Ministry of Defence

Synopsis of Causation

Head Injury

Author: Mr Douglas Gentleman, Centre for Brain Injury Rehabilitation, Royal Victoria Hospital, Dundee
Validator: Mr Neil Kitchen, National Hospital for Neurology and Neurosurgery, London

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Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

1.1. Head injury is the result of mechanical force being applied to the head. By convention, the term refers only to injury of the brain or its coverings (scalp and skull) and excludes injury to the face, jaws, or mouth.

1.2. Injury to the scalp alone is unlikely to be followed by major or long-term problems. Injury to the skull is often accompanied by underlying brain injury. Most of the clinical interest in head injury is of course in relation to the brain, and the term traumatic brain injury is in growing clinical use. Throughout this synopsis the term "head injury" will be used to cover injuries of all severity.

1.3. Injury to the brain is conventionally classified as primary (immediate) or secondary (delayed). It is now recognised that this is an over-simplification, but the concept is still helpful for clarifying clinical priorities. Primary injury is the result of energy transfer to the brain at the moment of injury, and its severity reflects the amount of energy transferred. Secondary injury is due to complications, such as intracranial bleeding or brain swelling, and can be made worse by systemic complications of trauma such as a blocked airway, inadequate breathing, or major blood loss causing shock.

1.4. There are no effective treatments for primary brain injury, and the main strategy is accident prevention (speed limits, seat belts, helmets, etc). However, secondary brain injury can be prevented or limited by good early care (e.g. vigorous resuscitation, early surgery for intracranial haematomas, intensive care units), training, and organisation of trauma services. This approach can lead to significant reductions in both mortality and long-term disability.[1]

1.5. The vast bulk of head trauma in civilian practice in the UK is blunt (closed head injury). In military practice, or conditions of civil unrest, penetrating head injury forms a significant proportion of the total workload. Blunt and penetrating injuries have different patterns of early and late complications. For example, penetrating injury carries a much greater risk of intracranial infection during the early days and weeks, and a greater risk of post-traumatic epilepsy, in the longer term.

1.6. Head injury is increasingly common in all countries. In developed countries, trauma is now the leading cause of death up to age 40, and the third most common overall, after cancer and vascular disease. Half of all trauma deaths are primarily due to a head injury. There is also a huge burden of long-term morbidity in survivors, much of it relatively invisible to the untrained eye.[2]

1.7. Every year in the UK, 1,000,000 people attend accident departments after a head injury, 100,000 are admitted to hospital for observation or treatment, and 10,000 are transferred to neurosurgery units, some immediately after initial assessment and resuscitation, others only after they have deteriorated from complications while being observed in hospital.[3]

1.8. Naturally, there has been great interest in defining clinical criteria to select patients for hospital admission, brain imaging, and referral to neurosurgery in order to minimise the risks of delayed deterioration and secondary brain damage. Clinical guidelines have been produced in Scotland,[4] England,[5] and several other countries to improve triage and early care after head injury.

2. Aetiology

2.1. Most head injuries result from one of four broad mechanisms: road traffic accidents, assaults, falls (from any height), and accidents during work or sport.

2.2. Service personnel are at particularly high risk of sustaining a head injury during operations or training, e.g. combat injuries, vehicle crashes, and accidents while climbing, abseiling, parachuting, or playing sport.

2.3. The causes of long-term disability after head injury are considered below.

3. Classification of head injury severity and implications for assessing long-term disability

3.1. For clinical and administrative reasons, it is important to have practical ways to classify head injuries by their severity. The most widely used early indices of severity are conscious level disturbance, post-traumatic amnesia, and structural damage (as seen on a CT or MRI brain scan). Each of these methods can help to predict early and late outcome after head injury, and the information they provide is additive.

3.2. **Conscious level assessment.** Conscious level is a global index of brain function. The Glasgow Coma Scale (GCS) is used throughout the world to monitor conscious level, in terms of three easily-measured variables: the eye opening response, the best motor response in the upper limbs, and the verbal response.[6] When the GCS was introduced in the 1970s, words alone were used to describe the levels of response, but soon they were also given numerical values.[7] The maximum GCS score is 15/15 (eyes open spontaneously, obeys commands, and orientated) and the minimum is 3/15 (no eye opening response, no motor response, and no verbal response to stimulation).

3.2.1. Patients with a GCS score of 3-8 are by definition in coma, not eye opening, not obeying commands, and not speaking, and they are classified as having a severe head injury. Those with a score of 9-12 have had a moderate head injury. Those with a score of 13-15 have had a "mild" head injury, but there is growing evidence that this term is a misnomer, with a significant minority of this group developing similar long-term problems to those with a moderate or severe injury and also requiring rehabilitation and support.[8,9]

3.2.2. Attempts have been made over the years to improve the sensitivity of the GCS at its upper end by adding additional clinical criteria to distinguish those who have had a brain injury (and are, therefore, at risk of long-term problems) from those who have not. The most widely used of these criteria is post-traumatic amnesia (memory loss).

3.3. **Post-traumatic amnesia.** Post-traumatic amnesia (PTA) is the time that elapses between injury and the recovery of continuous memory function, and can only be estimated in retrospect. Measuring it is especially useful for assessing patients who now seem physically well and have a normal conscious level as measured by the GCS score. The PTA assessment helps to identify those whose mild head injury includes an element of brain injury, and who as a result have an increased risk of early complications and/or long-term problems. Without this, the significance of problems that emerge later can be underestimated or even overlooked.

3.4. **Severity of injury and the risk of early and late complications**. As might be expected, the initial severity of a head injury has a bearing on the early and late outcome. Both early death and long-term disability are related to the depth and duration of altered consciousness.

3.4.1. Patients with a severe injury in terms of their GCS score, have a high mortality (30-40% in most series). Typically, they have suffered a

high-velocity vehicle accident, a fall from a height, or an assault causing major blunt or penetrating trauma. They may be in a coma for days or months, and about 20% of them undergo intracranial surgery to remove haematoma, disrupted brain tissue, or missile fragments. Many survivors are left with physical, cognitive, emotional, behavioural, and psychosocial problems that impede independent living and the ability to work and to pursue relationships. Their average age is less than 30, and in many cases their life expectancy has been little altered by the head injury, so these survivors can face years or even decades of living with disability.

3.4.2. Moderate and mild head injuries carry a much lower early mortality. They are due to a wide variety of causes: road accidents, falls, assaults, and injuries that occur at work, during sport, or in the home. A few of them are followed by early complications (e.g. an intracranial haematoma) that cause clinical deterioration and convert the head injury into a severe one. However, on the whole the disturbance of brain structure and function is less than after severe head injury, and so the individual usually makes a quicker and more complete physical recovery. However, this can bring its own risks. These patients often have disabling cognitive and emotional problems, which in the absence of physical symptoms are often slow to be recognised for what they are – the consequence of organic damage to the brain as a result of the head injury.

3.4.3. Using the duration of PTA, as well as the GCS score, to assess severity of injury can be particularly useful in this group**.** A PTA of under an hour predicts a low risk that there will be long-term neuropsychological problems. At the other end of the spectrum, a PTA of more than a week predicts a high risk of these.[10,11]

4. Clinical Issues

4.1. **Life expectancy.** Around one-third of people who reach hospital alive after a severe head injury die during the next few weeks, either from overwhelming primary brain damage sustained at the time of injury or from intracranial or systemic complications. Those who survive that early period but are left immobile and with a high level of physical dependency have been estimated to have a mean life expectancy of some 15 years.[12] Those who recover mobility, and at least some independence after a severe head injury, and virtually all those who have had a moderate or mild head injury, have conventionally been said to have a life expectancy broadly similar to what it would have been without the injury. However, recent research has suggested that there is a small but measurable decrease in life expectancy of around three years following even a mild head injury. This finding is thought to be due to consequences such as post-traumatic epilepsy, substance abuse, risk-taking behaviour, and suicide.[13] However, as the peak age incidence of head injury is 30 years, this still implies a residual life expectancy of around 40 years for many people living with the effects of a head injury.

4.1.1. The nature of the patient population clearly has an influence on normal life expectancy. For example, recent work from one UK city which has multiple indices of social deprivation have shown that even those who suffered a mild head injury had a one-year mortality of almost 10%.[14] Clearly, this cannot be explained by the head injury itself, and may instead be due to high rates of alcoholism, drug abuse, and HIV infection in some parts of this population.

4.2. **Post-concussion syndrome**. In the months after a mild or moderate head injury, it is common to see a group of symptoms that collectively constitute a "post-concussion syndrome", with few, if any, signs on physical examination. Typically, the person describes some of the following: dull headache, dizziness, hearing loss, tinnitus, unsteady gait, clumsiness of the hands, low physical and mental stamina, forgetfulness, poor concentration, loss of focus and drive, irritability, intolerance of noise, and emotional lability or blunting (this list is not exhaustive).[15] The person may exhibit denial or limited insight into how these problems affect their life. They are unfit for work or duty, cannot pursue leisure interests, and struggle with ordinary day-to-day tasks. Irritability and a perceived personality change often lead to marital difficulties, loss of friendships, and social isolation. They lack full understanding of what has happened to them, as sometimes do those around them. This often causes a loss of self-confidence and self-esteem, and can trigger a secondary mood disorder that makes the problems appear to be getting worse. Sometimes this prompts a fruitless search for a progressive physical condition, and the failure to find one merely adds to the sense of bewilderment and hopelessness.

4.2.1. It is common for the post-concussion syndrome to be misdiagnosed or underestimated, even by experienced professionals, such as a GP or an examining medical officer. This can sow the seeds of doubt about whether the patient's symptoms are related to the head injury at all, and sometimes leads to alternative and unflattering explanations, such as laziness or compensation neurosis. Not surprisingly, this can anger or demoralise the individual, to whom the symptoms are only too real, even if poorly understood.

4.2.2. One of the best treatments for post-concussion syndrome is to provide accurate information about head injury and its consequences, presented in a clear and sympathetic way. The author's experience is that many people with this syndrome genuinely believe that their condition is unusual or even unique, or that it is somehow their fault that they feel as they do. Their relief (and that of their family) when they get proper information and reassurance is often palpable. In fact, the post-concussion syndrome itself rarely lasts for more than a year, although some of the individual features can persist for much longer and even become permanent.

4.3. **Long-term disability in head injury survivors.** The initial severity of a head injury, as reflected in the depth and duration of altered consciousness and the duration of PTA, predicts the likelihood of long-term consequences. As might be expected, the more severe the initial injury, the more likely it is that there will be long-term problems. Almost always, these problems are a complex mix – physical function, communication, cognition, emotion, and behaviour. No two people have exactly the same mix, nor, of course, identical personalities or life experiences. An individual approach is, therefore, needed for assessment and treatment of these problems, as is access to a broad range of clinical expertise, usually through a multi-disciplinary (multi-professional) rehabilitation team.

4.4. **Physical problems.** Nearly all patients with a mild or moderate head injury and many of those with a severe injury make a good physical recovery, but some functions (e.g. stamina, high level balance, hand co-ordination) may be impaired for weeks or months. Some patients with severe head injury have long-term physical disability due to problems of muscle power and tone, co-ordination, hearing, visual field, speech, facial movements, swallowing, or sphincter control. Coincidental injuries of the limbs, trunk, spine, or face can also have significant long-term physical effects.

4.4.1. Some head injuries carry a high risk of post-traumatic epilepsy and a lifelong need for anticonvulsant medication. Studies of civilians and of veterans from World War II, Korea, and Vietnam have established that the risk is highest with penetrating brain wounds (including compound depressed skull fractures), after intracranial surgery for haematoma, and when there has been a fit (seizure) within one week of injury.[16,17] Anticonvulsant drugs are of no prophylactic value, but once fits have started to occur they are important for reducing their frequency. Repeated fits carry the risks of further brain damage and accidental death, and can interfere with the ability to pursue a normal life. An appropriate specialist (neurosurgeon, neurologist) should be involved in making the initial diagnosis of post-traumatic epilepsy, and a neurologist should be asked to assess patients who do not respond to standard, anticonvulsant drug treatment. A few patients eventually require a neurosurgical procedure, such as partial removal of a lobe of the brain, for control of intractable fits.

4.4.2. Blindness in one eye can occur from injury to the eye itself, or fractures of adjacent parts of the skull or face that damage the optic nerve. Visual field loss after head injury is commonly a homonymous hemianopia or quadrantanopia, in which the ability to see to either the right or left side (hemianopia) or in one quadrant of the visual field

(e.g. upper left) is lost. The usual cause is a haematoma in the parietal or temporal lobe of the brain that disrupts the visual pathways. Very high intracranial pressure, from brain swelling or a haematoma, can cause infarction of the occipital lobe and cortical blindness, in which virtually all vision is lost to one or other side, or even to both sides. Expert ophthalmological assessment is essential.

4.4.3. Conductive hearing loss is caused by blood in the middle ear (usually on one side only), and usually improves over a few months. Sensorineural hearing loss is caused by direct trauma to the cochlear nerve at the time of injury, and does not improve with time. If the hearing loss is only partial, various devices can be used to promote hearing and suppress tinnitus (ringing or buzzing in the ears, often more troublesome than the hearing loss itself). Impaired hearing can be accompanied by intermittent giddiness from damage to the nearby vestibular nerve, and this too can be quite disabling. Expert assessment by an ENT surgeon or audiological physician is essential.

4.4.4. Pituitary gland insufficiency is increasingly being recognised as a long-term effect of severe head injury. It can cause diabetes insipidus, fatigue, stunted growth in children, and impaired libido and fertility. Its onset can be insidious, and a high index of suspicion and the results of endocrine tests are needed to make the diagnosis.

4.5. **Non-physical problems.** Cognitive impairments are very common after head injury. They are also very easy to overlook or underestimate, especially if initial hospital contact has been brief or if there are few or no physical problems.

4.5.1. Cognitive functions include memory and learning, the understanding and use of language, visuo-perceptual function, sustained and divided attention, and "executive" function – the ability to plan, organise, execute, monitor, and terminate tasks. Individual impairments of these reflect injury to particular areas or pathways in the brain, e.g. the frontal lobes in the case of executive impairment. These problems can make it very difficult for someone to run a household, manage their affairs, sustain relationships, hold down a job, continue a course of study, or pursue sporting and leisure interests. The effects on day-to-day life can be far-reaching, and can chronically disable the individual and have a corrosive effect on personal and family life.[18,19]

4.5.2. Common emotional and behavioural problems after a head injury include tearfulness, pathological anxiety, low mood, irritability, loss of social skills, and apparent apathy.[20-22] These problems often worsen the disabling effects of cognitive impairments. A small number of people with head injury exhibit major challenging behaviour (e.g. physical aggression or sexual disinhibition) that can be incompatible with living in a family setting and that often leads to contact with the criminal justice system. This can be extremely difficult to treat outside a specialist behavioural unit, and can also cause major difficulties for those trying to support them in the community.

5. Treating the long-term effects

5.1. Depending on the severity of the head injury and its effects, appropriate treatment after the acute phase can range from general advice, reassurance, and monitoring by a local primary care team, all the way through to an intensive and lengthy goal-centred multi-professional rehabilitation programme in a specialist hospital unit. Such intervention may then be followed by long-term support over many years from family members, professional carers, and a variety of statutory and voluntary agencies. There is now a wealth of evidence supporting the clinical effectiveness and cost-effectiveness of rehabilitation after head injury.[23-27]

5.2. Unfortunately, most UK health and social care practitioners get very limited training in the long-term effects of head injury, and the provision of specialist facilities is patchy around the country. NHS and local authority services are often complemented by parts of the private and voluntary sectors, which tend to specialise in particular areas like the management of challenging behaviour, vocational rehabilitation, or carer support. Compared with other advanced countries, the UK has a poor record of investing in services for people with the long-term effects of head injury, and there are many gaps and inequities in the system. One gap that is being recognised increasingly is the lack of rehabilitation services for the "walking wounded", i.e. the people who have sustained a mild or moderate brain injury with a good physical recovery but continuing cognitive and emotional problems for which they receive little help.[28]

5.3. Paradoxically, this makes it very important when assessing long-term disability after a head injury to check how much rehabilitation the individual has had. Focused rehabilitation interventions can significantly reduce disability, even several years after the head injury.

5.4. Armed forces personnel in the UK are fortunate in having access to a well-established central head injury rehabilitation facility, with organised follow-up and support arrangements. A severe head injury can end a service career, and (depending on the individual's age, rank, and role) even a lesser injury can also have adverse career consequences.

5.5. In the next 5-10 years, it is quite possible that new treatments such as neuroprotective drugs, gene therapy, stem cell transplants, and innovative computer applications to rehabilitation problems may become available to limit and even reverse brain damage and to reduce long-term disability.

5.6. In most developed countries, brain injury rehabilitation services are better resourced than in the UK. There is growing recognition of the need to expand capacity in this country, and this is likely to involve forming new local and regional service networks that link the NHS, local authorities, and the independent and voluntary sectors in planning and service delivery. This may improve the prognosis of people with a brain injury, and may make it easier for an assessing officer to identify useful sources of information about the claimant's function and disability.

6. Assessing the late effects

6.1. Usually, a head injury is an unambiguous event, and there will be records of it. It is likely to involve a visit to a civilian or military medical facility and/or admission to hospital, and clinical records will have been kept. In general, the more serious the head injury the clearer is the trail likely to be that allows an assessment of whether the stated disability is likely to be due to it.

6.2. After a head injury, neurological and neuropsychological impairments tend to improve gradually over 6-24 months (depending on their severity) before reaching a plateau that may be permanent. The extent to which residual impairments disable the individual varies with personal circumstances. To take a very simple example, someone who has recovered well physically but is still forgetful and poor at planning could perhaps return to an unskilled labouring job but not to a professional or managerial career. Thus the same degree of impairment disables the latter person much more. Much of rehabilitation is focused on seeking ways to minimise the disabling long-term effects of neurological and neuropsychological impairments. This requires a holistic and creative approach to the individual's problems and to how they can be circumvented or overcome. Many professionals and agencies often have to be involved over an extended period, and this, of course, means that there may be quite a number of people with something useful to say about a head injured person's problems and progress when assessing a claim.

6.3. There is significant overlap between the clinical features of head injury and those of some psychiatric conditions. Many people with mental illness also have poor stamina and impaired memory and concentration, lead chaotic lifestyles, and find it hard to sustain relationships and keep jobs. Head injury and mood disorder often occur together, and their effects also interact with personality and with other health problems such as abuse of alcohol or other drugs.

6.3.1. It can then become quite a challenge to tease out the individual strands. What is due to the head injury? What is due to other problems, such as substance abuse or mood disorder, and has the head injury influenced these? Is it possible that some symptoms are being exaggerated or fabricated for gain? How clear is the causal relationship between the clinical features and the head injury?

6.3.2. Sometimes, answers to these questions are straightforward but sometimes they are not, and there should always be a low threshold for seeking specialist advice from a neurologist, neurosurgeon, clinical neuropsychologist, rehabilitation physician, psychiatrist, or therapist. Each has particular skills to contribute to the assessment of someone who has had a head injury and who claims to be disabled as a result.

7. Summary

7.1. Severe head injury can threaten life, and even an apparently mild one can be followed by early and late problems that are often devastating in their effects on health and wellbeing. Lack of awareness by the individual, their family and friends, and even some professionals about possible long-term consequences of head injury can add to the chronic disability, as can secondary factors such as mood disorder. Life expectancy is usually reduced only a little, and a large number of people with a head injury have to live with its consequences for many years.

7.2. The ideal approach includes recognition, information, rehabilitation, and a holistic approach to problem solving. Even late rehabilitation has much to offer in reducing disability. Specialist assessments are vital when considering the possible relationship between a particular head injury and a particular pattern of disability, and also for advice on the scope for further improvement.

8. Related Synopses

Spinal Cord Injury

Blast Injury to the Thorax and Abdomen

9. Glossary

clinical neuropsychologist	A practitioner in a specialist field within clinical psychology, who has particular skills and experience in the assessment and treatment of brain injury or disease by means of psychological techniques.
cognitive function	The intellectual functions of the brain, e.g. memory, learning, attention, executive function. Sometimes described as the "thinking skills" as opposed to the emotions.
computed tomographic (CT) scan	A radiological technique giving cross-sectional images of the brain (or other organs) that can show certain type of damage such as haematoma and brain contusion. A powerful tool since the 1970s in assessing and treating people with head injury.
disability	Limitation of function during normal life (including personal care, domestic skills, relationships, work, education, leisure, etc) as the result of disease or injury.
executive function	The ability to plan, organise, initiate, monitor, and terminate a wide variety of tasks. A function of the frontal lobes of the brain that is often affected by head injury.
Glasgow Coma Scale (GCS)	A system in widespread use for measuring conscious level, based on the eye opening response, the best motor response in the upper limbs, and the verbal response. Valuable in assessing injury severity and prognosis in the early stages after a head injury.
GCS score	A numerical score that is derived from the Glasgow Coma Scale, ranging from 15 (best) to 3 (worst), that is used to determine the severity of a head injury and to predict early outcome and the risk of long-term complications.
head injury	The result of mechanical force to the scalp, skull, or brain.
homonymous hemianopia	Loss of the visual field to either the right or the left side, due to interruption of the visual pathway by injury, disease, or surgery.
impairment	Abnormality of a specific neurological or neuropsychological function due to injury or disease.

infarction	Death of tissue as the result of interruption of its blood supply for whatever reason.
intracranial haematoma	A blood clot within the cranial cavity, lying on or inside the brain, which can cause a rise in intracranial pressure and set off a chain reaction of events that can have adverse or fatal consequences.
magnetic resonance (MR) scan	A radiological technique that uses a powerful magnetic field instead of x-rays to produce cross-sectional images of the brain (or other organs) in a variety of planes. Much more sensitive to brain damage than a CT scan but with a number of practical limitations in the early assessment of head injury.
post-concussion syndrome	A constellation of physical and psychological symptoms that follows traumatic injury to the brain and can cause disability for a period of weeks or months.
primary brain injury	Immediate damage to brain cells and their connections as the result of a head injury. Preventing the head injury in the first place is the only effective treatment.
quadrantanopia	A corresponding loss of one-quarter of the field of vision in each eye as the result of brain injury or disease, for example an upper left quadrantanopia.
secondary brain damage	Delayed damage to brain cells and their connections as the result of intracranial or systemic complications that occur after a head injury. Prompt and appropriate care can prevent or limit this damage
systemic	Affecting the body as a whole. In relation to a head injury, refers to complications that are remote from the head but can have a profound influence on the clinical course, such as shock following blood loss from major trunk or limb injuries.
tinnitus	A buzzing or ringing noise in the ears that can interfere with hearing and can greatly distress or alarm the patient. Often but not always caused by a head injury.
traumatic brain injury	Trauma to the head that causes observable alteration of brain function or structural brain damage (gross or microscopic). Increasingly used as a synonym for any head injury that is serious enough to involve the brain.

vocational rehabilitation	Rehabilitation that aims to prepare and support the individual during a return to work to either a previous or a new job.

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