

Acquired brain injury

Judith A Middleton

Children can acquire a brain injury at any time from conception onwards, and age is an important variable in determining cause and outcome.

Prenatal and birth damage

Prenatally, very early damage may lead to death of the embryo, damage later may lead to lack of development (e.g. anencephaly or agenesis of the corpus callosum) or abnormal development (e.g. microcephaly or lissencephaly). Trauma (e.g. from an injury to the mother or fetal stroke *in utero*) during a period of rapid development will lead to greater structural problems than when development is slower or has come to an end. Injury at birth can arise from complicated forceps delivery or hypoxia.

Postnatal Injury

After birth, children can acquire a brain injury from:

- trauma (e.g. head injury [including non-accidental injury], anoxia or stroke)
- metabolic disturbances (e.g. phenylketonuria)
- systemic illness (e.g. diabetes, sickle cell disease)
- central nervous system tumours
- infections (e.g. meningitis or encephalitis)
- toxins (e.g. use of alcohol or anticonvulsants during pregnancy)
- treatment (e.g. radiotherapy or chemotherapy for leukaemia; or CNS surgery).

Age and development

Age and development at injury and functional reorganization

Age and development at injury are also critical variables in determining functional outcome. The relationship between the degree of vulnerability to injury and the stage of brain development before birth continues post-natally. Controversy over the plasticity of the infant brain to recover from early brain injury pivots on whether there is focal injury or additional diffuse damage.

Judith A Middleton is Consultant Clinical Neuropsychologist at the Radcliffe Infirmary, Oxford, UK. She did a PhD in child development at the Institute of Education, University of London, and an MSc in clinical psychology at the University of Surrey, UK. Her special interests are in children with neurological problems, including acquired brain injury, and children with craniofacial disfigurement.

- Children with focal injury may recover relatively well; for example, acquiring speech after damage to the left hemisphere (e.g. following early stroke or surgery) with the assumption that the right hemisphere has taken over language function. However, there is some evidence that cognitive sequelae of childhood stroke (prenatal to 13 years) do not differ according to the side of lesion, suggesting the brain's ability to reorganize, although there is some global decrease in functioning.¹
- With diffuse damage, such as occurs after a closed head injury or CNS infection, younger children are at greater risk than older children of having more global and long-lasting effects.² Wherever there is a risk of CNS damage, such as the onset of diabetes or failure to maintain dietary control in PKU, etc., the younger the child the greater the degree of possible functional problems.^{3,4}

Age at presentation

The manifestation of problems will depend on children's age at presentation as well as their age at injury. Presenting problems change over the years. Knowledge of infant and child development and the expected emergence of functional skills at any age is crucial in judging whether failure or delay in the development of skills can be linked to the index event. Children should, therefore, be followed up for a number of years, as some skills and deficits will not be expected to emerge until later childhood or adolescence. This is particularly true of executive functioning, as it can be some years before difficulties directly related to the structural consequences of the injury will become apparent functionally. Early damage to the frontal lobes can lead to later aberrant development of other parts of the brain.

Injury and outcome

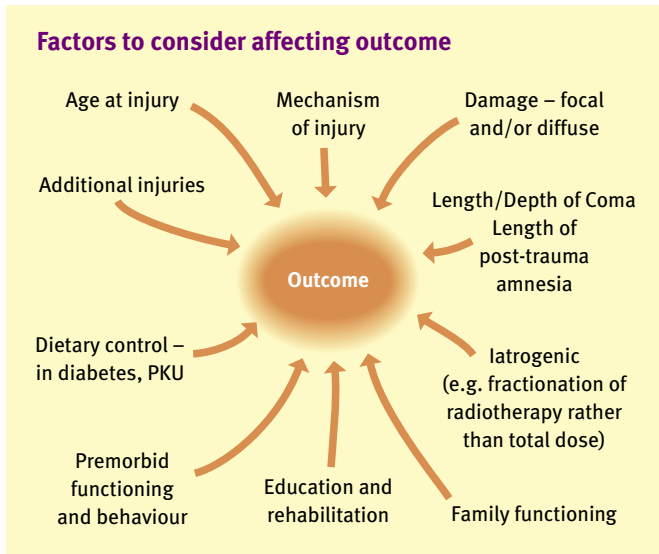
Problems following acquired brain injury may arise in a number of ways:

- directly from the damaged brain (see above)
- indirectly from the reaction to the injury and its sequelae (i.e. from early management of the child with a head injury or illness by professionals and parents; and the child's own reaction to their impairment and subsequent disability)
- due to an exacerbation of existing problems (i.e. where there has been a history of learning and/or behaviour problems prior to injury)
- owing to changed expectations (parents and teachers believing children will underachieve and setting lower goals, or denying problems and not accommodating at all)
- family variables such as pre-injury family functioning and coping, and psychiatric history within the family,⁵ as well as levels of social deprivation.⁶

The injury

A number of factors relating to the mechanism of injury contribute to predicting outcome (Figure 1). In terms of traumatic head injury:

- length and depth of coma (poorer outcome for children in coma for longer than 20–30 minutes, with a depth of coma of 12 or less on the Glasgow Coma Scale)
 - post-traumatic amnesia (for more than 1 week).
- There is usually a dose–response relationship between the



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severity of the injury (or the dose of radiotherapy for CNS tumours) and the functional loss. However, some children who have suffered severe damage do better than predicted, and others with relatively mild injuries may develop problems. Parent and professional disagreements may arise. It is important, even when injuries have been mild, not to dismiss concerns expressed by parents and teachers. Either directly or indirectly, there has been a change in the child, whatever the cause.

Pre-existing problems

While acquired brain injury through stroke, disease or iatrogenic causes may occur in any child, there is some evidence that children suffering head injury are a self-selecting group.⁷ For example, poor attention, impulsivity and overactivity are related to poor road-crossing skills. These may interact with other pre-morbid variables, which are indicators of poor outcome after injury (Figure 2). However, even if there are pre-morbid problems, difficulties post injury should not be assumed as unrelated to the index event. Pre-existing learning difficulties may mean a child is at greater risk, so problems are exacerbated. Crucially, it is the reported change in behaviour or learning trajectory that is important to assess.

Sequelae

Physical sequelae

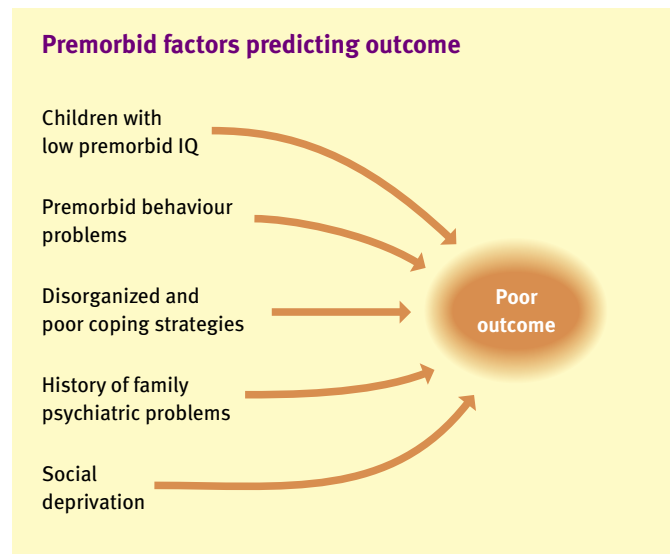
Physical impairments from acquired brain injury, apart from obvious gross motor difficulties, may have considerable impact on educational and psychosocial functioning. Epilepsy, tremor, weakness, sensory loss and increased fatigue, subtle visual problems and field defects as well as hearing loss may occur.⁸ These all have repercussions on children’s learning, social relationships and self-image.

Cognitive sequelae may be the subtlest yet most pervasive problems, giving rise to concerns about educational progress. Children may have difficulties in a range of information-processing skills. A thorough assessment should include the following:

- Speed of processing – slowness in information processing and thinking speed, and in responding to tasks demands can occur. The impact of this may be most noticeable only in fast-moving environments where there is a lot of background noise, such as the classroom.
- Attention and concentration – high levels of distractibility and poor concentration are common and have significant long-term effects on education.
- Language and communication – problems may not be obvious in one-to-one conversation, but verbal fluency, word-finding, inference and abstraction can be affected. Difficulties become more apparent in complex social situations and as verbal task demands increase.
- Visuo-perceptual and spatial skills are often affected but may initially be less obvious. Children may have difficulty in writing, drawing, constructional skills and work presentation, as well as in sports and understanding social distance.
- Memory and learning are frequently affected. Generally, information learnt prior to injury may be reasonably well preserved, but major problems occur in learning new information and integrating this into the existing knowledge base. Consequently, difficulties may go unnoticed for a year or two and then emerge slowly, often when the index event appears distant and unrelated to current problems.
- Executive skills. These include the ability to plan, set goals, organize, initiate and execute a plan to reach a desired goal. This will also include skills in evaluation and monitoring performance.

Children may have all these problems or any combination of them. The manifestation of these functional difficulties will depend, not only on the nature of the injury, but also the age of the child at presentation.

Educational sequelae: most recovery in terms of neuropsychological outcome usually occurs in the first year, but educational difficulties persist and may increase.⁹ It is not uncommon to find (after inquiry) concerns being expressed about lack of progress in reading, spelling, writing and mathematics in younger children,



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and about failure to grasp abstract thinking and conceptualization in older children.

Emotional and behavioural sequelae

Behavioural and emotional problems may indicate unrecognized cognitive sequelae and lowered self-image related to an awareness of functional and physical difficulties, and this should be explored.

- Disinhibition can be of great concern to parents, who find their child or adolescent presenting with socially inappropriate behaviour, such as making rude comments in public about strangers, or sexualized behaviour. This behaviour can become acutely embarrassing and distressing for the family and may, in extremes, put the child at risk.
- Impulsiveness is often seen both in terms of approach to schoolwork, and in general behaviour. Children may need greater supervision in the classroom to plan before attempting tasks, and parents may have to be highly vigilant in order to ensure their child is safe.
- Increased irritability, anger and outbursts of temper are not uncommon, at least in the early stages of recovery, and may continue for a long time. Oppositional defiant disorder may be related both to the severity of injury or pre-existing problems.⁹
- Fatigue and inertia may be part of the early natural recovery process, but can continue for long afterwards. This is characterized as lack of energy and interest in everything, struggling to maintain attention and to work at speed, passively carrying out suggestions, but not initiating activity. It is easily confused with similar behaviour arising from depression.
- Anxiety – children may be more anxious than in the past, this is often related to their understanding that they are not as proficient in many tasks as they were before, and feel they can cope less well in daily life. In school, the expectation that they will soon be able to catch up can produce considerable distress.
- Depression – whatever the cause of acquired brain injury, children may be aware of real or perceived losses (e.g. in levels of intellectual functioning, independence, academic status, career aspirations, status in the family, and loss of friendships). A combination of the cognitive and physical impairments can depress children’s sense of worth not only in terms of their individual achievements, but also through the fact that they might not be chosen for teams or are not allowed to join in playground activities. Even minor physical scarring can be stigmatizing and have a major impact on self-image.
- Fear – for children who have had treatment for life-threatening illnesses, fear of the future can be very real, and may be at the root of anxiety and depression. It may be difficult for them to express their feelings if they believe their family are also very distressed, and their silence may be a way of protecting their parents.
- Grief – children who have been victims in accidents where other members of their family or friends were killed, may have strong feelings of grief and possibly survivor guilt.
- Post-traumatic stress disorder (PTSD) – even without having a continuous memory of events following a head injury, it is still possible to have PTSD.

The cumulative effect of injuries

It is very rare for children to suffer all the problems described above, and it is clear that the type, extent and intensity of

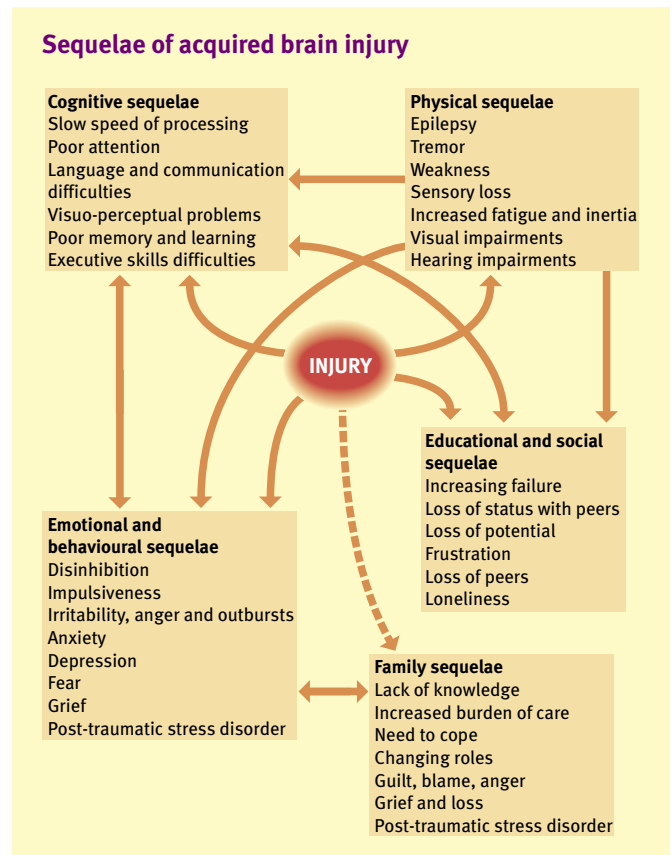
difficulties will vary depending on child, family, injury and treatment variables. Problems are frequently complex with even relatively mild cognitive and physical sequelae leading to extreme behavioural and emotional difficulties, which may be exacerbated by premorbid characteristics, family coping strategies and lack of understanding in education.

Older children may develop different problems, or new problems may emerge (i.e. difficulties in executive functioning), which may initially seem unrelated to the acquired brain injury. Transitional points such as moving up a year, changing schools, leaving school and entering adult life can suddenly highlight subtle problems. Adults unwittingly adapt their behaviour to a child’s strengths and weaknesses, and it may not be until this quiet support is removed that the functional implications of the injury become truly apparent. Fast-moving, complex environments where it is not always possible to predict and prepare in advance can be particularly difficult to cope with.

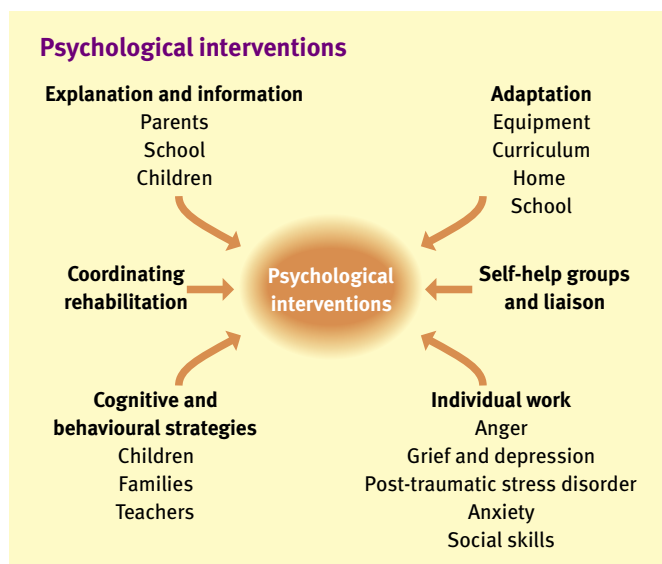
Family sequelae

Acquired brain injury never just affects the child and there are frequently profound repercussions throughout the immediate and often extended family (Figure 3). Issues to be considered include the following.

- Lack of knowledge about the full implications of the injury. Predicting the future is difficult, but parents welcome clear and honest information. Even if this is understood, how to steer a course through professional networks to get the appropriate support, therapy and education is complex and may be an unknown territory.



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- Burden of care – looking after either a physically disabled child and/or one needing constant supervision because of poor attention, memory and impulsive behaviour can be exhausting. Levels of stress tend to increase as the time since head injury increases and the full implications of the acquired brain injury become apparent. Support for the family from professionals may well decrease in inverse proportion to long-term need.
- Coping strategies – there is a relationship between child outcome, pre-injury and post-injury family functioning.^{10,11}
- Changing family roles – one or both parents may need to give up work, and siblings may need to take on supervisory or carer roles, affecting financial and social functioning.
- Guilt, blame and anger relating to the accident, late diagnosis and/or lack of long-term suitable provision of resources may occur and may be focused at professionals.
- Grief and loss may arise either for the pre-injury child who is so different from the post-injury child; or for projected loss from potentially life-threatening illness.
- PTSD – if parents or siblings have witnessed the accident, they may have intrusive flashbacks, nightmares and avoidant behaviour, leading to depression and anxiety.

Interventions

Thorough assessment and careful formulation in itself can be a useful intervention in delineating subtle cognitive problems and acknowledging emotional responses to the acquired brain injury. There are a number of psychological interventions that can help children, families and, separately, individual family members, teachers and schools (Figure 4), which will depend on the aetiology of the problem, functional sequelae and local resources. ♦

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