retention of previous information. The young child is therefore at a serious disadvantage because he has had less time in which to build up a fund of experience and knowledge before his injury.

## Family aspects

The responses of parents to the discovery that their child is handicapped can be regarded as a bereavement reaction to the loss of their perfect child and his replacement by one who is damaged or imperfect.[11 12] The unique awfulness of acquired brain injury is the loss of the person, and his replacement by someone who is different, a shadow of the former self, but with the same physical appearance. The parents of a child who dies can live with their memories but parents who have a head injured child have a daily reminder of the child they lost.

Parents must be part of the assessment and treatment process from the start. Their hopes and expectations need to be defined and discussed so that the professionals and the parents are both working for the same goals. Staff must be prepared for the anger, sadness, disappointment, and unrealistic aspirations that invariably surface. The dilemma for the rehabilitation team is that parents want their children to be managed by professionals who are enthusiastic and committed. Yet at the same time it is important to maintain some degree of objectivity; it would be unprofessional to adopt the hard sell approach of some 'brain-retraining' programmes.

## The purpose of rehabilitation

The overall aim of rehabilitation is best defined as the re-establishment of the maximum physical, intellectual, and emotional independence and dignity that is possible for that person in their particular environment. The disabled person is all too easily turned into the passive recipient of care and is not permitted to make decisions for himself. In planning a rehabilitation programme we describe the deficits of each child precisely and produce hypotheses about their mechanisms and origins, establish criteria by which progress could be recognised; organise general programme goals and specify intervention procedures that might help to achieve them, and where necessary design novel methods and test them against patient progress.[13]

Rehabilitation is expensive, whether it is provided by the NHS or by a charitable trust as in our unit, and we often have difficulty in choosing the optimum time to admit a child for intensive rehabilitation. Admission soon after the injury enables a rehabilitation team to capitalise on the natural recovery process and provides opportunities for parent counselling and for early liaison with the education authority. Six to 12 months later, parents may increasingly be faced with the possibility of permanent problems. The prognosis for independence and mobility is becoming clearer by this time and it is therefore easier to negotiate realistic goals with the parents. A period of rehabilitation has sometimes proved very beneficial even several years after the injury, at a stage when parents despair of any further progress.[14]

## Assessment

The aims of rehabilitation cannot be achieved by individual professionals working in isolation; an interdisciplinary approach is essential both for initial assessment and for the planning of a management programme.

### NEUROLOGICAL EVALUATION

The child's medical history is first reviewed with particular reference to the nature of the injury, the Glasgow coma scores in the first few weeks, the duration of coma and post traumatic amnesia, the computed tomography, electroencephalography and operative findings, and any associated injuries and procedures, in particular long bone fractures and tracheostomy that will have an important bearing on the rehabilitation programme.

A detailed neurological examination is undertaken. The nature and severity of any movement disorder is recorded. There may be spasticity or rigidity, usually asymmetric, and sometimes with a superimposed coarse tremor, attributed to a lesion in the cerebellum-olive-red nucleus pathways. There is often a pronounced poverty of movement and a slowness in initiating movement, but the dystonic or athetoid patterns of movement disorder often seen in cerebral palsy are less prominent in the head injured child. Baclofen sometimes helps to reduce spasticity, but we have been disappointed with drug treatment of tremor.[15]

In the most severely injured children, sleep-wake cycles return after a few weeks or months, but the appearance of wakefulness is accompanied by little or no evidence that there is any conscious awareness. Even this so called persistent vegetative state[16] is not necessarily permanent and may change over the next few months.

The problems attributable to the brain injury may be complicated by peripheral nerve injuries, fractures, and contractures. There is a high risk of tendo Achilles contracture, fixed flexion deformities at knees and hips, and scoliosis. Contracture can develop with alarming speed in the acute phase of the injury if physiotherapy has not been commenced sufficiently early.

Subluxation of the hip sometimes develops rapidly after acquired brain injury, and as it is often difficult to decide whether and when to undertake surgery in these circumstances, alcohol injection to temporarily inactivate muscle endplates may be employed as a diagnostic measure.[17] For all these reasons it is desirable to review these children with the treatment team in a combined orthopaedic and paediatric clinic.

A vision assessment is routine, because many head injured children have eye problems—for example, squints, which may give rise to diplogia, ptosis, more complex disturbances of gaze and tracking, and cortical visual deficits.

Epilepsy may occur at any time after head injury. The overall risk of epilepsy in head injury patients in hospital is said to be 5%, but

this risk is greater if there are seizures within the first week after injury, intracranial bleeding, diffuse brain injury, or a familial predisposition to epilepsy.[18] The seizure type is often difficult to classify; there may be a focal onset, but many seizures appear to be generalised. 'Absence' or minor attacks are more likely to be complex partial seizures than classic petit mal. The diagnosis of epilepsy can be difficult and if results of standard electroencephalography do not help, ambulatory recordings or telemetry with video recordings are desirable, though still extremely difficult to obtain in the United Kingdom.

Phenytoin seems to be the anticonvulsant most often recommended by neurosurgical units, but often the dose prescribed is insufficient to produce therapeutic concentrations. Because of the need to monitor this drug closely we prefer to use carbamazepine or valproate. The accepted principles of anticonvulsant treatment are particularly relevant to the head injured child.

## PSYCHOLOGICAL AND FUNCTIONAL ASSESSMENT

Cognitive problems are among the most important sequelae of head injury. They may affect learning, emotional state and behaviour, and often persist even after physical disabilities have resolved.[19]

Assessment is difficult and time consuming, particularly in children with attention deficits and in those with severe communication problems. Furthermore, in the early months after injury the situation is changing rapidly and repeated re-evaluation is needed. It is important to obtain information from the parents and the school about the child's previous abilities and attainments.

A wide variety of cognitive and emotional problems are found in children who have suffered head injury.[20] An apparent reduction in global intelligence may conceal a variety of more specific problems. It is important when testing to make appropriate allowances for any motor impairment that may put the child at a disadvantage in timed test items. Some items may be impossible if the child has severe motor disorder and alternative tests or subtests may have to be used.

In addition to motor slowness, reduced speed of information processing is often found, while visuoperceptual difficulties may further complicate the picture. Particular deficits are often found in recent memory and these are reflected in the child's difficulty in acquiring new knowledge and skills.

Observations made by nursing and care staff as well as the rehabilitation team provide information about the child's quality of attention and concentration, flexibility in the face of new situations, the strategies he uses to deal with problems, his awareness of his difficulties, his response to stress, and so on. A complete psychological assessment also includes, when appropriate, estimation of the child's current attainments in reading and arithmetic as a basis for restarting a formal educational programme. Teaching head injured children is difficult and there are a number of theoretical perspectives. Cognitive remediation incorporates some practical ways of achieving progress in this area.[21]

Emotional problems are common, notably lability of mood, outbursts of anger, disinhibition, and lack of motivation.[22] The child may need constant reminders to carry out tasks that are within his physical capability and memory—for example, going to the toilet. Behaviour modification techniques are used extensively, both for elimination of undesirable behaviours and for reinforcement of constructive activities and skills.

Many children retain or recover some degree of insight even after severe injury, and experience depression and a deep sense of loss. This involves not only their physical and intellectual capabilities but also their friends and peer group; loneliness is a common problem among our patients. Creating opportunities for establishing new friendships and continuing old ones is an important part of rehabilitation.

## MOBILITY AND INDEPENDENCE

The child's potential for mobility and self help is assessed and a programme is planned for each child, including aids and appliances if these would assist in gaining independence. Many children with severe injury can use a powered wheel chair, though it may be necessary to adapt the control system if upper limb function is severely impaired. Specialised items of equipment to assist in feeding, bathing, or dressing may be needed.

Swimming and horse riding are very popular activities with most children; they reduce spasticity and rigidity and enhance balance and trunk control. Stretching and passive movements help to preserve range of movement and are particularly important in a condition where gradual improvement is anticipated over many months or years.

## COMMUNICATION

Difficulties in speech production are often associated with pseudobulbar palsy and severe bilateral limb spasticity, and it is sometimes impossible to distinguish between dysphasia, dyspraxia, or dysarthria.[23] There may be problems with chewing, swallowing, and dribbling.

Assessment of comprehension is particularly difficult when the child cannot respond verbally and it is important to establish a communication system as soon as the child's cognitive abilities allow this. Even children who on admission were regarded as being in a persistent vegetative state have eventually shown evidence of a wish to communicate. Small movements, eye glances or blinks, or even changes in expression may provide the clue that the child is regaining some awareness and the ability to comprehend speech. The hearing should be checked; traumatic injury to both auditory nerves is unusual, as is disruption of the ossicular chain, but it is essential to rule out these possibilities.

We have used a variety of methods to establish alternative or augmented communication, including Bliss symbols and charts, pointers, and electronic speech synthesisers.[24] The latter have been extremely successful for several of our anarthric patients; it is unfortunate that

there is no budgetary provision in most districts for such items and they are purchased only after prolonged negotiations or with charitable funds.

NUTRITIONAL STATE

The nutritional state is often poor, because of the difficulty of feeding a child with neurological dysphagia. Disturbances of taste and smell may also contribute but these are usually difficult or impossible to assess. The distress associated with feeding and drinking, and the fear of choking can make mealtimes a harrowing time for all concerned and it may be necessary to resort to tube feeding for a time, preferably under the guidance of a dietician. Some children may actually prefer tube feeding.

Clinical assessment can be supplemented by videofluoroscopy, which shows the severity of the swallowing dysfunction and the extent to which swallowed food or liquids are likely to enter the lungs—with the risks of respiratory infections and exacerbation of asthma.[25] Gastro-oesophageal reflux and retrosternal pain may also require investigation and treatment.

## Educational needs

As the procedure required by the Education Act takes many months, it is advisable to liaise with the education authority at an early stage. A rehabilitation unit provides a suitable educational environment in which considered and rational decisions can be made.

The choice of school often presents great difficulties. For children with apparently mild injuries, impairment of concentration and emotional disturbances often lead to poor progress that is out of character with their previous abilities. The teaching staff, faced with an apparently normal looking child, may show little sympathy. Liaison with local educational and treatment staff after the child has been discharged is an essential function of a rehabilitation unit.

For severely injured children, the education authority may advise placement in a school for children with severe learning difficulties—a solution that may be quite inappropriate, as these children often retain enough insight to realise what has happened to them and to find such a placement extremely distressing.

## Legal advice

The true costs of lifelong disability are immense both for the victim and for his family. The parents should obtain legal advice from a solicitor with expertise in this field, and as soon as possible, as investigation into the cause of the accident is more likely to be rewarding while evidence is still easily accessible. Even if the police decide not to prosecute, it may still be possible to establish a legitimate claim.[26]

## Conclusions

Head injury is a devastating event in the life of a child and family. Our experience suggests that an interdisciplinary approach, with clearly defined goals and constant review of the programme, has real benefits, not only in improving function and independence but also in assisting the family to function more effectively and to come to terms with their loss.

No-one who cares for these irreparably damaged children can ignore the need to prevent such tragedies in the first place. Legislation regarding restraint of young children in cars,[3] and the fitting of window locks in high rise flats,[27] are potentially useful measures. The separation of children from motor traffic by all possible means, however, is the only effective way to prevent most of these tragedies as the victims are usually pedestrians or cyclists rather than passengers.


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